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Scientific Council 2026

Presentation of Fellows

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17 April 2026

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Data Analyst

Polina
LEMENKOVA



Insert your picture
(portrait)

AFFILIATION – Univeristy of Bologna
COUNTRY OF ORIGIN – Russia

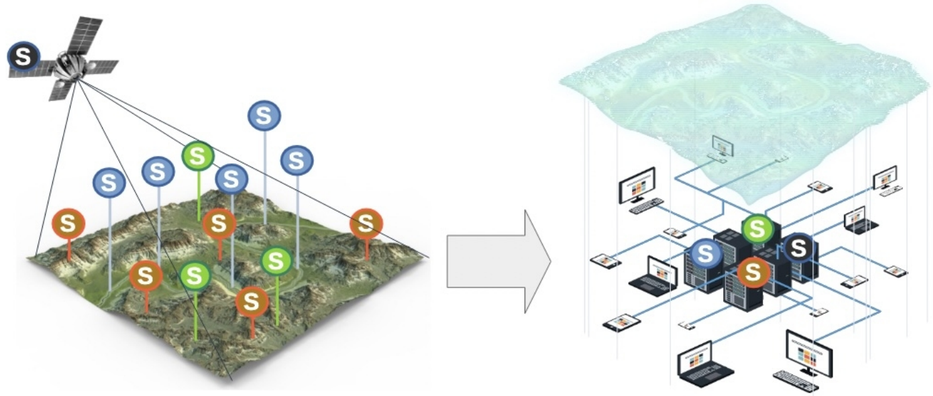
PERIOD : March 2026 - October 2026
HOST LABORATORY : JUNON (ARD CVL), La Technopole d'Orléans
HOST SCIENTIST : Frédéric Ros

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Main goal

Developing algorithms of automating workflows for extraction, interpretation, and analysis of geospatial datasets: Digital Twin of the Loire Valley (natural resources)



What is a Digital Twin?

A virtual model reflecting a physical entity, facilitating real-time monitoring and simulation.

Role of Environmental Management

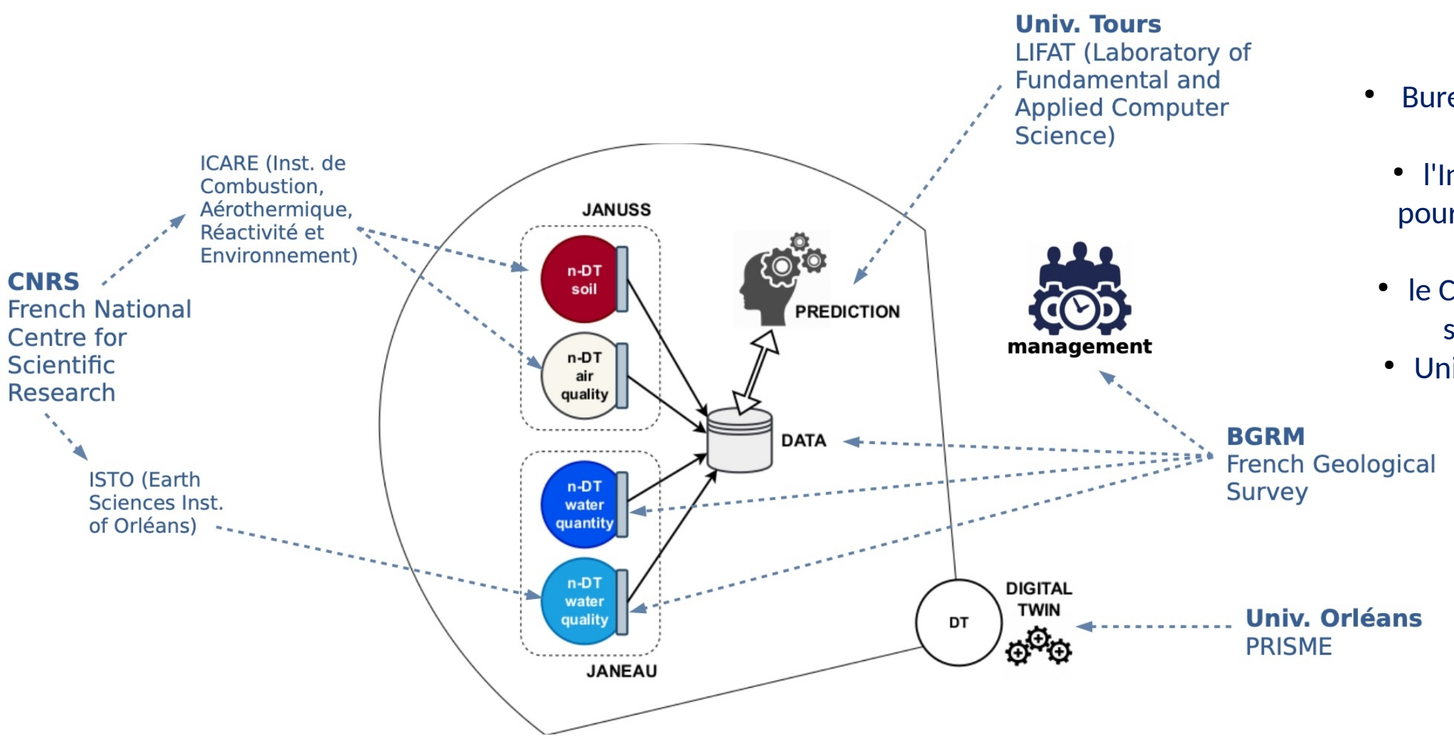
Enables efficient tracking and predictive analysis of resource usage.

