Introducing Asynchronous SQLAlchemy

Sebastiaan Zeeff — EuroPython 2021

The ingredients of this talk

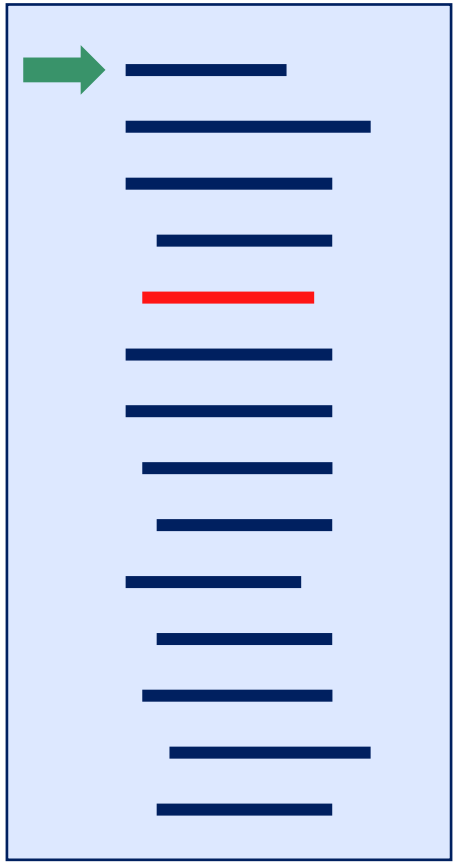
- Synchronous vs Asynchronous Input/Output
- A comparison between synchronous and asynchronous SQLAlchemy
- Managing implicit I/O: Eager vs Lazy loading

Personal introduction

- Sebastiaan Zeeff (35), The Netherlands
- Codesmith and developer for Ordina Pythoneers
- Owner of Python Discord

Synchronous vs Asynchronous Input/Output

Synchronous vs Asynchronous Input/Output



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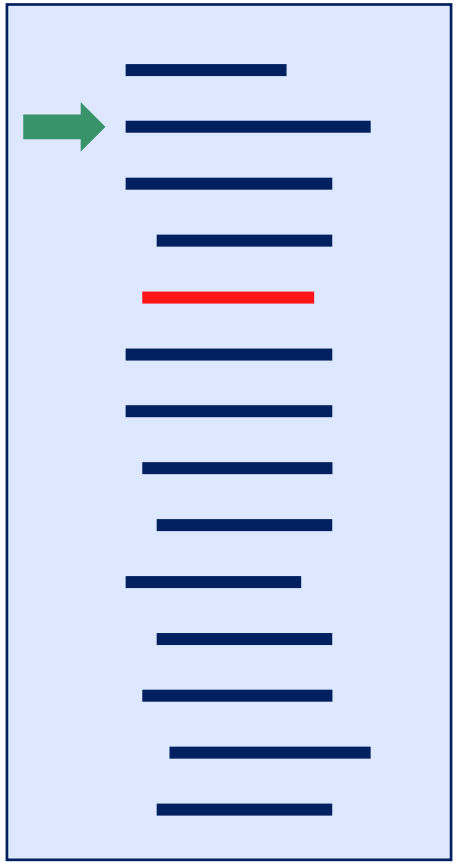

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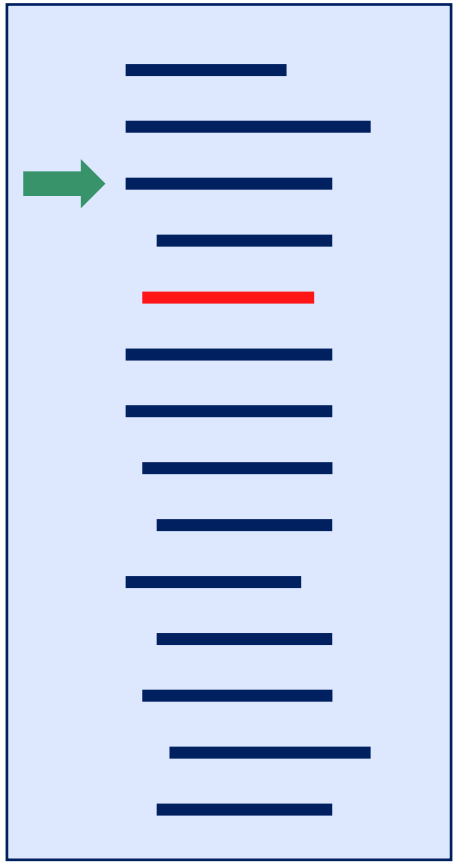

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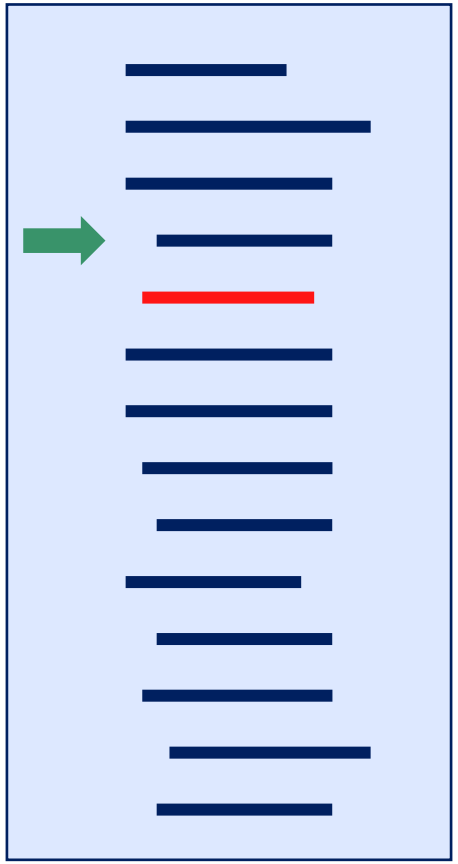

