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Composite AI through Serverless Orchestration

Introduction

Recent years have witnessed how technologies for cloud services are advancing at a very fast pace. Serverless services allows you to create and run applications quickly and with a lower total cost of ownership, since it is not necessary to provision and manage infrastructure. For the creation of this type of services, two tools will be used: OSCAR developed at the UPV and Node-RED developed by IBM, both open source.

- **Node-RED** (www.nodered.org**)** is a flow-based programming tool, originally developed by IBM’s Emerging Technology Services team and now a part of the OpenJS Foundation. It is a powerful tool that serves to communicate hardware and services in a fast and easy way.

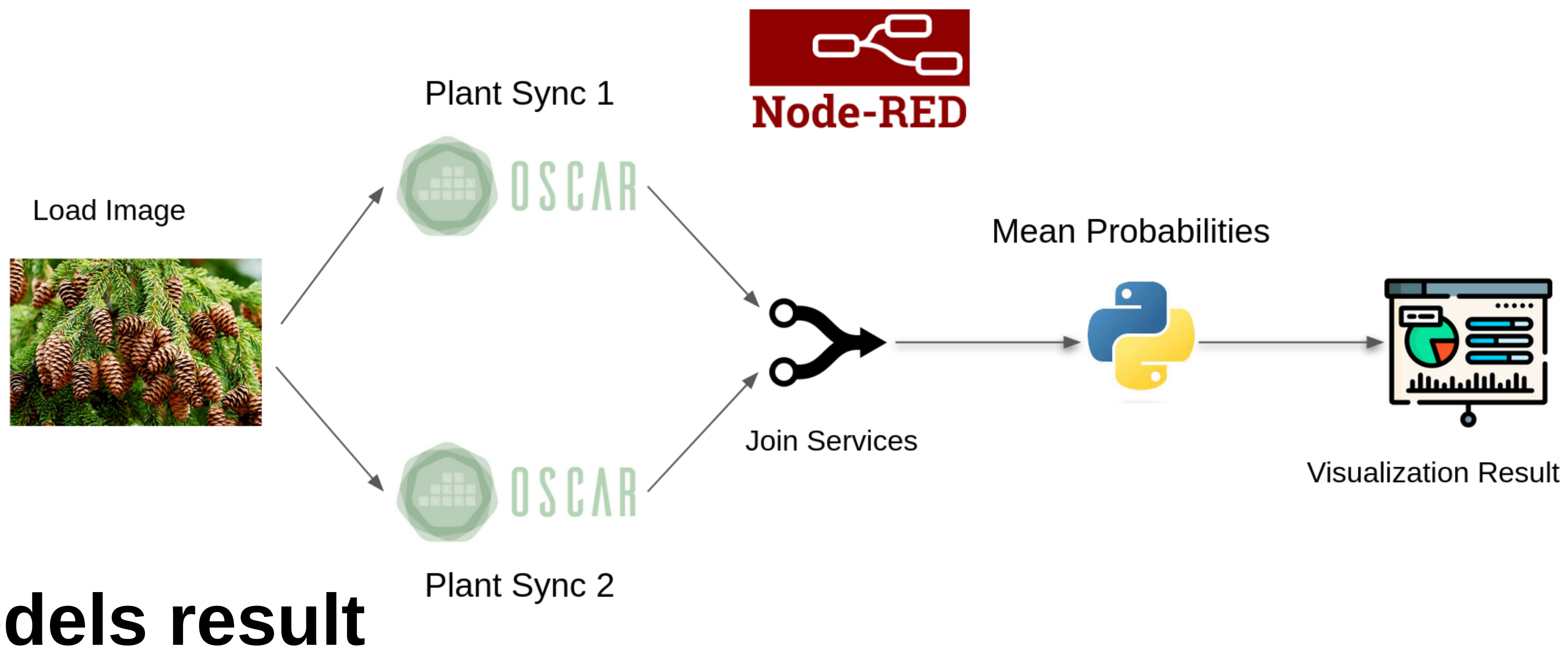
OSCAR (www.oscar.grycap.net) is a framework to efficiently support on-premises serverless applications for general-purpose data-processing computing applications. It supports a High Throughput Computing Programming Model to create highly-parallel event-driven file-processing serverless applications that execute on customized runtime environments provided by Docker containers run on AWS Lambda. [2]