ENVRI Reference Model

Promotes interoperability in environmental data through standardized frameworks.

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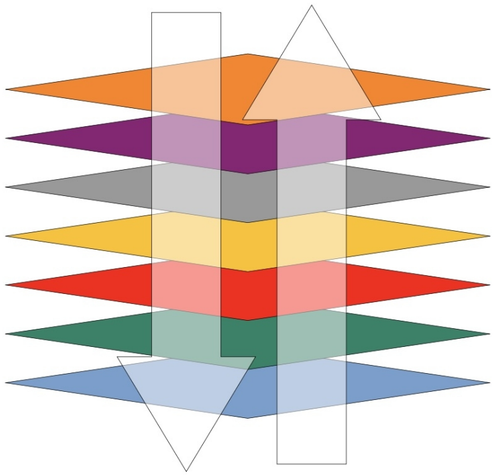
Joint research project:

- Bureau de Recherches Géologiques et Minières (BRGM),
- l'Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (INRAE),
- le Centre national de la recherche scientifique (CNRS), and the
- Universities of Orléans and Tours

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Challenges in the JUNON Project



- ...
- Logistic/resources
- Administration
- Management/Coordination
- Communication/vision
- **Scientific**
- **Technical/engineering**
- Infrastructure
- ...

Insert your images & texts

Theoretical Expertise of the Project:

- **Computer Science:** Machine learning, Artificial Intelligence (AI),
- **Data Science:** Data Analysis, Data Engineering, Data Management
- **IT DevOps: S**oftware development and IT operations of code
- **Methodologies** & Algorithms: Statistical Learning, Streaming Data

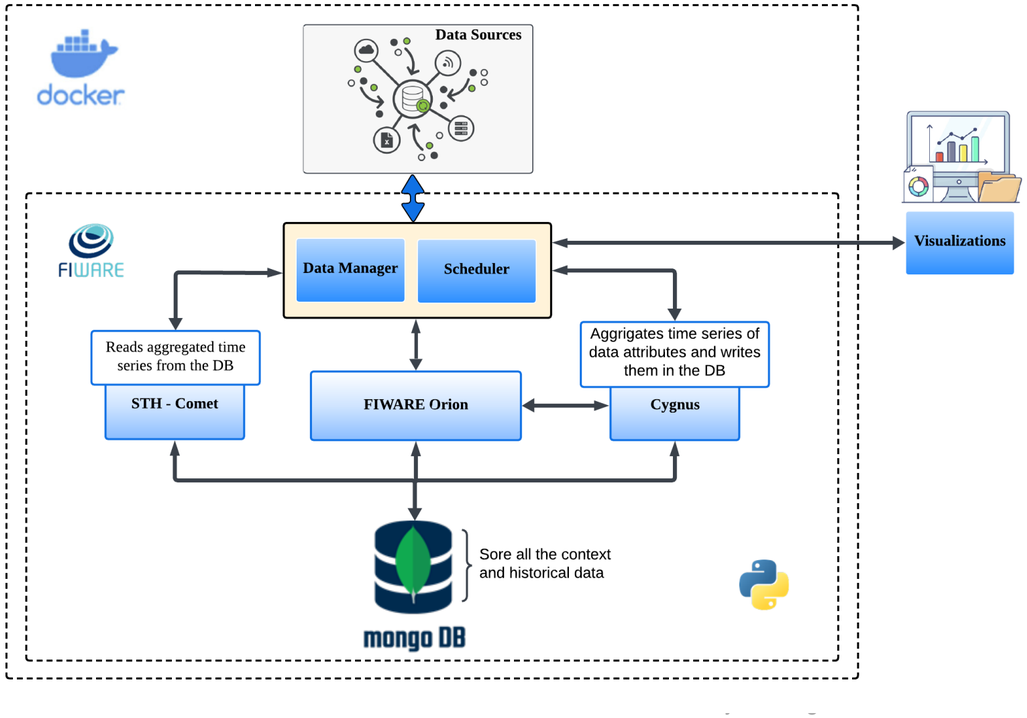
Scientific Applications:

- Communications and Safety,
- Network Security
- Building Automation, IoT
- Smart Grids, Renewable Energy
- Medical Applications

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Digital Twins: Project Architecture



