VANTAGE WORKSHOP

# V6 basics

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netherlands eScience center KNL

# What is vantage6

VANTAGE WORKSHOP

Vantage6 is an open-source software framework for privacy enhancing analysis and decentralized data analysis

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# Why using vantage6

VANTAGE WORKSHOP

Open source with Apache-2.0 licence

Container orchestration for PETs

Extensible to different data source types


Algorithms in any language

Other applications can connect using the API

Graphical User Interface

Managing collaboration policies

Minimal network requirements

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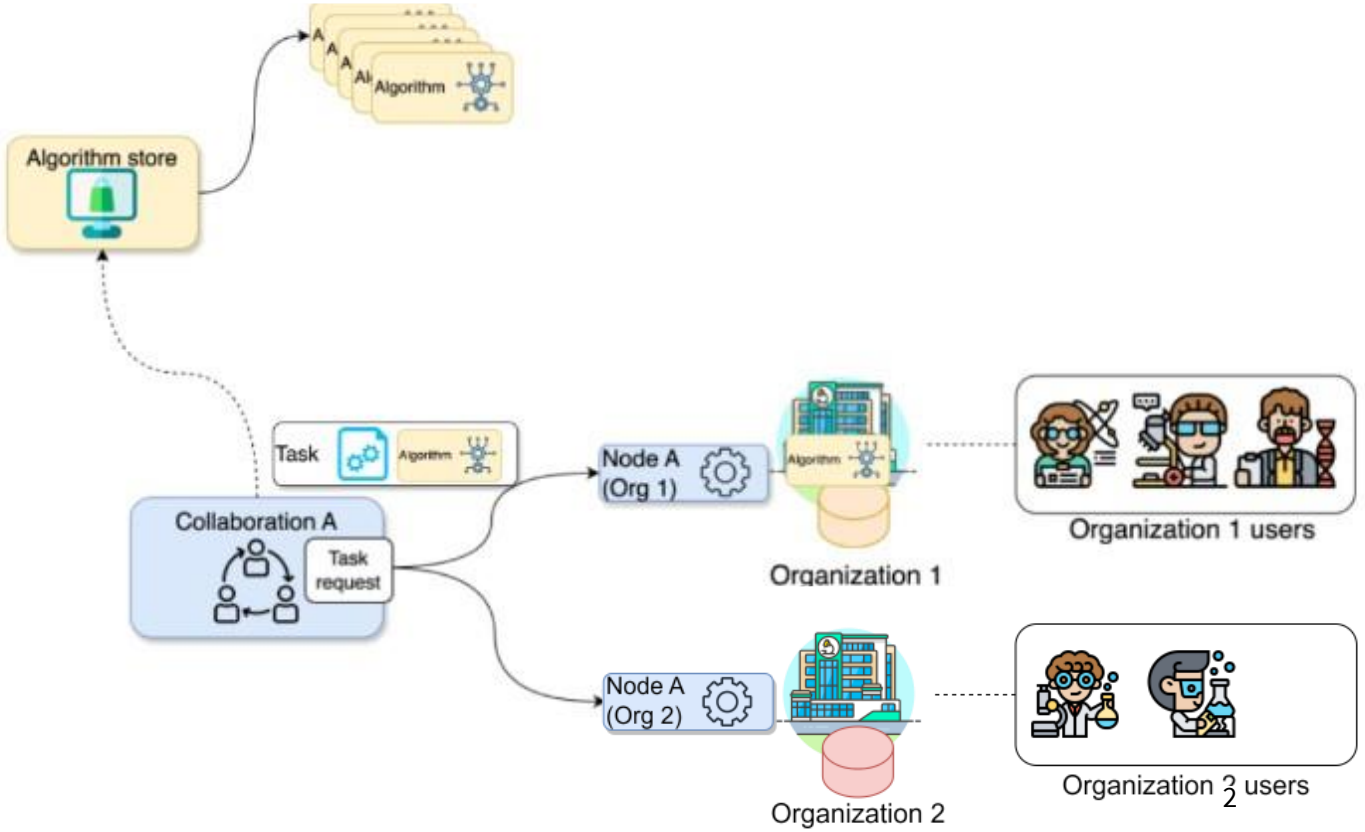
# Federated analysis projects with vantage6

VANTAGE WORKSHOP

**vantage6** encompasses a project administration system that allows the user to manage permissions and access to the resources, while assuring the protection of the data.



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# Federated analysis projects with vantage6

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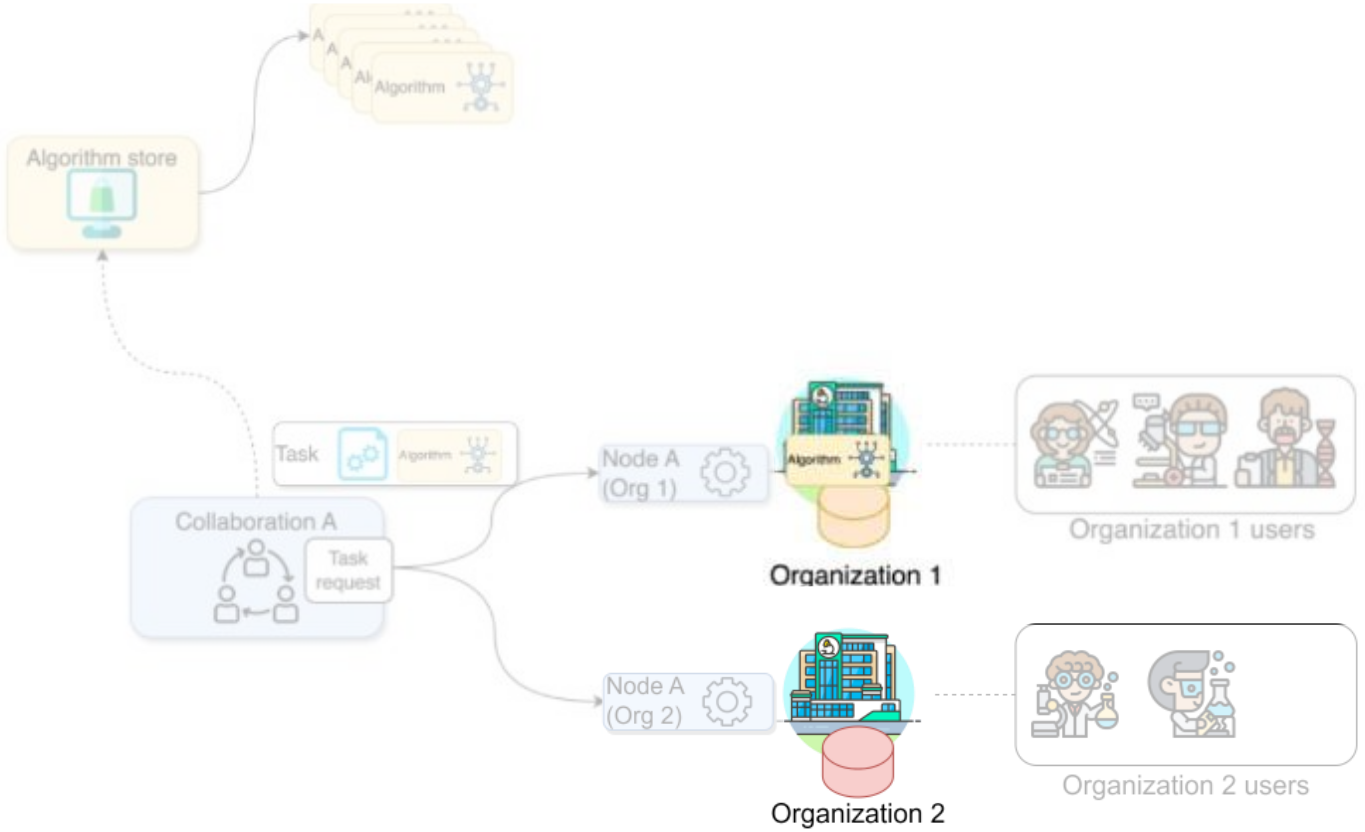
## Organization

*A group of users that share a common goal or interest (e.g., a consortium, an institute, etc.).*

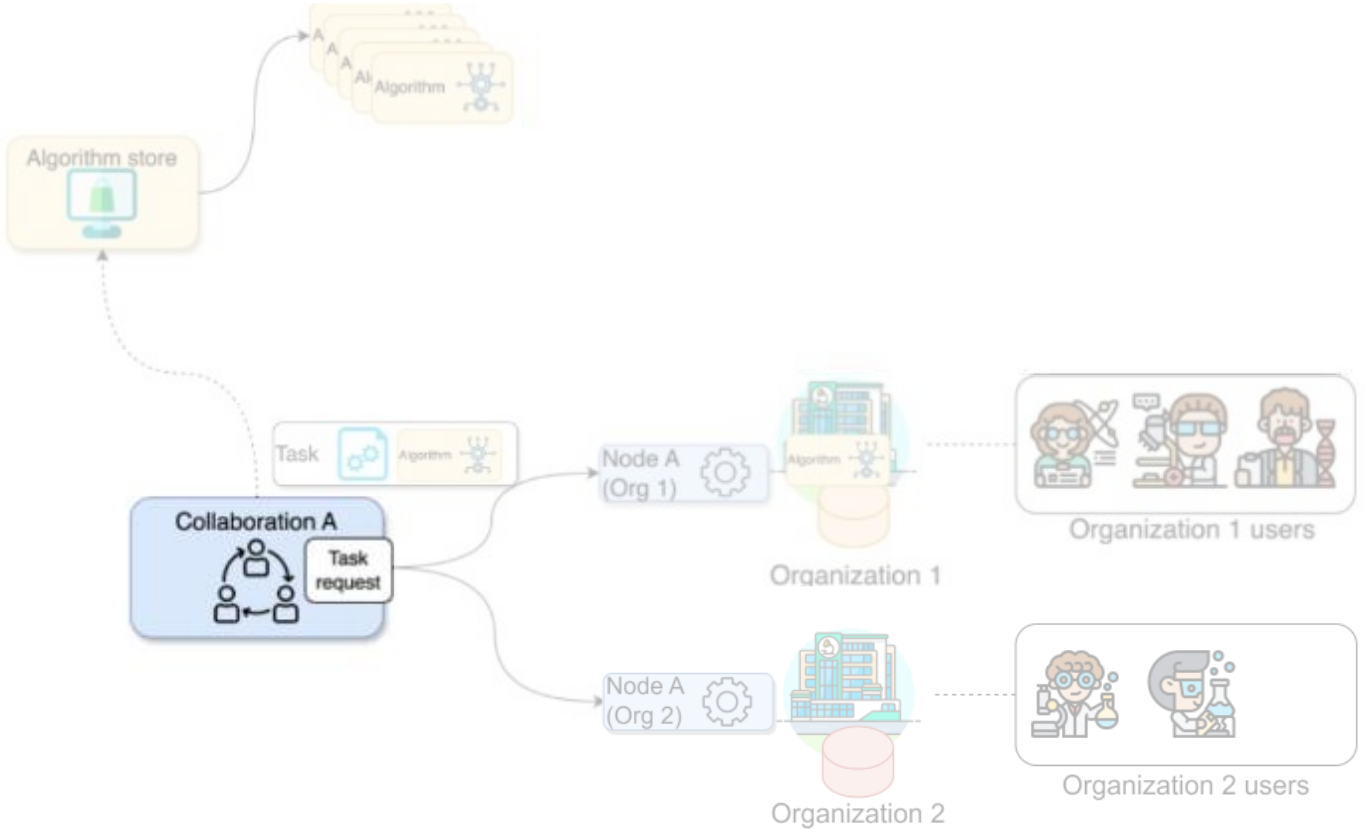


# Federated analysis projects with vantage6

VANTAGE WORKSHOP

## Collaboration

*One or more organizations working together towards a shared objective.*

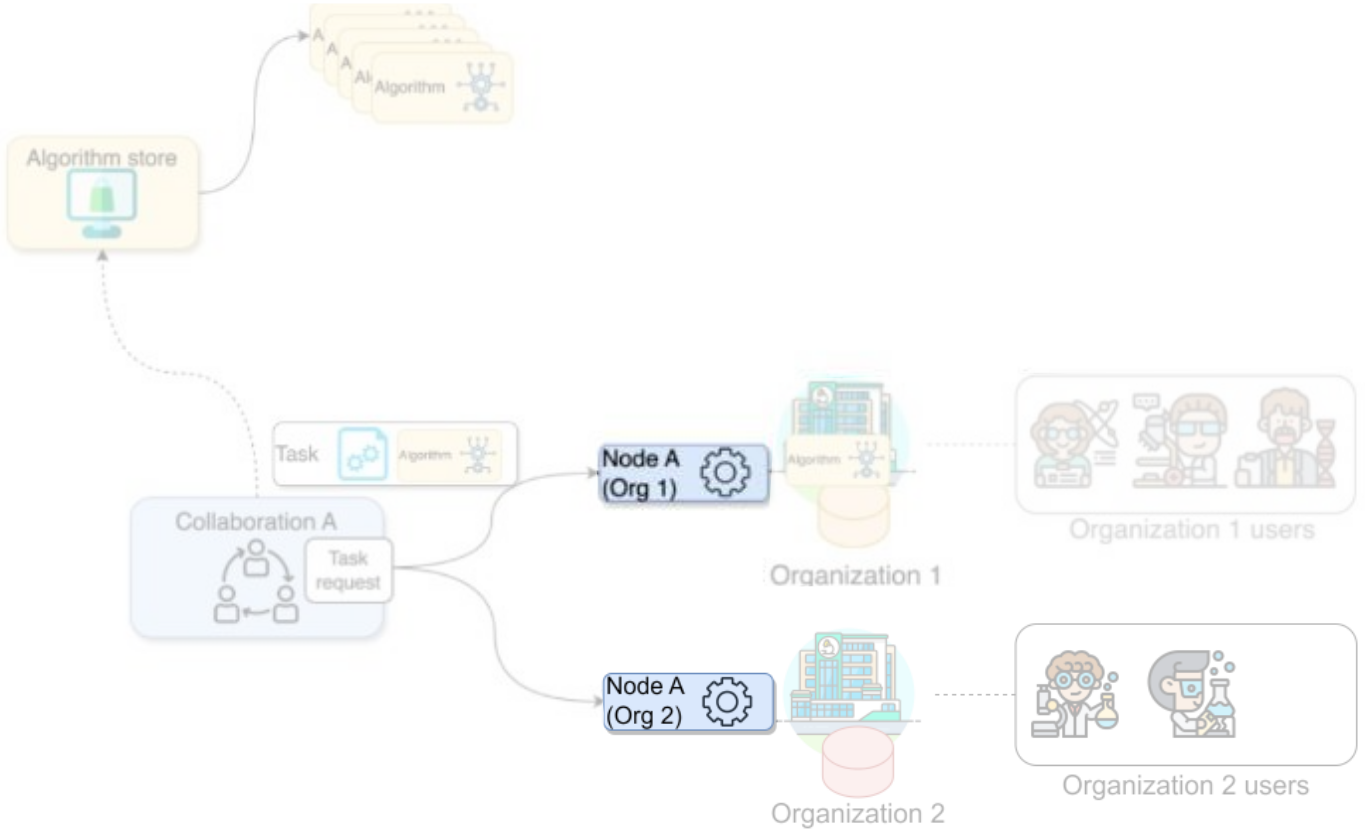


# Federated analysis projects with vantage6

VANTAGE WORKSHOP

## Node

*Component that accesses the organization data and executes algorithms on it.*

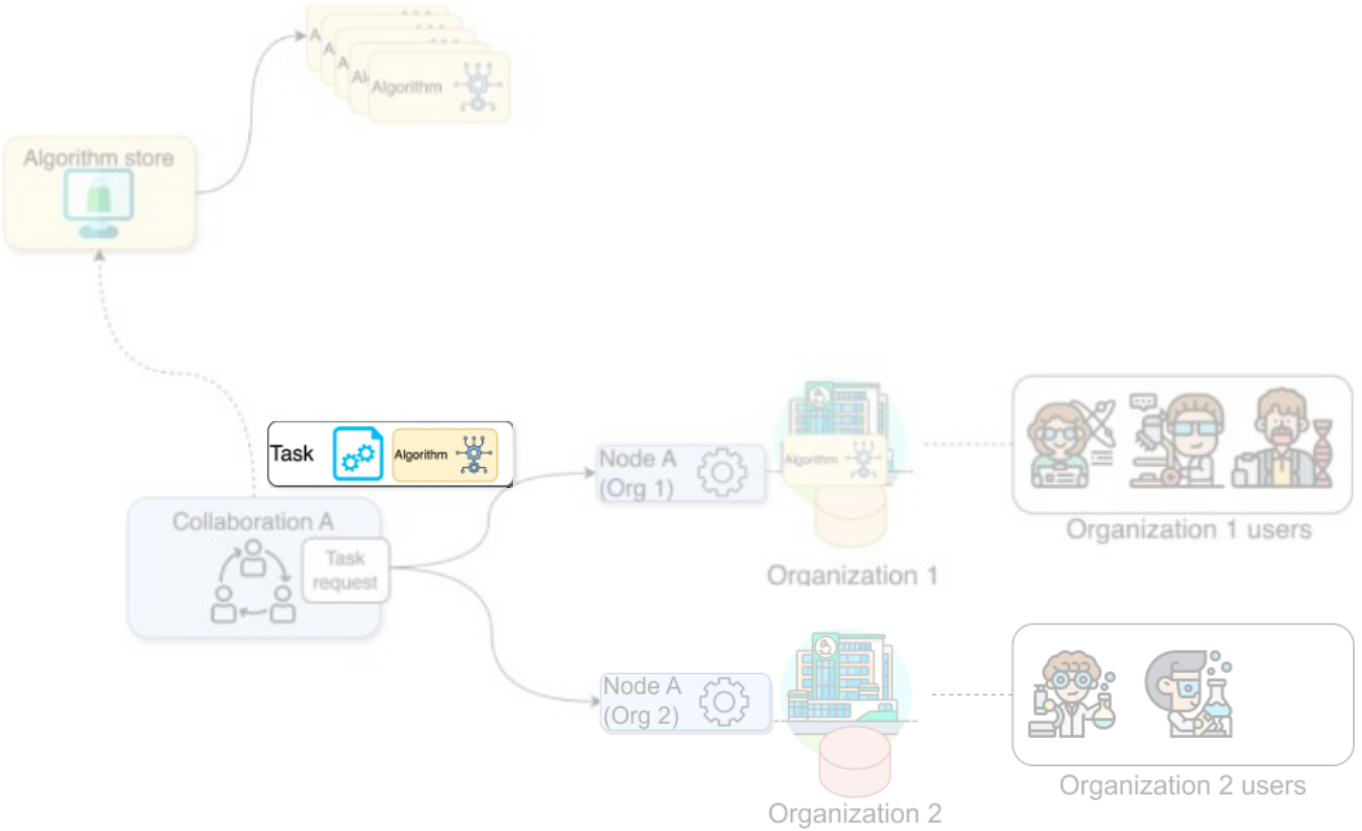


# Federated analysis projects with vantage6

VANTAGE WORKSHOP

## Task

*A request for the execution of an algorithm. It is handled by the corresponding organizations' nodes.*

