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https://www.meetup.com/brisbane-data-engineering-meetup/

Building an IoT Platform using Modern Data Stack

Prefect, DuckDB, FastAPI

Brisbane Data Engineering Meetup

6 December 2023

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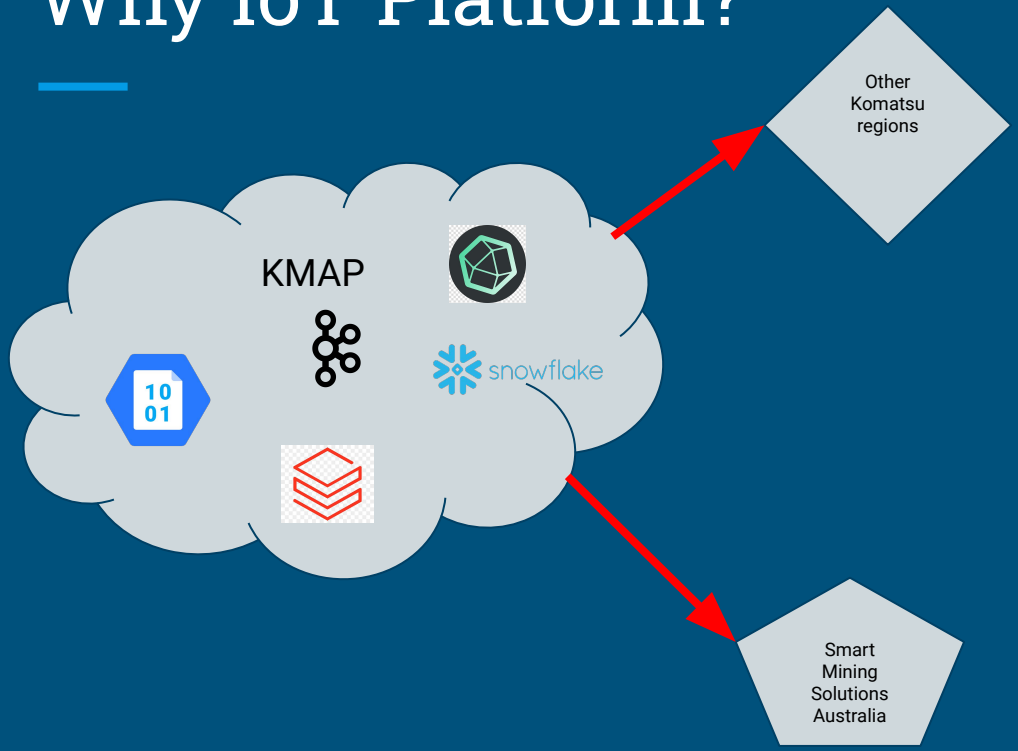
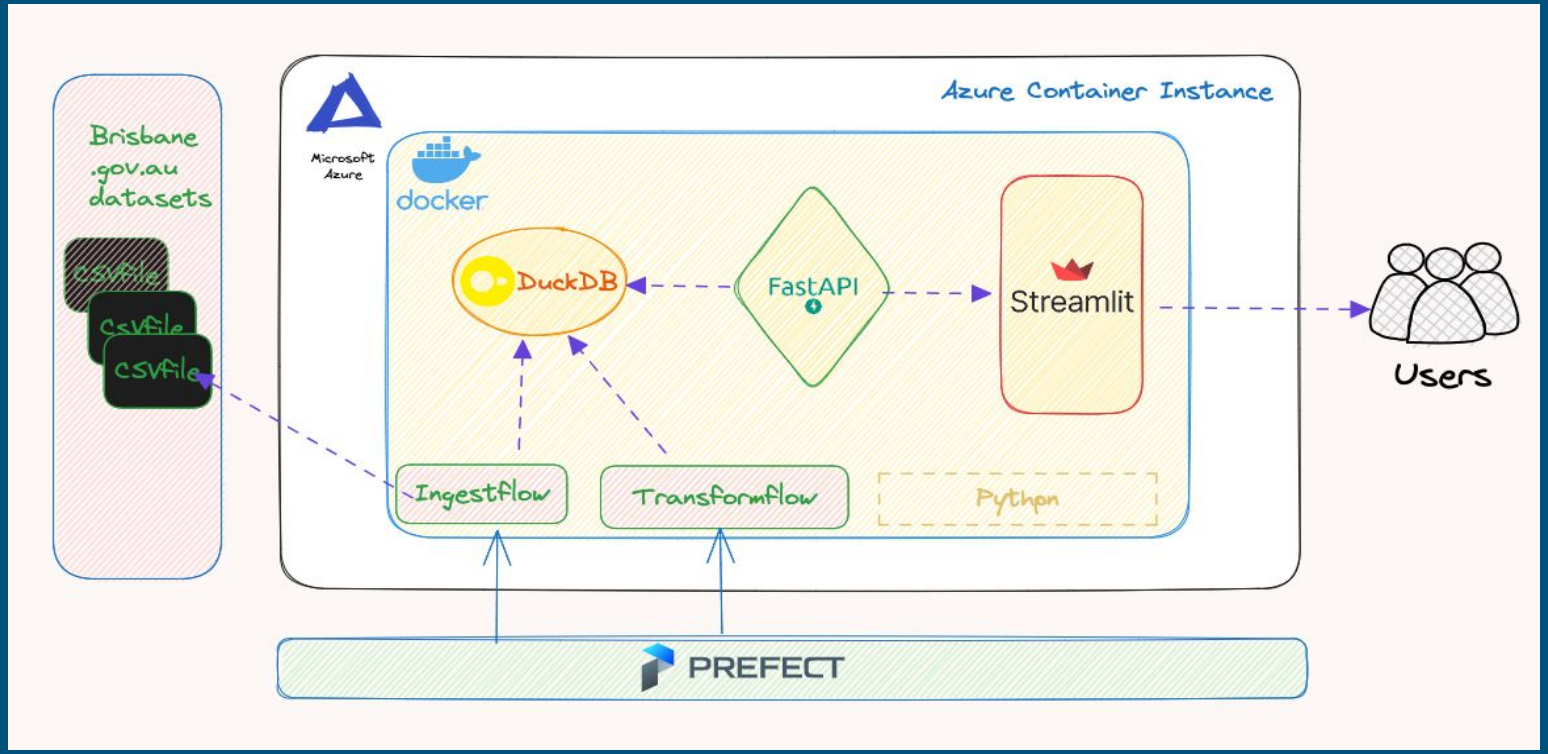
About Me

