influx/days

Advanced usages of flux

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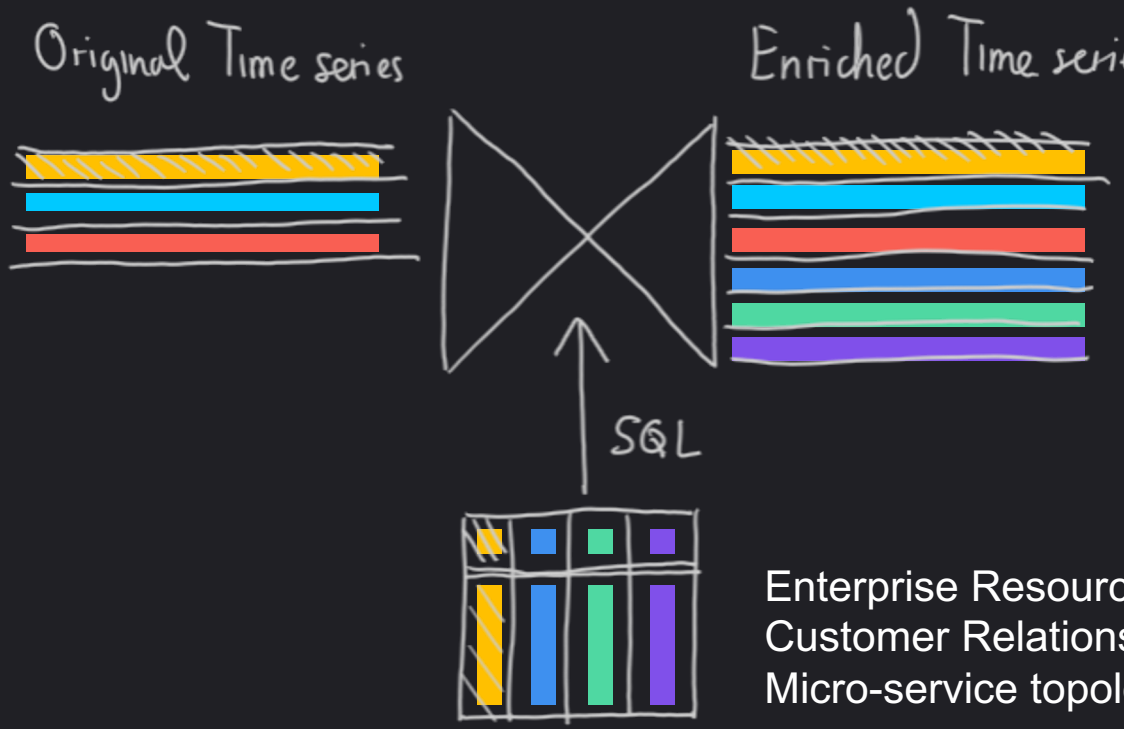
Time Series Enrichment