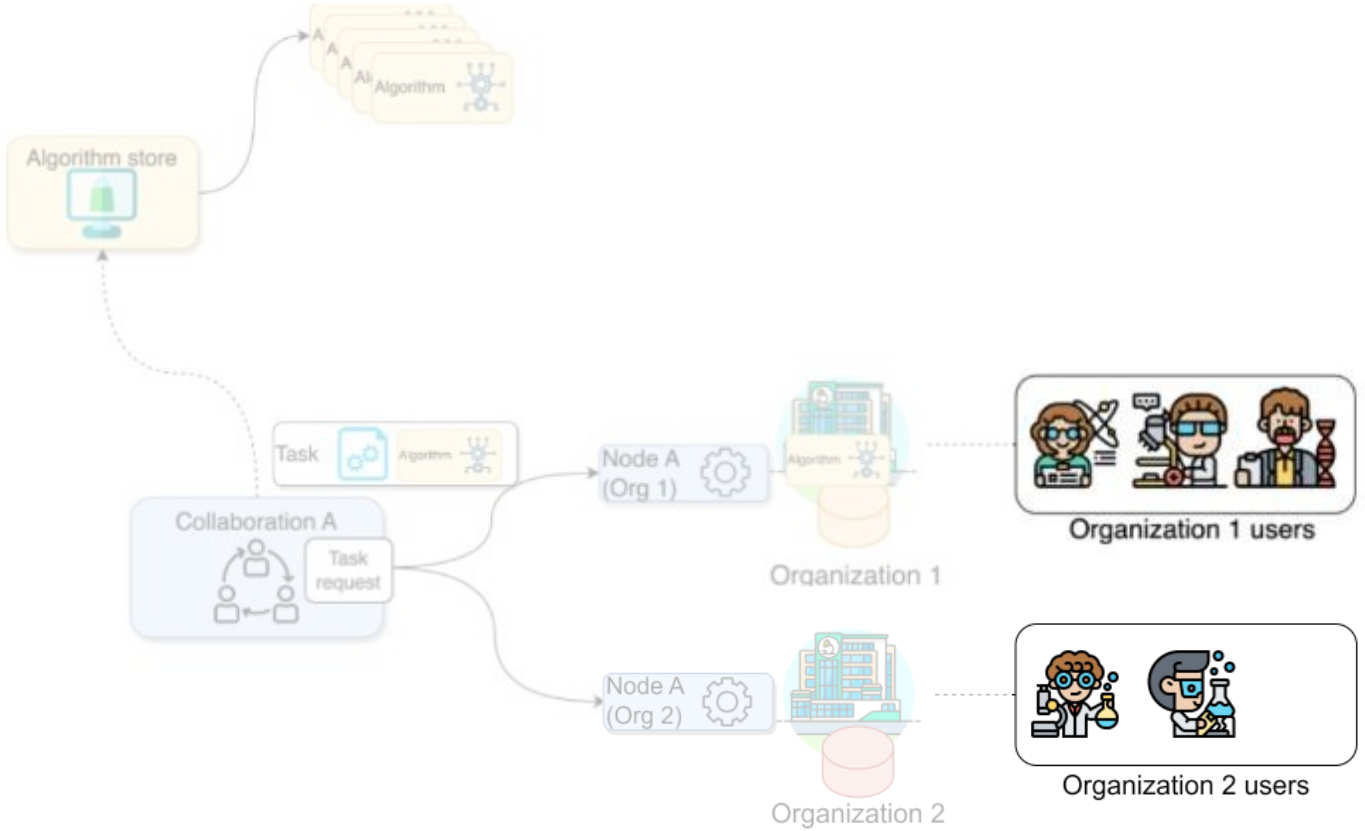


# Federated analysis projects with vantage6

VANTAGE WORKSHOP

## User

*A person that belongs to one organization who can create tasks for one or more organizations within a collaboration.*

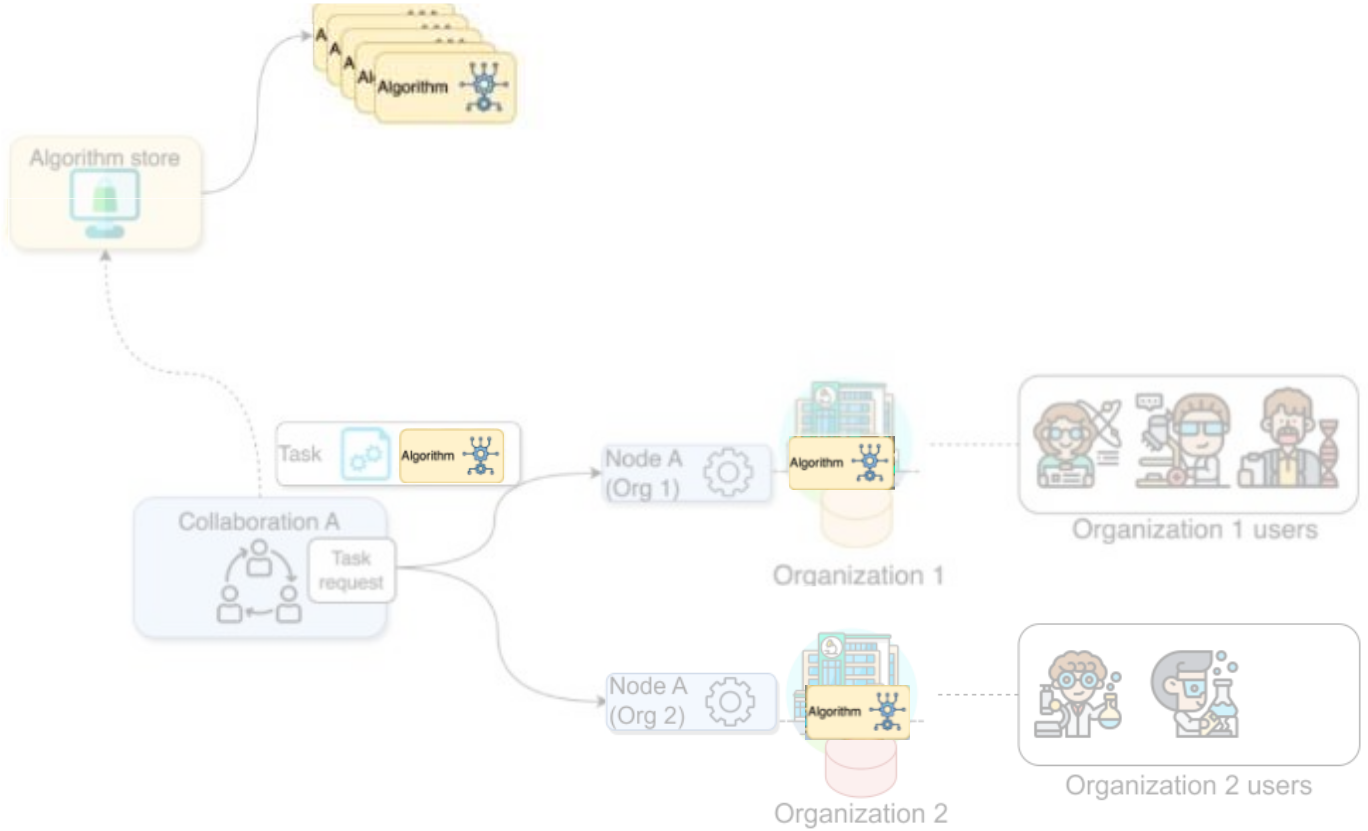


# Federated analysis projects with vantage6

VANTAGE WORKSHOP

## Algorithm

*A computational model or process which can be securely distributed to nodes for execution.*

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# Federated analysis projects with vantage6

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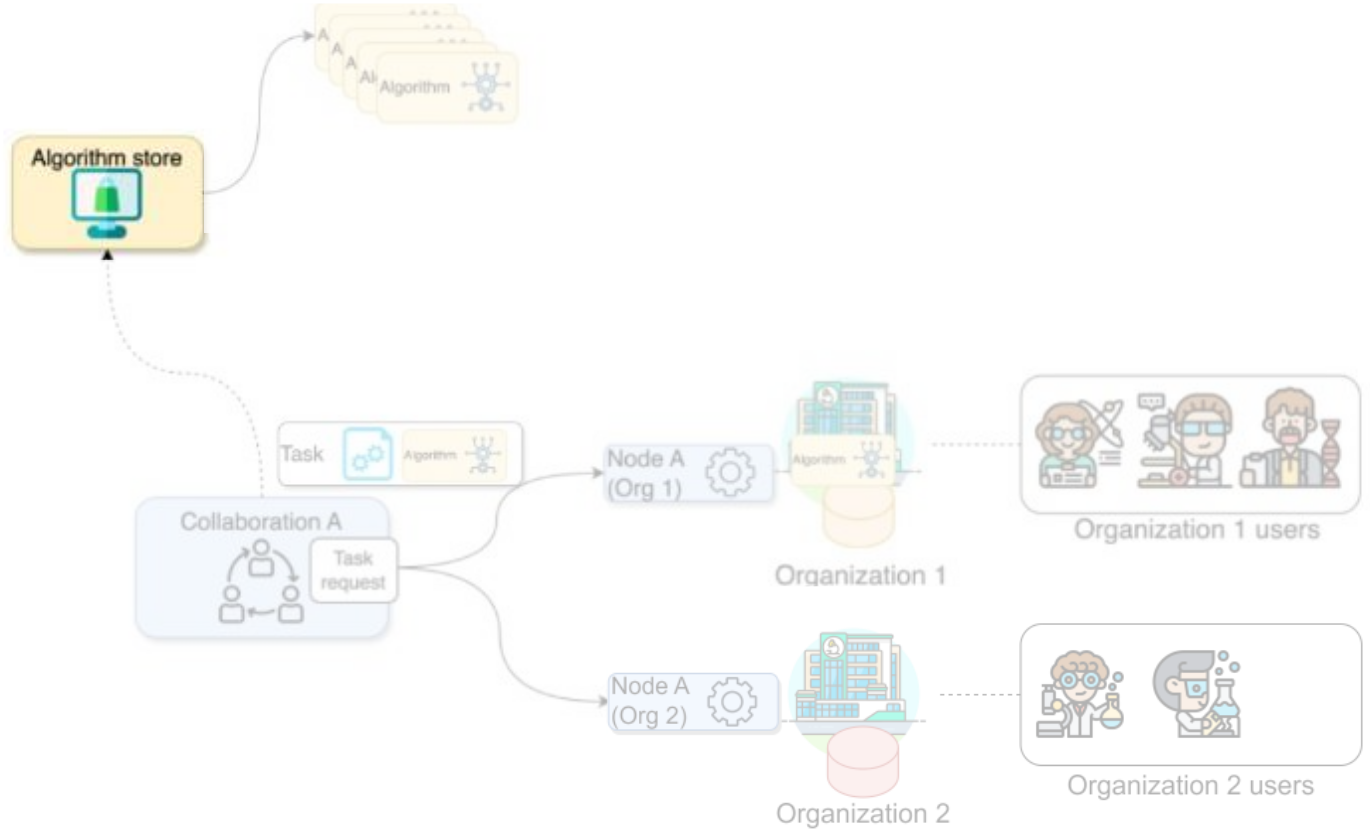
## Algorithm store

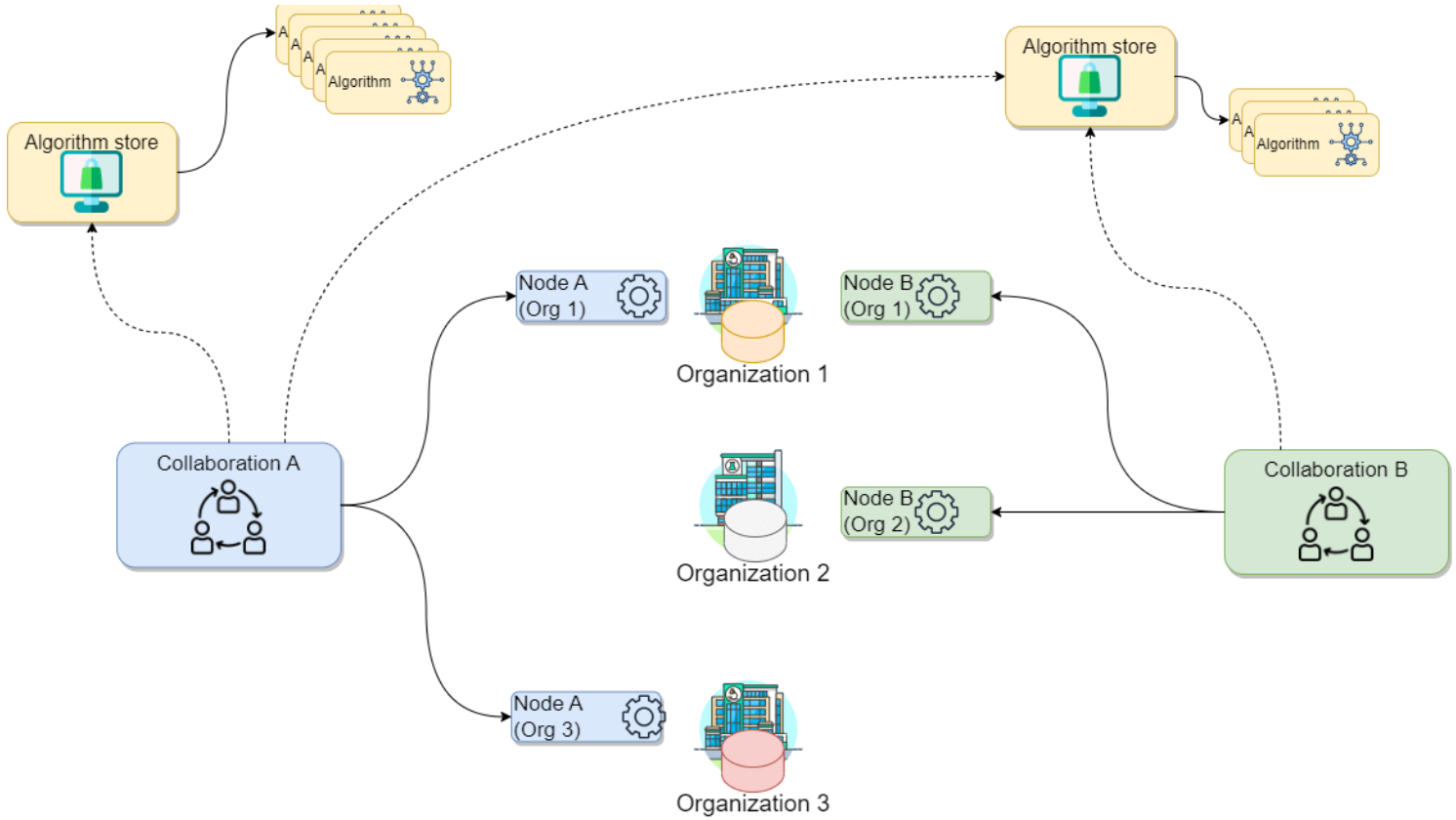
*A repository for trusted algorithms within a certain project.*



# Federated analysis projects with vantage6

VANTAGE WORKSHOP

Expanding the scenario:
Organizations can take part to multiple collaborations

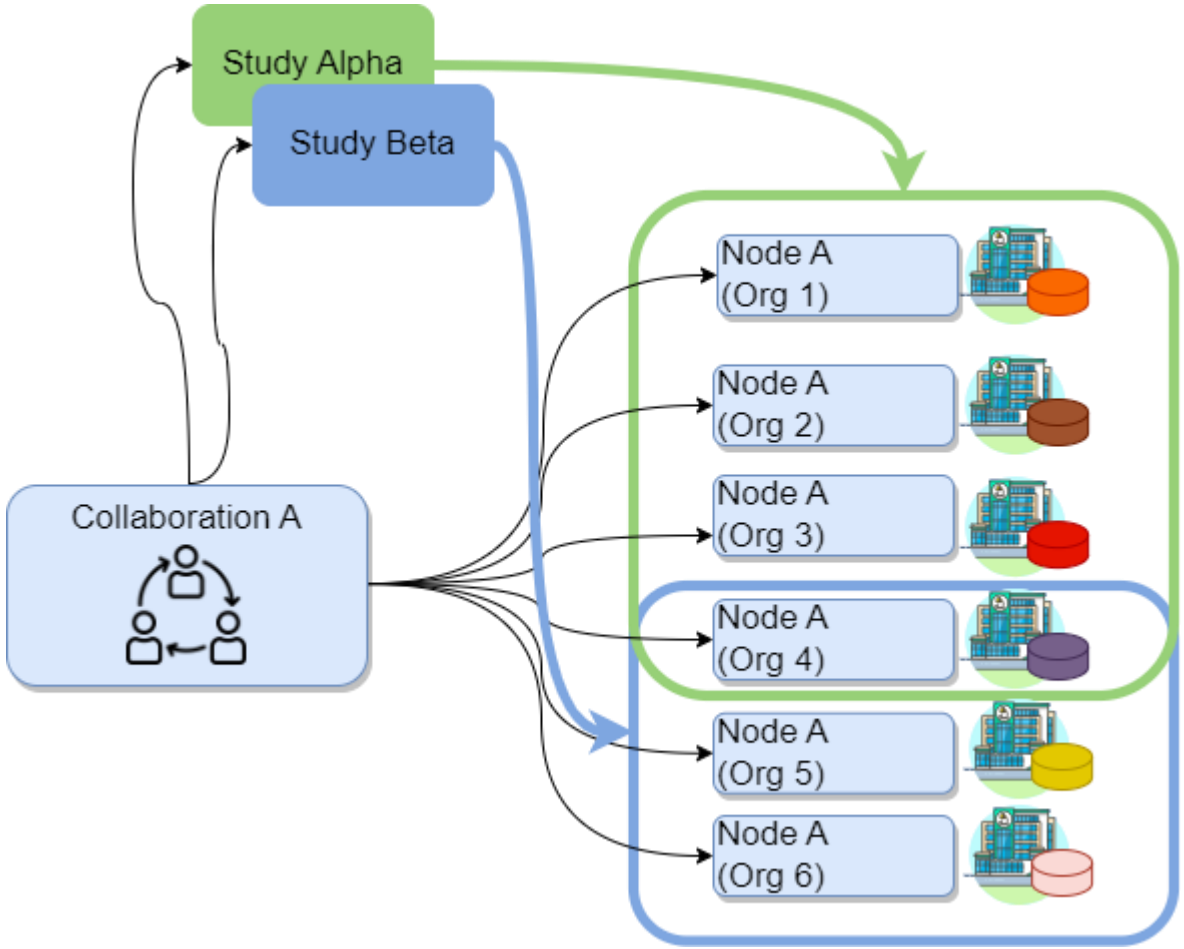


# Federated analysis projects with vantage6

VANTAGE WORKSHOP

## Study

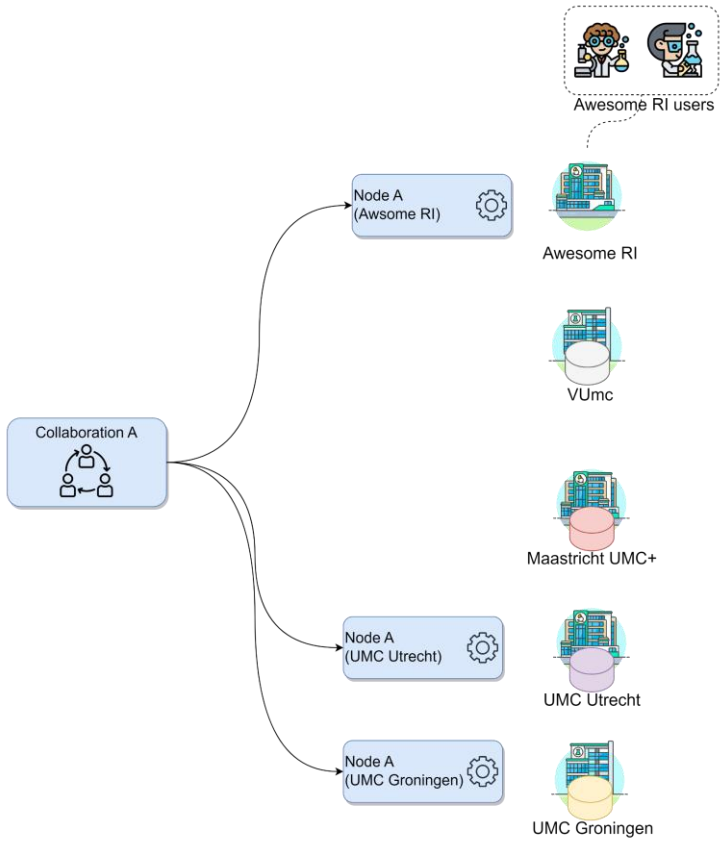
*A subset of organizations within a collaboration that are engaged in a specific research question.*