General Objective

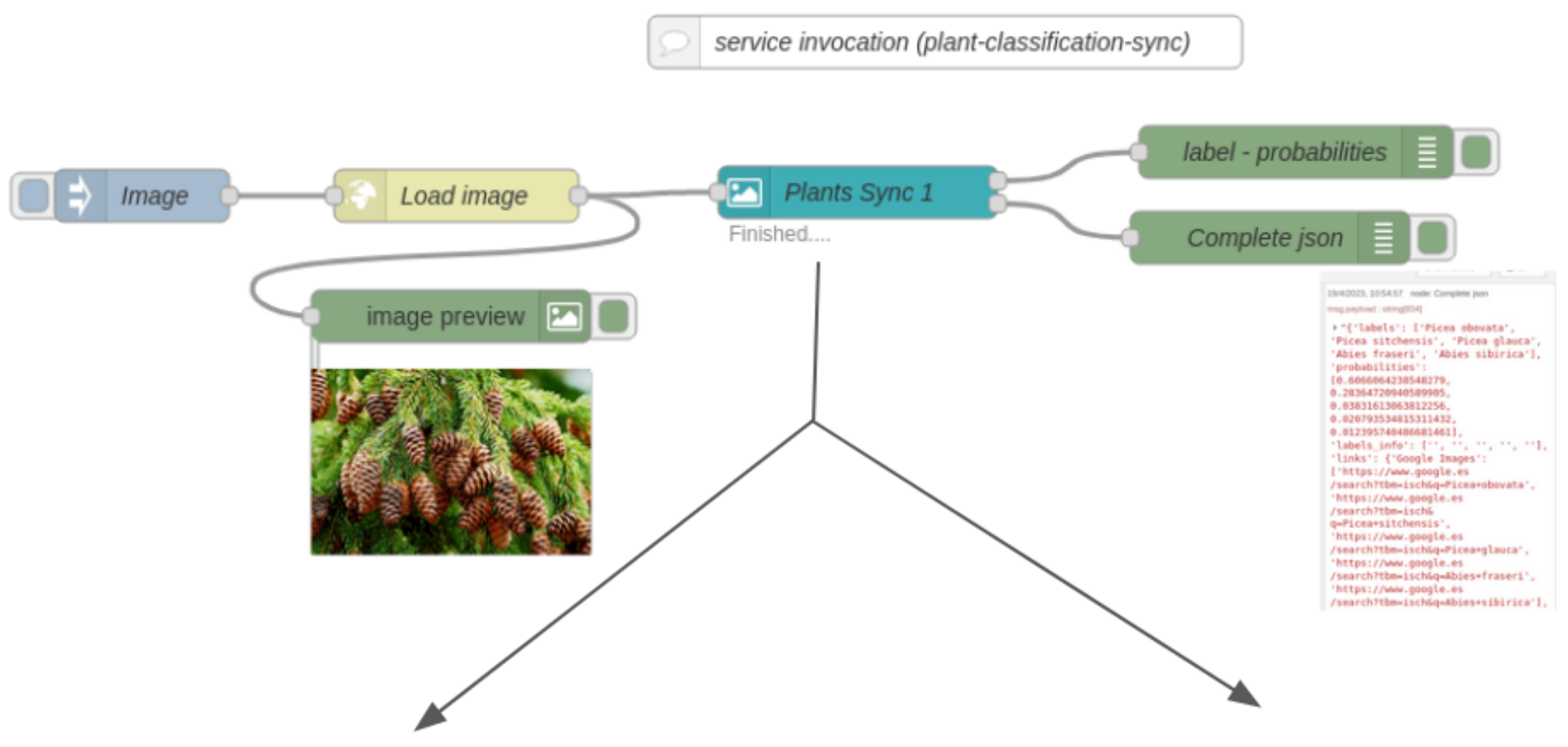
Develop workflows capable of orchestrating the distributed inference of AI models on OSCAR clusters with easy interaction by users through the usage of Node-RED.