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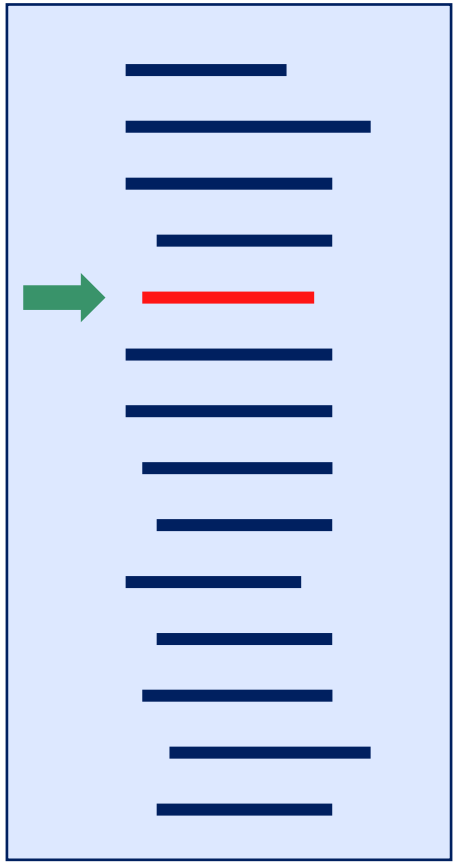

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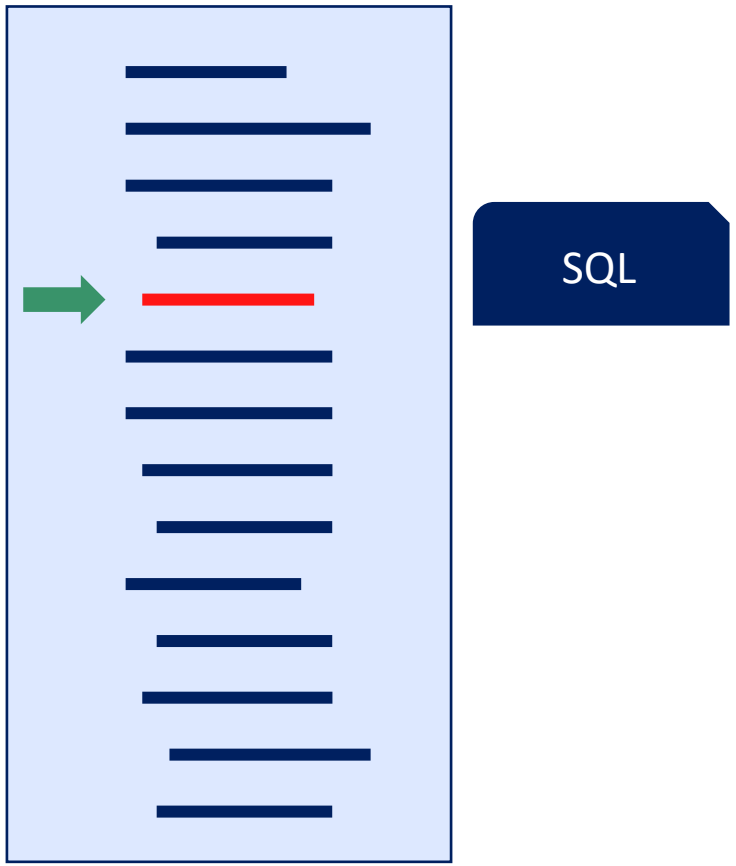

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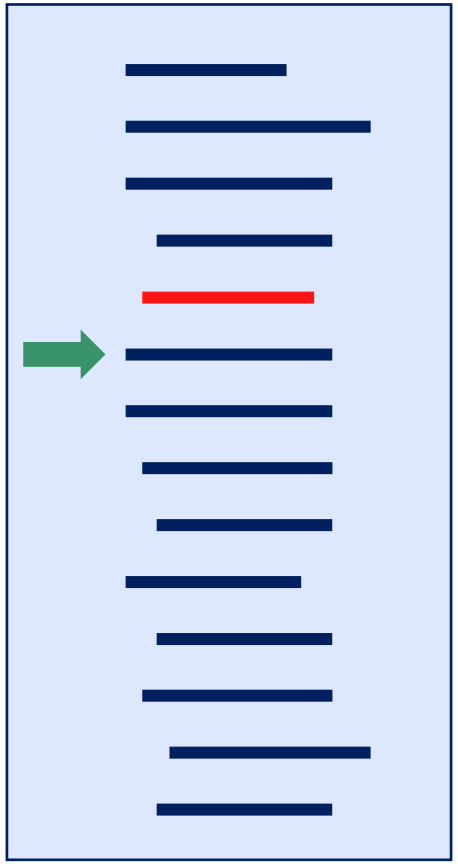

