WATER AND CLIMATE CHANGE
Balkans Joint Conference and Exhibition
4-6 November 2020, Tirana, Albania

SHUKALB | SHUKOS

The use of artificial intelligence for water network failure risk prediction and optimal asset management

Kevin Nirsimloo

altereo

Tirana, 6th november 2020

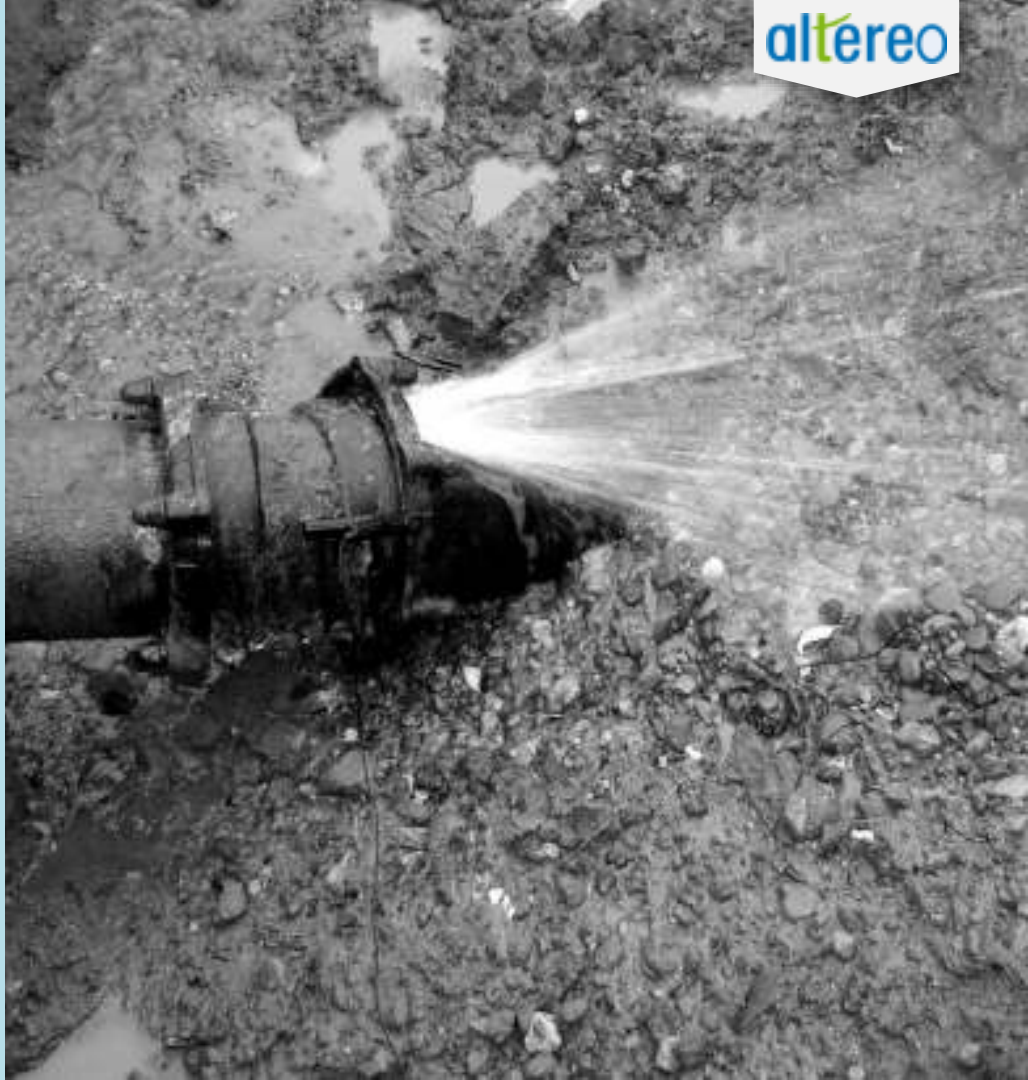
Water networks

Vast infrastructures ageing year by year

The challenge

for the years to come

More bursts and breaks
Increasing NRW
Costly unplanned maintenance
Exposure to critical failures
Deteriorating service levels
Decreasing customer satisfaction



The obvious solution for the future

Reduce the number of leaks

Reduce the duration of leaks

Easy to say

Not easy to do

How to make *rational* choices?