# Design your own project structure

VANTAGE WORKSHOP

**CHALLENGE**




You, a researcher at the Awesome RI, want to conduct a study across three academic hospitals : VUmc in Amsterdam, Maastricht UMC+, and UMC Utrecht. Consider the following:

- Your research institute has an existing collaboration with UMC Utrecht and UMC Groningen.
- You will be conducting this study with a colleague from your institute. Both of you are already registered on the organization.

**How would the concepts described so far map to your potential use case?**

1. **Which organizations will you need to add to your collaboration?**
2. **How many new nodes would you need to set up and on which organizations?**
3. **How many users would be created?**

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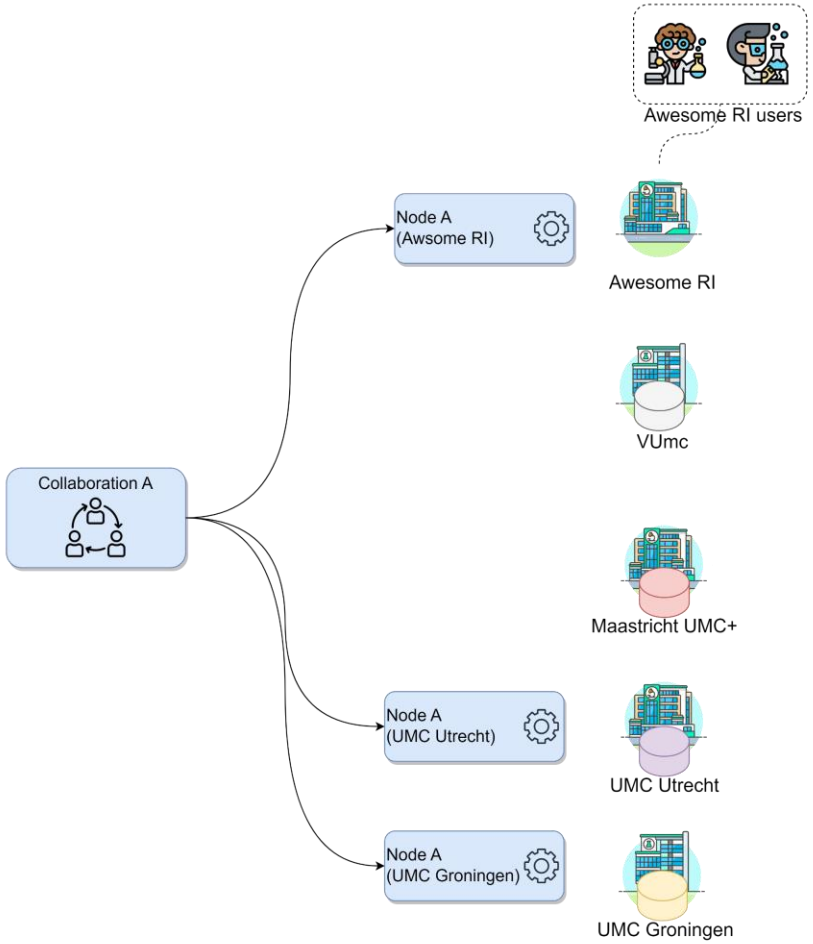
# Design your own project structure

**SOLUTION**

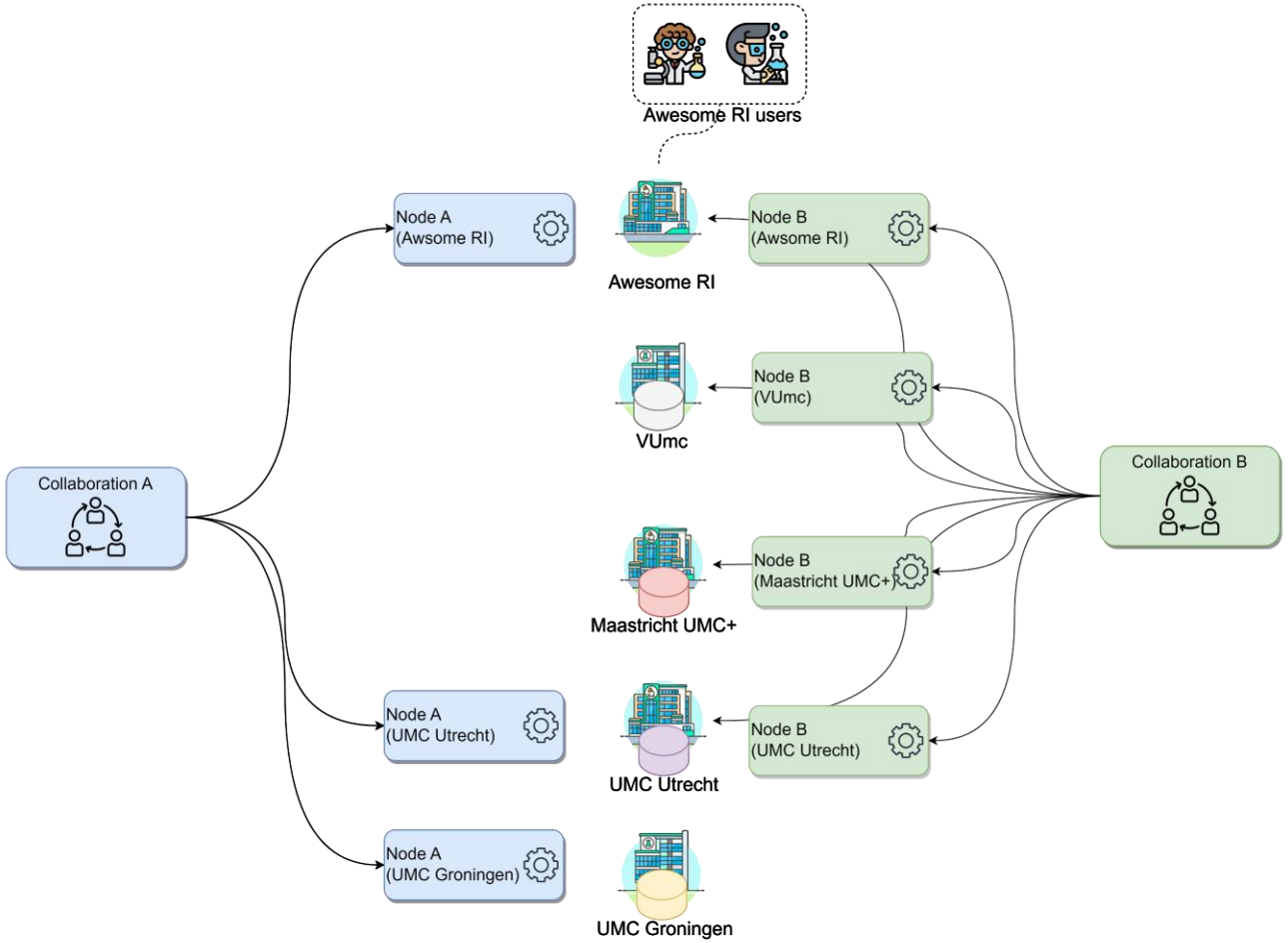



1. **Which organizations will you need to add to your collaboration?**

   All the academic hospitals as well as your own organization: VUmc, Maastricht UMC+, UMC Utrecht and your research institute.

# Design your own project structure

**SOLUTION**




1. **Which organizations will you need to add to your collaboration?**

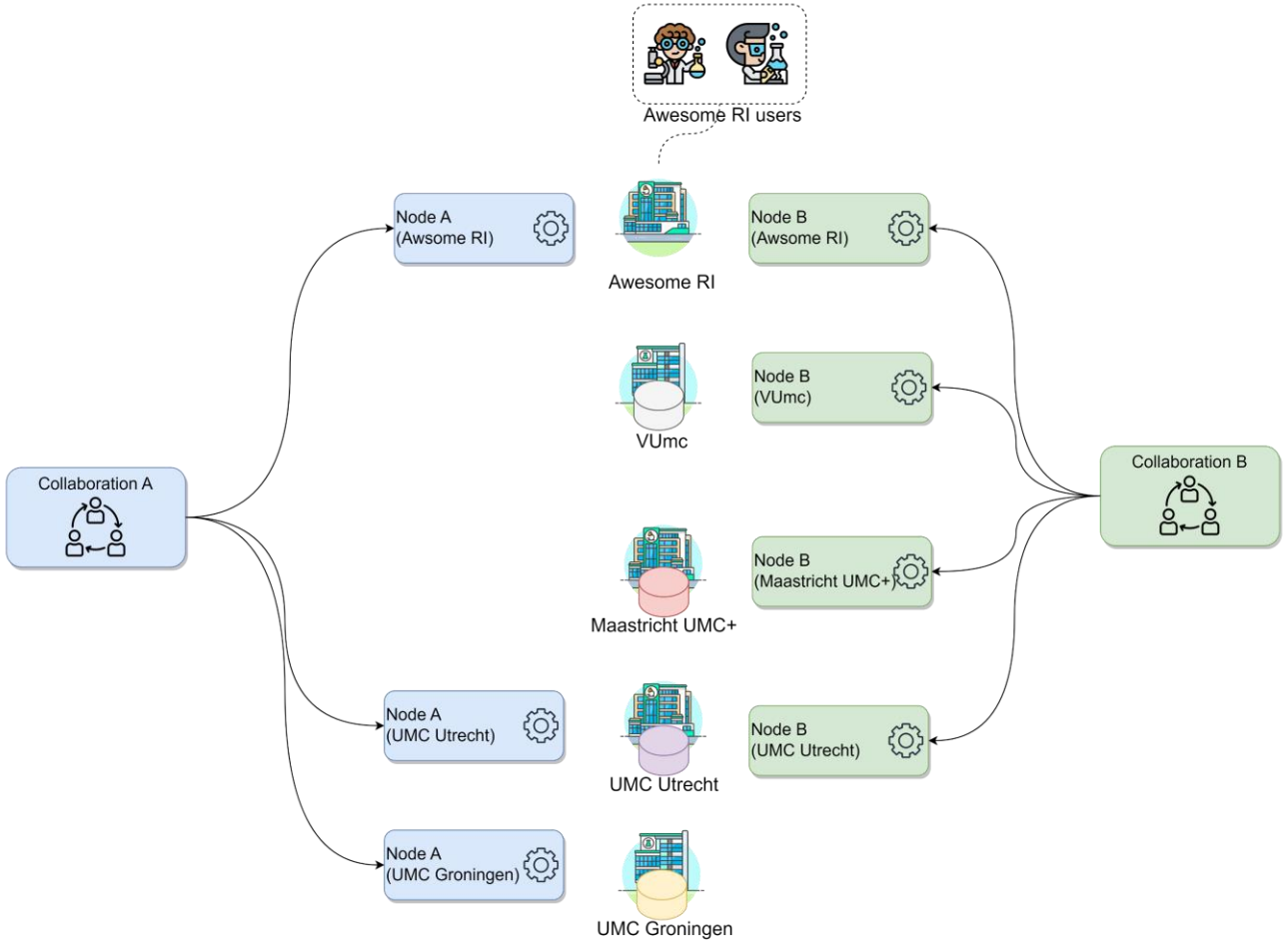
   All the academic hospitals as well as your own organization: VUmc, Maastricht UMC+, UMC Utrecht and your research institute.

2. **How many new nodes would you need to set up and on which organizations?**

   One node for every academic organization in the collaboration, so 4.

# Design your own project structure

**SOLUTION**




1. **Which organizations will you need to add to your collaboration?**

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2. **How many new nodes would you need to set up and on which organizations?**

   One node for every academic organization in the collaboration, so 4.

3. **How many users would be created?**

   There is no need to create new users, as these are already registered on the organization.

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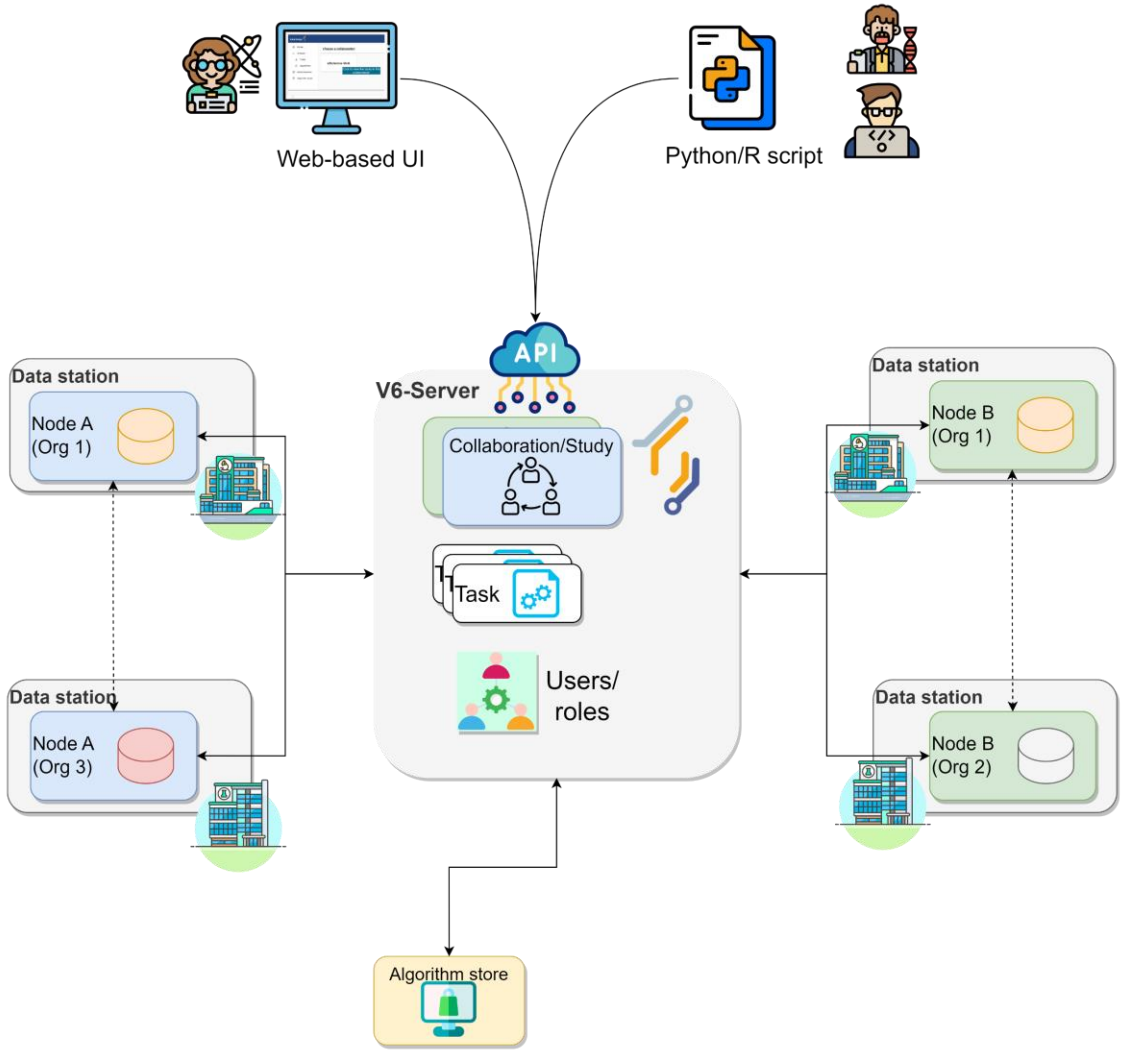
# The vantage6 infrastructure