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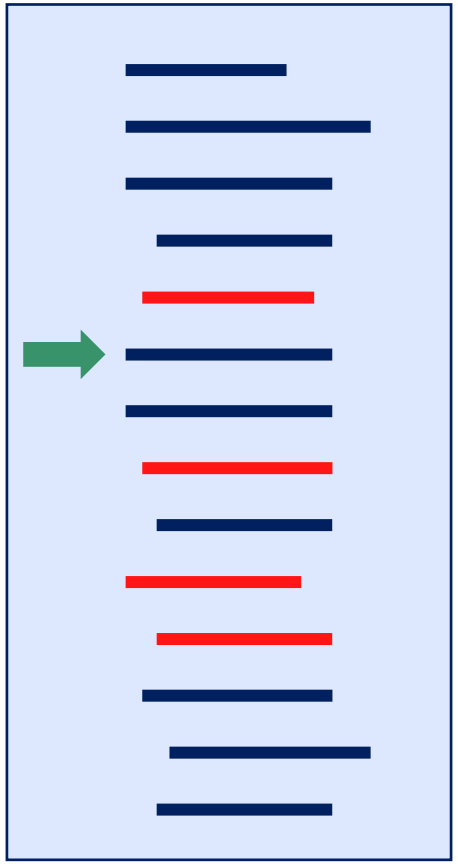
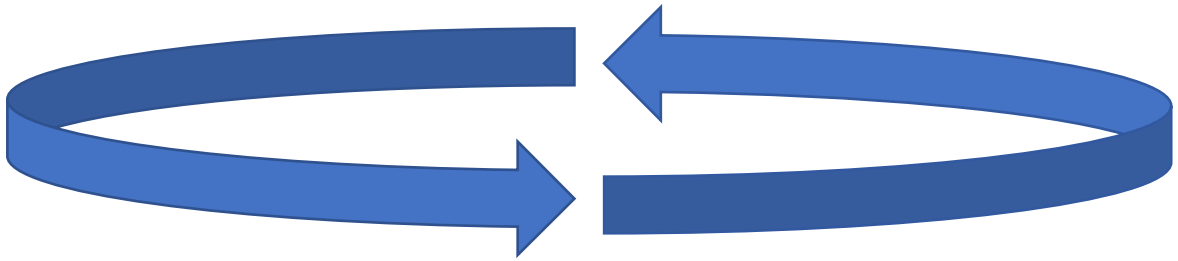


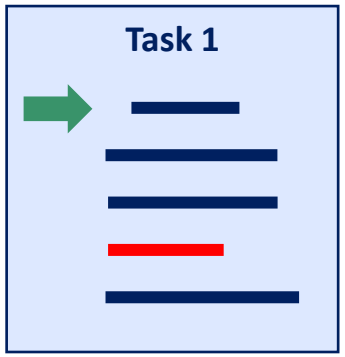
Synchronous vs Asynchronous Input/Output

Event loop



Synchronous vs Asynchronous Input/Output

Current task



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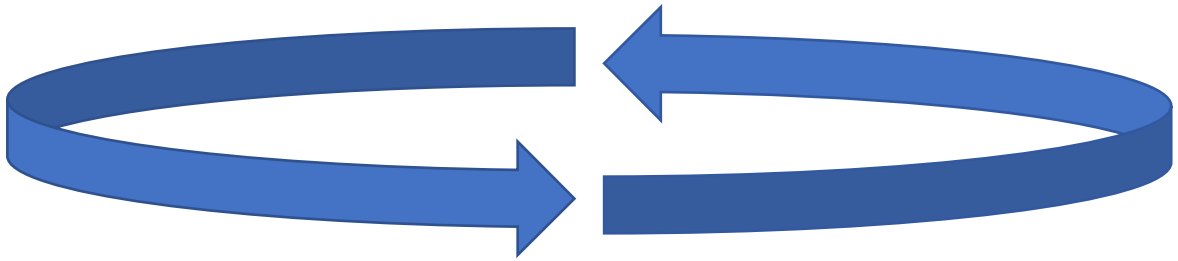

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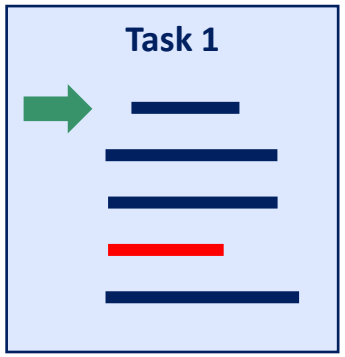
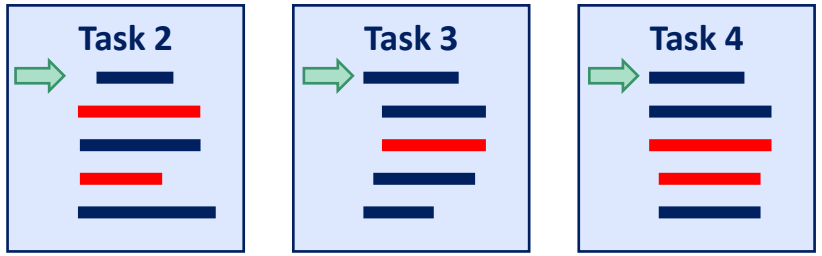
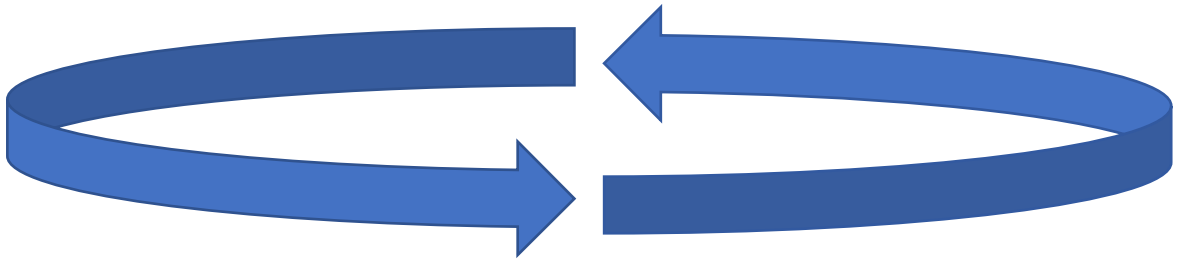


