Piccolo

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Piccolo is a modern, async query builder and ORM for Python, with lots of batteries included.

CHAPTER

ONE

GETTING STARTED

1.1 What is Piccolo?

Piccolo is a fast, easy to learn ORM and query builder.

Some of it's stand out features are:

- Support for *sync and async*.
- A builtin *playground*, which makes learning a breeze.
- Fully type annotated, with great *tab completion support* - it works great with iPython and VSCode.
- Batteries included - a *User model and authentication*, *migrations*, an *admin*, and more.
- Templates for creating your own *ASGI web app*.

1.1.1 History

Piccolo was created while working at a design agency, where almost all projects being undertaken were API driven (often with high traffic), and required web sockets. The author was naturally interested in the possibilities of `asyncio`. Piccolo is built from the ground up with asyncio in mind. Likewise, Piccolo makes extensive use of `type annotations`, another innovation in Python around the time Piccolo was started.

A really important thing when working at a design agency is having a **great admin interface**. A huge amount of effort has gone into Piccolo Admin to make something you'd be proud to give to a client.

A lot of batteries are included because Piccolo is a pragmatic framework focused on delivering quality, functional apps to customers. This is why we have templating tools like `piccolo asgi new` for getting a web app started quickly, automatic database migrations for making iteration fast, and lots of authentication middleware and endpoints for rapidly building APIs out of the box.

Piccolo has been used extensively by the author on professional projects, for a range of corporate and startup clients.

1.2 Database Support

Postgres is the primary database which Piccolo was designed for. It's robust, feature rich, and a great choice for most projects.

CockroachDB is also supported. It's designed to be scalable and fault tolerant, and is mostly compatible with Postgres. There may be some minor features not supported, but it's OK to use.

SQLite support was originally added to enable tooling like the *playground*, but over time we've added more and more support. Many people successfully use SQLite and Piccolo together in production. The main missing feature is support for *automatic database migrations* due to SQLite's limited support for `ALTER TABLE` DDL statements.

1.2.1 What about other databases?

Our focus is on providing great support for a limited number of databases (especially Postgres), however it's likely that we'll support more databases in the future.

1.3 Installing Piccolo

1.3.1 Python

You need Python 3.7 or above installed on your system.

1.3.2 Pip

Now install Piccolo, ideally inside a virtualenv:

```
# Optional - creating a virtualenv on Unix:
python3 -m venv my_project
cd my_project
source bin/activate

# The important bit:
pip install piccolo

# Install Piccolo with PostgreSQL or CockroachDB driver:
pip install 'piccolo[postgres]'

# Install Piccolo with SQLite driver:
pip install 'piccolo[sqlite]'

# Optional: orjson for improved JSON serialisation performance
pip install 'piccolo[orjson]'

# Optional: uvloop as the default event loop instead of asyncio
# If using Piccolo with Uvicorn, Uvicorn will set uvloop as the default
# event loop if installed
pip install 'piccolo[uvloop]'

# If you just want Piccolo with all of it's functionality, you might prefer
# to use this:
pip install 'piccolo[all]'
```

Hint: On Windows, you may need to use double quotes instead. For example `pip install "piccolo[all]"`.

1.4 Playground

Piccolo ships with a handy command called `playground`, which is a great way to learn the basics.

```
piccolo playground run
```

It will create an *example schema* for you, populates it with data, and launches an iPython shell.

You can follow along with the tutorials without first learning advanced concepts like migrations.

It's a nice place to experiment with querying / inserting / deleting data using Piccolo, no matter how experienced you are.

Warning: Each time you launch the playground it flushes out the existing tables and rebuilds them, so don't use it for anything permanent!

1.4.1 SQLite

SQLite is used by default, which provides a zero config way of getting started.

A `piccolo.sqlite` file will get created in the current directory.

1.4.2 Advanced usage

To see how to use the playground with Postgres, and other advanced usage, see *Advanced Playground Usage*.

1.4.3 Test queries

The schema generated in the playground represents fictional bands and their concerts.

When the playground is started it prints out the available tables.

Give these queries a go:

```
await Band.select()
await Band.objects()
await Band.select(Band.name)
await Band.select(Band.name, Band.manager.name)
```

1.4.4 Tab completion is your friend

Piccolo was designed to make tab completion available in as many situations as possible. Use it to find the column names for a table (e.g. `Band.name`), and the different query types (e.g. `Band.select`).

Using tab completion will help avoid errors, and speed up your coding.

1.5 Setup Postgres

1.5.1 Installation

Mac

The quickest way to get Postgres up and running on the Mac is using Postgres.app.

Ubuntu

On Ubuntu you can use `apt`.

```
sudo apt update
sudo apt install postgresql
```

1.5.2 Creating a database

Mac

psql

Postgres.app should make `psql` available for the user who installed it.

```
psql
```

Enter the following:

```
CREATE DATABASE "my_database_name";
```

pgAdmin

If you prefer a GUI, pgAdmin has an installer available.

Ubuntu

psql

Using `psql`:

```
sudo su postgres -c psql
```

Enter the following:

```
CREATE DATABASE "my_database_name";
```

pgAdmin

DEB packages are available for Ubuntu.

1.5.3 Postgres version

Piccolo is tested on most major Postgres versions (see the GitHub Actions file).

1.6 Setup Cockroach

1.6.1 Installation

Follow the instructions for your OS.

Versions

We support the latest stable version.

Note: Features using `format()` will be available in v22.2 or higher, but we recommend using the stable version so you can upgrade automatically when it becomes generally available.

Cockroach is designed to be a "rolling database": Upgrades are as simple as switching out to the next version of a binary (or changing a number in a `docker-compose.yml`). This has one caveat: You cannot upgrade an "alpha" release. It is best to stay on the latest stable.

1.6.2 Creating a database

cockroach sql

CockroachDB comes with its own management tooling.

```
cd ~/wherever/you/installed/cockroachdb
cockroach sql --insecure
```

Enter the following:

```
create database piccolo;
use piccolo;
```

Management GUI

CockroachDB comes with its own web-based management GUI available on localhost: http://127.0.0.1:8080/

Beekeeper Studio

If you prefer a GUI, Beekeeper Studio is recommended and has an installer available.

1.6.3 Column Types

As of this writing, CockroachDB will always convert `JSON` to `JSONB` and will always report `INTEGER` as `BIGINT`.

Piccolo will automatically handle these special cases for you, but we recommend being explicit about this to prevent complications in future versions of Piccolo.

- Use `JSONB()` instead of `JSON()`
- Use `BigInt()` instead of `Integer()`

1.7 Setup SQLite

1.7.1 Installation

The good news is SQLite is good to go out of the box with Python.

Some Piccolo features are only available with newer SQLite versions.

1.7.2 Check version

To check which SQLite version you're using, simply open a Python terminal, and do the following:

```
>>> import sqlite3
>>> sqlite3.sqlite_version
'3.39.0'
```

The easiest way to upgrade your SQLite version is to install the latest version of Python.

1.8 Example Schema

This is the schema used by the example queries throughout the docs, and also in the *playground*.

`Manager` and `Band` are most commonly used:

```
from piccolo.table import Table
from piccolo.columns import ForeignKey, Integer, Varchar


class Manager(Table):
    name = Varchar(length=100)


class Band(Table):
    name = Varchar(length=100)
    manager = ForeignKey(references=Manager)
    popularity = Integer()
```

We sometimes use these other tables in the examples too:

```
class Venue(Table):
    name = Varchar()
    capacity = Integer()


class Concert(Table):
    band_1 = ForeignKey(references=Band)
    band_2 = ForeignKey(references=Band)
    venue = ForeignKey(references=Venue)
    starts = Timestamp()
    duration = Interval()


class Ticket(Table):
    concert = ForeignKey(references=Concert)
    price = Numeric()


class RecordingStudio(Table):
    name = Varchar()
    facilities = JSONB()
```

To understand more about defining your own schemas, see *Defining a Schema*.

1.9 Sync and Async

One of the motivations for making Piccolo was the lack of ORMs and query builders which support asyncio.

Piccolo is designed to be async first. However, you can use Piccolo in synchronous apps as well, whether that be a WSGI web app, or a data science script.

1.9.1 Async example

You can await a query to run it:

```
>>> await Band.select(Band.name)
[{'name': 'Pythonistas'}]
```

Alternatively, you can await a query's `run` method:

```
# This makes it extra explicit that a database query is being made:
>>> await Band.select(Band.name).run()

# It also gives you more control over how the query is run.
# For example, if we wanted to bypass the connection pool for some reason:
>>> await Band.select(Band.name).run(in_pool=False)
```

Using the async version is useful for applications which require high throughput. Piccolo makes building an ASGI web app really simple - see *ASGI*.

1.9.2 Sync example

This lets you execute a query in an application which isn't using asyncio:

```
>>> Band.select(Band.name).run_sync()
[{'name': 'Pythonistas'}]
```

1.9.3 Explicit

By using `await` and `run_sync`, it makes it very explicit when a query is actually being executed.

Until you execute `await` or `run_sync`, you can chain as many methods onto your query as you like, safe in the knowledge that no database queries are being made.

CHAPTER

TWO

QUERY TYPES

There are many different queries you can perform using Piccolo.

The main ways to query data are with *Select*, which returns data as dictionaries, and *Objects*, which returns data as class instances, like a typical ORM.

2.1 Select

Hint: Follow along by installing Piccolo and running `piccolo playground run` - see *Playground*.

To get all rows:

```
>>> await Band.select()
[{'id': 1, 'name': 'Pythonistas', 'manager': 1, 'popularity': 1000},
 {'id': 2, 'name': 'Rustaceans', 'manager': 2, 'popularity': 500}]
```

To get certain columns:

```
>>> await Band.select(Band.name)
[{'name': 'Rustaceans'}, {'name': 'Pythonistas'}]
```

Or use an alias to make it shorter:

```
>>> b = Band
>>> await b.select(b.name)
[{'name': 'Rustaceans'}, {'name': 'Pythonistas'}]
```

Hint: All of these examples also work synchronously using `run_sync` - see *Sync and Async*.

2.1.1 as_alias

By using `as_alias`, the name of the row can be overriden in the response.

```
>>> await Band.select(Band.name.as_alias('title'))
[{'title': 'Rustaceans'}, {'title': 'Pythonistas'}]
```

This is equivalent to `SELECT name AS title FROM band` in SQL.

2.1.2 Joins

One of the most powerful things about `select` is it's support for joins.

```
>>> await Band.select(Band.name, Band.manager.name)
[
    {'name': 'Pythonistas', 'manager.name': 'Guido'},
    {'name': 'Rustaceans', 'manager.name': 'Graydon'}
]
```

The joins can go several layers deep.

```
>>> await Concert.select(Concert.id, Concert.band_1.manager.name)
[{'id': 1, 'band_1.manager.name': 'Guido'}]
```

all_columns

If you want all of the columns from a related table you can use `all_columns`, which is a useful shortcut which saves you from typing them all out:

```
>>> await Band.select(Band.name, Band.manager.all_columns())
[
    {'name': 'Pythonistas', 'manager.id': 1, 'manager.name': 'Guido'},
    {'name': 'Rustaceans', 'manager.id': 2, 'manager.name': 'Graydon'}
]
```

In Piccolo < 0.41.0 you had to explicitly unpack `all_columns`. This is equivalent to the code above:

```
>>> await Band.select(Band.name, *Band.manager.all_columns())
```

You can exclude some columns if you like:

```
>>> await Band.select(
...     Band.name,
...     Band.manager.all_columns(exclude=[Band.manager.id])
... )
[
    {'name': 'Pythonistas', 'manager.name': 'Guido'},
    {'name': 'Rustaceans', 'manager.name': 'Graydon'}
]
```

Strings are supported too if you prefer:

```
>>> await Band.select(
...     Band.name,
...     Band.manager.all_columns(exclude=['id'])
... )
[
    {'name': 'Pythonistas', 'manager.name': 'Guido'},
    {'name': 'Rustaceans', 'manager.name': 'Graydon'}
]
```

You can also use `all_columns` on the root table, which saves you time if you have lots of columns. It works identically to related tables:

```
>>> await Band.select(
...     Band.all_columns(exclude=[Band.id]),
...     Band.manager.all_columns(exclude=[Band.manager.id])
... )
[
    {'name': 'Pythonistas', 'popularity': 1000, 'manager.name': 'Guido'},
    {'name': 'Rustaceans', 'popularity': 500, 'manager.name': 'Graydon'}
]
```

Nested

You can also get the response as nested dictionaries, which can be very useful:

```
>>> await Band.select(Band.name, Band.manager.all_columns()).output(nested=True)
[
    {'name': 'Pythonistas', 'manager': {'id': 1, 'name': 'Guido'}},
    {'name': 'Rustaceans', 'manager': {'id': 2, 'manager.name': 'Graydon'}}
]
```

2.1.3 String syntax

You can specify the column names using a string if you prefer. The disadvantage is you won't have tab completion, but sometimes it's more convenient.

```
await Band.select('name')

# For joins:
await Band.select('manager.name')
```

2.1.4 Aggregate functions

Note: These can all be used in conjunction with the *group_by* clause.

Count

Hint: You can use the *count* query as a quick way of getting the number of rows in a table.

Returns the number of matching rows.

```
from piccolo.query.methods.select import Count

>> await Band.select(Count()).where(Band.popularity > 100)
[{'count': 3}]
```

To find out more about the options available, see *Count*.

Avg

Returns the average for a given column:

```
>>> from piccolo.query import Avg
>>> response = await Band.select(Avg(Band.popularity)).first()
>>> response["avg"]
750.0
```

Sum

Returns the sum for a given column:

```
>>> from piccolo.query import Sum
>>> response = await Band.select(Sum(Band.popularity)).first()
>>> response["sum"]
1500
```

Max

Returns the maximum for a given column:

```
>>> from piccolo.query import Max
>>> response = await Band.select(Max(Band.popularity)).first()
>>> response["max"]
1000
```

Min

Returns the minimum for a given column:

```
>>> from piccolo.query import Min
>>> response = await Band.select(Min(Band.popularity)).first()
>>> response["min"]
500
```

Additional features

You also can have multiple different aggregate functions in one query:

```
>>> from piccolo.query import Avg, Sum
>>> response = await Band.select(
...     Avg(Band.popularity),
...     Sum(Band.popularity)
... ).first()
>>> response
{"avg": 750.0, "sum": 1500}
```

And can use aliases for aggregate functions like this:

```
# Alternatively, you can use the `as_alias` method.
>>> response = await Band.select(
...     Avg(Band.popularity).as_alias("popularity_avg")
... ).first()
>>> response["popularity_avg"]
750.0
```

2.1.5 SelectRaw

In certain situations you may want to have raw SQL in your select query.

For example, if there's a Postgres function which you want to access, which isn't supported by Piccolo:

```
from piccolo.query import SelectRaw

>>> await Band.select(
...     Band.name,
...     SelectRaw("log(popularity) AS log_popularity")
... )
[{'name': 'Pythonistas', 'log_popularity': 3.0}]
```

> **Warning:** Only use SQL that you trust.

2.1.6 Query clauses

batch

See *batch*.

callback

See *callback*.

columns

By default all columns are returned from the queried table.

```
# Equivalent to SELECT * from band
await Band.select()
```

To restrict the returned columns, either pass in the columns into the `select` method, or use the `columns` method.

```
# Equivalent to SELECT name from band
await Band.select(Band.name)

# Or alternatively:
await Band.select().columns(Band.name)
```

The `columns` method is additive, meaning you can chain it to add additional columns.

```
await Band.select().columns(Band.name).columns(Band.manager)

# Or just define it one go:
await Band.select().columns(Band.name, Band.manager)
```

distinct

See *distinct*.

first

See *first*.

group_by

See *group_by*.

limit

See *limit*.

offset

See *offset*.

order_by

See *order_by*.

output

See *output*.

where

See *where*.

2.2 Objects

When doing *Select* queries, you get data back in the form of a list of dictionaries (where each dictionary represents a row). This is useful in a lot of situations, but it's sometimes preferable to get objects back instead, as we can manipulate them, and save the changes back to the database.

In Piccolo, an instance of a `Table` class represents a row. Let's do some examples.

2.2.1 Fetching objects

To get all objects:

```
>>> await Band.objects()
[<Band: 1>, <Band: 2>]
```

To get certain rows:

```
>>> await Band.objects().where(Band.name == 'Pythonistas')
[<Band: 1>]
```

To get a single row (or `None` if it doesn't exist):

```
>>> await Band.objects().get(Band.name == 'Pythonistas')
<Band: 1>
```

To get the first row:

```
>>> await Band.objects().first()
<Band: 1>
```

You'll notice that the API is similar to *Select* - except it returns all columns.

2.2.2 Creating objects

You can pass the column values using kwargs:

```
>>> band = Band(name="C-Sharps", popularity=100)
>>> await band.save()
```

Alternatively, you can pass in a dictionary, which is friendlier to static analysis tools like Mypy (it can easily detect typos in the column names):

```
>>> band = Band({Band.name: "C-Sharps", Band.popularity: 100})
>>> await band.save()
```

We also have this shortcut which combines the above into a single line:

```
>>> band = await Band.objects().create(name="C-Sharps", popularity=100)
```

2.2.3 Updating objects

Objects have a `save` method, which is convenient for updating values:

```
band = await Band.objects().where(
    Band.name == 'Pythonistas'
).first()

band.popularity = 100000

# This saves all values back to the database.
await band.save()

# Or specify specific columns to save:
await band.save([Band.popularity])
```

2.2.4 Deleting objects

Similarly, we can delete objects, using the `remove` method.

```
band = await Band.objects().where(
    Band.name == 'Pythonistas'
).first()

await band.remove()
```

2.2.5 Fetching related objects

get_related

If you have an object from a table with a *ForeignKey* column, and you want to fetch the related row as an object, you can do so using `get_related`.

```
band = await Band.objects().where(
    Band.name == 'Pythonistas'
).first()

manager = await band.get_related(Band.manager)
>>> manager
<Manager: 1>
>>> manager.name
'Guido'
```

Prefetching related objects

You can also prefetch the rows from related tables, and store them as child objects. To do this, pass *ForeignKey* columns into `objects`, which refer to the related rows you want to load.

```
band = await Band.objects(Band.manager).where(
    Band.name == 'Pythonistas'
).first()

>>> band.manager
<Manager: 1>
>>> band.manager.name
'Guido'
```

If you have a table containing lots of `ForeignKey` columns, and want to prefetch them all you can do so using `all_related`.

```
ticket = await Ticket.objects(
    Ticket.concert.all_related()
).first()

# Any intermediate objects will also be loaded:
>>> ticket.concert
```

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```
<Concert: 1>

>>> ticket.concert.band_1
<Band: 1>
>>> ticket.concert.band_2
<Band: 2>
```

You can manipulate these nested objects, and save the values back to the database, just as you would expect:

```
ticket.concert.band_1.name = 'Pythonistas 2'
await ticket.concert.band_1.save()
```

Instead of passing the *ForeignKey* columns into the `objects` method, you can use the `prefetch` clause if you prefer.

```
# These are equivalent:
ticket = await Ticket.objects(
    Ticket.concert.all_related()
).first()

ticket = await Ticket.objects().prefetch(
    Ticket.concert.all_related()
)
```

2.2.6 get_or_create

With `get_or_create` you can get an existing record matching the criteria, or create a new one with the `defaults` arguments:

```
band = await Band.objects().get_or_create(
    Band.name == 'Pythonistas', defaults={Band.popularity: 100}
)

# Or using string column names
band = await Band.objects().get_or_create(
    Band.name == 'Pythonistas', defaults={'popularity': 100}
)
```

You can find out if an existing row was found, or if a new row was created:

```
band = await Band.objects.get_or_create(
    Band.name == 'Pythonistas'
)
band._was_created  # True if it was created, otherwise False if it was already in the db
```

Complex where clauses are supported, but only within reason. For example:

```
# This works OK:
band = await Band.objects().get_or_create(
    (Band.name == 'Pythonistas') & (Band.popularity == 1000),
)
```

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```
# This is problematic, as it's unclear what the name should be if we
# need to create the row:
band = await Band.objects().get_or_create(
    (Band.name == 'Pythonistas') | (Band.name == 'Rustaceans'),
    defaults={'popularity': 100}
)
```

2.2.7 to_dict

If you need to convert an object into a dictionary, you can do so using the `to_dict` method.

```
band = await Band.objects().first()

>>> band.to_dict()
{'id': 1, 'name': 'Pythonistas', 'manager': 1, 'popularity': 1000}
```

If you only want a subset of the columns, or want to use aliases for some of the columns:

```
band = await Band.objects().first()

>>> band.to_dict(Band.id, Band.name.as_alias('title'))
{'id': 1, 'title': 'Pythonistas'}
```

2.2.8 refresh

If you have an object which has gotten stale, and want to refresh it, so it has the latest data from the database, you can use the *refresh* method.

```
# If we have an instance:
band = await Band.objects().first()

# And it has gotten stale, we can refresh it:
await band.refresh()

# Or just refresh certain columns:
await band.refresh([Band.name])
```

2.2.9 Query clauses

batch

See *batch*.

callback

See *callback*.

first

See *first*.

limit

See *limit*.

offset

See *offset*.

order_by

See *order_by*.

output

See *output*.

where

See *where* .

2.3 Count

The `count` query makes it really easy to retrieve the number of rows in a table:

```
>>> await Band.count()
3
```

It's equivalent to this `select` query:

```
from piccolo.query.methods.select import Count

>>> response = await Band.select(Count())
>>> response[0]['count']
3
```

As you can see, the `count` query is more convenient.

2.3.1 Non-null columns

If you want to retrieve the number of rows where a given column isn't null, we can do so as follows:

```
await Band.count(column=Band.name)

# Or simply:
await Band.count(Band.name)
```

Note, this is equivalent to:

```
await Band.count().where(Band.name.is_not_null())
```

Example

If we have the following database table:

```
class Band(Table):
    name = Varchar()
    popularity = Integer(null=True)
```

With the following data:

name	popularity
Pythonistas	1000
Rustaceans	800
C-Sharps	null

Then we get the following results:

```
>>> await Band.count()
3

>>> await Band.count(Band.popularity)
2
```

2.3.2 distinct

We can count the number of distinct (i.e. unique) rows.

```
await Band.count(distinct=[Band.name])

# This also works - use whichever you prefer:
await Band.count().distinct([Band.name])
```

With the following data:

name	popularity
Pythonistas	1000
Pythonistas	1000
Pythonistas	800
Rustaceans	800

Note how we have duplicate band names.

Hint: This is bad database design as we should add a unique constraint to prevent this, but go with it for this example!

Let's compare queries with and without `distinct`:

```
>>> await Band.count()
4

>>> await Band.count(distinct=[Band.name])
2
```

We can specify multiple columns:

```
>>> await Band.count(distinct=[Band.name, Band.popularity])
3
```

In the above example, this means we count rows where the combination of `name` and `popularity` is unique.

So `('Pythonistas', 1000)` is a distinct value from `('Pythonistas', 800)`, because even though the `name` is the same, the `popularity` is different.

2.3.3 Clauses

where

See *where*.

2.4 Alter

This is used to modify an existing table.

Hint: You can use migrations instead of manually altering the schema - see *Migrations*.

2.4.1 add_column

Used to add a column to an existing table.

```
await Band.alter().add_column('members', Integer())
```

2.4.2 drop_column

Used to drop an existing column.

```
await Band.alter().drop_column('popularity')
```

2.4.3 drop_table

Used to drop the table - use with caution!

```
await Band.alter().drop_table()
```

drop_db_tables / drop_db_tables_sync

If you have several tables which you want to drop, you can use *drop_db_tables* or *drop_db_tables_sync*. The tables will be dropped in the correct order based on their foreign keys.

```
# async version
>>> from piccolo.table import drop_db_tables
>>> await drop_db_tables(Band, Manager)

# sync version
>>> from piccolo.table import drop_db_tables_sync
>>> drop_db_tables_sync(Band, Manager)
```

2.4.4 rename_column

Used to rename an existing column.

```
await Band.alter().rename_column(Band.popularity, 'rating')
```

2.4.5 set_null

Set whether a column is nullable or not.

```
# To make a row nullable:
await Band.alter().set_null(Band.name, True)

# To stop a row being nullable:
await Band.alter().set_null(Band.name, False)
```

2.4.6 set_schema

Used to change the schema which a table belongs to.

```
await Band.alter().set_schema('schema_1')
```

Schemas are a way of organising the tables within a database. Only Postgres and Cockroach support schemas. *Learn more here*.

After changing a table's schema, you need to update your `Table` accordingly, otherwise subsequent queries will fail, as they'll be trying to find the table in the old schema.

```
Band._meta.schema = 'schema_1'
```

2.4.7 set_unique

Used to change whether a column is unique or not.

```
# To make a row unique:
await Band.alter().set_unique(Band.name, True)

# To stop a row being unique:
await Band.alter().set_unique(Band.name, False)
```

2.5 Create Table

This creates the table and columns in the database.

Hint: You can use migrations instead of manually altering the schema - see *Migrations*.

```
>>> await Band.create_table()
[]
```

To prevent an error from being raised if the table already exists:

```
>>> await Band.create_table(if_not_exists=True)
[]
```

2.5.1 create_db_tables / create_db_tables_sync

You can create multiple tables at once.

This function will automatically sort tables based on their foreign keys so they're created in the right order:

```
# async version
>>> from piccolo.table import create_db_tables
>>> await create_db_tables(Band, Manager, if_not_exists=True)

# sync version
>>> from piccolo.table import create_db_tables_sync
>>> create_db_tables_sync(Band, Manager, if_not_exists=True)
```

2.6 Delete

This deletes any matching rows from the table.

```
>>> await Band.delete().where(Band.name == 'Rustaceans')
[]
```

2.6.1 force

Piccolo won't let you run a delete query without a where clause, unless you explicitly tell it to do so. This is to help prevent accidentally deleting all the data from a table.

```
>>> await Band.delete()
Raises: DeletionError

# Works fine:
>>> await Band.delete(force=True)
[]
```

2.6.2 Query clauses

returning

See *returning*.

where

See *where*

2.7 Exists

This checks whether any rows exist which match the criteria.

```
>>> await Band.exists().where(Band.name == 'Pythonistas')
True
```

2.7.1 Query clauses

where

See *where*.

2.8 Insert

This is used to bulk insert rows into the table:

```
await Band.insert(
    Band(name="Pythonistas")
    Band(name="Darts"),
    Band(name="Gophers")
)
```

2.8.1 add

If we later decide to insert additional rows, we can use the `add` method:

```
query = Band.insert(Band(name="Pythonistas"))

if other_bands:
    query = query.add(
        Band(name="Darts"),
        Band(name="Gophers")
    )

await query
```

2.8.2 Query clauses

on_conflict

See *on_conflict*.

returning

See *returning*.

2.9 Raw

Should you need to, you can execute raw SQL.

```
>>> await Band.raw('select name from band')
[{'name': 'Pythonistas'}]
```

It's recommended that you parameterise any values. Use curly braces {} as placeholders:

```
>>> await Band.raw('select * from band where name = {}', 'Pythonistas')
[{'name': 'Pythonistas', 'manager': 1, 'popularity': 1000, 'id': 1}]
```

Warning: Be careful to avoid SQL injection attacks. Don't add any user submitted data into your SQL strings, unless it's parameterised.

2.10 Update

This is used to update any rows in the table which match the criteria.

```
>>> await Band.update({
...     Band.name: 'Pythonistas 2'
... }).where(
...     Band.name == 'Pythonistas'
... )
[]
```

2.10.1 force

Piccolo won't let you run an update query without a *where clause*, unless you explicitly tell it to do so. This is to prevent accidentally overwriting the data in a table.

```
>>> await Band.update()
Raises: UpdateError

# Works fine:
```

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```
>>> await Band.update({Band.popularity: 0}, force=True)

# Or just add a where clause:
>>> await Band.update({Band.popularity: 0}).where(Band.popularity < 50)
```

2.10.2 Modifying values

As well as replacing values with new ones, you can also modify existing values, for instance by adding an integer.

You can currently only combine two values together at a time.

Integer columns

You can add / subtract / multiply / divide values:

```
# Add 100 to the popularity of each band:
await Band.update(
    {
        Band.popularity: Band.popularity + 100
    },
    force=True
)

# Decrease the popularity of each band by 100.
await Band.update(
    {
        Band.popularity: Band.popularity - 100
    },
    force=True
)

# Multiply the popularity of each band by 10.
await Band.update(
    {
        Band.popularity: Band.popularity * 10
    },
    force=True
)

# Divide the popularity of each band by 10.
await Band.update(
    {
        Band.popularity: Band.popularity / 10
    },
    force=True
)

# You can also use the operators in reverse:
await Band.update(
```

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```
    {
        Band.popularity: 2000 - Band.popularity
    },
    force=True
)
```

Varchar / Text columns

You can concatenate values:

```
# Append "!!!" to each band name.
await Band.update(
    {
        Band.name: Band.name + "!!!"
    },
    force=True
)

# Concatenate the values in each column:
await Band.update(
    {
        Band.name: Band.name + Band.name
    },
    force=True
)

# Prepend "!!!" to each band name.
await Band.update(
    {
        Band.popularity: "!!!" + Band.popularity
    },
    force=True
)
```

Date / Timestamp / Timestamptz / Interval columns

You can add or substract a `timedelta` to any of these columns.

For example, if we have a `Concert` table, and we want each concert to start one day later, we can simply do this:

```
await Concert.update(
    {
        Concert.starts: Concert.starts + datetime.timedelta(days=1)
    },
    force=True
)
```

Likewise, we can decrease the values by 1 day:

```
await Concert.update(
    {
```

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```
        Concert.starts: Concert.starts - datetime.timedelta(days=1)
    },
    force=True
)
```

Array columns

You can append values to an array (Postgres only). See *cat*.

What about null values?

If we have a table with a nullable column:

```
class Band(Table):
    name = Varchar(null=True)
```

Any rows with a value of null aren't modified by an update:

```
>>> await Band.insert(Band(name="Pythonistas"), Band(name=None))
>>> await Band.update(
...     {
...         Band.name: Band.name + '!!!'
...     },
...     force=True
... )
>>> await Band.select()
# Note how the second row's name value is still `None`:
[{'id': 1, 'name': 'Pythonistas!!!'}, {'id': 2, 'name': None}]
```

It's more efficient to exclude any rows with a value of null using a *where clause*:

```
await Band.update(
    {
        Band.name + '!!!'
    },
    force=True
).where(
    Band.name.is_not_null()
)
```

2.10.3 Kwarg values

Rather than passing in a dictionary of values, you can use kwargs instead if you prefer:

```
await Band.update(
    name='Pythonistas 2'
).where(
    Band.name == 'Pythonistas'
)
```

2.10.4 Query clauses

returning

See *returning*.

where

See *where*.

2.11 Features

2.11.1 Transactions

Transactions allow multiple queries to be committed only once successful.

This is useful for things like migrations, where you can't have it fail in an inbetween state.

Accessing the `Engine`

In the examples below we need to access the database `Engine`.

Each `Table` contains a reference to its `Engine`, which is the easiest way to access it. For example, with our `Band` table:

```
DB = Band._meta.db
```

Atomic

This is useful when you want to programmatically add some queries to the transaction before running it.

```
transaction = DB.atomic()
transaction.add(Manager.create_table())
transaction.add(Concert.create_table())
await transaction.run()

# You're also able to run this synchronously:
transaction.run_sync()
```

Transaction

This is the preferred way to run transactions - it currently only works with async.

```
async with DB.transaction():
    await Manager.create_table()
    await Concert.create_table()
```

Commit

The transaction is automatically committed when you exit the context manager.

```
async with DB.transaction():
    await query_1
    await query_2
    # Automatically committed if the code reaches here.
```

You can manually commit it if you prefer:

```
async with DB.transaction() as transaction:
    await query_1
    await query_2
    await transaction.commit()
    print('transaction committed!')
```

Rollback

If an exception is raised within the body of the context manager, then the transaction is automatically rolled back. The exception is still propagated though.

Rather than raising an exception, if you want to rollback a transaction manually you can do so as follows:

```
async with DB.transaction() as transaction:
    await Manager.create_table()
    await Band.create_table()
    await transaction.rollback()
```

Nested transactions

Nested transactions aren't supported in Postgres, but we can achieve something similar using savepoints.

Nested context managers

If you have nested context managers, for example:

```
async with DB.transaction():
    async with DB.transaction():
        ...
```

By default, the inner context manager does nothing, as we're already inside a transaction.

You can change this behaviour using `allow_nested=False`, in which case a `TransactionError` is raised if you try creating a transaction when one already exists.