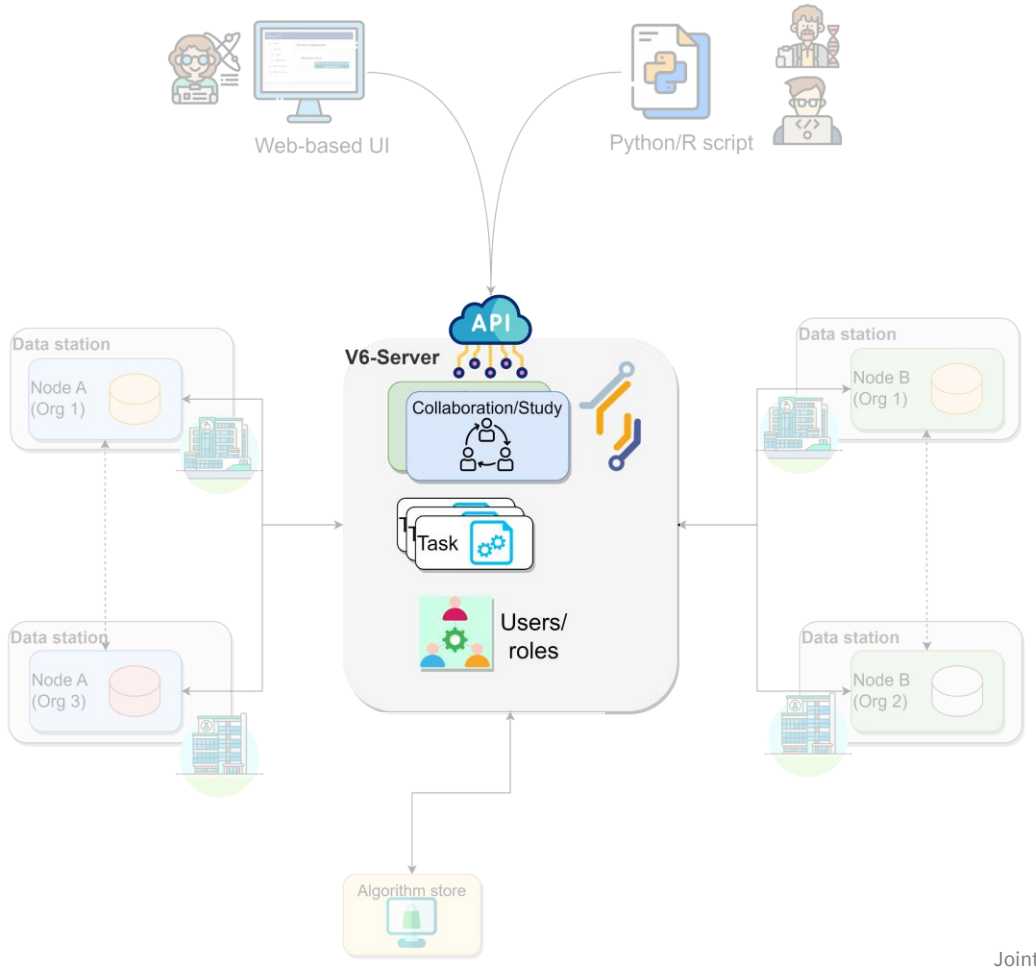


# The vantage6 infrastructure

VANTAGE WORKSHOP

## Server

*Communication hub between clients and nodes. It also handles authentication and authorization to the system.*

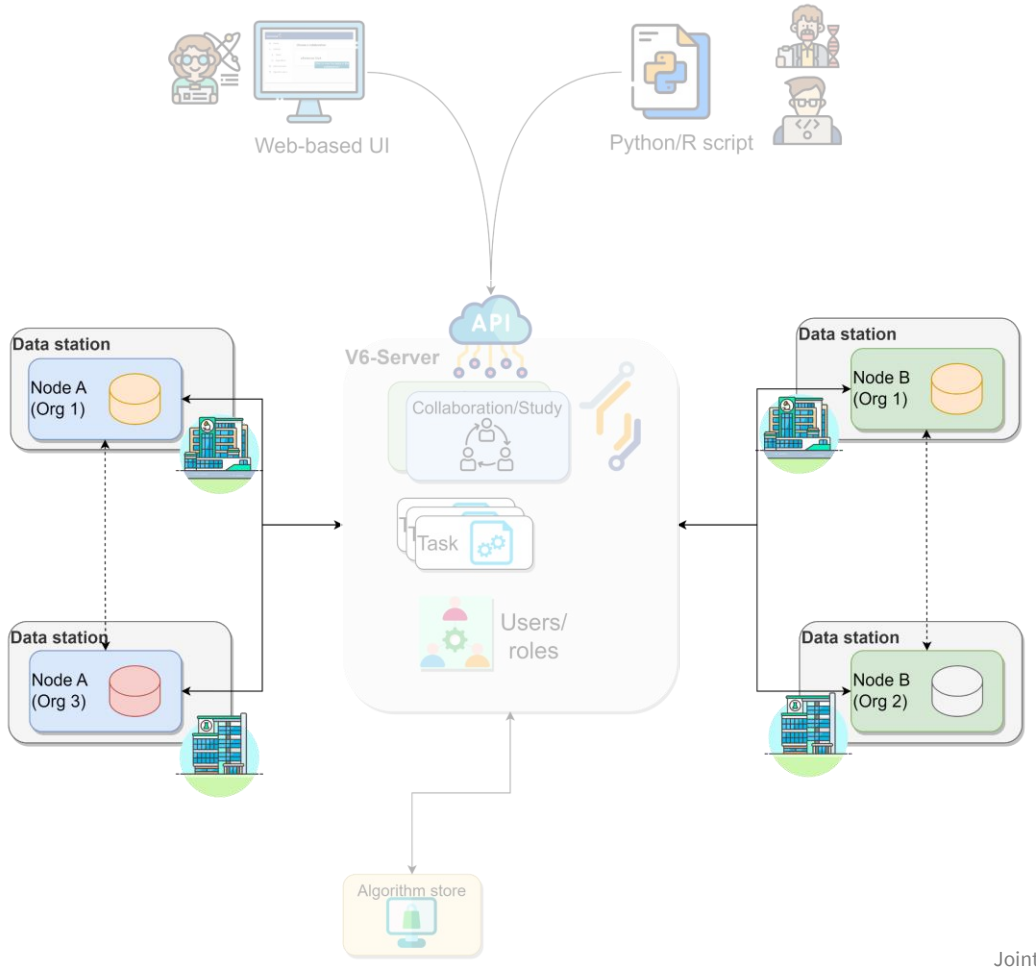


# The vantage6 infrastructure

VANTAGE WORKSHOP

## Data station

*Hosts the data and the vantage6 node. The vantage6 node executes the allowed algorithms on the local data and sends the results back to the server.*



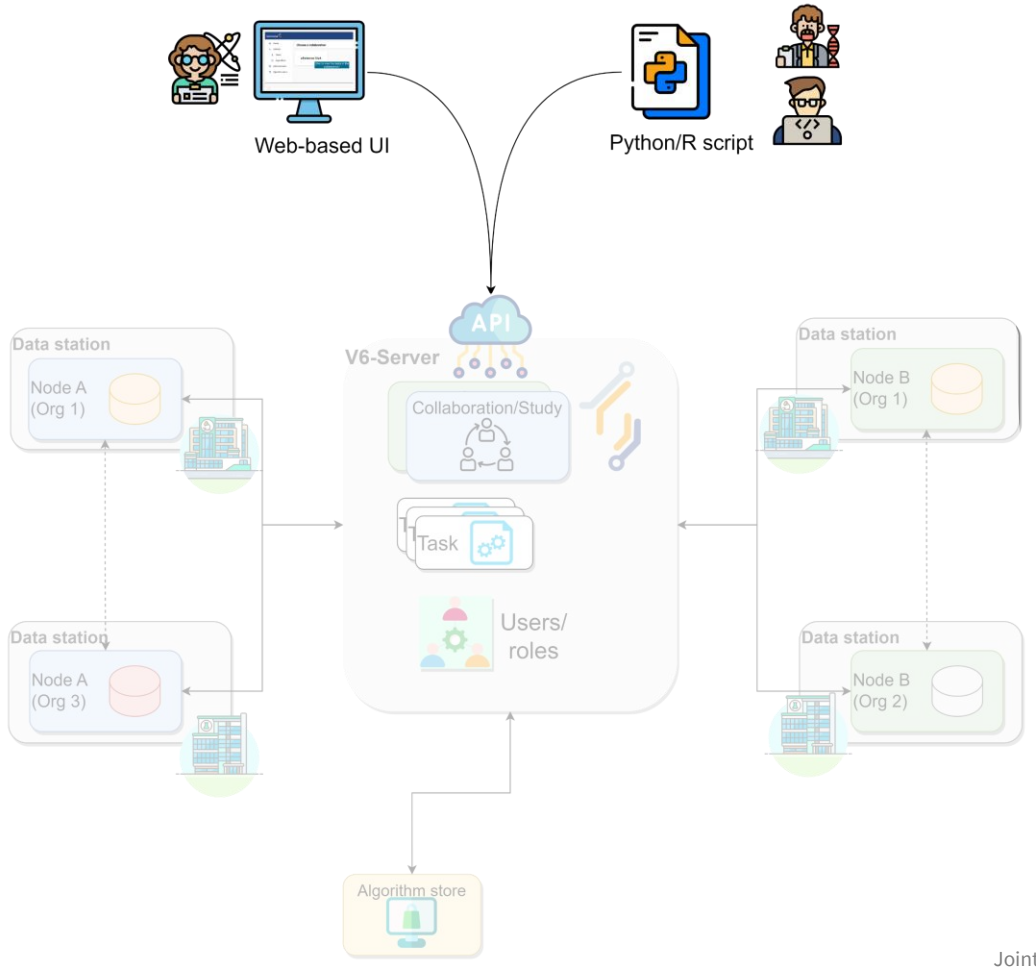
# The vantage6 infrastructure

VANTAGE WORKSHOP

## Client

*Entity that interacts with the vantage6 server via:*

- *API*
- *User interface*
- *Python client*

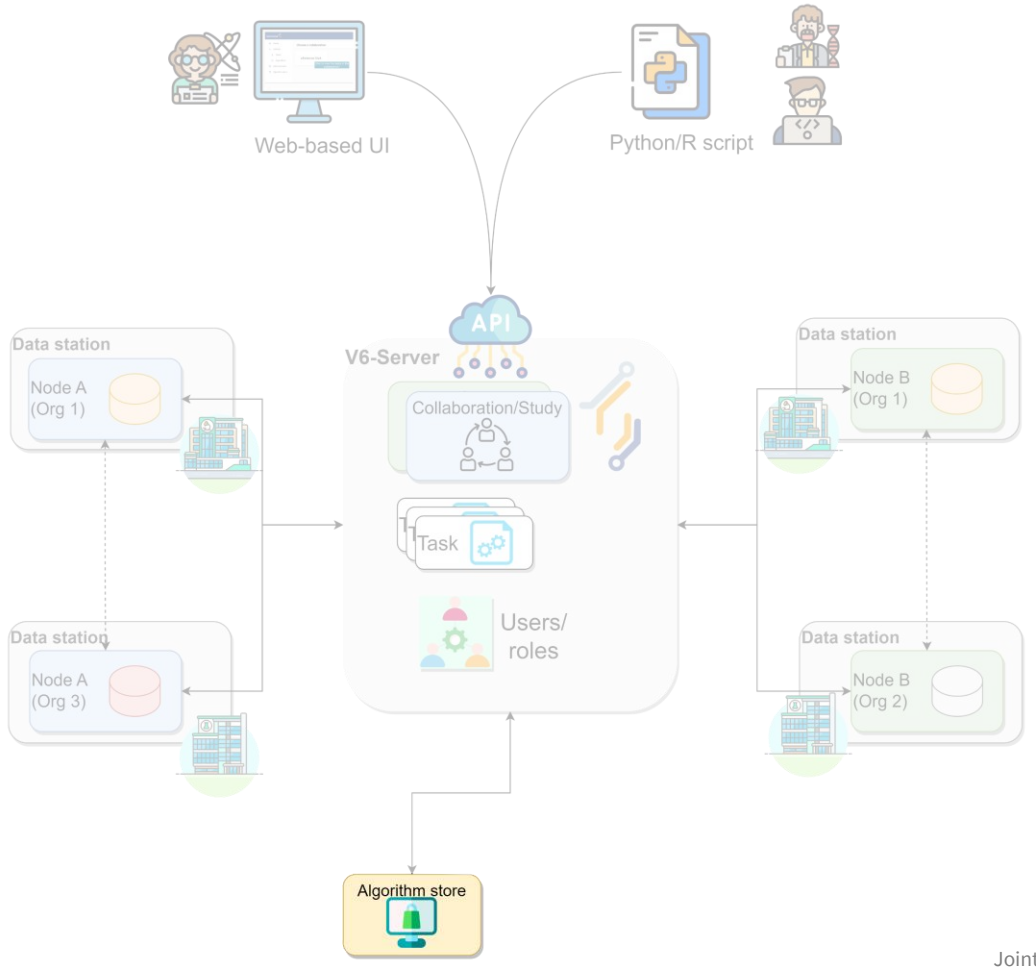


# The vantage6 infrastructure

VANTAGE WORKSHOP

## Algorithm store

*Repository for trusted algorithms. It allows researchers to explore which algorithms are available and how to run them.*

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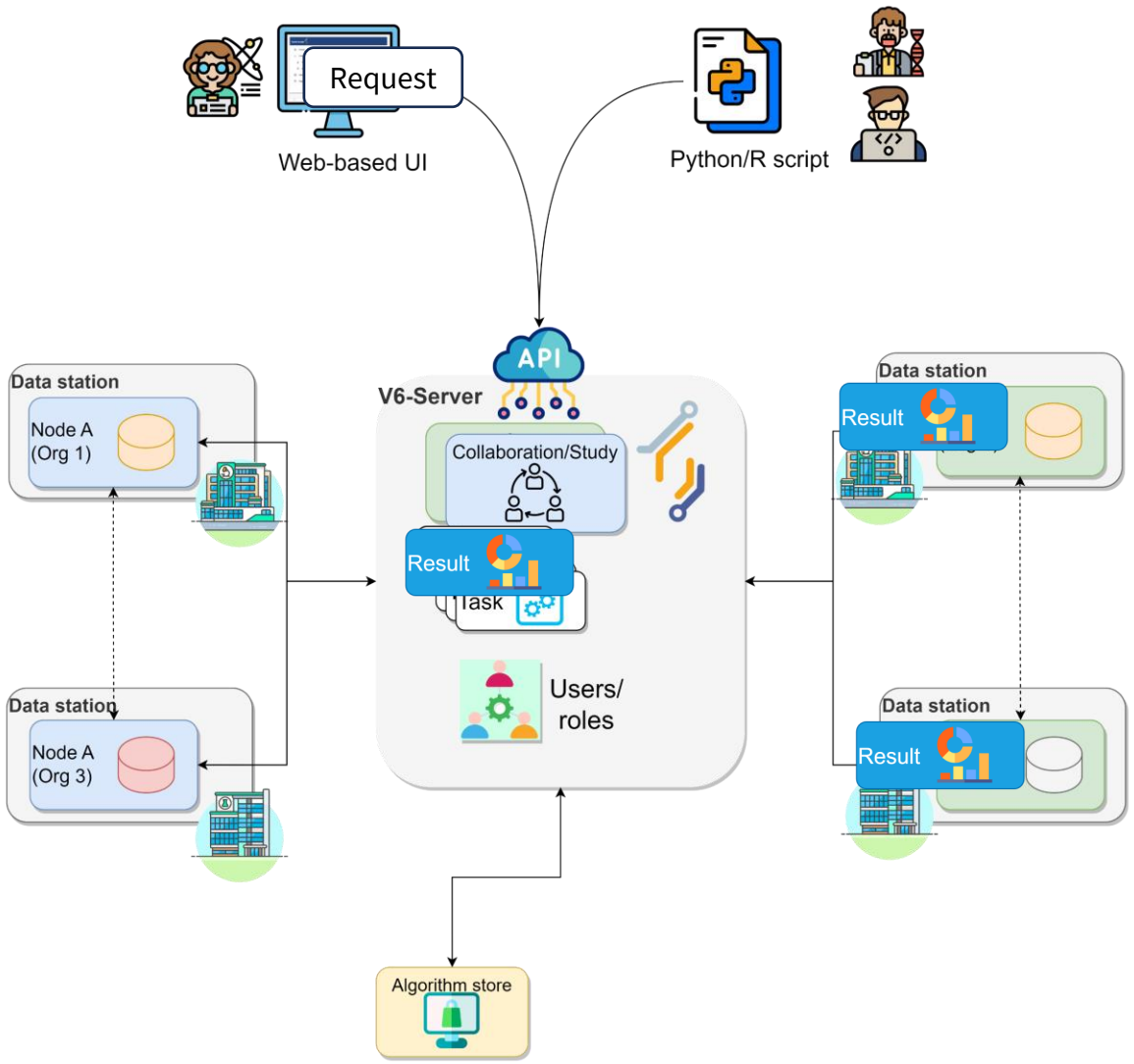
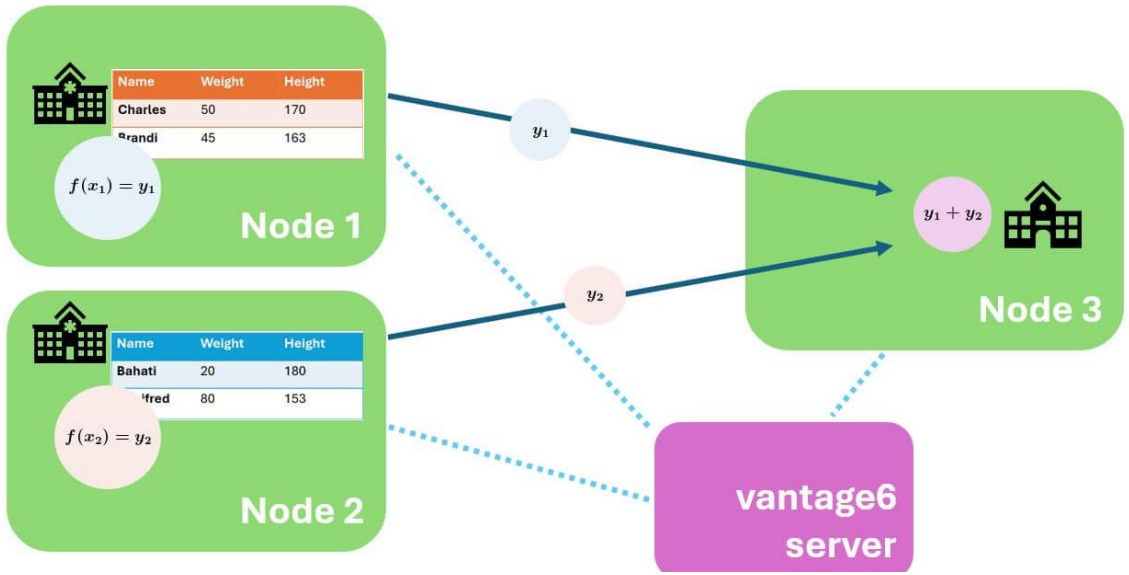
# The vantage6 infrastructure



# How algorithms run in vantage6

Let us consider the federated sum from chapter 1 again




Data sources and the aggregation entity are mapped to nodes.

