e2xhub

Simplifying Course Setup and Management in Education with JupyterHub at Scale

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Introduction

Motivation

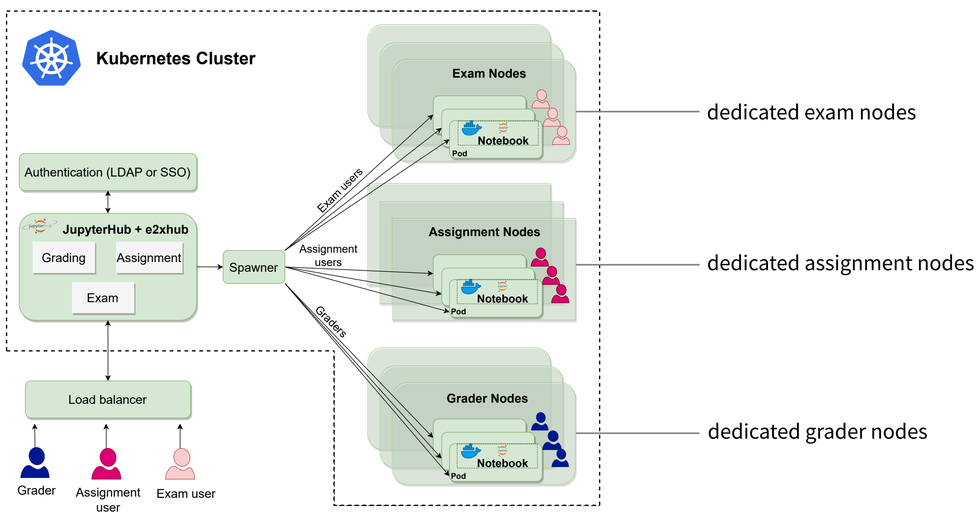
- Jupyter Notebook is widely used for **research**, **teaching**, and **examination** purposes.
- JupyterHub[1] enables multi-user Jupyter Notebook environments but only supports two roles: user and admin. However, teaching requires **additional roles** such as **teacher**, **grader**, and **student**.
- JupyterHub is not a Learning Management System (LMS), and thus the support for **multi-course** and **multi-grader** is currently lacking
- Nbgrader[2] is a tool for **managing assignments** such as content creation, release, submission, and feedback generation. However, using **Nbgrader with JupyterHub on Kubernetes can be challenging**, often requiring a sysadmin to provide the necessary environment.

To address the aforementioned issues, we propose **e2xhub**[3], an extension of JupyterHub that simplifies the process of managing courses and assignments.

Contributions

- **Simplify** course configuration **using YAML**, enabling non-admin users **to easily set up courses**.
- **Implement user isolation** with JupyterHub on Kubernetes to enhance **security** during examinations.
- **Improve** maintainability and scalability, enabling the deployment of **multiple courses** on a **single JupyterHub** deployment.
- **Leverage open-source projects** including Zero-to-JupyterHub (Z2JH[4]) and JupyterHub.
- **Open-source software**

System Overview



YAML as Course Specification

Course Specification

- Course id: MachineLearning-WS22
- Image: jupyter/datascience-notebook
- Resource:
  - 2 core CPU
  - 2GB memory
  - GPU node

Course Specification in YAML

```yaml
Machine-Learning:
  Wintersemester-22:
    image: jupyter/datascience-notebook:latest
    resources:
      cpu_limit: 2.0
      mem_limit: 2G
      node_affinity:
        matchExpressions:
        - key: "hub.jupyter.org/node-purpose"
          operator: In
          values:
          - "gpu"
```

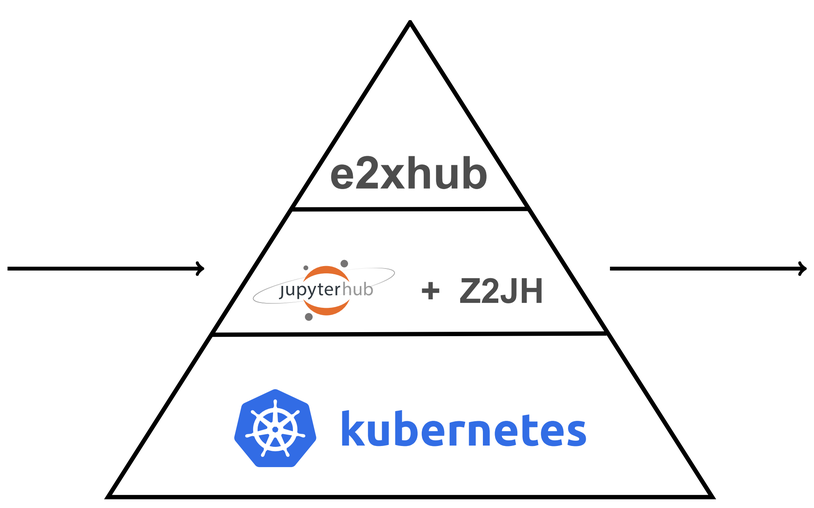
Configuring the course exchange using **e2xgrader**[5]:

```yaml
default_exchange:
  - echo from e2xgrader.config import configure_base >> /path/to/nbgrader_config.py
  - echo from e2xgrader.config import configure_exchange >> /path/to/nbgrader_config.py
  - echo configure_base \(c\) >> /path/to/nbgrader_config.py
  - echo configure_exchange \(c\) >> /path/to/nbgrader_config.py
```

