HPC/AI in Water and Energy

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Vodéna
Nature modeled

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Nature modeled

Our HPC/AI story begins in 2010 when we got a task

to solve the ENIGMA

several kilometers upstream of historical place

The Bridge on Drina

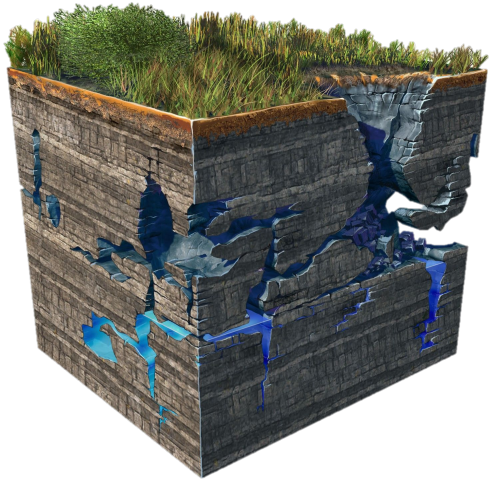
Since the construction, the dam of Višegrad hydropower plant has recorded a **water leakage** through the karst terrain, which by 2010 has risen to **25 Olympic swimming pools** per hour, loosing about $1 million yearly.

Reducing losses and preventing further **erosion and collapse** of the dam required **urgent remediation**.

The plan was to

fill the cracks under the dam

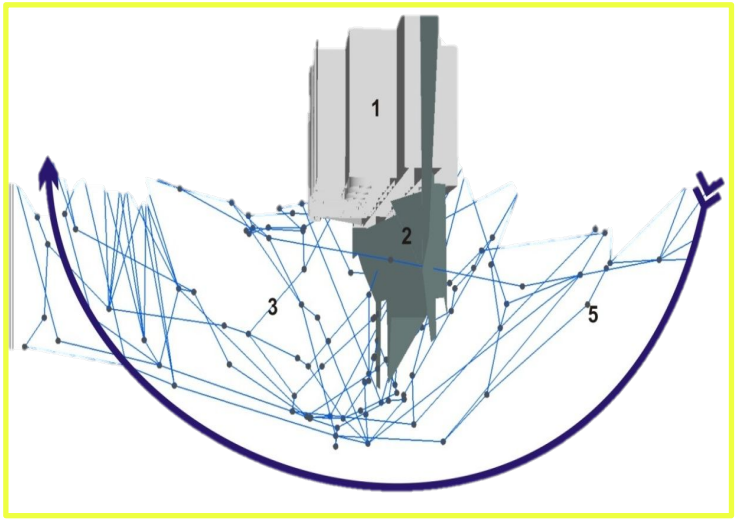
with stones and concrete.



But, **nobody** knew

where

the cracks were.



To reveal **the enigma**,

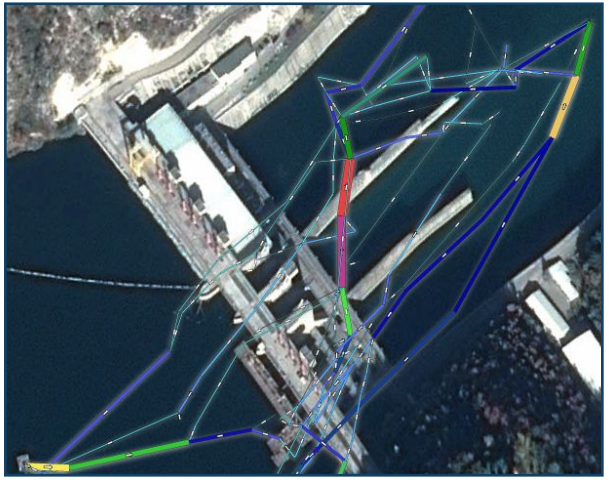
we have developed

a **computational model**

that simulates hydraulic and

solute transportation processes

under the dam.



If we obtained

such **dimensions** of the modeled cracks

that give results similar to the

measurements,

we could claim that the model represents

a **digital twin** of

underground network of fissures.