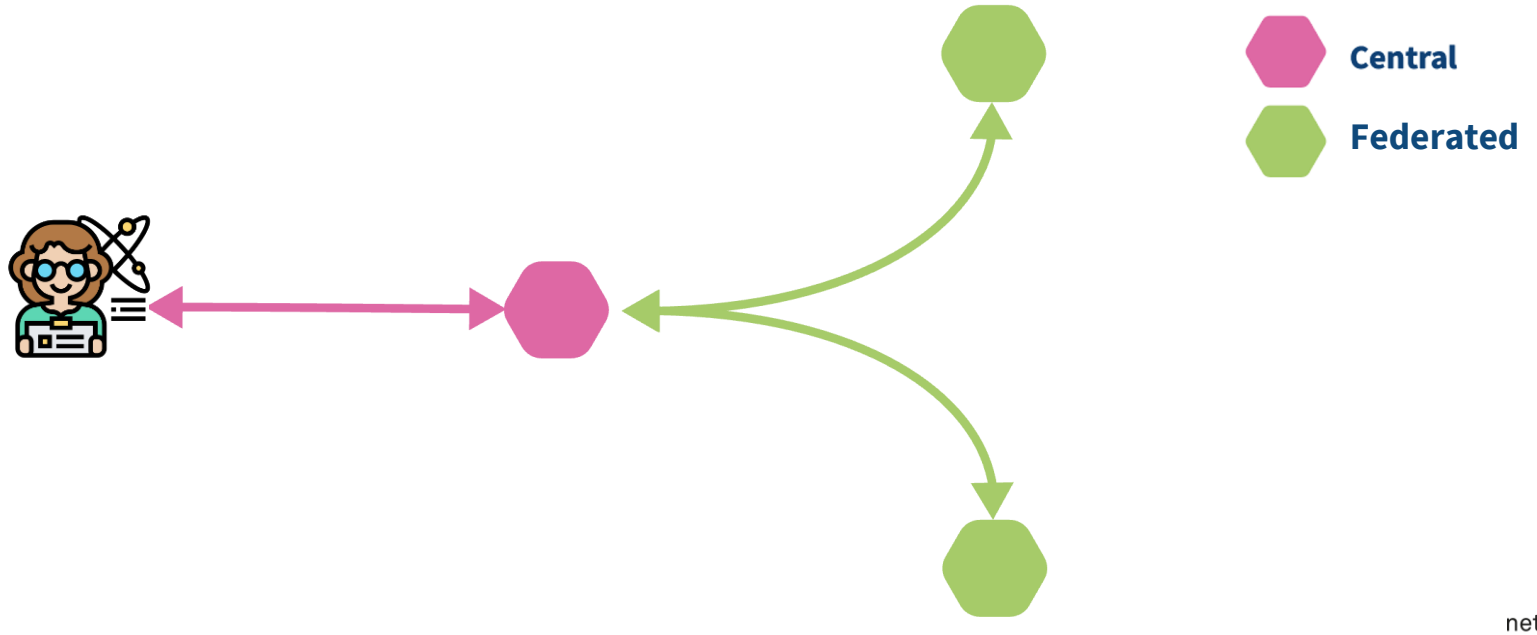
The vantage6 server is on the side, coordinating the analysis.

# How algorithms run in vantage6

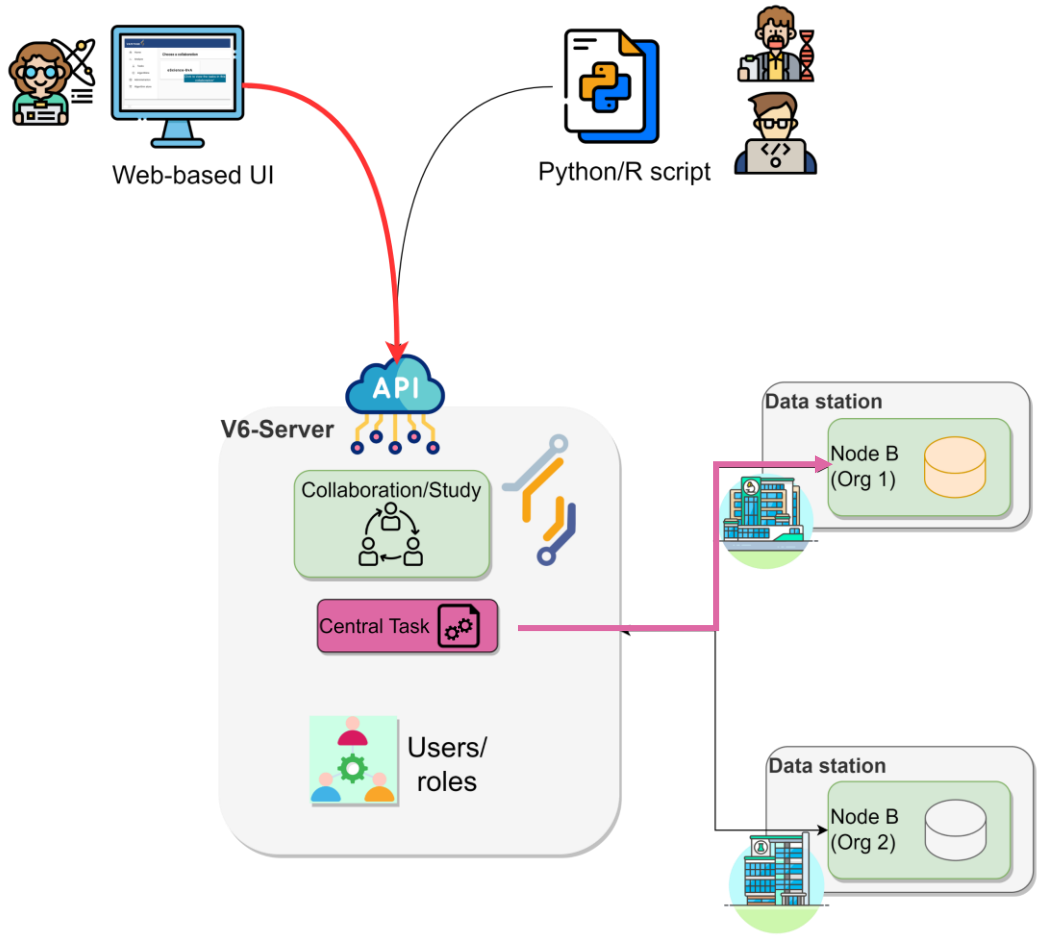
VANTAGE WORKSHOP

Federated algorithms can be split in a **federated** and a **central** part:

- **Central**: The central part of the algorithm is responsible for orchestration and aggregation of the partial results.
- **Federated**: The partial tasks are executing computations on the local privacy sensitive data.



# How algorithms run in vantage6



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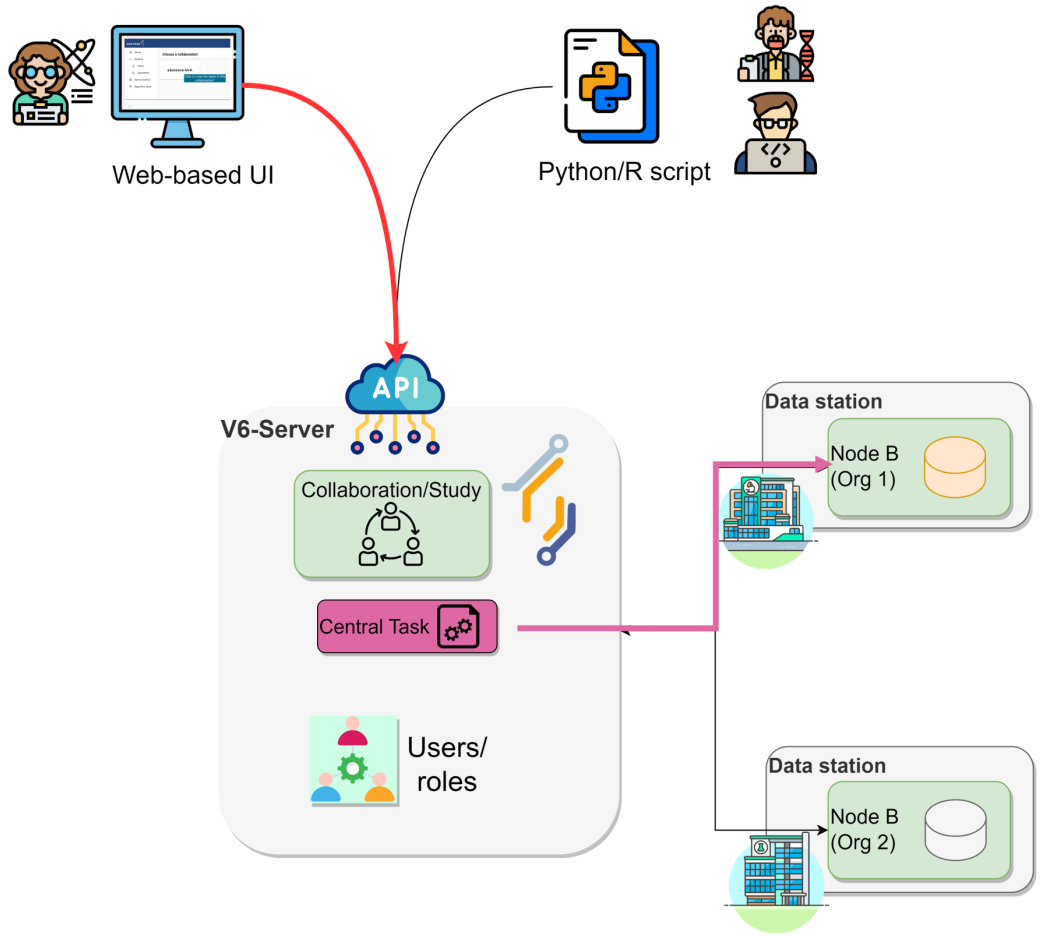

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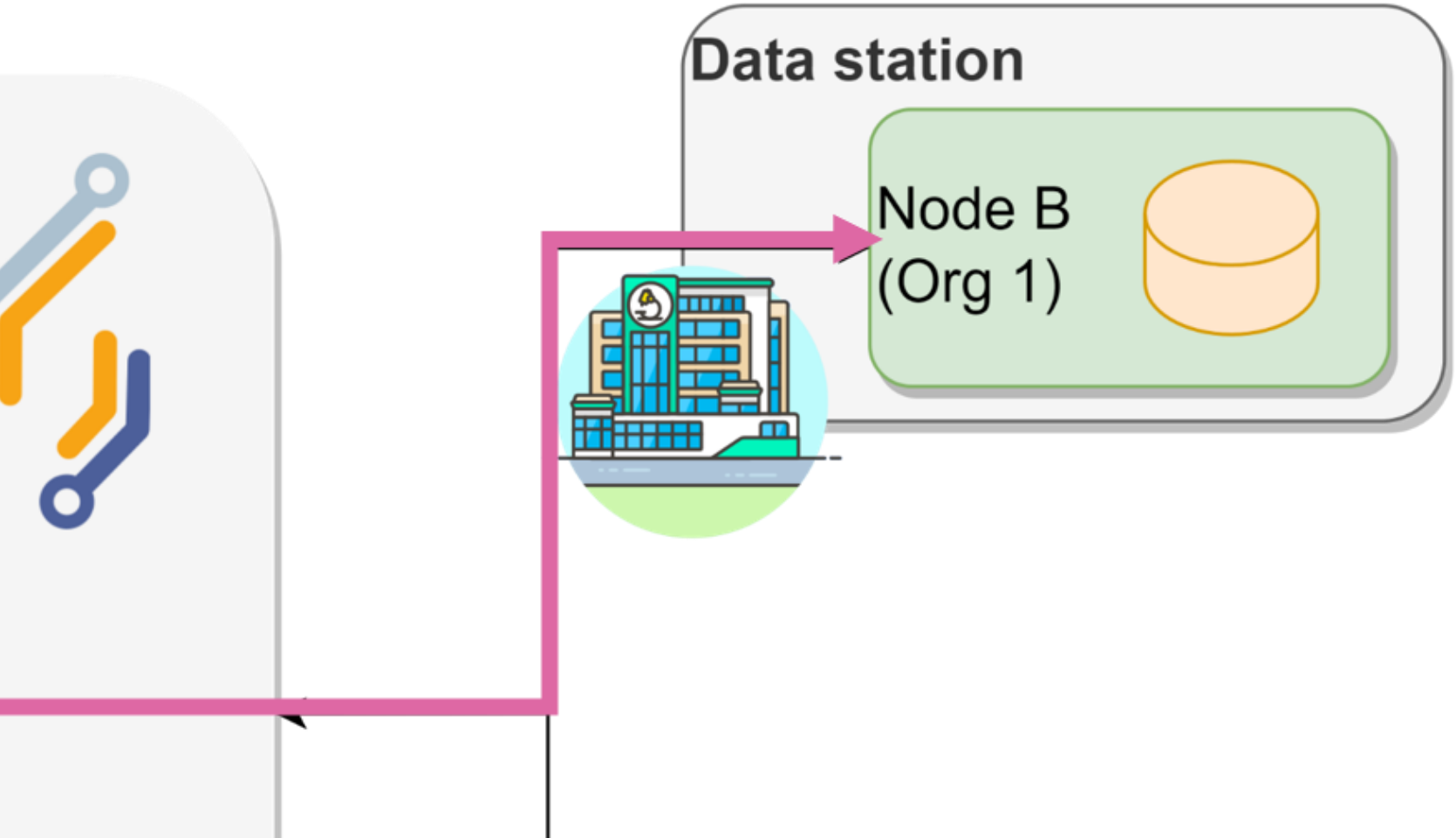
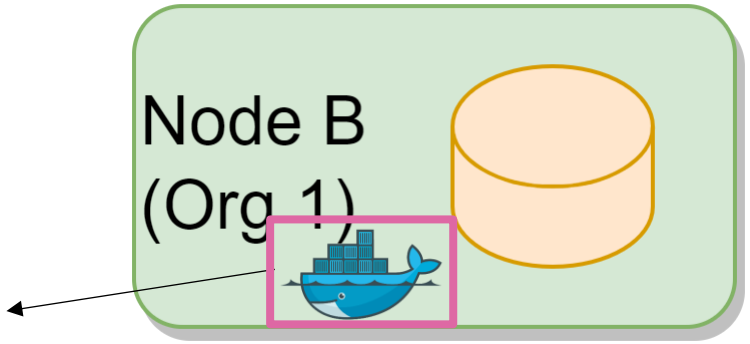


# How algorithms run in vantage6

Central algorithm process:

1. Request nodes to perform partial computations
2. Aggregate partial computation results



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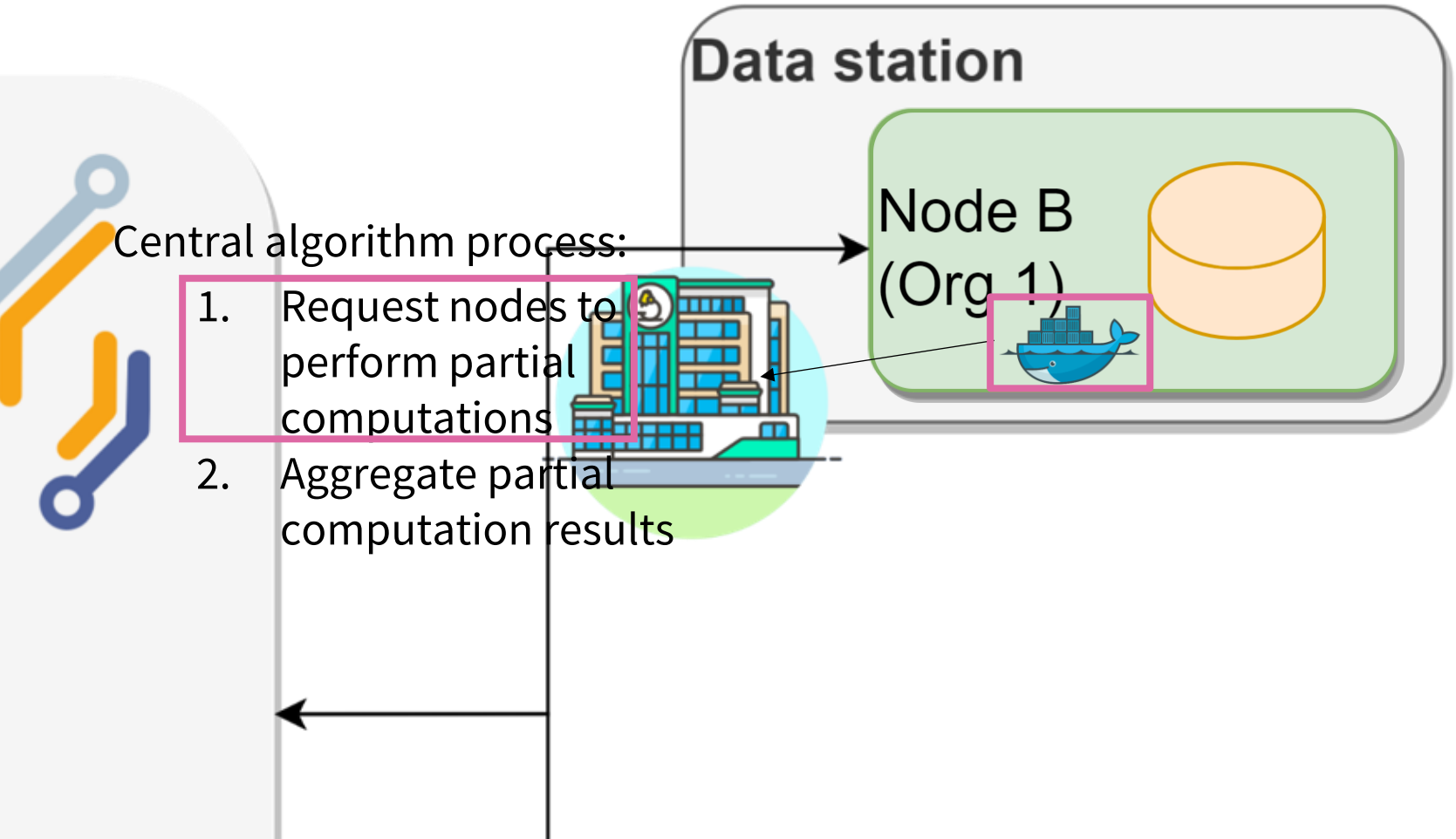