Time Series Enrichment – the intuition

IoT Sensors
Ratings
Metrics & Logs



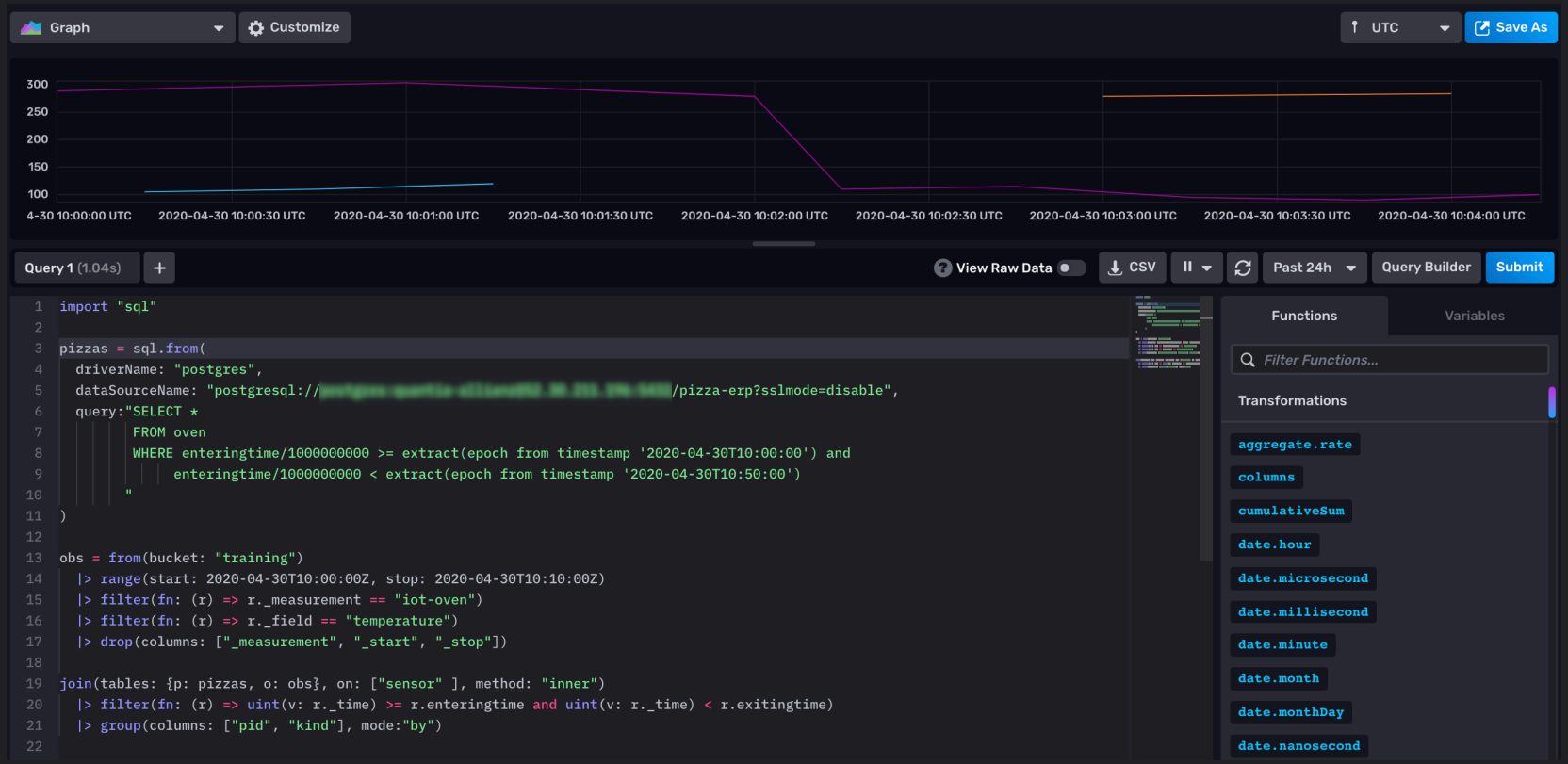
I4.0 apps
Customer 360°
Traces

Enterprise Resource Planning
Customer Relationship Mng.
Micro-service topology

Use case for the Linear Pizza Oven

- Enrich the IoT observations with the ID of the pizza and the kind of pizza contained in the Enterprise Resource Planning RDBMS