To solve the problem,
we have developed the software library

for EVOLUTIONARY BASED optimization.

However,

due to algorithm complexity
calculations would last for months,

which was NOT acceptable.

Decisions about remediation

had to be made
on daily basis!

In order to speed up the optimization process,

together with the experts from

the Faculty of Science,

we have developed

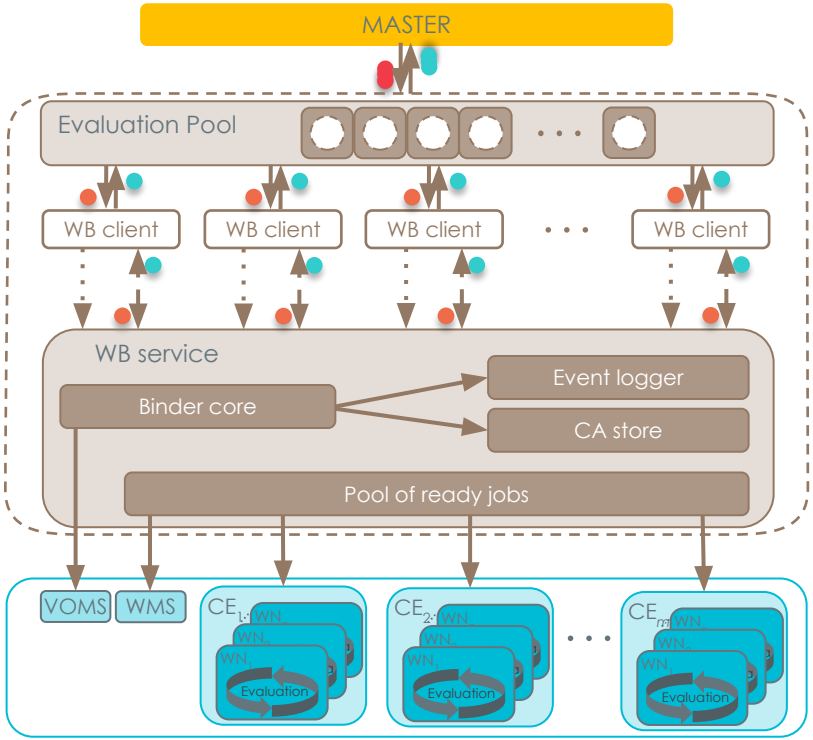
WoBinGO

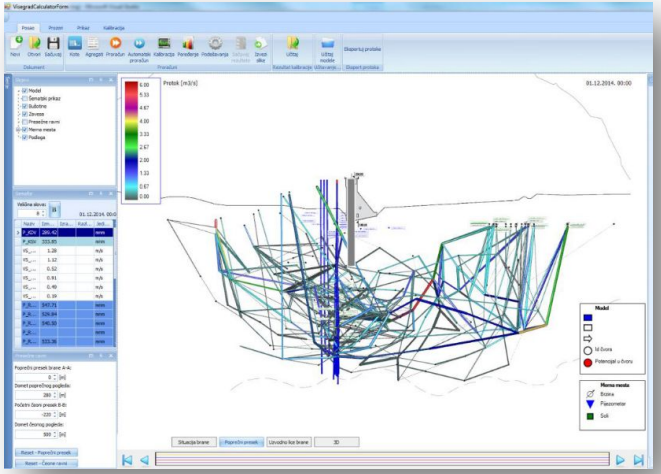
a software framework for

