Leak Detection in Water Distribution Networks

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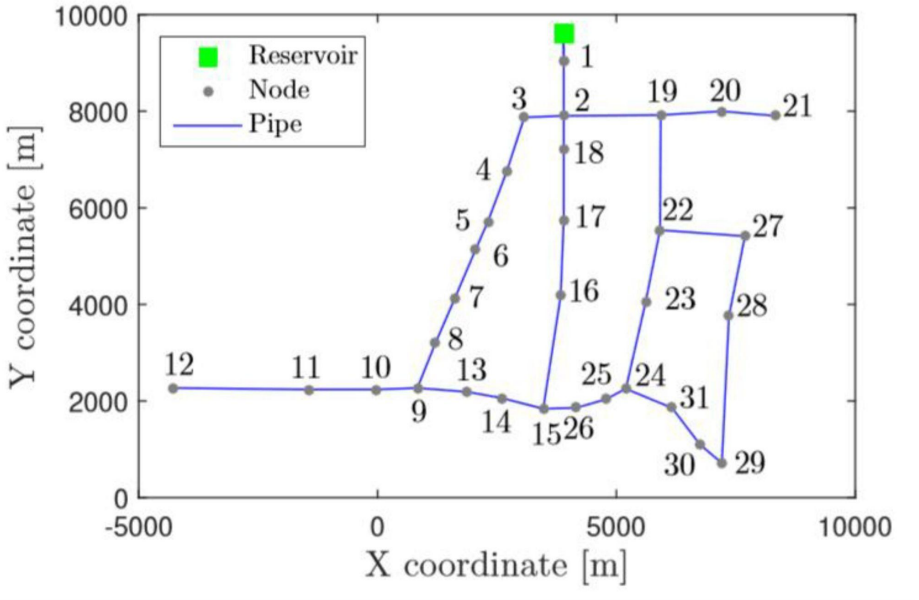
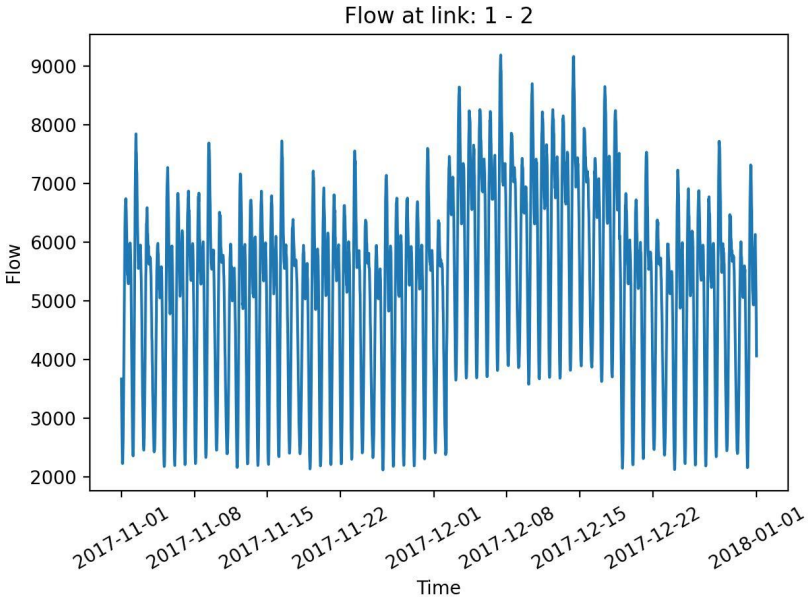
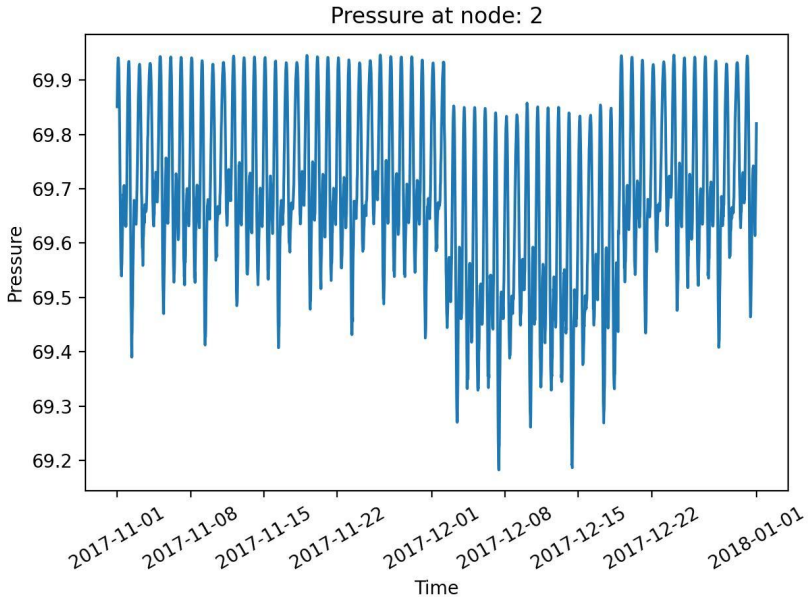
The problem of Leak Detection