Python: main instrument for Digital Twins

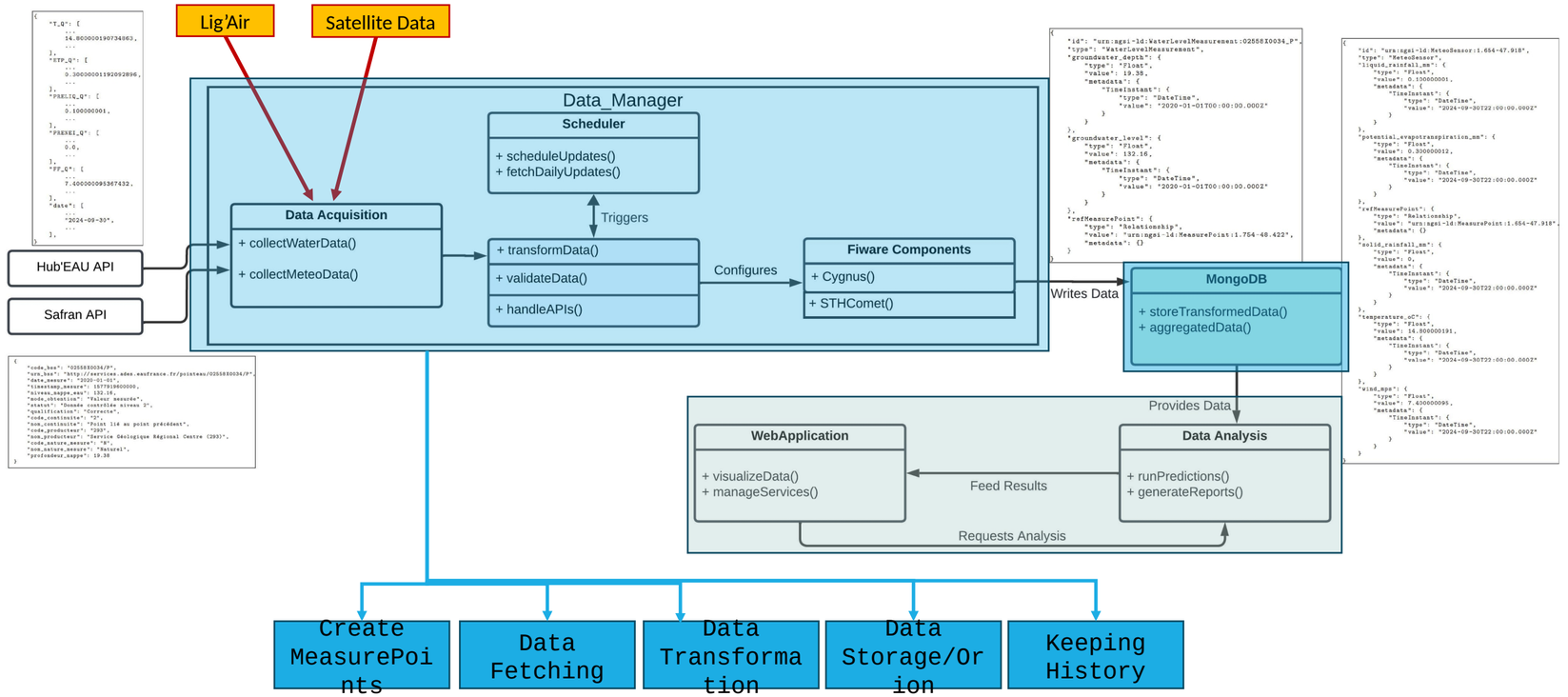
- **Python** programming language – tool for Digital Twins
- Python acts as the "glue" that connects 3D models to live data.
- In a project with many sources and many users, Python handles the complexity by leveraging specific libraries for each layer of the architecture.

How Python supports Digital Twins ?

- **Big Data Streaming**: Python allows the twin to subscribe to massive data streams,
- **Python** ensures the "Digital" stays in sync with the "Physical."
- **Python supports API** Management: Requests or FastAPI are used to pull data
- Environmental data are piped from external web sources (weather, soil, pH and CO_2 data).