```
async with DB.transaction():
    async with DB.transaction(allow_nested=False):
        # TransactionError('A transaction is already active.')
```

transaction_exists

You can check whether your code is currently inside a transaction using the following:

```
>>> DB.transaction_exists()
True
```

Savepoints

Postgres supports savepoints, which is a way of partially rolling back a transaction.

```
async with DB.transaction() as transaction:
    await Band.insert(Band(name='Pythonistas'))

    savepoint_1 = await transaction.savepoint()

    await Band.insert(Band(name='Terrible band'))

    # Oops, I made a mistake!
    await savepoint_1.rollback_to()
```

In the above example, the first query will be committed, but not the second.

Named savepoints

By default, we assign a name to the savepoint for you. But you can explicitly give it a name:

```
await transaction.savepoint('my_savepoint')
```

This means you can rollback to this savepoint at any point just using the name:

```
await transaction.rollback_to('my_savepoint')
```

Transaction types

SQLite

For SQLite you may want to specify the *transaction type*, as it can have an effect on how well the database handles concurrent requests.

2.11.2 Joins

Joins are handled automatically by Piccolo. They work everywhere you'd expect (select queries, where clauses, etc.).

A fluent interface is used, which lets you traverse foreign keys.

Here's an example of a select query which uses joins (using the *example schema*):

```
# This gets the band's name, and the manager's name by joining to the
# manager table:
>>> await Band.select(Band.name, Band.manager.name)
```

And a `where` clause which uses joins:

```
# This automatically joins with the manager table to perform the where
# clause. It only returns the columns from the band table though by default.
>>> await Band.select().where(Band.manager.name == 'Guido')
```

Left joins are used.

join_on

Joins are usually performed using `ForeignKey` columns, though there may be situations where you want to join using a column which isn't a `ForeignKey`.

You can do this using *join_on*.

It's generally best to join on unique columns.

2.12 Comparisons

If you're familiar with other ORMs, here are some guides which show the Piccolo equivalents of common queries.

2.12.1 Django Comparison

Here are some common queries, showing how they're done in Django vs Piccolo. All of the Piccolo examples can also be run *asynchronously*.

Queries

get

They are very similar, except Django raises an `ObjectDoesNotExist` exception if no match is found, whilst Piccolo returns `None`.

```
# Django
>>> Band.objects.get(name="Pythonistas")
<Band: 1>
>>> Band.objects.get(name="DOESN'T EXIST")  # ObjectDoesNotExist!

# Piccolo
>>> Band.objects().get(Band.name == 'Pythonistas').run_sync()
<Band: 1>
>>> Band.objects().get(Band.name == "DOESN'T EXIST").run_sync()
None
```

get_or_create

```
# Django
band, created = Band.objects.get_or_create(name="Pythonistas")
>>> band
<Band: 1>
>>> created
True

# Piccolo
>>> band = Band.objects().get_or_create(Band.name == 'Pythonistas').run_sync()
>>> band
<Band: 1>
>>> band._was_created
True
```

create

```
# Django
>>> band = Band(name="Pythonistas")
>>> band.save()
>>> band
<Band: 1>

# Piccolo
>>> band = Band(name="Pythonistas")
>>> band.save().run_sync()
>>> band
<Band: 1>
```

update

```
# Django
>>> band = Band.objects.get(name="Pythonistas")
>>> band
<Band: 1>
>>> band.name = "Amazing Band"
>>> band.save()

# Piccolo
>>> band = Band.objects().get(Band.name == 'Pythonistas').run_sync()
>>> band
<Band: 1>
>>> band.name = "Amazing Band"
>>> band.save().run_sync()
```

delete

Individual rows:

```
# Django
>>> band = Band.objects.get(name="Pythonistas")
>>> band.delete()

# Piccolo
>>> band = Band.objects().get(Band.name == 'Pythonistas').run_sync()
>>> band.remove().run_sync()
```

In bulk:

```
# Django
>>> Band.objects.filter(popularity__lt=1000).delete()

# Piccolo
>>> Band.delete().where(Band.popularity < 1000).run_sync()
```

filter

```
# Django
>>> Band.objects.filter(name="Pythonistas")
[<Band: 1>]

# Piccolo
>>> Band.objects().where(Band.name == "Pythonistas").run_sync()
[<Band: 1>]
```

values_list

```
# Django
>>> Band.objects.values_list('name')
[{'name': 'Pythonistas'}, {'name': 'Rustaceans'}]

# Piccolo
>>> Band.select(Band.name).run_sync()
[{'name': 'Pythonistas'}, {'name': 'Rustaceans'}]
```

With `flat=True`:

```
# Django
>>> Band.objects.values_list('name', flat=True)
['Pythonistas', 'Rustaceans']

# Piccolo
>>> Band.select(Band.name).output(as_list=True).run_sync()
['Pythonistas', 'Rustaceans']
```

select_related

Django has an optimisation called `select_related` which reduces the number of SQL queries required when accessing related objects.

```
# Django
band = Band.objects.get(name='Pythonistas')
>>> band.manager  # This triggers another db query
<Manager: 1>

# Django, with select_related
band = Band.objects.select_related('manager').get(name='Pythonistas')
>>> band.manager  # Manager is pre-cached, so there's no extra db query
<Manager: 1>
```

Piccolo has something similar:

```
# Piccolo
band = Band.objects(Band.manager).get(Band.name == 'Pythonistas').run_sync()
```

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```
>>> band.manager
<Manager: 1>
```

Database settings

In Django you configure your database in `settings.py`. With Piccolo, you define an `Engine` in `piccolo_conf.py`. See *Engines*.

Creating a new project

With Django you use `django-admin startproject mysite`.

In Piccolo you use `piccolo asgi new` (see *ASGI*).

CHAPTER

THREE

QUERY CLAUSES

Query clauses are used to modify a query by making it more specific, or by modifying the return values.

3.1 first

You can use `first` clauses with the following queries:

- *Objects*
- *Select*

Rather than returning a list of results, just the first result is returned.

```
>>> await Band.select().first()
{'name': 'Pythonistas', 'manager': 1, 'popularity': 1000, 'id': 1}
```

Likewise, with objects:

```
>>> await Band.objects().first()
<Band: 1>
```

If no match is found, then `None` is returned instead.

3.2 limit

You can use `limit` clauses with the following queries:

- *Objects*
- *Select*

Rather than returning all of the matching results, it will only return the number you ask for.

```
await Band.select().limit(2)
```

Likewise, with objects:

```
await Band.objects().limit(2)
```

3.3 order_by

You can use `order_by` clauses with the following queries:

- *Select*
- *Objects*

To order the results by a certain column (ascending):

```
await Band.select().order_by(
    Band.name
)
```

To order by descending:

```
await Band.select().order_by(
    Band.name,
    ascending=False
)
```

You can specify the column name as a string if you prefer:

```
await Band.select().order_by(
    'name'
)
```

You can order by multiple columns, and even use joins:

```
await Band.select().order_by(
    Band.name,
    Band.manager.name
)
```

3.3.1 Advanced

Ascending and descending

If you want to order by multiple columns, with some ascending, and some descending, then you can do so using multiple `order_by` statements:

```
await Band.select().order_by(
    Band.name,
).order_by(
    Band.popularity,
    ascending=False
)
```

OrderByRaw

SQL's `ORDER BY` clause is surprisingly rich in functionality, and there may be situations where you want to specify the `ORDER BY` explicitly using SQL. To do this use `OrderByRaw`.

In the example below, we are ordering the results randomly:

```
from piccolo.query import OrderByRaw

await Band.select(Band.name).order_by(
    OrderByRaw('random()'),
)
```

The above is equivalent to the following SQL:

```
SELECT "band"."name" FROM band ORDER BY random() ASC
```

3.4 where

You can use `where` clauses with the following queries:

- *Count*
- *Delete*
- *Exists*
- *Objects*
- *Select*
- *Update*

It allows powerful filtering of your data.

3.4.1 Equal / Not Equal

```
await Band.select().where(
    Band.name == 'Pythonistas'
)
```

```
await Band.select().where(
    Band.name != 'Rustaceans'
)
```

Hint: With *Boolean* columns, some linters will complain if you write `SomeTable.some_column == True` (because it's more Pythonic to do `is True`). To work around this, you can do `SomeTable.some_column.eq(True)`. Likewise, with `!=` you can use `SomeTable.some_column.ne(True)`

3.4.2 Greater than / less than

You can use the `<`, `>`, `<=`, `>=` operators, which work as you expect.

```
await Band.select().where(
    Band.popularity >= 100
)
```

3.4.3 like / ilike

The percentage operator is required to designate where the match should occur.

```
await Band.select().where(
    Band.name.like('Py%')  # Matches the start of the string
)

await Band.select().where(
    Band.name.like('%istas')  # Matches the end of the string
)

await Band.select().where(
    Band.name.like('%is%')  # Matches anywhere in the string
)

await Band.select().where(
    Band.name.like('Pythonistas')  # Matches the entire string
)
```

`ilike` is identical, except it's Postgres specific and case insensitive.

3.4.4 not_like

Usage is the same as `like` excepts it excludes matching rows.

```
await Band.select().where(
    Band.name.not_like('Py%')
)
```

3.4.5 is_in / not_in

You can get all rows with a value contained in the list:

```
await Band.select().where(
    Band.name.is_in(['Pythonistas', 'Rustaceans'])
)
```

And all rows with a value not contained in the list:

```
await Band.select().where(
    Band.name.not_in(['Terrible Band', 'Awful Band'])
)
```

3.4.6 is_null / is_not_null

These queries work, but some linters will complain about doing a comparison with `None`:

```
# Fetch all bands with a manager
await Band.select().where(
    Band.manager != None
)

# Fetch all bands without a manager
await Band.select().where(
    Band.manager == None
)
```

To avoid the linter errors, you can use `is_null` and `is_not_null` instead.

```
# Fetch all bands with a manager
await Band.select().where(
    Band.manager.is_not_null()
)

# Fetch all bands without a manager
await Band.select().where(
    Band.manager.is_null()
)
```

3.4.7 Complex queries - and / or

You can make complex `where` queries using `&` for AND, and `|` for OR.

```
await Band.select().where(
    (Band.popularity >= 100) & (Band.popularity < 1000)
)

await Band.select().where(
    (Band.popularity >= 100) | (Band.name ==  'Pythonistas')
)
```

You can make really complex `where` clauses if you so choose - just be careful to include brackets in the correct place.

```
((b.popularity >= 100) & (b.manager.name ==  'Guido')) | (b.popularity > 1000)
```

Using multiple `where` clauses is equivalent to an AND.

```
# These are equivalent:
await Band.select().where(
    (Band.popularity >= 100) & (Band.popularity < 1000)
)

await Band.select().where(
    Band.popularity >= 100
).where(
    Band.popularity < 1000
)
```

Also, multiple arguments inside `where` clause is equivalent to an AND.

```
# These are equivalent:
await Band.select().where(
    (Band.popularity >= 100) & (Band.popularity < 1000)
)

await Band.select().where(
    Band.popularity >= 100, Band.popularity < 1000
)
```

Using And / Or directly

Rather than using the `|` and `&` characters, you can use the `And` and `Or` classes, which are what's used under the hood.

```
from piccolo.columns.combination import And, Or

await Band.select().where(
    Or(
        And(Band.popularity >= 100, Band.popularity < 1000),
        Band.name == 'Pythonistas'
    )
)
```

3.4.8 WhereRaw

In certain situations you may want to have raw SQL in your where clause.

```
from piccolo.columns.combination import WhereRaw

await Band.select().where(
    WhereRaw("name = 'Pythonistas'")
)
```

It's important to parameterise your SQL statements if the values come from an untrusted source, otherwise it could lead to a SQL injection attack.

```
from piccolo.columns.combination import WhereRaw

value = "Could be dangerous"

await Band.select().where(
    WhereRaw("name = {}", value)
)
```

WhereRaw can be combined into complex queries, just as you'd expect:

```
from piccolo.columns.combination import WhereRaw

await Band.select().where(
    WhereRaw("name = 'Pythonistas'") | (Band.popularity > 1000)
)
```

3.4.9 Joins

The `where` clause has full support for joins. For example:

```
>>> await Band.select(Band.name).where(Band.manager.name == 'Guido')
[{'name': 'Pythonistas'}]
```

3.5 batch

You can use `batch` clauses with the following queries:

- *Objects*
- *Select*

3.5.1 Example

By default, a query will return as many rows as you ask it for. The problem is when you have a table containing millions of rows - you might not want to load them all into memory at once. To get around this, you can batch the responses.

```
# Returns 100 rows at a time:
async with await Manager.select().batch(batch_size=100) as batch:
    async for _batch in batch:
        print(_batch)
```

3.5.2 Node

If you're using `extra_nodes` with *PostgresEngine*, you can specify which node to query:

```
# Returns 100 rows at a time from read_replica_db
async with await Manager.select().batch(
    batch_size=100,
    node="read_replica_db",
) as batch:
    async for _batch in batch:
        print(_batch)
```

3.5.3 Synchronous version

There's currently no synchronous version. However, it's easy enough to achieve:

```
async def get_batch():
    async with await Manager.select().batch(batch_size=100) as batch:
        async for _batch in batch:
            print(_batch)

from piccolo.utils.sync import run_sync
run_sync(get_batch())
```

3.6 callback

You can use `callback` clauses with the following queries:

- *Select*
- *Objects*

Callbacks are used to run arbitrary code after a query completes.

3.6.1 Callback handlers

A callback handler is a function or coroutine that takes query results as its only parameter.

For example, you can automatically print the result of a select query using `print` as a callback handler:

```
>>> await Band.select(Band.name).callback(print)
[{'name': 'Pythonistas'}]
```

Likewise for an objects query:

```
>>> await Band.objects().callback(print)
[<Band: 1>]
```

3.6.2 Transforming results

Callback handlers are able to modify the results of a query by returning a value. Note that in the previous examples, the queries returned `None` since `print` itself returns `None`.

To modify query results with a custom callback handler:

```
>>> def uppercase_name(band):
        return band.name.upper()

>>> await Band.objects().first().callback(uppercase_name)
'PYTHONISTAS'
```

3.6.3 Multiple callbacks

You can add as many callbacks to a query as you like. This can be done in two ways.

Passing a list of callbacks:

```
Band.select(Band.name).callback([handler_a, handler_b])
```

Chaining `callback` clauses:

```
Band.select(Band.name).callback(handler_a).callback(handler_b)
```

3.7 distinct

You can use `distinct` clauses with the following queries:

- *Select*

```
>>> await Band.select(Band.name).distinct()
[{'title': 'Pythonistas'}]
```

This is equivalent to `SELECT DISTINCT name FROM band` in SQL.

3.7.1 on

Using the `on` parameter we can create `DISTINCT ON` queries.

Note: Postgres and CockroachDB only. For more info, see the Postgres docs.

If we have the following table:

```
class Album(Table):
    band = Varchar()
    title = Varchar()
    release_date = Date()
```

With this data in the database:

Table 1: Albums

id	band	title	release_date
1	Pythonistas	Py album 2021	2021-12-01
2	Pythonistas	Py album 2022	2022-12-01
3	Rustaceans	Rusty album 2021	2021-12-01
4	Rustaceans	Rusty album 2022	2022-12-01

To get the latest album for each band, we can do so with a query like this:

```
>>> await Album.select().distinct(
...     on=[Album.band]
... ).order_by(
...     Album.band
... ).order_by(
...     Album.release_date,
...     ascending=False
... )

[
    {
        'id': 2,
        'band': 'Pythonistas',
        'title': 'Py album 2022',
        'release_date': '2022-12-01'
    },
    {
        'id': 4,
        'band': 'Rustaceans',
        'title': 'Rusty album 2022',
        'release_date': '2022-12-01'
    },
]
```

The first column specified in `on` must match the first column specified in `order_by`, otherwise a *DistinctOnError* will be raised.

Source

class piccolo.query.mixins.**DistinctOnError**

Raised when `DISTINCT ON` queries are malformed.

3.8 freeze

You can use the `freeze` clause with any query type.

3.8.1 Source

`Query.`**`freeze`**`()` → FrozenQuery

This is a performance optimisation when the same query is run repeatedly. For example:

```
TOP_BANDS = Band.select(
    Band.name
).order_by(
    Band.popularity,
    ascending=False
).limit(
    10
).output(
    as_json=True
).freeze()

# In the corresponding view/endpoint of whichever web framework
# you're using:
async def top_bands(self, request):
    return await TOP_BANDS
```

It means that Piccolo doesn't have to work as hard each time the query is run to generate the corresponding SQL - some of it is cached. If the query is defined within the view/endpoint, it has to generate the SQL from scratch each time.

Once a query is frozen, you can't apply any more clauses to it (`where`, `limit`, `output` etc).

Even though `freeze` helps with performance, there are limits to how much it can help, as most of the time is still spent waiting for a response from the database. However, for high throughput apps and data science scripts, it's a worthwhile optimisation.

3.9 group_by

You can use `group_by` clauses with the following queries:

- *Select*

It is used in combination with the *aggregate functions* - for example, `Count`.

3.9.1 Count

In the following query, we get a count of the number of bands per manager:

```
>>> from piccolo.query.methods.select import Count

>>> await Band.select(
...     Band.manager.name.as_alias('manager_name'),
...     Count(alias='band_count')
... ).group_by(
...     Band.manager
... )

[
    {"manager_name": "Graydon", "band_count": 1},
    {"manager_name": "Guido", "band_count": 1}
]
```

3.9.2 Other aggregate functions

These work the same as `Count`. See *aggregate functions*.

3.10 offset

You can use `offset` clauses with the following queries:

- *Objects*
- *Select*

This will omit the first X rows from the response.

It's highly recommended to use it along with an *order_by* clause, otherwise the results returned could be different each time.

```
>>> await Band.select(Band.name).offset(1).order_by(Band.name)
[{'name': 'Pythonistas'}, {'name': 'Rustaceans'}]
```

Likewise, with objects:

```
>>> await Band.objects().offset(1).order_by(Band.name)
[Band2, Band3]
```

3.11 on_conflict

Hint: This is an advanced topic, and first time learners of Piccolo can skip if they want.

You can use the `on_conflict` clause with the following queries:

- *Insert*

3.11.1 Introduction

When inserting rows into a table, if a unique constraint fails on one or more of the rows, then the insertion fails.

Using the `on_conflict` clause, we can instead tell the database to ignore the error (using `DO NOTHING`), or to update the row (using `DO UPDATE`).

This is sometimes called an **upsert** (update if it already exists else insert).

3.11.2 Example data

If we have the following table:

```
class Band(Table):
    name = Varchar(unique=True)
    popularity = Integer()
```

With this data:

id	name	popularity
1	Pythonistas	1000

Let's try inserting another row with the same `name`, and we'll get an error:

```
>>> await Band.insert(
...     Band(name="Pythonistas", popularity=1200)
... )
Unique constraint error!
```

3.11.3 DO NOTHING

To ignore the error:

```
>>> await Band.insert(
...     Band(name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO NOTHING"
... )
```

If we fetch the data from the database, we'll see that it hasn't changed:

```
>>> await Band.select().where(Band.name == "Pythonistas").first()
{'id': 1, 'name': 'Pythonistas', 'popularity': 1000}
```

3.11.4 DO UPDATE

Instead, if we want to update the `popularity`:

```
>>> await Band.insert(
...     Band(name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO UPDATE",
...     values=[Band.popularity]
... )
```

If we fetch the data from the database, we'll see that it was updated:

```
>>> await Band.select().where(Band.name == "Pythonistas").first()
{'id': 1, 'name': 'Pythonistas', 'popularity': 1200}
```

3.11.5 target

Using the `target` argument, we can specify which constraint we're concerned with. By specifying `target=Band.name` we're only concerned with the unique constraint for the `band` column. If you omit the `target` argument, then it works for all constraints on the table.

```
>>> await Band.insert(
...     Band(name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO NOTHING",
...     target=Band.name
... )
```

If you want to target a composite unique constraint, you can do so by passing in a tuple of columns:

```
>>> await Band.insert(
...     Band(name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO NOTHING",
...     target=(Band.name, Band.popularity)
... )
```

You can also specify the name of a constraint using a string:

```
>>> await Band.insert(
...     Band(name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO NOTHING",
...     target='some_constraint'
... )
```

3.11.6 values

This lets us specify which values to update when a conflict occurs.

By specifying a *Column*, this means that the new value for that column will be used:

```
# The new popularity will be 1200.
>>> await Band.insert(
...     Band(name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO UPDATE",
...     values=[Band.popularity]
... )
```

Instead, we can specify a custom value using a tuple:

```
# The new popularity will be 1111.
>>> await Band.insert(
...     Band(name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO UPDATE",
...     values=[(Band.popularity, 1111)]
... )
```

If we want to update all of the values, we can use *all_columns*.

```
>>> await Band.insert(
...     Band(id=1, name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO UPDATE",
...     values=Band.all_columns()
... )
```

3.11.7 where

This can be used with `DO UPDATE`. It gives us more control over whether the update should be made:

```
>>> await Band.insert(
...     Band(id=1, name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO UPDATE",
...     values=[Band.popularity],
...     where=Band.popularity < 1000
... )
```

3.11.8 Multiple `on_conflict` clauses

SQLite allows you to specify multiple `ON CONFLICT` clauses, but Postgres and Cockroach don't.

```
>>> await Band.insert(
...     Band(name="Pythonistas", popularity=1200)
... ).on_conflict(
...     action="DO UPDATE",
...     ...
... ).on_conflict(
...     action="DO NOTHING",
...     ...
... )
```

3.11.9 Learn more

- Postgres docs
- Cockroach docs
- SQLite docs

3.11.10 Source

Insert.on_conflict(*target: t.Optional[t.Union[str, Column, t.Tuple[Column, ...]]] = None*, *action: t.Union[OnConflictAction, t.Literal['DO NOTHING', 'DO UPDATE']] = OnConflictAction.do_nothing*, *values: t.Optional[t.Sequence[t.Union[Column, t.Tuple[Column, t.Any]]]] = None*, *where: t.Optional[Combinable] = None*) → Self

class piccolo.query.methods.insert.**OnConflictAction**(*value*, *names=None*, ***, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

Specify which action to take on conflict.

do_nothing = 'DO NOTHING'

do_update = 'DO UPDATE'

3.12 output

You can use `output` clauses with the following queries:

- *Select*
- *Objects*

3.12.1 Select queries only

as_json

To return the data as a JSON string:

```
>>> await Band.select(Band.name).output(as_json=True)
'[{"name":"Pythonistas"}]'
```

Piccolo can use orjson for JSON serialisation, which is blazing fast, and can handle most Python types, including dates, datetimes, and UUIDs. To install Piccolo with orjson support use `pip install 'piccolo[orjson]'`.

as_list

If you're just querying a single column from a database table, you can use `as_list` to flatten the results into a single list.

```
>>> await Band.select(Band.id).output(as_list=True)
[1, 2]
```

nested

Output any data from related tables in nested dictionaries.

```
>>> await Band.select(Band.name, Band.manager.name).first().output(nested=True)
{'name': 'Pythonistas', 'manager': {'name': 'Guido'}}
```

3.12.2 Select and Objects queries

load_json

If querying *JSON* or *JSONB* columns, you can tell Piccolo to deserialise the JSON values automatically.

```
>>> await RecordingStudio.select().output(load_json=True)
[{'id': 1, 'name': 'Abbey Road', 'facilities': {'restaurant': True, 'mixing_desk': True}}
↪]

>>> studio = await RecordingStudio.objects().first().output(load_json=True)
>>> studio.facilities
{'restaurant': True, 'mixing_desk': True}
```

3.13 returning

You can use the `returning` clause with the following queries:

- *Insert*
- *Update*
- *Delete*

By default, an update query returns an empty list, but using the `returning` clause you can retrieve values from the updated rows.

```
>>> await Band.update({
...     Band.name: 'Pythonistas Tribute Band'
... }).where(
...     Band.name == 'Pythonistas'
... ).returning(Band.id, Band.name)
[{'id': 1, 'name': 'Pythonistas Tribute Band'}]
```

Similarly, for an insert query - we can retrieve some of the values from the inserted rows:

```
>>> await Manager.insert(
...     Manager(name="Maz"),
...     Manager(name="Graydon")
... ).returning(Manager.id, Manager.name)

[{'id': 1, 'name': 'Maz'}, {'id': 1, 'name': 'Graydon'}]
```

As another example, let's use delete and return the full row(s):

```
>>> await Band.delete().where(
...     Band.name == "Pythonistas"
... ).returning(*Band.all_columns())

[{'id': 1, 'name': 'Pythonistas', 'manager': 1, 'popularity': 1000}]
```

By counting the number of elements of the returned list, you can find out how many rows were affected or processed by the operation.

Warning: This works for all versions of Postgres, but only SQLite 3.35.0 and above support the returning clause. See the *docs* on how to check your SQLite version.

3.14 as_of

Note: Cockroach only.

You can use `as_of` clause with the following queries:

- *Select*
- *Objects*

To retrieve historical data from 5 minutes ago:

```
await Band.select().where(
    Band.name == 'Pythonistas'
).as_of('-5min')
```

This generates an `AS OF SYSTEM TIME` clause. See documentation.

This clause accepts a wide variety of time and interval string formats.

This is very useful for performance, as it will reduce transaction contention across a cluster.

CHAPTER

FOUR

SCHEMA

The schema is how you define your database tables, columns and relationships.

4.1 Defining a Schema

The schema is usually defined within the `tables.py` file of your *Piccolo app*.

This reflects the tables in your database. Each table consists of several columns. Here's a very simple schema:

```
# tables.py
from piccolo.table import Table
from piccolo.columns import Varchar


class Band(Table):
    name = Varchar(length=100)
```

For a full list of columns, see *column types*.

Hint: If you're using an existing database, see Piccolo's *auto schema generation command*, which will save you some time.

4.1.1 Primary Key

Piccolo tables are automatically given a primary key column called `id`, which is an auto incrementing integer.

There is currently experimental support for specifying a custom primary key column. For example:

```
# tables.py
from piccolo.table import Table
from piccolo.columns import UUID, Varchar


class Band(Table):
    id = UUID(primary_key=True)
    name = Varchar(length=100)
```

4.1.2 Tablename

By default, the name of the table in the database is the Python class name, converted to snakecase. For example `Band -> band`, and `MusicAward -> music_award`.

You can specify a custom tablename to use instead.

```
class Band(Table, tablename="music_band"):
    name = Varchar(length=100)
```

4.1.3 Connecting to the database

In order to create the table and query the database, you need to provide Piccolo with your connection details. See *Engines*.

4.2 Column Types

Hint: You'll notice that the column names tend to match their SQL equivalents.

4.2.1 Column

class piccolo.columns.base.**Column**(*null: bool = False*, *primary_key: bool = False*, *unique: bool = False*, *index: bool = False*, *index_method:* IndexMethod *= IndexMethod.btree*, *required: bool = False*, *help_text: Optional[str] = None*, *choices: Optional[Type[Enum]] = None*, *db_column_name: Optional[str] = None*, *secret: bool = False*, *auto_update: Any = Ellipsis*, ***kwargs*)

All other columns inherit from `Column`. Don't use it directly.

The following arguments apply to all column types:

Parameters

- **null** – Whether the column is nullable.
- **primary_key** – If set, the column is used as a primary key.
- **default** – The column value to use if not specified by the user.
- **unique** – If set, a unique constraint will be added to the column.
- **index** – Whether an index is created for the column, which can improve the speed of selects, but can slow down inserts.
- **index_method** – If index is set to `True`, this specifies what type of index is created.
- **required** – This isn't used by the database - it's to indicate to other tools that the user must provide this value. Example uses are in serialisers for API endpoints, and form fields.
- **help_text** – This provides some context about what the column is being used for. For example, for a `Decimal` column called `value`, it could say `'The units are millions of dollars'`. The database doesn't use this value, but tools such as Piccolo Admin use it to show a tooltip in the GUI.

- **choices** – An optional Enum - when specified, other tools such as Piccolo Admin will render the available options in the GUI.
- **db_column_name** – If specified, you can override the name used for the column in the database. The main reason for this is when using a legacy database, with a problematic column name (for example `'class'`, which is a reserved Python keyword). Here's an example:

```
class MyTable(Table):
    class_ = Varchar(db_column_name="class")

>>> await MyTable.select(MyTable.class_)
[{'id': 1, 'class': 'test'}]
```

  This is an advanced feature which you should only need in niche situations.

- **secret** – If `secret=True` is specified, it allows a user to automatically omit any fields when doing a select query, to help prevent inadvertent leakage of sensitive data.

```
class Band(Table):
    name = Varchar()
    net_worth = Integer(secret=True)

>>> await Band.select(exclude_secrets=True)
[{'name': 'Pythonistas'}]
```

- **auto_update** – Allows you to specify a value to set this column to each time it is updated (via `MyTable.update`, or `MyTable.save` on an existing row). A common use case is having a `modified_on` column.

```
class Band(Table):
    name = Varchar()
    popularity = Integer()
    # The value can be a function or static value:
    modified_on = Timestamp(auto_update=datetime.datetime.now)

# This will automatically set the `modified_on` column to the
# current timestamp, without having to explicitly set it:
>>> await Band.update({
...     Band.popularity: Band.popularity + 100
... }).where(Band.name == 'Pythonistas')
```

  Note - this feature is implemented purely within the ORM. If you want similar functionality on the database level (i.e. if you plan on using raw SQL to perform updates), then you may be better off creating SQL triggers instead.

4.2.2 Bytea

class piccolo.columns.column_types.**Bytea**(*default: Optional[Union[bytes, bytearray, Enum, Callable[[], bytes], Callable[[], bytearray]]] = b''*, ***kwargs*)

Used for storing bytes.

Example

```
class Token(Table):
    token = Bytea(default=b'token123')

# Create
>>> await Token(token=b'my-token').save()

# Query
>>> await Token.select(Token.token)
{'token': b'my-token'}
```

Hint: There is also a `Blob` column type, which is an alias for `Bytea`.

4.2.3 Boolean

class piccolo.columns.column_types.**Boolean**(*default: Optional[Union[bool, Enum, Callable[[], bool]]] = False*, ***kwargs*)

Used for storing `True` / `False` values. Uses the `bool` type for values.

Example

```
class Band(Table):
    has_drummer = Boolean()

# Create
>>> await Band(has_drummer=True).save()

# Query
>>> await Band.select(Band.has_drummer)
{'has_drummer': True}
```

4.2.4 ForeignKey

class piccolo.columns.column_types.**ForeignKey**(*references: t.Union[t.Type[Table], LazyTableReference, str], default: t.Any = None, null: bool = True, on_delete: OnDelete = OnDelete.cascade, on_update: OnUpdate = OnUpdate.cascade, target_column: t.Union[str, Column, None] = None*, ***kwargs*)

Used to reference another table. Uses the same type as the primary key column on the table it references.

