Introduction to IoT data

ANALYZING IOT DATA IN PYTHON

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Course overview

- Collect and analyze IoT data
- Gather data
  - API Endpoints
  - Data Streams
- Visualize data
- Combine datasets
- Detect patterns
- ML Model based alerts

What is IoT?

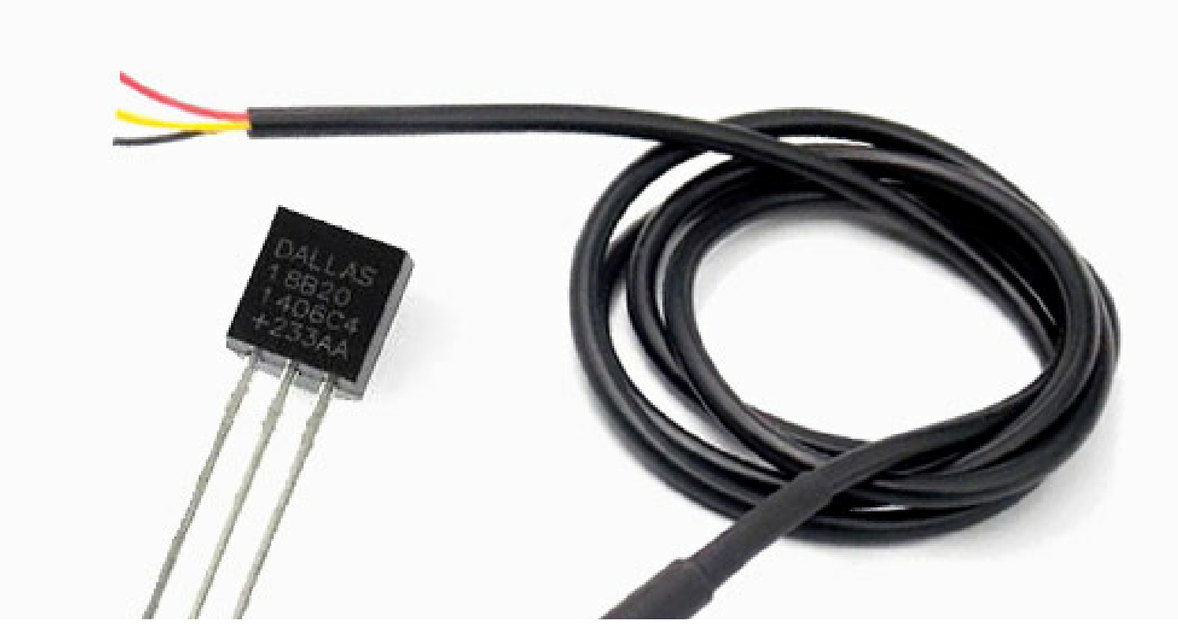
IoT == Internet of Things

- Network of connected devices
- Measure and collect data
- Interact with environment

IoT Devices

Connected devices

- Smart locks
- Connected thermostats
- Temperature sensors



Industrial connected devices

- Connected machines
- Robots / Cobots
- Package tracking

IoT Data formats

- http / json
- plain text
- binary data
- XML
- Proprietary protocols

Data aquisition

- Data streams
- Gathered from a device
- API endpoints

Data aquisition - requests

```
import requests
url = "https://demo.datacamp.com/api/temp?count=3"
r = requests.get(url)
print(r.json())
```

```
[{'timestamp': 1536924000000, 'value': 22.3},
 {'timestamp': 1536924600000, 'value': 22.8},
 {'timestamp': 1536925200000, 'value': 23.3}]
```

```
print(pd.DataFrame(r.json()).head())
```

```
       timestamp  value
0  1536924000000   22.3
1  1536924600000   22.8
2  1536925200000   23.3
```

Data aquisition - pandas

```
import pandas as pd
df_env = pd.read_json("https://demo.datacamp.com/api/temp?count=3")
print(df_env.head())
```

```
             timestamp  value
0 2018-09-14 11:20:00   22.3
1 2018-09-14 11:30:00   22.8
2 2018-09-14 11:40:00   23.3
```

```
print(df_env.dtypes)
```

```
timestamp    datetime64[ns]
value               float64
dtype: object
```

Let's Practice

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Understand the data

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Store data to disk

Reasons to store IoT Data

- Limited historical data availability
- Reproducible results
- Training ML Models

Store data using pandas

```
df_env.to_json("data.json", orient="records")
```

```
!cat data.json
[{'timestamp': 1536924000000, 'value': 22.3},
 {'timestamp': 1536924600000, 'value': 22.8},
 {'timestamp': 1536925200000, 'value': 23.3},
 {'timestamp': 1536925800000, 'value': 23.6},
 {'timestamp': 1536926400000, 'value': 23.5}]
```

Reading stored data

- From JSON files

```
import pandas as pd
df_env = pd.read_json("data.json")
```

- From CSV file

```
import pandas as pd
df_env = pd.read_csv("data.csv")
```

Validate data load

- Correct column headers
- Check Data formats

```
df_env.head()
```

```
             timestamp  humidity  pressure  sunshine  temperature
0 2018-09-01 00:00:00      95.6    1016.3     599.2         16.1
2 2018-09-01 00:10:00      95.5    1016.4     600.0         16.1
4 2018-09-01 00:20:00      95.2    1016.5     598.9         16.1
6 2018-09-01 00:30:00      95.1    1016.4     600.0         16.1
8 2018-09-01 00:40:00      95.3    1016.3     600.0         16.1
```

DataFrame.info()

```
df_env.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 13085 entries, 0 to 13085
Data columns (total 5 columns):
pressure                13085 non-null float64
humidity                13085 non-null float64
sunshine                13083 non-null float64
temperature             13059 non-null float64
timestamp               13085 non-null datetime64[ns]
dtypes: datetime64[ns](1), float64(6)
memory usage: 1.4 MB
```

pandas describe()

```
df_env.describe()
```

```
          humidity      pressure      sunshine  temperature
count  13057.000000  13057.000000  13057.000000  13057.00000
mean      73.748350   1019.173003    187.794746     14.06647
std       20.233558      6.708031    274.094951      6.61272
min        8.900000    989.500000      0.000000     -1.80000
25%       57.500000   1016.000000      0.000000      9.80000
50%       78.800000   1019.700000      0.000000     13.40000
75%       91.300000   1023.300000    598.900000     18.90000
max      100.100000   1039.800000    600.000000     30.40000
```

Time for Practice!