Time Series Enrichment in flux

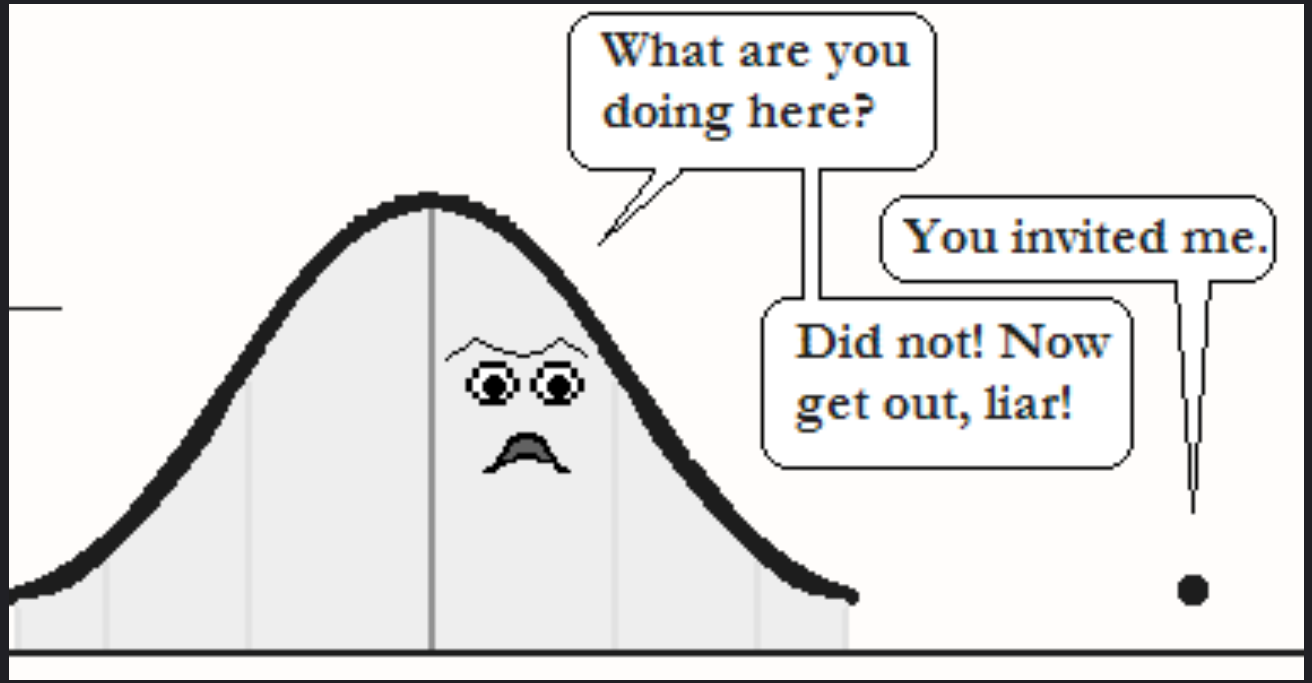


Anomaly Detection

Anomaly Detection

- Anomaly detection is a challenging data analysis task
- Anomalies can represent
  - spurious data to clean out
  - important patterns to detect
- This generality makes anomaly detection a powerful tool used in network security, remote sensing, fault detection, and many other domains

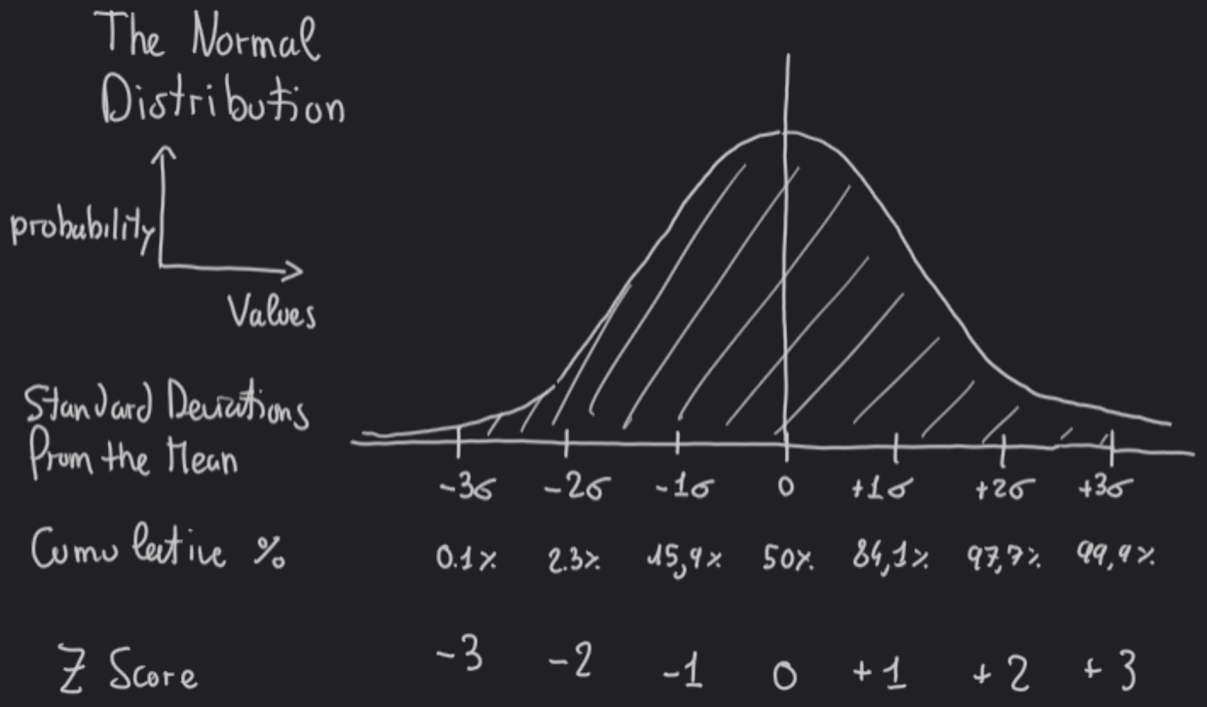
Anomaly Detection – the intuition



[image: https://cerijayne.files.wordpress.com/2011/10/outliersss.png]