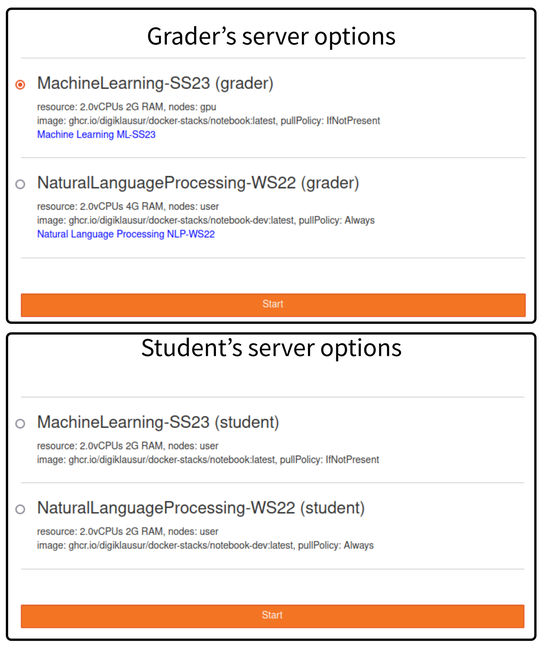
Course Management Using e2xhub

```yaml
server:
  e2x_dev:
    image:
      name: digiklausur/notebook
      ...
    resources:
      cpu_limit: 2.0
      mem_limit: 2G
    nbgrader:
      grader_course_cfg:
        MachineLearning:
          SS23:
            image: digiklausur/notebook-ml:latest
            resources:
             node_affinity:
               matchExpressions:
               - key: "hub.jupyter.org/node"
                 operator: In
                 values:
                 - "gpu"
      student_course_cfg:
        MachineLearning:
          SS23:
            ...
      default_exchange:
      ...
    extra_mounts:
    ...
    commands:
    ...
```

- Specify user's notebook server resource
- Configure each course's settings
- Optionally include extra volumes or commands

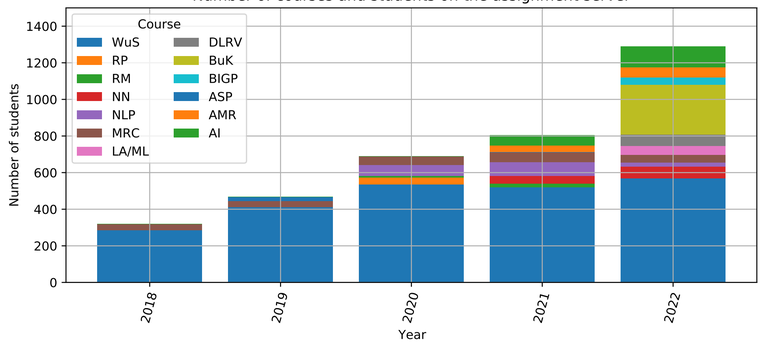


- Load and parse config using e2xhub
- **Using e2xhub**:
  - **Override JupyterHub profile list** with course list
  - **Update** Jupyter Notebook server **resource** and **environment**
  - Additionally include **extra volumes**
  - **Execute extra commands** before the server starts

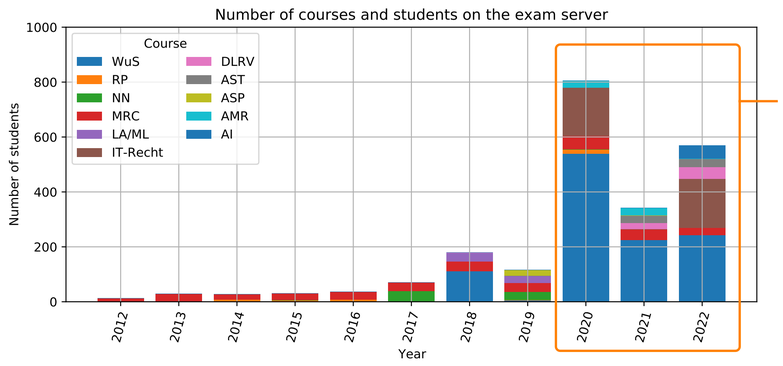


- Present users with the course they are registered in, along with appropriate resources given in the configuration

Statistics



since the first iteration
e2xhub used for teaching
a total of 3,569 students
13 different courses



since 2020
e2xhub used for exams
a total of 1,716 students
8 different courses

Contact

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1 github.com/jupyterhub/jupyterhub
2 github.com/jupyter/nbgrader
3 github.com/DigiKlausur/e2xhub
4 github.com/jupyterhub/zero-to-jupyterhub-k8
5 github.com/DigiKlausur/e2xgrader

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