From theory to practice

Running a PET analysis (without programming) on vantage6

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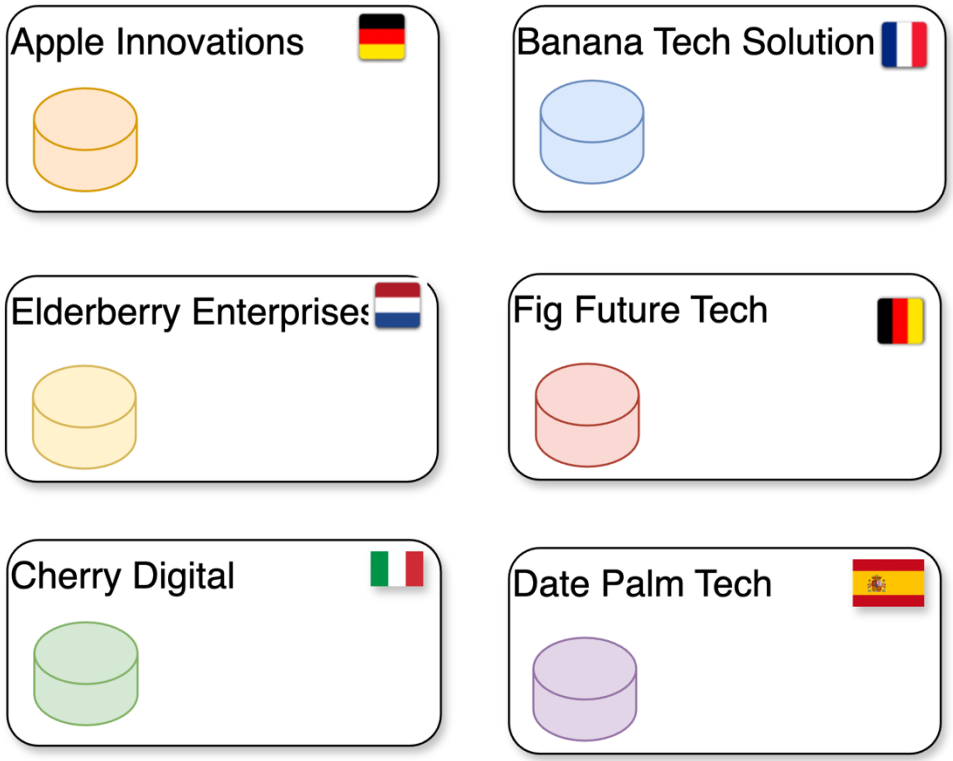
A theoretical scenario

VANTAGE

- An international consortium of research organizations working together on aging research.



gender	age	height	weight	isOverweight	ageGroup
M	39	152	108	False	30 - 40
M	8	118	106	False	0 - 10
M	16	161	110	True	10 - 20
M	94	110	115	True	90 - 100
M	47	117	152	True	40 - 50
F	29	127	110	True	20 - 30
M	5	95	65	False	0 - 10
M	39	142	196	False	30 - 40
F	20	189	112	False	20 - 30
F	84	145	116	False	80 - 90

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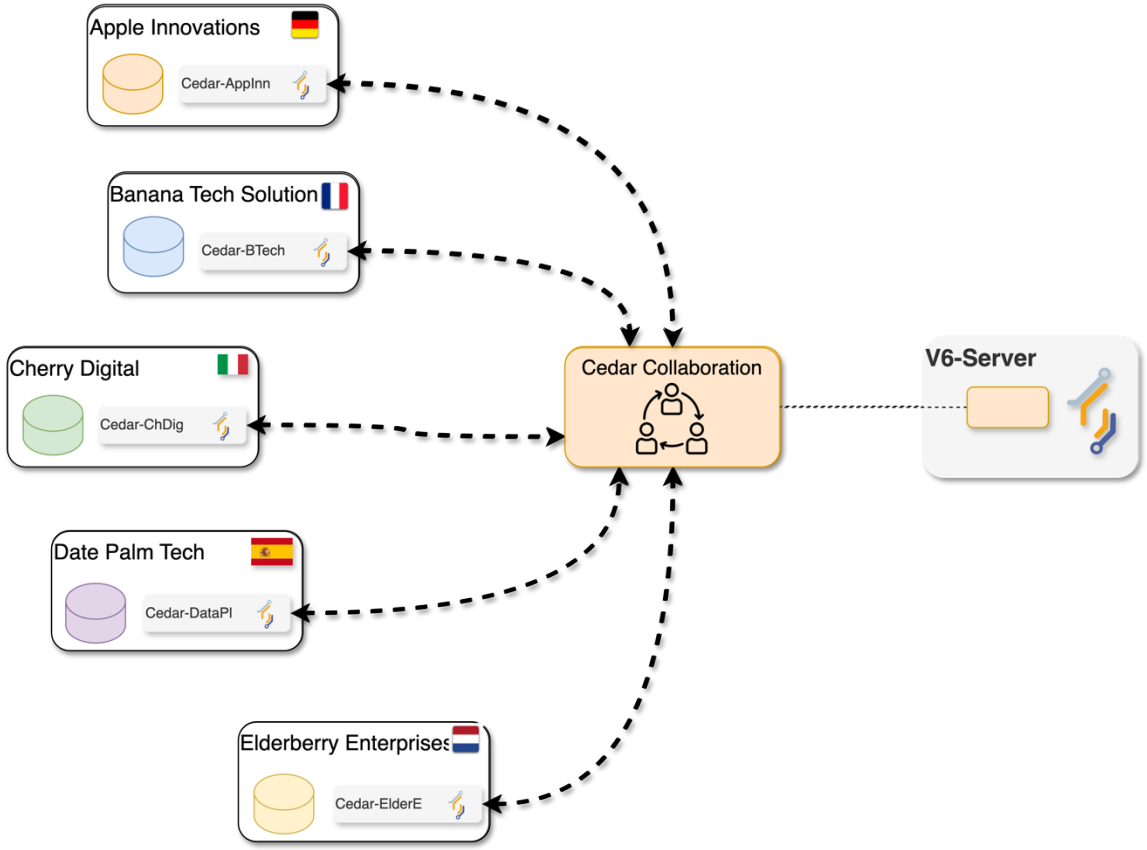
The scenario – checking v6 concepts!



- Six organizations, one collaboration.
- How many nodes need to be set up?

Node

- Where are these nodes installed?

The scenario – checking v6 concepts!

VANTAGE

The consortium (from now on also referred as the **collaboration**) will initially focus on two different projects, each one involving different organizations:

- *Age-Related Variations in Overweight Prevalence: A Comparative Analysis Across Gender and Age Groups* **(AGOT2024)** : *four organization with relevant data.*

- *The Effect of Gender on Height Development Across Various Age Groups* **(GGA2024)**: *three organization with relevant data.*

Which V6 concept is applicable here?

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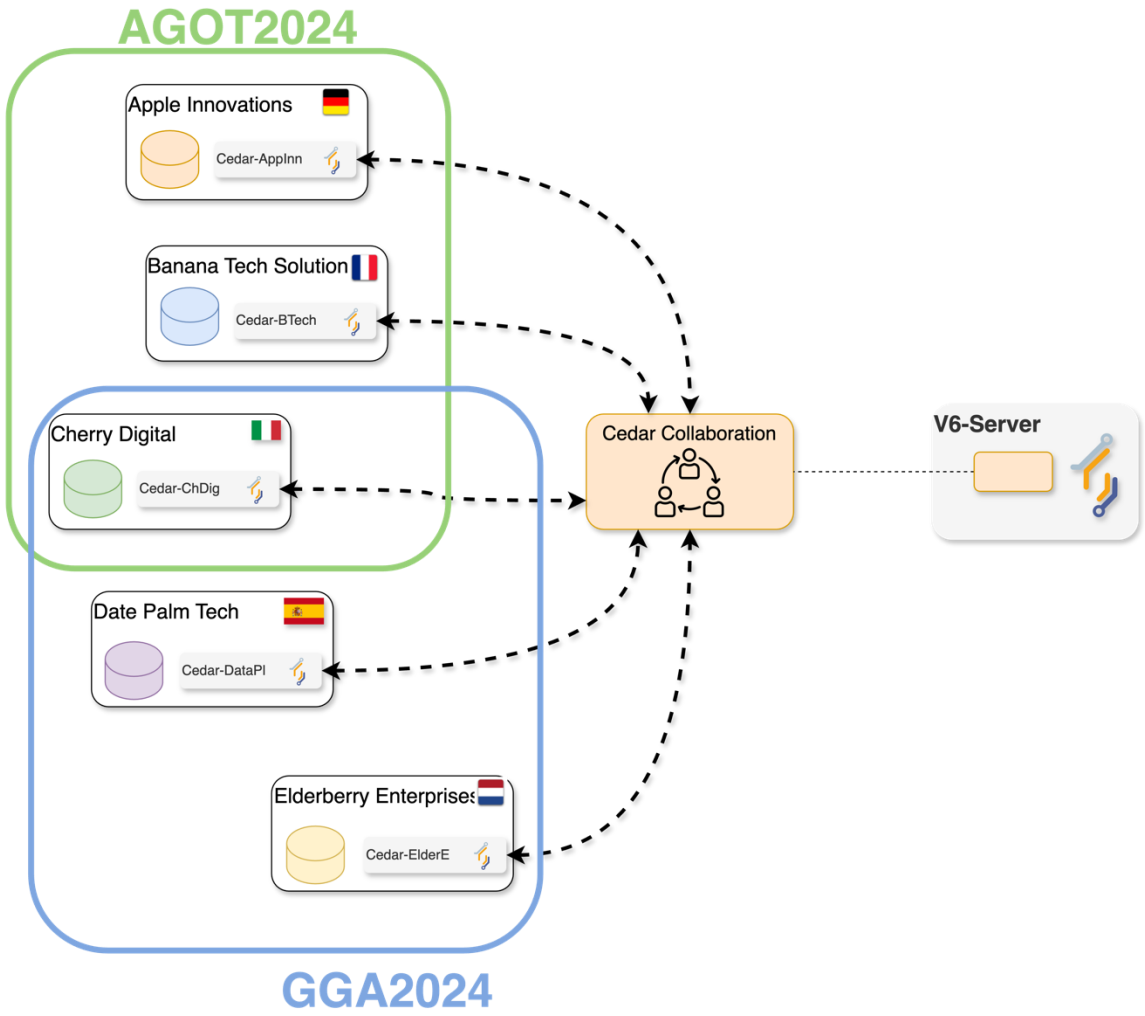
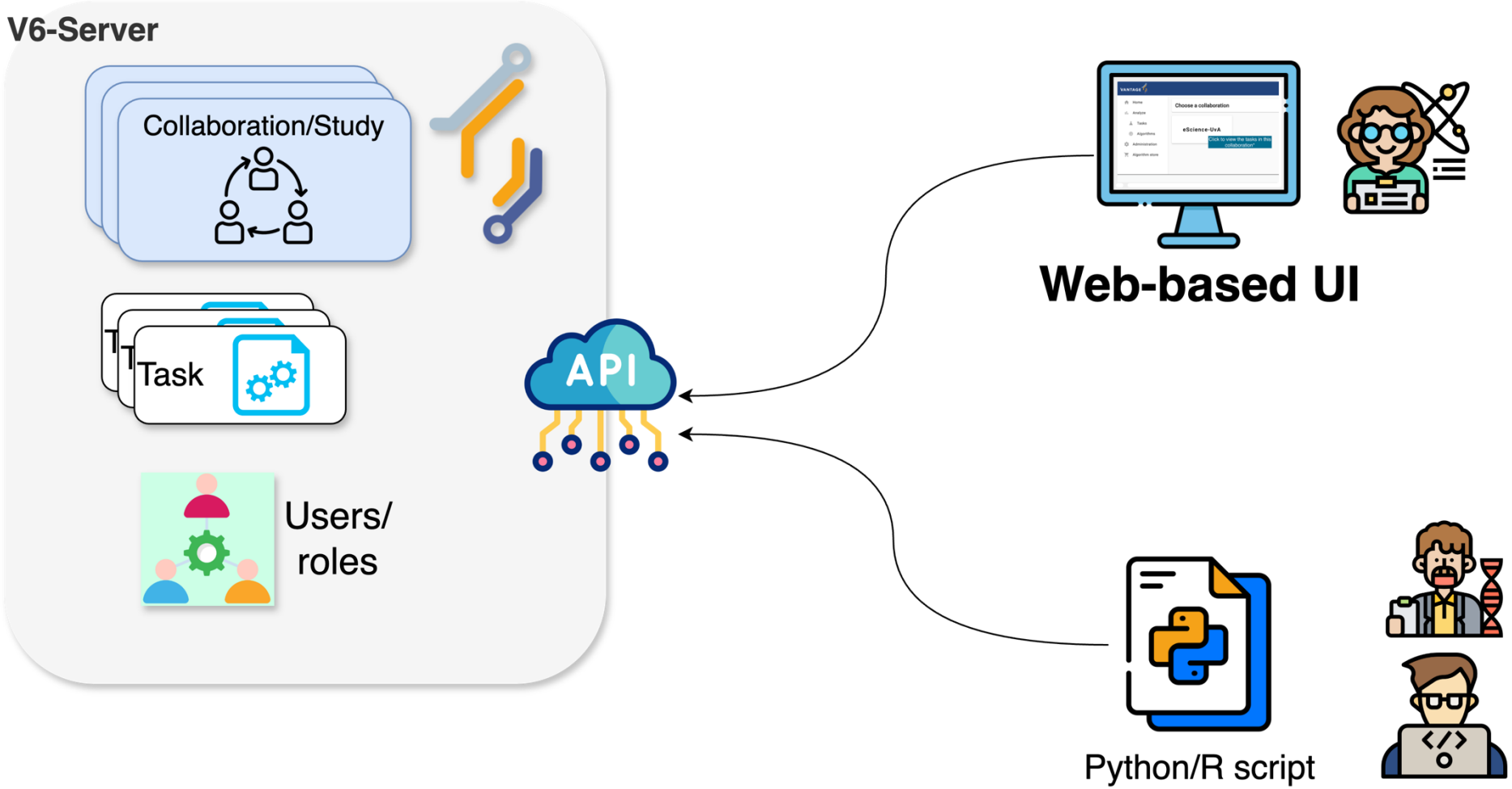
The scenario – checking v6 concepts!