Considering the distribution of the data point in a time series, anomalous points are **anomalies**, a.k.a. *outliers*

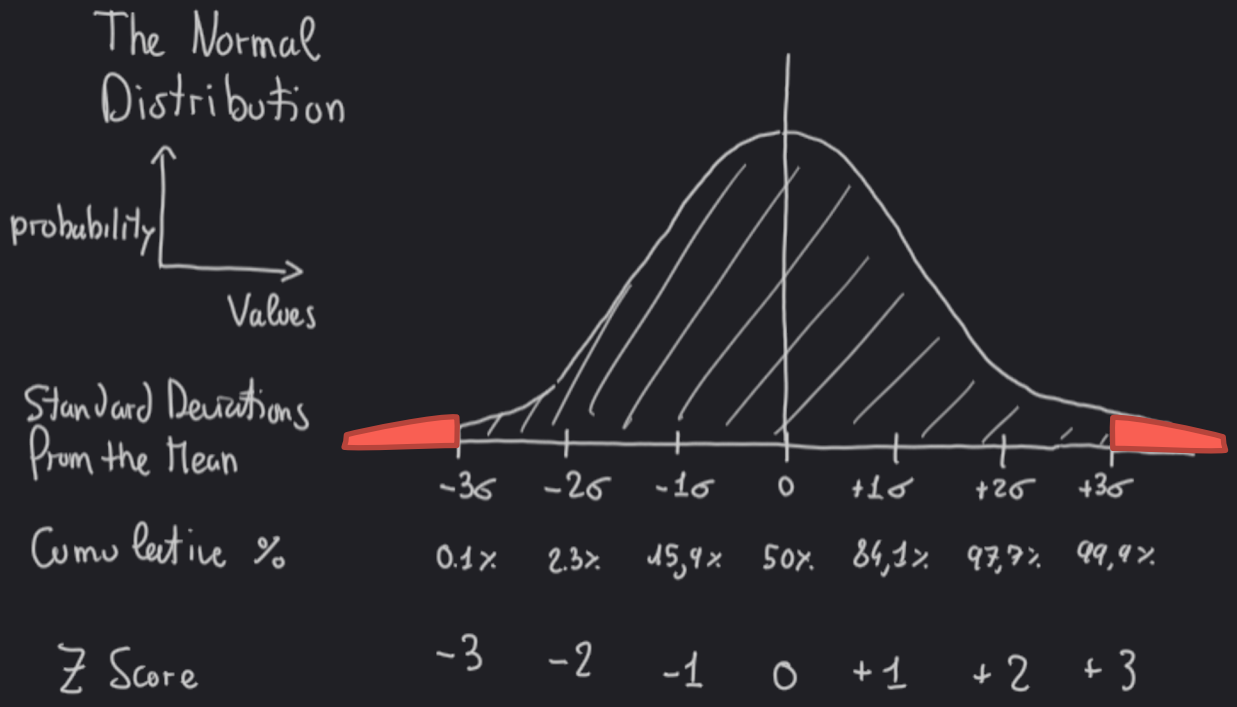
Let’s operationalize this intuition using the Z score