- Almost 20+ years in Software Engineering (NEC, IBM , TOSHIBA, SAMSUNG)
- 6+ years in Data Engineering space
- Love working with Startups - (co-founded 3 in Philippines)
- Currently working as Senior Data Engineer at Komatsu Australia (Smart Mining Solutions) - Software and Data Engineering team lead
- Trekking
- Basketball
- Chess

Why IoT Platform?



The GOAL


Brisbane
.gov.au
datasets
csvfile
csvfile
csvfile
Microsoft
Azure
Azure Container Instance
docker
DuckDB
FastAPI
Streamlit
Users
Ingestflow
Transformflow
Python
PREFECT

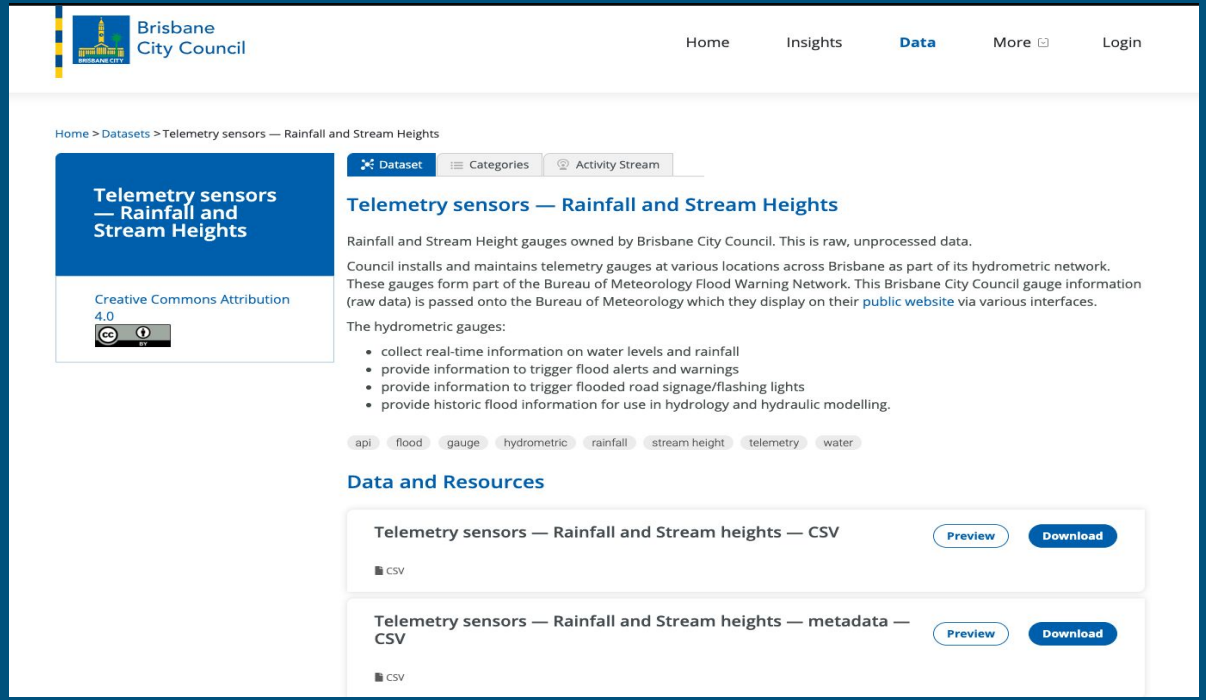
Modern Data Stack (for my use case only)

- PREFECT - Workflow orchestration
- DuckDB - Database / Data warehouse
- FastAPI - API Layer
- Streamlit - Visualization
- docker - Deployment env

Bonus:

PDM (Python Dependency Manager) PDM

Our Data



Site - https://www.data.brisbane.qld.gov.au/data/dataset/telemetry-sensors-rainfall-and-stream-heights

Metadata and Raw sensor data

https://www.data.brisbane.qld.gov.au/data/dataset/01af4647-dd69-4061-9c68-64fa43bfaac7/resource/117218af-4adc-4f8e-927a-0fe43c46cdb4/download/rainfall-and-stream-heights-metadata-20231205t110000.csv

https://www.data.brisbane.qld.gov.au/data/dataset/01af4647-dd69-4061-9c68-64fa43bfaac7/resource/78c37b45-ecb5-4a99-86b2-f7a514f0f447/download/gauge-data-20231205t183704.csv

Exploratory Data Analysis (EDA)

```
"Sensor ID","Location ID","Location Name","Sensor Type","Unit of Measure","Latitude","Longitude"
"E1809","540801","Rachele Close, Forest Lake","Rainfall","mm","-27.631476","152.953555"
"E1531","540118","Bancroft Park, Kelvin Grove","Stream Height AHD","m","-27.444481","153.005314"
"E1515","540099","Chadston Close, Kenmore Hills","Rainfall","mm","-27.504712","152.924885"
"E1512","540117","ABQ-2 Mt Coot -tha","Rainfall","mm","-27.463952","152.947533"
"E2020","540071","Corinda High School, Corinda","Rainfall","mm","-27.546892","152.988372"
"E1886","540800","Rosewood Place, Murarrie","Rainfall","mm","-27.465266","153.094268"
"E2111","40788","Johnson Rd (Adermann Br), Forestdale","Stream Height AHD","m","-27.655308","153.000406"
"E1594","540286","Mouth of Breakfast Ck, Newstead","Stream Height AHD","m","-27.441564","153.047296"
"E1561","540124","Burralong St, Deagon","Stream Height AHD","m","-27.334180","153.058401"
"E1560","540124","Burralong St, Deagon","Rainfall","mm","-27.334180","153.058401"
```