Reduce the number of leaks

- Replace pipes
- Based on…?
  - Age?
  - Material?
  - Diameter?
  - Location?
  - Importance?
  - Break frequency?

Reduce the duration of leaks

- Detect and repair leaks
- Based on…?
  - Complaints?
  - DMA and night flow monitoring?
  - Permanent acoustic loggers?
  - Systematic field surveys?

Challenges and *limits*

Reduce the number of leaks

- Replace pipes
- Based on…?
  - Age?
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Need good GIS data

Reduce the duration of leaks

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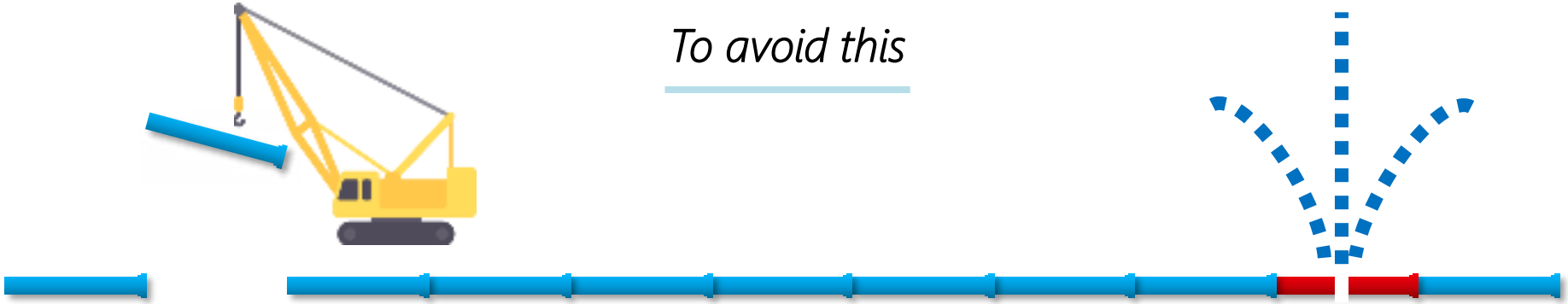
Need costly equipment

Major limit: *curative* approach
Reacting *after* the problems

How to switch to a *preventive* approach?

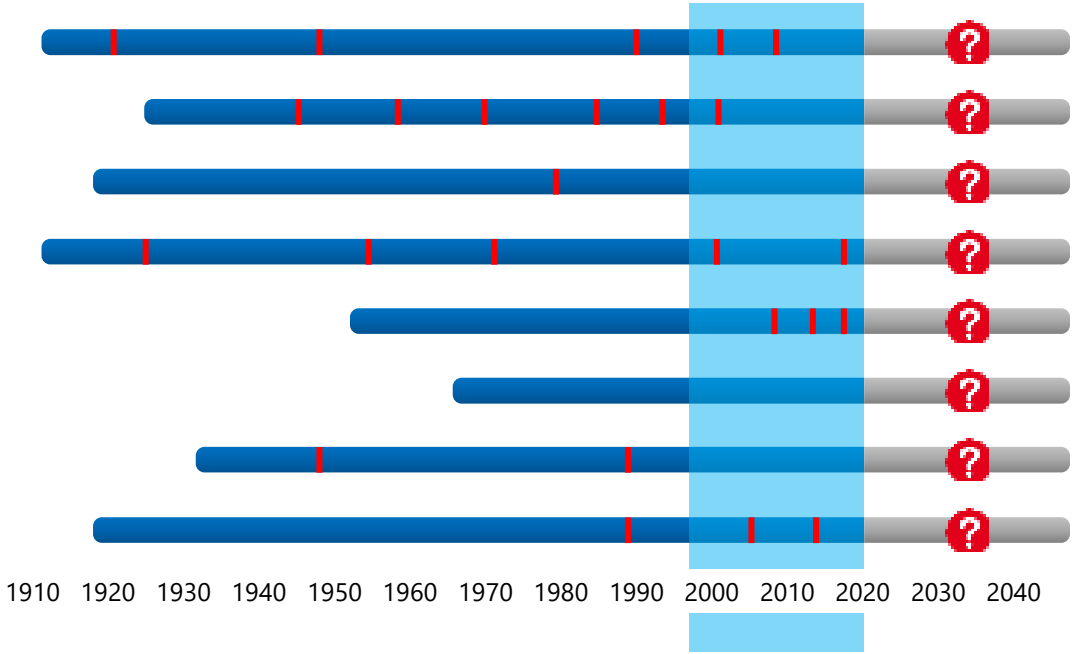
- Switching to a preventive approach
- Calculating the probability, likelihood or risk of network failure in the **future**