District Metered Areas (Hanoi)



Leak Scenario: Node 2



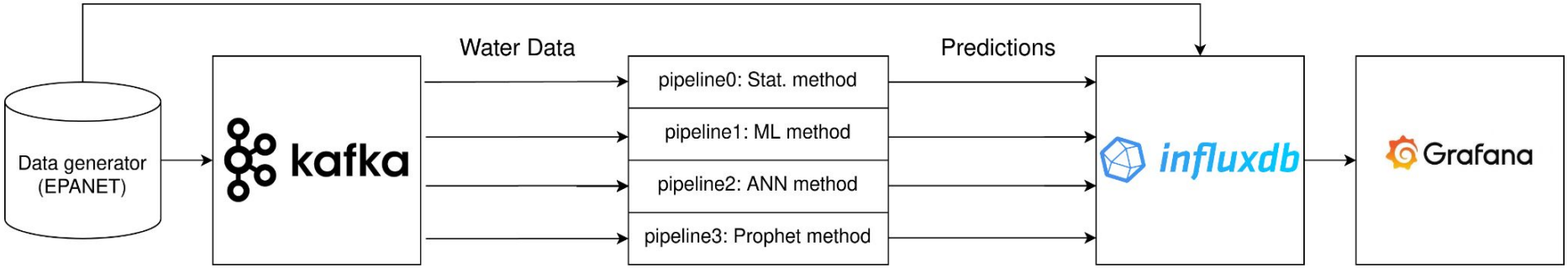


Architecture

Goals

- Simulate real-time leak detection
- Different methods with different trade-off quality-efficiency
- Pipelines can be easily altered or replaced
- Everything containerized
- Data invariance
- Network invariance

Architecture Overview



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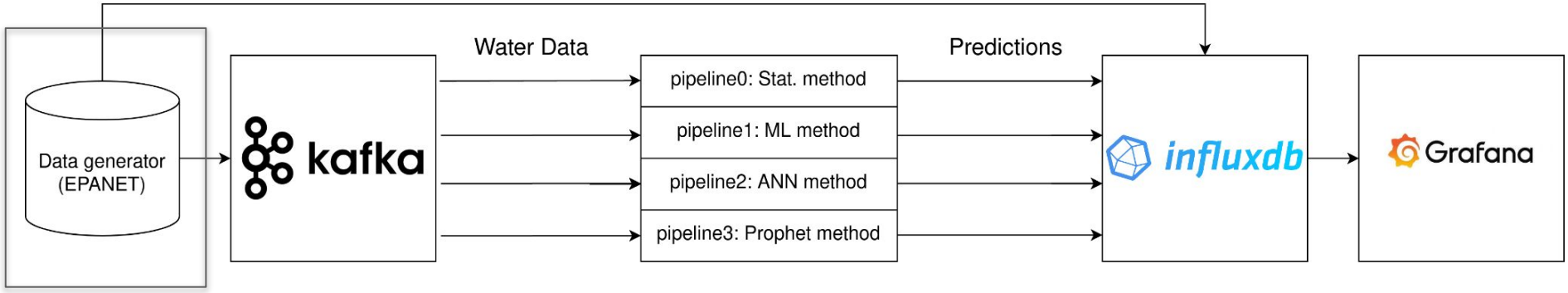