Stages of development

The work is based on the implementation of a workflow on Node-RED [1][2] in which two services are called on OSCAR in parallel. This service is Plant Classification with Lasagne/Theano [3]. Once the results are obtained, the results are aggregated for enhanced accuracy.

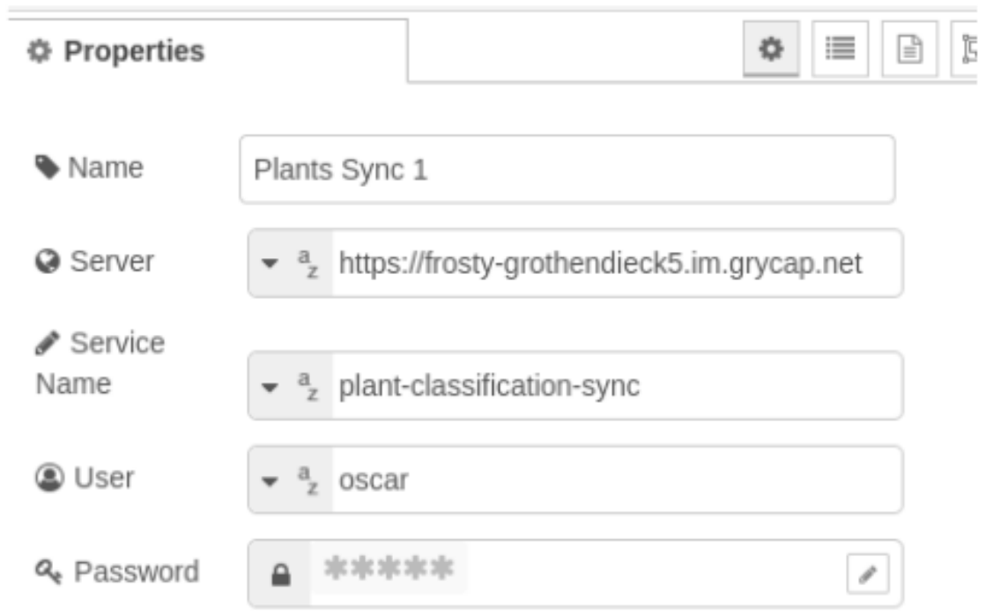


Composite AI models result



```
19/4/2023, 10:54:57   node: Complete json
msg.payload : string[834]
"{'labels': ['Picea obovata', 'Picea sitchensis', 'Picea glauca', 'Abies fraseri', 'Abies sibirica'], 'probabilities': [0.6066064238548279, 0.2836472094058905, 0.03831613063812256, 0.020793534815311432, 0.012395740486681461], 'labels_info': ['', '', '', '', ''], 'links': {'Google Images': ['https://www.google.es/search?tbm=isch&q=Picea+obovata', 'https://www.google.es/search?tbm=isch&q=Picea+sitchensis', 'https://www.google.es/search?tbm=isch&q=Picea+glauca', 'https://www.google.es/search?tbm=isch&q=Abies+fraseri', 'https://www.google.es/search?tbm=isch&q=Abies+sibirica'],
```