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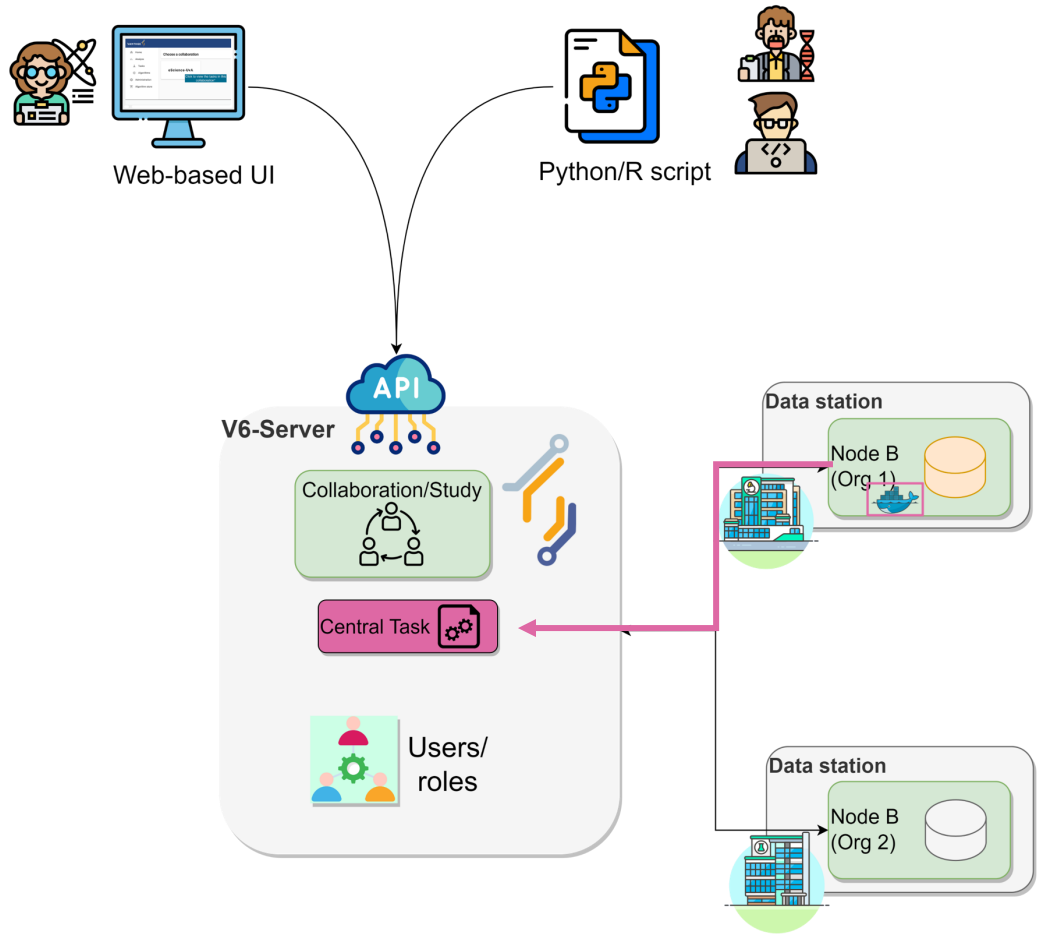

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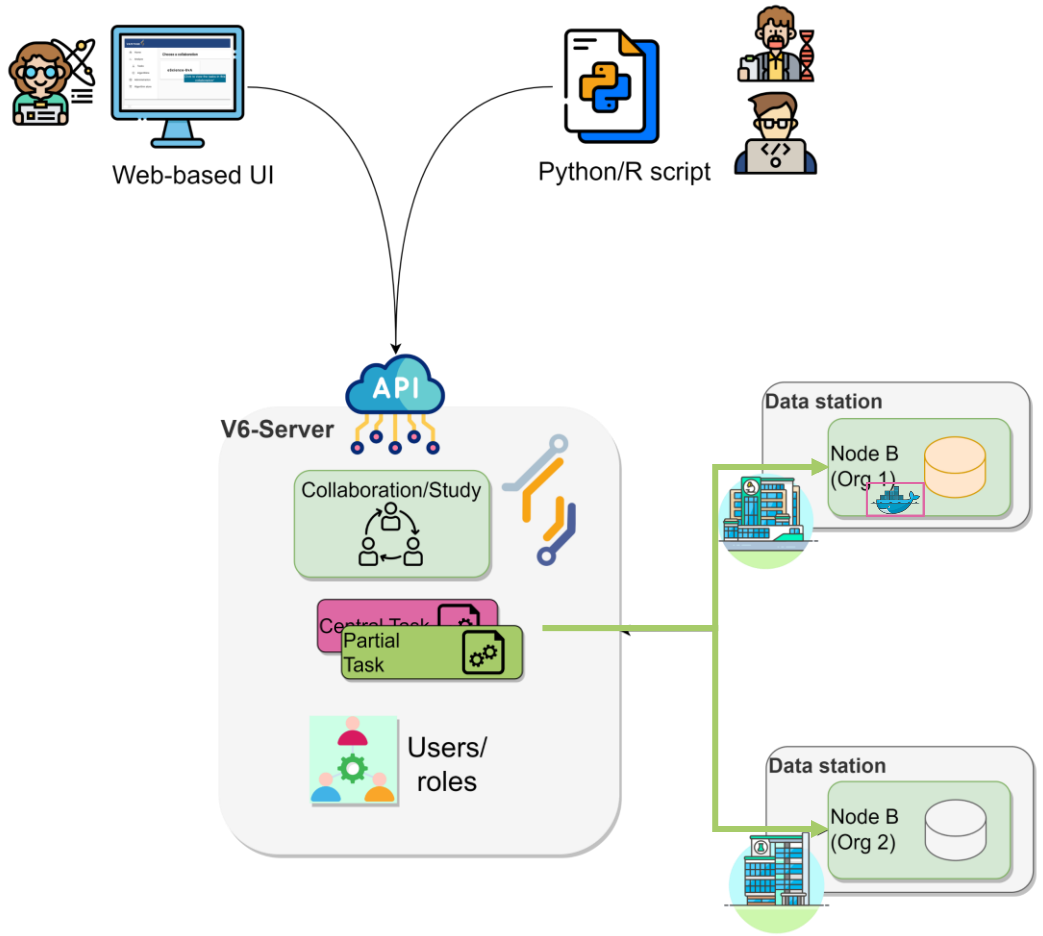

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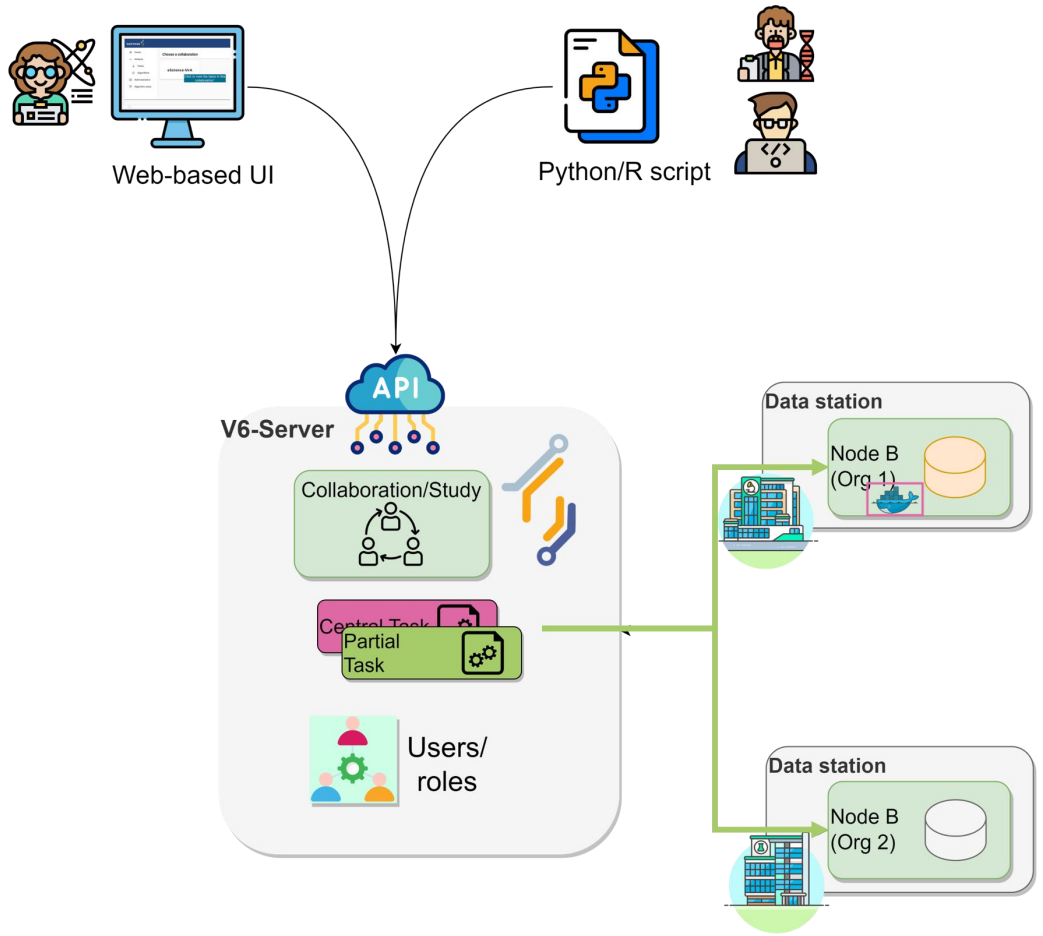

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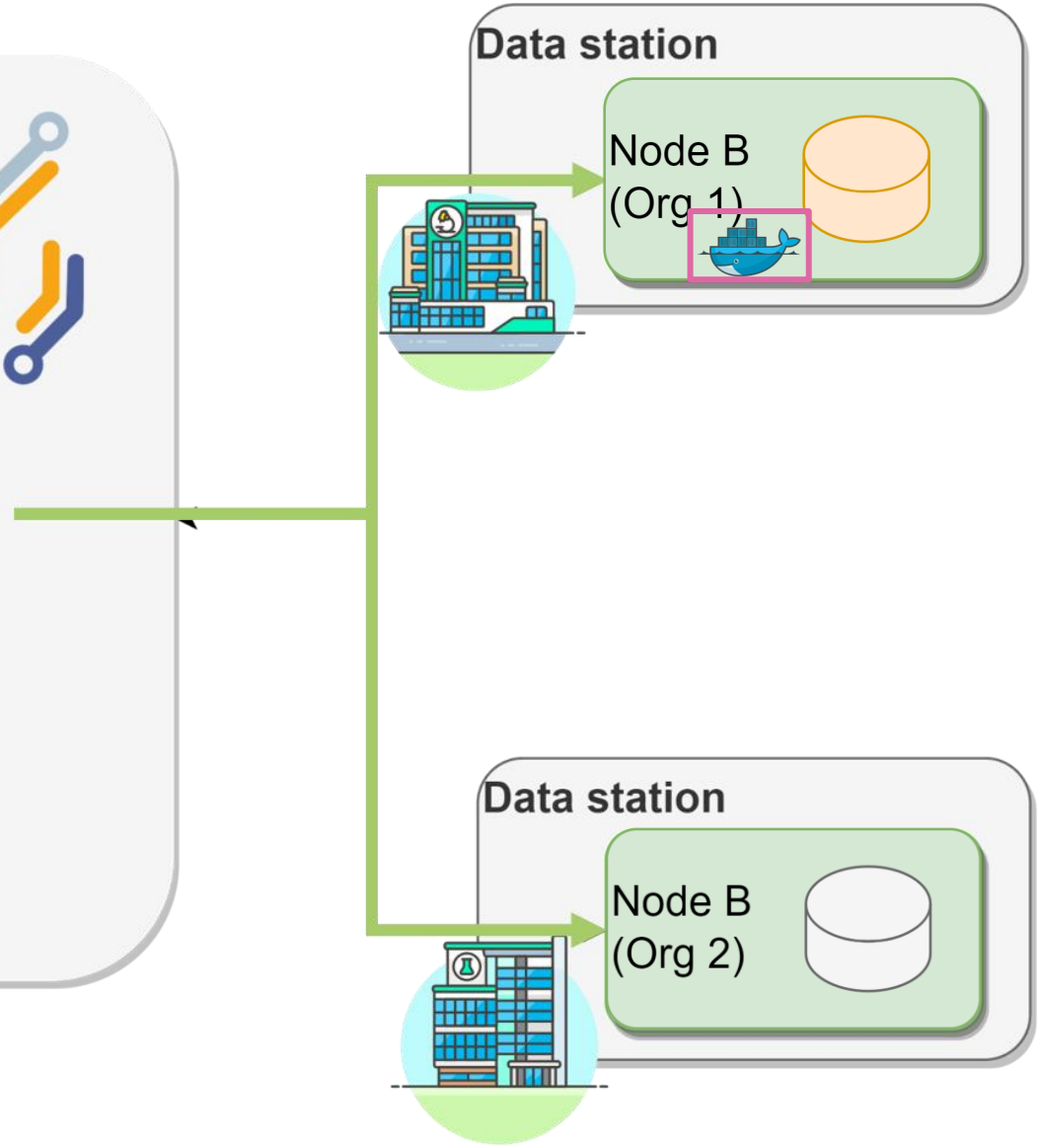

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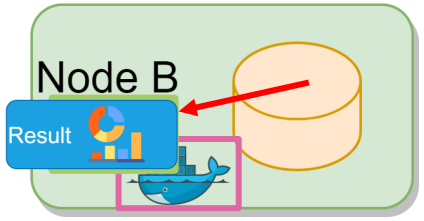
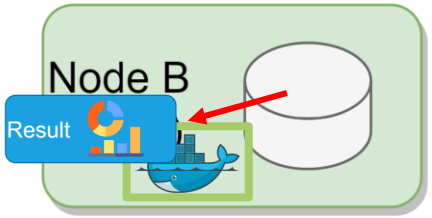



Federated algorithm process:

1. Read local data
2. Compute partial results



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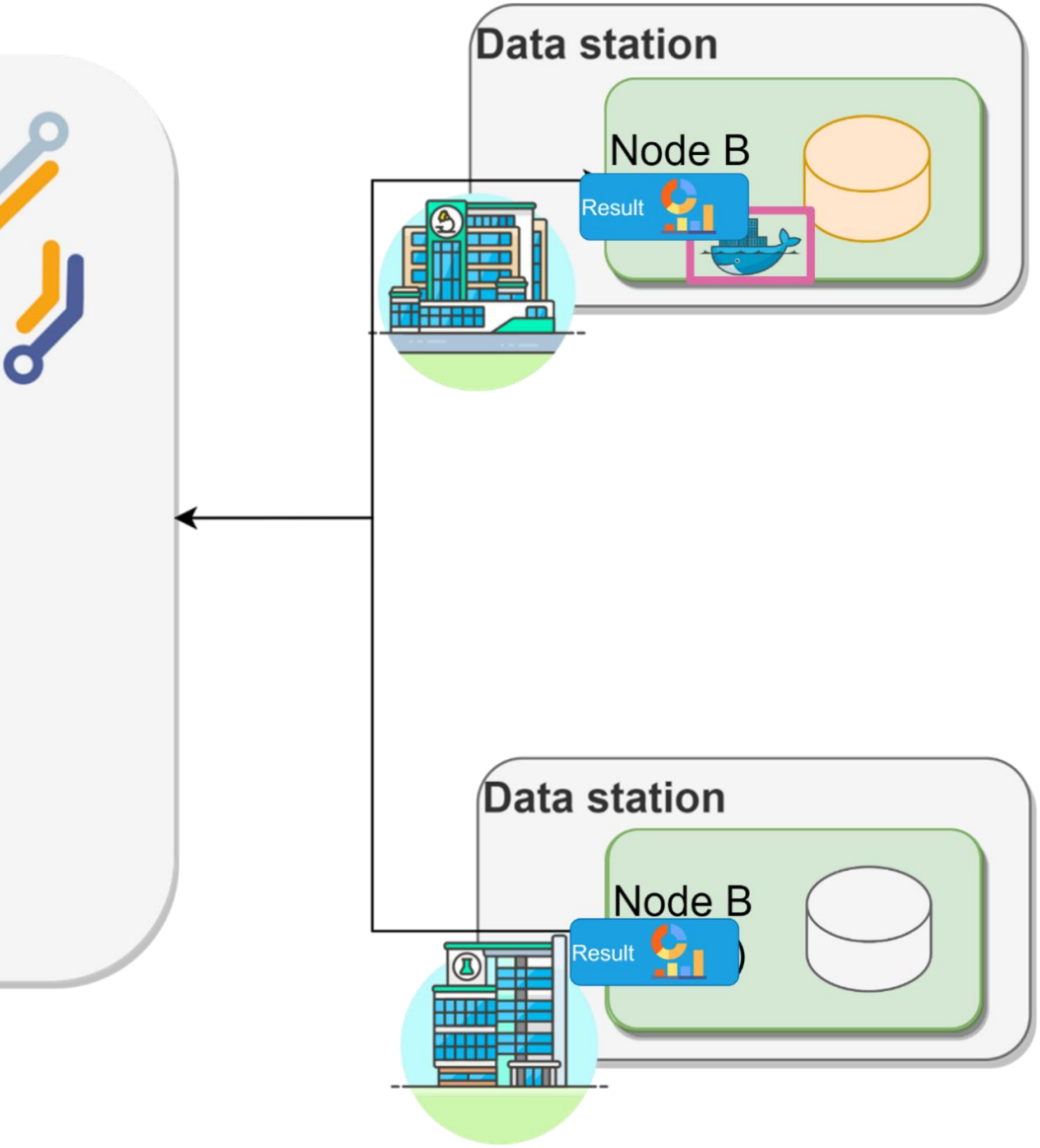