metadata

```
"Measured","E1809","E1531","E1515","E1512","E2020","E1886","E2111","E1594",
"2023-12-04T18:40:00","0","-","0","0","0","0","-","0.04","-0.12","0","0","-
"2023-12-04T18:45:00","0","-","0","0","0","0","-","0.04","-","0","0","-","0
"2023-12-04T18:50:00","0","-","0","0","0","0","-","-0.01","-0.17","0","0",
"2023-12-04T18:55:00","0","-","0","0","0","0","-","-","-","0","0","-","0",
"2023-12-04T19:00:00","0","-","0","0","0","0","-","-","-0.22","0","0","-",
"2023-12-04T19:05:00","0","-","0","0","0","0","-","-0.06","-0.27","0","0",
"2023-12-04T19:10:00","0","-","0","0","0","0","-","-0.11","-","0","0","-",
"2023-12-04T19:15:00","0","-","0","0","0","0","-","-0.16","-0.32","0","0",
"2023-
Col 1: Measured
,"0","-","0","0","0","0","-","-","-","0","0","-","0",
```

sensor data

1st file	"Measured","E1809", "2023-09-16T19:50:00","0.24"	....	"Measured","E1809", "2023-09-17T19:40:00","0.20"	
next file	"Measured","E1809", "2023-09-16T20:00:00","0.20"	....		"Measured","E1809", "2023-09-17T19:50:00","0.21"

Note:

Automatically collected telemetry data for rainfall and stream height gauges owned by Brisbane City Council.

The dataset includes raw gauge readings in 5-minute increments covering a 24-hour rolling period. The data is updated every 10 minutes. Dataset includes gauge readings, descriptions and location details.

Our ELT pipeline - PREFECT

Prefect orchestrates workflows — it simplifies the creation, scheduling, and monitoring of complex data pipelines. With Prefect, you define workflows as Python code and let it handle the rest.

Basic concepts in PREFECT:

- **Task** - a python function that handle workload
- **Flows** - series of tasks (inorder) . Think of Airflow DAGs. calls tasks, and other flows (subflows)
- **Server** - orchestration engine - could be locally of or hosted in the cloud
- **Agents** - daemon process running on local/cloud/container which executes flows
- **Deployments -** A server-side concept that encapsulates flow metadata, allowing it to be scheduled and triggered via API.
- **Pools** - prioritize and manage deployment runs and control the infrastructure they run on.

https://www.prefect.io/

How to PREFECT?

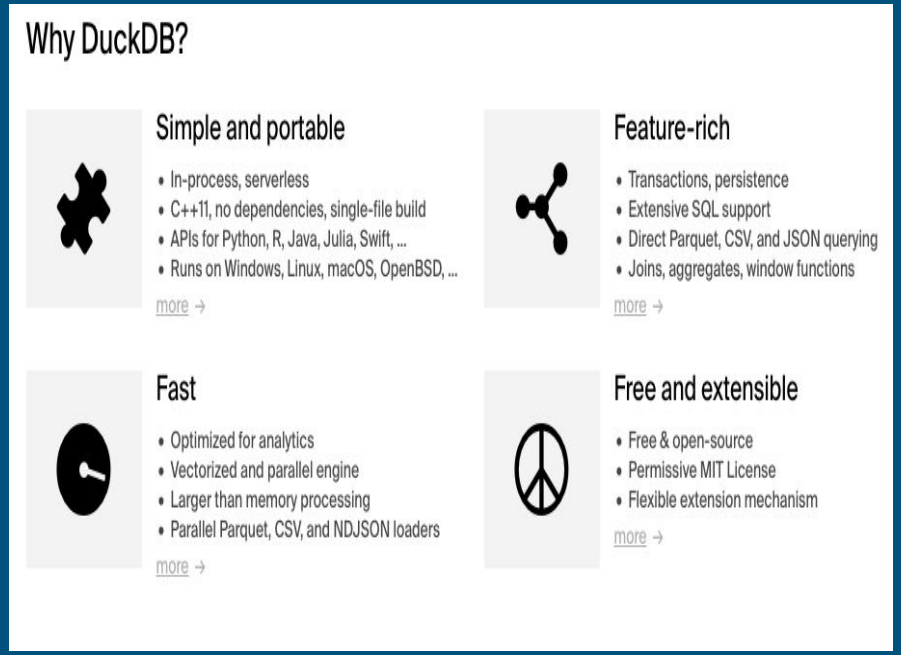
Note: Prefect requires Python 3.8 or newer.

