Getting Started with HAL

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ILLINOIS
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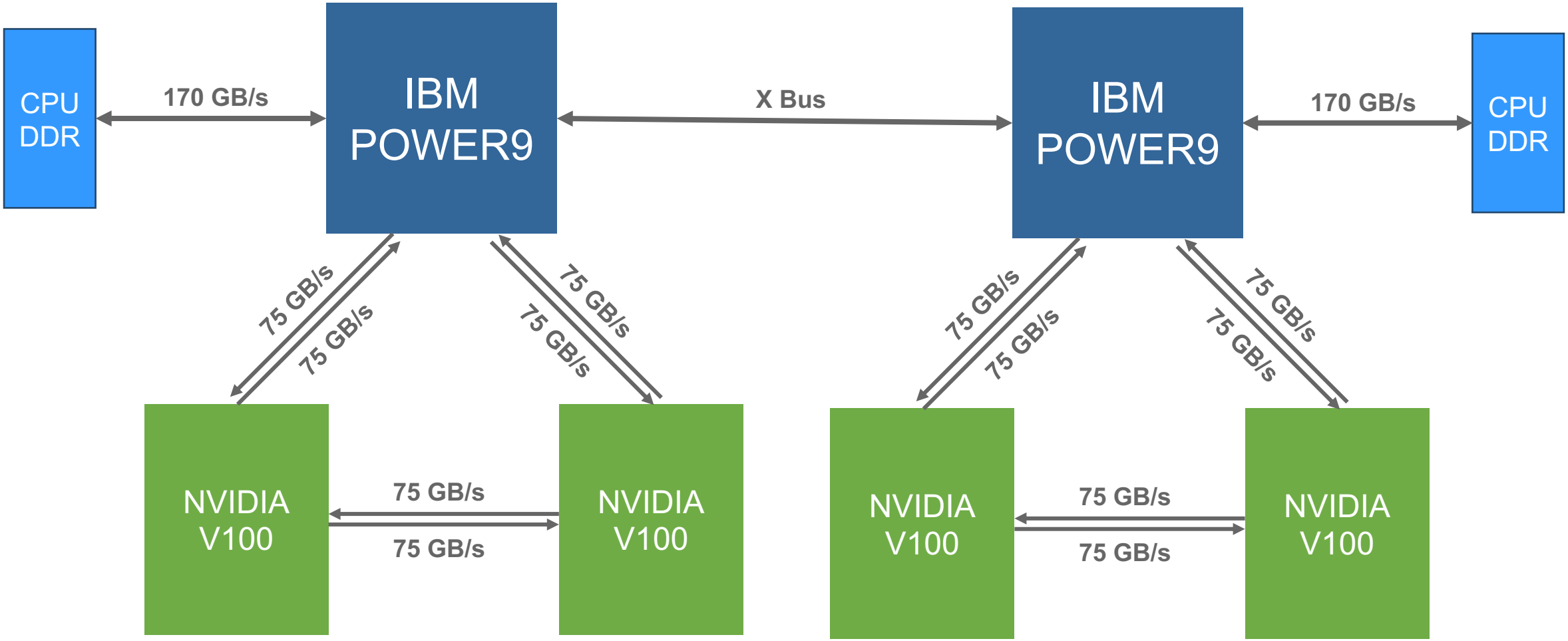
HAL System Overview

- **NSF-funded IBM cluster for Deep Learning applications**
- **16 nodes, 2560 CPU cores, 64 Nvidia GPUs**
- **224 TB of All-Flash Storage**
- **The Origin of the Name**
  - 2001: a space odyssey
  - Early concept of an Artificial Intelligence system

HAL System Overview

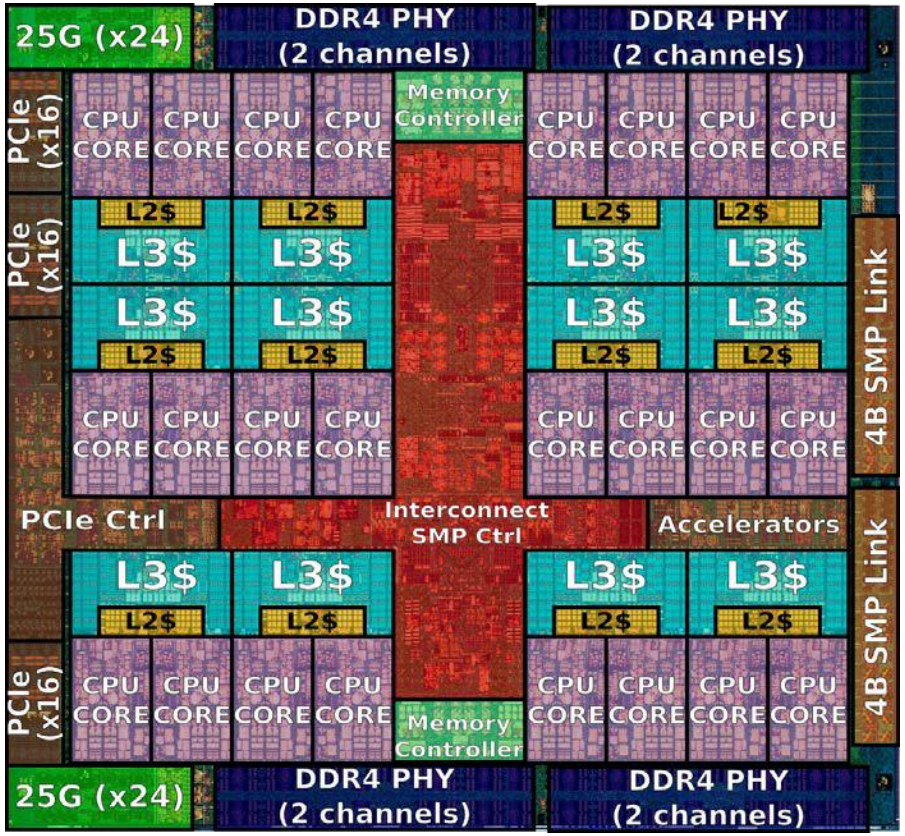
- HAL Hardware
  - 1x IBM 9006-12P LC921 Login Node
    - 2x 16-core IBM POWER9 CPU @ 2.2GHz
    - 256 GB DDR4
  - 16x IBM AC922 Nodes IBM 8335-GTH AC922 Server
    - 2x 20-core IBM POWER9 CPU @ 2.4GHz
    - 256 GB DDR4
    - 4x NVIDIA V100 GPUs
      - 5120 cores
      - 16 GB HBM 2
    - 2-Port EDR 100 Gb IB ConnectX-5 Adapter
  - 2x DDN GS400NVE Flash Arrays
    - 224 TB usable, NVME SSD-based storage
    - Spectrum Scale File System