- Two studies: GGA2024, AGOT2024.
- Your setup may be different!

How to conduct an analysis?

VANTAGE



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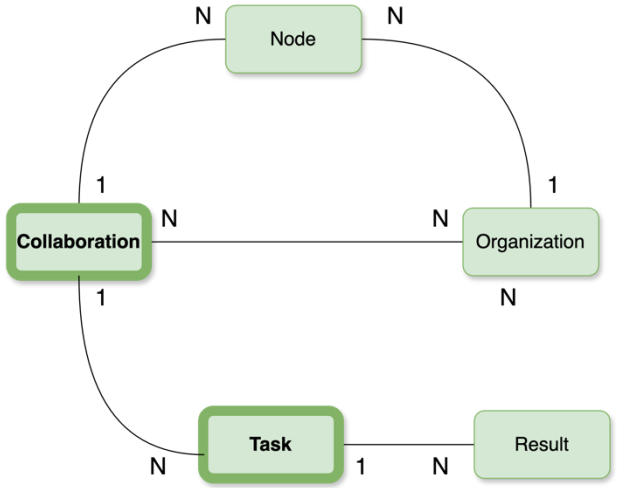
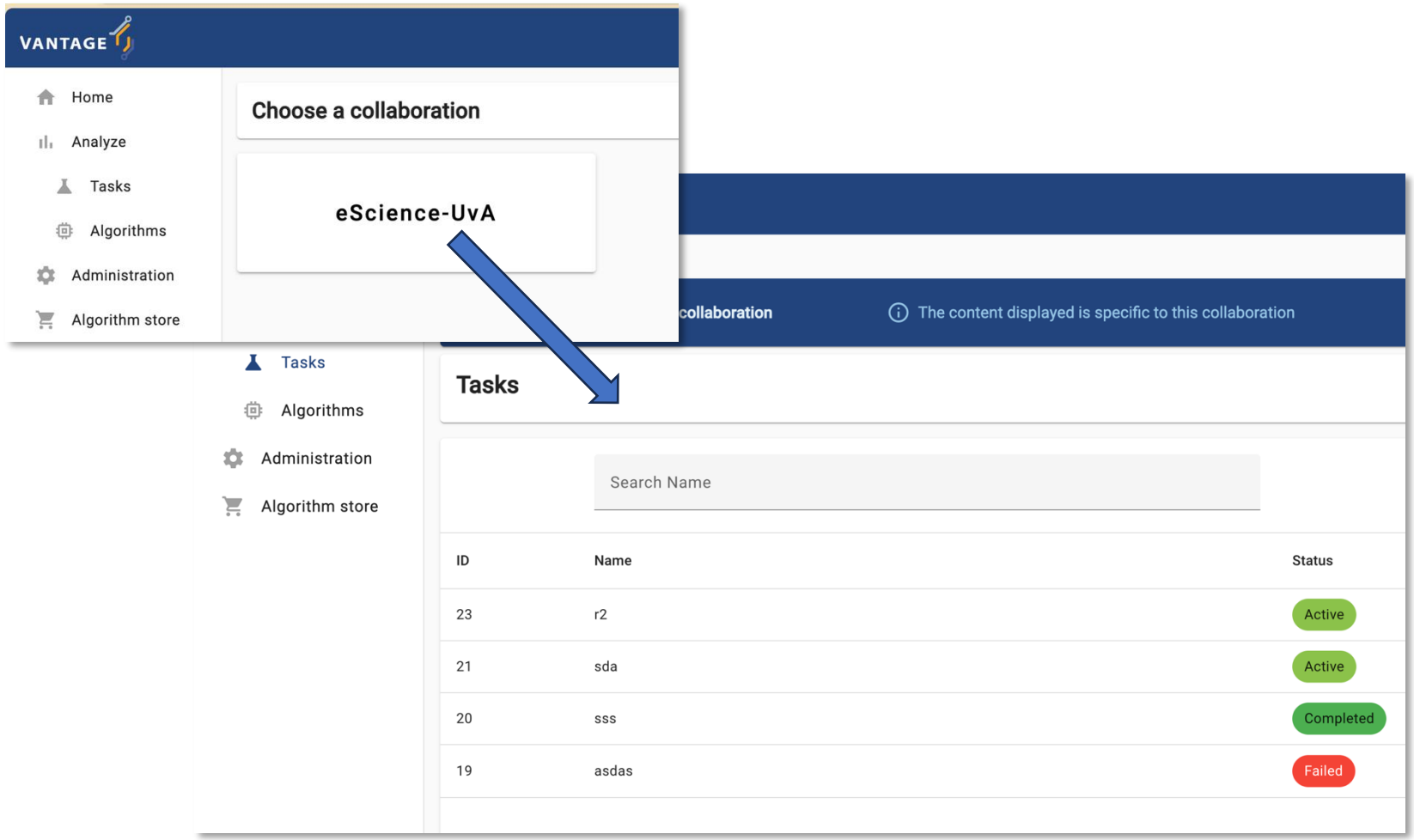
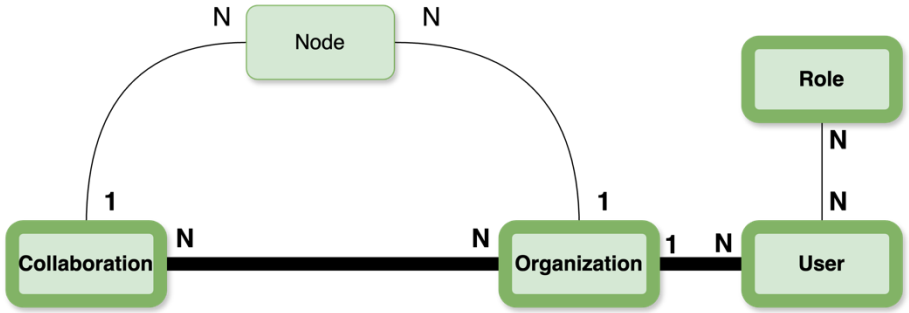
In this episode: web-based UI