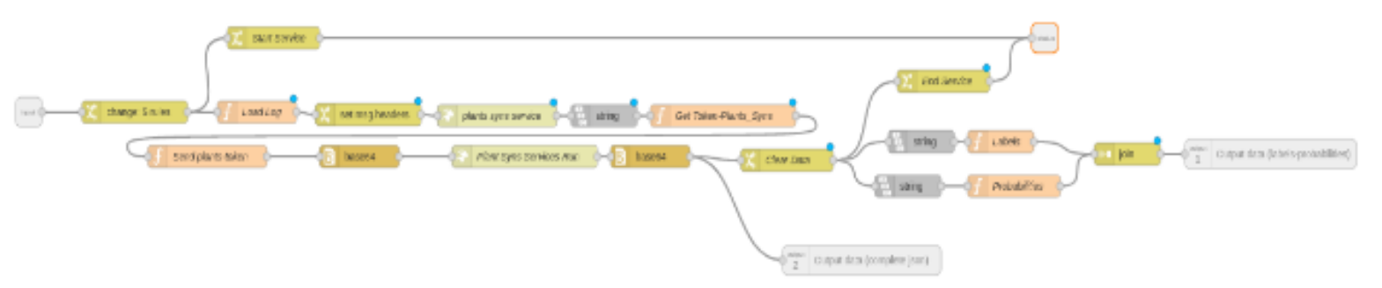
Service configuration

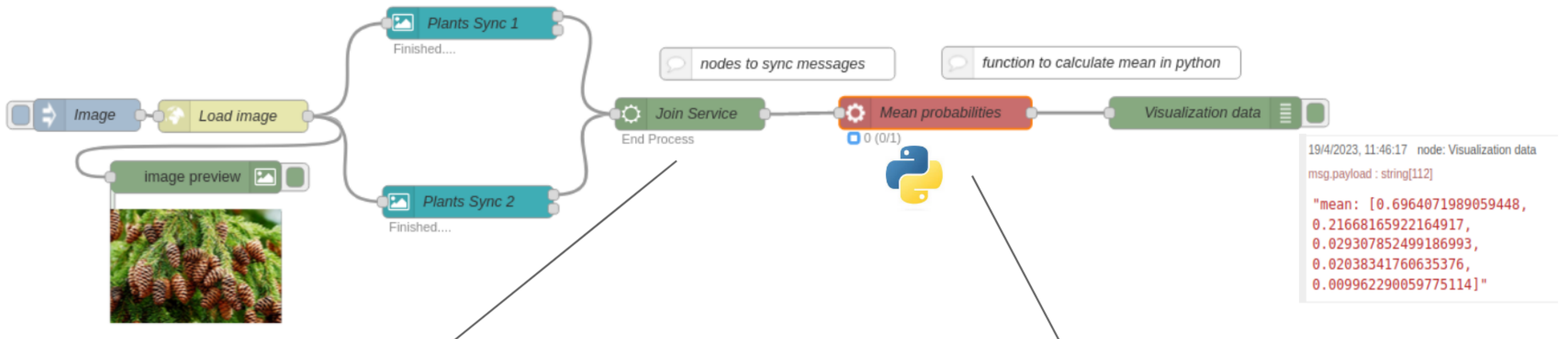


⚙ Properties

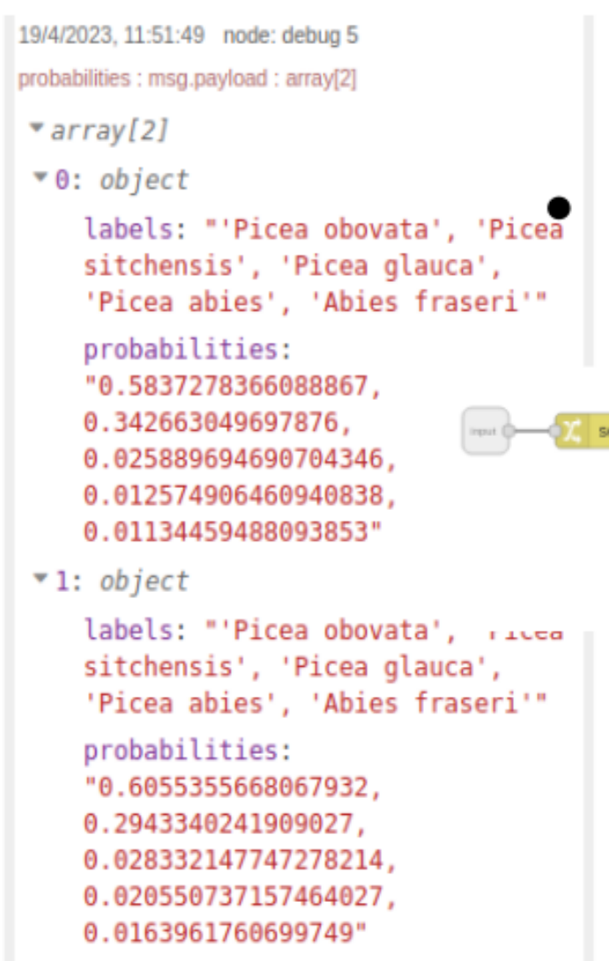
Name	Plants Sync 1
Server	https://frosty-grothendieck5.im.grycap.net
Service Name	plant-classification-sync
User	oscar
Password	*****

