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# AI-based approach for provider selection in the INDIGO PaaS Orchestration system of INFN Cloud

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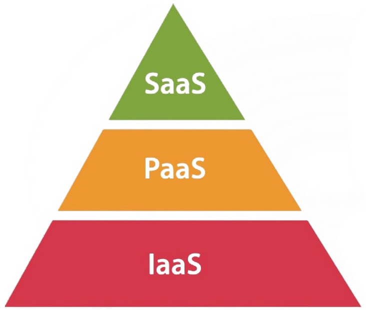
# The INFN Cloud infrastructure

INFN CLOUD

INFN decided to implement a **national Cloud computing infrastructure** for research

- as a **federation** of existing distributed infrastructures
- as an "user-centric" infrastructure which makes available to the final users a dynamic **set of services** tailored on specific use cases
- leveraging the outcomes of several national and European cloud projects where INFN actively participated, e.g. INDIGO DataCloud

INFN Cloud was officially made available to users in **March 2021**




e.g. Notebook as a Service

e.g. Virtual Machine, Docker compose

e.g. Start & Stop, Hostname choice


## Backbone

~ 2000 vCPU
~ 15 TB RAM
~ 1.6 PB Storage (RAW)
> 600 TB Storage net,
~ 10% SSD, ~ 320 TB for object storage

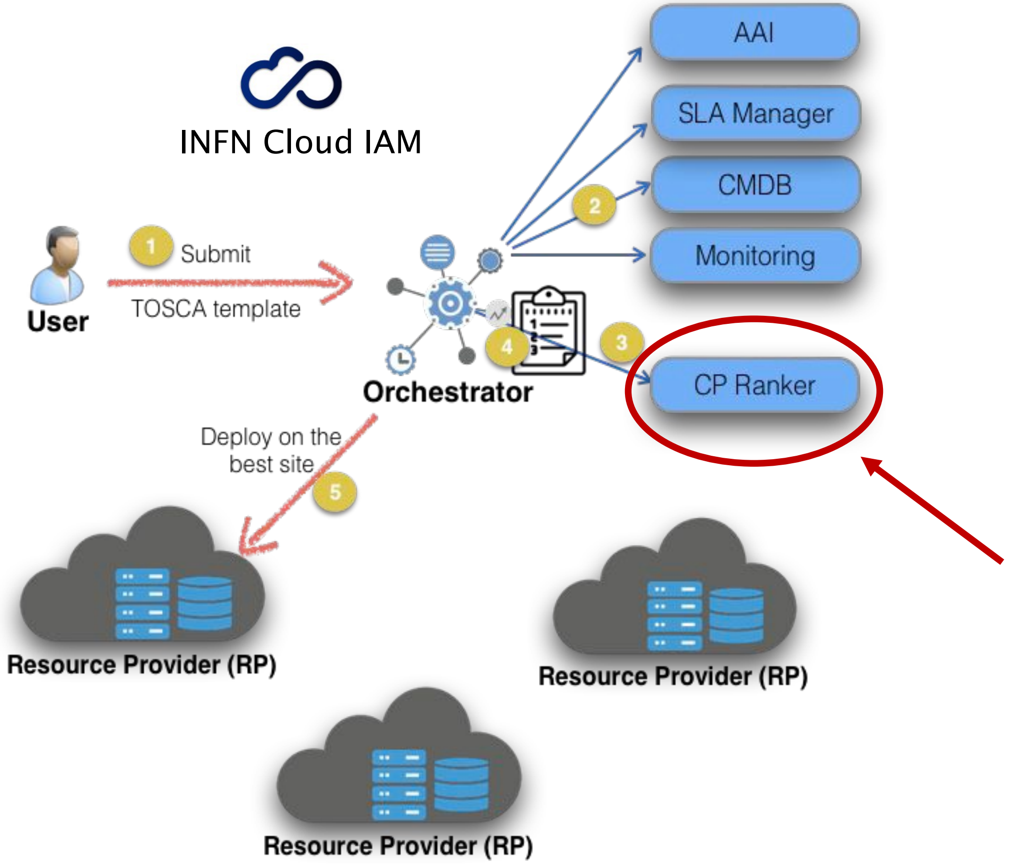
## Federated Clouds

~ 3955 vCPU
~ 84 TB RAM
~ 343 TB Storage net

# The INDIGO PaaS Orchestration system of INFN Cloud

The federative middleware of INFN Cloud is based on the **INDIGO PaaS orchestration system**, consisting of interconnected open-source microservices

- The **Orchestrator** receives high-level deployment requests in the form of TOSCA templates and coordinates the process of creating deployments
- The Orchestrator interacts with the provider services through the **Infrastructure Manager (IM)** for deploying complex and customized virtual infrastructures on the IaaS platforms made available by the federated providers