Web-based UI


N
Node
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Role
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1
1
Collaboration
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N
Organization
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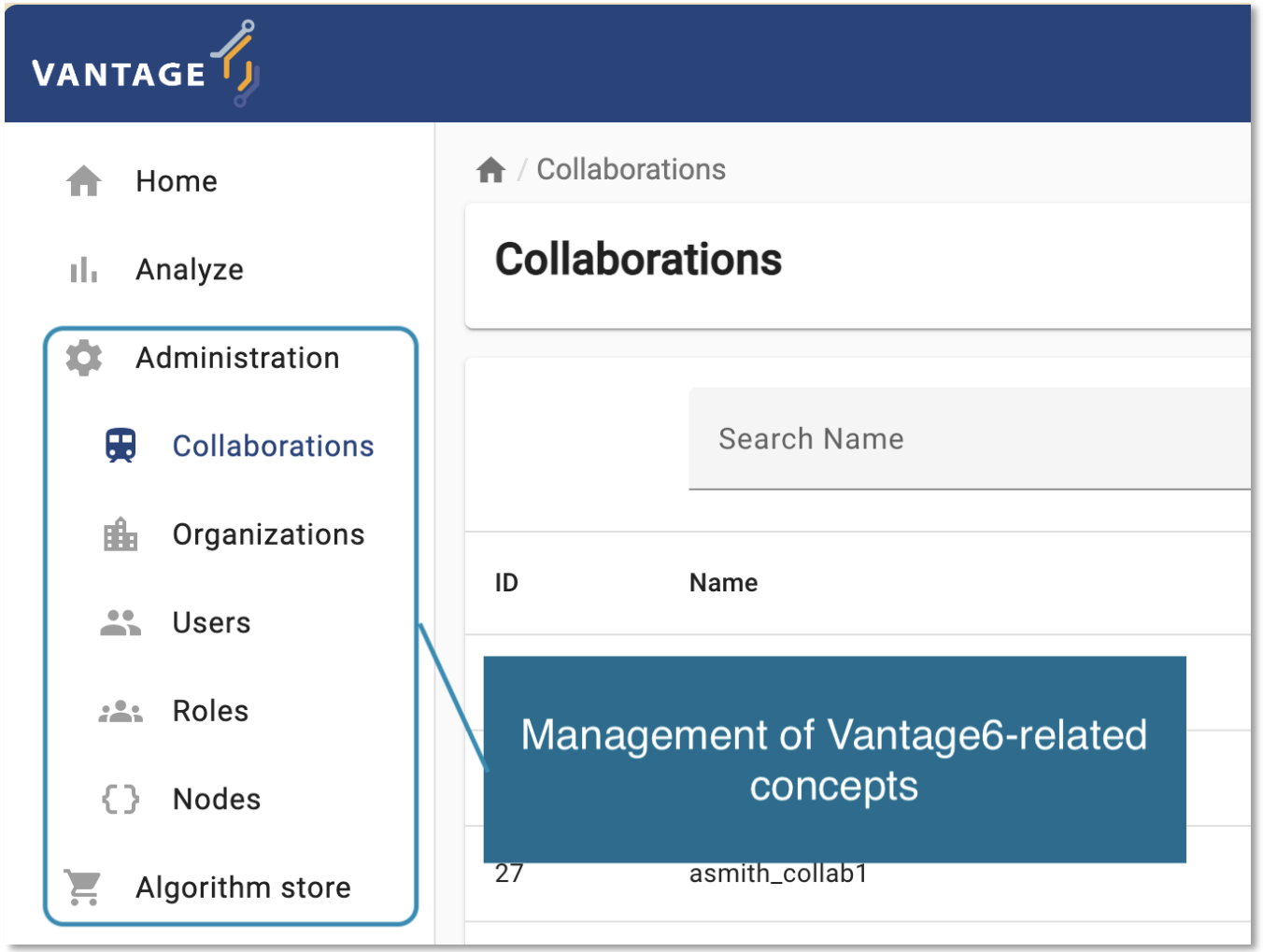
User


VANTAGE
Home
Analyze
Administration
Collaborations
Organizations
Users
Roles
Nodes
Algorithm store
/ Collaborations
Collaborations
Search Name
ID
Name
27
asmith_collab1
Management of Vantage6-related concepts

Getting familiar with the UI

VANTAGE

CHALLENGE 1

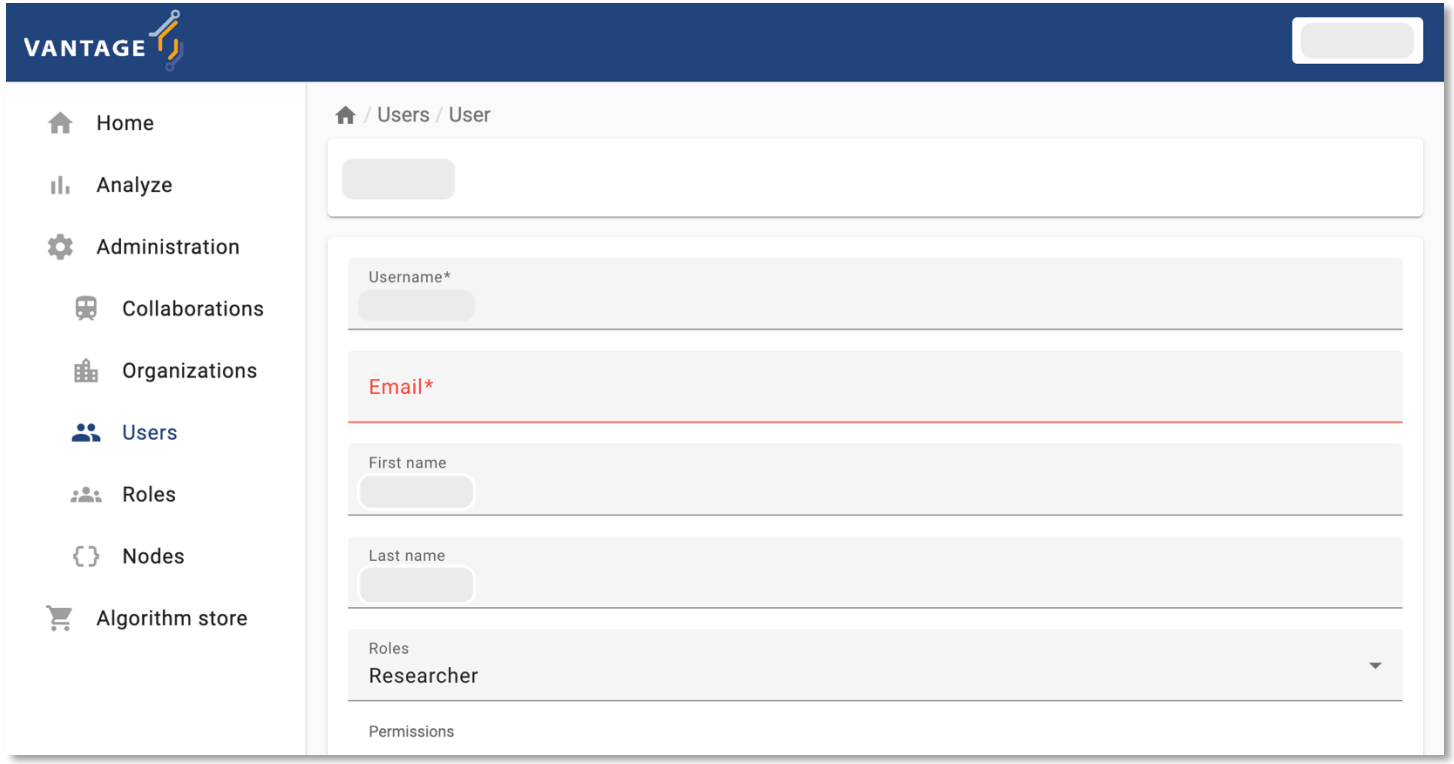
Log into the UI using the information provided and navigate to the administration page. Then, update your email, first name, and last name.

HINT
Use the **Users** option on the Administration panel on the left.

Getting familiar with the UI

VANTAGE

SOLUTION



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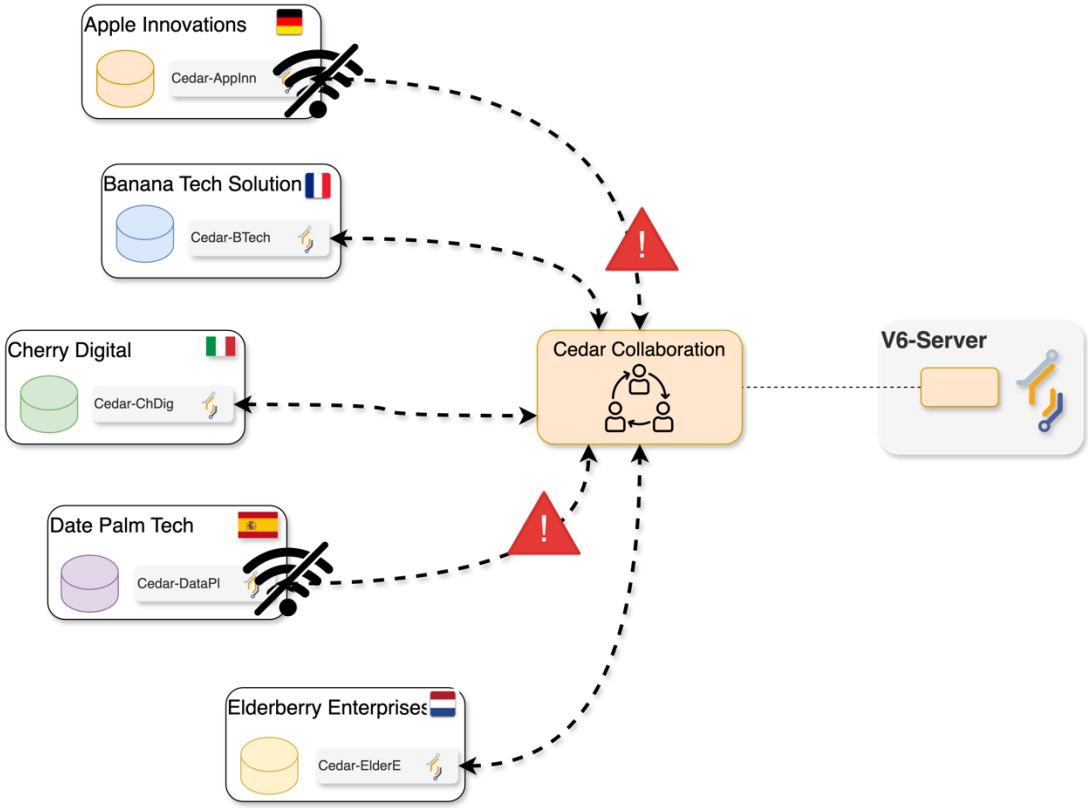
Running a PET: federated analysis

VANTAGE

Are the nodes on my collaboration or study ready for a federated analysis?

- Node within a collaboration: autonomously managed by its corresponding organization.
- Some could be offline.
- UI is handy for checking this!



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Running a PET: federated analysis

VANTAGE

CHALLENGE 2

With your researcher credentials, explore the collaboration you have access to. Check which organizations are part of it and if they are online. Then, check which organizations were assigned to each study: **AGOT2024**, **GGA2924**.

1. Which study is ready for a federated analysis?
2. If you need to perform an analysis for the study that is **not** ready, which organization you would need to contact to fix this situation?

** Take note of which Study is not ready, and the name of the 'offline' organization.*

HINT
Use the **Collaborations** option on the Administration panel on the left.