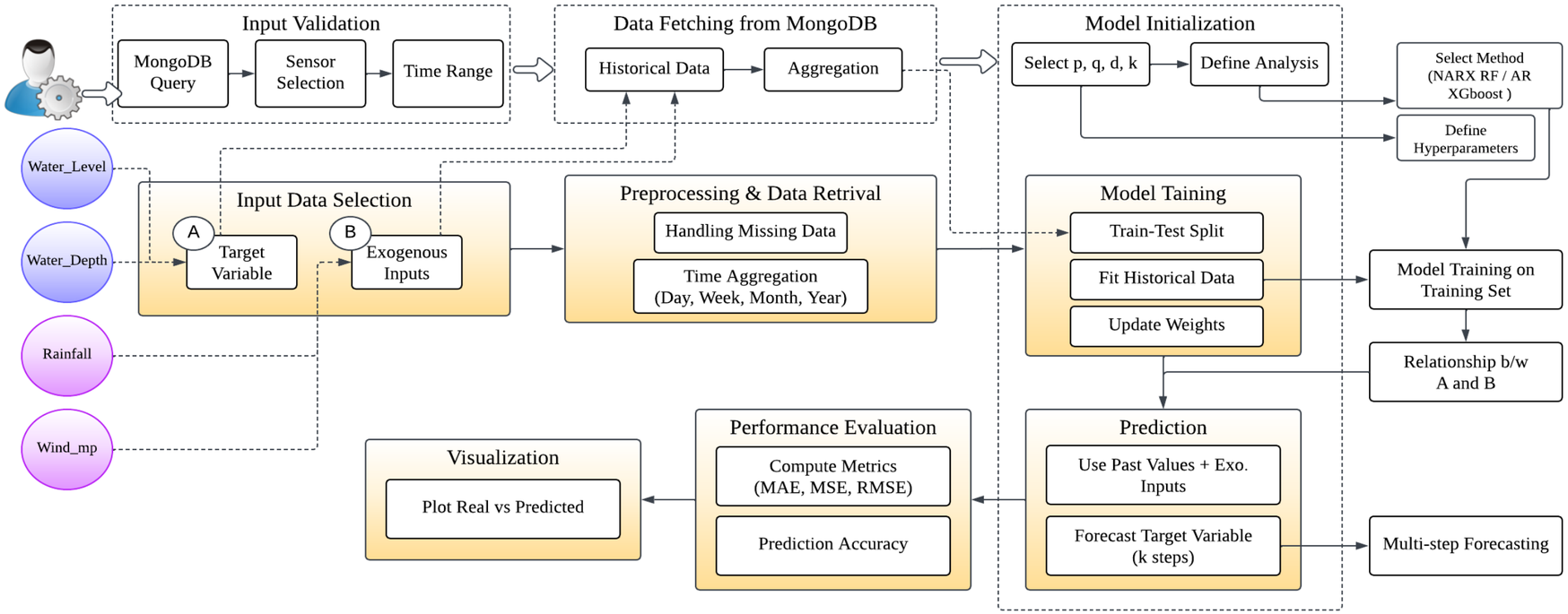
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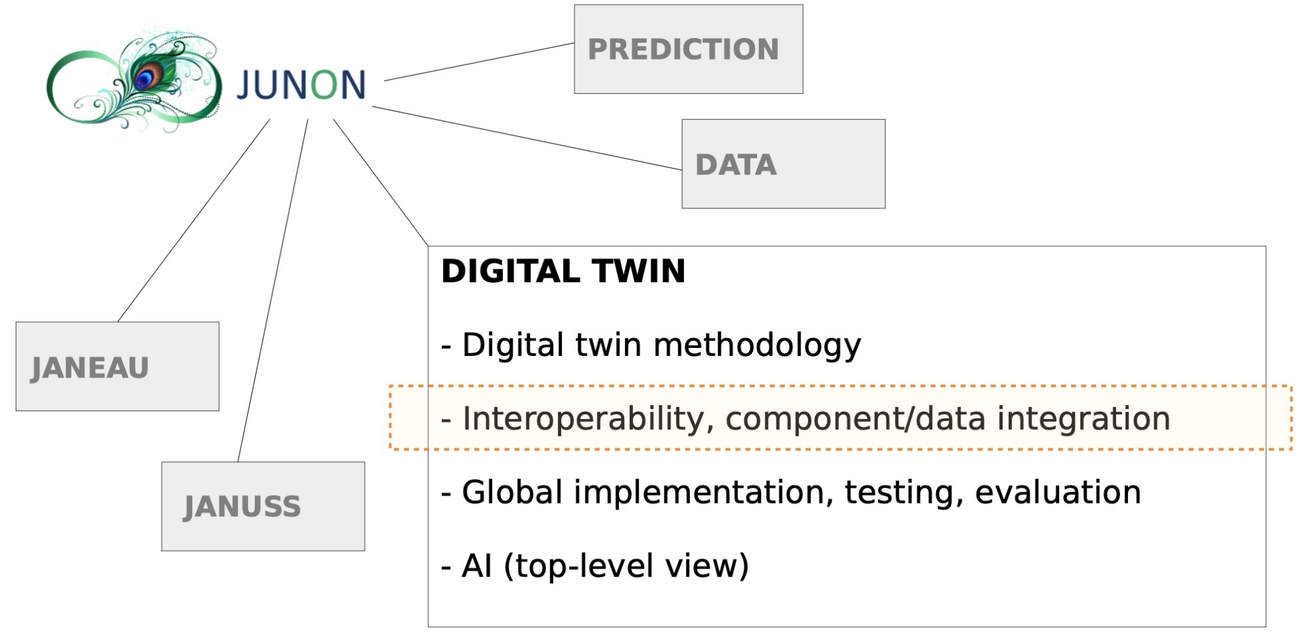
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DIGITAL TWIN team

- **Data Integration** in Science
- **Data Sources** (Data Ingestion & Connectivity)
- **Data Pipelines** – ETL/ELT (Extract, Transform, and Load) scheme