Scheduled tasks



Event loop



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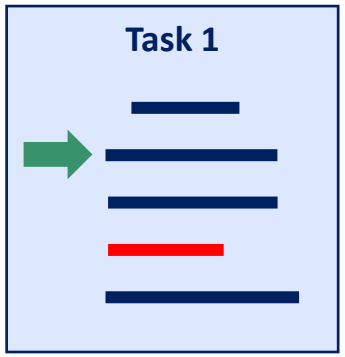

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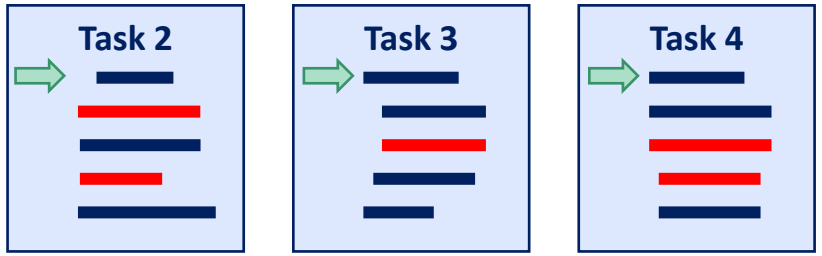

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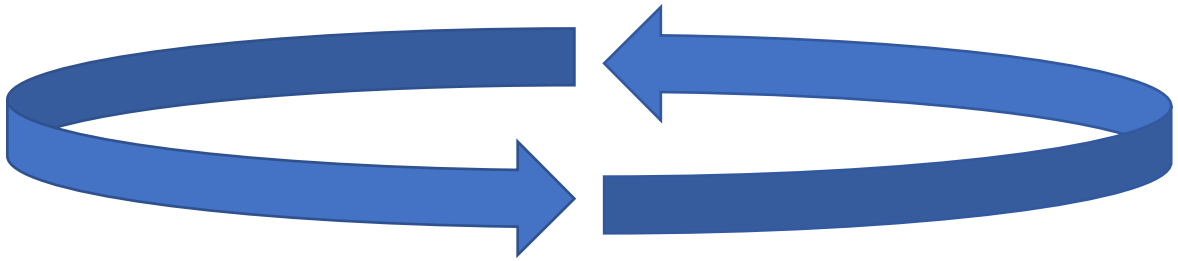

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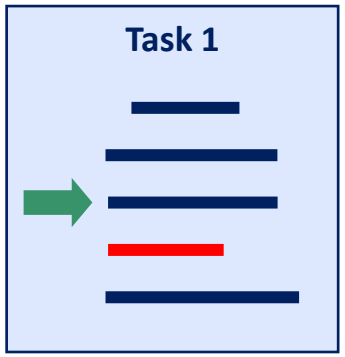

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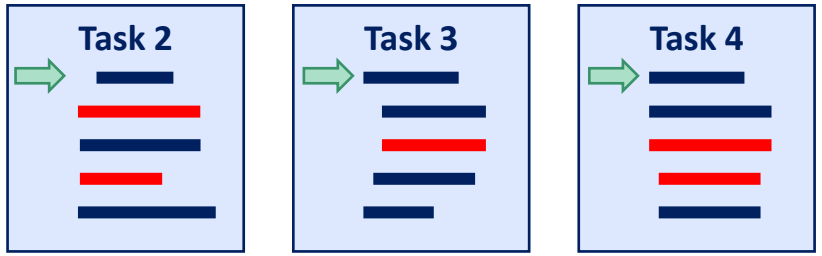

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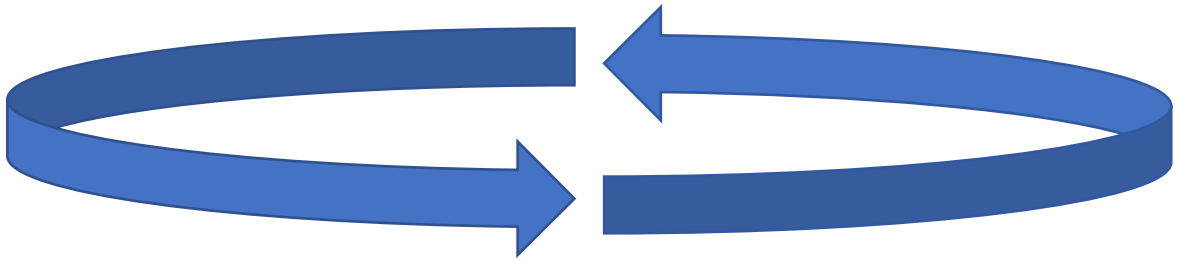

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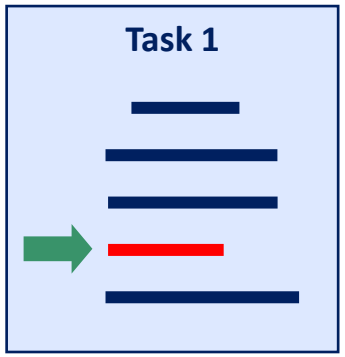