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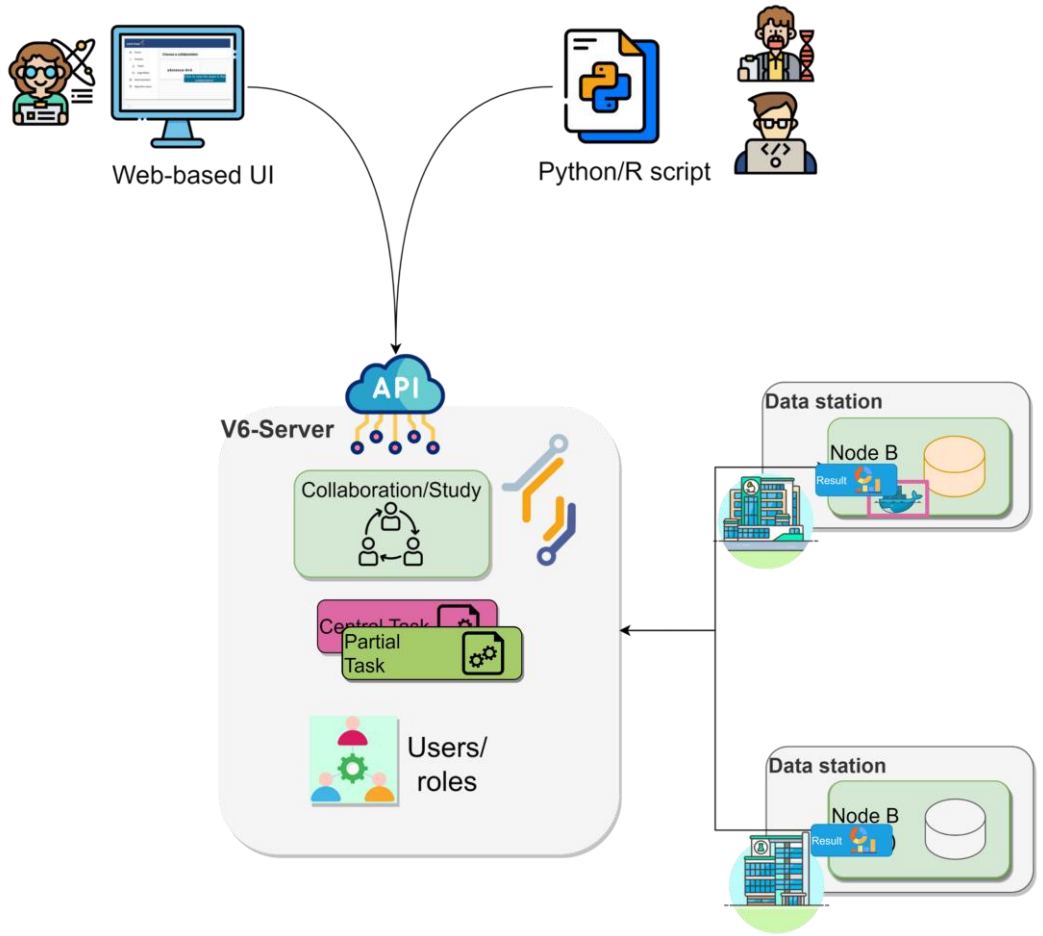

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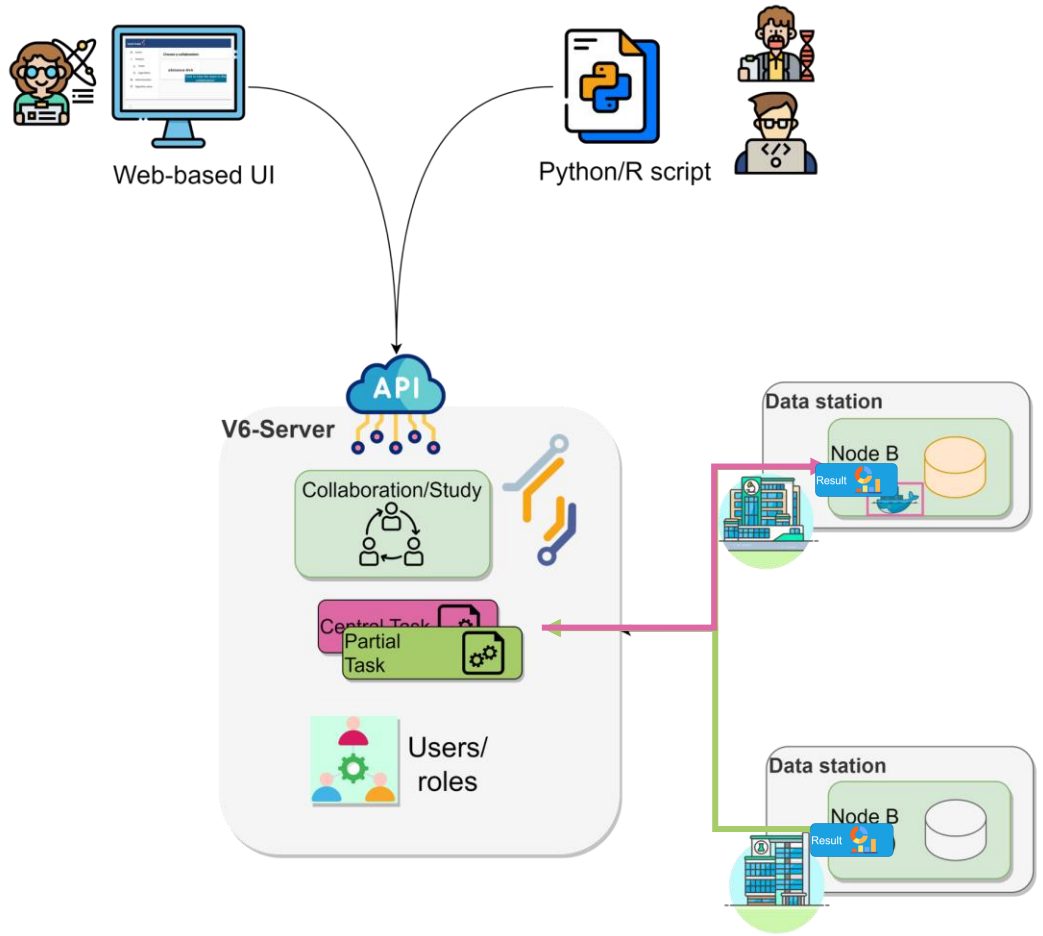

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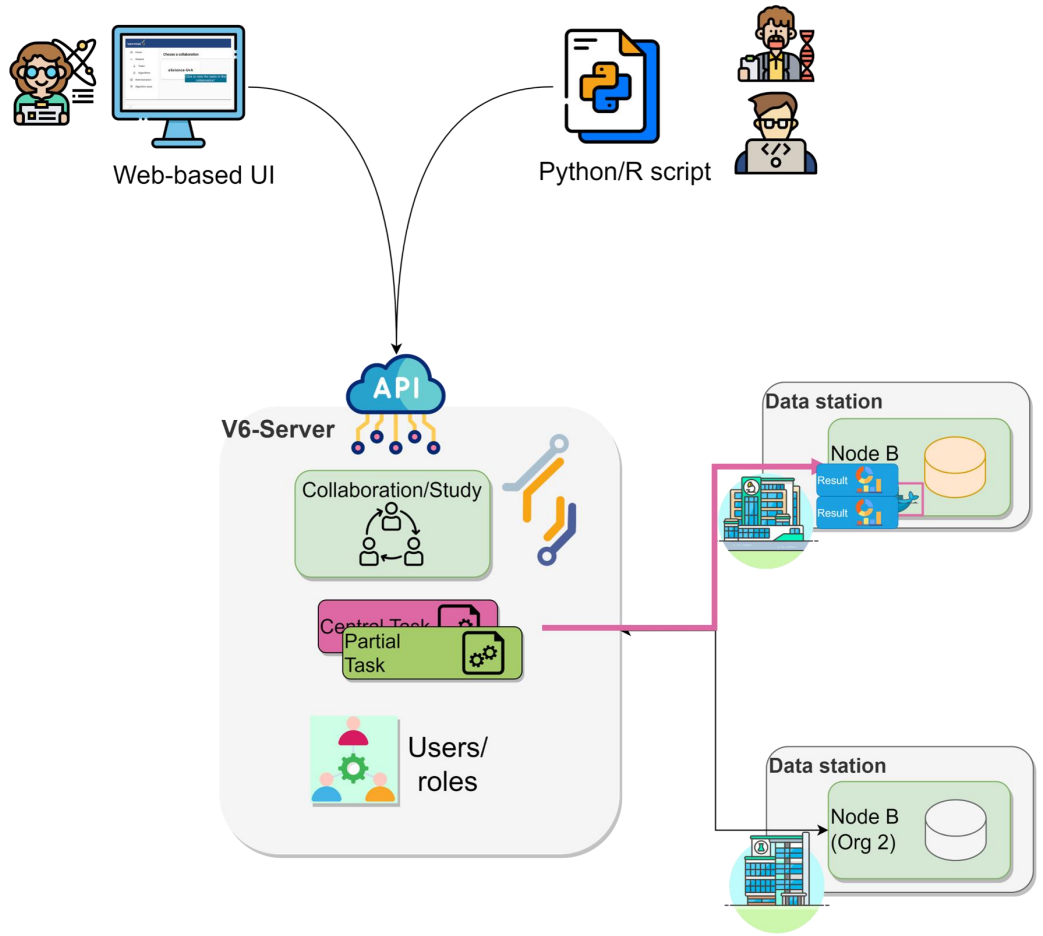

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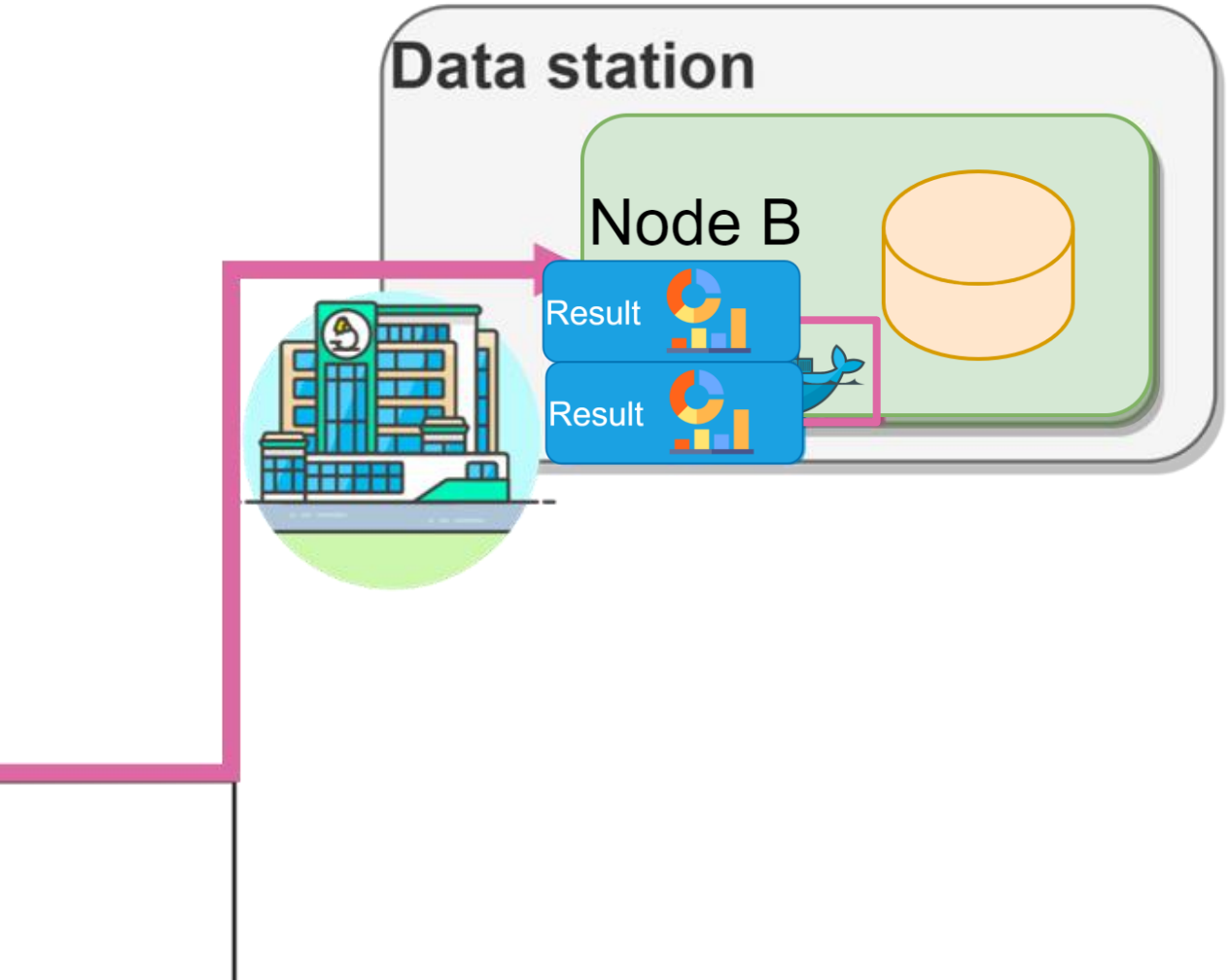

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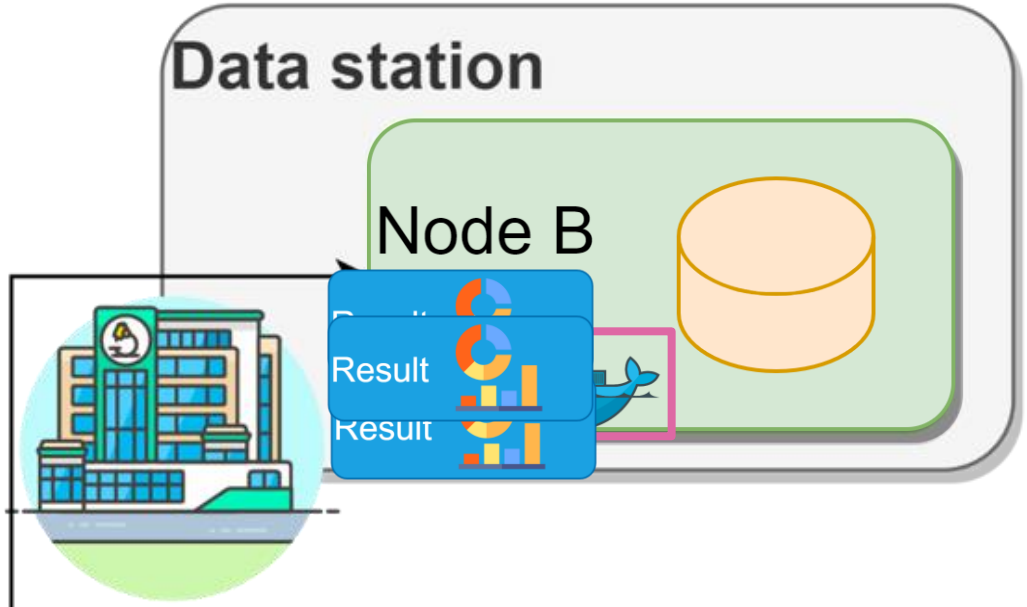


Central algorithm process:

1. Request nodes to perform partial computations
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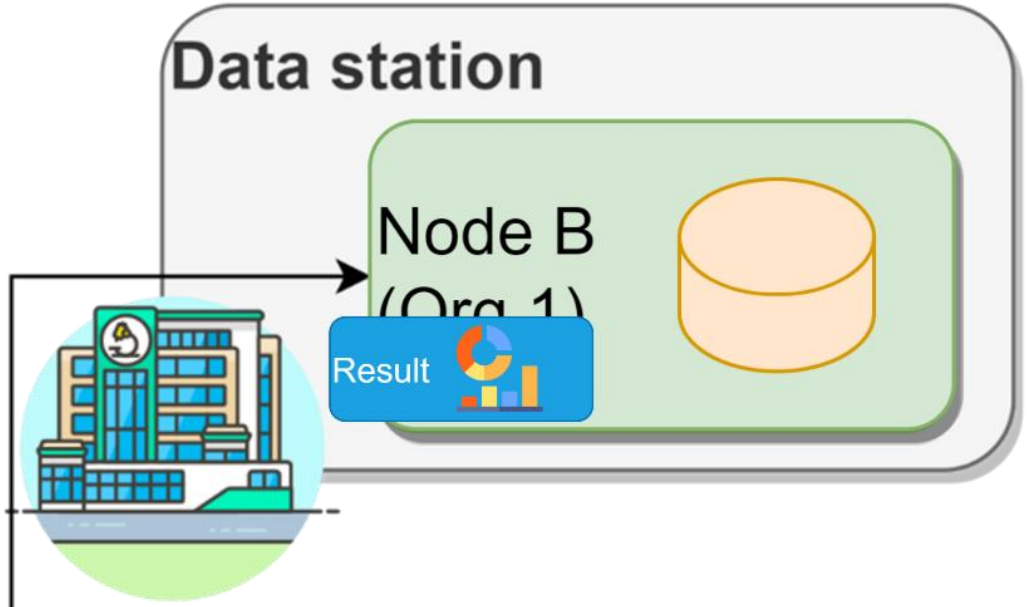
# How algorithms run in vantage6



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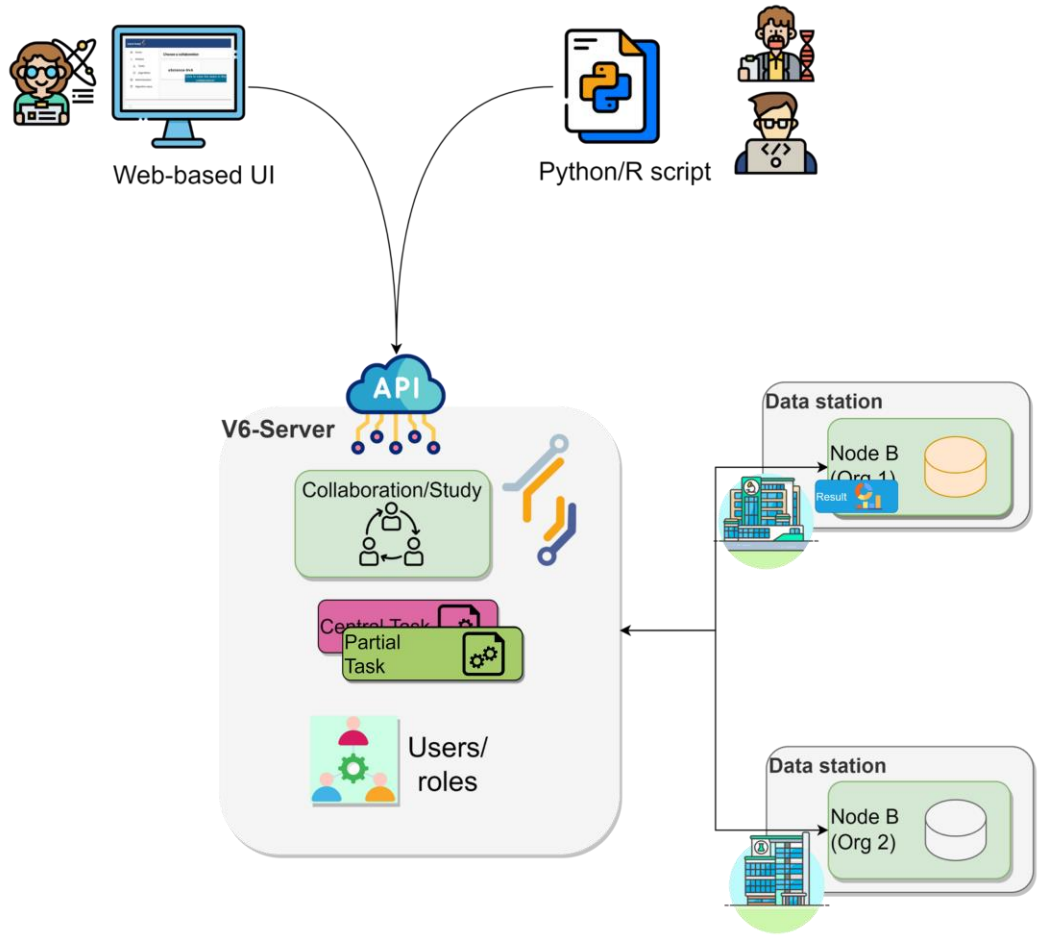