Investing **inefficiently**
in replacement on one side

And **still be impacted** by severe incidents on the other side

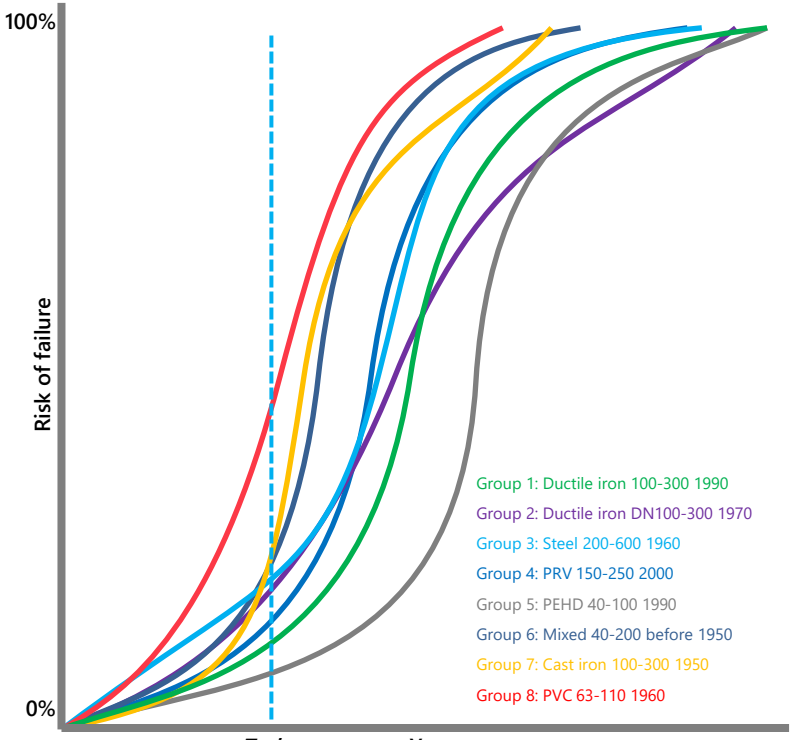
A **COMPLEX EQUATION** to solve
We know only a *fraction* of the lifespan and leaks of the networks



Observation frame on a fraction of the lifespan and leaks

Risk of failure curves

Likelihood of failure is not constant in time



How to switch to a *preventive* approach?

- Switching to a preventive approach
- Calculating the probability, likelihood or risk of network failure in the *future*

Using statistical models

- Have been around for years
- Predetermined models
- Calibrated onto your network
- Need good statistical knowledge
- Manual operation
- Risk of operator bias

R&D to overcome constraints

- Scientific literature review
- Learning from the medical world
- Selecting algorithms
- Testing algorithms
- Assembling and adapting algorithms
- Pilot testing and final solution