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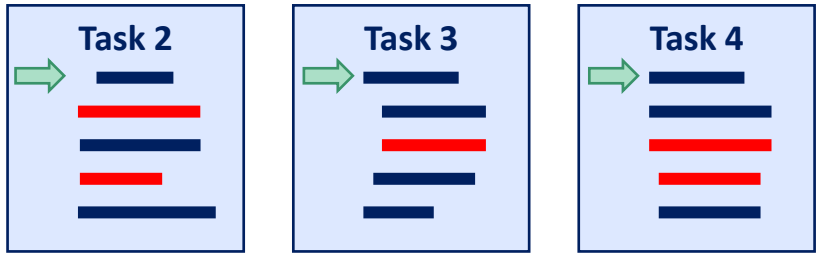

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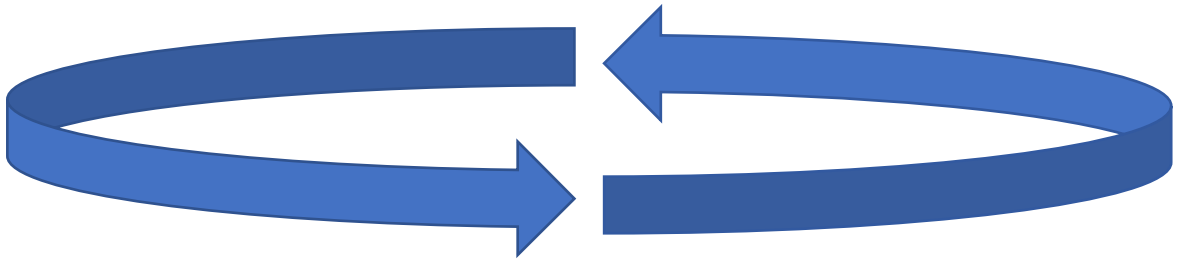

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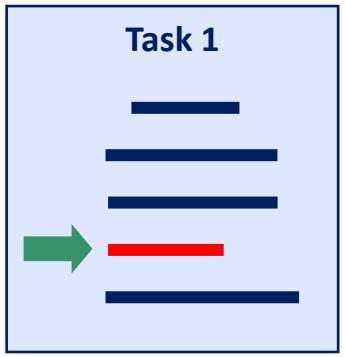

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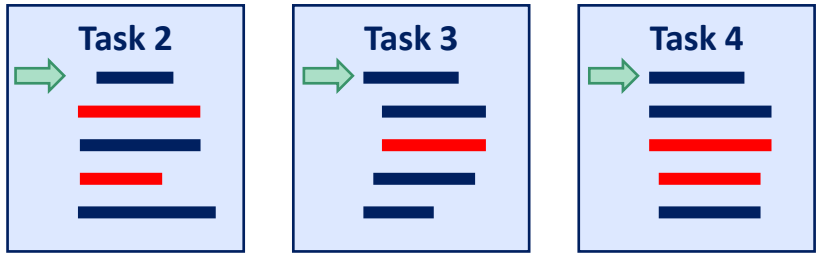

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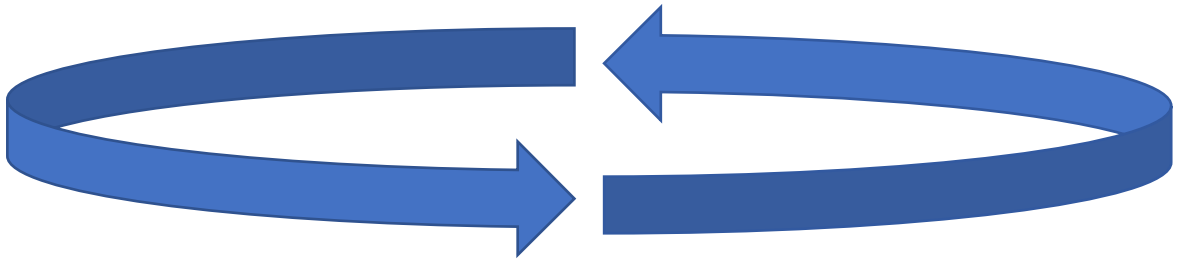

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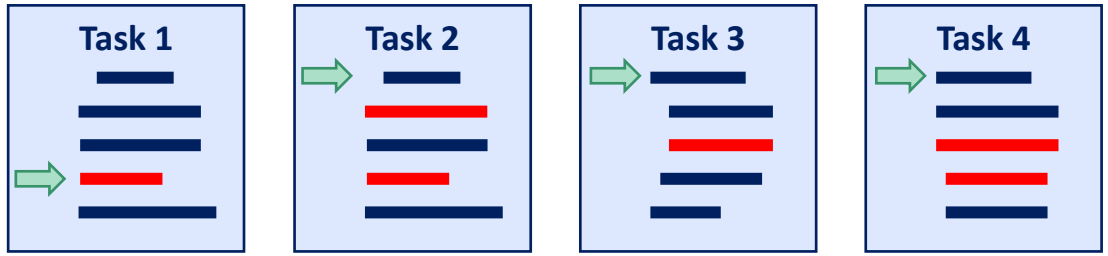