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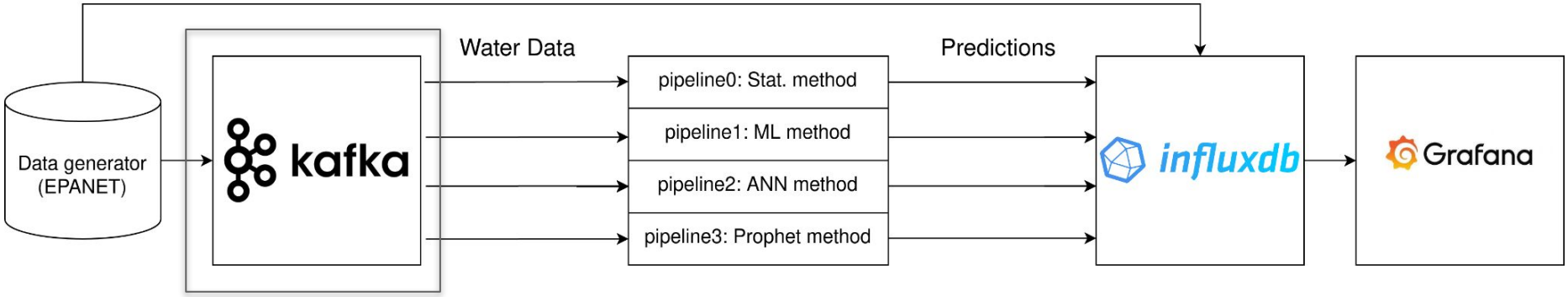

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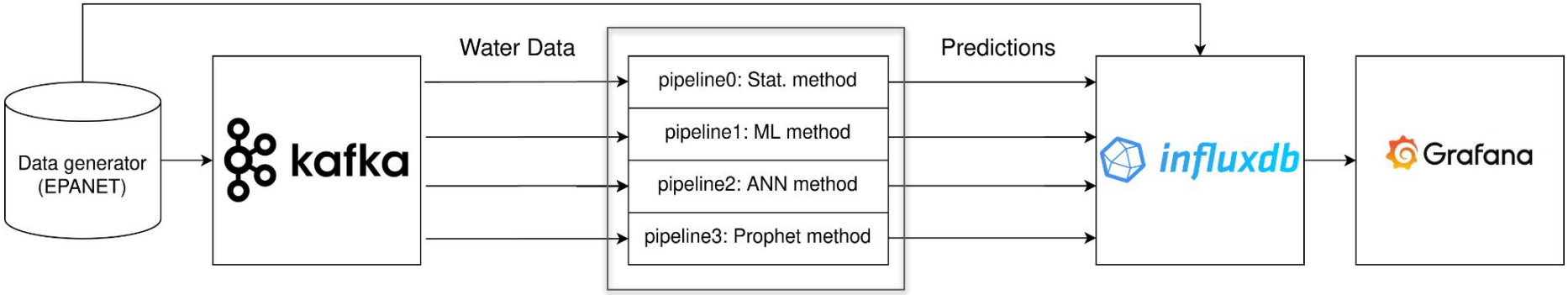