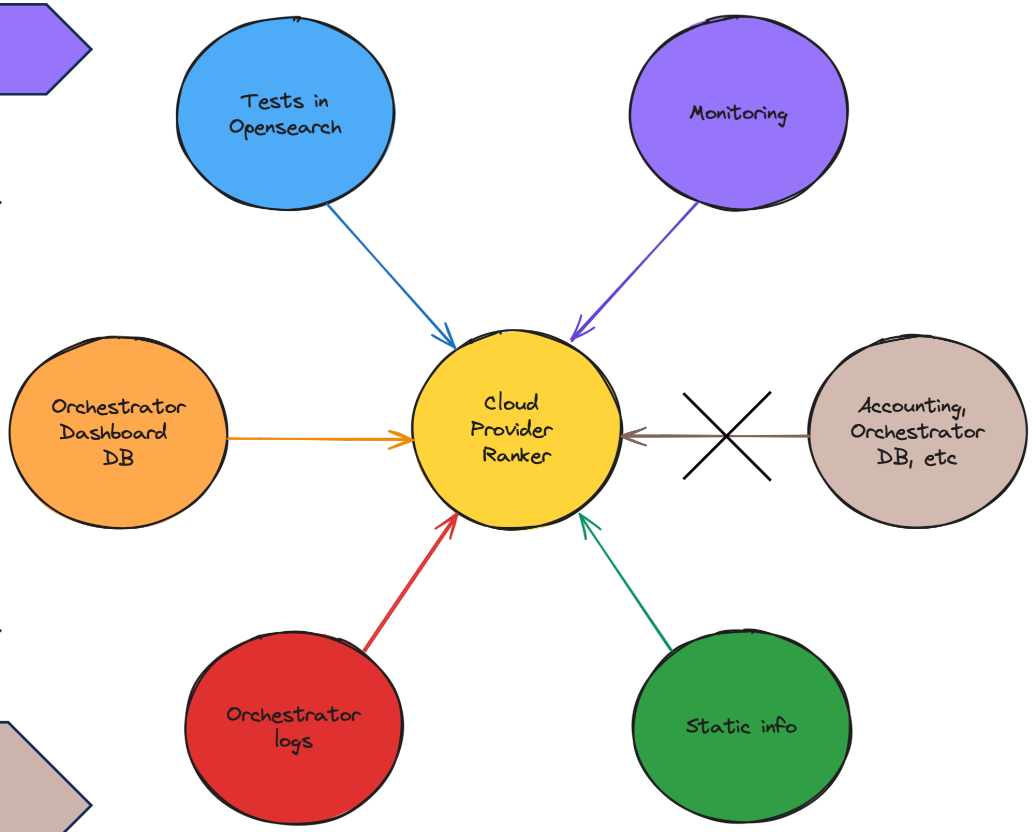

Gives a ranked list of providers. **We want to add ML here**

# Machine Learning workflow

1) Identification of data sources
2) Identification of features
3) Data collection and dataset creation: associate info from each source with each deployment
4) Data exploration
5) Data cleaning
6) Data transformation and feature engineering
7) Model and training design
8) Performance evaluation

# Identification of data sources

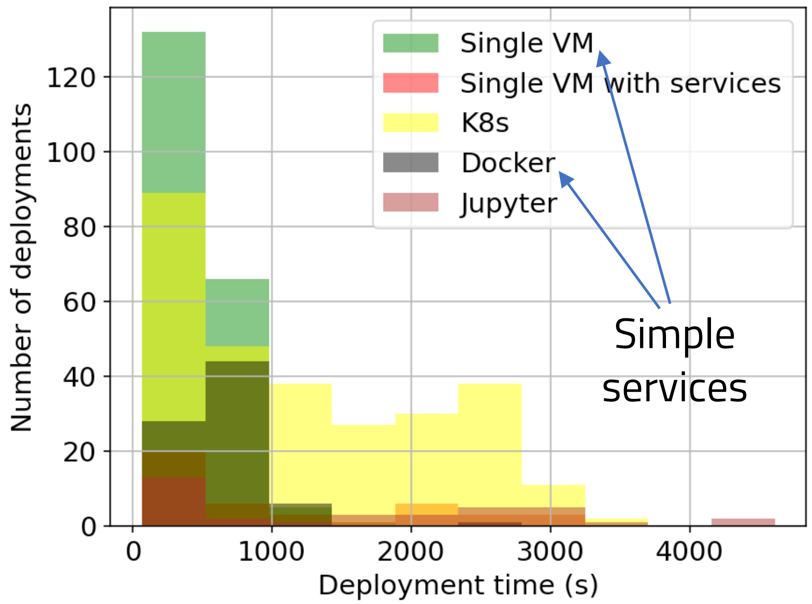
- Monitoring: info about resource usage per group and provider over time
- Tests in Opensearch: info about simple tests (e.g. VM creation) done on the providers
- Orchestrator Dashboard DB: info about all deployments
- Orchestrator logs: info about the history of all deployments
- Static info: badwidth, overbooking, etc
- Accounting: aggregated info in time slots about resource usage per group and provider
  Orchestrator DB: info about not deleted deployments