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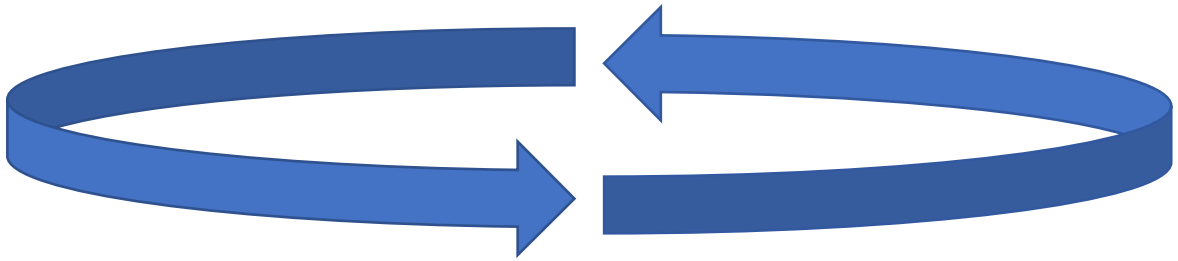
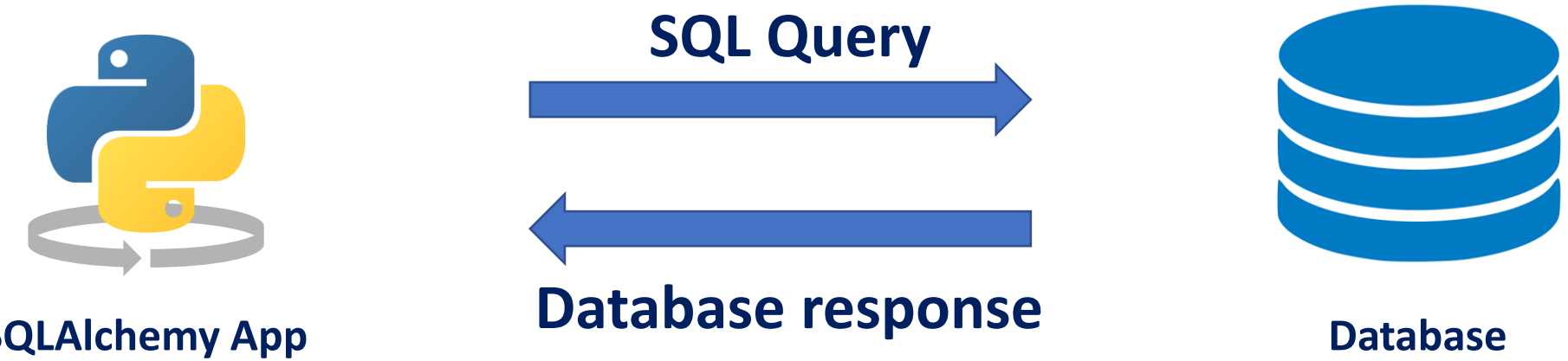


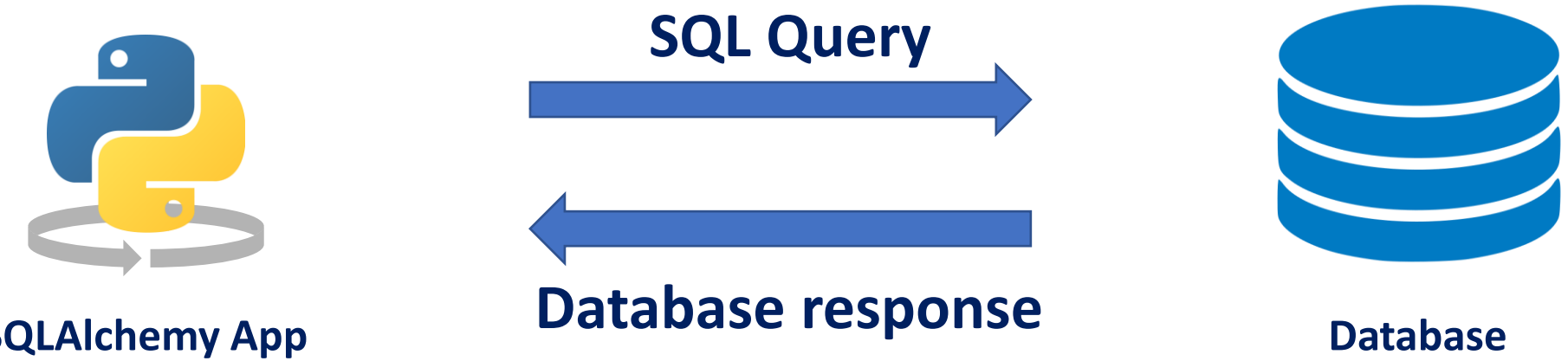
SQLAlchemy App

Database

- Asyncio is about how we schedule input/put asynchronously in our SQLAlchemy app



- Asyncio is about how we schedule input/put asynchronously in our SQLAlchemy app
- The database queries and responses you generate will mostly stay the same (although…).