genetic algorithm based optimizations

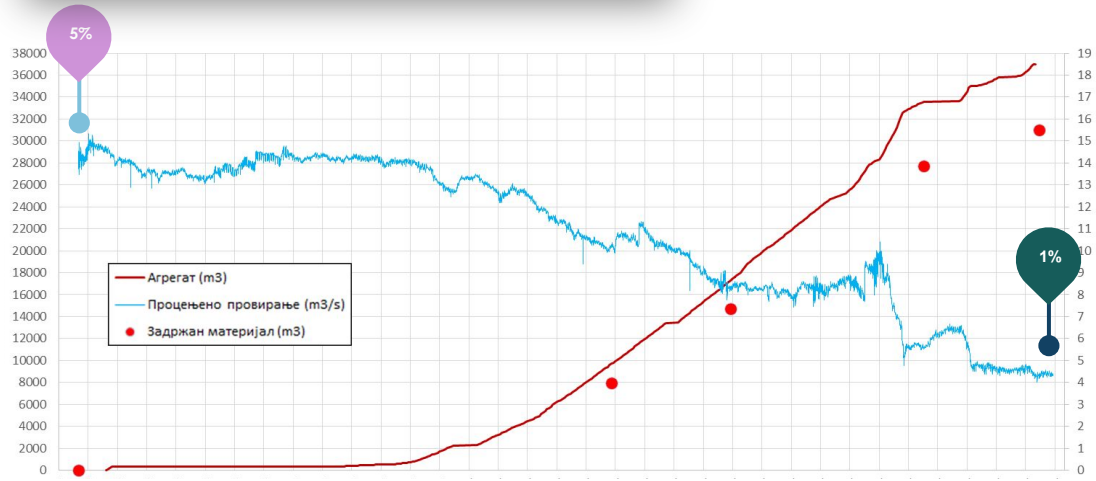
in

DISTRIBUTED computing environment.

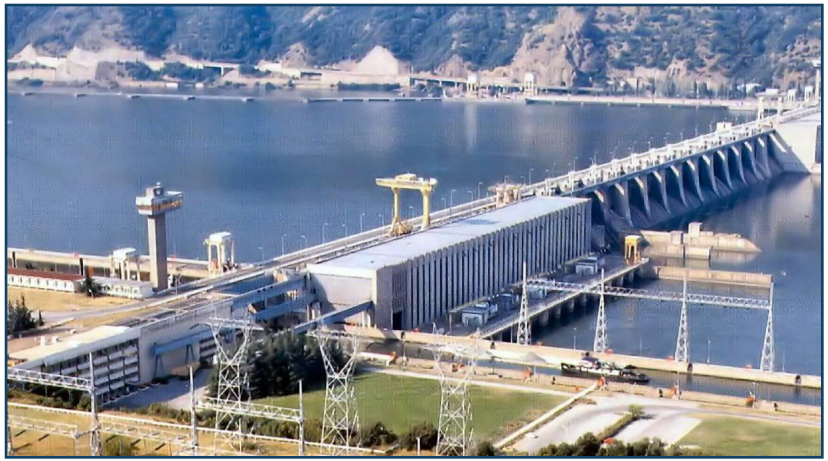




To solve the problem, we have developed an **evolutionary** algorithm for karst configuration estimation, and a **software tool** for making daily decisions about remediation actions.



After a year, financed by World Bank, the remediation was completed successfully. The leakage was reduced about **five times**.