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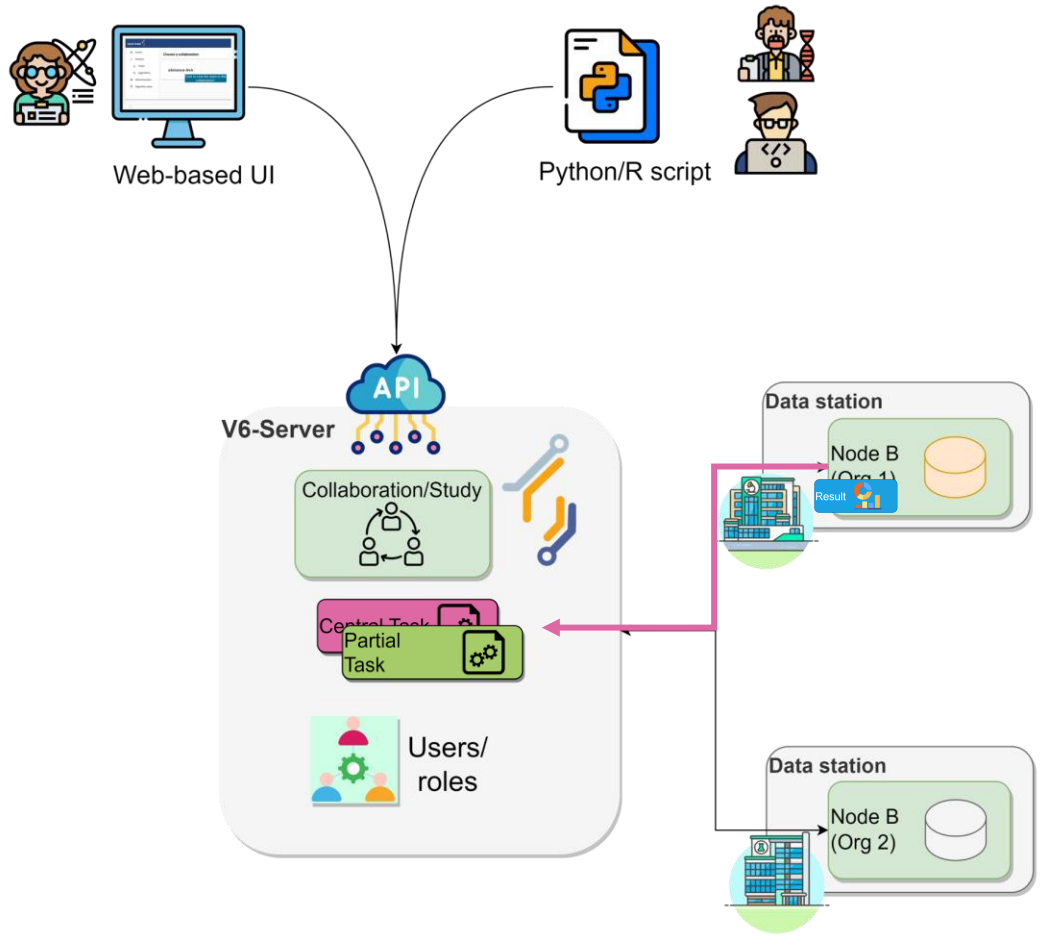
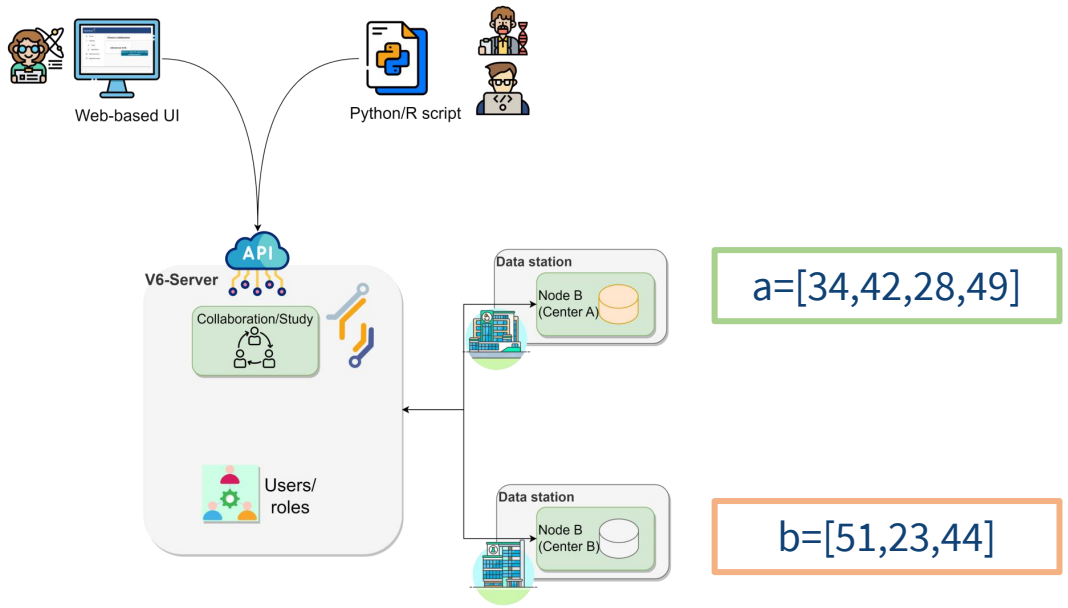


# Who computes what?

VANTAGE WORKSHOP

**CHALLENGE**

Two centers A and B have data regarding the age of a set of patients




**Which part of the infrastructure will execute each part of the computation?**

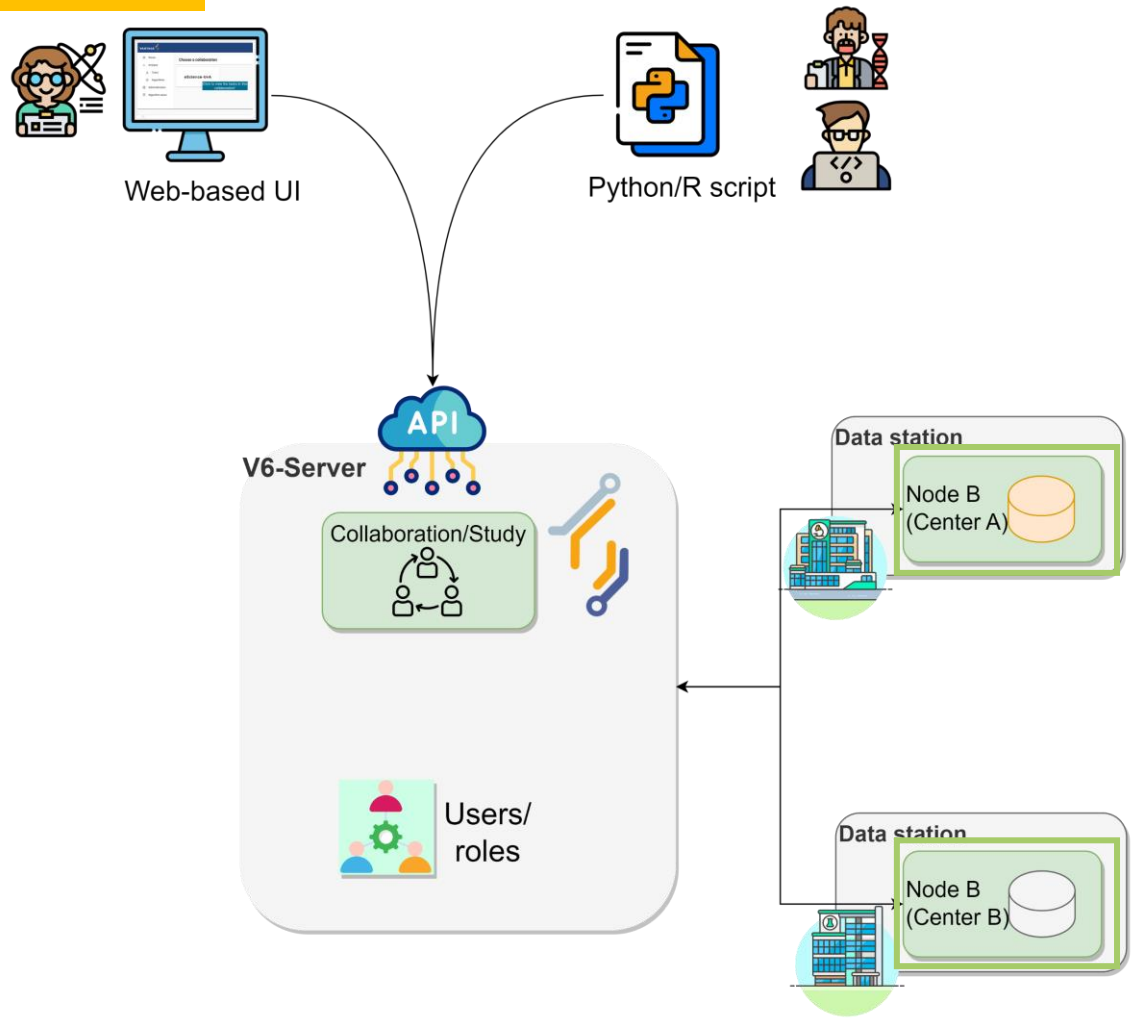
**Which is the result returned by the different parts?**

They want to compute the average age:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{34 + 42 + 28 + 49 + 51 + 23 + 44}{4 + 3} = \frac{1}{n_a + n_b}\sum_{i=1}^{n_a} a_i + \sum_{i=1}^{n_b} b_i$$

# Who computes what?

**SOLUTION**




$$S_a = \sum_{i=1}^{n_a} a_i = 34 + 42 + 28 + 49$$

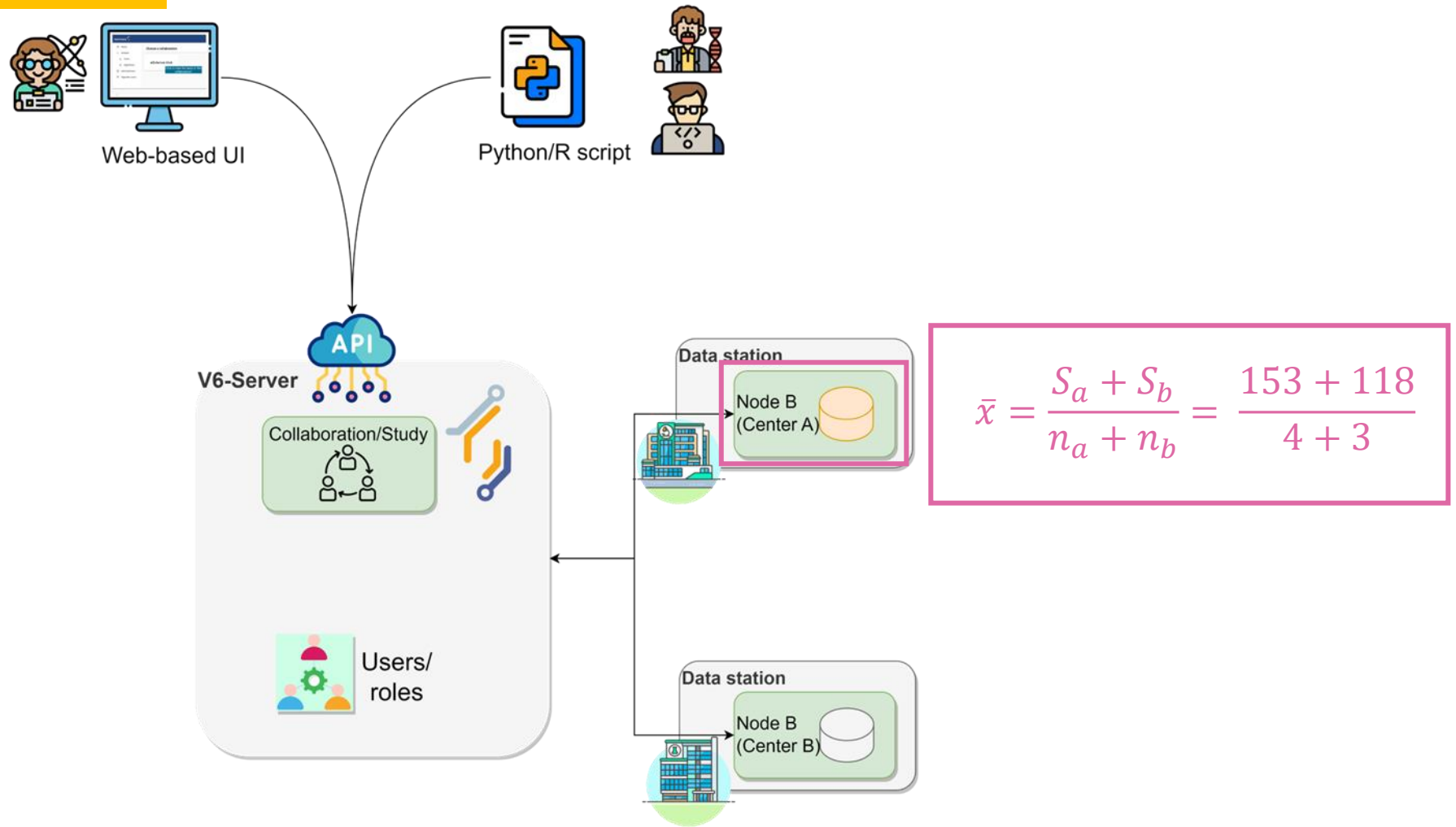
$$n_a = 3$$

$$S_b = \sum_{i=1}^{n_b} b_i = 51 + 23 + 44$$

$$n_b = 3$$

# Who computes what?

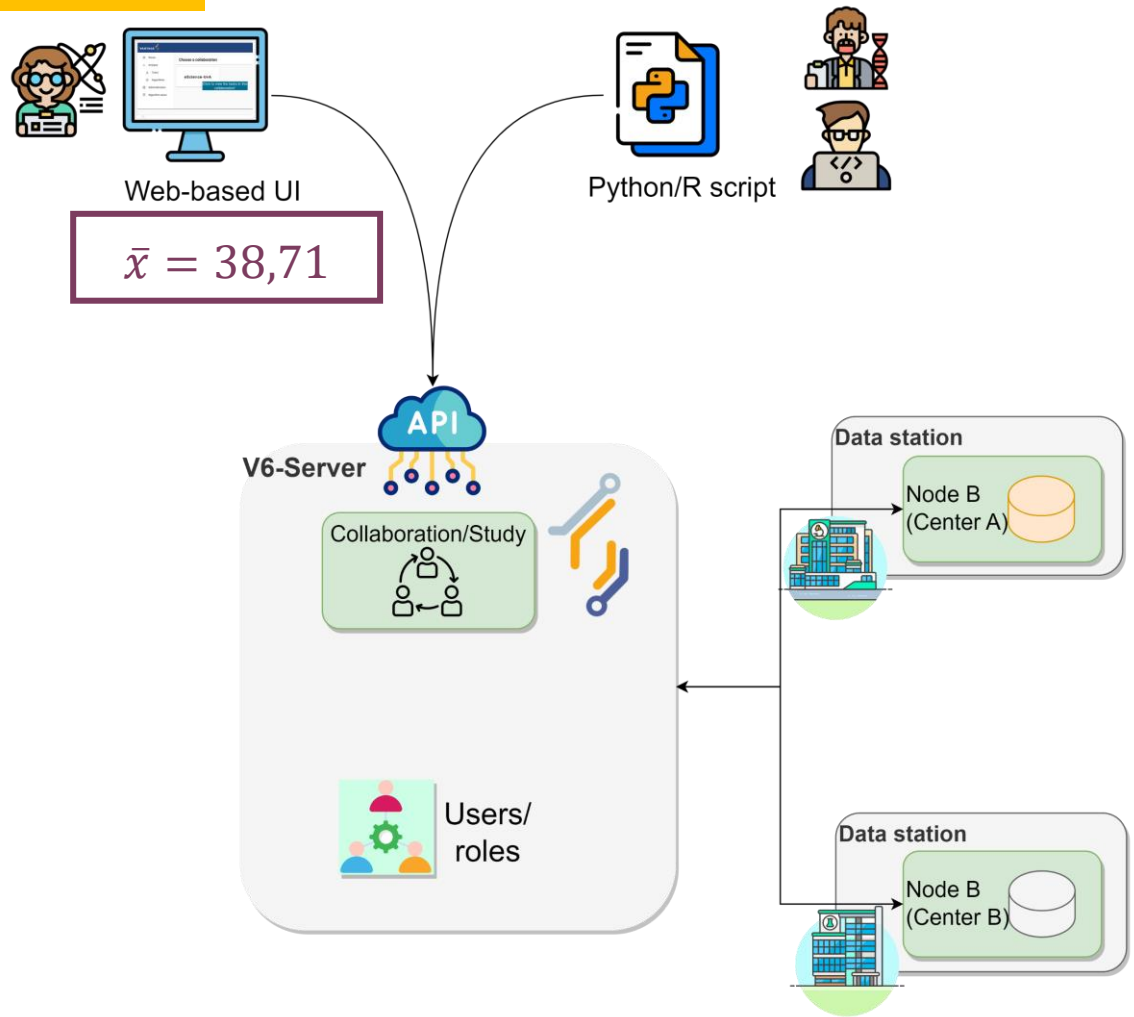
**SOLUTION**




$$\bar{x} = \frac{S_a + S_b}{n_a + n_b} = \frac{153 + 118}{4 + 3}$$

# Who computes what?

**SOLUTION**



# Future developments of vantage6

VANTAGE WORKSHOP

- **Policies**: we want to extend the current available policies to a more generic policy framework in which any aspect of the vantage6 platform can be controlled by policies. This will maximize the flexibility of the platform and make it easier to adapt to new use cases.

- **Model repository**: Currently, vantage6 is focused on privacy enhancing techniques. Some of these techniques result in a model that can be used to make predictions. We want to extend vantage6 with a model repository in which these models can be stored, shared and used. This will make it easier to reuse models and to compare the performance of different models.