- Asyncio is about how we schedule input/put asynchronously in our SQLAlchemy app
- The database queries and responses you generate will mostly stay the same (although…).
- **This means that you can (mostly) build your queries in the way you're already used to!**

Asynchronous SQLAlchemy in Action

- I'll compare the sync and async versions of the same action
- Versions used:
  - Python 3.9.6
  - SQLAlchemy 1.4.22
    - The asyncio extension is currently considered to be in a **beta** release
  - asyncpg 0.23.0 (async adapter); Psycopg2 2.9.1 (sync adapter)
  - PostgreSQL 13.3 in an alpine-based Docker container

Setting up the engine

```
Python REPL 3.9.6
>>> import sqlalchemy
>>> engine = sqlalchemy.create_engine(
...     "postgresql+psycopg2://europython:europython@127.0.0.1:9876/europython",
...     echo=True,
...     future=True,
... )
>>>
```

```
asyncio REPL 3.9.6
>>> from sqlalchemy.ext import asyncio as asyncio_ext
>>> engine = asyncio_ext.create_async_engine(
...     "postgresql+asyncpg://europython:europython@127.0.0.1:9876/europython",
...     echo=True,
...     future=True,
... )
>>>
```

Executing a simple SQL statement

```
Python REPL 3.9.6
>>> statement = sqlalchemy.text("SELECT 'Hello, EuroPython 2021!'")
>>> with engine.connect() as conn:
...     result = conn.execute(statement)
...
>>> print(result.scalar())
Hello, EuroPython 2021!
```

```
asyncio REPL 3.9.6
>>> statement = sqlalchemy.text("SELECT 'Hello, EuroPython 2021!'")
>>> async with engine.connect() as conn:
...     result = await conn.execute(statement)
...
>>> print(result.scalar())
Hello, EuroPython 2021!
```

Eager vs Lazy loading

- That looks simple, what's the catch?

Eager vs Lazy loading

- That looks simple, what's the catch?
- **You can't just rely on implicit I/O!**

A simple ORM model

```
class Traveler(Base):
    """A model representing a traveler."""

    __tablename__ = "traveler"

    id = Column(Integer, primary_key=True)
    created_at = Column(DateTime, server_default=func.now())
    name = Column(String(128))
    age = Column(Integer)
```

Lazy loading vs Eager loading (server defaults)

```
>>> sebastiaan = Traveler(name="Sebastiaan", age=35)
>>> with orm.Session(engine) as session:
...     with session.begin():
...         session.add(sebastiaan)
...
...     print("=" * 64)
...     print("Sebastiaan was created at:", sebastiaan.created_at)
```

Lazy loading vs Eager loading (server defaults)

```
>>> sebastiaan = Traveler(name="Sebastiaan", age=35)
>>> with orm.Session(engine) as session:
...     with session.begin():
...         session.add(sebastiaan)
...
...     print("=" * 64)
...     print("Sebastiaan was created at:", sebastiaan.created_at)
BEGIN (implicit)
INSERT INTO traveler (name, age) VALUES (%(name)s, %(age)s) RETURNING traveler.id
[generated in 0.00026s] {'name': 'Sebastiaan', 'age': 35}
COMMIT
================================================================
```

Lazy loading vs Eager loading (server defaults)

```
>>> sebastiaan = Traveler(name="Sebastiaan", age=35)
>>> with orm.Session(engine) as session:
...     with session.begin():
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...
...     print("=" * 64)
...     print("Sebastiaan was created at:", sebastiaan.created_at)
BEGIN (implicit)
INSERT INTO traveler (name, age) VALUES (%(name)s, %(age)s) RETURNING traveler.id
[generated in 0.00026s] {'name': 'Sebastiaan', 'age': 35}
COMMIT
================================================================
BEGIN (implicit)
SELECT traveler.id AS traveler_id, traveler.created_at AS traveler_created_at, traveler.name  #...
WHERE traveler.id = %(pk_1)s
[generated in 0.00018s] {'pk_1': 1}
Sebastiaan was created at: 2021-07-28 09:42:06.723638
ROLLBACK
```

Lazy loading vs Eager loading (server defaults)

```
>>> sebastiaan = Traveler(name="Sebastiaan", age=35)
>>> async_session = orm.sessionmaker(
...     engine,
...     expire_on_commit=False,
...     class_=asyncio_ext.AsyncSession
...)
>>> async with async_session() as session:
...     async with session.begin():
...         session.add(sebastiaan)
...     print("=" * 64)
...     print("Sebastiaan was created at:", sebastiaan.created_at)
```

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...     print("=" * 64)
...     print("Sebastiaan was created at:", sebastiaan.created_at)
BEGIN (implicit)
INSERT INTO traveler (name, age) VALUES (%s, %s) RETURNING traveler.id
[generated in 0.00049s] ('Sebastiaan', 35)
COMMIT
================================================================
```

Lazy loading vs Eager loading (server defaults)

```
>>> async with async_session() as session:
...     async with session.begin():
...         session.add(sebastiaan)
...     print("=" * 64)
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...
BEGIN (implicit)
INSERT INTO traveler (name, age) VALUES (%s, %s) RETURNING traveler.id
[generated in 0.00049s] ('Sebastiaan', 35)
COMMIT
================================================================
```

Lazy loading vs Eager loading (server defaults)

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>>> async with async_session() as session:
...     async with session.begin():
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BEGIN (implicit)
INSERT INTO traveler (name, age) VALUES (%s, %s) RETURNING traveler.id
[generated in 0.00049s] ('Sebastiaan', 35)
COMMIT
================================================================
BEGIN (implicit)
SELECT traveler.created_at AS traveler_created_at
FROM traveler
WHERE traveler.id = %s
[generated in 0.00061s] (2,)
ROLLBACK
Traceback (most recent call last):
    ...
sqlalchemy.exc.MissingGreenlet: greenlet_spawn has not been called; can't call await_() here. Was
IO attempted in an unexpected place? (Background on this error at: https://sqlalche.me/e/14/xd2s)
```

Working with ORM models

```
class Traveler(Base):
    """A model representing a traveler."""

    __tablename__ = "traveler"

    id = Column(Integer, primary_key=True)
    created_at = Column(DateTime, server_default=func.now())
    name = Column(String(128))
    age = Column(Integer)
```