Example

```
class Band(Table):
    manager = ForeignKey(references=Manager)

# Create
>>> await Band(manager=1).save()

# Query
>>> await Band.select(Band.manager)
{'manager': 1}

# Query object
>>> band = await Band.objects().first()
>>> band.manager
1
```

Joins

You also use it to perform joins:

```
>>> await Band.select(Band.name, Band.manager.name).first()
{'name': 'Pythonistas', 'manager.name': 'Guido'}
```

To retrieve all of the columns in the related table:

```
>>> await Band.select(Band.name, *Band.manager.all_columns()).first()
{'name': 'Pythonistas', 'manager.id': 1, 'manager.name': 'Guido'}
```

To get a referenced row as an object:

```
manager = await Manager.objects().where(
    Manager.id == some_band.manager
)
```

Or use either of the following, which are just a proxy to the above:

```
manager = await band.get_related('manager')
manager = await band.get_related(Band.manager)
```

To change the manager:

```
band.manager = some_manager_id
await band.save()
```

Parameters

- **references** – The `Table` being referenced.

  ```
  class Band(Table):
      manager = ForeignKey(references=Manager)
  ```

  A table can have a reference to itself, if you pass a `references` argument of `'self'`.

  ```
  class Musician(Table):
      name = Varchar(length=100)
      instructor = ForeignKey(references='self')
  ```

In certain situations, you may be unable to reference a `Table` class if it causes a circular dependency. Try and avoid these by refactoring your code. If unavoidable, you can specify a lazy reference. If the `Table` is defined in the same file:

```
class Band(Table):
    manager = ForeignKey(references='Manager')
```

If the `Table` is defined in a Piccolo app:

```
from piccolo.columns.reference import LazyTableReference

class Band(Table):
    manager = ForeignKey(
        references=LazyTableReference(
           table_class_name="Manager", app_name="my_app",
        )
    )
```

If you aren't using Piccolo apps, you can specify a `Table` in any Python module:

```
from piccolo.columns.reference import LazyTableReference

class Band(Table):
    manager = ForeignKey(
        references=LazyTableReference(
           table_class_name="Manager",
           module_path="some_module.tables",
        )
        # Alternatively, Piccolo will interpret this string as
        # the same as above:
        # references="some_module.tables.Manager"
    )
```

- **on_delete** – Determines what the database should do when a row is deleted with foreign keys referencing it. If set to `OnDelete.cascade`, any rows referencing the deleted row are also deleted.

  Options:

  – `OnDelete.cascade` (default)

  – `OnDelete.restrict`

  – `OnDelete.no_action`

  – `OnDelete.set_null`

  – `OnDelete.set_default`

  To learn more about the different options, see the Postgres docs.

```
from piccolo.columns import OnDelete

class Band(Table):
    name = ForeignKey(
        references=Manager,
        on_delete=OnDelete.cascade
    )
```

- **on_update** – Determines what the database should do when a row has it's primary key updated. If set to `OnUpdate.cascade`, any rows referencing the updated row will have their references updated to point to the new primary key.

  Options:

  – `OnUpdate.cascade` (default)

  – `OnUpdate.restrict`

  – `OnUpdate.no_action`

  – `OnUpdate.set_null`

  – `OnUpdate.set_default`

  To learn more about the different options, see the Postgres docs.

```
from piccolo.columns import OnUpdate

class Band(Table):
    name = ForeignKey(
        references=Manager,
        on_update=OnUpdate.cascade
    )
```

- **target_column** – By default the `ForeignKey` references the primary key column on the related table. You can specify an alternative column (it must have a unique constraint on it though). For example:

```
# Passing in a column reference:
ForeignKey(references=Manager, target_column=Manager.passport_number)

# Or just the column name:
ForeignKey(references=Manager, target_column='passport_number')
```

4.2.5 Number

BigInt

class piccolo.columns.column_types.**BigInt**(*default: Optional[Union[int, Enum, Callable[[], int]]] = 0*, ***kwargs*)

In Postgres, this column supports large integers. In SQLite, it's an alias to an Integer column, which already supports large integers. Uses the `int` type for values.

Example

```
class Band(Table):
    value = BigInt()

# Create
>>> await Band(popularity=1000000).save()

# Query
```

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```
>>> await Band.select(Band.popularity)
{'popularity': 1000000}
```

BigSerial

class piccolo.columns.column_types.**BigSerial**(*null: bool = False*, *primary_key: bool = False*, *unique: bool = False*, *index: bool = False*, *index_method: IndexMethod = IndexMethod.btree*, *required: bool = False*, *help_text: Optional[str] = None*, *choices: Optional[Type[Enum]] = None*, *db_column_name: Optional[str] = None*, *secret: bool = False*, *auto_update: Any = Ellipsis*, ***kwargs*)

An alias to a large autoincrementing integer column in Postgres.

Double Precision

class piccolo.columns.column_types.**DoublePrecision**(*default: Optional[Union[float, Enum, Callable[[], float]]] = 0.0*, ***kwargs*)

The same as `Real`, except the numbers are stored with greater precision.

Integer

class piccolo.columns.column_types.**Integer**(*default: Optional[Union[int, Enum, Callable[[], int]]] = 0*, ***kwargs*)

Used for storing whole numbers. Uses the `int` type for values.

Example

```
class Band(Table):
    popularity = Integer()

# Create
>>> await Band(popularity=1000).save()

# Query
>>> await Band.select(Band.popularity)
{'popularity': 1000}
```

Numeric

class piccolo.columns.column_types.**Numeric**(*digits: Optional[Tuple[int, int]] = None*, *default: Optional[Union[Decimal, Enum, Callable[[], Decimal]]] = Decimal('0')*, ***kwargs*)

Used for storing decimal numbers, when precision is important. An example use case is storing financial data. The value is returned as a `Decimal`.

Example

```
from decimal import Decimal

class Ticket(Table):
    price = Numeric(digits=(5,2))

# Create
>>> await Ticket(price=Decimal('50.0')).save()

# Query
>>> await Ticket.select(Ticket.price)
{'price': Decimal('50.0')}
```

Parameters

digits – When creating the column, you specify how many digits are allowed using a tuple. The first value is the `precision`, which is the total number of digits allowed. The second value is the `range`, which specifies how many of those digits are after the decimal point. For example, to store monetary values up to £999.99, the digits argument is `(5,2)`.

Hint: There is also a `Decimal` column type, which is an alias for `Numeric`.

Real

class piccolo.columns.column_types.**Real**(*default: Optional[Union[float, Enum, Callable[[], float]]] = 0.0*, ***kwargs*)

Can be used instead of `Numeric` for storing numbers, when precision isn't as important. The `float` type is used for values.

Example

```
class Concert(Table):
    rating = Real()

# Create
>>> await Concert(rating=7.8).save()

# Query
>>> await Concert.select(Concert.rating)
{'rating': 7.8}
```

Hint: There is also a `Float` column type, which is an alias for `Real`.

Serial

class piccolo.columns.column_types.**Serial**(*null: bool = False*, *primary_key: bool = False*, *unique: bool = False*, *index: bool = False*, *index_method: IndexMethod = IndexMethod.btree*, *required: bool = False*, *help_text: Optional[str] = None*, *choices: Optional[Type[Enum]] = None*, *db_column_name: Optional[str] = None*, *secret: bool = False*, *auto_update: Any = Ellipsis*, ***kwargs*)

An alias to an autoincrementing integer column in Postgres.

SmallInt

class piccolo.columns.column_types.**SmallInt**(*default: Optional[Union[int, Enum, Callable[[], int]]] = 0*, ***kwargs*)

In Postgres, this column supports small integers. In SQLite, it's an alias to an Integer column. Uses the `int` type for values.

Example

```
class Band(Table):
    value = SmallInt()

# Create
>>> await Band(popularity=1000).save()

# Query
>>> await Band.select(Band.popularity)
{'popularity': 1000}
```

4.2.6 UUID

class piccolo.columns.column_types.**UUID**(*default: Optional[Union[UUID4, UUID, str, Enum]] = UUID4()*, ***kwargs*)

Used for storing UUIDs - in Postgres a UUID column type is used, and in SQLite it's just a Varchar. Uses the `uuid.UUID` type for values.

Example

```
import uuid

class Band(Table):
    uuid = UUID()

# Create
>>> await DiscountCode(code=uuid.uuid4()).save()

# Query
>>> await DiscountCode.select(DiscountCode.code)
{'code': UUID('09c4c17d-af68-4ce7-9955-73dcd892e462')}
```

4.2.7 Text

Secret

class piccolo.columns.column_types.**Secret**(**args*, ***kwargs*)

This is just an alias to `Varchar(secret=True)`. It's here for backwards compatibility.

Text

class piccolo.columns.column_types.**Text**(*default: Union[str, Enum, None, Callable[[], str]] = ''*, ***kwargs*)

Use when you want to store large strings, and don't want to limit the string size. Uses the `str` type for values.

Example

```
class Band(Table):
    name = Text()

# Create
>>> await Band(name='Pythonistas').save()

# Query
>>> await Band.select(Band.name)
{'name': 'Pythonistas'}
```

Varchar

class piccolo.columns.column_types.**Varchar**(*length: int = 255*, *default: Optional[Union[str, Enum, Callable[[], str]]] = ''*, ***kwargs*)

Used for storing text when you want to enforce character length limits. Uses the `str` type for values.

Example

```
class Band(Table):
    name = Varchar(length=100)

# Create
>>> await Band(name='Pythonistas').save()

# Query
>>> await Band.select(Band.name)
{'name': 'Pythonistas'}
```

Parameters

length – The maximum number of characters allowed.

Email

class piccolo.columns.column_types.**Email**(*length: int = 255*, *default: Optional[Union[str, Enum, Callable[[], str]]] = ''*, ***kwargs*)

Used for storing email addresses. It's identical to `Varchar`, except when using `create_pydantic_model` - we add email validation to the Pydantic model. This means that *Piccolo Admin* also validates emails addresses.

4.2.8 Time

Date

class piccolo.columns.column_types.**Date**(*default: Union[DateOffset, DateCustom, DateNow, Enum, None, date] = DateNow()*, ***kwargs*)

Used for storing dates. Uses the `date` type for values.

Example

```
import datetime

class Concert(Table):
    starts = Date()

# Create
>>> await Concert(
...     starts=datetime.date(year=2020, month=1, day=1)
... ).save()

# Query
>>> await Concert.select(Concert.starts)
{'starts': datetime.date(2020, 1, 1)}
```

Interval

class piccolo.columns.column_types.**Interval**(*default: Union[IntervalCustom, Enum, None, timedelta] = IntervalCustom(weeks=0, days=0, hours=0, minutes=0, seconds=0, milliseconds=0, microseconds=0)*, ***kwargs*)

Used for storing timedeltas. Uses the `timedelta` type for values.

Example

```
from datetime import timedelta

class Concert(Table):
    duration = Interval()

# Create
>>> await Concert(
...     duration=timedelta(hours=2)
... ).save()
```

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```
# Query
>>> await Concert.select(Concert.duration)
{'duration': datetime.timedelta(seconds=7200)}
```

Time

class piccolo.columns.column_types.**Time**(*default: Union[TimeCustom, TimeNow, TimeOffset, Enum, None, time] = TimeNow()*, ***kwargs*)

Used for storing times. Uses the `time` type for values.

Example

```
import datetime

class Concert(Table):
    starts = Time()

# Create
>>> await Concert(
...     starts=datetime.time(hour=20, minute=0, second=0)
... ).save()

# Query
>>> await Concert.select(Concert.starts)
{'starts': datetime.time(20, 0, 0)}
```

Timestamp

class piccolo.columns.column_types.**Timestamp**(*default: Union[TimestampCustom, TimestampNow, TimestampOffset, Enum, None, datetime, DatetimeDefault] = TimestampNow()*, ***kwargs*)

Used for storing datetimes. Uses the `datetime` type for values.

Example

```
import datetime

class Concert(Table):
    starts = Timestamp()

# Create
>>> await Concert(
...     starts=datetime.datetime(year=2050, month=1, day=1)
... ).save()

# Query
>>> await Concert.select(Concert.starts)
{'starts': datetime.datetime(2050, 1, 1, 0, 0)}
```

Timestamptz

class piccolo.columns.column_types.**Timestamptz**(*default: Union[TimestamptzCustom, TimestamptzNow, TimestamptzOffset, Enum, None, datetime] = TimestamptzNow()*, ***kwargs*)

Used for storing timezone aware datetimes. Uses the `datetime` type for values. The values are converted to UTC in the database, and are also returned as UTC.

Example

```
import datetime

class Concert(Table):
    starts = Timestamptz()

# Create
>>> await Concert(
...     starts=datetime.datetime(
...         year=2050, month=1, day=1, tzinfo=datetime.timezone.tz
...     )
... ).save()

# Query
>>> await Concert.select(Concert.starts)
{
    'starts': datetime.datetime(
        2050, 1, 1, 0, 0, tzinfo=datetime.timezone.utc
    )
}
```

4.2.9 JSON

Storing JSON can be useful in certain situations, for example - raw API responses, data from a Javascript app, and for storing data with an unknown or changing schema.

JSON

class piccolo.columns.column_types.**JSON**(*default: Optional[Union[str, List, Dict, Callable[[], Union[str, List, Dict]]]] = '{}'*, ***kwargs*)

Used for storing JSON strings. The data is stored as text. This can be preferable to JSONB if you just want to store and retrieve JSON without querying it directly. It works with SQLite and Postgres.

Parameters

default – Either a JSON string can be provided, or a Python `dict` or `list` which is then converted to a JSON string.

JSONB

class piccolo.columns.column_types.**JSONB**(*default: Optional[Union[str, List, Dict, Callable[[], Union[str, List, Dict]]]] = '{}'*, ***kwargs*)

Used for storing JSON strings - Postgres only. The data is stored in a binary format, and can be queried. Insertion can be slower (as it needs to be converted to the binary format). The benefits of JSONB generally outweigh the downsides.

Parameters

default – Either a JSON string can be provided, or a Python `dict` or `list` which is then converted to a JSON string.

Serialising

Piccolo automatically converts Python values into JSON strings:

```
studio = RecordingStudio(
    name="Abbey Road",
    facilities={"restaurant": True, "mixing_desk": True}  # Automatically serialised
)
await studio.save()
```

You can also pass in a JSON string if you prefer:

```
studio = RecordingStudio(
    name="Abbey Road",
    facilities='{"restaurant": true, "mixing_desk": true}'
)
await studio.save()
```

Deserialising

The contents of a `JSON` / `JSONB` column are returned as a string by default:

```
>>> await RecordingStudio.select(RecordingStudio.facilities)
[{facilities: '{"restaurant": true, "mixing_desk": true}'}]
```

However, we can ask Piccolo to deserialise the JSON automatically (see *load_json*):

```
>>> await RecordingStudio.select(
...     RecordingStudio.facilities
... ).output(
...     load_json=True
... )
[facilities: {"restaurant": True, "mixing_desk": True}}]
```

With `objects` queries, we can modify the returned JSON, and then save it:

```
studio = await RecordingStudio.objects().get(
    RecordingStudio.name == 'Abbey Road'
).output(load_json=True)
```

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```
studio['facilities']['restaurant'] = False
await studio.save()
```

arrow

`JSONB` columns have an `arrow` function, which is useful for retrieving a subset of the JSON data:

```
>>> await RecordingStudio.select(
...     RecordingStudio.name,
...     RecordingStudio.facilities.arrow('mixing_desk').as_alias('mixing_desk')
... ).output(load_json=True)
[{'name': 'Abbey Road', 'mixing_desk': True}]
```

It can also be used for filtering in a where clause:

```
>>> await RecordingStudio.select(RecordingStudio.name).where(
...     RecordingStudio.facilities.arrow('mixing_desk') == True
... )
[{'name': 'Abbey Road'}]
```

Handling null

When assigning a value of `None` to a `JSON` or `JSONB` column, this is treated as null in the database.

```
await RecordingStudio(name="ABC Studios", facilities=None).save()

>>> await RecordingStudio.select(
...     RecordingStudio.facilities
... ).where(
...     RecordingStudio.name == "ABC Studios"
... )
[{'facilities': None}]
```

If instead you want to store JSON null in the database, assign a value of `'null'` instead.

```
await RecordingStudio(name="ABC Studios", facilities='null').save()

>>> await RecordingStudio.select(
...     RecordingStudio.facilities
... ).where(
...     RecordingStudio.name == "ABC Studios"
... )
[{'facilities': 'null'}]
```

4.2.10 Array

Arrays of data can be stored, which can be useful when you want to store lots of values without using foreign keys.

class piccolo.columns.column_types.**Array**(*base_column:* Column, *default:* *Optional[Union[List, Enum, Callable[[], List]]]* = *list*, ***kwargs*)

Used for storing lists of data.

Example

```
class Ticket(Table):
    seat_numbers = Array(base_column=Integer())

# Create
>>> await Ticket(seat_numbers=[34, 35, 36]).save()

# Query
>>> await Ticket.select(Ticket.seat_numbers)
{'seat_numbers': [34, 35, 36]}
```

Accessing individual elements

Array.**__getitem__**(*value: int*) → *Array*

Allows queries which retrieve an item from the array. The index starts with 0 for the first value. If you were to write the SQL by hand, the first index would be 1 instead (see Postgres array docs).

However, we keep the first index as 0 to fit better with Python.

For example:

```
>>> await Ticket.select(Ticket.seat_numbers[0]).first()
{'seat_numbers': 325}
```

any

Array.**any**(*value: Any*) → Where

Check if any of the items in the array match the given value.

```
>>> await Ticket.select().where(Ticket.seat_numbers.any(510))
```

all

Array.**all**(*value: Any*) → Where

Check if all of the items in the array match the given value.

```
>>> await Ticket.select().where(Ticket.seat_numbers.all(510))
```

cat

`Array.cat(value: List[Any])` → QueryString

Used in an `update` query to append items to an array.

```
>>> await Ticket.update({
...     Ticket.seat_numbers: Ticket.seat_numbers.cat([1000])
... }).where(Ticket.id == 1)
```

You can also use the + symbol if you prefer:

```
>>> await Ticket.update({
...     Ticket.seat_numbers: Ticket.seat_numbers + [1000]
... }).where(Ticket.id == 1)
```

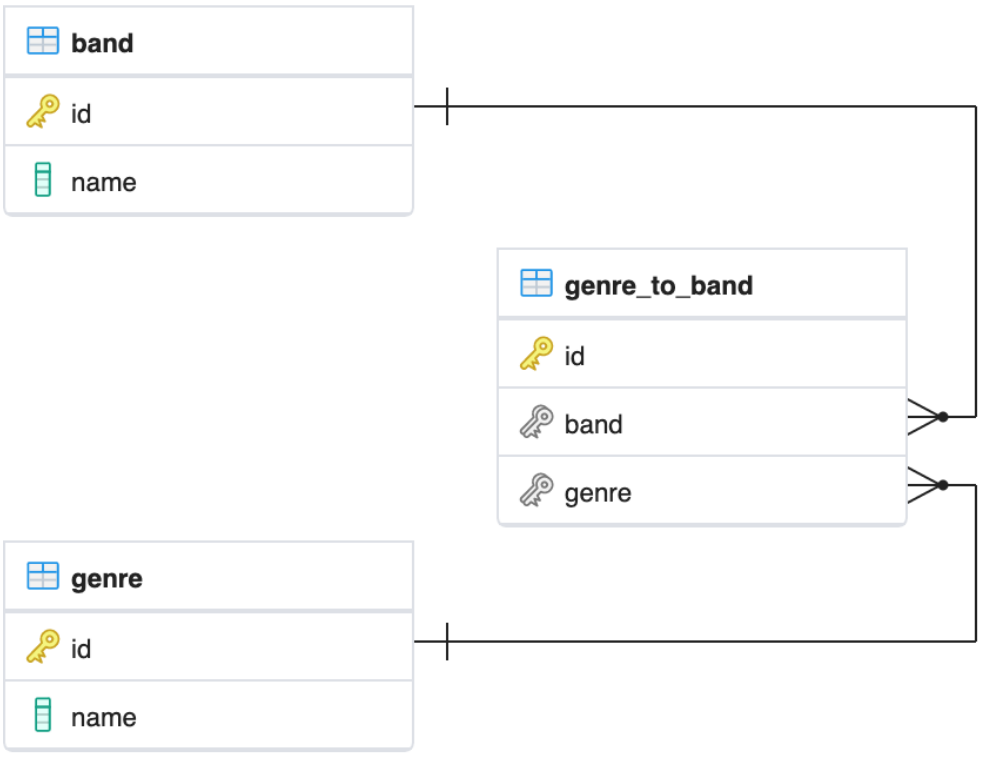
4.3 M2M

Note: There is a video tutorial on YouTube.

Sometimes in database design you need many-to-many (M2M) relationships.

For example, we might have our `Band` table, and want to describe which genres of music each band belongs to (e.g. rock and electronic). As each band can have multiple genres, a `ForeignKey` on the `Band` table won't suffice. Our options are using an `Array` / `JSON` / `JSONB` column, or using an `M2M` relationship.

Postgres and SQLite don't natively support `M2M` relationships - we create them using a joining table which has foreign keys to each of the related tables (in our example, `Genre` and `Band`).



We create it in Piccolo like this:

```
from piccolo.columns.column_types import (
    ForeignKey,
    LazyTableReference,
    Varchar
)
from piccolo.columns.m2m import M2M
from piccolo.table import Table


class Band(Table):
    name = Varchar()
    genres = M2M(LazyTableReference("GenreToBand", module_path=__name__))


class Genre(Table):
    name = Varchar()
    bands = M2M(LazyTableReference("GenreToBand", module_path=__name__))


# This is our joining table:
class GenreToBand(Table):
    band = ForeignKey(Band)
    genre = ForeignKey(Genre)
```

Note: We use `LazyTableReference` because when Python evaluates `Band` and `Genre`, the `GenreToBand` class

doesn't exist yet.

By using `M2M` it unlocks some powerful and convenient features.

4.3.1 Select queries

If we want to select each band, along with a list of genres that they belong to, we can do this:

```
>>> await Band.select(Band.name, Band.genres(Genre.name, as_list=True))
[
    {"name": "Pythonistas", "genres": ["Rock", "Folk"]},
    {"name": "Rustaceans", "genres": ["Folk"]},
    {"name": "C-Sharps", "genres": ["Rock", "Classical"]},
]
```

You can request whichever column you like from the related table:

```
>>> await Band.select(Band.name, Band.genres(Genre.id, as_list=True))
[
    {"name": "Pythonistas", "genres": [1, 2]},
    {"name": "Rustaceans", "genres": [2]},
    {"name": "C-Sharps", "genres": [1, 3]},
]
```

You can also request multiple columns from the related table:

```
>>> await Band.select(Band.name, Band.genres(Genre.id, Genre.name))
[
    {
        'name': 'Pythonistas',
        'genres': [
            {'id': 1, 'name': 'Rock'},
            {'id': 2, 'name': 'Folk'}
        ]
    },
    ...
]
```

If you omit the columns argument, then all of the columns are returned.

```
>>> await Band.select(Band.name, Band.genres())
[
    {
        'name': 'Pythonistas',
        'genres': [
            {'id': 1, 'name': 'Rock'},
            {'id': 2, 'name': 'Folk'}
        ]
    },
    ...
]
```

As we defined `M2M` on the `Genre` table too, we can get each band in a given genre:

```
>>> await Genre.select(Genre.name, Genre.bands(Band.name, as_list=True))
[
    {"name": "Rock", "bands": ["Pythonistas", "C-Sharps"]},
    {"name": "Folk", "bands": ["Pythonistas", "Rustaceans"]},
    {"name": "Classical", "bands": ["C-Sharps"]},
]
```

4.3.2 Objects queries

Piccolo makes it easy working with objects and `M2M` relationship.

add_m2m

Table.**add_m2m**(**rows:* Table, *m2m: M2M*, *extra_column_values: Dict[Union[*Column*, str], Any] = {}*) → M2MAddRelated

Save the row if it doesn't already exist in the database, and insert an entry into the joining table.

```
>>> band = await Band.objects().get(Band.name == "Pythonistas")
>>> await band.add_m2m(
...     Genre(name="Punk rock"),
...     m2m=Band.genres
... )
[{'id': 1}]
```

Parameters

extra_column_values – If the joining table has additional columns besides the two required foreign keys, you can specify the values for those additional columns. For example, if this is our joining table:

```
class GenreToBand(Table):
    band = ForeignKey(Band)
    genre = ForeignKey(Genre)
    reason = Text()
```

We can provide the `reason` value:

```
await band.add_m2m(
    Genre(name="Punk rock"),
    m2m=Band.genres,
    extra_column_values={
        "reason": "Their second album was very punk."
    }
)
```

get_m2m

Table.**get_m2m**(*m2m: M2M*) → M2MGetRelated

Get all matching rows via the join table.

```
>>> band = await Band.objects().get(Band.name == "Pythonistas")
>>> await band.get_m2m(Band.genres)
[<Genre: 1>, <Genre: 2>]
```

remove_m2m

Table.**remove_m2m**(**rows: Table*, *m2m: M2M*) → M2MRemoveRelated

Remove the rows from the joining table.

```
>>> band = await Band.objects().get(Band.name == "Pythonistas")
>>> genre = await Genre.objects().get(Genre.name == "Rock")
>>> await band.remove_m2m(
...     genre,
...     m2m=Band.genres
... )
```

Hint: All of these methods can be run synchronously as well - for example, `band.get_m2m(Band.genres).run_sync()`.

4.4 Advanced

4.4.1 Schemas

Postgres and CoackroachDB have a concept called **schemas**.

It's a way of grouping the tables in a database. To learn more:

- Postgres docs
- CockroachDB docs

To specify a table's schema, do the following:

```
class Band(Table, schema="music"):
    ...

# The table will be created in the `music` schema.
# The music schema will also be created if it doesn't already exist.
>>> await Band.create_table()
```

If the `schema` argument isn't specified, then the table is created in the `public` schema.

Migration support

Schemas are fully supported in *database migrations*. For example, if we change the `schema` argument:

```
class Band(Table, schema="music_2"):
    ...
```

Then create an automatic migration and run it, then the table will be moved to the new schema:

```
>>> piccolo migrations new my_app --auto
>>> piccolo migrations forwards my_app
```

SchemaManager

The *SchemaManager* class is used internally by Piccolo to interact with schemas. You may find it useful if you want to write a script to interact with schemas (create / delete / list etc).

4.4.2 Readable

Sometimes Piccolo needs a succinct representation of a row - for example, when displaying a link in the *Piccolo Admin*. Rather than just displaying the row ID, we can specify something more user friendly using `Readable`.

```
# tables.py
from piccolo.table import Table
from piccolo.columns import Varchar
from piccolo.columns.readable import Readable


class Band(Table, tablename="music_band"):
    name = Varchar(length=100)

    @classmethod
    def get_readable(cls):
        return Readable(template="%s", columns=[cls.name])
```

Specifying the `get_readable` classmethod isn't just beneficial for Piccolo tooling - you can also use it your own queries.

```
await Band.select(Band.get_readable())
```

Here is an example of a more complex `Readable`.

```
class Band(Table, tablename="music_band"):
    name = Varchar(length=100)

    @classmethod
    def get_readable(cls):
        return Readable(template="Band %s - %s", columns=[cls.id, cls.name])
```

As you can see, the template can include multiple columns, and can contain your own text.

4.4.3 Table Tags

`Table` subclasses can be given tags. The tags can be used for filtering, for example with *table_finder*.

```
class Band(Table, tags=["music"]):
    name = Varchar(length=100)
```

4.4.4 Mixins

If you're frequently defining the same columns over and over again, you can use mixins to reduce the amount of repetition.

```
from piccolo.columns import Varchar, Boolean
from piccolo.table import Table


class FavouriteMixin:
    favourite = Boolean(default=False)


class Manager(FavouriteMixin, Table):
    name = Varchar()
```

4.4.5 Choices

You can specify choices for a column, using Python's `Enum` support.

```
from enum import Enum

from piccolo.columns import Varchar
from piccolo.table import Table


class Shirt(Table):
    class Size(str, Enum):
        small = 's'
        medium = 'm'
        large = 'l'

    size = Varchar(length=1, choices=Size)
```

We can then use the `Enum` in our queries.

```
>>> await Shirt(size=Shirt.Size.large).save()

>>> await Shirt.select()
[{'id': 1, 'size': 'l'}]
```

Note how the value stored in the database is the `Enum` value (in this case `'l'`).

You can also use the `Enum` in `where` clauses, and in most other situations where a query requires a value.

```
>>> await Shirt.insert(
...     Shirt(size=Shirt.Size.small),
...     Shirt(size=Shirt.Size.medium)
... )

>>> await Shirt.select().where(Shirt.size == Shirt.Size.small)
[{'id': 1, 'size': 's'}]
```

Advantages

By using choices, you get the following benefits:

- Signalling to other programmers what values are acceptable for the column.
- Improved storage efficiency (we can store `'l'` instead of `'large'`).
- Piccolo Admin support

`Array` columns

You can also use choices with *`Array`* columns.

```
class Ticket(Table):
    class Extras(str, enum.Enum):
        drink = "drink"
        snack = "snack"
        program = "program"

    extras = Array(Varchar(), choices=Extras)
```

Note how you pass `choices` to `Array`, and not the `base_column`:

```
# CORRECT:
Array(Varchar(), choices=Extras)

# INCORRECT:
Array(Varchar(choices=Extras))
```

We can then use the `Enum` in our queries:

```
>>> await Ticket.insert(
...     Ticket(extras=[Extras.drink, Extras.snack]),
...     Ticket(extras=[Extras.program]),
... )
```

4.4.6 Reflection

This is a very advanced feature, which is only required for specialist use cases. Currently, just Postgres is supported.

Instead of writing your `Table` definitions in a `tables.py` file, Piccolo can dynamically create them at run time, by inspecting the database. These `Table` classes are then stored in memory, using a singleton object called `TableStorage`.

Some example use cases:

- You have a very dynamic database, where new tables are being created constantly, so updating a `tables.py` is impractical.
- You use Piccolo on the command line to explore databases.

Full reflection

Here's an example, where we reflect the entire schema:

```
from piccolo.table_reflection import TableStorage

storage = TableStorage()
await storage.reflect(schema_name="music")
```

`Table` objects are accessible from `TableStorage.tables`:

```
>>> storage.tables
{"music.Band": <class 'Band'>, ... }

>>> Band = storage.tables["music.Band"]
```

Then you can use them like your normal `Table` classes:

```
>>> await Band.select()
[{'id': 1, 'name': 'Pythonistas', 'manager': 1}, ...]
```

Partial reflection

Full schema reflection can be a heavy process based on the size of your schema. You can use `include`, `exclude` and `keep_existing` parameters of the `reflect` method to limit the overhead dramatically.

Only reflect the needed table(s):

```
from piccolo.table_reflection import TableStorage

storage = TableStorage()
await storage.reflect(schema_name="music", include=['band', ...])
```

Exclude table(s):

```
await storage.reflect(schema_name="music", exclude=['band', ...])
```

If you set `keep_existing=True`, only new tables on the database will be reflected and the existing tables in `TableStorage` will be left intact.

```
await storage.reflect(schema_name="music", keep_existing=True)
```

get_table

`TableStorage` has a helper method named `get_table`. If the table is already present in the `TableStorage`, this will return it and if the table is not present, it will be reflected and returned.