Employing evolutionary algorithms,

we have developed

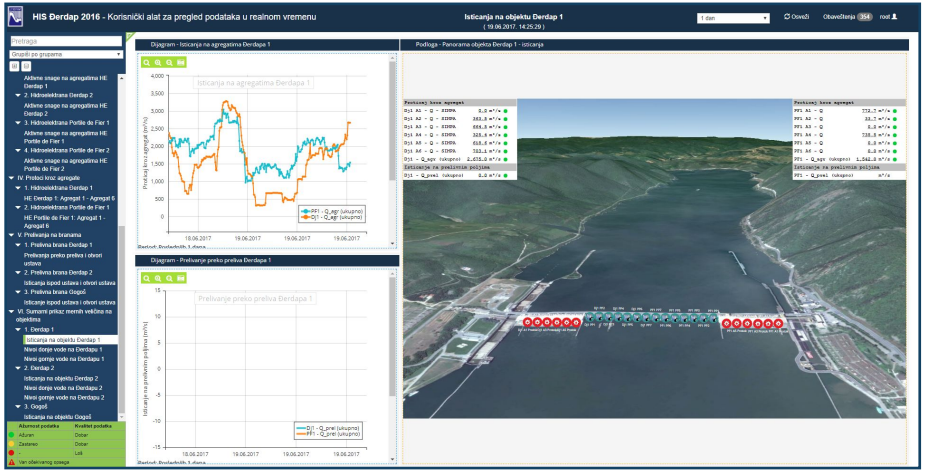
a **power production**

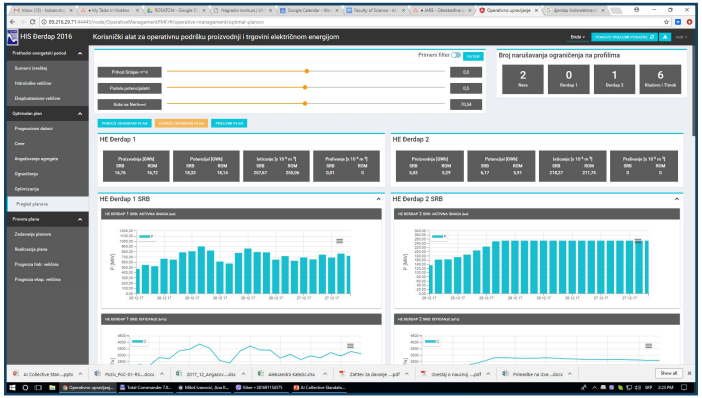
optimization tool for the

Iron Gate,

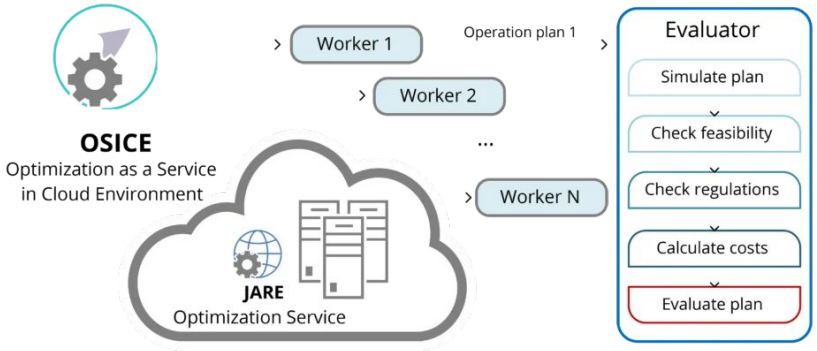
one of the **largest** hydropower plants in Europe,

located on the Danube river.





Based on the hydrological **forecast** and expected energy **prices**, power **production** is optimized within the given physical, ecological, and legal **constraints**.



OSICE is a cloud service intended

for solving complex **optimization problems**

in the **distributed** computing environment.

Solving real-world optimization problems is

a privilege of **large enterprise** and research institutions

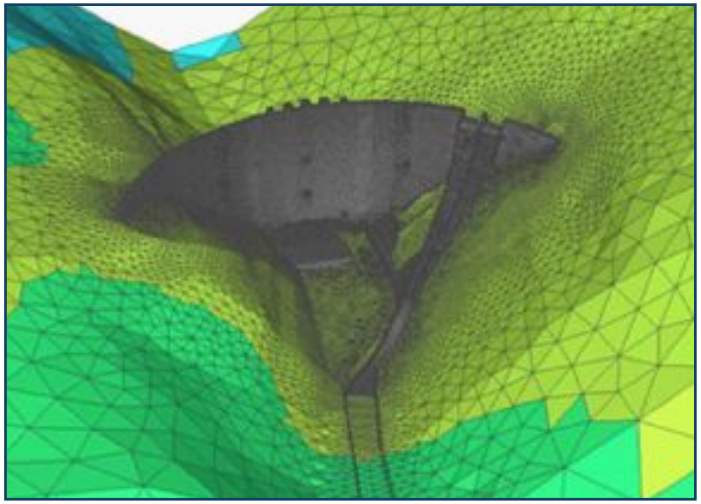
that can afford **specialized expert** teams

and necessary **computing infrastructure**.

OSICE **simplifies optimization** process

and make it available to **wide range of users**,

regardless of their financial, technological or knowledge level.