Subflow (Plant-classification-sync)



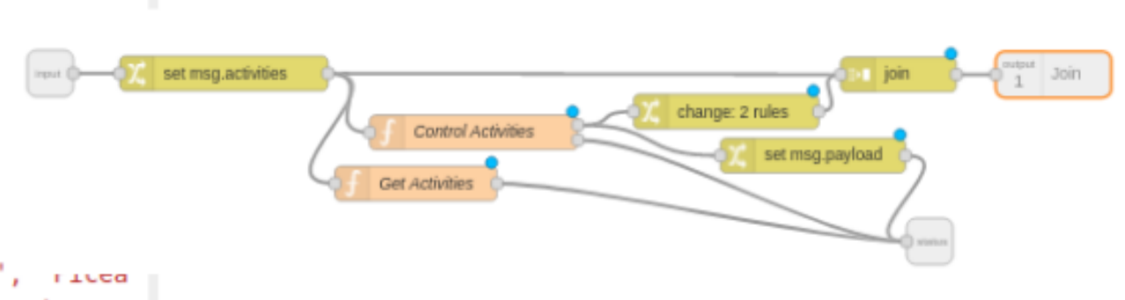


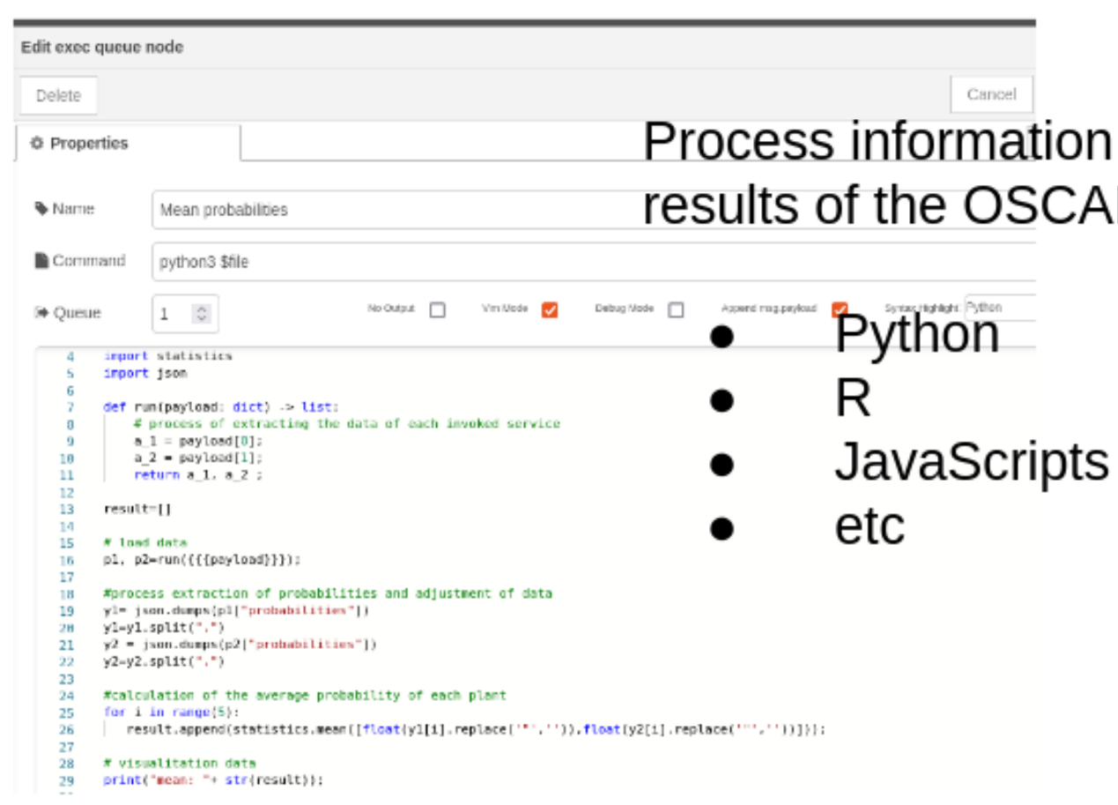
```
19/4/2023, 11:46:17   node: Visualization data
msg.payload : string[112]
"mean: [0.6964071989059448, 0.21668165922164917, 0.029307852499186993, 0.02038341760635376, 0.009962290059775114]"
```



```
19/4/2023, 11:51:49   node: debug 5
probabilities : msg.payload : array[2]
▾array[2]
 ▾0: object
   labels: "'Picea obovata', 'Picea sitchensis', 'Picea glauca', 'Picea abies', 'Abies fraseri'"
   probabilities: "0.5837278366088867, 0.342663049697876, 0.025889694690704346, 0.012574906460940838, 0.01134459488093853"
 ▾1: object
   labels: "'Picea obovata', 'Picea sitchensis', 'Picea glauca', 'Picea abies', 'Abies fraseri'"
   probabilities: "0.6055355668067932, 0.2943340241909027, 0.028332147747278214, 0.020550737157464027, 0.0163961760699749"
```