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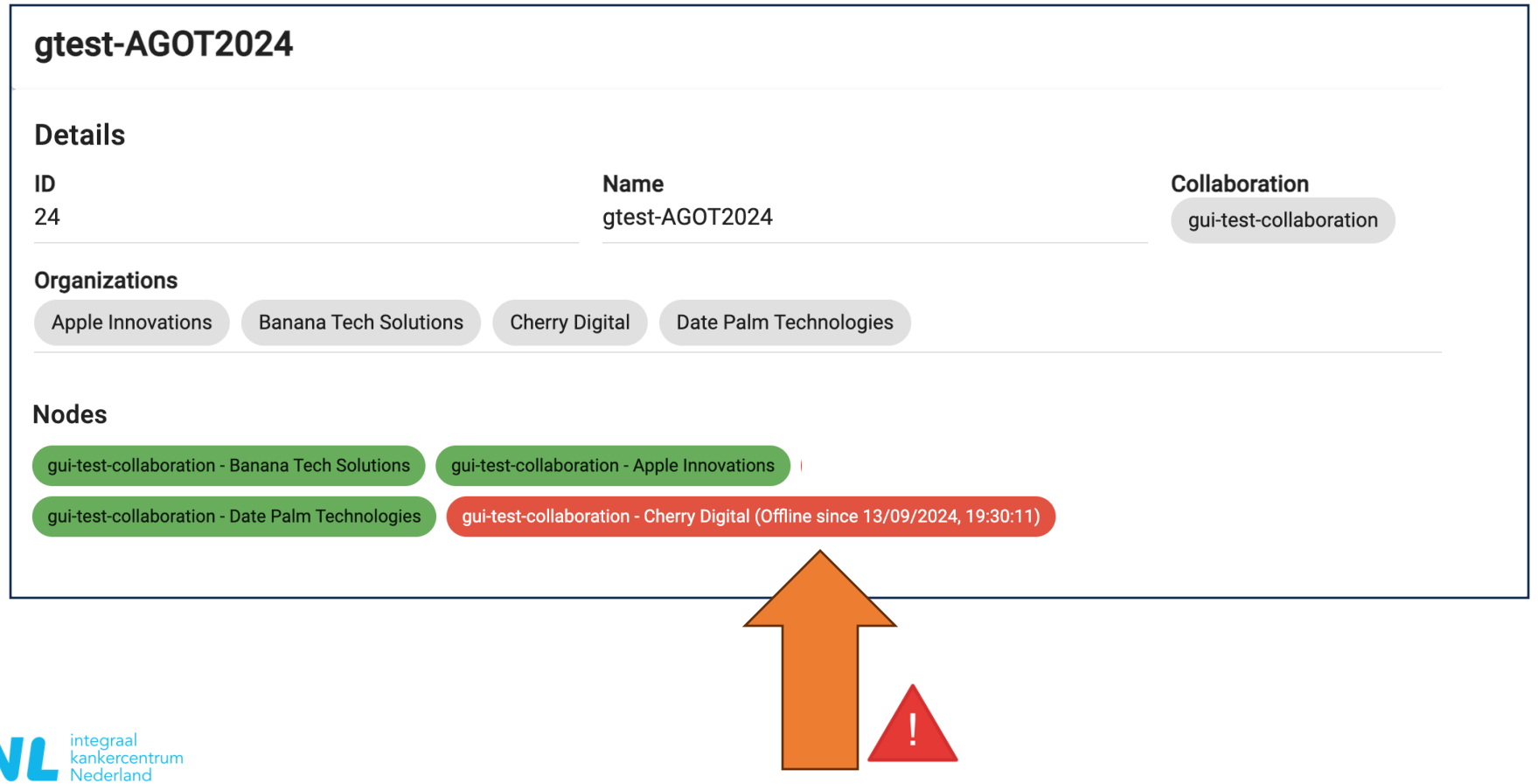
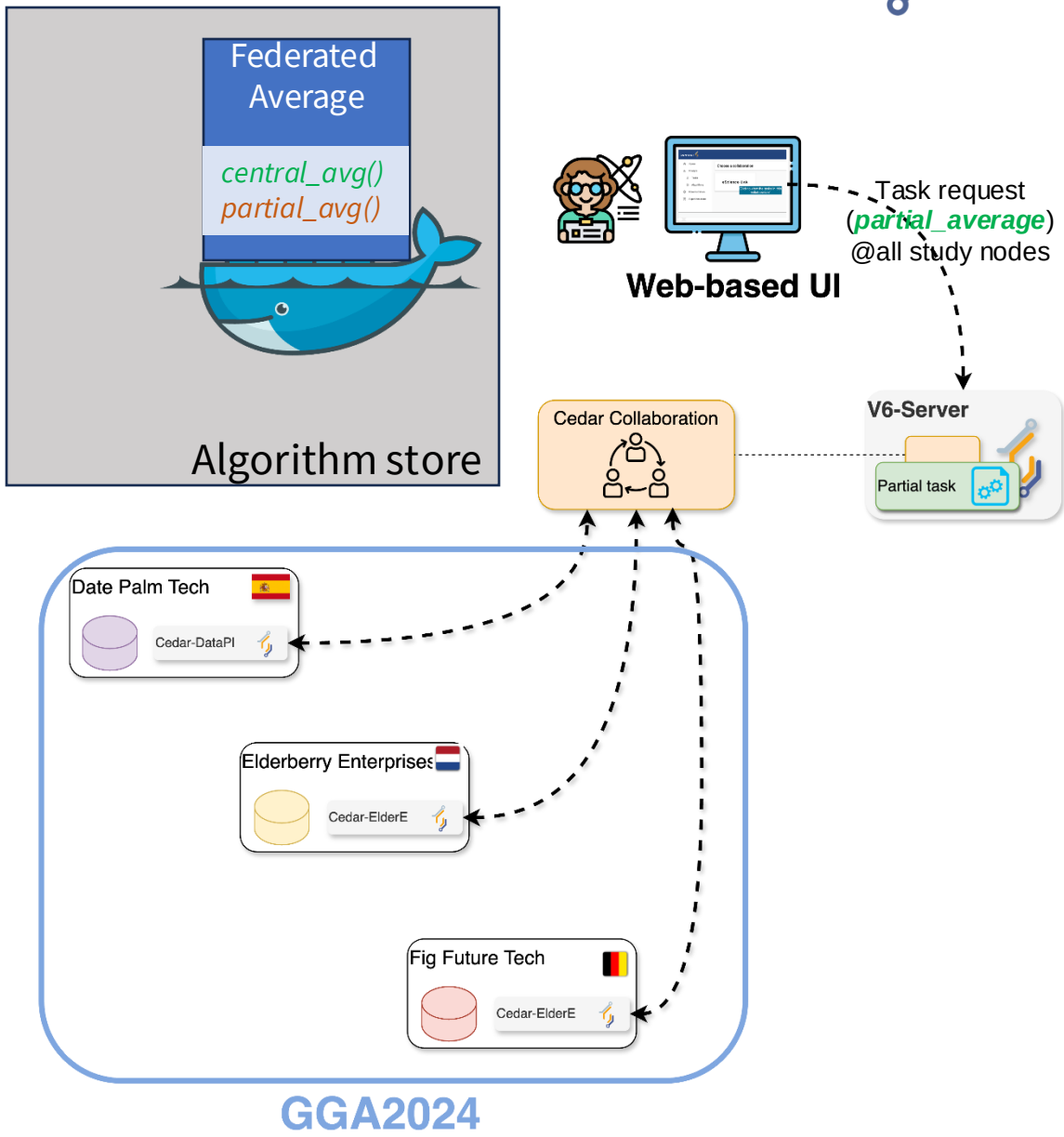
Getting familiar with the UI

SOLUTION



Running a PET: federated analysis

- Creating a new task:
  - You will run the ***partial_average*** function, of the ***Federated Average algorithm***, on **all** the nodes of a study (the one with no offline nodes).



Running a federated algorithm

VANTAGE

CHALLENGE 3

Create your first task!

- Use the *study* with **no** offline nodes.
- **Give your own name to the task so you can find it later.**
- Choose the Average algorithm.
- Select the ***partial_average*** function and all the organizations within the study.
- Choose the ***default*** database.
- Choose a numerical variable as the input.

The task you just requested should be listed with a 'pending' status. Once finished, download the JSON results and open them on a text editor.

- What does the content of these files mean? Why the results are formatted like that?

gender	age	height	weight	isOverweight	ageGroup
M	39	152	108	False	30 - 40
M	8	118	106	False	0 - 10
M	16	161	110	True	10 - 20
M	94	110	115	True	90 - 100
M	47	117	152	True	40 - 50
F	29	127	110	True	20 - 30
M	5	95	65	False	0 - 10
M	39	142	196	False	30 - 40
F	20	189	112	False	20 - 30
F	84	145	116	False	80 - 90

HINT
The data on 'default' databases on all the nodes looks like this ☝.

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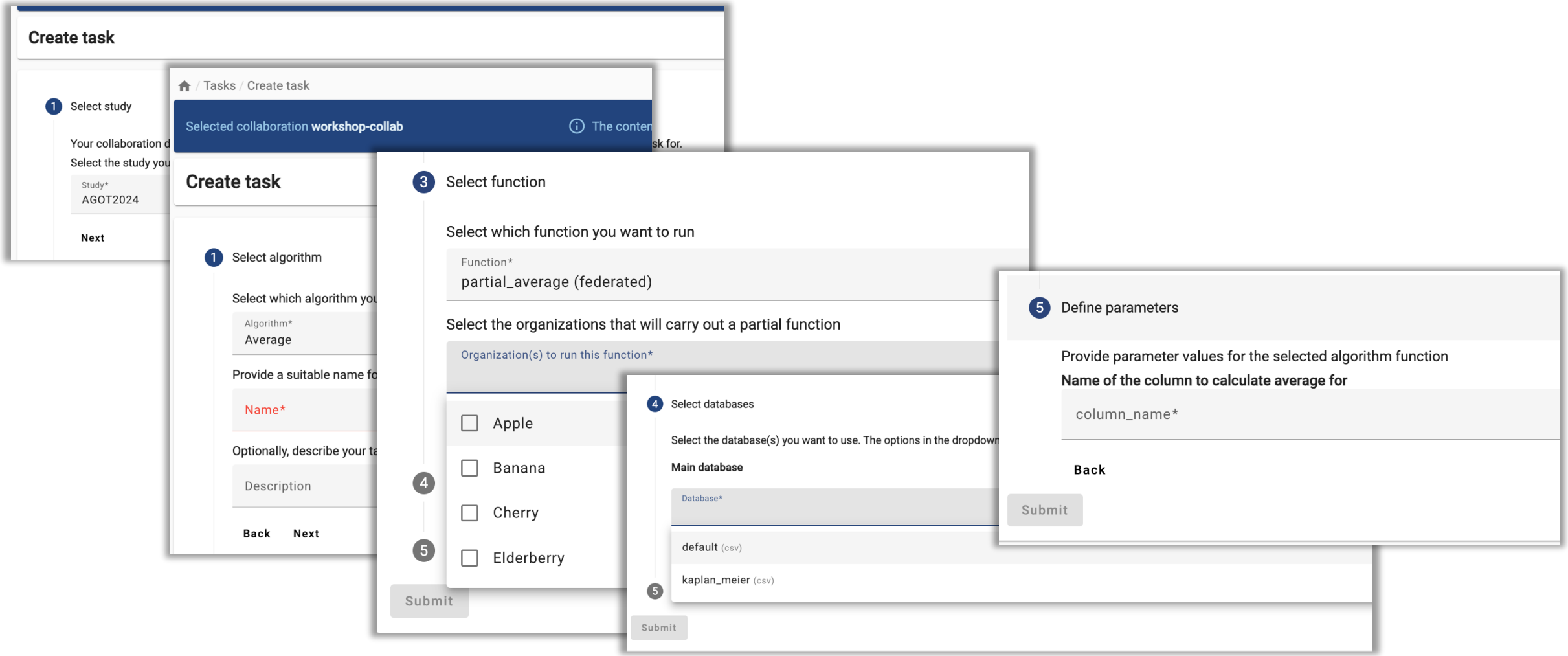
Running a federated algorithm