```
Band = storage.get_table(tablename='band')
```

Hint: Reflection will automatically create `Table` classes for referenced tables too. For example, if `Table1` references `Table2`, then `Table2` will automatically be added to `TableStorage`.

4.4.7 How to create custom column types

Sometimes, the column types shipped with Piccolo don't meet your requirements, and you will need to define your own column types.

Generally there are two ways to define your own column types:

- Create a subclass of an existing column type; or
- Directly subclass the *Column* class.

Try to use the first method whenever possible because it is more straightforward and can often save you some work. Otherwise, subclass *Column*.

Example

In this example, we create a column type called `MyColumn`, which is fundamentally an `Integer` type but has a custom attribute `custom_attr`:

```
from piccolo.columns import Integer

class MyColumn(Integer):
    def __init__(self, *args, custom_attr: str = '', **kwargs):
        self.custom_attr = custom_attr
        super().__init__(*args, **kwargs)

    @property
    def column_type(self):
        return 'INTEGER'
```

Hint: It is **important** to specify the `column_type` property, which tells the database engine the **actual** storage type of the custom column.

Now we can use `MyColumn` in our table:

```
from piccolo.table import Table

class MyTable(Table):
    my_col = MyColumn(custom_attr='foo')
    ...
```

And later we can retrieve the value of the attribute:

```
>>> MyTable.my_col.custom_attr
'foo'
```

CHAPTER

FIVE

PROJECTS AND APPS

By using Piccolo projects and apps, you can build a larger, more modular, application.

5.1 Piccolo Projects

A Piccolo project is a collection of apps.

5.1.1 piccolo_conf.py

A project requires a `piccolo_conf.py` file. To create this, use the following command:

```
piccolo project new
```

The file serves two important purposes:

- Contains your database settings.
- Is used for registering *Piccolo Apps*.

Location

By convention, the `piccolo_conf.py` file should be at the root of your project:

```
my_project/
    piccolo_conf.py
    my_app/
        piccolo_app.py
```

This means that when you use the `piccolo` CLI from the `my_project` folder it can import `piccolo_conf.py`.

If you prefer to keep `piccolo_conf.py` in a different location, or to give it a different name, you can do so using the `PICCOLO_CONF` environment variable (see *PICCOLO_CONF*). For example:

```
my_project/
    conf/
        piccolo_conf_local.py
    my_app/
        piccolo_app.py
```

```
export PICCOLO_CONF=conf.piccolo_conf_local
```

5.1.2 Example

Here's an example:

```
from piccolo.engine.postgres import PostgresEngine


from piccolo.conf.apps import AppRegistry


DB = PostgresEngine(
    config={
        "database": "piccolo_project",
        "user": "postgres",
        "password": "",
        "host": "localhost",
        "port": 5432,
    }
)


APP_REGISTRY = AppRegistry(
    apps=["home.piccolo_app", "piccolo_admin.piccolo_app"]
)
```

5.1.3 DB

The DB setting is an `Engine` instance (see the *Engine docs*).

5.1.4 APP_REGISTRY

The `APP_REGISTRY` setting is an `AppRegistry` instance.

class piccolo.conf.apps.**AppRegistry**(*apps: List[str] = None*)

Records all of the Piccolo apps in your project. Kept in `piccolo_conf.py`.

Parameters

apps – A list of paths to Piccolo apps, e.g. `['blog.piccolo_app']`.

5.2 Piccolo Apps

By leveraging Piccolo apps you can:

- Modularise your code.
- Share your apps with other Piccolo users.
- Unlock some useful functionality like auto migrations.

5.2.1 Creating an app

Run the following command within your project:

```
piccolo app new my_app
```

Where `my_app` is your new app's name. This will create a folder like this:

```
my_app/
    __init__.py
    piccolo_app.py
    piccolo_migrations/
        __init__.py
    tables.py
```

It's important to register your new app with the `APP_REGISTRY` in `piccolo_conf.py`.

```
# piccolo_conf.py
APP_REGISTRY = AppRegistry(apps=['my_app.piccolo_app'])
```

Anytime you invoke the `piccolo` command, you will now be able to perform operations on your app, such as *Migrations*.

5.2.2 AppConfig

Inside your app's `piccolo_app.py` file is an `AppConfig` instance. This is how you customise your app's settings.

```
# piccolo_app.py
import os

from piccolo.conf.apps import AppConfig
from .tables import (
    Author,
    Post,
    Category,
    CategoryToPost,
)


CURRENT_DIRECTORY = os.path.dirname(os.path.abspath(__file__))
```

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```
APP_CONFIG = AppConfig(
    app_name='blog',
    migrations_folder_path=os.path.join(
        CURRENT_DIRECTORY,
        'piccolo_migrations'
    ),
    table_classes=[Author, Post, Category, CategoryToPost],
    migration_dependencies=[],
    commands=[]
)
```

app_name

This is used to identify your app, when using the `piccolo` CLI, for example:

```
piccolo migrations forwards blog
```

migrations_folder_path

Specifies where your app's migrations are stored. By default, a folder called `piccolo_migrations` is used.

table_classes

Use this to register your app's `Table` subclasses. This is important for *auto migrations*.

You can register them manually (see the example above), or can use *table_finder*.

migration_dependencies

Used to specify other Piccolo apps whose migrations need to be run before the current app's migrations.

commands

You can register functions and coroutines, which are automatically added to the `piccolo` CLI.

The targ library is used under the hood. It makes it really easy to write command lines tools - just use type annotations and docstrings. Here's an example:

```
def say_hello(name: str):
    """
    Say hello.

    :param name:
        The person to greet.

    """
    print("hello,", name)
```

We then register it with the `AppConfig`.

```
# piccolo_app.py

APP_CONFIG = AppConfig(
    # ...
    commands=[say_hello]
)
```

And from the command line:

```
>>> piccolo my_app say_hello bob
hello, bob
```

If the code contains an error to see more details in the output add a `--trace` flag to the command line.

```
>>> piccolo my_app say_hello bob --trace
```

By convention, store the command definitions in a `commands` folder in your app.

```
my_app/
    __init__.py
    piccolo_app.py
    commands/
        __init__.py
        say_hello.py
```

Piccolo itself is bundled with several apps - have a look at the source code for inspiration.

5.2.3 table_finder

Instead of manually registering `Table` subclasses, you can use `table_finder` to automatically import any `Table` subclasses from a given list of modules.

```
from piccolo.conf.apps import table_finder

APP_CONFIG = AppConfig(
    app_name='blog',
    migrations_folder_path=os.path.join(
        CURRENT_DIRECTORY,
        'piccolo_migrations'
    ),
    table_classes=table_finder(modules=['blog.tables']),
    migration_dependencies=[],
    commands=[]
)
```

The module path should be from the root of the project (the same directory as your `piccolo_conf.py` file, rather than a relative path).

You can filter the `Table` subclasses returned using *tags*.

Source

piccolo.conf.apps.**table_finder**(*modules: Sequence[str]*, *include_tags: Sequence[str] = None*, *exclude_tags: Sequence[str] = None*, *exclude_imported: bool = False*) → List[Type[*Table*]]

Rather than explicitly importing and registering table classes with the `AppConfig`, `table_finder` can be used instead. It imports any `Table` subclasses in the given modules. Tags can be used to limit which `Table` subclasses are imported.

Parameters

- **modules** – The module paths to check for `Table` subclasses. For example, `['blog.tables']`. The path should be from the root of your project, not a relative path.
- **include_tags** – If the `Table` subclass has one of these tags, it will be imported. The special tag `'__all__'` will import all `Table` subclasses found.
- **exclude_tags** – If the `Table` subclass has any of these tags, it won't be imported. `exclude_tags` overrides `include_tags`.
- **exclude_imported** – If `True`, only `Table` subclasses defined within the module are used. Any `Table` subclasses imported by that module from other modules are ignored. For example:

```
from piccolo.table import Table
from piccolo.column import Varchar, ForeignKey
from piccolo.apps.user.tables import BaseUser # excluded

class Task(Table): # included
    title = Varchar()
    creator = ForeignKey(BaseUser)
```

5.2.4 Sharing Apps

By breaking up your project into apps, the project becomes more maintainable. You can also share these apps between projects, and they can even be installed using pip.

5.3 Included Apps

Just as you can modularise your own code using *apps*, Piccolo itself ships with several builtin apps, which provide a lot of its functionality.

5.3.1 Auto includes

The following are registered with your *AppRegistry* automatically.

Hint: To find out more about each of these commands you can use the `--help` flag on the command line. For example `piccolo app new --help`.

---

app

Lets you create new Piccolo apps. See *Piccolo Apps*.

```
piccolo app new
```

---

asgi

Lets you scaffold an ASGI web app. See *ASGI*.

```
piccolo asgi new
```

---

fixtures

Fixtures are used when you want to seed your database with essential data (for example, country names).

Once you have created a fixture, it can be used by your colleagues when setting up an application on their local machines, or when deploying to a new environment.

Databases such as Postgres have built-in ways of dumping and restoring data (via `pg_dump` and `pg_restore`). Some reasons to use the fixtures app instead:

- When you want the data to be loadable in a range of database types and versions.
- Fixtures are stored in JSON, which are a bit friendlier for source control.

dump

To dump the data into a new fixture file:

```
piccolo fixtures dump > fixtures.json
```

By default, the fixture contains data from all apps and tables. You can specify a subset of apps and tables instead, for example:

```
piccolo fixtures dump --apps=blog --tables=Post > fixtures.json
```

Or for multiple apps / tables:

```
piccolo fixtures dump --apps=blog,shop --tables=Post,Product > fixtures.json
```

load

To load the fixture:

```
piccolo fixtures load fixtures.json
```

If you load the fixture again, you will get primary key errors because the rows already exist in the database. But what if we need to run it again, because we had a typo in our fixture, or were missing some data? We can upsert the data using `--on_conflict`.

There are two options:

1. `DO NOTHING` - if any of the rows already exist in the database, just leave them as they are, and don't raise an exception.
2. `DO UPDATE` - if any of the rows already exist in the database, override them with the latest data in the fixture file.

```
# DO NOTHING
piccolo fixtures load fixtures.json --on_conflict='DO NOTHING'

# DO UPDATE
piccolo fixtures load fixtures.json --on_conflict='DO UPDATE'
```

And finally, if you're loading a really large fixture, you can specify the `chunk_size`. By default, Piccolo inserts up to 1,000 rows at a time, as the database adapter will complain if a single insert query is too large. So if your fixture containts 10,000 rows, this will mean 10 insert queries.

You can tune this number higher or lower if you want (lower if the table has a lot of columns, or higher if the table has few columns).

```
piccolo fixtures load fixtures.json --chunk_size=500
```

---

meta

Tells you which version of Piccolo is installed.

```
piccolo meta version
```

---

migrations

Lets you create and run migrations. See *Migrations*.

---

playground

Lets you learn the Piccolo query syntax, using an example schema. See *Playground*.

```
piccolo playground run
```

---

project

Lets you create a new `piccolo_conf.py` file. See *Piccolo Projects*.

```
piccolo project new
```

---

schema

generate

Lets you auto generate Piccolo `Table` classes from an existing database. Make sure the credentials in `piccolo_conf.py` are for the database you're interested in, then run the following:

```
piccolo schema generate > tables.py
```

Warning: This feature is still a work in progress. However, even in it's current form it will save you a lot of time. Make sure you check the generated code to make sure it's correct.

graph

A basic schema visualisation tool. It prints out the contents of a GraphViz dot file representing your schema.

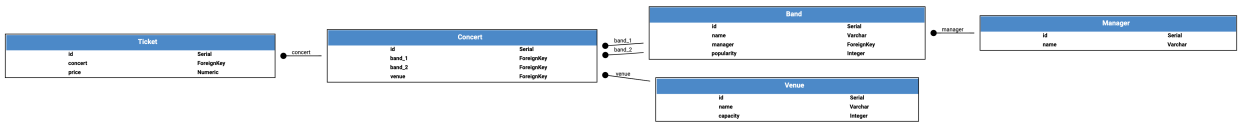
```
piccolo schema graph
```

You can pipe the output to your clipboard (`piccolo schema graph | pbcopy` on a Mac), then paste it into a website like this to turn it into an image file.

Or if you have Graphviz installed on your machine, you can do this to create an image file:

```
piccolo schema graph | dot -Tpdf -o graph.pdf
```

Here's an example of a generated image:



Note: There is a video tutorial on YouTube.

---

shell

Launches an iPython shell, and automatically imports all of your registered `Table` classes. It's great for running adhoc database queries using Piccolo.

```
piccolo shell run
```

Note: There is a video tutorial on YouTube.

---

sql_shell

Launches a SQL shell (`psql` or `sqlite3` depending on the engine), using the connection settings defined in `piccolo_conf.py`. It's convenient if you need to run raw SQL queries on your database.

```
piccolo sql_shell run
```

For it to work, the underlying command needs to be on the path (i.e. `psql` or `sqlite3` depending on which you're using).

Note: There is a video tutorial on YouTube.

---

tester

Launches pytest , which runs your unit test suite. The advantage of using this rather than running `pytest` directly, is the `PICCOLO_CONF` environment variable will automatically be set before the testing starts, and will be restored to it's initial value once the tests finish.

```
piccolo tester run
```

Setting the *PICCOLO_CONF* environment variable means your code will use the database engine specified in that file for the duration of the testing.

By default `piccolo tester run` sets `PICCOLO_CONF` to `'piccolo_conf_test'`, meaning that a file called `piccolo_conf_test.py` will be imported.

Within the `piccolo_conf_test.py` file, override the database settings, so it uses a test database:

```
from piccolo_conf import *

DB = PostgresEngine(
    config={
        "database": "my_app_test"
    }
)
```

If you prefer, you can set a custom `PICCOLO_CONF` value:

```
piccolo tester run --piccolo_conf=my_custom_piccolo_conf
```

You can also pass arguments to pytest:

```
piccolo tester run --pytest_args="-s foo"
```

5.3.2 Optional includes

These need to be explicitly registered with your *AppRegistry*.

user

Provides a user table, and commands for creating / managing users. See *Authentication*.

Note: There is a video tutorial on YouTube.

CHAPTER

SIX

ENGINES

Engines are what execute the SQL queries. Each supported backend has its own *engine*.

It's important that each `Table` class knows which engine to use. There are two ways of doing this - setting it explicitly via the `db` argument, or letting Piccolo find it using `engine_finder`.

6.1 Explicit

This can be useful when writing a simple script which needs to use Piccolo to connect to a database.

```
from piccolo.engine.sqlite import SQLiteEngine
from piccolo.table import Table
from piccolo.columns import Varchar


DB = SQLiteEngine(path='my_db.sqlite')


# Here we explicitly reference an engine:
class MyTable(Table, db=DB):
    name = Varchar()
```

6.2 engine_finder

By default Piccolo uses `engine_finder`. Piccolo will look for a file called `piccolo_conf.py` on the path, and will try and import a `DB` variable, which defines the engine.

You can ask Piccolo to create the `piccolo_conf.py` file for you, using the following command:

```
piccolo project new
```

Here's an example `piccolo_conf.py` file:

```
# piccolo_conf.py
from piccolo.engine.sqlite import SQLiteEngine


DB = SQLiteEngine(path='my_db.sqlite')
```

Hint: A good place for your `piccolo_conf.py` file is at the root of your project, where the Python interpreter will be launched.

6.2.1 PICCOLO_CONF environment variable

You can modify the configuration file location by using the `PICCOLO_CONF` environment variable.

In your terminal:

```
export PICCOLO_CONF=piccolo_conf_test
```

Or at the entrypoint of your app, before any other imports:

```
import os
os.environ['PICCOLO_CONF'] = 'piccolo_conf_test'
```

This is helpful during tests - you can specify a different configuration file which contains the connection details for a test database.

Hint: Piccolo has a builtin command which will do this for you - automatically setting `PICCOLO_CONF` for the duration of your tests. See *tester*.

```
# An example piccolo_conf_test.py
from piccolo.engine.sqlite import SQLiteEngine


DB = SQLiteEngine(path='my_test_db.sqlite')
```

It's also useful if you're deploying your code to different environments (e.g. staging and production). Have two configuration files, and set the environment variable accordingly.

If the `piccolo_conf.py` file is located in a sub-module (rather than the root of your project) you can specify the path like this:

```
export PICCOLO_CONF=sub_module.piccolo_conf
```

6.3 Engine types

Hint: Postgres is the preferred database to use, especially in production. It is the most feature complete.

6.3.1 SQLiteEngine

Configuration

The `SQLiteEngine` is very simple - just specify a file path. The database file will be created automatically if it doesn't exist.

```
# piccolo_conf.py
from piccolo.engine.sqlite import SQLiteEngine


DB = SQLiteEngine(path='my_app.sqlite')
```

Source

class piccolo.engine.sqlite.**SQLiteEngine**(*path: str = 'piccolo.sqlite'*, *log_queries: bool = False*, *log_responses: bool = False*, ***connection_kwargs*)

Parameters

- **path** – A relative or absolute path to the the SQLite database file (it will be created if it doesn't already exist).
- **log_queries** – If `True`, all SQL and DDL statements are printed out before being run. Useful for debugging.
- **log_responses** – If `True`, the raw response from each query is printed out. Useful for debugging.
- **connection_kwargs** – These are passed directly to the database adapter. We recommend setting `timeout` if you expect your application to process a large number of concurrent writes, to prevent queries timing out. See Python's sqlite3 docs for more info.

Production tips

If you're planning on using SQLite in production with Piccolo, with lots of concurrent queries, then here are some *useful tips*.

6.3.2 PostgresEngine

Configuration

```
# piccolo_conf.py
from piccolo.engine.postgres import PostgresEngine


DB = PostgresEngine(config={
    'host': 'localhost',
    'database': 'my_app',
    'user': 'postgres',
    'password': ''
})
```

config

The config dictionary is passed directly to the underlying database adapter, asyncpg. See the asyncpg docs to learn more.

Connection pool

To use a connection pool, you need to first initialise it. The best place to do this is in the startup event handler of whichever web framework you are using.

Here's an example using Starlette. Notice that we also close the connection pool in the shutdown event handler.

```
from piccolo.engine import engine_finder
from starlette.applications import Starlette


app = Starlette()


@app.on_event('startup')
async def open_database_connection_pool():
    engine = engine_finder()
    await engine.start_connection_pool()


@app.on_event('shutdown')
async def close_database_connection_pool():
    engine = engine_finder()
    await engine.close_connection_pool()
```

Hint: Using a connection pool helps with performance, since connections are reused instead of being created for each query.

Once a connection pool has been started, the engine will use it for making queries.

Hint: If you're running several instances of an app on the same server, you may prefer an external connection pooler - like pgbouncer.

Configuration

The connection pool uses the same configuration as your engine. You can also pass in additional parameters, which are passed to the underlying database adapter. Here's an example:

```
# To increase the number of connections available:
await engine.start_connection_pool(max_size=20)
```

Source

class piccolo.engine.postgres.**PostgresEngine**(*config: Dict[str, Any]*, *extensions: Sequence[str] = ('uuid-ossp',)*, *log_queries: bool = False*, *log_responses: bool = False*, *extra_nodes: Mapping[str,* PostgresEngine*] = None*)

Used to connect to PostgreSQL.

Parameters

- **config** – The config dictionary is passed to the underlying database adapter, asyncpg. Common arguments you're likely to need are:
  - host
  - port
  - user
  - password
  - database

  For example, `{'host': 'localhost', 'port': 5432}`.

  See the asyncpg docs for all available options.
- **extensions** – When the engine starts, it will try and create these extensions in Postgres. If you're using a read only database, set this value to an empty tuple `()`.
- **log_queries** – If `True`, all SQL and DDL statements are printed out before being run. Useful for debugging.
- **log_responses** – If `True`, the raw response from each query is printed out. Useful for debugging.
- **extra_nodes** – If you have additional database nodes (e.g. read replicas) for the server, you can specify them here. It's a mapping of a memorable name to a `PostgresEngine` instance. For example:

```
DB = PostgresEngine(
    config={'database': 'main_db'},
    extra_nodes={
        'read_replica_1': PostgresEngine(
            config={
                'database': 'main_db',
                host: 'read_replicate.my_db.com'
            },
            extensions=()
        )
    }
)
```

Note how we set `extensions=()`, because it's a read only database.

When executing a query, you can specify one of these nodes instead of the main database. For example:

```
>>> await MyTable.select().run(node="read_replica_1")
```

6.3.3 CockroachEngine

Configuration

```
# piccolo_conf.py
from piccolo.engine.cockroach import CockroachEngine


DB = CockroachEngine(config={
    'host': 'localhost',
    'database': 'piccolo',
    'user': 'root',
    'password': '',
    'port': '26257',
})
```

config

The config dictionary is passed directly to the underlying database adapter, asyncpg. See the asyncpg docs to learn more.

Connection pool

To use a connection pool, you need to first initialise it. The best place to do this is in the startup event handler of whichever web framework you are using.

Here's an example using Starlette. Notice that we also close the connection pool in the shutdown event handler.

```
from piccolo.engine import engine_finder
from starlette.applications import Starlette


app = Starlette()


@app.on_event('startup')
async def open_database_connection_pool():
    engine = engine_finder()
    await engine.start_connection_pool()


@app.on_event('shutdown')
async def close_database_connection_pool():
    engine = engine_finder()
    await engine.close_connection_pool()
```

Hint: Using a connection pool helps with performance, since connections are reused instead of being created for each query.

Once a connection pool has been started, the engine will use it for making queries.

Hint: If you're running several instances of an app on the same server, you may prefer an external connection pooler - like pgbouncer.

Configuration

The connection pool uses the same configuration as your engine. You can also pass in additional parameters, which are passed to the underlying database adapter. Here's an example:

```
# To increase the number of connections available:
await engine.start_connection_pool(max_size=20)
```

Source

class piccolo.engine.cockroach.**CockroachEngine**(*config: Dict[str, Any]*, *extensions: Sequence[str] = ()*, *log_queries: bool = False*, *log_responses: bool = False*, *extra_nodes: Dict[str,* CockroachEngine*] = None*)

An extension of *PostgresEngine*.

CHAPTER

SEVEN

MIGRATIONS

7.1 Creating migrations

Migrations are Python files which are used to modify the database schema in a controlled way. Each migration belongs to a *Piccolo app*.

You can either manually populate migrations, or allow Piccolo to do it for you automatically.

We recommend using *auto migrations* where possible, as it saves you time.

7.1.1 Manual migrations

First, let's create an empty migration:

```
piccolo migrations new my_app
```

This creates a new migration file in the migrations folder of the app. By default, the migration filename is the name of the app, followed by a timestamp, but you can rename it to anything you want:

```
piccolo_migrations/
    my_app_2022_12_06T13_58_23_024723.py
```

Note: We changed the naming convention for migration files in version `0.102.0` (previously they were like `2022-12-06T13-58-23-024723.py`). As mentioned, the name isn't important - change it to anything you want. The new format was chosen because a Python file should start with a letter by convention.

The contents of an empty migration file looks like this:

```
from piccolo.apps.migrations.auto.migration_manager import MigrationManager


ID = "2022-02-26T17:38:44:758593"
VERSION = "0.69.2" # The version of Piccolo used to create it
DESCRIPTION = "Optional description"


async def forwards():
    manager = MigrationManager(
```

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```
        migration_id=ID,
        app_name="my_app",
        description=DESCRIPTION
    )

    def run():
        # Replace this with something useful:
        print(f"running {ID}")

    manager.add_raw(run)
    return manager
```

The `ID` is very important - it uniquely identifies the migration, and shouldn't be changed.

Replace the `run` function with whatever you want the migration to do - typically running some SQL. It can be a function or a coroutine.

Running raw SQL

If you want to run raw SQL within your migration, you can do so as follows:

```
from piccolo.apps.migrations.auto.migration_manager import MigrationManager
from piccolo.table import Table


ID = "2022-02-26T17:38:44:758593"
VERSION = "0.69.2"
DESCRIPTION = "Updating each band's popularity"


# This is just a dummy table we use to execute raw SQL with:
class RawTable(Table):
    pass


async def forwards():
    manager = MigrationManager(
        migration_id=ID,
        app_name="my_app",
        description=DESCRIPTION
    )

    ################################################################
    # This will get run when using `piccolo migrations forwards`:

    async def run():
        await RawTable.raw('UPDATE band SET popularity={}', 1000)

    manager.add_raw(run)

    ################################################################
    # If we want to run some code when reversing the migration,
```

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```
    # using `piccolo migrations backwards`:

    async def run_backwards():
        await RawTable.raw('UPDATE band SET popularity={}', 0)

    manager.add_raw_backwards(run_backwards)

    ############################################################
    # We must always return the MigrationManager:

    return manager
```

Hint: You can learn more about *raw queries here*.

Using your `Table` classes

In the above example, we executed raw SQL, but what if we wanted to use the `Table` classes from our project instead?

We have to be quite careful with this. Here's an example:

```
from piccolo.apps.migrations.auto.migration_manager import MigrationManager

# We're importing a table from our project:
from music.tables import Band


ID = "2022-02-26T17:38:44:758593"
VERSION = "0.69.2"
DESCRIPTION = "Updating each band's popularity"


async def forwards():
    manager = MigrationManager(
        migration_id=ID,
        app_name="my_app",
        description=DESCRIPTION
    )

    async def run():
        await Band.update({Band.popularity: 1000})

    manager.add_raw(run)
    return manager
```

We want our migrations to be repeatable - so if someone runs them a year from now, they will get the same results.

By directly importing our tables, we have the following risks:

- If the `Band` class is deleted from the codebase, it could break old migrations.
- If we modify the `Band` class, perhaps by removing columns, this could also break old migrations.

Try and make your migration files independent of other application code, so they're self contained and repeatable. Even though it goes against DRY, it's better to copy the relevant tables into your migration file:

```
from piccolo.apps.migrations.auto.migration_manager import MigrationManager
from piccolo.columns.column_types import Integer
from piccolo.table import Table


ID = "2022-02-26T17:38:44:758593"
VERSION = "0.69.2"
DESCRIPTION = "Updating each band's popularity"


# We defined the table within the file, rather than importing it.
class Band(Table):
    popularity = Integer()


async def forwards():
    manager = MigrationManager(
        migration_id=ID,
        app_name="my_app",
        description=DESCRIPTION
    )

    async def run():
        await Band.update({Band.popularity: 1000})

    manager.add_raw(run)
    return manager
```

7.1.2 Auto migrations

Manually writing your migrations gives you a good level of control, but Piccolo supports *auto migrations* which can save a great deal of time.

Piccolo will work out which tables to add by comparing previous auto migrations, and your current tables. In order for this to work, you have to register your app's tables with the `AppConfig` in the `piccolo_app.py` file at the root of your app (see *Piccolo Apps*).

Creating an auto migration:

```
piccolo migrations new my_app --auto
```

Hint: Auto migrations are the preferred way to create migrations with Piccolo. We recommend using *empty migrations* for special circumstances which aren't supported by auto migrations, or to modify the data held in tables, as opposed to changing the tables themselves.

Warning: Auto migrations aren't supported in SQLite, because of SQLite's extremely limited support for SQL Alter statements. This might change in the future.

Troubleshooting

Auto migrations can accommodate most schema changes. There may be some rare edge cases where a single migration is trying to do too much in one go, and fails. To avoid these situations, create auto migrations frequently, and keep them fairly small.

7.1.3 Migration descriptions

To make the migrations more memorable, you can give them a description. Inside the migration file, you can set a `DESCRIPTION` global variable manually, or can specify it when creating the migration:

```
piccolo migrations new my_app --auto --desc="Adding name column"
```

The Piccolo CLI will then use this description when listing migrations, to make them easier to identify.

7.2 Running migrations

Hint: To see all available options for these commands, use the `--help` flag, for example `piccolo migrations forwards --help`.

7.2.1 Forwards

When the migration is run, the forwards function is executed. To do this:

```
piccolo migrations forwards my_app
```

Multiple apps

If you have multiple apps you can run them all using:

```
piccolo migrations forwards all
```

Fake

We can 'fake' running a migration - we record that it ran in the database without actually running it.

```
piccolo migrations forwards my_app 2022-09-04T19:44:09 --fake
```

This is useful if we started from an existing database using `piccolo schema generate`, and the initial migration we generated is for tables which already exist, hence we fake run it.

7.2.2 Reversing migrations

To reverse the migration, run the following command, specifying the ID of a migration:

```
piccolo migrations backwards my_app 2022-09-04T19:44:09
```

Piccolo will then reverse the migrations for the given app, starting with the most recent migration, up to and including the migration with the specified ID.

You can try going forwards and backwards a few times to make sure it works as expected.

7.2.3 Preview

To see the SQL queries of a migration without actually running them, use the `--preview` flag.

This works when running migrations forwards:

```
piccolo migrations forwards my_app --preview
```

Or backwards:

```
piccolo migrations backwards 2022-09-04T19:44:09 --preview
```

7.2.4 Checking migrations

You can easily check which migrations have and haven't ran using the following:

```
piccolo migrations check
```

7.2.5 Source

These are the underlying Python functions which are called, so you can see all available options. These functions are convered into a CI using targ.

async piccolo.apps.migrations.commands.forwards.**forwards**(*app_name: str*, *migration_id: str = 'all'*, *fake: bool = False*, *preview: bool = False*)

Runs any migrations which haven't been run yet.

Parameters

- **app_name** – The name of the app to migrate. Specify a value of 'all' to run migrations for all apps.
- **migration_id** – Migrations will be ran up to and including this migration_id. Specify a value of 'all' to run all of the migrations. Specify a value of '1' to just run the next migration.
- **fake** – If set, will record the migrations as being run without actually running them.
- **preview** – If true, don't actually run the migration, just print the SQL queries

async piccolo.apps.migrations.commands.backwards.**backwards**(*app_name: str*, *migration_id: str = '1'*, *auto_agree: bool = False*, *clean: bool = False*, *preview: bool = False*)

Undo migrations up to a specific migration.

Parameters

- **app_name** – The app to reverse migrations for. Specify a value of 'all' to reverse migrations for all apps.
- **migration_id** – Migrations will be reversed up to and including this migration_id. Specify a value of 'all' to undo all of the migrations. Specify a value of '1' to undo the most recent migration.
- **auto_agree** – If true, automatically agree to any input prompts.
- **clean** – If true, the migration files which have been run backwards are deleted from the disk after completing.
- **preview** – If true, don't actually run the migration, just print the SQL queries.

async piccolo.apps.migrations.commands.check.**check**(*app_name: str = 'all'*)

Lists all migrations which have and haven't ran.

Parameters

app_name – The name of the app to check. Specify a value of 'all' to check the migrations for all apps.

CHAPTER

EIGHT

AUTHENTICATION

Piccolo ships with authentication support out of the box.

8.1 Registering the app

Make sure `'piccolo.apps.user.piccolo_app'` is in your `AppRegistry` (see *Piccolo Projects*).

8.2 Tables

8.2.1 BaseUser

`BaseUser` is a `Table` you can use to store and authenticate your users.

Creating the Table

Run the migrations:

```
piccolo migrations forwards user
```

Commands

The app comes with some useful commands.

create

Creates a new user. It presents an interactive prompt, asking for the username, password etc.

```
piccolo user create
```

If you'd prefer to create a user without the interactive prompt (perhaps in a script), you can pass all of the arguments in as follows:

```
piccolo user create --username=bob --password=bob123 --email=foo@bar.com  --is_admin=t --
↪is_superuser=t --is_active=t
```

Warning: If you choose this approach then be careful, as the password will be in the shell's history.

change_password

Change a user's password.

```
piccolo user change_password
```

change_permissions

Change a user's permissions. The options are `--admin`, `--superuser` and `--active`, which change the corresponding attributes on `BaseUser`.

For example:

```
piccolo user change_permissions some_user --active=true
```

The *Piccolo Admin* uses these attributes to control who can login and what they can do.

- **active** and **admin** - must be true for a user to be able to login.
- **superuser** - must be true for a user to be able to change other user's passwords.

Within your code

create_user / create_user_sync

To create a new user:

```
# From within a coroutine:
await BaseUser.create_user(username="bob", password="abc123", active=True)

# When not in an event loop:
BaseUser.create_user_sync(username="bob", password="abc123", active=True)
```

It saves the user in the database, and returns the created `BaseUser` instance.

Note: It is preferable to use this rather than instantiating and saving `BaseUser` directly, as we add additional validation.

login / login_sync

To check a user's credentials, do the following:

```
from piccolo.apps.user.tables import BaseUser

# From within a coroutine:
>>> await BaseUser.login(username="bob", password="abc123")
1

# When not in an event loop:
>>> BaseUser.login_sync(username="bob", password="abc123")
1
```

If the login is successful, the user's id is returned, otherwise `None` is returned.

update_password / update_password_sync

To change a user's password:

```
# From within a coroutine:
await BaseUser.update_password(username="bob", password="abc123")

# When not in an event loop:
BaseUser.update_password_sync(username="bob", password="abc123")
```

Warning: Don't use bulk updates for passwords - use `update_password` / `update_password_sync`, and they'll correctly hash the password.

Limits

The maximum password length allowed is 128 characters. This should be sufficiently long for most use cases.

Extending `BaseUser`

If you want to extend `BaseUser` with additional fields, we recommend creating a `Profile` table with a `ForeignKey` to `BaseUser`, which can include any custom fields.

```
from piccolo.apps.user.tables import BaseUser
from piccolo.columns import ForeignKey, Text, Varchar
from piccolo.table import Table

class Profile(Table):
    custom_user = ForeignKey(BaseUser)
    phone_number = Varchar()
    bio = Text()
```

Alternatively, you can copy the entire user app into your project, and customise it to fit your needs.