Project Circularity: All about data

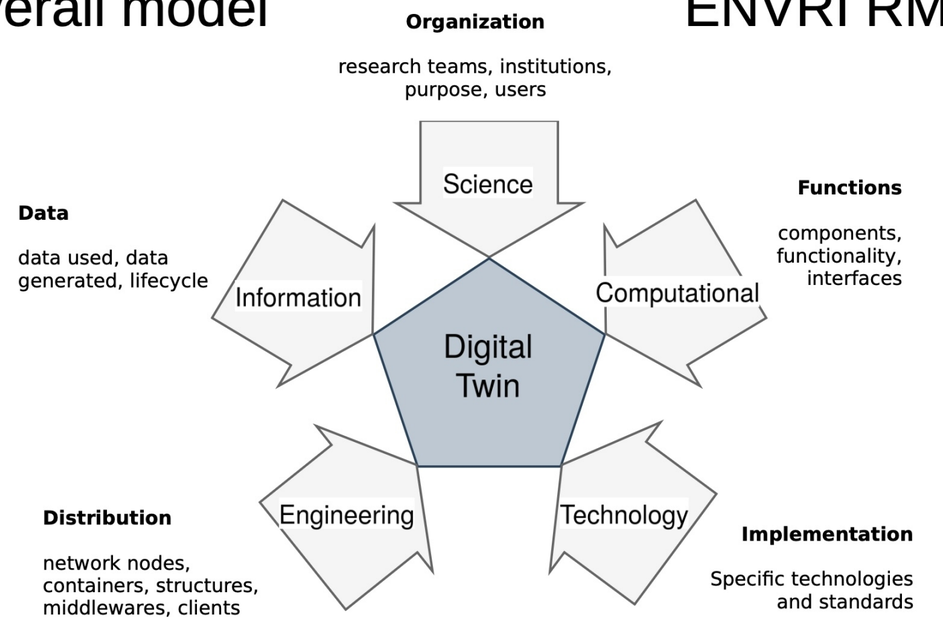
- **Data Integration** in Applied Science
Data engineering for large-scale project
- **Data application** defines project architecture
- **Project architecture** helps data visualization
- **Data visualization** leads to information extraction and data-driven decision making

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Overall model

ENVRI RM



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DIGITAL TWIN focus: all about data

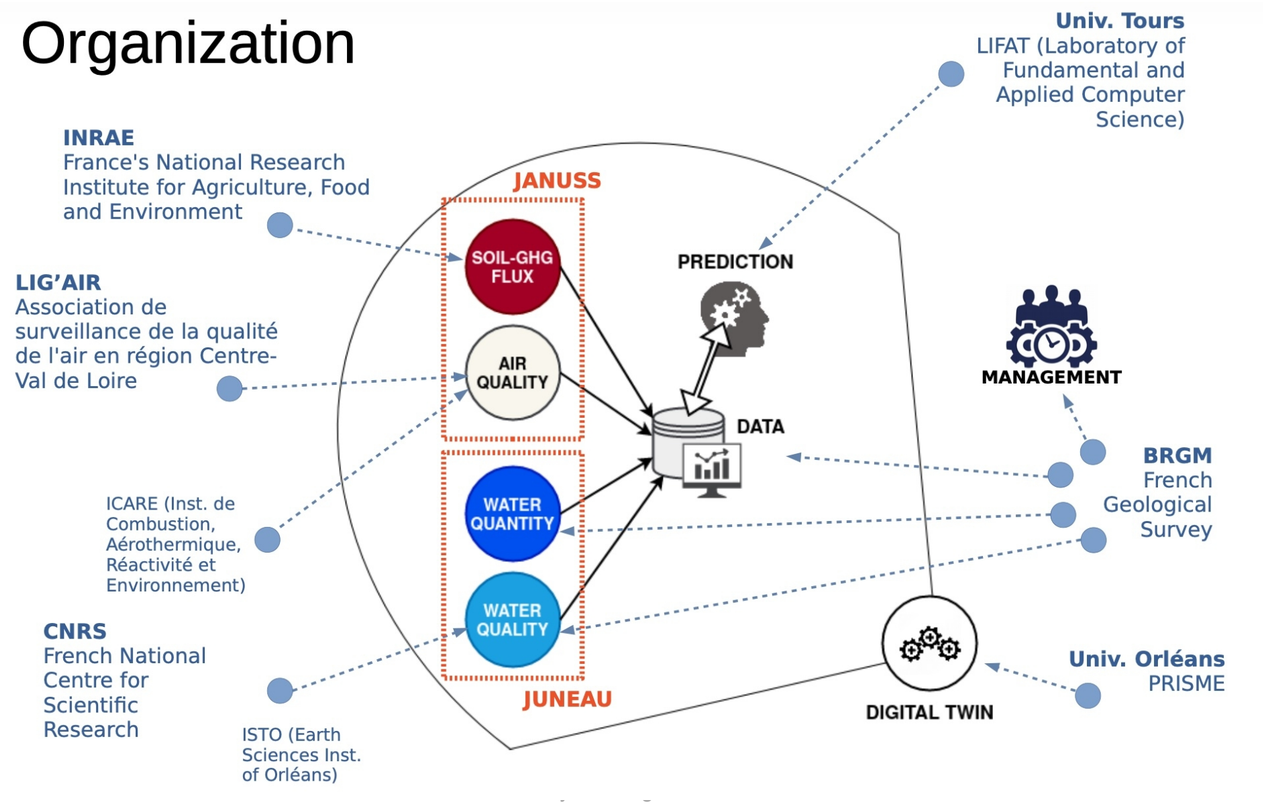
Digital Twin - a virtual model of a system,
Digital Twins – dynamic representation of a real-world physical environment,
Digital Twin - updated with real-time data,
Digital Twins – linked and synchronized with the real world via IoT (Internet of Things)

Data: Core of Digital Twins

Data – the "nervous system" of a Digital Twin
Data connects the model to the physical world.
Environmental Data – External feeds (weather patterns, CO_2 water quality, or satellite imagery.