1. Install
   pip install prefect
2. Write your ‘flows’ in python
3. Start Server
   prefect server start - > Self- hosted
   prefect cloud login -> Prefect Cloud
4. Deploy flow and run deployment
   -`python flow.py`
   - prefect deployment run 'hello_universe/first-deploy’
5. Start agent pool
   prefect agent start --pool "default-agent-pool"

```python
from prefect import flow, task

@task(log_prints=True)
def say_hello(name: str):
  print(f"Hello {name}!")


@flow
def hello_universe(names: list[str]):
  for name in names:
    say_hello(name)


if __name__ == "__main__":
  # create your first deployment to automate your flow
  hello_universe.serve(name="your-first-deployment")
```

Our Database - DuckDB

- An in-memory/in-process OLAP SQL database
- SQL on top of your csv and parquet files
- No dependency cli - **duckdb cli**
- Python API
- Lightweight
- https://shell.duckdb.org/
- https://duckdb.org/docs/archive/0.9.2/api/cli



https://duckdb.org/

How to make your DB quack!

1. **Install or Download**
   - brew install duckdb
   - https://github.com/duckdb/duckdb
     - /releases/download/v0.9.2/duckdb_cli-osx-universal.zip
   - pip install duckdb==0.9.2

2. **Create a .duckdb file**
   - touch demo.duckdb

3. **Connect to duckdb**

   ```
   import duckdb
   duckdb.connect(database=db, read_only=is_shared)
   ```

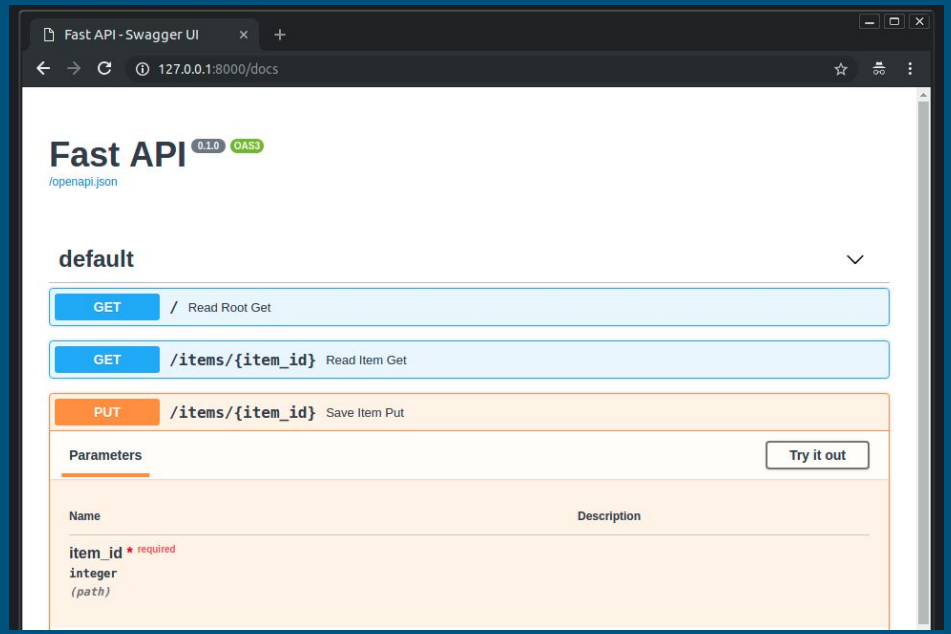
4. **Query Data**

   ```
   ./duckdb
   D .open db.datahack.duckdb
   D .databases
   D. tables
   ```

```
import duckdb

def get_db_conn(db=':memory:',is_shared=False):
    return duckdb.connect(database=db, read_only=is_shared)

conn = get_db_conn('db/datahack.duckdb')

conn.execute(
        """
            DROP TABLE IF EXISTS gauge_sensors_metadata;
            CREATE TABLE gauge_sensors_metadata AS
            SELECT *
            FROM read_csv_auto

('src/data/metadata/rainfall-and-stream-heights-metadata-20230917t110000.csv')
        """
    )
```

Our API - FastAPI

- Modern Python-based API Framework
- Very High performance
- Built-in Swagger documentation
- Robust and fast framework
- Fast to code
- Based on Open API



https://fastapi.tiangolo.com/

How fast is FastAPI?