VANTAGE

SOLUTION



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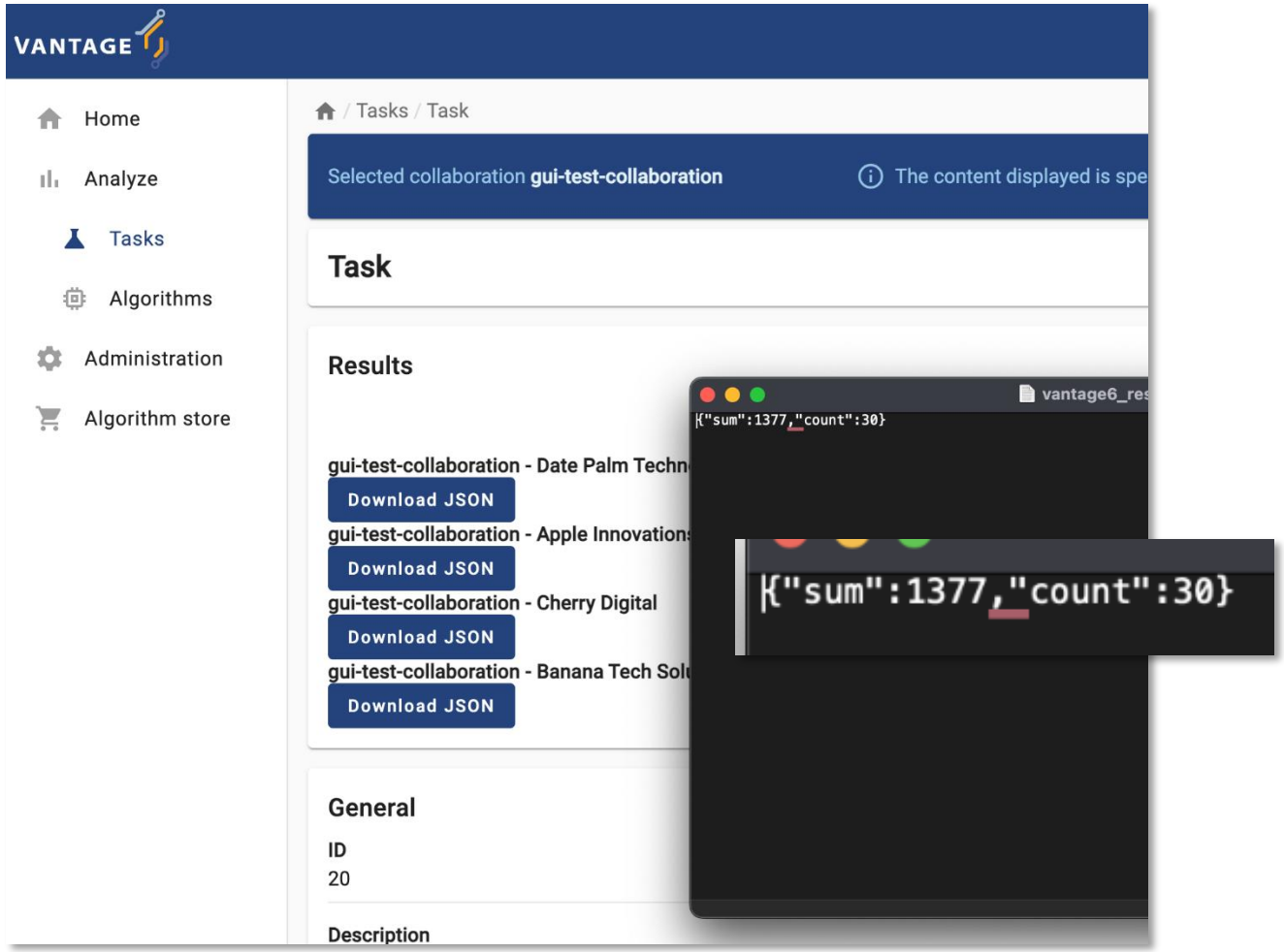
Getting familiar with the UI

VANTAGE

SOLUTION

The ***partial_average*** returns the two values needed by the central function of the ‘federated average’ algorithm, as described in Chapter 2: the number of records within the database, and their sum.

The algorithm is ‘encoding’ these values as a JSON document, so they can used later (e.g., by another function or program).



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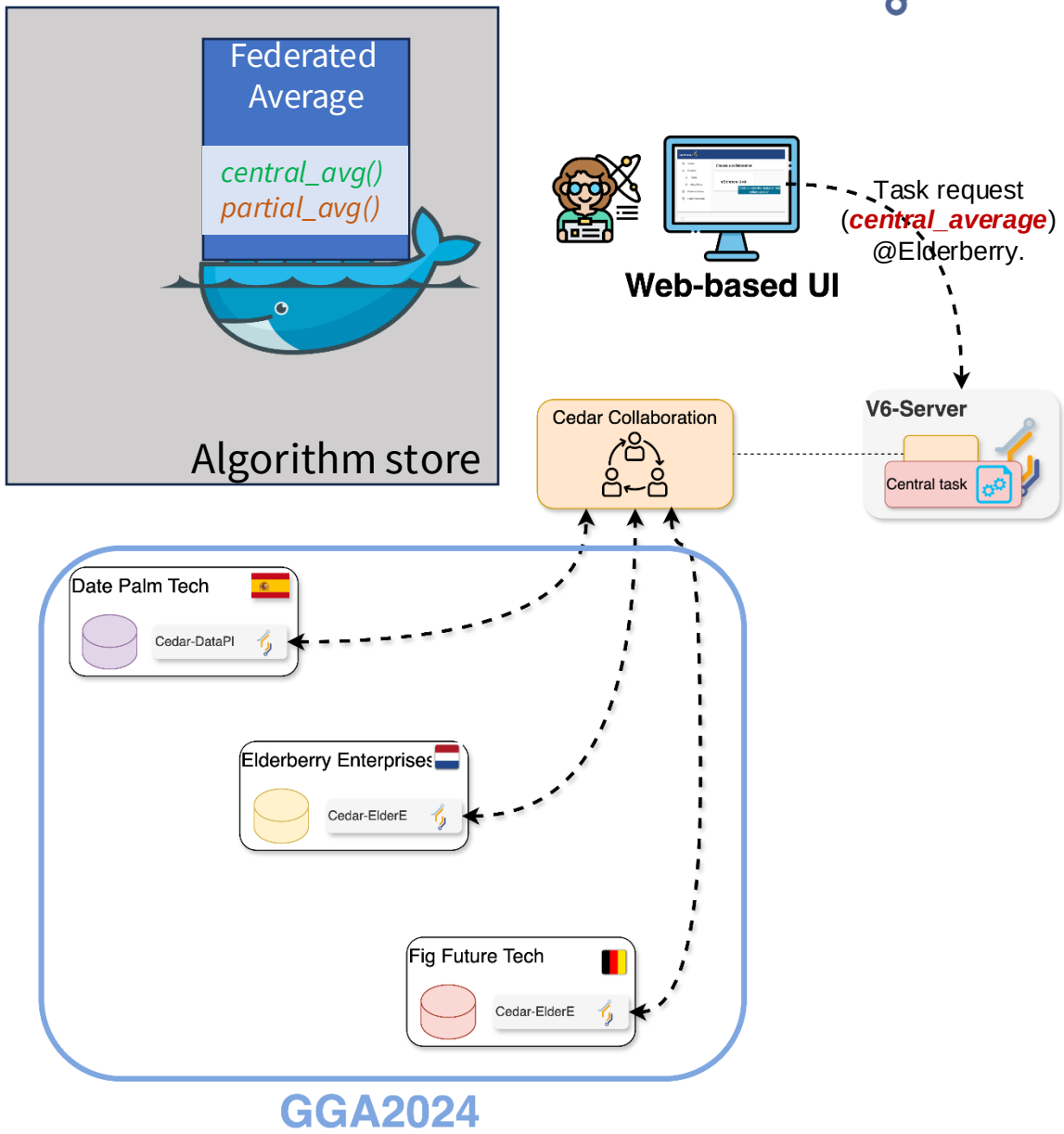
Running a PET: federated analysis

- Let's create yet another task.
  - This time you will run the ***central_average*** function, of the ***Federated Average algorithm***, on **one** of the study nodes (once again, on the study with **no** offline nodes).



Running a federated algorithm

VANTAGE

CHALLENGE 4

Let’s see what the central function does under the hood!

- Use the study with **no** offline nodes.
- Choose the **Average algorithm**.
- Select the ***central_average*** function and one of the organizations within the study.
- Choose the default database.
- Choose a numerical variable as the input.

Keep an eye on the Tasks section, and see how the processes are created:

- Why does one of the nodes show up as a Main process and also as a Child one?

HINT

As soon your task is created, go to the task list and open it. See how ‘child processes’ are created.