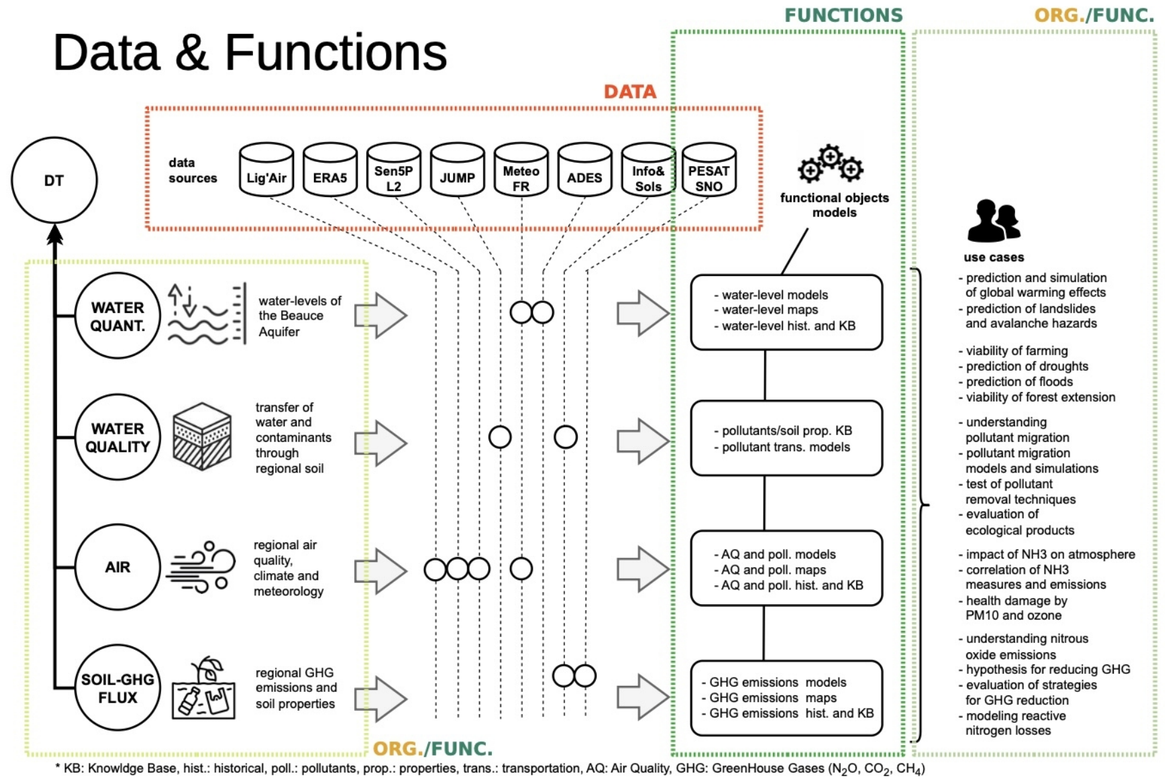
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Digital Twin project:

- Modular, layered architecture
- Large scale size project with data stream,
- Upscaled from ‘file-level’ to ‘model-level