Our **dam health assessment** solutions

rely on detailed **physics-based**

numerical models,

providing dam operators with powerful tools

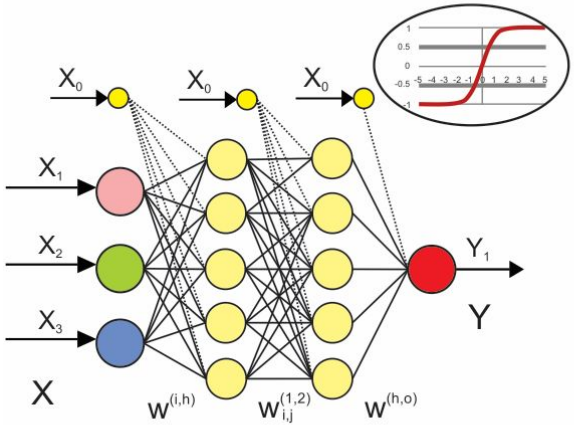
for thermal, seepage and structural **analyses**.

Since the **computationally demanding** numerical models

are inappropriate in daily operational tasks,

we have enriched our dam safety solutions

with **surrogate models**, based on **AI methods**.

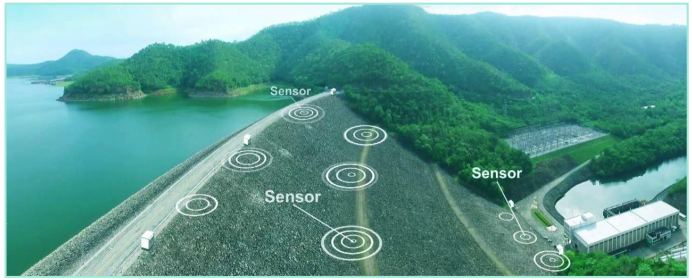


How we have faced the reality?

Dam health monitoring

Deep neural network for dam displacements prediction.

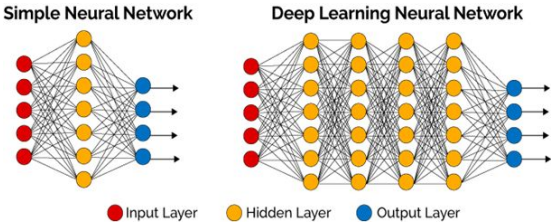
Alarming if measured displacements significantly differ from predicted (expected) ones.



Static models are mostly useless

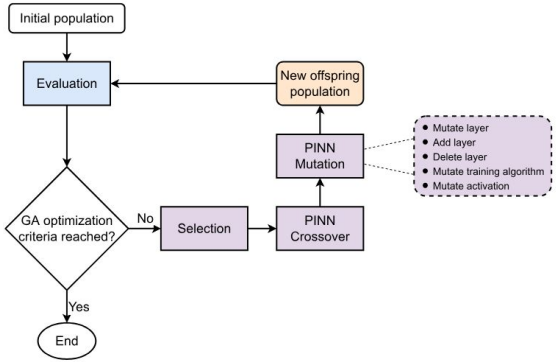
Data drift. Concept drift.

So what? Just retrain it.



Failures of the measuring equipment can lead to a situation in which a selected model becomes unusable because of the volatility of the input variables set.

How we solved it?

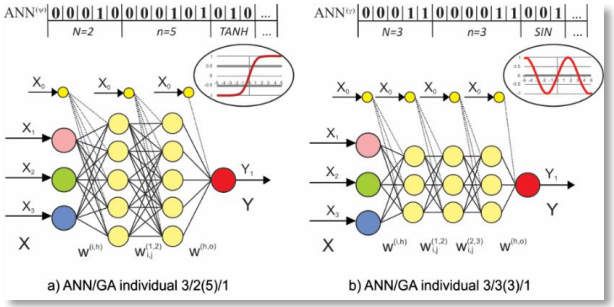


Creating ML model manually

Tedious. Repetitive. Time-consuming. Uncertain.

Automated creation of ML models

Evolutionary algorithms.
Distributed computing.
Optimized hyperparameters.



And BLACKFOX was born

Automates most of the tasks associated with constructing and implementing a machine learning pipeline that would normally be engineered by specialized teams.