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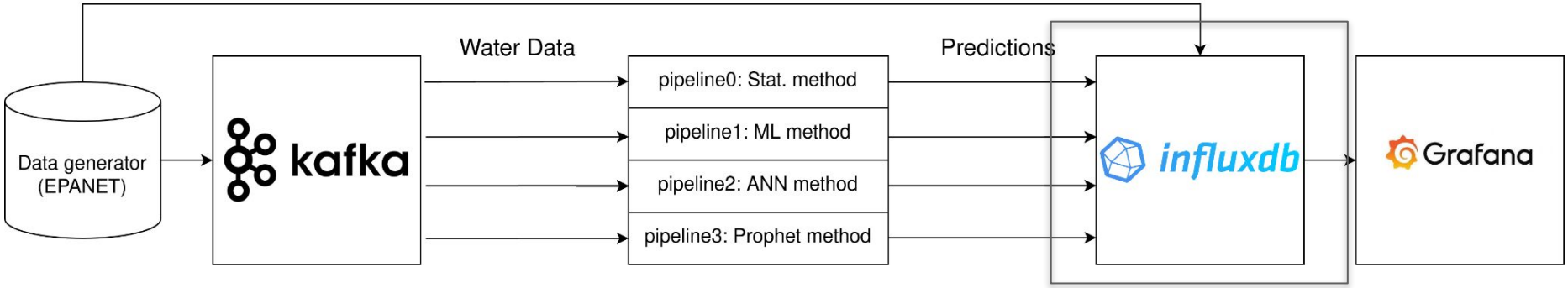

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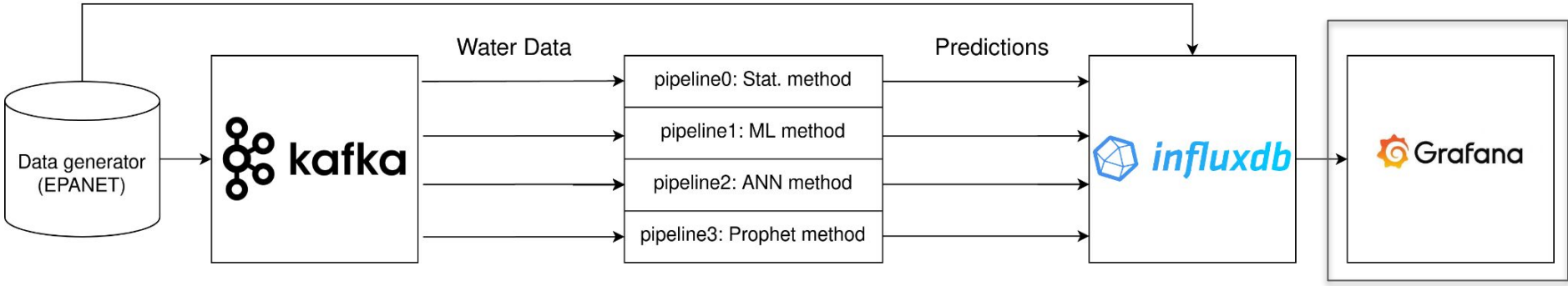

Leak prediction methods

Pipeline 1: Fault Sensitivity Matrix Correlation for pressure

- Simulate leak at each node
- Save characteristic pressure to matrix
- Calculate correlation with matrix at each time point

https://doi.org/10.1016/j.conengprac.2011.06.004

Pipeline 2: Random Forest for pressure

- Treat as classification problem with binary labels
- Makes no use of temporal property

Pipeline 3: LSTM network flow prediction

- State of the art for time series prediction
- Double thresholding
- Tri-layered LSTM network
- Predicts all 34 links at once

https://doi.org/10.3390/su13169262

Pipeline 4: Facebook’s Prophet flow prediction

- Alternative to SARIMA-model
- Prophet model for each link
- Double thresholding

https://facebook.github.io/prophet/

Performance results (easy dataset)

Leak diameter = random(0.02, 0.2)
Number of data points = 80.000
Number of scenarios = 34

One scenario for each possible leak location

	Correlation	RFC	ANN	Prophet
Precision	0.96	0.98	0.99	0.99
Recall	0.96	0.98	0.99	0.99
F-1	0.96	0.98	0.99	0.99

Demo

Future work

- Improve model performance
- Prediction speed using Spark
- Leak detection suite instead of real-time simulation

Thanks for attending, questions?