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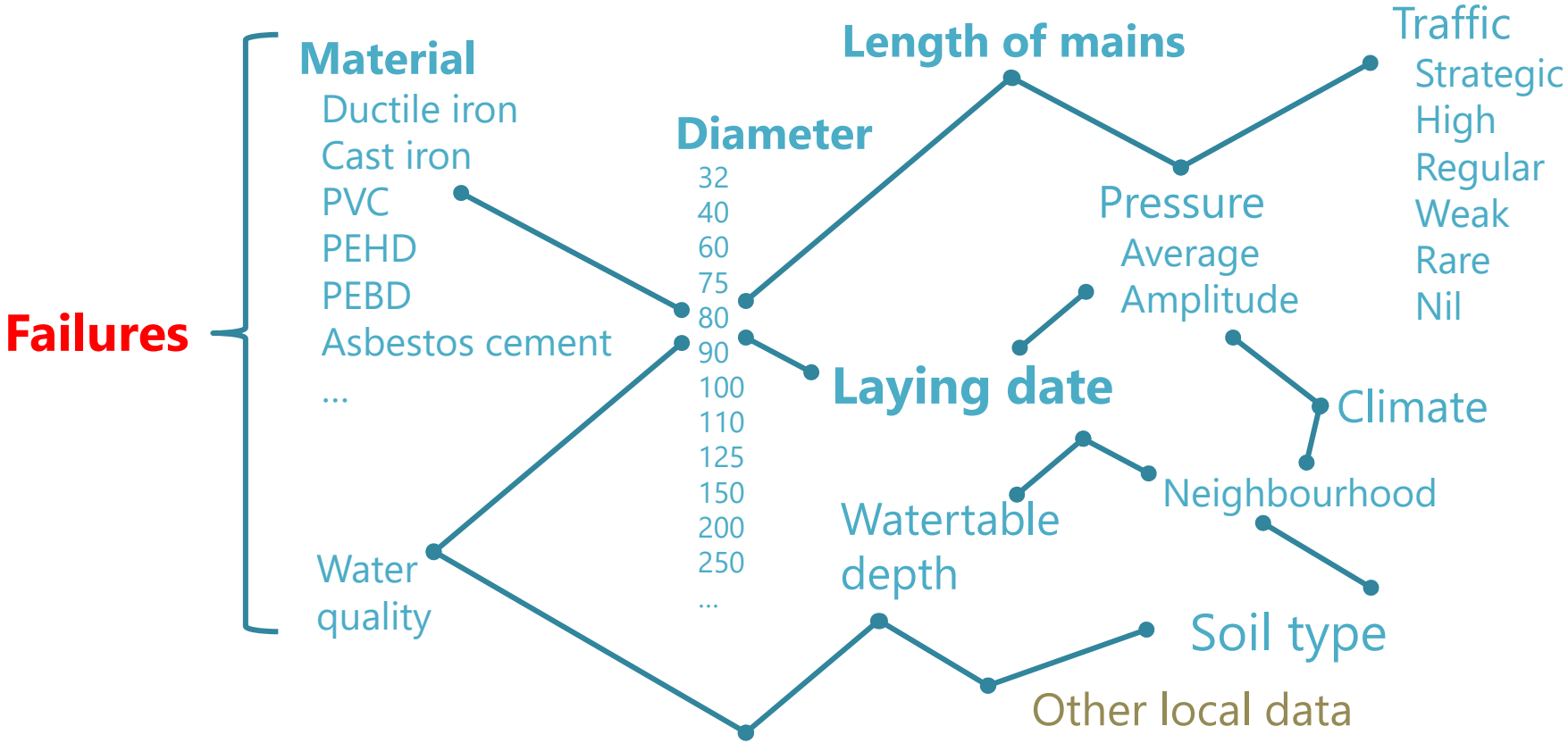
Using artificial intelligence