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Introduction to Data streams

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What is a Data Stream

- Constant stream of Data
- Examples
  - Twitter messages
  - Online News Articles
  - Video streams
  - Sensor data (IoT)
  - Market orders (financial)

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- Constant stream of Data
- Examples
  - Twitter messages
  - Online News Articles
  - Video streams
  - **Sensor data (IoT)**
  - Market orders (financial)

MQTT

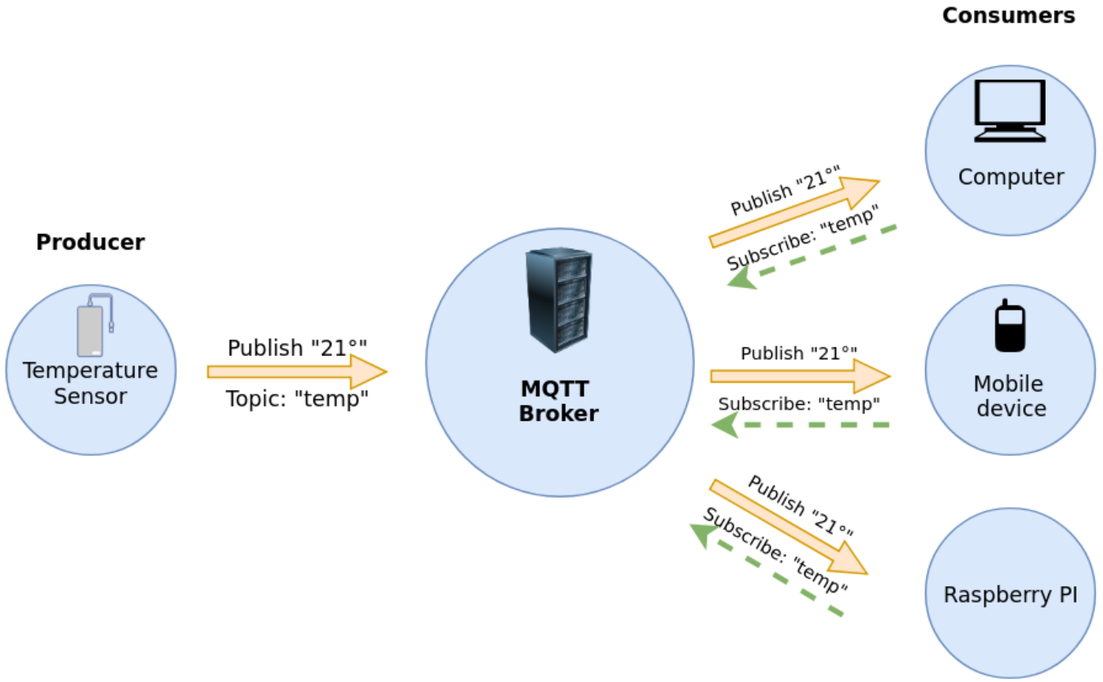
- Message protocol
- Publish / subscribe
- Small footprint

Server -> Acts as a message Broker

Client:

- Connects to a Broker
- Publishes data
- Subscribes to topics

Message **Q**ueuing **T**elemetry **T**ransport



Python library

Eclipse Paho™ MQTT Python Client

```
# Import MQTT library
import paho.mqtt
```

More information and the documentation available at GitHub

https://github.com/eclipse/paho.mqtt.python

Single message

```
import paho.mqtt.subscribe as subscribe
msg = subscribe.simple("paho/test/simple",
                       hostname="test.mosquitto.org")
print(f"{msg.topic}, {msg.payload}")
```

Output:

```
paho/test/simple, {"time": 1549481572, "humidity": 77, "temp": 21}
```

Callback

```
def on_message(client, userdata, message):
    print(f"{message.topic} : {message.payload}")
```

Arguments

- `client` - client instance
- `userdata` - private user data
- `message` - instance of MQTTMessage

Callback

```
import paho.mqtt.subscribe as subscribe


subscribe.callback(on_message,
                   topics="datacamp/roomtemp",
                   hostname="test.mosquitto.org")
```

MQTT Subscribe

```
import paho.mqtt.subscribe as subscribe
def on_message(client, userdata, message):
    print("{} : {}".format(message.topic, message.payload))
subscribe.callback(on_message,
                   topics="datacamp/roomtemp",
                   hostname="test.mosquitto.org")
```

```
datacamp/roomtemp : b'{"time": 1543344857, "hum": 34, "temp": 24}'
datacamp/roomtemp : b'{"time": 1543344858, "hum": 35, "temp": 23}'
datacamp/roomtemp : b'{"time": 1543344860, "hum": 36, "temp": 22}'
datacamp/roomtemp : b'{"time": 1543344946, "hum": 37, "temp": 22}'
datacamp/roomtemp : b'{"time": 1543345010, "hum": 36, "temp": 13}'
```

Let's practice!

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