Source

class piccolo.apps.user.tables.**BaseUser**(***kwargs*)

Provides a basic user, with authentication support.

async classmethod create_user(*username: str*, *password: str*, ***extra_params*) → *BaseUser*

Creates a new user, and saves it in the database. It is recommended to use this rather than instantiating and saving `BaseUser` directly, as we add extra validation.

Raises
`ValueError` – If the username or password is invalid.

Returns
The created `BaseUser` instance.

classmethod create_user_sync(*username: str*, *password: str*, ***extra_params*) → *BaseUser*

A sync equivalent of *create_user()*.

async classmethod login(*username: str*, *password: str*) → Optional[int]

Make sure the user exists and the password is valid. If so, the `last_login` value is updated in the database.

Returns
The id of the user if a match is found, otherwise `None`.

classmethod login_sync(*username: str*, *password: str*) → Optional[int]

A sync equivalent of *login()*.

async classmethod update_password(*user: Union[str, int]*, *password: str*)

The password is the raw password string e.g. `'password123'`. The user can be a user ID, or a username.

classmethod update_password_sync(*user: Union[str, int]*, *password: str*)

A sync equivalent of *update_password()*.

8.3 Web app integration

Our sister project, Piccolo API, contains powerful endpoints and middleware for integrating session auth and token auth into your ASGI web application, using `BaseUser`.

CHAPTER

NINE

ASGI

Using Piccolo standalone is fine if you want to build a data science script, but often you'll want to build a web application around it.

ASGI is a standardised way for async Python libraries to interoperate. It's the equivalent of WSGI in the synchronous world.

By using the `piccolo asgi new` command, Piccolo will scaffold an ASGI web app for you, which includes everything you need to get started. The command will ask for your preferences on which libraries to use.

9.1 Routing frameworks

Currently, Starlette, FastAPI, BlackSheep, and Litestar are supported.

Other great ASGI routing frameworks exist, and may be supported in the future (Quart , Sanic , Django etc).

9.1.1 Which to use?

All are great choices. FastAPI is built on top of Starlette, so they're very similar. FastAPI and BlackSheep are great if you want to document a REST API, as they have built-in OpenAPI support.

9.2 Web servers

Hypercorn and Uvicorn are available as ASGI servers. Daphne can't be used programatically so was omitted at this time.

CHAPTER

TEN

SERIALIZATION

Piccolo uses Pydantic internally to serialize and deserialize data.

Using `create_pydantic_model` you can easily create Pydantic models for your application.

10.1 create_pydantic_model

Using `create_pydantic_model` we can easily create a Pydantic model from a Piccolo `Table`.

Using this example schema:

```
from piccolo.columns import ForeignKey, Integer, Varchar
from piccolo.table import Table

class Manager(Table):
    name = Varchar()

class Band(Table):
    name = Varchar(length=100)
    manager = ForeignKey(Manager)
    popularity = Integer()
```

Creating a Pydantic model is as simple as:

```
from piccolo.utils.pydantic import create_pydantic_model

BandModel = create_pydantic_model(Band)
```

We can then create model instances from data we fetch from the database:

```
# If using objects:
band = await Band.objects().get(Band.name == 'Pythonistas')
model = BandModel(**band.to_dict())

# If using select:
band = await Band.select().where(Band.name == 'Pythonistas').first()
model = BandModel(**band)

>>> model.name
'Pythonistas'
```

You have several options for configuring the model, as shown below.

10.1.1 include_columns / exclude_columns

If we want to exclude the `popularity` column from the `Band` table:

```
BandModel = create_pydantic_model(Band, exclude_columns=(Band.popularity,))
```

Conversely, if you only wanted the `popularity` column:

```
BandModel = create_pydantic_model(Band, include_columns=(Band.popularity,))
```

10.1.2 nested

Another great feature is `nested=True`. For each `ForeignKey` in the Piccolo `Table`, the Pydantic model will contain a sub model for the related table.

For example:

```
BandModel = create_pydantic_model(Band, nested=True)
```

If we were to write `BandModel` by hand instead, it would look like this:

```
from pydantic import BaseModel

class ManagerModel(BaseModel):
    name: str

class BandModel(BaseModel):
    name: str
    manager: ManagerModel
    popularity: int
```

But with `nested=True` we can achieve this with one line of code.

To populate a nested Pydantic model with data from the database:

```
# If using objects:
band = await Band.objects(Band.manager).get(Band.name == 'Pythonistas')
model = BandModel(**band.to_dict())

# If using select:
band = await Band.select(
    Band.all_columns(),
    Band.manager.all_columns()
).where(
    Band.name == 'Pythonistas'
).first().output(
    nested=True
)
model = BandModel(**band)
```

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```
>>> model.manager.name
'Guido'
```

Note: There is a video tutorial on YouTube.

10.1.3 include_default_columns

Sometimes you'll want to include the Piccolo `Table`'s primary key column in the generated Pydantic model. For example, in a `GET` endpoint, we usually want to include the `id` in the response:

```
// GET /api/bands/1/
// Response:
{"id": 1, "name": "Pythonistas", "popularity": 1000}
```

Other times, you won't want the Pydantic model to include the primary key column. For example, in a `POST` endpoint, when using a Pydantic model to serialise the payload, we don't expect the user to pass in an `id` value:

```
// POST /api/bands/
// Payload:
{"name": "Pythonistas", "popularity": 1000}
```

By default the primary key column isn't included - you can add it using:

```
BandModel = create_pydantic_model(Band, include_default_columns=True)
```

10.1.4 pydantic_config_class

You can specify a custom class to use as the base for the Pydantic model's config. This class should be a subclass of `pydantic.BaseConfig`.

For example, let's set the `extra` parameter to tell pydantic how to treat extra fields (that is, fields that would not otherwise be in the generated model). The allowed values are:

- `'ignore'` (default): silently ignore extra fields
- `'allow'`: accept the extra fields and assigns them to the model
- `'forbid'`: fail validation if extra fields are present

So if we want to disallow extra fields, we can do:

```
class MyPydanticConfig(pydantic.BaseConfig):
    extra = 'forbid'

model = create_pydantic_model(
    table=MyTable,
    pydantic_config_class=MyPydanticConfig
)
```

10.1.5 Required fields

You can specify which fields are required using the `required` argument of *Column*. For example:

```
class Band(Table):
    name = Varchar(required=True)

BandModel = create_pydantic_model(Band)

# Omitting the field raises an error:
>>> BandModel()
ValidationError - name field required
```

You can override this behaviour using the `all_optional` argument. An example use case is when you have a model which is used for filtering, then you'll want all fields to be optional.

```
class Band(Table):
    name = Varchar(required=True)

BandFilterModel = create_pydantic_model(
    Band,
    all_optional=True,
    model_name='BandFilterModel',
)

# This no longer raises an exception:
>>> BandModel()
```

10.1.6 Subclassing the model

If the generated model doesn't perfectly fit your needs, you can subclass it to add additional fields, and to override existing fields.

```
class Band(Table):
    name = Varchar(required=True)

BandModel = create_pydantic_model(Band)

class CustomBandModel(BandModel):
    genre: str

>>> CustomBandModel(name="Pythonistas", genre="Rock")
```

10.1.7 Source

piccolo.utils.pydantic.**create_pydantic_model**(*table: Type[Table], nested: Union[bool, Tuple[ForeignKey, ...]] = False, exclude_columns: Tuple[Column, ...] = (), include_columns: Tuple[Column, ...] = (), include_default_columns: bool = False, include_readable: bool = False, all_optional: bool = False, model_name: Optional[str] = None, deserialize_json: bool = False, recursion_depth: int = 0, max_recursion_depth: int = 5, pydantic_config_class: Optional[Type[BaseConfig]] = None, **schema_extra_kwargs*) → Type[BaseModel]

Create a Pydantic model representing a table.

Parameters

- **table** – The Piccolo `Table` you want to create a Pydantic serialiser model for.
- **nested** – Whether `ForeignKey` columns are converted to nested Pydantic models. If `False`, none are converted. If `True`, they all are converted. If a tuple of `ForeignKey` columns is passed in, then only those are converted.
- **exclude_columns** – A tuple of `Column` instances that should be excluded from the Pydantic model. Only specify `include_columns` or `exclude_columns`.
- **include_columns** – A tuple of `Column` instances that should be included in the Pydantic model. Only specify `include_columns` or `exclude_columns`.
- **include_default_columns** – Whether to include columns like `id` in the serialiser. You will typically include these columns in GET requests, but don't require them in POST requests.
- **include_readable** – Whether to include 'readable' columns, which give a string representation of a foreign key.
- **all_optional** – If True, all fields are optional. Useful for filters etc.
- **model_name** – By default, the classname of the Piccolo `Table` will be used, but you can override it if you want multiple Pydantic models based off the same Piccolo table.
- **deserialize_json** – By default, the values of any Piccolo `JSON` or `JSONB` columns are returned as strings. By setting this parameter to `True`, they will be returned as objects.
- **recursion_depth** – Not to be set by the user - used internally to track recursion.
- **max_recursion_depth** – If using nested models, this specifies the max amount of recursion.
- **pydantic_config_class** – Config class to use as base for the generated pydantic model. You can create your own subclass of `pydantic.BaseConfig` and pass it here.
- **schema_extra_kwargs** – This can be used to add additional fields to the schema. This is very useful when using Pydantic's JSON Schema features. For example:

```
>>> my_model = create_pydantic_model(Band, my_extra_field="Hello")
>>> my_model.schema()
{..., "my_extra_field": "Hello"}
```

Returns

A Pydantic model.

Hint: A good place to see `create_pydantic_model` in action is PiccoloCRUD, as it uses `create_pydantic_model` extensively to create Pydantic models from Piccolo tables.

10.2 FastAPI template

Piccolo's FastAPI template uses `create_pydantic_model` to create serializers.

To create a new FastAPI app using Piccolo, simply use:

```
piccolo asgi new
```

See the *ASGI docs* for more details.

CHAPTER

ELEVEN

TESTING

Piccolo provides a few tools to make testing easier.

11.1 Test runner

Piccolo ships with a handy command for running your unit tests using pytest. See the *tester app*.

You can put your test files anywhere you like, but a good place is in a `tests` folder within your Piccolo app. The test files should be named like `test_*. py` or `*_test.py` for pytest to recognise them.

11.2 Model Builder

When writing unit tests, it's usually required to have some data seeded into the database. You can build and save the records manually or use *ModelBuilder* to generate random records for you.

This way you can randomize the fields you don't care about and specify important fields explicitly and reduce the amount of manual work required. `ModelBuilder` currently supports all Piccolo column types and features.

Let's say we have the following schema:

```
from piccolo.columns import ForeignKey, Varchar

class Manager(Table):
    name = Varchar(length=50)

class Band(Table):
    name = Varchar(length=50)
    manager = ForeignKey(Manager, null=True)
```

You can build a random `Band` which will also build and save a random `Manager`:

```
from piccolo.testing.model_builder import ModelBuilder

# Band instance with random values persisted:
band = await ModelBuilder.build(Band)
```

Note: `ModelBuilder.build(Band)` persists the record into the database by default.

You can also run it synchronously if you prefer:

```
manager = ModelBuilder.build_sync(Manager)
```

To specify any attribute, pass the `defaults` dictionary to the `build` method:

```
manager = ModelBuilder.build(Manager)

# Using table columns:
band = await ModelBuilder.build(
    Band,
    defaults={Band.name: "Guido", Band.manager: manager}
)

# Or using strings as keys:
band = await ModelBuilder.build(
    Band,
    defaults={"name": "Guido", "manager": manager}
)
```

To build objects without persisting them into the database:

```
band = await ModelBuilder.build(Band, persist=False)
```

To build objects with minimal attributes, leaving nullable fields empty:

```
# Leaves manager empty:
band = await ModelBuilder.build(Band, minimal=True)
```

11.3 Creating the test schema

When running your unit tests, you usually start with a blank test database, create the tables, and then install test data.

To create the tables, there are a few different approaches you can take. Here we use *create_db_tables_sync* and *drop_db_tables_sync*.

Note: The async equivalents are *create_db_tables* and *drop_db_tables*.

```
from unittest import TestCase

from piccolo.table import create_db_tables_sync, drop_db_tables_sync
from piccolo.conf.apps import Finder

TABLES = Finder().get_table_classes()

class TestApp(TestCase):
```

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```
    def setUp(self):
        create_db_tables_sync(*TABLES)

    def tearDown(self):
        drop_db_tables_sync(*TABLES)

    def test_app(self):
        # Do some testing ...
        pass
```

Alternatively, you can run the migrations to setup the schema if you prefer:

```
from unittest import TestCase

from piccolo.apps.migrations.commands.backwards import run_backwards
from piccolo.apps.migrations.commands.forwards import run_forwards
from piccolo.utils.sync import run_sync

class TestApp(TestCase):
    def setUp(self):
        run_sync(run_forwards("all"))

    def tearDown(self):
        run_sync(run_backwards("all", auto_agree=True))

    def test_app(self):
        # Do some testing ...
        pass
```

11.4 Testing async code

There are a few options for testing async code using pytest.

You can either call any async code using Piccolo's `run_sync` utility:

```
from piccolo.utils.sync import run_sync

async def get_data():
    ...

def test_get_data():
    rows = run_sync(get_data())
    assert len(rows) == 1
```

Alternatively, you can make your tests natively async.

If you prefer using pytest's function based tests, then take a look at pytest-asyncio. Simply install it using `pip install pytest-asyncio`, then you can then write tests like this:

```
async def test_select():
    rows = await MyTable.select()
    assert len(rows) == 1
```

If you prefer class based tests, and are using Python 3.8 or above, then have a look at `IsolatedAsyncioTestCase` from Python's standard library. You can then write tests like this:

```
from unittest import IsolatedAsyncioTestCase

class MyTest(IsolatedAsyncioTestCase):
    async def test_select(self):
        rows = await MyTable.select()
        assert len(rows) == 1
```

CHAPTER

TWELVE

FEATURES

12.1 Types and Tab Completion

12.1.1 Type annotations

The Piccolo codebase uses type annotations extensively. This means it has great tab completion support in tools like iPython and VSCode.

It also means it works well with type checkers like Mypy.

To learn more about how Piccolo achieves this, read this article about type annotations, and this article about descriptors.

12.1.2 Troubleshooting

Here are some issues you may encounter when using Mypy, or another type checker.

`id` column doesn't exist

If you don't explicitly declare a column on your table with `primary_key=True`, Piccolo creates a `Serial` column for you called `id`.

In the following situation, the type checker might complains that `id` doesn't exist:

```
await Band.select(Band.id)
```

You can fix this as follows:

```
# tables.py
from piccolo.table import Table
from piccolo.columns.column_types import Serial, Varchar


class Band(Table):
    id: Serial  # Add an annotation
    name = Varchar()
```

12.2 Security

12.2.1 SQL Injection protection

If you look under the hood, Piccolo uses a custom class called `QueryString` for composing queries. It keeps query parameters separate from the query string, so we can pass parameterised queries to the engine. This helps prevent SQL Injection attacks.

12.3 Syntax

12.3.1 As close as possible to SQL

The classes / methods / functions in Piccolo mirror their SQL counterparts as closely as possible.

For example:

- In other ORMs, you define models - in Piccolo you define tables.
- Rather than using a filter method, you use a *where* method like in SQL.

12.3.2 Get the SQL at any time

At any time you can access the `__str__` method of a query, to see the underlying SQL - making the ORM feel less magic.

```
>>> query = Band.select(Band.name).where(Band.popularity >= 100)
>>> print(query)
'SELECT name from band where popularity > 100'
```

CHAPTER

THIRTEEN

PLAYGROUND

Piccolo ships with a handy command to help learn the different queries. For simple usage see *Playground*.

13.1 Advanced Playground Usage

13.1.1 Postgres

If you want to use Postgres instead of SQLite, you need to create a database first.

Install Postgres

See *the docs on settings up Postgres*.

Create database

By default the playground expects a local database to exist with the following credentials:

```
user: "piccolo"
password: "piccolo"
host: "localhost"  # or 127.0.0.1
database: "piccolo_playground"
port: 5432
```

You can create a database using pgAdmin.

If you want to use different credentials, you can pass them into the playground command (use `piccolo playground run --help` for details).

Connecting

When you have the database setup, you can connect to it as follows:

```
piccolo playground run --engine=postgres
```

13.1.2 iPython

The playground is built on top of iPython. We provide sensible defaults out of the box for syntax highlighting etc. However, to use your own custom iPython profile (located in `~/.ipython`), do the following:

```
piccolo playground run --ipython_profile
```

See the iPython docs for more information.

CHAPTER

FOURTEEN

ECOSYSTEM

14.1 Piccolo API

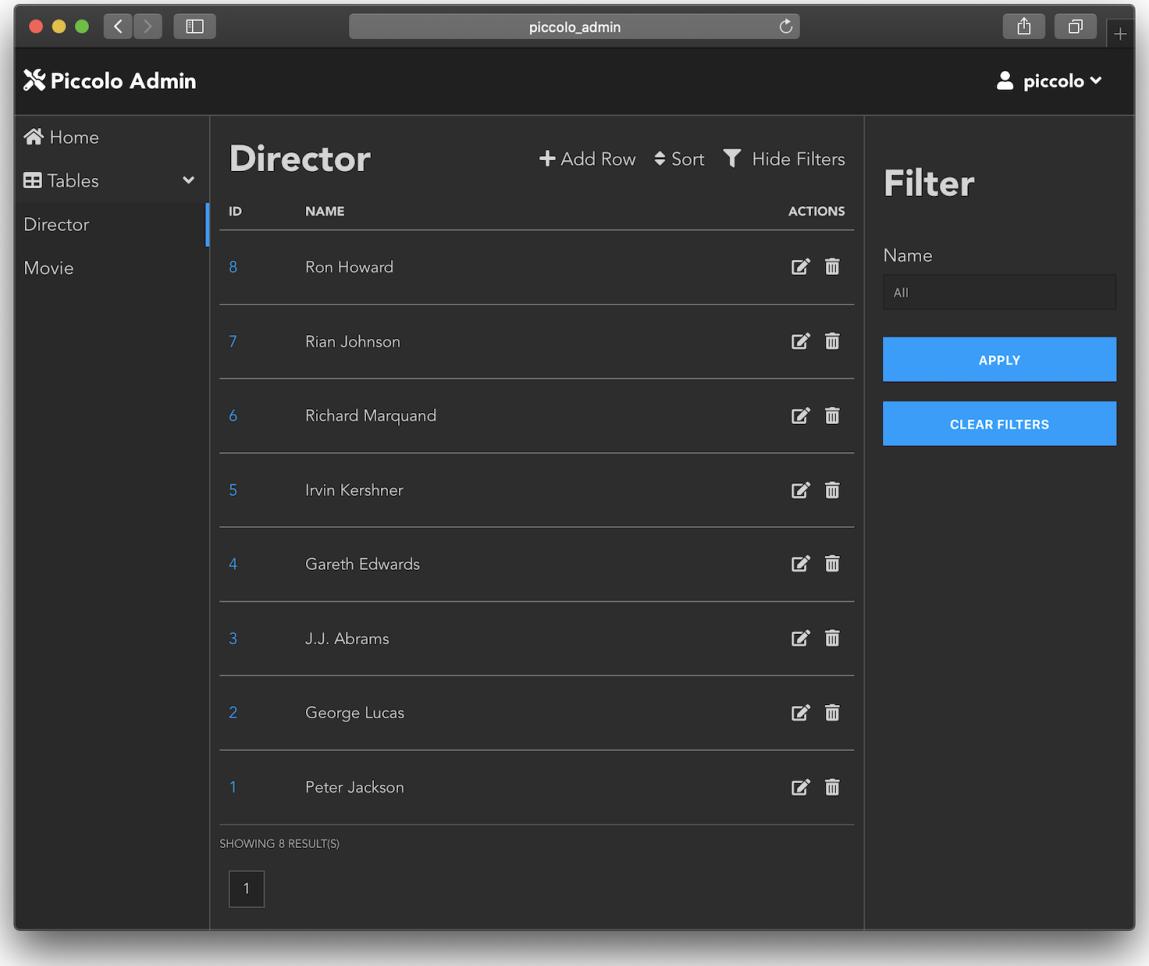
Provides some handy utilities for creating an API around your Piccolo tables. Examples include:

- Easily creating CRUD endpoints for ASGI apps, based on Piccolo tables.
- Automatically creating Pydantic models from your Piccolo tables.
- Great FastAPI integration.
- Authentication and rate limiting.

See the docs for more information.

14.2 Piccolo Admin

Lets you create a powerful web GUI for your tables in two minutes. View the project on Github, and the docs for more information.



It's a modern UI built with Vue JS, which supports powerful data filtering, and CSV exports. It's the crown jewel in the Piccolo ecosystem!

14.3 Piccolo Examples

A repository containing example projects built with Piccolo, as well as links to community projects.

CHAPTER

FIFTEEN

TUTORIALS

These tutorials bring together information from across the documentation, to help you solve common problems:

15.1 Migrate an existing project to Piccolo

15.1.1 Introduction

If you have an existing project and Postgres database, and you want to use Piccolo with it, these are the steps you need to take.

15.1.2 Option 1 - `piccolo asgi new`

This is the recommended way of creating brand new projects. If this is your first experience with Piccolo, then it's a good idea to create a test project:

```
mkdir test_project
cd test_project
piccolo asgi new
```

You'll learn a lot about how Piccolo works by looking at the generated code. You can then copy over the relevant files to your existing project if you like.

Alternatively, doing it from scratch, you'll need to do the following:

15.1.3 Option 2 - from scratch

Create a Piccolo project file

Create a new `piccolo_conf.py` file in the root of your project:

```
piccolo project new
```

This contains your database details, and is used to register Piccolo apps.

Create a new Piccolo app

The app contains your `Table` classes and migrations. Run this command at the root of your project:

```
# Replace 'my_app' with whatever you want to call your app
piccolo app new my_app
```

Register the new Piccolo app

Register this new app in `piccolo_conf.py`. For example:

```
APP_REGISTRY = AppRegistry(
    apps=[
        "my_app.piccolo_app",
    ]
)
```

While you're at it, make sure the database credentials are correct in `piccolo_conf.py`.

Make `Table` classes for your current database

Now, if you run:

```
piccolo schema generate
```

It will output Piccolo `Table` classes for your current database. Copy the output into `my_app/tables.py`. Double check that everything looks correct.

In `my_app/piccolo_app.py` make sure it's tracking these tables for migration purposes.

```
from piccolo.conf.apps import AppConfig, table_finder

APP_CONFIG = AppConfig(
    table_classes=table_finder(["my_app.tables"], exclude_imported=True),
    ...
)
```

Create an initial migration

This will create a new file in `my_app/piccolo_migrations`:

```
piccolo migrations new my_app --auto
```

These tables already exist in the database, as it's an existing project, so you need to fake apply this initial migration:

```
piccolo migrations forwards my_app --fake
```

Making queries

Now you're basically setup - to make database queries:

```
from my_app.tables import MyTable

async def my_endpoint():
    data = await MyTable.select()
    return data
```

Making new migrations

Just modify the files in `tables.py`, and then run:

```
piccolo migrations new my_app --auto
piccolo migrations forwards my_app
```

15.2 Using SQLite and asyncio effectively

When using Piccolo with SQLite, there are some best practices to follow.

15.2.1 asyncio => lots of connections

With asyncio, we can potentially open lots of database connections, and attempt to perform concurrent database writes.

SQLite doesn't support such concurrent behavior as effectively as Postgres, so we need to be careful.

One write at a time

SQLite can easily support lots of transactions concurrently if they are reading, but only one write can be performed at a time.

15.2.2 Transactions

SQLite has several transaction types, as specified by Piccolo's `TransactionType` enum:

class piccolo.engine.sqlite.**TransactionType**(*value*, *names=None*, ***, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

See the SQLite docs for more info.

deferred = 'DEFERRED'

exclusive = 'EXCLUSIVE'

immediate = 'IMMEDIATE'

Which to use?

When creating a transaction, Piccolo uses `DEFERRED` by default (to be consistent with SQLite).

This means that the first SQL query executed within the transaction determines whether it's a **READ** or **WRITE**:

- **READ** - if the first query is a `SELECT`
- **WRITE** - if the first query is something like an `INSERT` / `UPDATE` / `DELETE`

If a transaction starts off with a `SELECT`, but then tries to perform an `INSERT` / `UPDATE` / `DELETE`, SQLite tries to 'promote' the transaction so it can write.

The problem is, if multiple concurrent connections try doing this at the same time, SQLite will return a database locked error.

So if you're creating a transaction which you know will perform writes, then create an `IMMEDIATE` transaction:

```
from piccolo.engine.sqlite import TransactionType

async with Band._meta.db.transaction(
    transaction_type=TransactionType.immediate
):
    # We perform a SELECT first, but as it's an IMMEDIATE transaction,
    # we can later perform writes without getting a database locked
    # error.
    if not await Band.exists().where(Band.name == 'Pythonistas'):
        await Band.objects().create(name="Pythonistas")
```

Multiple `IMMEDIATE` transactions can exist concurrently - SQLite uses a lock to make sure only one of them writes at a time.

If your transaction will just be performing `SELECT` queries, then just use the default `DEFERRED` transactions - you will get improved performance, as no locking is involved:

```
async with Band._meta.db.transaction():
    bands = await Band.select()
    managers = await Manager.select()
```

15.2.3 timeout

It's recommended to specify the `timeout` argument in *SQLiteEngine*.

```
DB = SQLiteEngine(timeout=60)
```

Imagine you have a web app, and each endpoint creates a transaction which runs multiple queries. With SQLite, only a single write operation can happen at a time, so if several connections are open, they may be queued for a while.

By increasing `timeout` it means that queries are less likely to timeout.

To find out more about `timeout` see the Python `sqlite3 docs`.

15.3 Deploying using Docker

15.3.1 Docker

Docker is a very popular way of deploying applications, using containers.

Base image

Piccolo has several dependencies which are compiled (e.g. asyncpg, orjson), which is great for performance, but you may run into difficulties when using Alpine Linux as your base Docker image. Alpine uses a different compiler toolchain to most Linux distros.

It's highly recommended to use Debian as your base Docker image. Many Python packages have prebuilt versions for Debian, meaning you don't have to compile them at all during install. The result is a much faster build process, and potentially even a smaller overall Docker image size (the size of Alpine quickly balloons after you've added all of the compilation dependencies).

Environment variables

By using environment variables, we can inject the database credentials for Piccolo.

Example Dockerfile

This is a very simple Dockerfile, and illustrates the basics:

```
# Specify the base image:
FROM python:3.10-slim-bullseye

# Install the pip requirements:
RUN pip install --upgrade pip
ADD app/requirements.txt /
RUN pip install -r /requirements.txt

# Add the application code:
ADD app /app

# Environment variables:
ENV PG_HOST=localhost
ENV PG_PORT=5432
ENV PG_USER=my_database_user
ENV PG_PASSWORD=""
ENV PG_DATABASE=my_database

CMD ["/usr/local/bin/python", "/app/main.py"]
```

We can then modify our *piccolo_conf.py* file to use these environment variables:

```
# piccolo_conf.py

import os

```

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```
DB = PostgresEngine(
    config={
        "port": int(os.environ.get("PG_PORT", "5432")),
        "user": os.environ.get("PG_USER", "my_database_user"),
        "password": os.environ.get("PG_PASSWORD", ""),
        "database": os.environ.get("PG_DATABASE", "my_database"),
        "host": os.environ.get("PG_HOST", "localhost"),
    }
)
```

When we run the container (usually via Kubernetes, Docker Compose, or similar), we can specify the database credentials using environment variables, which will be used by our application.

15.4 FastAPI

FastAPI is a popular ASGI web framework. The purpose of this tutorial is to give some hints on how to get started with Piccolo and FastAPI.

Piccolo and FastAPI are a great match, and are commonly used together.

15.4.1 Creating a new project

Using the `piccolo asgi new` command, Piccolo will scaffold a new FastAPI app for you - simple!

15.4.2 Pydantic models

FastAPI uses Pydantic for serialising and deserialising data.

Piccolo provides *create_pydantic_model* which creates Pydantic models for you based on your Piccolo tables.

Of course, you can also just define your Pydantic models by hand.

15.4.3 Transactions

Using FastAPI's dependency injection system, we can easily wrap each endpoint in a transaction.

```
from fastapi import Depends, FastAPI
from pydantic import BaseModel

from piccolo.columns.column_types import Varchar
from piccolo.engine.sqlite import SQLiteEngine
from piccolo.table import Table

DB = SQLiteEngine()


class Band(Table, db=DB):
    """
    You would usually import this from tables.py
```

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```
    """

    name = Varchar()


async def transaction():
    async with DB.transaction() as transaction:
        yield transaction


app = FastAPI()


@app.get("/bands/", dependencies=[Depends(transaction)])
async def get_bands():
    return await Band.select()


class CreateBandModel(BaseModel):
    name: str


@app.post("/bands/", dependencies=[Depends(transaction)])
async def create_band(model: CreateBandModel):
    await Band({Band.name: model.name}).save()

    # If an exception is raised then the transaction is rolled back.
    raise Exception("Oops")


async def main():
    await Band.create_table(if_not_exists=True)


if __name__ == "__main__":
    import asyncio

    import uvicorn

    asyncio.run(main())
    uvicorn.run(app)
```

FastAPI dependencies can be declared at the endpoint, `APIRouter`, or even app level.

15.4.4 `FastAPIWrapper`

Piccolo API has a powerful utility called `FastAPIWrapper` which generates REST endpoints based on your Piccolo tables, and adds them to FastAPI's Swagger docs. It's a very productive way of building an API.

15.4.5 Authentication

Piccolo API ships with authentication middleware which is compatible with FastAPI middleware.

CHAPTER

SIXTEEN

CONTRIBUTING

If you want to dig deeper into the Piccolo internals, follow these instructions.

16.1 Running Cockroach

To get a local Cockroach instance running, you can use:

```
cockroach start-single-node --insecure --store=type=mem,size=2GiB
```

Make sure the test database exists:

```
cockroach sql --insecure
>>> create database piccolo
>>> use piccolo
```

16.2 Get the tests running

- Create a new virtualenv
- Clone the Git repo
- `cd piccolo`
- Install default dependencies: `pip install -r requirements/requirements.txt`
- Install development dependencies: `pip install -r requirements/dev-requirements.txt`
- Install test dependencies: `pip install -r requirements/test-requirements.txt`
- Setup Postgres, and make sure a database called `piccolo` exists (see `tests/postgres_conf.py`).
- Run the automated code linting/formatting tools: `./scripts/lint.sh`
- Run the test suite with Postgres: `./scripts/test-postgres.sh`
- Run the test suite with Cockroach: `./scripts/test-cockroach.sh`
- Run the test suite with Sqlite: `./scripts/test-sqlite.sh`

16.3 Contributing to the docs

The docs are written using Sphinx. To get them running locally:

- Install the requirements: `pip install -r requirements/doc-requirements.txt`
- `cd docs`
- Do an initial build of the docs: `make html`
- Serve the docs: `./scripts/run-docs.sh`
- The docs will auto rebuild as you make changes.

16.4 Code style

Piccolo uses Black for formatting, preferably with a max line length of 79, to keep it consistent with PEP8 .

You can configure VSCode by modifying `settings.json` as follows:

```
{
    "python.linting.enabled": true,
    "python.linting.mypyEnabled": true,
    "python.formatting.provider": "black",
    "python.formatting.blackArgs": [
        "--line-length",
        "79"
    ],
    "editor.formatOnSave": true
}
```

Type hints are used throughout the project.

16.5 Profiling

This isn't required to contribute to Piccolo, but is useful when investigating performance problems.

- Install the dependencies: `pip install requirements/profile-requirements.txt`
- Make sure a Postgres database called `piccolo_profile` exists.
- Run `./scripts/profile.sh` to get performance data.

CHAPTER

SEVENTEEN

CHANGES

17.1 0.119.0

`ModelBuilder` now works with `LazyTableReference` (which is used when we have circular references caused by a `ForeignKey`).