Z score

$$z = \frac{x - \mu}{\sigma}$$

Let’s operationalize this intuition using the Z score



Z score

$$z = \frac{x - \mu}{\sigma}$$

Anomaly

$Abs(z) > 3$

0.2% of data

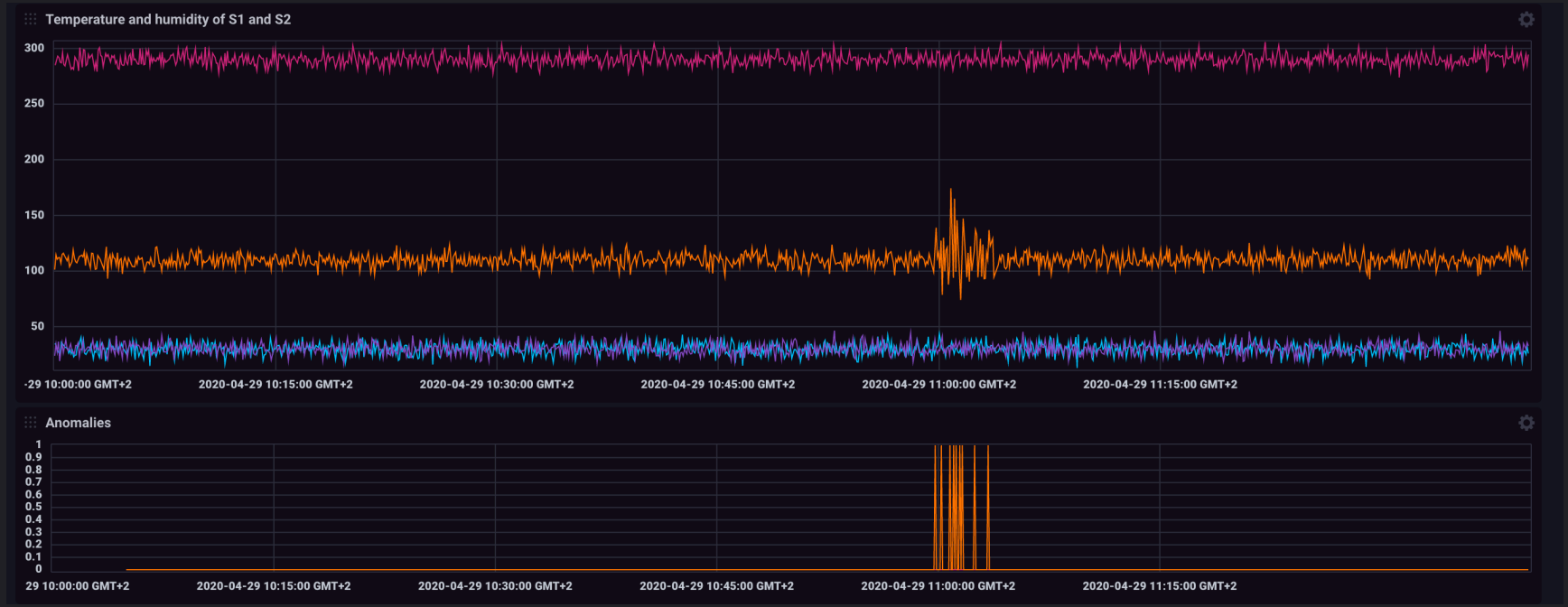
Use case for the Linear Pizza Oven

- Detect if a failures of the temperature controller of the mozzarella melting area
  - Correct behavior: 110 ± 10 C°
  - Anomalous: ?

Use case for the Linear Pizza Oven

- Detect if a failures of the temperature controller of the mozzarella melting area
  - Correct behavior: 110 ± 10 C°
  - Anomalous: let's compute the z-score where
    - the Mean is computed with aggregateWindow(every: 5m, fn: mean)
    - the StdDev is computed with aggregateWindow(every: 5m, fn: stddev)
    - the Z score is computed joining the times-series of all observations with the one of the Mean and the one the StdDev

Use case for the Linear Pizza Oven – data viz



Use case for the Linear Pizza Oven – solution 1/3

```
movingAvg = from(bucket: "training")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> aggregateWindow(every: 5m, fn: mean, createEmpty: false)
  |> filter(fn: (r) => r._stop != r._time)
  |> drop(columns: ["_start", "_stop", "_measurement"])
  |> rename(columns: {_value: "avg"})
```

Use case for the Linear Pizza Oven – solution 2/3

```
movingStddev = from(bucket: "training")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> aggregateWindow(every: 5m, fn: mean, createEmpty: false)
  |> filter(fn: (r) => r._stop != r._time)
  |> drop(columns: ["_start", "_stop", "_measurement"])
  |> rename(columns: {_value: "stddev"})


join1 = join(tables: {all: movingAvg, avg: movingStddev},
             on: ["_time","sensor","_field"])
```

Use case for the Linear Pizza Oven – solution 3/3

```
allData = from(bucket: "training")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> drop(columns: ["_start", "_stop", "_measurement"])

join(tables: {all: allData, j: join1}, on: ["sensor","_field"])
  |> filter(fn: (r) => uint(v: r._time_all)-uint(v: r._time_j) > 0)
  |> filter(fn: (r) => uint(v: r._time_all)-uint(v: r._time_j) <=
                                        (5*60*1000000000))
  |> map(fn: (r) => ({ r with zscore:
    if math.abs(x: (r._value - r.avg)/r.stddev)>3 then 1 else 0}))
```

A Network Security example

- Finding anomalies in the number of times users inserts a wrong password when they log into a system
  - Refuse the access to a user that inserts the right password at the first time if she gets in average the right password after 3 attempts
- Much more effective than any rule based approach