Accelerate modeling process

Automated feature selection and scaling

Optimized model architecture and parameters

BLACKFOX

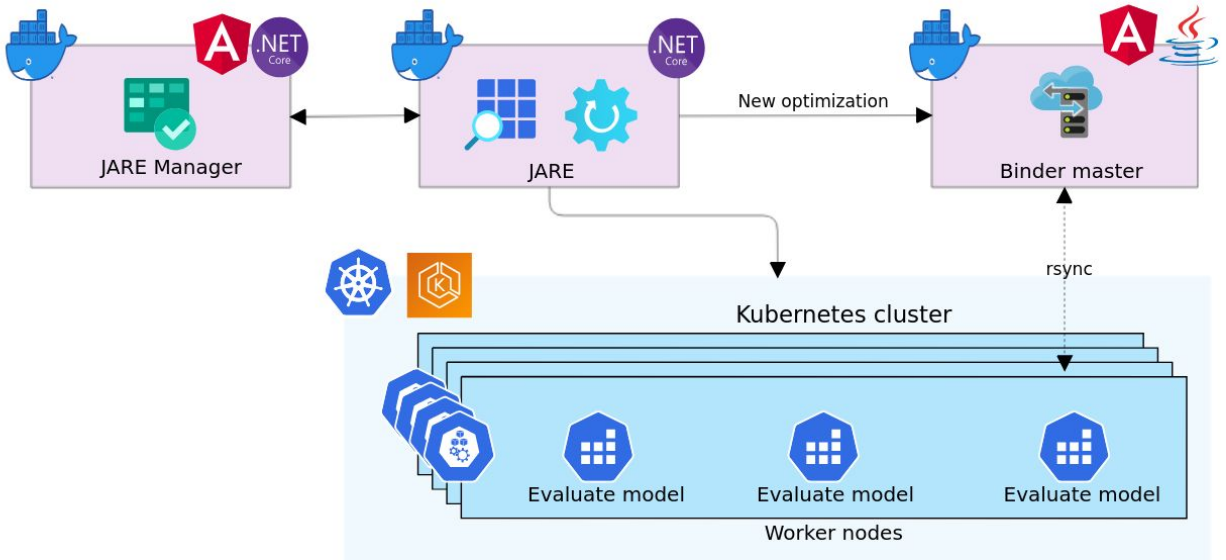
DEVONNA

DEVONNA is our robust artificial intelligence software solution for near real-time dam health monitoring based on artificial neural networks, capable of operating in circumstances of permanent structural changes and occasional failures of measuring equipment. It performs genetic algorithm optimization of all elements of the network with the aim of generating a model that best describes structural dam behavior under given conditions.

- Second place at **VERBUND Innovation Challenge 2017** organized by largest Austrian electricity provider
- **Horizon 2020 Seal of Excellence** certified by European Commission.

Blackfox internals

- Based on microservices
- Available on HPC and Kubernetes
- Utilizes all available resources



Sales Forecasting

MiGROS TiCARET A.Ş.

43,000 sales prediction models are simultaneously running, fully automated, monitored, retrained and adjusted