With this table:

```
class Band(Table):
    manager = ForeignKey(
        LazyTableReference(
            'Manager',
            module_path='some.other.folder.tables'
        )
    )
```

We can now create a dynamic test fixture:

```
my_model = await ModelBuilder.build(Band)
```

17.2 0.118.0

If you have lots of Piccolo apps, you can now create auto migrations for them all in one go:

```
piccolo migrations new all --auto
```

Thanks to @hoosnick for suggesting this new feature.

The documentation for running migrations has also been improved, as well as improvements to the sorting of migrations based on their dependencies.

Support for Python 3.7 was dropped in this release as it's now end of life.

17.3 0.117.0

Version pinning Pydantic to v1, as v2 has breaking changes.

We will add support for Pydantic v2 in a future release.

Thanks to @sinisaos for helping with this.

17.4 0.116.0

17.4.1 Fixture formatting

When creating a fixture:

```
piccolo fixtures dump
```

The JSON output is now nicely formatted, which is useful because we can pipe it straight to a file, and commit it to Git without having to manually run a formatter on it.

```
piccolo fixtures dump > my_fixture.json
```

Thanks to @sinisaos for this.

17.4.2 Protected table names

We used to raise a `ValueError` if a table was called `user`.

```
class User(Table):  # ValueError!
    ...
```

It's because `user` is already used by Postgres (e.g. try `SELECT user` or `SELECT * FROM user`).

We now emit a warning instead for these reasons:

- Piccolo wraps table names in quotes to avoid clashes with reserved keywords.
- Sometimes you're stuck with a table name from a pre-existing schema, and can't easily rename it.

17.4.3 Re-export `WhereRaw`

If you want to write raw SQL in your where queries you use `WhereRaw`:

```
>>> Band.select().where(WhereRaw('TRIM(name) = {}', 'Pythonistas'))
```

You can now import it from `piccolo.query` to be consistent with `SelectRaw` and `OrderByRaw`.

```
from piccolo.query import WhereRaw
```

17.5 0.115.0

17.5.1 Fixture upserting

Fixtures can now be upserted. For example:

```
piccolo fixtures load my_fixture.json --on_conflict='DO UPDATE'
```

The options are:

- `DO NOTHING`, meaning any rows with a matching primary key will be left alone.
- `DO UPDATE`, meaning any rows with a matching primary key will be updated.

This is really useful, as you can now edit fixtures and load them multiple times without getting foreign key constraint errors.

17.5.2 Schema fixes

We recently added support for schemas, for example:

```
class Band(Table, schema='music'):
    ...
```

This release contains:

- A fix for migrations when changing a table's schema back to 'public' (thanks to @sinisaos for discovering this).
- A fix for `M2M` queries, when the tables are in a schema other than 'public' (thanks to @quinnalfaro for reporting this).

17.5.3 Added `distinct` method to `count` queries

We recently added support for `COUNT DISTINCT` queries. The syntax is:

```
await Concert.count(distinct=[Concert.start_date])
```

The following alternative syntax now also works (just to be consistent with other queries like `select`):

```
await Concert.count().distinct([Concert.start_date])
```

17.6 0.114.0

`count` queries can now return the number of distinct rows. For example, if we have this table:

```
class Concert(Table):
    band = Varchar()
    start_date = Date()
```

With this data:

band	start_date
Pythonistas	2023-01-01
Pythonistas	2023-02-03
Rustaceans	2023-01-01

We can easily get the number of unique concert dates:

```
>>> await Concert.count(distinct=[Concert.start_date])
2
```

We could have just done this instead:

```
len(await Concert.select(Concert.start_date).distinct())
```

But it's far less efficient when you have lots of rows, because all of the distinct rows need to be returned from the database.

Also, the docs for the `count` query, aggregate functions, and `group_by` clause were significantly improved.

Many thanks to @lqmanh and @sinisaos for their help with this.

17.7 0.113.0

If Piccolo detects a renamed table in an auto migration, it asks the user for confirmation. When lots of tables have been renamed, Piccolo is now more intelligent about when to ask for confirmation. Thanks to @sumitsharansatsangi for suggesting this change, and @sinisaos for reviewing.

Also, fixed the type annotations for `MigrationManager.add_table`.

17.8 0.112.1

Fixed a bug with serialising table classes in migrations.

17.9 0.112.0

Added support for schemas in Postgres and CockroachDB.

For example:

```
class Band(Table, schema="music"):
    ...
```

When creating the table, the schema will be created automatically if it doesn't already exist.

```
await Band.create_table()
```

It also works with migrations. If we change the `schema` value for the table, Piccolo will detect this, and create a migration for moving it to the new schema.

```
class Band(Table, schema="music_2"):
    ...

# Piccolo will detect that the table needs to be moved to a new schema.
>>> piccolo migrations new my_app --auto
```

17.10 0.111.1

Fixing a bug with `ModelBuilder` and `Decimal` / `Numeric` columns.

17.11 0.111.0

Added the `on_conflict` clause for `insert` queries. This enables **upserts**.

For example, here we insert some bands, and if they already exist then do nothing:

```
await Band.insert(
    Band(name='Pythonistas'),
    Band(name='Rustaceans'),
    Band(name='C-Sharps'),
).on_conflict(action='DO NOTHING')
```

Here we insert some albums, and if they already exist then we update the price:

```
await Album.insert(
    Album(title='OK Computer', price=10.49),
    Album(title='Kid A', price=9.99),
    Album(title='The Bends', price=9.49),
).on_conflict(
    action='DO UPDATE',
    target=Album.title,
    values=[Album.price]
)
```

Thanks to @sinisaos for helping with this.

17.12 0.110.0

17.12.1 ASGI frameworks

The ASGI frameworks in `piccolo asgi new` have been updated. `starlite` has been renamed to `litestar`. Thanks to @sinisaos for this.

17.12.2 ModelBuilder

Generic types are now used in `ModelBuilder`.

```
# mypy knows this is a `Band` instance:
band = await ModelBuilder.build(Band)
```

17.12.3 DISTINCT ON

Added support for `DISTINCT ON` queries. For example, here we fetch the most recent album for each band:

```
>>> await Album.select().distinct(
...     on=[Album.band]
... ).order_by(
...     Album.band
... ).order_by(
...     Album.release_date,
...     ascending=False
... )
```

Thanks to @sinisaos and @williamflaherty for their help with this.

17.13 0.109.0

Joins are now possible without foreign keys using `join_on`.

For example:

```
class Manager(Table):
    name = Varchar(unique=True)
    email = Varchar()

class Band(Table):
    name = Varchar()
    manager_name = Varchar()

>>> await Band.select(
...     Band.name,
...     Band.manager_name.join_on(Manager.name).email
... )
```

17.14 0.108.0

Added support for savepoints within transactions.

```
async with DB.transaction() as transaction:
    await Manager.objects().create(name="Great manager")
    savepoint = await transaction.savepoint()
    await Manager.objects().create(name="Great manager")
    await savepoint.rollback_to()
    # Only the first manager will be inserted.
```

The behaviour of nested context managers has also been changed slightly.

```
async with DB.transaction():
    async with DB.transaction():
        # This used to raise an exception
```

We no longer raise an exception if there are nested transaction context managers, instead the inner ones do nothing.

If you want the existing behaviour:

```
async with DB.transaction():
    async with DB.transactiona(allow_nested=False):
        # TransactionError!
```

17.15 0.107.0

Added the `log_responses` option to the database engines. This makes the engine print out the raw response from the database for each query, which is useful during debugging.

```
# piccolo_conf.py

DB = PostgresEngine(
  config={'database': 'my_database'},
  log_queries=True,
  log_responses=True
)
```

We also updated the Starlite ASGI template - it now uses the new import paths (thanks to @sinisaos for this).

17.16 0.106.0

Joins now work within `update` queries. For example:

```
await Band.update({
    Band.name: 'Amazing Band'
}).where(
    Band.manager.name == 'Guido'
)
```

Other changes:

- Improved the template used by `piccolo app new` when creating a new Piccolo app (it now uses `table_finder`).

17.17 0.105.0

Improved the performance of select queries with complex joins. Many thanks to @powellnorma and @sinisaos for their help with this.

17.18 0.104.0

Major improvements to Piccolo's typing / auto completion support.

For example:

```
>>> bands = await Band.objects()  # List[Band]

>>> band = await Band.objects().first()  # Optional[Band]

>>> bands = await Band.select().output(as_json=True)  # str
```

17.19 0.103.0

17.19.1 SelectRaw

This allows you to access features in the database which aren't exposed directly by Piccolo. For example, Postgres functions:

```
from piccolo.query import SelectRaw

>>> await Band.select(
...     Band.name,
```

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```
...     SelectRaw("log(popularity) AS log_popularity")
... )
[{'name': 'Pythonistas', 'log_popularity': 3.0}]
```

17.19.2 Large fixtures

Piccolo can now load large fixtures using `piccolo fixtures load`. The rows are inserted in batches, so the database adapter doesn't raise any errors.

17.20 0.102.0

17.20.1 Migration file names

The naming convention for migrations has changed slightly. It used to be just a timestamp - for example:

```
2021-09-06T13-58-23-024723.py
```

By convention Python files should start with a letter, and only contain `a-z`, `0-9` and `_`, so the new format is:

```
my_app_2021_09_06T13_58_23_024723.py
```

Note: You can name a migration file anything you want (it's the `ID` value inside it which is important), so this change doesn't break anything.

17.20.2 Enhanced Pydantic configuration

We now expose all of Pydantic's configuration options to `create_pydantic_model`:

```
class MyPydanticConfig(pydantic.BaseConfig):
    extra = 'forbid'

model = create_pydantic_model(
    table=MyTable,
    pydantic_config_class=MyPydanticConfig
)
```

Thanks to @waldner for this.

17.20.3 Other changes

- Fixed a bug with `get_or_create` and null columns (thanks to @powellnorma for reporting this issue).
- Updated the Starlite ASGI template, so it uses the latest syntax for mounting Piccolo Admin (thanks to @sinisaos for this, and the Starlite team).

17.21 0.101.0

`piccolo fixtures load` is now more intelligent about how it loads data, to avoid foreign key constraint errors.

17.22 0.100.0

`Array` columns now support choices.

```
class Ticket(Table):
    class Extras(str, enum.Enum):
        drink = "drink"
        snack = "snack"
        program = "program"

    extras = Array(Varchar(), choices=Extras)
```

We can then use the `Enum` in our queries:

```
>>> await Ticket.insert(
...     Ticket(extras=[Extras.drink, Extras.snack]),
...     Ticket(extras=[Extras.program]),
... )
```

This will also be supported in Piccolo Admin in the next release.

17.23 0.99.0

You can now use the `returning` clause with `delete` queries.

For example:

```
>>> await Band.delete().where(Band.popularity < 100).returning(Band.name)
[{'name': 'Terrible Band'}, {'name': 'Awful Band'}]
```

This also means you can count the number of deleted rows:

```
>>> len(await Band.delete().where(Band.popularity < 100).returning(Band.id))
2
```

Thanks to @waldner for adding this feature.

17.24 0.98.0

17.24.1 SQLite `TransactionType`

You can now specify the transaction type for SQLite.

This is useful when using SQLite in production, as it's possible to get `database locked` errors if you're running lots of transactions concurrently, and don't use the correct transaction type.

In this example we use an `IMMEDIATE` transaction:

```
from piccolo.engine.sqlite import TransactionType

async with Band._meta.db.transaction(
    transaction_type=TransactionType.immediate
):
    band = await Band.objects().get_or_create(Band.name == 'Pythonistas')
    ...
```

We've added a new tutorial which explains this in more detail, as well as other tips for using asyncio and SQLite together effectively.

Thanks to @powellnorma and @sinisaos for their help with this.

17.24.2 Other changes

- Fixed a bug with camelCase column names (we recommend using snake_case, but sometimes it's unavoidable when using Piccolo with an existing schema). Thanks to @sinisaos for this.
- Fixed a typo in the docs with `raw` queries - thanks to @StitiFatah for this.

17.25 0.97.0

Some big improvements to `order_by` clauses.

It's now possible to combine ascending and descending:

```
await Band.select(
    Band.name,
    Band.popularity
).order_by(
    Band.name
).order_by(
    Band.popularity,
    ascending=False
)
```

You can also order by anything you want using `OrderByRaw`:

```
from piccolo.query import OrderByRaw

await Band.select(
    Band.name
).order_by(
    OrderByRaw('random()')
)
```

17.26 0.96.0

Added the `auto_update` argument to `Column`. Its main use case is columns like `modified_on` where we want the value to be updated automatically each time the row is saved.

```
class Band(Table):
    name = Varchar()
    popularity = Integer()
    modified_on = Timestamp(
      null=True,
      default=None,
      auto_update=datetime.datetime.now
    )

  # The `modified_on` column will automatically be updated to the current
  # timestamp:
  >>> await Band.update({
  ...     Band.popularity: Band.popularity + 100
  ... }).where(
  ...     Band.name == 'Pythonistas'
  ... )
```

It works with `MyTable.update` and also when using the `save` method on an existing row.

17.27 0.95.0

Made improvements to the Piccolo playground.

- Syntax highlighting is now enabled.
- The example queries are now async (iPython supports top level await, so this works fine).
- You can optionally use your own iPython configuration `piccolo playground run --ipython_profile` (for example if you want a specific colour scheme, rather than the one we use by default).

Thanks to @haffi96 for this. See PR 656.

17.28 0.94.0

Fixed a bug with `MyTable.objects().create()` and columns which are not nullable. Thanks to @metakot for reporting this issue.

We used to use `logging.getLogger(__file__)`, but as @Drapersniper pointed out, the Python docs recommend `logging.getLogger(__name__)`, so it has been changed.

17.29 0.93.0

- Fixed a bug with nullable `JSON` / `JSONB` columns and `create_pydantic_model` - thanks to @eneacosta for this fix.
- Made the `Time` column type importable from `piccolo.columns`.
- Python 3.11 is now supported.
- Postgres 9.6 is no longer officially supported, as it's end of life, but Piccolo should continue to work with it just fine for now.
- Improved docs for transactions, added docs for the `as_of` clause in CockroachDB (thanks to @gnat for this), and added docs for `add_raw_backwards`.

17.30 0.92.0

Added initial support for Cockroachdb (thanks to @gnat for this massive contribution).

Fixed Pylance warnings (thanks to @MiguelGuthridge for this).

17.31 0.91.0

Added support for Starlite. If you use `piccolo asgi new` you'll see it as an option for a router.

Thanks to @sinisaos for adding this, and @peterschutt for helping debug ASGI mounting.

17.32 0.90.0

Fixed an edge case, where a migration could fail if:

- 5 or more tables were being created at once.
- They all contained foreign keys to each other, as shown below.

```
class TableA(Table):
    pass

class TableB(Table):
    fk = ForeignKey(TableA)

class TableC(Table):
    fk = ForeignKey(TableB)

class TableD(Table):
    fk = ForeignKey(TableC)

class TableE(Table):
    fk = ForeignKey(TableD)
```

Thanks to @sumitsharansatsangi for reporting this issue.

17.33 0.89.0

Made it easier to access the `Email` columns on a table.

```
>>> MyTable._meta.email_columns
[MyTable.email_column_1, MyTable.email_column_2]
```

This was added for Piccolo Admin.

17.34 0.88.0

Fixed a bug with migrations - when using `db_column_name` it wasn't being used in some alter statements. Thanks to @theelderbeever for reporting this issue.

```
class Concert(Table):
    # We use `db_column_name` when the column name is problematic - e.g. if
    # it clashes with a Python keyword.
    in_ = Varchar(db_column_name='in')
```

17.35 0.87.0

When using `get_or_create` with `prefetch` the behaviour was inconsistent - it worked as expected when the row already existed, but prefetch wasn't working if the row was being created. This now works as expected:

```
>>> band = Band.objects(Band.manager).get_or_create(
...     (Band.name == "New Band 2") & (Band.manager == 1)
... )

>>> band.manager
<Manager: 1>
>>> band.manager.name
"Mr Manager"
```

Thanks to @backwardspy for reporting this issue.

17.36 0.86.0

Added the `Email` column type. It's basically identical to `Varchar`, except that when we use `create_pydantic_model` we add email validation to the generated Pydantic model.

```
from piccolo.columns.column_types import Email
from piccolo.table import Table
from piccolo.utils.pydantic import create_pydantic_model


class MyTable(Table):
    email = Email()


model = create_pydantic_model(MyTable)

model(email="not a valid email")
# ValidationError!
```

Thanks to @sinisaos for implementing this feature.

17.37 0.85.1

Fixed a bug with migrations - when run backwards, `raw` was being called instead of `raw_backwards`. Thanks to @translunar for the fix.

17.38 0.85.0

You can now append items to an array in an update query:

```
await Ticket.update({
    Ticket.seat_numbers: Ticket.seat_numbers + [1000]
}).where(Ticket.id == 1)
```

Currently Postgres only. Thanks to @sumitsharansatsangi for suggesting this feature.

17.39 0.84.0

You can now preview the DDL statements which will be run by Piccolo migrations.

```
piccolo migrations forwards my_app --preview
```

Thanks to @AliSayyah for adding this feature.

17.40 0.83.0

We added support for Postgres read-slaves a few releases ago, but the `batch` clause didn't support it until now. Thanks to @guruvignesh01 for reporting this issue, and @sinisaos for help implementing it.

```
# Returns 100 rows at a time from read_replica_db
async with await Manager.select().batch(
    batch_size=100,
    node="read_replica_db",
) as batch:
    async for _batch in batch:
        print(_batch)
```

17.41 0.82.0

Traditionally, when instantiating a `Table`, you passed in column values using kwargs:

```
>>> await Manager(name='Guido').save()
```

You can now pass in a dictionary instead, which makes it easier for static typing analysis tools like Mypy to detect typos.

```
>>> await Manager({Manager.name: 'Guido'}).save()
```

See PR 565 for more info.

17.42 0.81.0

Added the `returning` clause to `insert` and `update` queries.

This can be used to retrieve data from the inserted / modified rows.

Here's an example, where we update the unpopular bands, and retrieve their names, in a single query:

```
>>> await Band.update({
...     Band.popularity: Band.popularity + 5
... }).where(
...     Band.popularity < 10
... ).returning(
...     Band.name
... )
[{'name': 'Bad sound band'}, {'name': 'Tone deaf band'}]
```

See PR 564 and PR 563 for more info.

17.43 0.80.2

Fixed a bug with `Combination.__str__`, which meant that when printing out a query for debugging purposes it was wasn't showing correctly (courtesy @destos).

17.44 0.80.1

Fixed a bug with Piccolo Admin and `_get_related_readable`, which is used to show a human friendly identifier for a row, rather than just the ID.

Thanks to @ethagnawl and @sinisaos for their help with this.

17.45 0.80.0

There was a bug when doing joins with a `JSONB` column with `as_alias`.

```
class User(Table, tablename="my_user"):
    name = Varchar(length=120)
    config = JSONB(default={})


class Subscriber(Table, tablename="subscriber"):
    name = Varchar(length=120)
    user = ForeignKey(references=User)
```

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```
async def main():
    # This was failing:
    await Subscriber.select(
        Subscriber.name,
        Subscriber.user.config.as_alias("config")
    )
```

Thanks to @Anton-Karpenko for reporting this issue.

Even though this is a bug fix, the minor version number has been bumped because the fix resulted in some refactoring of Piccolo's internals, so is a fairly big change.

17.46 0.79.0

Added a custom `__repr__` method to `Table`'s metaclass. It's needed to improve the appearance of our Sphinx docs. See issue 549 for more details.

17.47 0.78.0

Added the `callback` clause to `select` and `objects` queries (courtesy @backwardspy). For example:

```
>>> await Band.select().callback(my_callback)
```

The callback can be a normal function or async function, which is called when the query is successful. The callback can be used to modify the query's output.

It allows for some interesting and powerful code. Here's a very simple example where we modify the query's output:

```
>>> def get_uppercase_names() -> Select:
...     def make_uppercase(response):
...         return [{'name': i['name'].upper()} for i in response]
...
...     return Band.select(Band.name).callback(make_uppercase)

>>> await get_uppercase_names().where(Band.manager.name == 'Guido')
[{'name': 'PYTHONISTAS'}]
```

Here's another example, where we perform validation on the query's output:

```
>>> def get_concerts() -> Select:
...     def check_length(response):
...         if len(response) == 0:
...             raise ValueError('No concerts!')
...         return response
...
...     return Concert.select().callback(check_length)
```

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```
>>> await get_concerts().where(Concert.band_1.name == 'Terrible Band')
ValueError: No concerts!
```

At the moment, callbacks are just triggered when a query is successful, but in the future other callbacks will be added, to hook into more of Piccolo's internals.

17.48 0.77.0

Added the `refresh` method. If you have an object which has gotten stale, and want to refresh it, so it has the latest data from the database, you can now do this:

```
# If we have an instance:
band = await Band.objects().first()

# And it has gotten stale, we can refresh it:
await band.refresh()
```

Thanks to @trondhindenes for suggesting this feature.

17.49 0.76.1

Fixed a bug with `atomic` when run async with a connection pool.

For example:

```
atomic = Band._meta.db.atomic()
atomic.add(query_1, query_1)
# This was failing:
await atomic.run()
```

Thanks to @Anton-Karpenko for reporting this issue.

17.50 0.76.0

17.50.1 create_db_tables / drop_db_tables

Added `create_db_tables` and `create_db_tables_sync` to replace `create_tables`. The problem was `create_tables` was sync only, and was inconsistent with the rest of Piccolo's API, which is async first. `create_tables` will continue to work for now, but is deprecated, and will be removed in version 1.0.

Likewise, `drop_db_tables` and `drop_db_tables_sync` have replaced `drop_tables`.

When calling `create_tables` / `drop_tables` within other async libraries (such as ward) it was sometimes unreliable - the best solution was just to make async versions of these functions. Thanks to @backwardspy for reporting this issue.

17.50.2 `BaseUser` password validation

We centralised the password validation logic in `BaseUser` into a method called `_validate_password`. This is needed by Piccolo API, but also makes it easier for users to override this logic if subclassing `BaseUser`.

17.50.3 More `run_sync` refinements

`run_sync`, which is the main utility function which Piccolo uses to run async code, has been further simplified for Python > v3.10 compatibility.

17.51 0.75.0

Changed how `piccolo.utils.sync.run_sync` works, to prevent a warning on Python 3.10. Thanks to @Dragersniper for reporting this issue.

Lots of documentation improvements - particularly around testing, and Docker deployment.

17.52 0.74.4

`piccolo schema generate` now outputs a warning when it can't detect the `ON DELETE` and `ON UPDATE` for a `ForeignKey`, rather than raising an exception. Thanks to @theelderbeever for reporting this issue.

`run_sync` doesn't use the connection pool by default anymore. It was causing issues when an app contained sync and async code. Thanks to @WintonLi for reporting this issue.

Added a tutorial to the docs for using Piccolo with an existing project and database. Thanks to @virajkanwade for reporting this issue.

17.53 0.74.3

If you had a table containing an array of `BigInt`, then migrations could fail:

```
from piccolo.table import Table
from piccolo.columns.column_types import Array, BigInt

class MyTable(Table):
    my_column = Array(base_column=BigInt())
```

It's because the `BigInt` base column needs access to the parent table to know if it's targeting Postgres or SQLite. See PR 501.

Thanks to @cheesycod for reporting this issue.

17.54 0.74.2

If a user created a custom `Column` subclass, then migrations would fail. For example:

```
class CustomColumn(Varchar):
    def __init__(self, custom_arg: str = '', *args, **kwargs):
        self.custom_arg = custom_arg
        super().__init__(*args, **kwargs)

    @property
    def column_type(self):
        return 'VARCHAR'
```

See PR 497. Thanks to @WintonLi for reporting this issue.

17.55 0.74.1

When using `pip install piccolo[all]` on Windows it would fail because uvloop isn't supported. Thanks to @jack1142 for reporting this issue.

17.56 0.74.0

We've had the ability to bulk modify rows for a while. Here we append `'!!!'` to each band's name:

```
>>> await Band.update({Band.name: Band.name + '!!!'}, force=True)
```

It only worked for some columns - `Varchar`, `Text`, `Integer` etc.

We now allow `Date`, `Timestamp`, `Timestamptz` and `Interval` columns to be bulk modified using a `timedelta`. Here we modify each concert's start date, so it's one day later:

```
>>> await Concert.update(
...     {Concert.starts: Concert.starts + timedelta(days=1)},
...     force=True
... )
```

Thanks to @theelderbeever for suggesting this feature.

17.57 0.73.0

You can now specify extra nodes for a database. For example, if you have a read replica.

```
DB = PostgresEngine(
    config={'database': 'main_db'},
    extra_nodes={
        'read_replica_1': PostgresEngine(
            config={
                'database': 'main_db',
                'host': 'read_replica_1.my_db.com'
            }
        )
    }
)
```

And can then run queries on these other nodes:

```
>>> await MyTable.select().run(node="read_replica_1")
```

See PR 481. Thanks to @dashsatish for suggesting this feature.

Also, the `targ` library has been updated so it tells users about the `--trace` argument which can be used to get a full traceback when a CLI command fails.

17.58 0.72.0

Fixed typos with `drop_constraints`. Courtesy @smythp.

Lots of documentation improvements, such as fixing Sphinx's autodoc for the `Array` column.

`AppConfig` now accepts a `pathlib.Path` instance. For example:

```
# piccolo_app.py

import pathlib

APP_CONFIG = AppConfig(
    app_name="blog",
    migrations_folder_path=pathlib.Path(__file__) /  "piccolo_migrations"
)
```

Thanks to @theelderbeever for recommending this feature.

17.59 0.71.1

Fixed a bug with `ModelBuilder` and nullable columns (see PR 462). Thanks to @fiolet069 for reporting this issue.

17.60 0.71.0

The `ModelBuilder` class, which is used to generate mock data in tests, now supports `Array` columns. Courtesy @backwardspy.

Lots of internal code optimisations and clean up. Courtesy @yezz123.

Added docs for troubleshooting common MyPy errors.

Also thanks to @adriangb for helping us with our dependency issues.

17.61 0.70.1

Fixed a bug with auto migrations. If renaming multiple columns at once, it could get confused. Thanks to @theelderbeever for reporting this issue, and @sinisaos for helping to replicate it. See PR 457.

17.62 0.70.0

We ran a profiler on the Piccolo codebase and identified some optimisations. For example, we were calling `self.querystring` multiple times in a method, rather than assigning it to a local variable.

We also ran a linter which identified when list / set / dict comprehensions could be more efficient.

The performance is now slightly improved (especially when fetching large numbers of rows from the database).

Example query times on a MacBook, when fetching 1000 rows from a local Postgres database (using `await SomeTable.select()`):

- 8 ms without a connection pool
- 2 ms with a connection pool

As you can see, having a connection pool is the main thing you can do to improve performance.

Thanks to @AliSayyah for all his work on this.

17.63 0.69.5

Made improvements to `piccolo schema generate`, which automatically generates Piccolo `Table` classes from an existing database.

There were situations where it would fail ungracefully when it couldn't parse an index definition. It no longer crashes, and we print out the problematic index definitions. See PR 449. Thanks to @gmos for originally reporting this issue.

We also improved the error messages if schema generation fails for some reason by letting the user know which table caused the error. Courtesy @AliSayyah.

17.64 0.69.4

We used to raise a `ValueError` if a column was both `null=False` and `default=None`. This has now been removed, as there are situations where it's valid for columns to be configured that way. Thanks to @gmos for suggesting this change.

17.65 0.69.3

The `where` clause now raises a `ValueError` if a boolean value is passed in by accident. This was possible in the following situation:

```
await Band.select().where(Band.has_drummer is None)
```

Piccolo can't override the `is` operator because Python doesn't allow it, so `Band.has_drummer is None` will always equal `False`. Thanks to @trondhindenes for reporting this issue.

We've also put a lot of effort into improving documentation throughout the project.

17.66 0.69.2

- Lots of documentation improvements, including how to customise `BaseUser` (courtesy @sinisaos).
- Fixed a bug with creating indexes when the column name clashes with a SQL keyword (e.g. `'order'`). See Pr 433. Thanks to @wmshort for reporting this issue.
- Fixed an issue where some slots were incorrectly configured (courtesy @ariebovenberg). See PR 426.

17.67 0.69.1

Fixed a bug with auto migrations which rename columns - see PR 423. Thanks to @theelderbeever for reporting this, and @sinisaos for help investigating.

17.68 0.69.0

Added Xpresso as a supported ASGI framework when using `piccolo asgi new` to generate a web app.

Thanks to @sinisaos for adding this template, and @adriangb for reviewing.

We also took this opportunity to update our FastAPI and BlackSheep ASGI templates.

17.69 0.68.0

17.69.1 `Update` queries without a `where` clause

If you try and perform an update query without a `where` clause you will now get an error:

```
>>> await Band.update({Band.name: 'New Band'})
UpdateError
```

If you want to update all rows in the table, you can still do so, but you must pass `force=True`.

```
>>> await Band.update({Band.name: 'New Band'}, force=True)
```

This is a similar to `delete` queries, which require a `where` clause or `force=True`.

It was pointed out by @theelderbeever that an accidental mass update is almost as bad as a mass deletion, which is why this safety measure has been added.

See PR 412.

Warning: This is a breaking change. It you're doing update queries without a where clause, you will need to add `force=True`.

17.69.2 `JSONB` improvements

Fixed some bugs with nullable `JSONB` columns. A value of `None` is now stored as `null` in the database, instead of the JSON string `'null'`. Thanks to @theelderbeever for reporting this.

See PR 413.

17.70 0.67.0

17.70.1 create_user

`BaseUser` now has a `create_user` method, which adds some extra password validation vs just instantiating and saving `BaseUser` directly.

```
>>> await BaseUser.create_user(username='bob', password='abc123XYZ')
<BaseUser: 1>
```

We check that passwords are a reasonable length, and aren't already hashed. See PR 402.

17.70.2 async first

All of the docs have been updated to show the async version of queries.

For example:

```
# Previous:
Band.select().run_sync()

# Now:
await Band.select()
```

Most people use Piccolo in async apps, and the playground supports top level await, so you can just paste in `await Band.select()` and it will still work. See PR 407.

We decided to use `await Band.select()` instead of `await Band.select().run()`. Both work, and have their merits, but the simpler version is probably easier for newcomers.

17.71 0.66.1

In Piccolo you can print out any query to see the SQL which will be generated:

```
>>> print(Band.select())
SELECT "band"."id", "band"."name", "band"."manager", "band"."popularity" FROM band
```

It didn't represent `UUID` and `datetime` values correctly, which is now fixed (courtesy @theelderbeever). See PR 405.

17.72 0.66.0

Using descriptors to improve MyPy support (PR 399).

MyPy is now able to correctly infer the type in lots of different scenarios:

```
class Band(Table):
    name = Varchar()

# MyPy knows this is a Varchar
Band.name

band = Band()
band.name = "Pythonistas"  # MyPy knows we can assign strings when it's a class instance
band.name  # MyPy knows we will get a string back

band.name = 1  # MyPy knows this is an error, as we should only be allowed to assign␣
↪strings
```

17.73 0.65.1

Fixed bug with `BaseUser` and Piccolo API.

17.74 0.65.0

The `BaseUser` table hashes passwords before storing them in the database.

When we create a fixture from the `BaseUser` table (using `piccolo fixtures dump`), it looks something like:

```
{
  "id": 11,
  "username": "bob",
  "password": "pbkdf2_sha256$10000$abc123",
}
```

When we load the fixture (using `piccolo fixtures load`) we need to be careful in case `BaseUser` tries to hash the password again (it would then be a hash of a hash, and hence incorrect). We now have additional checks in place to prevent this.

Thanks to @mrbazzan for implementing this, and @sinisaos for help reviewing.

17.75 0.64.0

Added initial support for `ForeignKey` columns referencing non-primary key columns. For example:

```
class Manager(Table):
    name = Varchar()
    email = Varchar(unique=True)

class Band(Table):
    manager = ForeignKey(Manager, target_column=Manager.email)
```

Thanks to @theelderbeever for suggesting this feature, and with help testing.

17.76 0.63.1

Fixed an issue with the `value_type` of `ForeignKey` columns when referencing a table with a custom primary key column (such as a `UUID`).

17.77 0.63.0

Added an `exclude_imported` option to `table_finder`.