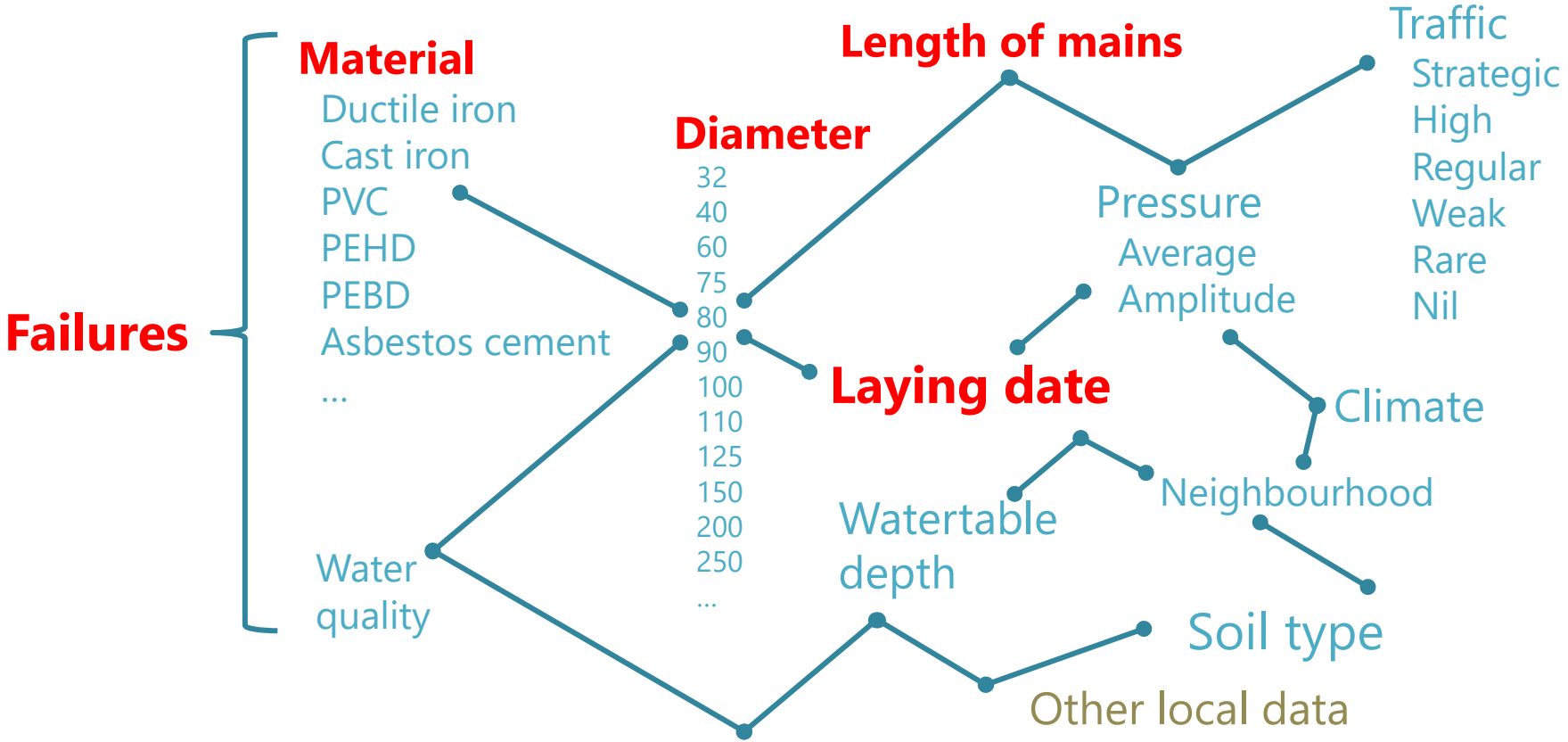
- New
- Machine learning from *your* data
- Learning and testing on your data
- No need for statistical knowledge
- Automatic
- No risk of operator bias

Artificial intelligence **LEARNS AUTOMATICALLY**

and generates *decision trees* based on the **failure history** and **descriptive data**



Our experience and AI capacities lead to **efficient** failure risk **predictions** using the highlighted categories of data *as a minimum*