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    id = Column(Integer, primary_key=True)
    created_at = Column(DateTime, server_default=func.now())
    name = Column(String(128))
    age = Column(Integer)

    __mapper_args__ = {"eager_defaults": True}
```

Lazy loading vs Eager loading (server defaults)

```
>>> async with async_session() as session:
...     async with session.begin():
...         session.add(sebastiaan)
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...     print("Sebastiaan was created at:", sebastiaan.created_at)
BEGIN (implicit)
INSERT INTO traveler (name, age) VALUES (%s, %s) RETURNING traveler.id, traveler.created_at
[generated in 0.00040s] ('Sebastiaan', 35)
COMMIT
================================================================
Sebastiaan was created at: 2021-07-28 10:15:32.675294
```

Models with a relationship

```
class Traveler(Base):
    """A model representing a traveler."""

    __tablename__ = "traveler"

    id = Column(Integer, primary_key=True)
    name = Column(String(128))
    age = Column(Integer)
    destination_id = Column(Integer, ForeignKey("country.id"))
    destination = orm.relationship("Country")


class Country(Base):
    """A model representing a country."""

    __tablename__ = "country"

    id = Column(Integer, primary_key=True)
    name = Column(String(128))
```

Executing a simple SQL statement

```
>>> sebastiaan = Traveler(name="Sebastiaan", age=35, destination=Country(name="Norway"))
>>> async with async_session() as session:
...     async with session.begin():
...         session.add(sebastiaan)
...
```

Eager vs Lazy loading (relationships)

```
>>> sebastiaan = Traveler(name="Sebastiaan", age=35, destination=Country(name="Norway"))
>>> async with async_session() as session:
...     async with session.begin():
...         session.add(sebastiaan)
...
>>> statement = sqlalchemy.select(Traveler).where(Traveler.name == "Sebastiaan")
```

Eager vs Lazy loading (relationships)

```
>>> sebastiaan = Traveler(name="Sebastiaan", age=35, destination=Country(name="Norway"))
>>> async with async_session() as session:
...     async with session.begin():
...         session.add(sebastiaan)
...
>>> statement = sqlalchemy.select(Traveler).where(Traveler.name == "Sebastiaan")
>>> async with async_session() as session:
...     result = await session.execute(statement)
...     sebastiaan = result.scalar()
...
>>>
```

Eager vs Lazy loading (relationships)

```
>>> sebastiaan = Traveler(name="Sebastiaan", age=35, destination=Country(name="Norway"))
>>> async with async_session() as session:
...     async with session.begin():
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>>> statement = sqlalchemy.select(Traveler).where(Traveler.name == "Sebastiaan")
>>> async with async_session() as session:
...     result = await session.execute(statement)
...     sebastiaan = result.scalar()
...
>>> print(sebastiaan)
Traveler(destination=NOT_LOADED, id=1, name='Sebastiaan', age=35, destination_id=1)
```

Eager vs Lazy loading (relationships)

```
>>> sebastiaan = Traveler(name="Sebastiaan", age=35, destination=Country(name="Norway"))
>>> async with async_session() as session:
...     async with session.begin():
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...
>>> statement = sqlalchemy.select(Traveler).where(Traveler.name == "Sebastiaan")
>>> async with async_session() as session:
...     result = await session.execute(statement)
...     sebastiaan = result.scalar()
...
>>> print(sebastiaan)
Traveler(destination=NOT_LOADED, id=1, name='Sebastiaan', age=35, destination_id=1)
>>> print(sebastiaan.destination)  # ERROR! Requires I/O to lazily load destination!
```

Eager vs Lazy loading (relationships)

```
>>> statement = (
...     sqlalchemy.select(Traveler)
...     .where(Traveler.name == "Sebastiaan")
...     .options(orm.joinedload(Traveler.destination))
...)
```

Eager vs Lazy loading (relationships)

```
>>> statement = (
...     sqlalchemy.select(Traveler)
...     .where(Traveler.name == "Sebastiaan")
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...)
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...     sebastiaan = result.scalar()
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```

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>>> statement = (
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...)
>>> async with async_session() as session:
...     result = await session.execute(statement)
...     sebastiaan = result.scalar()
...
>>> print(sebastiaan)
Traveler(
    destination=Country(id=1, name='Norway'), id=1, name='Sebastiaan', age=35, destination_id=1
)
```

Eager vs Lazy loading (relationships)

```
>>> statement = (
...     sqlalchemy.select(Traveler)
...     .where(Traveler.name == "Sebastiaan")
...     .options(orm.joinedload(Traveler.destination))
...)
>>> async with async_session() as session:
...     result = await session.execute(statement)
...     sebastiaan = result.scalar()
...
>>> print(sebastiaan)
Traveler(
    destination=Country(id=1, name='Norway'), id=1, name='Sebastiaan', age=35, destination_id=1
)
>>> print("Sebastiaan is traveling to:", sebastiaan.destination.name)
Sebastiaan is traveling to Norway
```

Using `run_sync`

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- You can use AsyncSession.run_sync!

```
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...     await session.run_sync(Base.metadata.create_all)
```

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- For example, you can use the `MetaData.create_all` function like this:

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Using `run_sync`

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```
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```

- This only works for asynchronous adapter functions!

Summary

- Most of your knowledge of SQLAlchemy is directly transferable
- You need to think carefully about operations that perform I/O
- You can still run synchronous database I/O functions with run_sync

Questions?

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