1. Install fastapi package

```
pip install fastapi
```

2. Install uvicorn package

```
pip install "uvicorn[standard]"
```

3. Import fastapi module

```
from fastapi import FastAPI
```

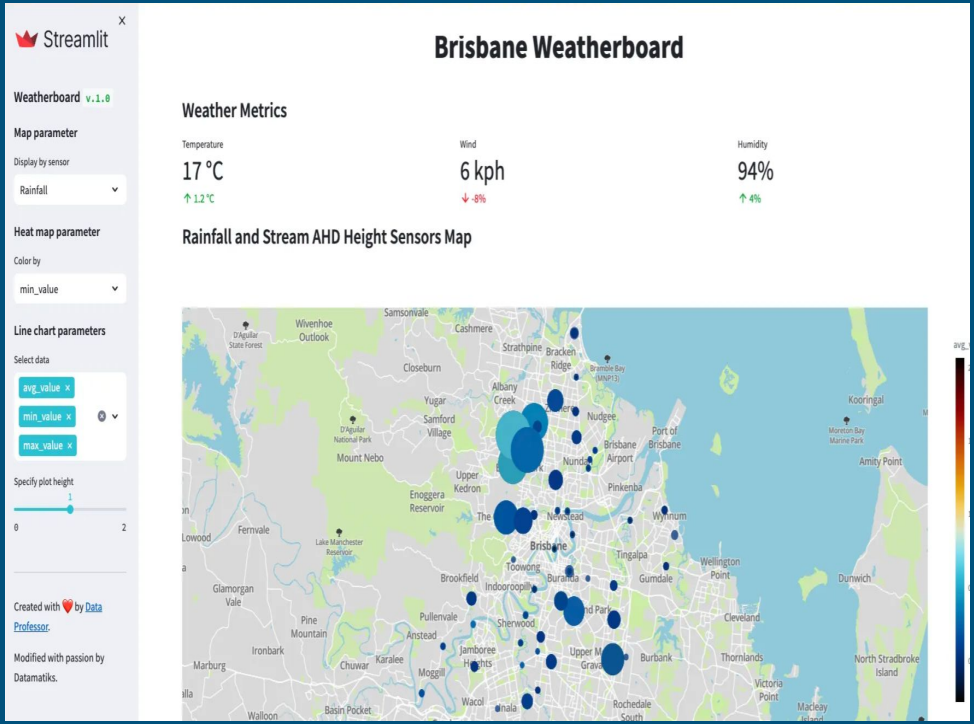
4. Run server

```
uvicorn fast-demo:app --reload
```

```
from typing import Union

from fastapi import FastAPI

app = FastAPI()


@app.get("/")
def read_root():
    return {"Hello": "World"}


@app.get("/items/{item_id}")
def read_item(item_id: int, q: Union[str, None] = None):
    return {"item_id": item_id, "q": q}
```

Our Visualization

- A Python web framework for creating Data Apps
- Turns data scripts into shareable web apps in minutes.
- Opensource
- Deploy locally or cloud
- Bought by Snowflake



https://streamlit.io/

template- https://youtube.com/dataprofessor/

How to Streamlit?

1. Install streamlit

   ```
   pip install streamlit
   ```

2. Create streamlit app in python
3. Execute python code

   ```
   streamlit run myapp.py
   ```

```
import streamlit as st
import pandas as pd

st.write("""
# My first app
Hello *world!*
""")

df =
pd.read_csv("src/data/metadata/rainfall-and-stream-heights-
metadata-20231205t110000.csv")
st.line_chart(df)
```

Thank You!