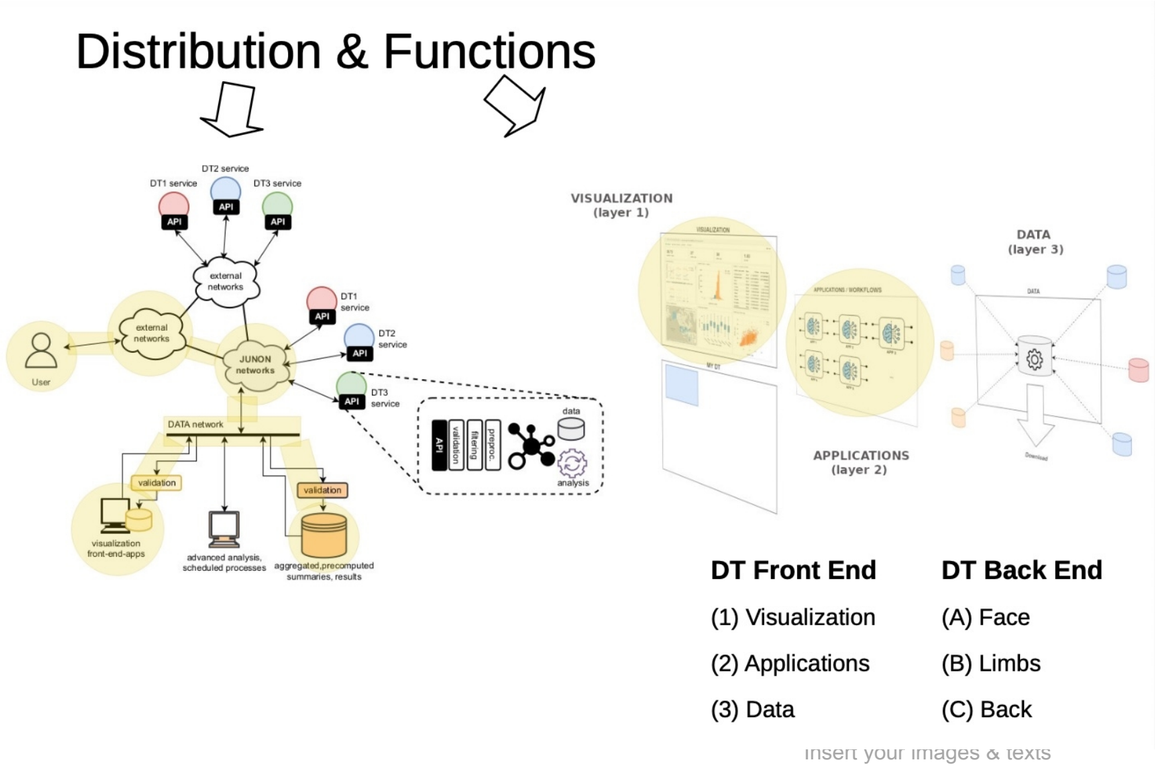
Data Organization in Digital Twins:
The Asset Hierarchy

Data is organized using relationships.

- The Entity (The "Twin"): The top level
- Sub-Assets: Components of the entity (e.g., soil, water, climate data).
- Properties: The static data (e.g., temperature, water pH).
- The live data streams (e.g., temperature, water usage, pollutant levels in water, GHG emissions).

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Digital Twin project: Functional organization as a layered data stack

- To manage many sources and many users, the functions are organized into "layers" so that a change in one doesn't break the others.
- Functions that use Python languages and its libraries
- REST APIs for web data
- Data digital thread: functions of Digital Twins link data across the entire lifecycle (from design to archive)
- Physics-Based Models in Digital Twins: functions use embedded math to simulate climate data: heat, or fluid dynamics.

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Proof of Concept: Water Quantity



data sources

- ADES - Hub'Eau
  Piezometric water levels (hourly)
- ERA5
  Meterorological (hourly): precipitation, evapotranspiration
- METEOFRANCE (hourly): rainfall, temperature, pressure, humidity, solar radiation, etc.
- SAFRAN
  Meteorological models (daily): effective rainfall, potential evapotranspiration



models, functional objects, analysis pipelines

water level models and maps (temporal and geolocation) based on multivariate data with interpolation and extrapolation capabilities and consistent with “what if” scenarios