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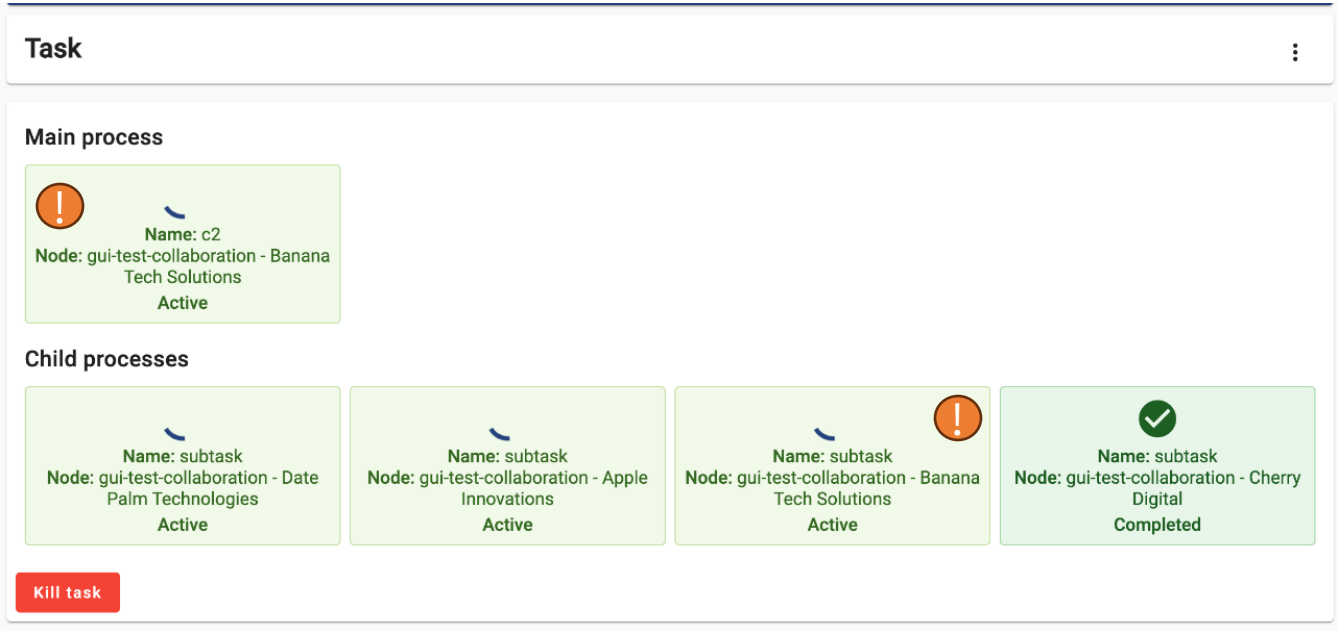
Running a federated algorithm

CHALLENGE 4



- Why does one of the nodes show up as a Main process and as a Child one?

Algorithm pseudo-code

VANTAGE

CHALLENGE 4

```
FUNCTION partial_average(dataset, column_name)

1   INFO("Extracting column", column_name)
2   column_values = dataset[column_name]
3
4   INFO("Computing partials")
5   local_sum = SUM(column_values)
6   local_count = SIZE(column_values)
7
8   RETURN {"sum": local_sum, "count": local_count}

END FUNCTION
```

- Why does one of the nodes show up as a Main process and also as a Child one?

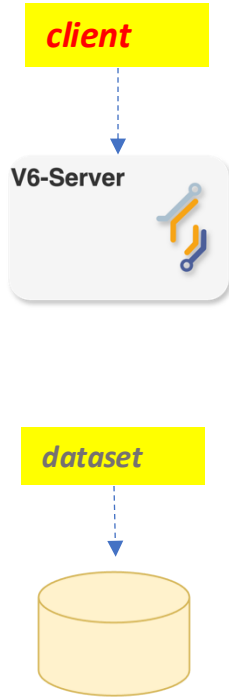
Actual python code?
https://bit.ly/v6-federated-avg

```
FUNCTION central_average(client, column_name)

1    study_orgs = client.study.list()
2
3
4   INFO("Requesting partial computation")
5   task = client.task.create(
6      function = "partial_average"
7      column = column_name
8      organizations = study_orgs
9   )
10
11  INFO("Waiting for results")
12  results = client.wait_for_results(task)
13
14  global_sum = 0
15  global_count = 0
16
17  FOR EACH output IN results
18     global_sum = global_sum + output.sum
19     global_count = global_count + output.count
20
21  average = global_sum/global_count
22
23  RETURN {"average": average}

END FUNCTION
```

HINT



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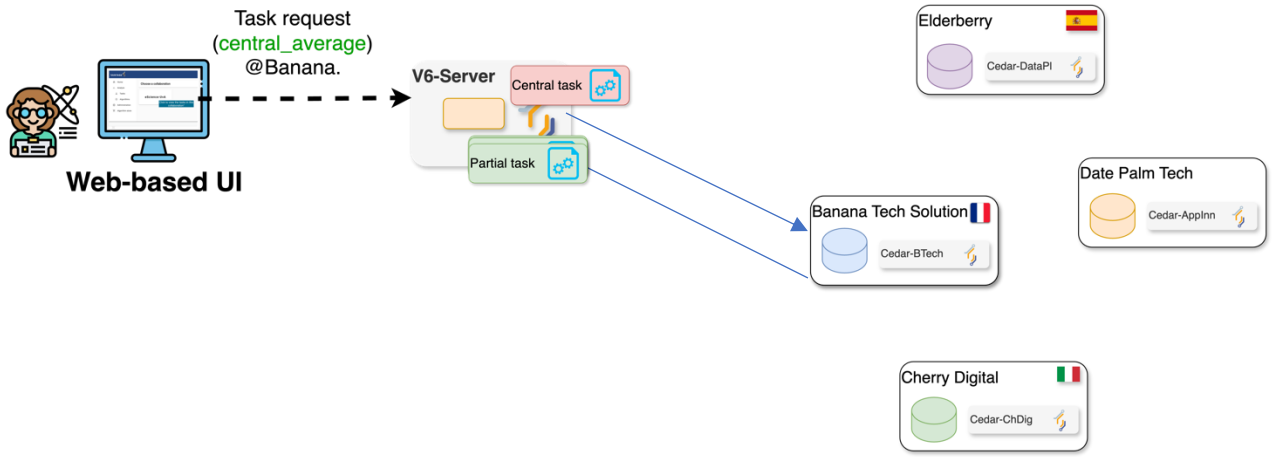
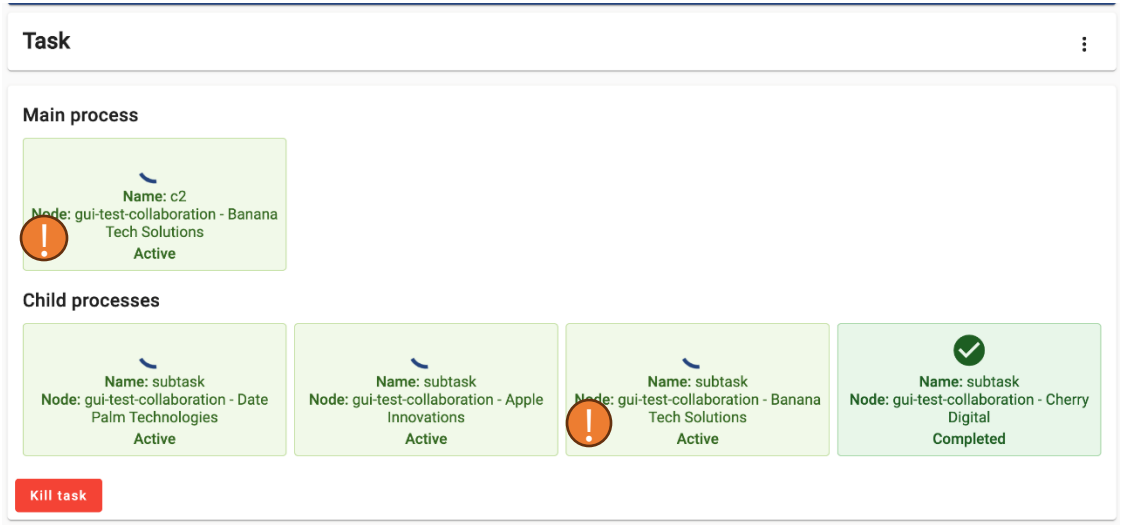
Getting familiar with the UI

VANTAGE

SOLUTION

The **Task** with the **central_average** function, when executed by a node, requests **all** the nodes within the **Study** to run the **partial_average** one. This particular node is also part of the **Study**, so in the end it gets his own request!





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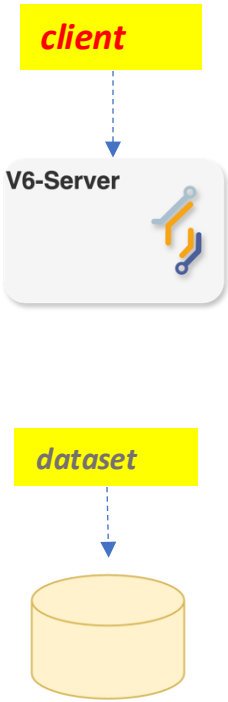
Revisiting key concepts…

VANTAGE

```
FUNCTION partial_average(dataset, column_name)

1  INFO("Extracting column", column_name)
2  column_values = dataset[column_name]
3
4  INFO("Computing partials")
5  local_sum = SUM(column_values)
6  local_count = SIZE(column_values)
7
8  RETURN {"sum": local_sum, "count": local_count}

END FUNCTION
```

- Why does the ***central_average*** function, unlike ***partial_average***, **not** get any ***dataset*** as an input?
- Why does the ***partial_average*** function, unlike ***central_average***, **not** get any ***client*** as an input?

```
FUNCTION central_average(client, column_name)

1    study_orgs = client.study.list()
2
3
4  INFO("Requesting partial computation")
5  task = client.task.create(
6      function = "partial_average"
7      column = column_name
8      organizations = study_orgs
9  )
10
11 INFO("Waiting for results")
12 results = client.wait_for_results(task)
13
14 global_sum = 0
15 global_count = 0
16
17 FOR EACH output IN results
18    global_sum = global_sum + output.sum
19    global_count = global_count + output.count
20
21 average = global_sum/global_count
22
23 RETURN {"average": average}

END FUNCTION
```