# Results

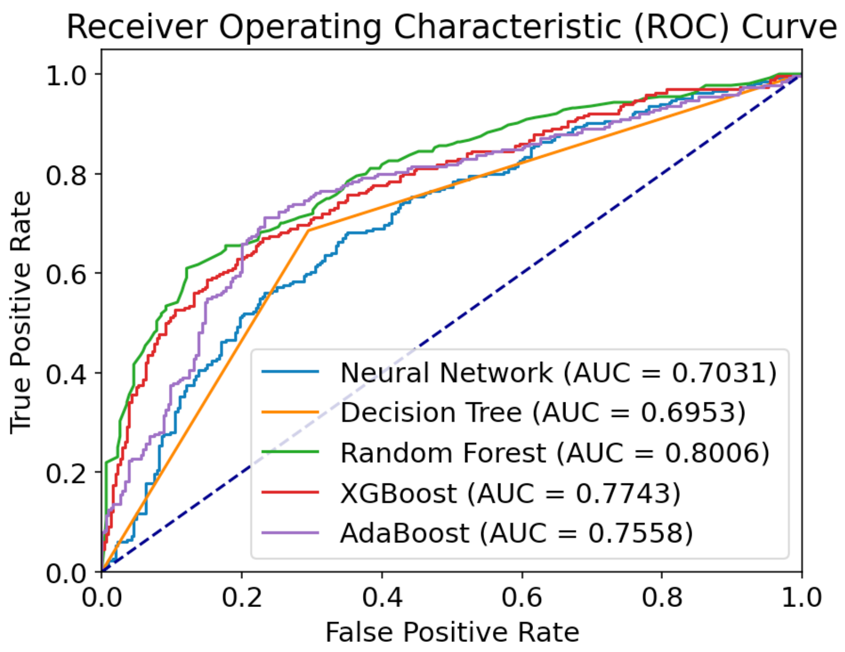
- **6 months of data** used: 08.2023 – 01.2024, **643 entries** (**very few!**)
- Different entries associated to different service deployments/templates: tried **grouping** them according to their **complexity**
- **Reduction in the number of features** through data cleaning and feature engineering, e.g. ram_diff = (quota_ram – ram_used) – requested_ram
- Finally used **11 features**

| Ranking | Feature | Importance |
|---|---|---|
| 1 | ram_diff | 0.162 |
| 2 | cpu_diff | 0.147 |
| 3 | failure_percentage | 0.146 |
| 4 | avg_deployment_time | 0.120 |
| 5 | storage_diff | 0.114 |



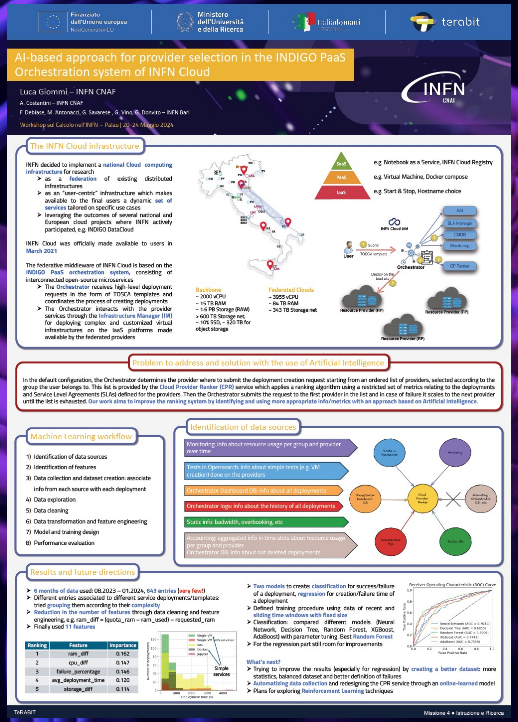
# Results and future directions

- **Two models** to create:
  - **classification** for success/failure of a deployment
  - **regression** for creation/failure time of a deployment
- Defined training procedure using data of recent and **sliding time windows with fixed size**
- Classification: compared different models with parameter tuning. Best **Random Forest**
- For the regression part still room for improvements




## What's next?

- Trying to improve the results (especially for regression) by **creating a better dataset**: more statistics, balanced dataset and better definition of failures
- **Automatizing data collection** and redesigning the CPR service through an **online-learned** model
- Plans for exploring **Reinforcement Learning** techniques




# Thank you

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