Artificial intelligence algorithms perform a special type of

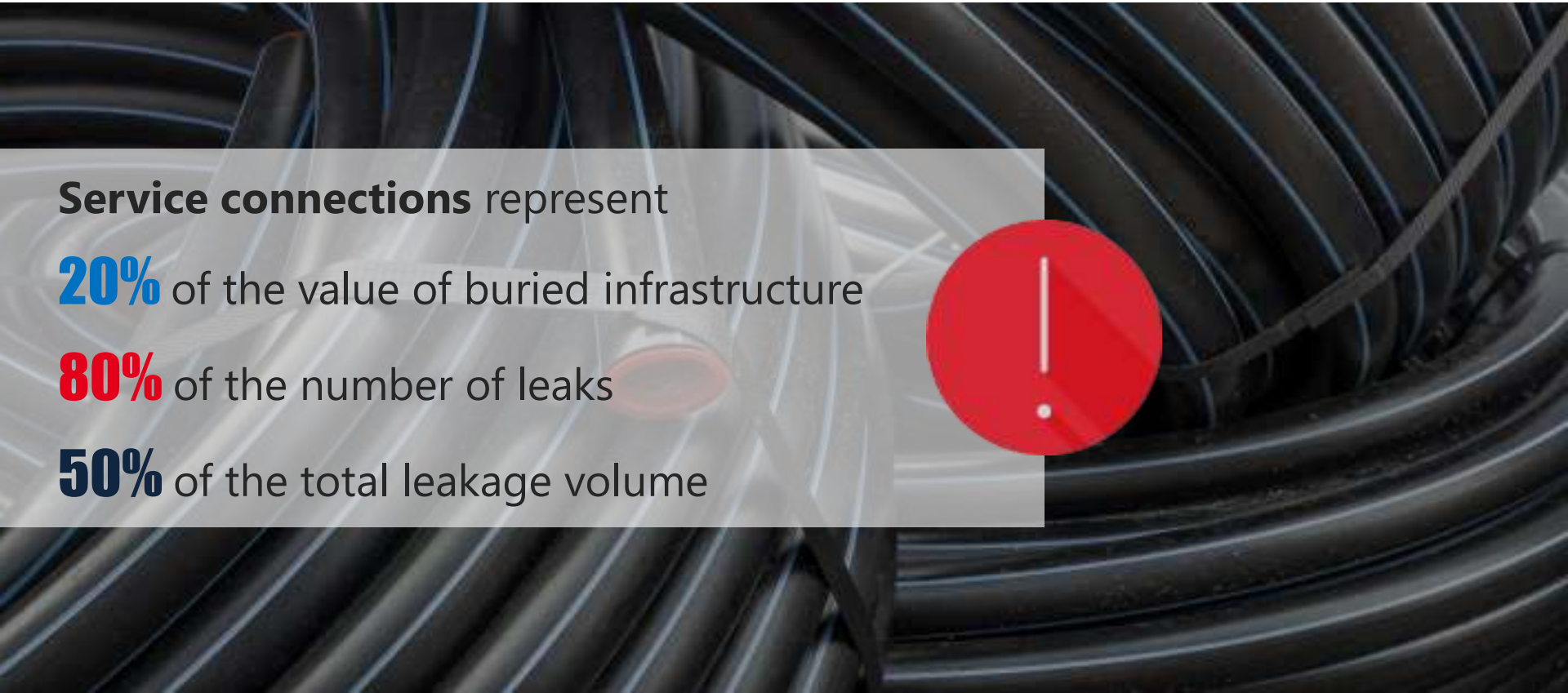
SURVIVAL ANALYSIS and generate *a new criterion*

The failure risk

Likelihood of failure

- Mains
- Service connections
- Other equipment

Altereo's experience and records show that...



Service connections represent

20% of the value of buried infrastructure

80% of the number of leaks

50% of the total leakage volume

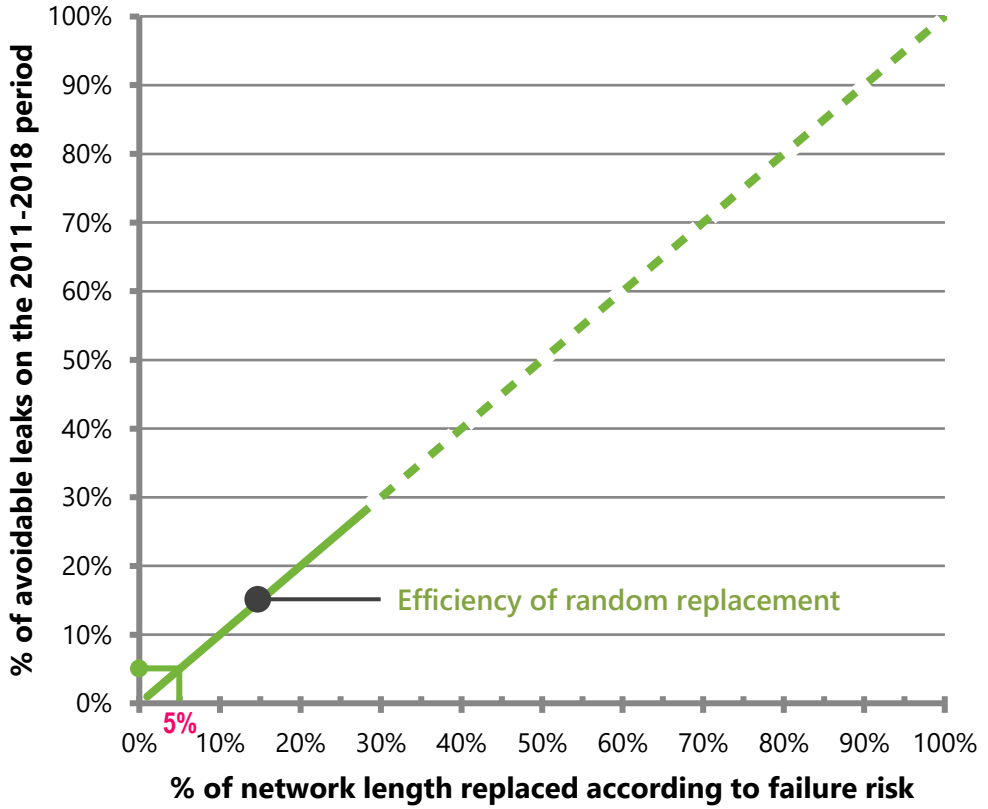
How can we *trust* artificial intelligence?