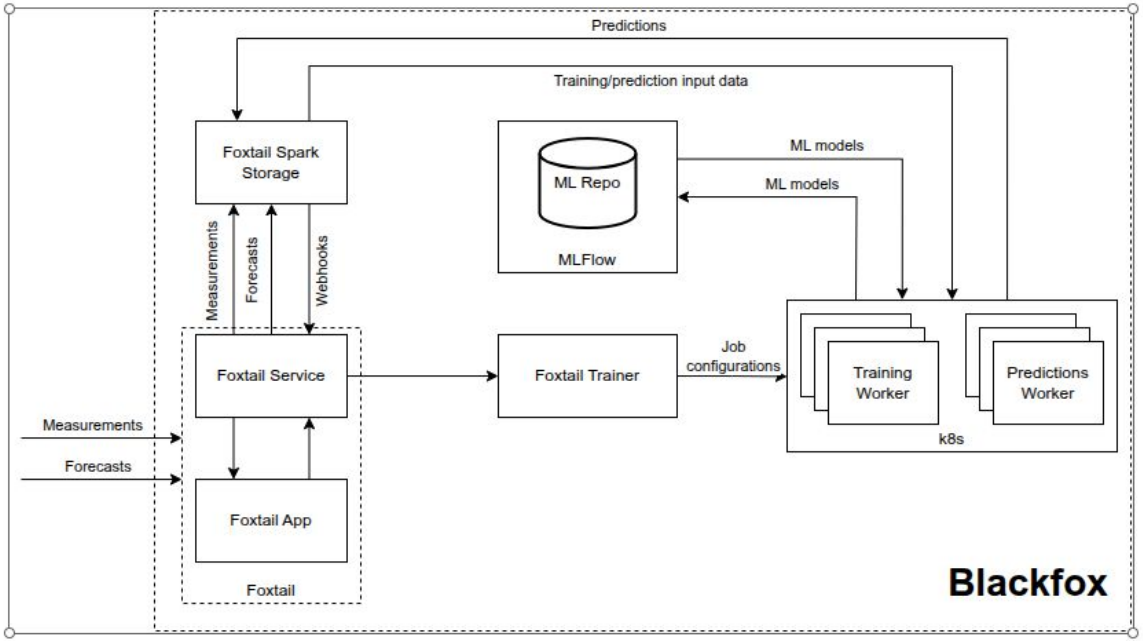
1000x

Increased demand forecasting granularity

MIGROS retail company

Maintain hundreds of ML models

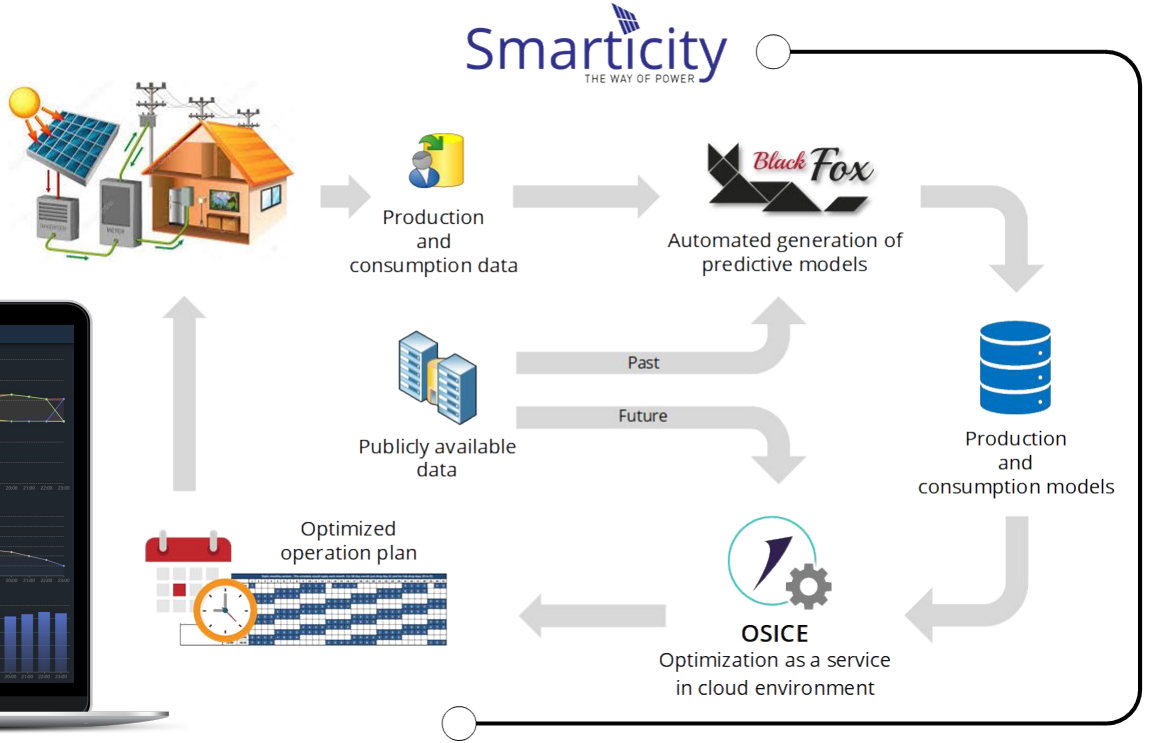
- ML Model repository based on MLFlow
- Asynchonous training triggered by events such as “new data available”
- Any data format available to Apache Spark