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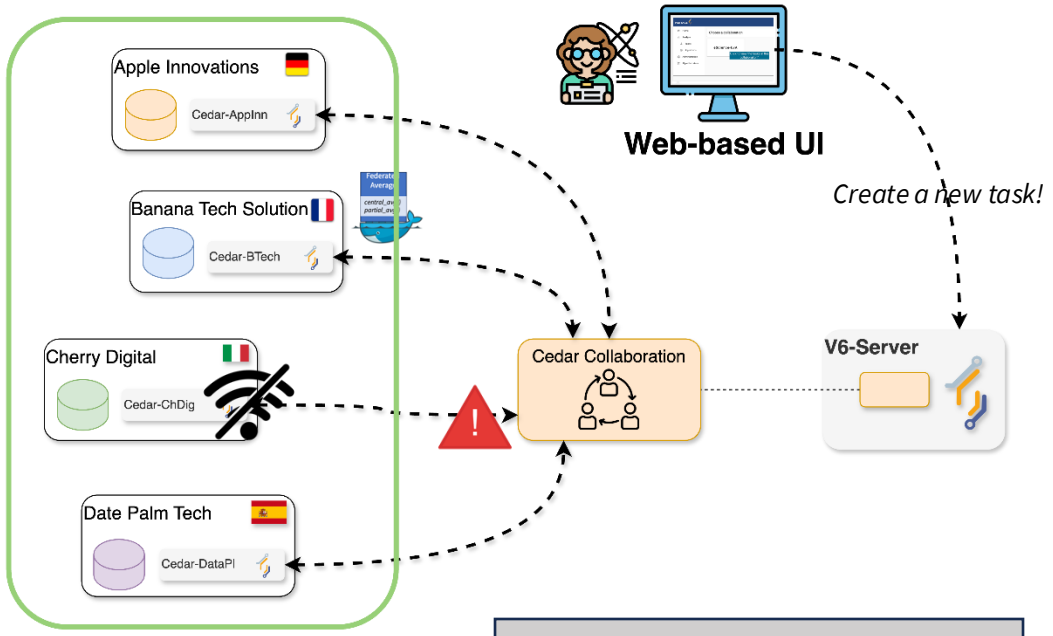
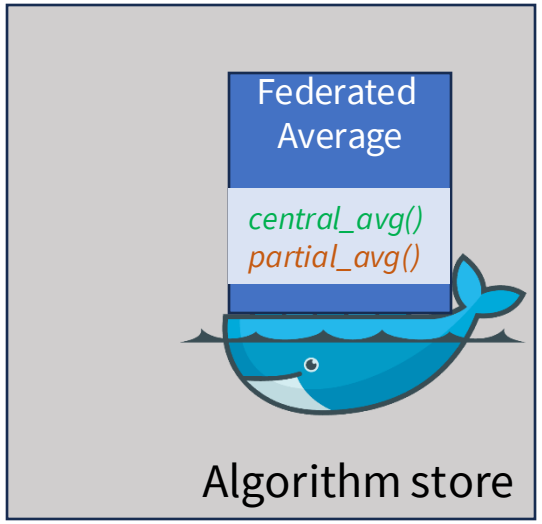
Running a PET: federated analysis

VANTAGE

Problems on a node?

- What if…
  - You run the ***central_average*** function (***Federated Average algorithm)***, on the study that has an **offline** node?





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Running a federated algorithm

VANTAGE

CHALLENGE 5

handling problems through the UI!

- Use the study that has **an offline node**.
- Choose the **Average algorithm**.
- Select the ***central_average*** function and an **online** organizations within the study.
- Choose the *default* database.
- Choose a numerical variable as the input.

What happened with the task? Why?

FUNCTION central_average(client, column_name)

```
1    study_orgs = client.study.list()
2
3
4   INFO("Requesting partial computation")
5   task = client.task.create(
6      function = "partial_average"
7      column = column_name
8      organizations = study_orgs
9   )
10
11  INFO("Waiting for results")
12  results = client.wait_for_results(task)
13
14  global_sum = 0
15  global_count = 0
16
17  FOR EACH output IN results
18     global_sum = global_sum + output.sum
19     global_count = global_count + output.count
20
21  average = global_sum/global_count
22
23  RETURN {"average": average}
```

END FUNCTION

HINT

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Getting familiar with the UI

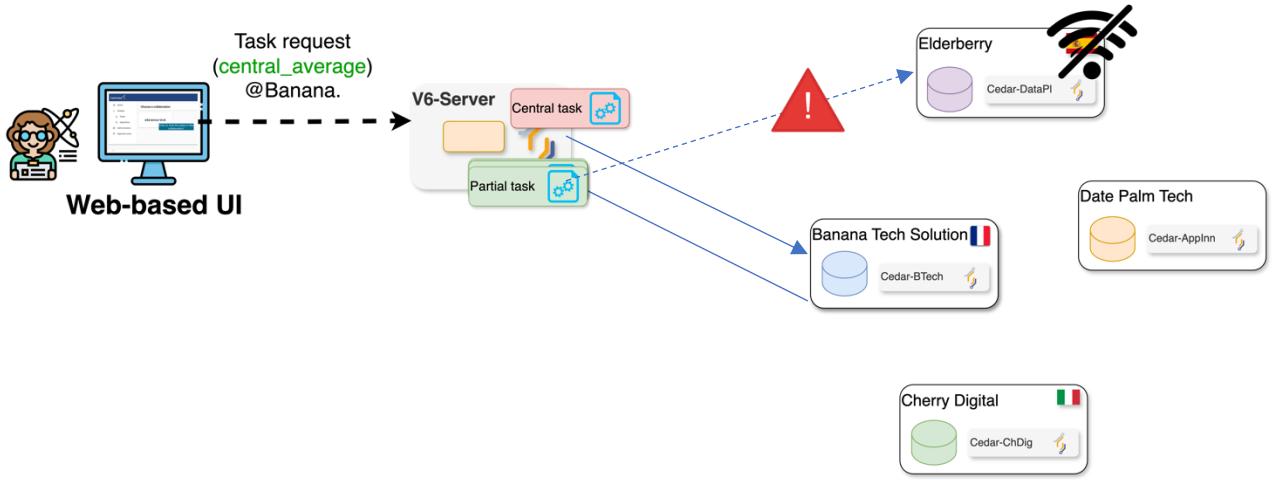
VANTAGE

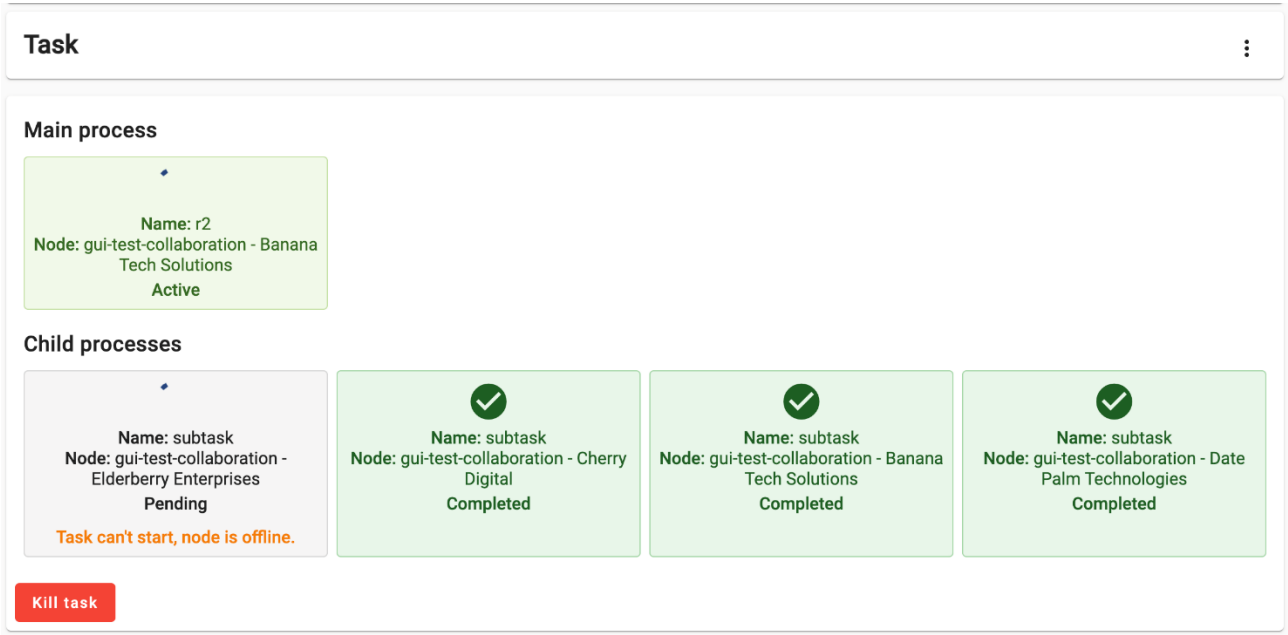
SOLUTION

The algorithm didn’t crash.

The Central task requests all the nodes in the study to run the ‘partial’ function. As the server is unable to transfer this request to the offline node, this child process is kept on hold, until the node is back online.

Consequently, the Main process is also kept on hold, and the process stays with an ‘Active’ status indefinitely (or until the node is back online).





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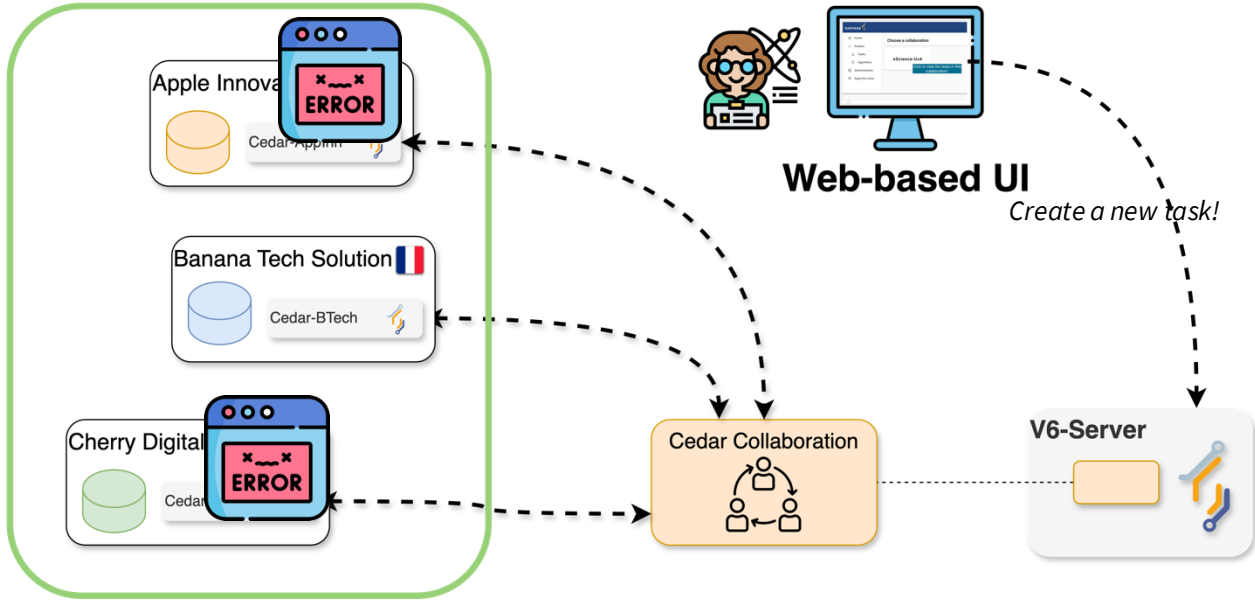
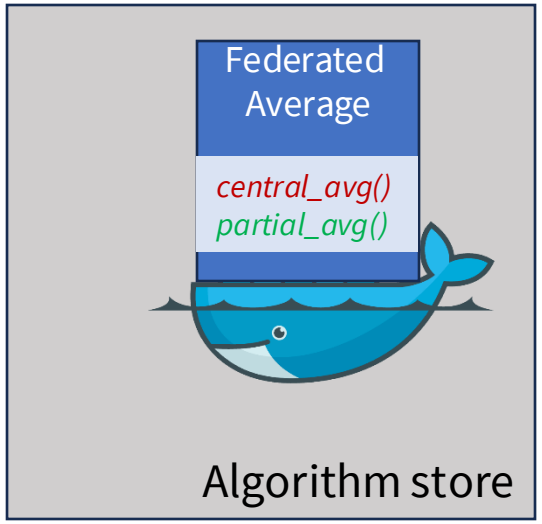
Running a PET: federated analysis

VANTAGE

Problems at the code level?