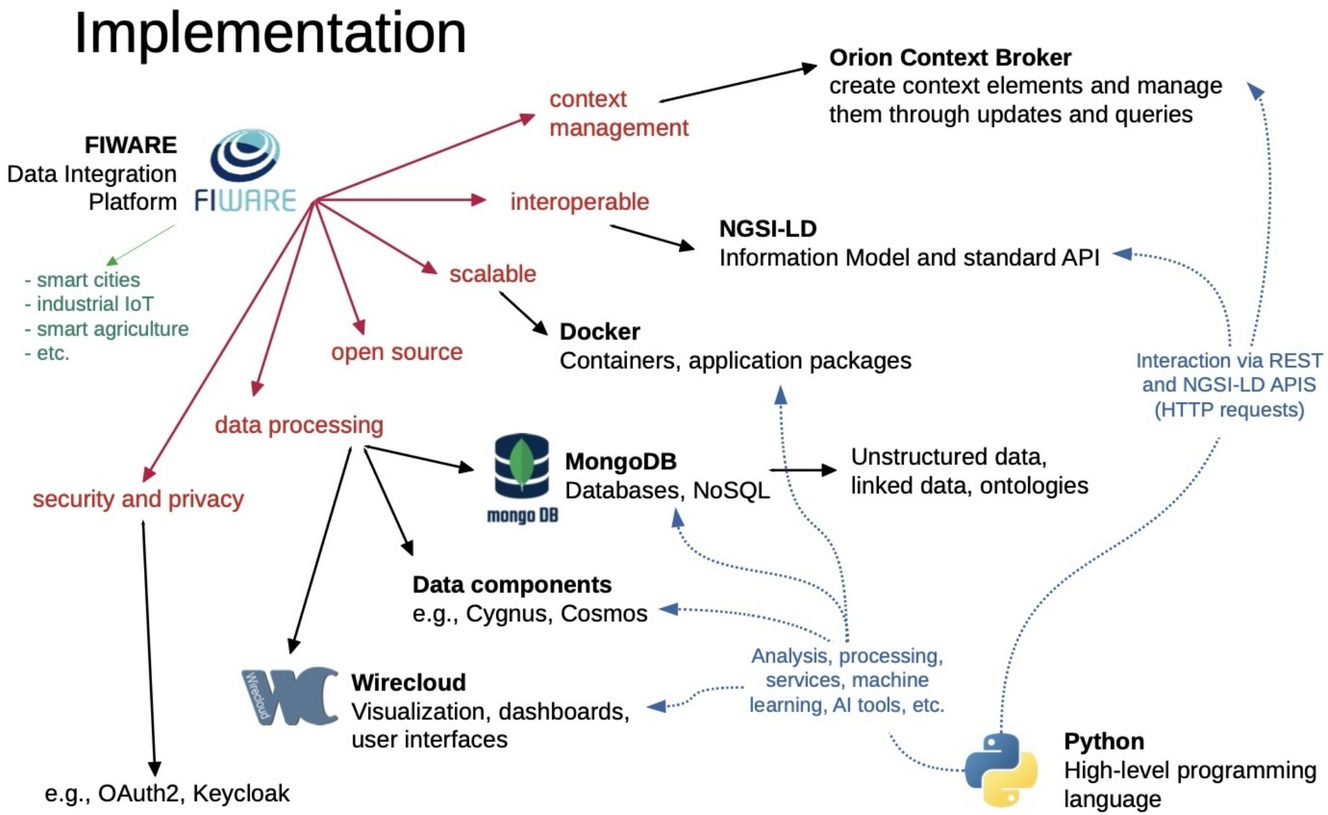


goals, use cases, scenarios

- SC.1 – Monitoring current and historical water levels
- SC.2 – Visualization by interactive/informative 2D and 3D maps
- SC.3 – Prediction of water levels and availability for irrigation
- SC.4 – Identification and prediction of critical levels and vulnerable areas or in danger (droughts)

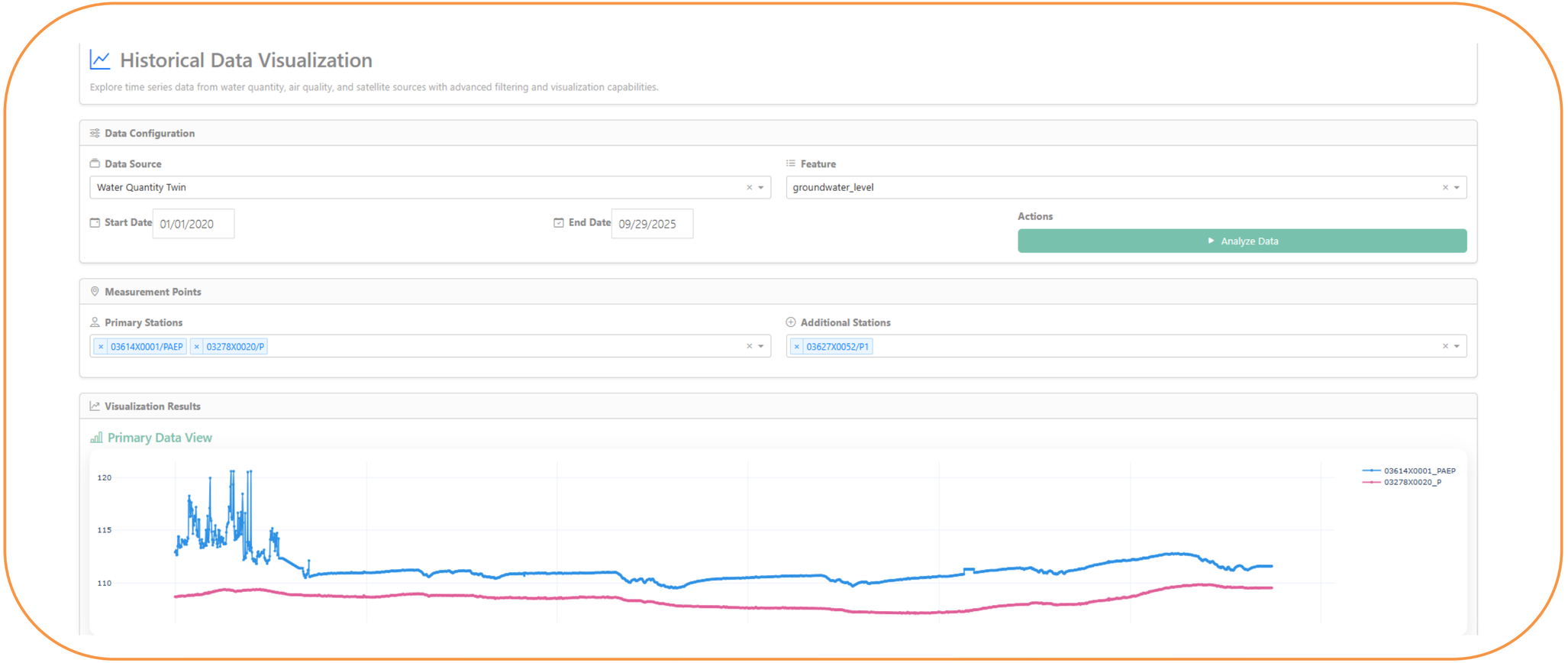
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