Advanced
Time Series Analytics

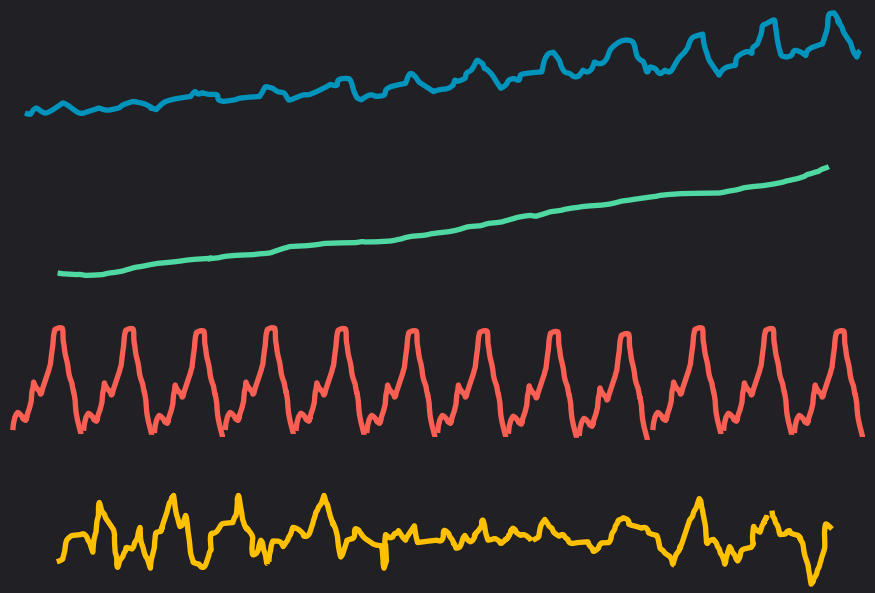
Holt-Winter's method

Given a time series

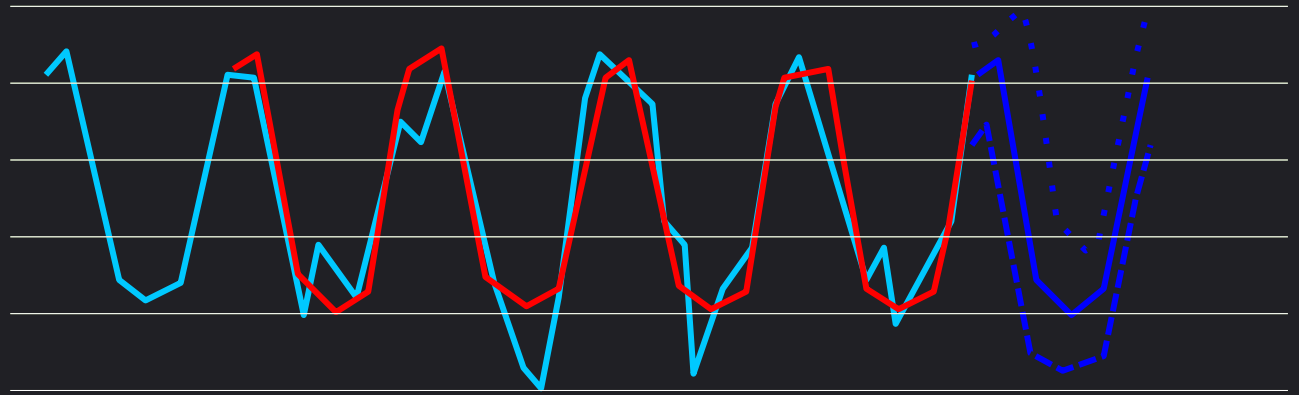
It is often possible to extract

- a **trend**: a long term variation of the time series.
- a **seasonality**: a short term recurring pattern

What is left is call **residual**



Forecasting with Holt-Winter's method



Holt-Winter's in Flux

Holt-Winter's in Flux

```
from(bucket: "training")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r._measurement == "fill_level")
  |> filter(fn: (r) => r._field == "value")
  |> filter(fn: (r) => r.tank == "B2")
  |> aggregateWindow(every: 1m, fn: first)
  |> holtWinters(n: 10, seasonality: 8, interval: 1m)
```

What (else) can I do with Flux?

What (else) can I do with flux?

- Map/Reduce
- Derivative, Difference, Integral
- Histograms
- Regular expression matching
- String functions
- Go Math library parity
- Quantile
- Conditional Expressions
- Cross-measurement calculations
- Conditional expressions
- Sorting
- Data Generation
- In-language test assertions
- …
- And more every day!

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