Demonstration on a real-life case
Network failure history 2000-2018

Model TRAINING
AI machine learning
2000-2010 dataset

Model TESTING
Risk vs reality
2011-2018 dataset

Measure of the efficiency of the AI model



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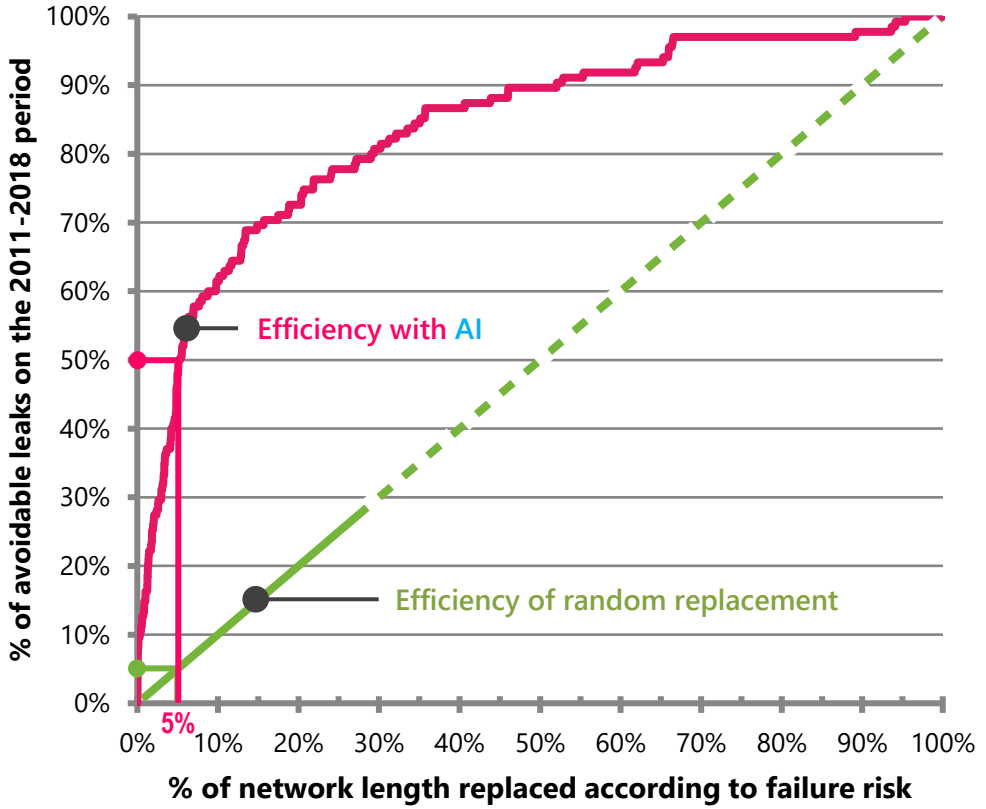
Measure of the efficiency of the AI model

On the **test period**, **replacing only 5%** of the network **avoids 50% of leaks** that really occurred. This is the performance potential of **AI risk predictions** for the future.



How to make the *best rational* choices?

Failure risk X

- Impact on water distribution
- Impact on sensitive customers
- Impact on sensitive resources
- Impact on road traffic
- Impact on OPEX
- Impact on KPIs
- Impact on utility's image
- Customised criteria

Artificial intelligence makes preventive approaches *more accessible* to water utilities