Smarticity automates finding an **optimal pattern**

in energy consumption and production

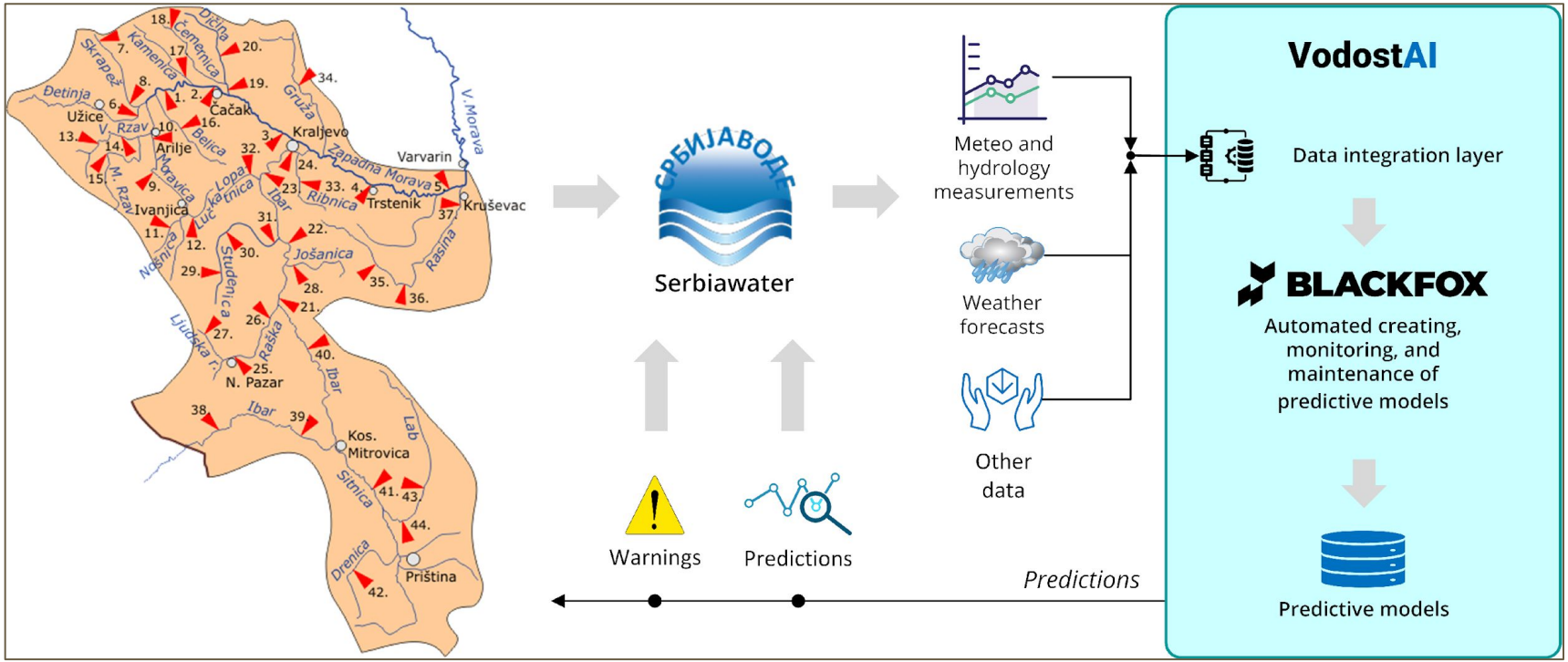
in case of facilities with renewable energy resources.



VodostAI is a software platform

for **flood prediction and prevention**

based on AI methods and IoT devices.



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Thanks for your attention!

https://vodena.rs

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