- Configure to join the results of n(2) OSCAR services.





Edit exec queue node

Delete   Cancel

⚙ Properties

Name	Mean probabilities
Command	python3 $file
Queue	1

No Output ☐ Vim Mode ☑ Debug Mode ☐ Append msg.payload ☑ Syntax highlight Python

```
import statistics
import json

def run(payload: dict) -> list:
    # process of extracting the data of each invoked service
    a_1 = payload[0];
    a_2 = payload[1];
    return a_1, a_2 ;

result=[]

# load data
p1, p2=run({{{payload}}});

#process extraction of probabilities and adjustment of data
y1= json.dumps(p1["probabilities"])
y1=y1.split(",")
y2 = json.dumps(p2["probabilities"])
y2=y2.split(",")

#calculation of the average probability of each plant
for i in range(5):
    result.append(statistics.mean([float(y1[i].replace('"','')),float(y2[i].replace('"',''))]));

# visualitation data
print("mean: "+ str(result));
```

Process information of the parameters, results of the OSCAR services invoked.

- Python
- R
- JavaScripts
- etc

Expected Results

- Specific nodes (or subflows) in Node-Red can be created for the different AI Models for easier definition of the workflows.
- Each node can be configured to invoke an OSCAR service within specific OSCAR clusters.
- Pre-defined workflows can be created to facilitate interaction among the AI models in from the AI4EOSC project.
- Event-driven serverless workflows can be used to combine the outputs of different AI Models.
- Dashboards can be created to facilitate output data processing within the framework.

AI4 | eosc

References

[1] Kousiouris, G., Ambroziak, S., Costantino, D., Tsarsitalidis, S., Boutas, E., Mamelli, A., & Stamati, T. (2022). Combining node-red and openwhisk for pattern-based development and execution of complex faas workflows. *arXiv preprint arXiv:2202.09683*.

[2] Kousiouris, G., Ambroziak, S., Zarzycki, B., Costantino, D., Tsarsitalidis, S., Katevas, V., ... & Stamati, T. (2023, April). A Pattern-based Function and Workflow Visual Environment for FaaS Development across the Continuum. In *Companion of the 2023 ACM/SPEC International Conference on Performance Engineering.*

[3] Heredia, I. (2017, May). Large-scale plant classification with deep neural networks. In *Proceedings of the Computing Frontiers Conference* .

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