```
APP_CONFIG = AppConfig(
    table_classes=table_finder(['music.tables'], exclude_imported=True)
)
```

It's useful when we want to import `Table` subclasses defined within a module itself, but not imported ones:

```
# tables.py
from piccolo.apps.user.tables import BaseUser # excluded
from piccolo.columns.column_types import ForeignKey, Varchar
from piccolo.table import Table


class Musician(Table): # included
    name = Varchar()
    user = ForeignKey(BaseUser)
```

This was also possible using tags, but was less convenient. Thanks to @sinisaos for reporting this issue.

17.78 0.62.3

Fixed the error message in `LazyTableReference`.

Fixed a bug with `create_pydantic_model` with nested models. For example:

```
create_pydantic_model(Band, nested=(Band.manager,))
```

Sometimes Pydantic couldn't uniquely identify the nested models. Thanks to @wmshort and @sinisaos for their help with this.

17.79 0.62.2

Added a max password length to the `BaseUser` table. By default it's set to 128 characters.

17.80 0.62.1

Fixed a bug with `Readable` when it contains lots of joins.

`Readable` is used to create a user friendly representation of a row in Piccolo Admin.

17.81 0.62.0

Added Many-To-Many support.

```
from piccolo.columns.column_types import (
    ForeignKey,
    LazyTableReference,
    Varchar
)
from piccolo.columns.m2m import M2M


class Band(Table):
    name = Varchar()
    genres = M2M(LazyTableReference("GenreToBand", module_path=__name__))


class Genre(Table):
    name = Varchar()
    bands = M2M(LazyTableReference("GenreToBand", module_path=__name__))


# This is our joining table:
class GenreToBand(Table):
    band = ForeignKey(Band)
    genre = ForeignKey(Genre)


>>> await Band.select(Band.name, Band.genres(Genre.name, as_list=True))
[
  {
    "name": "Pythonistas",
    "genres": ["Rock", "Folk"]
  },
  ...
]
```

See the docs for more details.

Many thanks to @sinisaos and @yezz123 for all the input.

17.82 0.61.2

Fixed some edge cases where migrations would fail if a column name clashed with a reserved Postgres keyword (for example `order` or `select`).

We now have more robust tests for `piccolo asgi new` - as part of our CI we actually run the generated ASGI app to make sure it works (thanks to @AliSayyah and @yezz123 for their help with this).

We also improved docstrings across the project.

17.83 0.61.1

17.83.1 Nicer ASGI template

When using `piccolo asgi new` to generate a web app, it now has a nicer home page template, with improved styles.

17.83.2 Improved schema generation

Fixed a bug with `piccolo schema generate` where it would crash if the column type was unrecognised, due to failing to parse the column's default value. Thanks to @gmos for reporting this issue, and figuring out the fix.

17.83.3 Fix Pylance error

Added `start_connection_pool` and `close_connection_pool` methods to the base `Engine` class (courtesy @gmos).

17.84 0.61.0

The `save` method now supports a `columns` argument, so when updating a row you can specify which values to sync back. For example:

```
band = await Band.objects().get(Band.name == "Pythonistas")
band.name = "Super Pythonistas"
await band.save([Band.name])

# Alternatively, strings are also supported:
await band.save(['name'])
```

Thanks to @trondhindenes for suggesting this feature.

17.85 0.60.2

Fixed a bug with `asyncio.gather` not working with some query types. It was due to them being dataclasses, and they couldn't be hashed properly. Thanks to @brnosouza for reporting this issue.

17.86 0.60.1

Modified the import path for `MigrationManager` in migration files. It was confusing Pylance (VSCode's type checker). Thanks to @gmos for reporting and investigating this issue.

17.87 0.60.0

17.87.1 Secret columns

All column types can now be secret, rather than being limited to the `Secret` column type which is a `Varchar` under the hood (courtesy @sinisaos).

```
class Manager(Table):
    name = Varchar()
    net_worth = Integer(secret=True)
```

The reason this is useful is you can do queries such as:

```
>>> Manager.select(exclude_secrets=True).run_sync()
[{'id': 1, 'name': 'Guido'}]
```

In the Piccolo API project we have `PiccoloCRUD` which is an incredibly powerful way of building an API with very little code. `PiccoloCRUD` has an `exclude_secrets` option which lets you safely expose your data without leaking sensitive information.

17.87.2 Pydantic improvements

max_recursion_depth

`create_pydantic_model` now has a `max_recursion_depth` argument, which is useful when using `nested=True` on large database schemas.

```
>>> create_pydantic_model(MyTable, nested=True, max_recursion_depth=3)
```

Nested tuple

You can now pass a tuple of columns as the argument to `nested`:

```
>>> create_pydantic_model(Band, nested=(Band.manager,))
```

This gives you more control than just using `nested=True`.

include_columns / exclude_columns

You can now include / exclude columns from related tables. For example:

```
>>> create_pydantic_model(Band, nested=(Band.manager,), exclude_columns=(Band.manager.
↪country))
```

Similarly:

```
>>> create_pydantic_model(Band, nested=(Band.manager,), include_columns=(Band.name, Band.
↪manager.name))
```

17.88 0.59.0

- When using `piccolo asgi new` to generate a FastAPI app, the generated code is now cleaner. It also contains a `conftest.py` file, which encourages people to use `piccolo tester run` rather than using `pytest` directly.
- Tidied up docs, and added logo.
- Clarified the use of the `PICCOLO_CONF` environment variable in the docs (courtesy @theelderbeever).
- `create_pydantic_model` now accepts an `include_columns` argument, in case you only want a few columns in your model, it's faster than using `exclude_columns` (courtesy @sinisaos).
- Updated linters, and fixed new errors.

17.89 0.58.0

17.89.1 Improved Pydantic docs

The Pydantic docs used to be in the Piccolo API repo, but have been moved over to this repo. We took this opportunity to improve them significantly with additional examples. Courtesy @sinisaos.

17.89.2 Internal code refactoring

Some of the code has been optimised and cleaned up. Courtesy @yezz123.

17.89.3 Schema generation for recursive foreign keys

When using `piccolo schema generate`, it would get stuck in a loop if a table had a foreign key column which referenced itself. Thanks to @knguyen5 for reporting this issue, and @wmshort for implementing the fix. The output will now look like:

```
class Employee(Table):
    name = Varchar()
    manager = ForeignKey("self")
```

17.89.4 Fixing a bug with Alter.add_column

When using the `Alter.add_column` API directly (not via migrations), it would fail with foreign key columns. For example:

```
SomeTable.alter().add_column(
    name="my_fk_column",
    column=ForeignKey(SomeOtherTable)
  ).run_sync()
```

This has now been fixed. Thanks to @wmshort for discovering this issue.

17.89.5 create_pydantic_model improvements

Additional fields can now be added to the Pydantic schema. This is useful when using Pydantic's JSON schema functionality:

```
my_model = create_pydantic_model(Band, my_extra_field="Hello")
>>> my_model.schema()
{..., "my_extra_field": "Hello"}
```

This feature was added to support new features in Piccolo Admin.

17.89.6 Fixing a bug with import clashes in migrations

In certain situations it was possible to create a migration file with clashing imports. For example:

```
from uuid import UUID
from piccolo.columns.column_types import UUID
```

Piccolo now tries to detect these clashes, and prevent them. If they can't be prevented automatically, a warning is shown to the user. Courtesy @0scarB.

17.90 0.57.0

Added Python 3.10 support (courtesy @kennethcheo).

17.91 0.56.0

17.91.1 Fixed schema generation bug

When using `piccolo schema generate` to auto generate Piccolo `Table` classes from an existing database, it would fail in this situation:

- A table has a column with an index.
- The column name clashed with a Postgres type.

For example, we couldn't auto generate this `Table` class:

```
class MyTable(Table):
    time = Timestamp(index=True)
```

This is because `time` is a builtin Postgres type, and the `CREATE INDEX` statement being inspected in the database wrapped the column name in quotes, which broke our regex.

Thanks to @knguyen5 for fixing this.

17.91.2 Improved testing docs

A convenience method called `get_table_classes` was added to `Finder`.

`Finder` is the main class in Piccolo for dynamically importing projects / apps / tables / migrations etc.

`get_table_classes` lets us easily get the `Table` classes for a project. This makes writing unit tests easier, when we need to setup a schema.

```
from unittest import TestCase

from piccolo.table import create_tables, drop_tables
from piccolo.conf.apps import Finder

TABLES = Finder().get_table_classes()

class TestApp(TestCase):
    def setUp(self):
        create_tables(*TABLES)

    def tearDown(self):
        drop_tables(*TABLES)

    def test_app(self):
        # Do some testing ...
        pass
```

The docs were updated to reflect this.

When dropping tables in a unit test, remember to use `piccolo tester run`, to make sure the test database is used.

17.91.3 get_output_schema

`get_output_schema` is the main entrypoint for database reflection in Piccolo. It has been modified to accept an optional `Engine` argument, which makes it more flexible.

17.92 0.55.0

17.92.1 Table._meta.refresh_db

Added the ability to refresh the database engine.

```
MyTable._meta.refresh_db()
```

This causes the `Table` to fetch the `Engine` again from your `piccolo_conf.py` file. The reason this is useful, is you might change the `PICCOLO_CONF` environment variable, and some `Table` classes have already imported an engine. This is now used by the `piccolo tester run` command to ensure all `Table` classes have the correct engine.

17.92.2 ColumnMeta edge cases

Fixed an edge case where `ColumnMeta` couldn't be copied if it had extra attributes added to it.

17.92.3 Improved column type conversion

When running migrations which change column types, Piccolo now provides the `USING` clause to the `ALTER COLUMN` DDL statement, which makes it more likely that type conversion will be successful.

For example, if there is an `Integer` column, and it's converted to a `Varchar` column, the migration will run fine. In the past, running this in reverse would fail. Now Postgres will try and cast the values back to integers, which makes reversing migrations more likely to succeed.

17.92.4 Added drop_tables

There is now a convenience function for dropping several tables in one go. If the database doesn't support `CASCADE`, then the tables are sorted based on their `ForeignKey` columns, so they're dropped in the correct order. It all runs inside a transaction.

```
from piccolo.table import drop_tables

drop_tables(Band, Manager)
```

This is a useful tool in unit tests.

17.92.5 Index support in schema generation

When using `piccolo schema generate`, Piccolo will now reflect the indexes from the database into the generated `Table` classes. Thanks to @wmshort for this.

17.93 0.54.0

Added the `db_column_name` option to columns. This is for edge cases where a legacy database is being used, with problematic column names. For example, if a column is called `class`, this clashes with a Python builtin, so the following isn't possible:

```
class MyTable(Table):
    class = Varchar()  # Syntax error!
```

You can now do the following:

```
class MyTable(Table):
    class_ = Varchar(db_column_name='class')
```

Here are some example queries using it:

```
# Create - both work as expected
MyTable(class_='Test').save().run_sync()
MyTable.objects().create(class_='Test').run_sync()

# Objects
row = MyTable.objects().first().where(MyTable.class_ == 'Test').run_sync()
>>> row.class_
'Test'

# Select
>>> MyTable.select().first().where(MyTable.class_ == 'Test').run_sync()
{'id': 1, 'class': 'Test'}
```

17.94 0.53.0

An internal code clean up (courtesy @yezz123).

Dramatically improved CLI appearance when running migrations (courtesy @wmshort).

Added a runtime reflection feature, where `Table` classes can be generated on the fly from existing database tables (courtesy @AliSayyah). This is useful when dealing with very dynamic databases, where tables are frequently being added / modified, so hard coding them in a `tables.py` is impractical. Also, for exploring databases on the command line. It currently just supports Postgres.

Here's an example:

```
from piccolo.table_reflection import TableStorage

storage = TableStorage()
Band = await storage.get_table('band')
>>> await Band.select().run()
[{'id': 1, 'name': 'Pythonistas', 'manager': 1}, ...]
```

17.95 0.52.0

Lots of improvements to `piccolo schema generate`:

- Dramatically improved performance, by executing more queries in parallel (courtesy @AliSayyah).
- If a table in the database has a foreign key to a table in another schema, this will now work (courtesy @AliSayyah).
- The column defaults are now extracted from the database (courtesy @wmshort).
- The `scale` and `precision` values for `Numeric` / `Decimal` column types are extracted from the database (courtesy @wmshort).
- The `ON DELETE` and `ON UPDATE` values for `ForeignKey` columns are now extracted from the database (courtesy @wmshort).

Added `BigSerial` column type (courtesy @aliereno).

Added GitHub issue templates (courtesy @AbhijithGanesh).

17.96 0.51.1

Fixing a bug with `on_delete` and `on_update` not being set correctly. Thanks to @wmshort for discovering this.

17.97 0.51.0

Modified `create_pydantic_model`, so `JSON` and `JSONB` columns have a `format` attribute of `'json'`. This will be used by Piccolo Admin for improved JSON support. Courtesy @sinisaos.

Fixing a bug where the `piccolo fixtures load` command wasn't registered with the Piccolo CLI.

17.98 0.50.0

The `where` clause can now accept multiple arguments (courtesy @AliSayyah):

```
Concert.select().where(
    Concert.venue.name == 'Royal Albert Hall',
    Concert.band_1.name == 'Pythonistas'
).run_sync()
```

It's another way of expressing *AND*. It's equivalent to both of these:

```
Concert.select().where(
    Concert.venue.name == 'Royal Albert Hall'
).where(
    Concert.band_1.name == 'Pythonistas'
).run_sync()

Concert.select().where(
    (Concert.venue.name == 'Royal Albert Hall') & (Concert.band_1.name == 'Pythonistas')
).run_sync()
```

Added a `create` method, which is an easier way of creating objects (courtesy @AliSayyah).

```
# This still works:
band = Band(name="C-Sharps", popularity=100)
band.save().run_sync()

# But now we can do it in a single line using `create`:
band = Band.objects().create(name="C-Sharps", popularity=100).run_sync()
```

Fixed a bug with `piccolo schema generate` where columns with unrecognised column types were omitted from the output (courtesy @AliSayyah).

Added docs for the `--trace` argument, which can be used with Piccolo commands to get a traceback if the command fails (courtesy @hipertracker).

Added `DoublePrecision` column type, which is similar to `Real` in that it stores `float` values. However, those values are stored at greater precision (courtesy @AliSayyah).

Improved `AppRegistry`, so if a user only adds the app name (e.g. `blog`), instead of `blog.piccolo_app`, it will now emit a warning, and will try to import `blog.piccolo_app` (courtesy @aliereno).

17.99 0.49.0

Fixed a bug with `create_pydantic_model` when used with a `Decimal` / `Numeric` column when no `digits` arguments was set (courtesy @AliSayyah).

Added the `create_tables` function, which accepts a sequence of `Table` subclasses, then sorts them based on their `ForeignKey` columns, and creates them. This is really useful for people who aren't using migrations (for example, when using Piccolo in a simple data science script). Courtesy @AliSayyah.

```
from piccolo.tables import create_tables

create_tables(Band, Manager, if_not_exists=True)

# Equivalent to:
Manager.create_table(if_not_exists=True).run_sync()
Band.create_table(if_not_exists=True).run_sync()
```

Fixed typos with the new fixtures app - sometimes it was referred to as `fixture` and other times `fixtures`. It's now standardised as `fixtures` (courtesy @hipertracker).

17.100 0.48.0

The `piccolo user create` command can now be used by passing in command line arguments, instead of using the interactive prompt (courtesy @AliSayyah).

For example `piccolo user create --username=bob ...`.

This is useful when you want to create users in a script.

17.101 0.47.0

You can now use `pip install piccolo[all]`, which will install all optional requirements.

17.102 0.46.0

Added the fixtures app. This is used to dump data from a database to a JSON file, and then reload it again. It's useful for seeding a database with essential data, whether that's a colleague setting up their local environment, or deploying to production.

To create a fixture:

```
piccolo fixtures dump --apps=blog > fixture.json
```

To load a fixture:

```
piccolo fixtures load fixture.json
```

As part of this change, Piccolo's Pydantic support was brought into this library (prior to this it only existed within the `piccolo_api` library). At a later date, the `piccolo_api` library will be updated, so it's Pydantic code just proxies to what's within the main `piccolo` library.

17.103 0.45.1

Improvements to `piccolo schema generate`. It's now smarter about which imports to include. Also, the `Table` classes output will now be sorted based on their `ForeignKey` columns. Internally the sorting algorithm has been changed to use the `graphlib` module, which was added in Python 3.9.

17.104 0.45.0

Added the `piccolo schema graph` command for visualising your database structure, which outputs a Graphviz file. It can then be turned into an image, for example:

```
piccolo schema map | dot -Tpdf -o graph.pdf
```

Also made some minor changes to the ASGI templates, to reduce MyPy errors.

17.105 0.44.1

Updated `to_dict` so it works with nested objects, as introduced by the `prefetch` functionality.

For example:

```
band = Band.objects(Band.manager).first().run_sync()

>>> band.to_dict()
{'id': 1, 'name': 'Pythonistas', 'manager': {'id': 1, 'name': 'Guido'}}
```

It also works with filtering:

```
>>> band.to_dict(Band.name, Band.manager.name)
{'name': 'Pythonistas', 'manager': {'name': 'Guido'}}
```

17.106 0.44.0

Added the ability to prefetch related objects. Here's an example:

```
band = await Band.objects(Band.manager).run()
>>> band.manager
<Manager: 1>
```

If a table has a lot of `ForeignKey` columns, there's a useful shortcut, which will return all of the related rows as objects.

```
concert = await Concert.objects(Concert.all_related()).run()
>>> concert.band_1
<Band: 1>
>>> concert.band_2
<Band: 2>
>>> concert.venue
<Venue: 1>
```

Thanks to @wmshort for all the input.

17.107 0.43.0

Migrations containing `Array`, `JSON` and `JSONB` columns should be more reliable now. More unit tests were added to cover edge cases.

17.108 0.42.0

You can now use `all_columns` at the root. For example:

```
await Band.select(
    Band.all_columns(),
    Band.manager.all_columns()
).run()
```

You can also exclude certain columns if you like:

```
await Band.select(
    Band.all_columns(exclude=[Band.id]),
    Band.manager.all_columns(exclude=[Band.manager.id])
).run()
```

17.109 0.41.1

Fix a regression where if multiple tables are created in a single migration file, it could potentially fail by applying them in the wrong order.

17.110 0.41.0

Fixed a bug where if `all_columns` was used two or more levels deep, it would fail. Thanks to @wmshort for reporting this issue.

Here's an example:

```
Concert.select(
    Concert.venue.name,
    *Concert.band_1.manager.all_columns()
).run_sync()
```

Also, the `ColumnsDelegate` has now been tweaked, so unpacking of `all_columns` is optional.

```
# This now works the same as the code above (we have omitted the *)
Concert.select(
    Concert.venue.name,
    Concert.band_1.manager.all_columns()
).run_sync()
```

17.111 0.40.1

Loosen the `typing-extensions` requirement, as it was causing issues when installing `asyncpg`.

17.112 0.40.0

Added `nested` output option, which makes the response from a `select` query use nested dictionaries:

```
>>> await Band.select(Band.name, *Band.manager.all_columns()).output(nested=True).run()
[{'name': 'Pythonistas', 'manager': {'id': 1, 'name': 'Guido'}}]
```

Thanks to @wmshort for the idea.

17.113 0.39.0

Added `to_dict` method to `Table`.

If you just use `__dict__` on a `Table` instance, you get some non-column values. By using `to_dict` it's just the column values. Here's an example:

```
class MyTable(Table):
    name = Varchar()

instance = MyTable.objects().first().run_sync()
```

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```
>>> instance.__dict__
{'_exists_in_db': True, 'id': 1, 'name': 'foo'}

>>> instance.to_dict()
{'id': 1, 'name': 'foo'}
```

Thanks to @wmshort for the idea, and @aminalaee and @sinisaos for investigating edge cases.

17.114 0.38.2

Removed problematic type hint which assumed pytest was installed.

17.115 0.38.1

Minor changes to `get_or_create` to make sure it handles joins correctly.

```
instance = (
    Band.objects()
    .get_or_create(
        (Band.name == "My new band")
        & (Band.manager.name == "Excellent manager")
    )
    .run_sync()
)
```

In this situation, there are two columns called `name` - we need to make sure the correct value is applied if the row doesn't exist.

17.116 0.38.0

`get_or_create` now supports more complex where clauses. For example:

```
row = await Band.objects().get_or_create(
    (Band.name == 'Pythonistas') & (Band.popularity == 1000)
).run()
```

And you can find out whether the row was created or not using `row._was_created`.

Thanks to @wmshort for reporting this issue.

17.117 0.37.0

Added `ModelBuilder`, which can be used to generate data for tests (courtesy @aminalaee).

17.118 0.36.0

Fixed an issue where `like` and `ilike` clauses required a wildcard. For example:

```
await Manager.select().where(Manager.name.ilike('Guido%')).run()
```

You can now omit wildcards if you like:

```
await Manager.select().where(Manager.name.ilike('Guido')).run()
```

Which would match on `'guido'` and `'Guido'`, but not `'Guidoxyz'`.

Thanks to @wmshort for reporting this issue.

17.119 0.35.0

- Improved `PrimaryKey` deprecation warning (courtesy @tonybaloney).
- Added `piccolo schema generate` which creates a Piccolo schema from an existing database.
- Added `piccolo tester run` which is a wrapper around pytest, and temporarily sets `PICCOLO_CONF`, so a test database is used.
- Added the `get` convenience method (courtesy @aminalaee). It returns the first matching record, or `None` if there's no match. For example:

```
manager = await Manager.objects().get(Manager.name == 'Guido').run()

# This is equivalent to:
manager = await Manager.objects().where(Manager.name == 'Guido').first().run()
```

17.120 0.34.0

Added the `get_or_create` convenience method (courtesy @aminalaee). Example usage:

```
manager = await Manager.objects().get_or_create(
    Manager.name == 'Guido'
).run()
```

17.121 0.33.1

- Bug fix, where `compare_dicts` was failing in migrations if any `Column` had an unhashable type as an argument. For example: `Array(default=[])`. Thanks to @hipertracker for reporting this problem.
- Increased the minimum version of orjson, so binaries are available for Macs running on Apple silicon (courtesy @hipertracker).

17.122 0.33.0

Fix for auto migrations when using custom primary keys (thanks to @adriangb and @aminalaee for investigating this issue).

17.123 0.32.0

Migrations can now have a description, which is shown when using `piccolo migrations check`. This makes migrations easier to identify (thanks to @davidolrik for the idea).

17.124 0.31.0

Added an `all_columns` method, to make it easier to retrieve all related columns when doing a join. For example:

```
await Band.select(Band.name, *Band.manager.all_columns()).first().run()
```

Changed the instructions for installing additional dependencies, so they're wrapped in quotes, to make sure it works on ZSH (i.e. `pip install 'piccolo[postgres]'` instead of `pip install piccolo[postgres]`).

17.125 0.30.0

The database drivers are now installed separately. For example: `pip install piccolo[postgres]` (courtesy @aminalaee).

For some users this might be a **breaking change** - please make sure that for existing Piccolo projects, you have either `asyncpg`, or `piccolo[postgres]` in your `requirements.txt` file.

17.126 0.29.0

The user can now specify the primary key column (courtesy @aminalaee). For example:

```
class RecordingStudio(Table):
    pk = UUID(primary_key=True)
```

The BlackSheep template generated by `piccolo asgi new` now supports mounting of the Piccolo Admin (courtesy @sinisaos).

17.127 0.28.0

Added aggregations functions, such as `Sum`, `Min`, `Max` and `Avg`, for use in select queries (courtesy @sinisaos).

17.128 0.27.0

Added uvloop as an optional dependency, installed via *pip install piccolo[uvloop]* (courtesy @aminalaee). uvloop is a faster implementation of the asyncio event loop found in Python's standard library. When uvloop is installed, Piccolo will use it to increase the performance of the Piccolo CLI, and web servers such as Uvicorn will use it to increase the performance of your ASGI app.

17.129 0.26.0

Added `eq` and `ne` methods to the `Boolean` column, which can be used if linters complain about using `SomeTable.some_column == True`.

17.130 0.25.0

- Changed the migration IDs, so the timestamp now includes microseconds. This is to make clashing migration IDs much less likely.
- Added a lot of end-to-end tests for migrations, which revealed some bugs in `Column` defaults.

17.131 0.24.1

A bug fix for migrations. See issue 123 for more information.

17.132 0.24.0

Lots of improvements to `JSON` and `JSONB` columns. Piccolo will now automatically convert between Python types and JSON strings. For example, with this schema:

```
class RecordingStudio(Table):
    name = Varchar()
    facilities = JSON()
```

We can now do the following:

```
RecordingStudio(
    name="Abbey Road",
    facilities={'mixing_desk': True}  # Will automatically be converted to a JSON string
).save().run_sync()
```

Similarly, when fetching data from a JSON column, Piccolo can now automatically deserialise it.

```
>>> RecordingStudio.select().output(load_json=True).run_sync()
[{'id': 1, 'name': 'Abbey Road', 'facilities': {'mixing_desk': True}]

>>> studio = RecordingStudio.objects().first().output(load_json=True).run_sync()
>>> studio.facilities
{'mixing_desk': True}
```

17.133 0.23.0

Added the `create_table_class` function, which can be used to create `Table` subclasses at runtime. This was required to fix an existing bug, which was effecting migrations (see issue 111 for more details).

17.134 0.22.0

- An error is now raised if a user tries to create a Piccolo app using `piccolo app new` with the same name as a builtin Python module, as it will cause strange bugs.
- Fixing a strange bug where using an expression such as `Concert.band_1.manager.id` in a query would cause an error. It only happened if multiple joins were involved, and the last column in the chain was `id`.
- `where` clauses can now accept `Table` instances. For example: `await Band.select().where(Band.manager == some_manager).run()`, instead of having to explicity reference the `id`.

17.135 0.21.2

Fixing a bug with serialising `Enum` instances in migrations. For example: `Varchar(default=Colour.red)`.

17.136 0.21.1

Fix missing imports in FastAPI and Starlette app templates.

17.137 0.21.0

- Added a `freeze` method to `Query`.
- Added BlackSheep as an option to `piccolo asgi new`.

17.138 0.20.0

Added `choices` option to `Column`.

17.139 0.19.1

- Added `piccolo user change_permissions` command.
- Added aliases for CLI commands.

17.140 0.19.0

Changes to the `BaseUser` table - added a `superuser`, and `last_login` column. These are required for upgrades to Piccolo Admin.

If you're using migrations, then running `piccolo migrations forwards all` should add these new columns for you.

If not using migrations, the `BaseUser` table can be upgraded using the following DDL statements:

```
ALTER TABLE piccolo_user ADD COLUMN "superuser" BOOLEAN NOT NULL DEFAULT false
ALTER TABLE piccolo_user ADD COLUMN "last_login" TIMESTAMP DEFAULT null
```

17.141 0.18.4

- Fixed a bug when multiple tables inherit from the same mixin (thanks to @brnosouza).
- Added a `log_queries` option to `PostgresEngine`, which is useful during debugging.
- Added the *inflection* library for converting `Table` class names to database table names. Previously, a class called `TableA` would wrongly have a table called `table` instead of `table_a`.
- Fixed a bug with `SerialisedBuiltin.__hash__` not returning a number, which could break migrations (thanks to @sinisaos).

17.142 0.18.3

Improved `Array` column serialisation - needed to fix auto migrations.

17.143 0.18.2

Added support for filtering `Array` columns.

17.144 0.18.1

Add the `Array` column type as a top level import in `piccolo.columns`.

17.145 0.18.0

- Refactored `forwards` and `backwards` commands for migrations, to make them easier to run programatically.
- Added a simple `Array` column type.
- `table_finder` now works if just a string is passed in, instead of having to pass in an array of strings.

17.146 0.17.5

Catching database connection exceptions when starting the default ASGI app created with `piccolo asgi new` - these errors exist if the Postgres database hasn't been created yet.

17.147 0.17.4

Added a `help_text` option to the `Table` metaclass. This is used in Piccolo Admin to show tooltips.

17.148 0.17.3

Added a `help_text` option to the `Column` constructor. This is used in Piccolo Admin to show tooltips.

17.149 0.17.2

- Exposing `index_type` in the `Column` constructor.
- Fixing a typo with `start_connection_pool` and ``close_connection_pool` - thanks to paolodina for finding this.
- Fixing a typo in the `PostgresEngine` docs - courtesy of paolodina.

17.150 0.17.1

Fixing a bug with `SchemaSnapshot` if column types were changed in migrations - the snapshot didn't reflect the changes.

17.151 0.17.0

- Migrations now directly import `Column` classes - this allows users to create custom `Column` subclasses. Migrations previously only worked with the builtin column types.
- Migrations now detect if the column type has changed, and will try and convert it automatically.

17.152 0.16.5

The Postgres extensions that `PostgresEngine` tries to enable at startup can now be configured.

17.153 0.16.4

- Fixed a bug with `MyTable.column != None`
- Added `is_null` and `is_not_null` methods, to avoid linting issues when comparing with None.

17.154 0.16.3

- Added `WhereRaw`, so raw SQL can be used in where clauses.
- `piccolo shell run` now uses syntax highlighting - courtesy of Fingel.

17.155 0.16.2

Reordering the dependencies in requirements.txt when using `piccolo asgi new` as the latest FastAPI and Starlette versions are incompatible.

17.156 0.16.1

Added `Timestamptz` column type, for storing datetimes which are timezone aware.

17.157 0.16.0

- Fixed a bug with creating a `ForeignKey` column with `references="self"` in auto migrations.
- Changed migration file naming, so there are no characters in there which are unsupported on Windows.

17.158 0.15.1

Changing the status code when creating a migration, and no changes were detected. It now returns a status code of 0, so it doesn't fail build scripts.

17.159 0.15.0

Added `Bytea` / `Blob` column type.

17.160 0.14.13

Fixing a bug with migrations which drop column defaults.

17.161 0.14.12

- Fixing a bug where re-running `Table.create(if_not_exists=True)` would fail if it contained columns with indexes.
- Raising a `ValueError` if a relative path is provided to `ForeignKey` `references`. For example, `.tables.Manager`. The paths must be absolute for now.

17.162 0.14.11

Fixing a bug with `Boolean` column defaults, caused by the `Table` metaclass not being explicit enough when checking falsy values.

17.163 0.14.10

- The `ForeignKey` `references` argument can now be specified using a string, or a `LazyTableReference` instance, rather than just a `Table` subclass. This allows a `Table` to be specified which is in a Piccolo app, or Python module. The `Table` is only loaded after imports have completed, which prevents circular import issues.
- Faster column copying, which is important when specifying joins, e.g. `await Band.select(Band.manager.name).run()`.
- Fixed a bug with migrations and foreign key contraints.

17.164 0.14.9

Modified the exit codes for the `forwards` and `backwards` commands when no migrations are left to run / reverse. Otherwise build scripts may fail.

17.165 0.14.8

- Improved the method signature of the `output` query clause (explicitly added args, instead of using `**kwargs`).
- Fixed a bug where `output(as_list=True)` would fail if no rows were found.
- Made `piccolo migrations forwards` command output more legible.
- Improved renamed table detection in migrations.
- Added the `piccolo migrations clean` command for removing orphaned rows from the migrations table.
- Fixed a bug where `get_migration_managers` wasn't inclusive.
- Raising a `ValueError` if `is_in` or `not_in` query clauses are passed an empty list.
- Changed the migration commands to be top level async.
- Combined `print` and `sys.exit` statements.

17.166 0.14.7

- Added missing type annotation for `run_sync`.
- Updating type annotations for column default values - allowing callables.
- Replaced instances of `asyncio.run` with `run_sync`.
- Tidied up aiosqlite imports.

17.167 0.14.6

- Added JSON and JSONB column types, and the arrow function for JSONB.
- Fixed a bug with the distinct clause.
- Added `as_alias`, so select queries can override column names in the response (i.e. SELECT foo AS bar from baz).
- Refactored JSON encoding into a separate utils file.