1

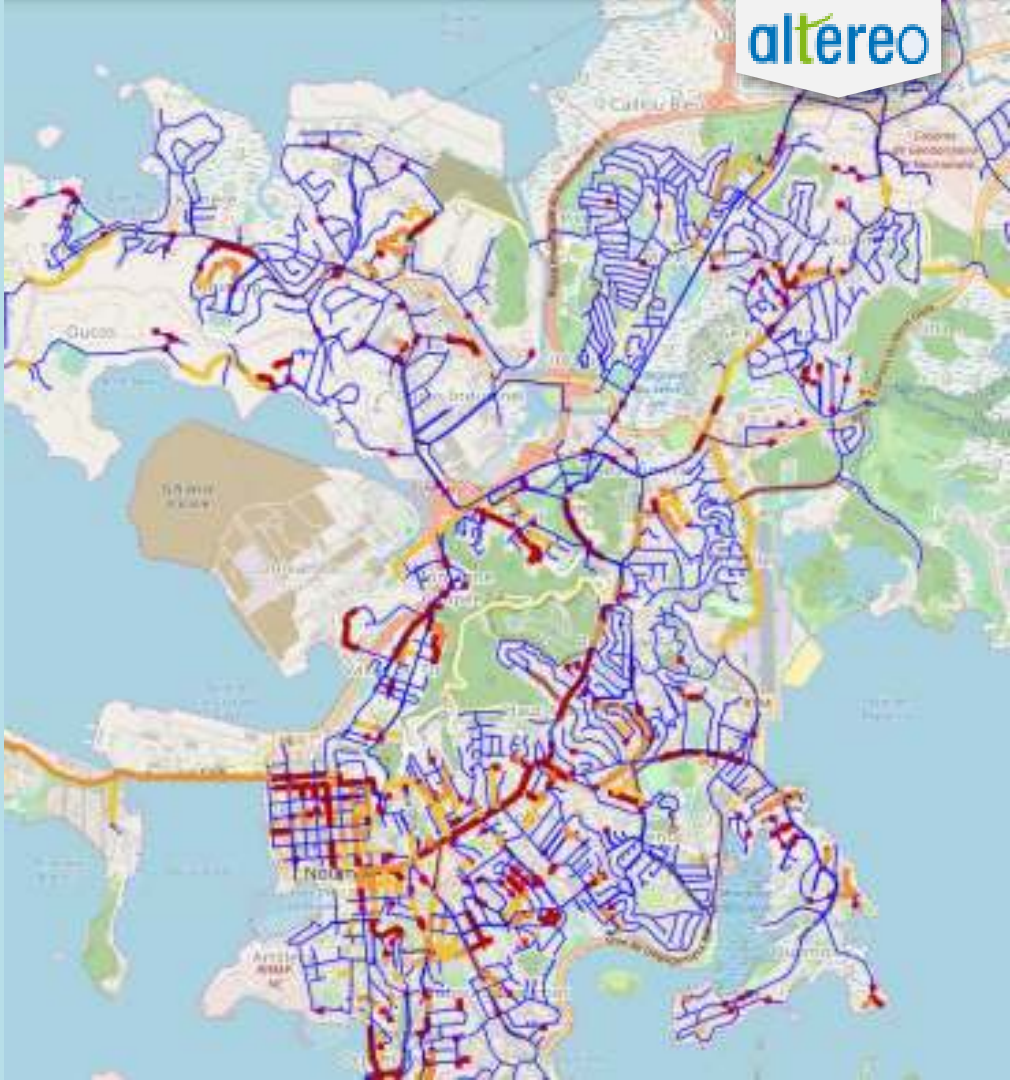
To reduce the number of leaks

Optimised replacement program

2

To reduce the duration of leaks

Targeted leak detection



Artificial intelligence makes preventive approaches *more accessible* to water utilities

1

To reduce the number of leaks

Targeted and operational network replacement program

Optimisation of every €uro invested in network replacement

Artificial intelligence makes preventive approaches *more accessible* to water utilities

2

To reduce the duration of leaks

Identification of network elements for targeted leak detection

NRW improvement, without additional costs

Benefits

Continuity of drinking water supply

Health safety *(COVID19 pandemia)*

Preservation of water resources

Energy savings within water utilities

Reduction of CO_2 emissions

Optimisation of public investment

Thank you for your attention

Kevin Nirsimloo
k.nirsimloo@altereo.fr
www.altereo.fr/hpo

Projects

1. Orléans Métropole *(ongoing)*
2. Tours Métropole *(ongoing)*
3. Limoges Métropole [completed]
4. Chartres Métropole Eau *(recurrent)*
5. Nouméa [completed]
6. Keetmanshoop, Namibia [completed]
7. Further R&D with the SEDIF (Greater Paris Area)

   Largest French utility with 10,000 km of networks
   Full prediction on mains, service connections and other buried equipment by mining huge data sets