- What if…
  - You run the ***central_average*** function (***Federated Average algorithm)***, *and later on* a node gets a runtime error? (e.g., a code bug, unexpected input, etc.)





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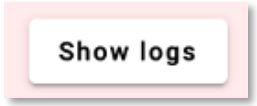
Running a federated algorithm

VANTAGE

CHALLENGE 6

Handling problems through the UI!

- Use the study that has **no** offline nodes.
- Choose the **Average algorithm**.
- Select the ***central_average*** function and one of the organizations within the study.
- Choose the default database.
- Choose the **ageGroup** variable as the input.

Look at the error logs. 

What was the cause of the failure of the ***partial_average***? What about the ***central_average***?

gender	age	height	weight	isOverweight	ageGroup
M	39	152	108	False	30 - 40
M	8	118	106	False	0 - 10
M	16	161	110	True	10 - 20
M	94	110	115	True	90 - 100
M	47	117	152	True	40 - 50
F	29	127	110	True	20 - 30
M	5	95	65	False	0 - 10
M	39	142	196	False	30 - 40
F	20	189	112	False	20 - 30
F	84	145	116	False	80 - 90

HINT

The error logs contain the error messages generated by the Python interpreter while running the algorithm functions. Look for messages that hint the root cause of the problem.

Running a federated algorithm

VANTAGE

CHALLENGE 6

```
FUNCTION partial_average(dataset, column_name)

1   INFO("Extracting column", column_name)
2   column_values = dataset[column_name]
3
4   INFO("Computing partials")
5   local_sum = SUM(column_values)
6   local_count = SIZE(column_values)
7
8   RETURN {"sum": local_sum, "count": local_count}

END FUNCTION
```

HINT

Look at the error logs. What was the cause of the failure of the ***partial_average***? What about the ***central_average***?

```
FUNCTION central_average(client, column_name)

1     study_orgs = client.study.list()
2
3
4   INFO("Requesting partial computation")
5   task = client.task.create(
6       function = "partial_average"
7       column = column_name
8       organizations = study_orgs
9   )
10
11  INFO("Waiting for results")
12  results = client.wait_for_results(task)
13
14  global_sum = 0
15  global_count = 0
16
17  FOR EACH output IN results
18      global_sum = global_sum + output.sum
19      global_count = global_count + output.count
20
21  average = global_sum/global_count
22
23  RETURN {"average": average}

END FUNCTION
```

HINT

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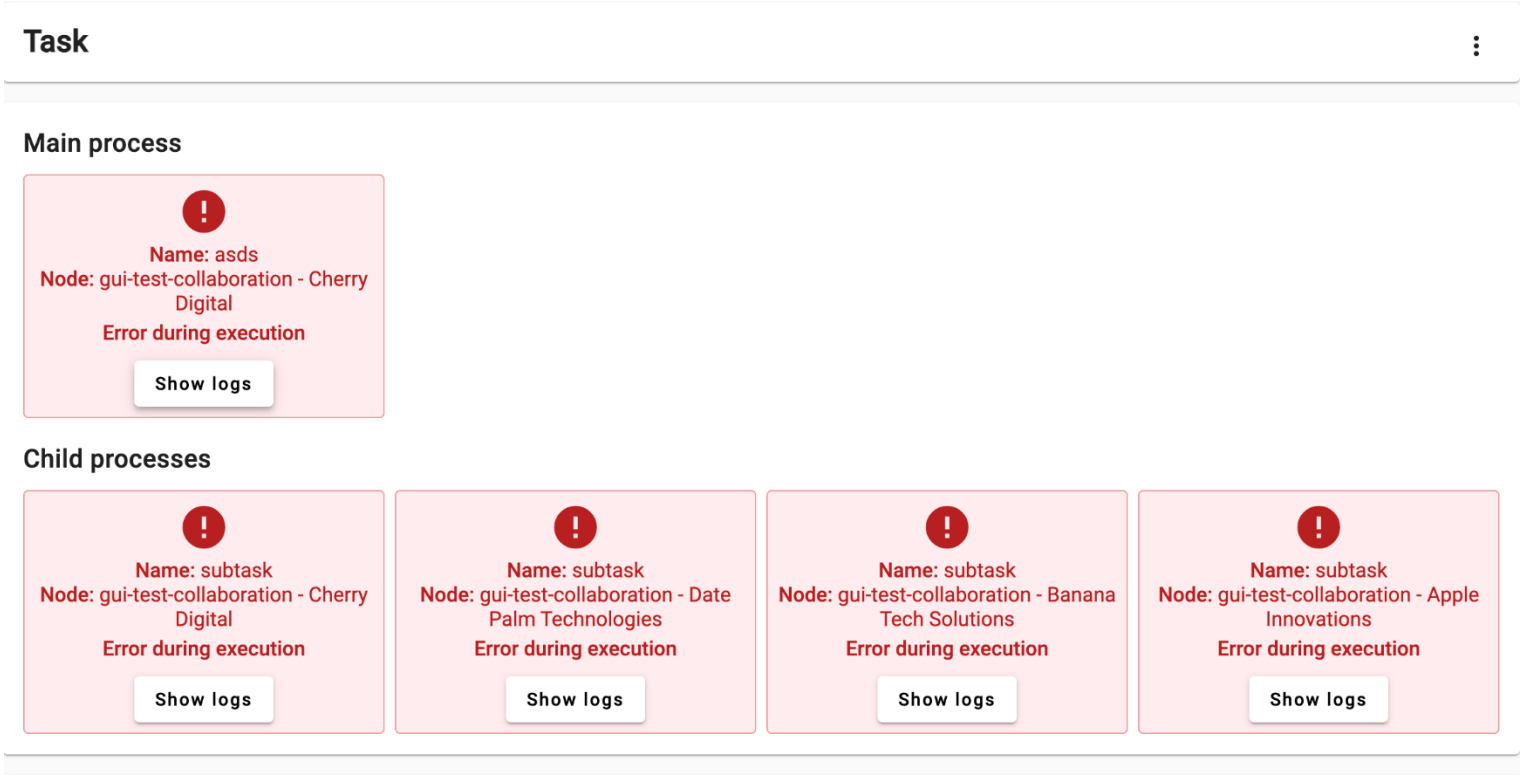
Getting familiar with the UI

VANTAGE

SOLUTION

1. This time,
   the ***partial_average*** function on all the data nodes crashes, which lead to the failure of the Main process (***central_average***).

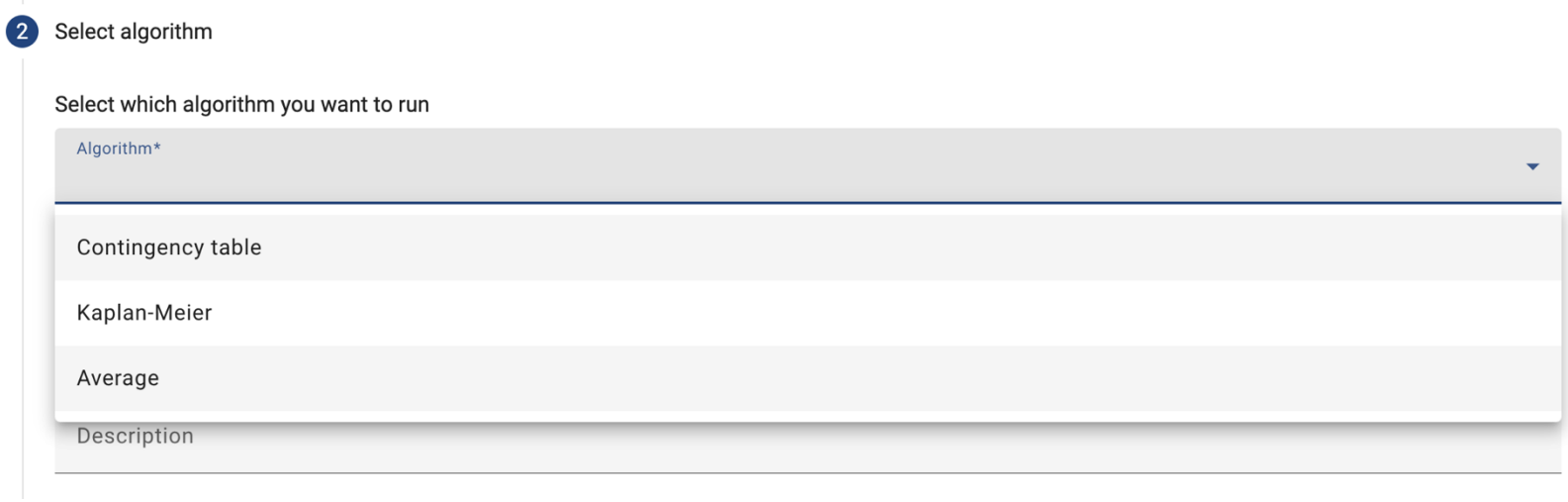
2. The ***partial_average*** crashed while trying to parse the input as a number.
   The ***central_average*** crashed due to a division-by-zero.



Play around with other algorithms

CHALLENGE 7

Try to run other (more advanced) algorithms!



HINT

For Kaplan-Meier, choose the *kaplan_meier (csv)* database!

age	months	censor	days
56	31	1	926
58	56	0	1690
62	79	0	2374
44	52	0	1569
47	55	0	1646
62	34	1	1010
63	88	0	2646
68	70	0	2105
35	103	0	3075
64	94	0	2832