17.168 0.14.5

- Removed old iPython version recommendation in the `piccolo shell run` and `piccolo playground run`, and enabled top level await.
- Fixing outstanding mypy warnings.
- Added optional requirements for the playground to setup.py

17.169 0.14.4

- Added `piccolo sql_shell run` command, which launches the psql or sqlite3 shell, using the connection parameters defined in `piccolo_conf.py`. This is convenient when you want to run raw SQL on your database.
- `run_sync` now handles more edge cases, for example if there's already an event loop in the current thread.
- Removed asgiref dependency.

17.170 0.14.3

- Queries can be directly awaited - `await MyTable.select()`, as an alternative to using the run method `await MyTable.select().run()`.
- The `piccolo asgi new` command now accepts a `name` argument, which is used to populate the default database name within the template.

17.171 0.14.2

- Centralised code for importing Piccolo apps and tables - laying the foundation for fixtures.
- Made orjson an optional dependency, installable using `pip install piccolo[orjson]`.
- Improved version number parsing in Postgres.

17.172 0.14.1

Fixing a bug with dropping tables in auto migrations.

17.173 0.14.0

Added `Interval` column type.

17.174 0.13.5

- Added `allowed_hosts` to `create_admin` in ASGI template.
- Fixing bug with default `root` argument in some piccolo commands.

17.175 0.13.4

- Fixed bug with `SchemaSnapshot` when dropping columns.
- Added custom `__repr__` method to `Table`.

17.176 0.13.3

Added `piccolo shell run` command for running adhoc queries using Piccolo.

17.177 0.13.2

- Fixing bug with auto migrations when dropping columns.
- Added a `root` argument to `piccolo asgi new`, `piccolo app new` and `piccolo project new` commands, to override where the files are placed.

17.178 0.13.1

Added support for `group_by` and `Count` for aggregate queries.

17.179 0.13.0

Added *required* argument to `Column`. This allows the user to indicate which fields must be provided by the user. Other tools can use this value when generating forms and serialisers.

17.180 0.12.6

- Fixing a typo in `TimestampCustom` arguments.
- Fixing bug in `TimestampCustom` SQL representation.
- Added more extensive deserialisation for migrations.

17.181 0.12.5

- Improved `PostgresEngine` docstring.
- Resolving rename migrations before adding columns.
- Fixed bug serialising `TimestampCustom`.
- Fixed bug with altering column defaults to be non-static values.
- Removed `response_handler` from `Alter` query.

17.182 0.12.4

Using orjson for JSON serialisation when using the `output(as_json=True)` clause. It supports more Python types than ujson.

17.183 0.12.3

Improved `piccolo user create` command - defaults the username to the current system user.

17.184 0.12.2

Fixing bug when sorting `extra_definitions` in auto migrations.

17.185 0.12.1

- Fixed typos.
- Bumped requirements.

17.186 0.12.0

- Added `Date` and `Time` columns.
- Improved support for column default values.
- Auto migrations can now serialise more Python types.
- Added `Table.indexes` method for listing table indexes.
- Auto migrations can handle adding / removing indexes.
- Improved ASGI template for FastAPI.

17.187 0.11.8

ASGI template fix.

17.188 0.11.7

- Improved `UUID` columns in SQLite - prepending 'uuid:' to the stored value to make the type more explicit for the engine.
- Removed SQLite as an option for `piccolo asgi new` until auto migrations are supported.

17.189 0.11.6

Added support for FastAPI to `piccolo asgi new`.

17.190 0.11.5

Fixed bug in `BaseMigrationManager.get_migration_modules` - wasn't excluding non-Python files well enough.

17.191 0.11.4

- Stopped `piccolo migrations new` from creating a config.py file - was legacy.
- Added a README file to the *piccolo_migrations* folder in the ASGI template.

17.192 0.11.3

Fixed *__pycache__* bug when using `piccolo asgi new`.

17.193 0.11.2

- Showing a warning if trying auto migrations with SQLite.
- Added a command for creating a new ASGI app - `piccolo asgi new`.
- Added a meta app for printing out the Piccolo version - `piccolo meta version`.
- Added example queries to the playground.

17.194 0.11.1

- Added `table_finder`, for use in `AppConfig`.
- Added support for concatenating strings using an update query.
- Added more tables to the playground, with more column types.
- Improved consistency between SQLite and Postgres with `UUID` columns, `Integer` columns, and `exists` queries.

17.195 0.11.0

Added `Numeric` and `Real` column types.

17.196 0.10.8

Fixing a bug where Postgres versions without a patch number couldn't be parsed.

17.197 0.10.7

Improving release script.

17.198 0.10.6

Sorting out packaging issue - old files were appearing in release.

17.199 0.10.5

Auto migrations can now run backwards.

17.200 0.10.4

Fixing some typos with `Table` imports. Showing a traceback when piccolo_conf can't be found by `engine_finder`.

17.201 0.10.3

Adding missing jinja templates to setup.py.

17.202 0.10.2

Fixing a bug when using `piccolo project new` in a new project.

17.203 0.10.1

Fixing bug with enum default values.

17.204 0.10.0

Using targ for the CLI. Refactored some core code into apps.

17.205 0.9.3

Suppressing exceptions when trying to find the Postgres version, to avoid an `ImportError` when importing *piccolo_conf.py*.

17.206 0.9.2

`.first()` bug fix.

17.207 0.9.1

Auto migration fixes, and `.first()` method now returns None if no match is found.

17.208 0.9.0

Added support for auto migrations.

17.209 0.8.3

Can use operators in update queries, and fixing 'new' migration command.

17.210 0.8.2

Fixing release issue.

17.211 0.8.1

Improved transaction support - can now use a context manager. Added `Secret`, `BigInt` and `SmallInt` column types. Foreign keys can now reference the parent table.

17.212 0.8.0

Fixing bug when joining across several tables. Can pass values directly into the `Table.update` method. Added `if_not_exists` option when creating a table.

17.213 0.7.7

Column sequencing matches the definition order.

17.214 0.7.6

Supporting *ON DELETE* and *ON UPDATE* for foreign keys. Recording reverse foreign key relationships.

17.215 0.7.5

Made `response_handler` async. Made it easier to rename columns.

17.216 0.7.4

Bug fixes and dependency updates.

17.217 0.7.3

Adding missing `__int__.py` file.

17.218 0.7.2

Changed migration import paths.

17.219 0.7.1

Added `remove_db_file` method to `SQLiteEngine` - makes testing easier.

17.220 0.7.0

Renamed `create` to `create_table`, and can register commands via *piccolo_conf*.

17.221 0.6.1

Adding missing `__init__.py` files.

17.222 0.6.0

Moved `BaseUser`. Migration refactor.

17.223 0.5.2

Moved drop table under `Alter` - to help prevent accidental drops.

17.224 0.5.1

Added `batch` support.

17.225 0.5.0

Refactored the `Table` Metaclass - much simpler now. Scoped more of the attributes on `Column` to avoid name clashes. Added `engine_finder` to make database configuration easier.

17.226 0.4.1

SQLite is now returning datetime objects for timestamp fields.

17.227 0.4.0

Refactored to improve code completion, along with bug fixes.

17.228 0.3.7

Allowing `Update` queries in SQLite.

17.229 0.3.6

Falling back to *LIKE* instead of *ILIKE* for SQLite.

17.230 0.3.5

Renamed `User` to `BaseUser`.

17.231 0.3.4

Added `ilike`.

17.232 0.3.3

Added value types to columns.

17.233 0.3.2

Default values infer the engine type.

17.234 0.3.1

Update click version.

17.235 0.3

Tweaked API to support more auto completion. Join support in where clause. Basic SQLite support - mostly for playground.

17.236 0.2

Using `QueryString` internally to represent queries, instead of raw strings, to harden against SQL injection.

17.237 0.1.2

Allowing joins across multiple tables.

17.238 0.1.1

Added playground.

CHAPTER

EIGHTEEN

HELP

If you have any questions then the best place to ask them is the discussions section on our GitHub page.

CHAPTER

NINETEEN

API REFERENCE

19.1 Table

class piccolo.table.**Table**(*_data: Dict[*Column*, *Any*] = None*, *_ignore_missing: bool = False*, *_exists_in_db: bool = False*, **kwargs*)

The class represents a database table. An instance represents a row.

The constructor can be used to assign column values.

Note: The `_data`, `_ignore_missing`, and `_exists_in_db` arguments are prefixed with an underscore to help prevent a clash with a column name which might be passed in via kwargs.

Parameters

- **`_data`** – There's two ways of passing in the data for each column. Firstly, you can use kwargs:

```
Band(name="Pythonistas")
```

  Secondly, you can pass in a dictionary which maps column classes to values:

```
Band({Band.name: 'Pythonistas'})
```

  The advantage of this second approach is it's more strongly typed, and linters such as flake8 or MyPy will more easily detect typos.

- **`_ignore_missing`** – If `False` a `ValueError` will be raised if any column values haven't been provided.
- **`_exists_in_db`** – Used internally to track whether this row exists in the database.

add_m2m(**rows: Table*, *m2m: M2M*, *extra_column_values: Dict[Union[Column, str], Any] = {}*) → M2MAddRelated

Save the row if it doesn't already exist in the database, and insert an entry into the joining table.

```
>>> band = await Band.objects().get(Band.name == "Pythonistas")
>>> await band.add_m2m(
...     Genre(name="Punk rock"),
...     m2m=Band.genres
... )
[{'id': 1}]
```

Parameters

extra_column_values – If the joining table has additional columns besides the two required foreign keys, you can specify the values for those additional columns. For example, if this is our joining table:

```
class GenreToBand(Table):
    band = ForeignKey(Band)
    genre = ForeignKey(Genre)
    reason = Text()
```

We can provide the `reason` value:

```
await band.add_m2m(
    Genre(name="Punk rock"),
    m2m=Band.genres,
    extra_column_values={
        "reason": "Their second album was very punk."
    }
)
```

classmethod all_columns(*exclude: Sequence[Union[str,* Column*]] = None*) → List[*Column*]

Used in conjunction with `select` queries. Just as we can use `all_columns` to retrieve all of the columns from a related table, we can also use it at the root of our query to get all of the columns for the root table. For example:

```
await Band.select(
    Band.all_columns(),
    Band.manager.all_columns()
)
```

This is mostly useful when the table has a lot of columns, and typing them out by hand would be tedious.

Parameters

exclude – You can request all columns, except these.

classmethod all_related(*exclude: List[Union[str,* ForeignKey*]] = None*) → List[*Column*]

Used in conjunction with `objects` queries. Just as we can use `all_related` on a `ForeignKey`, you can also use it for the table at the root of the query, which will return each related row as a nested object. For example:

```
concert = await Concert.objects(
    Concert.all_related()
)

>>> concert.band_1
<Band: 1>
>>> concert.band_2
<Band: 2>
>>> concert.venue
<Venue: 1>
```

This is mostly useful when the table has a lot of foreign keys, and typing them out by hand would be tedious. It's equivalent to:

```
concert = await Concert.objects(
    Concert.venue,
    Concert.band_1,
    Concert.band_2
)
```

Parameters

exclude – You can request all columns, except these.

classmethod alter() → Alter

Used to modify existing tables and columns.

```
await Band.alter().rename_column(Band.popularity, 'rating')
```

classmethod count(*column: Optional[Column] = None*, *distinct: Optional[Sequence[Column]] = None*) → Count

Count the number of matching rows:

```
await Band.count().where(Band.popularity > 1000)
```

Parameters

- **column** – If specified, just count rows where this column isn't null.
- **distinct** – Counts the number of distinct values for these columns. For example, if we have a concerts table:

```
class Concert(Table):
    band = Varchar()
    start_date = Date()
```

With this data:

band	start_date
Pythonistas	2023-01-01
Pythonistas	2023-02-03
Rustaceans	2023-01-01

Without the `distinct` argument, we get the count of all rows:

```
>>> await Concert.count()
3
```

To get the number of unique concert dates:

```
>>> await Concert.count(distinct=[Concert.start_date])
2
```

classmethod create_index(*columns: List[Union[Column, str]]*, *method:* IndexMethod = *IndexMethod.btree*, *if_not_exists: bool = False*) → CreateIndex

Create a table index. If multiple columns are specified, this refers to a multicolumn index, rather than multiple single column indexes.

```
await Band.create_index([Band.name])
```

classmethod create_table(*if_not_exists=False*, *only_default_columns=False*, *auto_create_schema: bool = True*) → Create

Create table, along with all columns.

```
await Band.create_table()
```

classmethod delete(*force=False*) → Delete

Delete rows from the table.

```
await Band.delete().where(Band.name == 'Pythonistas')
```

Parameters

force – Unless set to `True`, deletions aren't allowed without a `where` clause, to prevent accidental mass deletions.

classmethod drop_index(*columns: List[Union[Column, str]]*, *if_exists: bool = True*) → DropIndex

Drop a table index. If multiple columns are specified, this refers to a multicolumn index, rather than multiple single column indexes.

```
await Band.drop_index([Band.name])
```

classmethod exists() → Exists

Use it to check if a row exists, not if the table exists.

```
await Band.exists().where(Band.name == 'Pythonistas')
```

classmethod from_dict(*data: Dict[str, Any]*) → TableInstance

Used when loading fixtures. It can be overriden by subclasses in case they have specific logic / validation which needs running when loading fixtures.

get_m2m(*m2m: M2M*) → M2MGetRelated

Get all matching rows via the join table.

```
>>> band = await Band.objects().get(Band.name == "Pythonistas")
>>> await band.get_m2m(Band.genres)
[<Genre: 1>, <Genre: 2>]
```

classmethod get_readable() → Readable

Creates a readable representation of the row.

get_related(*foreign_key: Union[ForeignKey, str]*) → First[*Table*]

Used to fetch a `Table` instance, for the target of a foreign key.

```
band = await Band.objects().first()
manager = await band.get_related(Band.manager)
>>> print(manager.name)
'Guido'
```

It can only follow foreign keys one level currently. i.e. `Band.manager`, but not `Band.manager.x.y.z`.

classmethod indexes() → Indexes

Returns a list of the indexes for this tables.

```
await Band.indexes()
```

classmethod insert(**rows: TableInstance*) → Insert[TableInstance]

Insert rows into the database.

```
await Band.insert(
    Band(name="Pythonistas", popularity=500, manager=1)
)
```

classmethod objects(**prefetch: Union[*ForeignKey, *List[*ForeignKey*]]*) → Objects[TableInstance]

Returns a list of table instances (each representing a row), which you can modify and then call 'save' on, or can delete by calling 'remove'.

```
pythonistas = await Band.objects().where(
    Band.name == 'Pythonistas'
).first()

pythonistas.name = 'Pythonistas Reborn'

await pythonistas.save()

# Or to remove it from the database:
await pythonistas.remove()
```

Parameters

prefetch – Rather than returning the primary key value of this related table, a nested object will be returned for the row on the related table.

```
# Without nested
band = await Band.objects().first()
>>> band.manager
1

# With nested
band = await Band.objects(Band.manager).first()
>>> band.manager
<Band 1>
```

property querystring: QueryString

Used when inserting rows.

classmethod raw(*sql: str*, **args: Any*) → Raw

Execute raw SQL queries on the underlying engine - use with caution!

```
await Band.raw('select * from band')
```

Or passing in parameters:

```
await Band.raw("SELECT * FROM band WHERE name = {}", 'Pythonistas')
```

classmethod ref(*column_name: str*) → *Column*

Used to get a copy of a column from a table referenced by a `ForeignKey` column. It's unlikely an end user of this library will ever need to do this, but other libraries built on top of Piccolo may need this functionality.

```
Band.ref('manager.name')
```

refresh(*columns: Optional[Sequence[*Column*]] = None*) → *Refresh*

Used to fetch the latest data for this instance from the database. Modifies the instance in place, but also returns it as a convenience.

Parameters

columns – If you only want to refresh certain columns, specify them here. Otherwise all columns are refreshed.

Example usage:

```
# Get an instance from the database.
instance = await Band.objects.first()

# Later on we can refresh this instance with the latest data
# from the database, in case it has gotten stale.
await instance.refresh()

# Alternatively, running it synchronously:
instance.refresh().run_sync()
```

remove() → Delete

A proxy to a delete query.

remove_m2m(**rows:* Table, *m2m: M2M*) → M2MRemoveRelated

Remove the rows from the joining table.

```
>>> band = await Band.objects().get(Band.name == "Pythonistas")
>>> genre = await Genre.objects().get(Genre.name == "Rock")
>>> await band.remove_m2m(
...     genre,
...     m2m=Band.genres
... )
```

save(*columns: Optional[Sequence[Union[str,* Column*]]] = None*) → Union[Insert, Update]

A proxy to an insert or update query.

Parameters

columns – Only the specified columns will be synced back to the database when doing an update. For example:

```
band = await Band.objects().first()
band.popularity = 2000
await band.save(columns=[Band.popularity])
```

If `columns=None` (the default) then all columns will be synced back to the database.

classmethod select(**columns: t.Union[Selectable, str], exclude_secrets=False*) → Select

Get data in the form of a list of dictionaries, with each dictionary representing a row.

These are all equivalent:

```
await Band.select().columns(Band.name)
await Band.select(Band.name)
await Band.select('name')
```

Parameters

exclude_secrets – If `True`, any columns with `secret=True` are omitted from the response. For example, we use this for the password column of *BaseUser*. Even though the passwords are hashed, you still don't want them being passed over the network if avoidable.

classmethod table_exists() → TableExists

Check if the table exists in the database.

```
await Band.table_exists()
```

to_dict(**columns:* Column) → Dict[str, Any]

A convenience method which returns a dictionary, mapping column names to values for this table instance.

```
instance = await Manager.objects().get(
    Manager.name == 'Guido'
)

>>> instance.to_dict()
{'id': 1, 'name': 'Guido'}
```

If the columns argument is provided, only those columns are included in the output. It also works with column aliases.

```
>>> instance.to_dict(Manager.id, Manager.name.as_alias('title'))
{'id': 1, 'title': 'Guido'}
```

classmethod update(*values: Dict[Union[*Column*, str], Any] = None*, *force: bool = False*, *use_auto_update: bool = True*, ***kwargs*) → Update

Update rows.

All of the following work, though the first is preferable:

```
await Band.update(
    {Band.name: "Spamalot"}
).where(
    Band.name == "Pythonistas"
)

await Band.update(
    {"name": "Spamalot"}
).where(
    Band.name == "Pythonistas"
)

await Band.update(
    name="Spamalot"
).where(
    Band.name == "Pythonistas"
)
```

Parameters

- **force** – Unless set to `True`, updates aren't allowed without a `where` clause, to prevent accidental mass overriding of data.
- **use_auto_update** – Whether to use the `auto_update` values on any columns. See the `auto_update` argument on *Column* for more information.

19.2 SchemaManager

class piccolo.schema.**SchemaManager**(*db: Optional[Engine] = None*)

A useful utility class for interacting with schemas.

Parameters

db – Used to execute the database queries. If not specified, we try and import it from `piccolo_conf.py`.

create_schema(*schema_name: str*, *, *if_not_exists: bool = True*) → CreateSchema

Creates the specified schema:

```
>>> await SchemaManager().create_schema(schema_name="music")
```

Parameters

- **schema_name** – The name of the schema to create.
- **if_not_exists** – No error will be raised if the schema already exists.

drop_schema(*schema_name: str*, *, *if_exists: bool = True*, *cascade: bool = False*) → DropSchema

Drops the specified schema:

```
>>> await SchemaManager().drop_schema(schema_name="music")
```

Parameters

- **schema_name** – The name of the schema to drop.
- **if_exists** – No error will be raised if the schema doesn't exist.
- **cascade** – If `True` then it will automatically drop the tables within the schema.

list_schemas() → ListSchemas

Returns the name of each schema in the database:

```
>>> await SchemaManager().list_schemas()
['public', 'schema_1']
```

list_tables(*schema_name: str*) → ListTables

Returns the name of each table in the given schema:

```
>>> await SchemaManager().list_tables(schema_name="music")
['band', 'manager']
```

Parameters
schema_name – List the tables in this schema.

move_table(*table_name: str*, *new_schema: str*, *current_schema: Optional[str] = None*) → MoveTable

Moves a table to a different schema:

```
>>> await SchemaManager().move_schema(
...     table_name='my_table',
...     new_schema='schema_1'
... )
```

Parameters

- **table_name** – The name of the table to move.
- **new_schema** – The name of the scheam you want to move the table too.

Current_schema
If not specified, `'public'` is assumed.

rename_schema(*schema_name: str*, *new_schema_name: str*) → RenameSchema

Rename the schema:

```
>>> await SchemaManager().rename_schema(
...     schema_name="music",
...     new_schema_name="music_info"
... )
```

Parameters

- **schema_name** – The current name of the schema.
- **new_schema_name** – What to rename the schema to.

19.3 Column

class piccolo.columns.base.**Column**(*null: bool = False*, *primary_key: bool = False*, *unique: bool = False*, *index: bool = False*, *index_method:* IndexMethod *= IndexMethod.btree*, *required: bool = False*, *help_text: Optional[str] = None*, *choices: Optional[Type[Enum]] = None*, *db_column_name: Optional[str] = None*, *secret: bool = False*, *auto_update: Any = Ellipsis*, ***kwargs*)

All other columns inherit from `Column`. Don't use it directly.

The following arguments apply to all column types:

Parameters

- **null** – Whether the column is nullable.
- **primary_key** – If set, the column is used as a primary key.
- **default** – The column value to use if not specified by the user.
- **unique** – If set, a unique constraint will be added to the column.

- **index** – Whether an index is created for the column, which can improve the speed of selects, but can slow down inserts.
- **index_method** – If index is set to `True`, this specifies what type of index is created.
- **required** – This isn't used by the database - it's to indicate to other tools that the user must provide this value. Example uses are in serialisers for API endpoints, and form fields.
- **help_text** – This provides some context about what the column is being used for. For example, for a `Decimal` column called `value`, it could say `'The units are millions of dollars'`. The database doesn't use this value, but tools such as Piccolo Admin use it to show a tooltip in the GUI.
- **choices** – An optional Enum - when specified, other tools such as Piccolo Admin will render the available options in the GUI.
- **db_column_name** – If specified, you can override the name used for the column in the database. The main reason for this is when using a legacy database, with a problematic column name (for example `'class'`, which is a reserved Python keyword). Here's an example:

```
class MyTable(Table):
    class_ = Varchar(db_column_name="class")

>>> await MyTable.select(MyTable.class_)
[{'id': 1, 'class': 'test'}]
```

  This is an advanced feature which you should only need in niche situations.

- **secret** – If `secret=True` is specified, it allows a user to automatically omit any fields when doing a select query, to help prevent inadvertent leakage of sensitive data.

```
class Band(Table):
    name = Varchar()
    net_worth = Integer(secret=True)

>>> await Band.select(exclude_secrets=True)
[{'name': 'Pythonistas'}]
```

- **auto_update** – Allows you to specify a value to set this column to each time it is updated (via `MyTable.update`, or `MyTable.save` on an existing row). A common use case is having a `modified_on` column.

```
class Band(Table):
    name = Varchar()
    popularity = Integer()
    # The value can be a function or static value:
    modified_on = Timestamp(auto_update=datetime.datetime.now)

# This will automatically set the `modified_on` column to the
# current timestamp, without having to explicitly set it:
>>> await Band.update({
...     Band.popularity: Band.popularity + 100
... }).where(Band.name == 'Pythonistas')
```

  Note - this feature is implemented purely within the ORM. If you want similar functionality on the database level (i.e. if you plan on using raw SQL to perform updates), then you may be better off creating SQL triggers instead.

as_alias(*name: str*) → *Column*

Allows column names to be changed in the result of a select.

For example:

```
>>> await Band.select(Band.name.as_alias('title')).run()
{'title': 'Pythonistas'}
```

property ddl: str

Used when creating tables.

get_default_value() → Any

If the column has a default attribute, return it. If it's callable, return the response instead.

get_select_string(*engine_type: str*, *with_alias: bool = True*) → str

How to refer to this column in a SQL query, taking account of any joins and aliases.

get_sql_value(*value: Any*) → Any

When using DDL statements, we can't parameterise the values. An example is when setting the default for a column. So we have to convert from the Python type to a string representation which we can include in our DDL statements.

Parameters
value – The Python value to convert to a string usable in a DDL statement e.g. 1.

Returns
The string usable in the DDL statement e.g. '1'.

ilike(*value: str*) → Where

Only Postgres supports ILIKE. It's used for case insensitive matching.

For SQLite, it's just proxied to a LIKE query instead.

is_not_null() → Where

Can be used instead of `MyTable.column != None`, because some linters don't like a comparison to `None`.

is_null() → Where

Can be used instead of `MyTable.column == None`, because some linters don't like a comparison to `None`.

join_on(*column: Column*) → *ForeignKey*

Joins are typically performed via foreign key columns. For example, here we get the band's name and the manager's name:

```
class Manager(Table):
    name = Varchar()

class Band(Table):
    name = Varchar()
    manager = ForeignKey(Manager)

>>> await Band.select(Band.name, Band.manager.name)
```

The `join_on` method lets you join tables even when foreign keys don't exist, by joining on a column in another table.

For example, here we want to get the manager's email, but no foreign key exists:

```
class Manager(Table):
    name = Varchar(unique=True)
    email = Varchar()

class Band(Table):
    name = Varchar()
    manager_name = Varchar()

>>> await Band.select(
...     Band.name,
...     Band.manager_name.join_on(Manager.name).email
... )
```

like(*value: str*) → Where

Both SQLite and Postgres support LIKE, but they mean different things.

In Postgres, LIKE is case sensitive (i.e. 'foo' equals 'foo', but 'foo' doesn't equal 'Foo').

In SQLite, LIKE is case insensitive for ASCII characters (i.e. 'foo' equals 'Foo'). But not for non-ASCII characters. To learn more, see the docs:

https://sqlite.org/lang_expr.html#the_like_glob_regexp_and_match_operators

value_type

alias of `int`

19.4 Aggregate functions

19.4.1 Count

class piccolo.query.methods.select.**Count**(*column: Optional[Column] = None*, *distinct: Optional[Sequence[Column]] = None*, *alias: str = 'count'*)

Used in `Select` queries, usually in conjunction with the `group_by` clause:

```
>>> await Band.select(
...     Band.manager.name.as_alias('manager_name'),
...     Count(alias='band_count')
... ).group_by(Band.manager)
[{'manager_name': 'Guido', 'count': 1}, ...]
```

It can also be used without the `group_by` clause (though you may prefer to the *`Table.count`* method instead, as it's more convenient):

```
>>> await Band.select(Count())
[{'count': 3}]
```

Parameters

- **column** – If specified, the count is for non-null values in that column.
- **distinct** – If specified, the count is for distinct values in those columns.
- **alias** – The name of the value in the response:

```
# These two are equivalent:

await Band.select(
    Band.name, Count(alias="total")
).group_by(Band.name)

await Band.select(
    Band.name,
    Count().as_alias("total")
).group_by(Band.name)
```

19.5 Refresh

class piccolo.query.methods.refresh.**Refresh**(*instance:* Table, *columns: t.Optional[t.Sequence[*Column*]] = None*)

Used to refresh *Table* instances with the latest data data from the database. Accessible via *refresh*.

Parameters

- **instance** – The instance to refresh.
- **columns** – Which columns to refresh - it not specified, then all columns are refreshed.

async run(*in_pool: bool = True*, *node: t.Optional[str] = None*) → *Table*

Run it asynchronously. For example:

```
await my_instance.refresh().run()

# or for convenience:
await my_instance.refresh()
```

Modifies the instance in place, but also returns it as a convenience.

run_sync(**args*, ***kwargs*) → *Table*

Run it synchronously. For example:

```
my_instance.refresh().run_sync()
```

19.6 LazyTableReference

class piccolo.columns.**LazyTableReference**(*table_class_name: str*, *app_name: Optional[str] = None*, *module_path: Optional[str] = None*)

Holds a reference to a *Table* subclass. Used to avoid circular dependencies in the `references` argument of *ForeignKey* columns.

Parameters

- **table_class_name** – The name of the `Table` subclass. For example, `'Manager'`.

- **app_name** – If specified, the `Table` subclass is imported from a Piccolo app with the given name.
- **module_path** – If specified, the `Table` subclass is imported from this path. For example, `'my_app.tables'`.

19.7 Enums

19.7.1 Foreign Keys

class piccolo.columns.**OnDelete**(*value*, *names=None*, ***, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

Used by *ForeignKey* to specify the behaviour when a related row is deleted.

cascade = 'CASCADE'

no_action = 'NO ACTION'

restrict = 'RESTRICT'

set_default = 'SET DEFAULT'

set_null = 'SET NULL'

class piccolo.columns.**OnUpdate**(*value*, *names=None*, ***, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

Used by *ForeignKey* to specify the behaviour when a related row is updated.

cascade = 'CASCADE'

no_action = 'NO ACTION'

restrict = 'RESTRICT'

set_default = 'SET DEFAULT'

set_null = 'SET NULL'

19.7.2 Indexes

class piccolo.columns.indexes.**IndexMethod**(*value*, *names=None*, ***, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

Used to specify the index method for a *Column*.

btree = 'btree'

gin = 'gin'

gist = 'gist'

hash = 'hash'

19.8 Column defaults

19.8.1 Date

class piccolo.columns.defaults.**DateOffset**(*days: int*)

This makes the default value for a *Date* column the current date, but offset by a number of days.

For example, if you wanted the default to be tomorrow, you can specify `DateOffset(days=1)`:

```
class DiscountCode(Table):
    expires = Date(default=DateOffset(days=1))
```

Parameters
days – The number of days to offset.

19.9 Testing

19.9.1 ModelBuilder

class piccolo.testing.model_builder.**ModelBuilder**

async classmethod build(*table_class: Type[TableInstance]*, *defaults: Dict[Union[*Column*, str], Any] = None*, *persist: bool = True*, *minimal: bool = False*) → TableInstance

Build a `Table` instance with random data and save async. If the `Table` has any foreign keys, then the related rows are also created automatically.

Parameters

- **table_class** – Table class to randomize.
- **defaults** – Any values specified here will be used instead of random values.
- **persist** – Whether to save the new instance in the database.
- **minimal** – If `True` then any columns with `null=True` are assigned a value of `None`.

Examples:

```
# Create a new instance with all random values:
manager = await ModelBuilder.build(Manager)

# Create a new instance, with certain defaults:
manager = await ModelBuilder.build(
    Manager,
    {Manager.name: 'Guido'}
)

# Create a new instance, but don't save it in the database:
manager = await ModelBuilder.build(Manager, persist=False)

# Create a new instance, with all null values set to None:
```

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```
manager = await ModelBuilder.build(Manager, minimal=True)

# We can pass other table instances in as default values:
band = await ModelBuilder.build(Band, {Band.manager: manager})
```

classmethod build_sync(*table_class: Type[TableInstance]*, *defaults: Dict[Union[*Column*, str], Any] = None*, *persist: bool = True*, *minimal: bool = False*) → TableInstance

A sync wrapper around *build()*.

19.9.2 create_db_tables / drop_db_tables

async piccolo.table.**create_db_tables**(**tables: Type[*Table*]*, *if_not_exists: bool = False*) → None

Creates the database table for each `Table` class passed in. The tables are created in the correct order, based on their foreign keys.

Parameters

- **tables** – The tables to create in the database.
- **if_not_exists** – No errors will be raised if any of the tables already exist in the database.

piccolo.table.**create_db_tables_sync**(**tables: Type[*Table*]*, *if_not_exists: bool = False*) → None

A sync wrapper around *create_db_tables()*.

async piccolo.table.**drop_db_tables**(**tables: Type[*Table*]*) → None

Drops the database table for each `Table` class passed in. The tables are dropped in the correct order, based on their foreign keys.

Parameters

tables – The tables to delete from the database.

piccolo.table.**drop_db_tables_sync**(**tables: Type[*Table*]*) → None

A sync wrapper around *drop_db_tables()*.

CHAPTER

TWENTY

TLDR

Install Piccolo:

```
pip install piccolo
```

Experiment with queries:

```
piccolo playground run
```

Give me an ASGI web app!

```
piccolo asgi new
```

FastAPI, Starlette, BlackSheep, and Litestar are currently supported, with more coming soon.

CHAPTER

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VIDEOS

Piccolo has some tutorial videos on YouTube, which are a great companion to the docs.

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