HAL System Overview



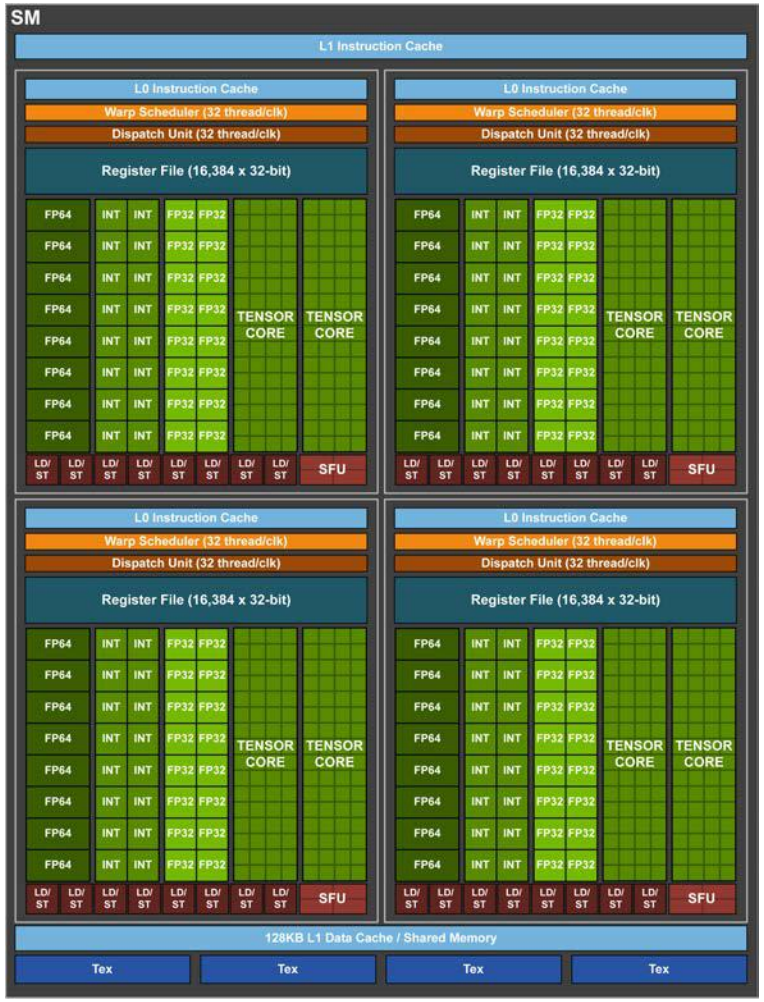
HAL System Overview

- **IBM POWER9 CPUs**
  - 14nm finFET semiconductor
  - Stronger Thread Performance – SMT
  - POWER ISA 3.0 Architecture
  - Enhanced Cache Hierarchy
  - NVIDIA NVLink 2.0
  - I/O System – PCIe Gen4
- **2x 20 Cores with SMT4**
  - Map to OS as 160 CPUs per node



HAL System Overview

- NVIDIA V100 GPUs
  - Peak 7.8 TFLOP/s (double-precision).
  - Peak 15 TFLOP/s (single-precision).
  - SM / Cores : 80 / 5120.
  - HBM2 Memory 16 GB : 900 GB/s.
  - Config up to 128 KB L1 Cache per SM.
  - Config up to 96 KB Shared Memory per SM.
  - Constant memory 64 KB.
  - 65536 32-bit Registers per SM.
  - Clock Frequency : 1530 MHz



HAL Software Overview

- **HAL Software**
  - **OS : Red Hat Enterprise Linux (RHEL) 8.4**
  - **Compilers :**
    - **GNU 8.4.1**
    - **CUDA 11.4.48**
    - **Nvidia HPC SDK 21.5**
  - **Tools :**
    - **OpenCE 1.2.0**
    - **PowerAI 1.7.0 (Watson Machine Learning Community Edition)**
    - **OpenMPI 4.1.1**
    - **CMake 3.20.3**
    - **Singularity 3.8.0**

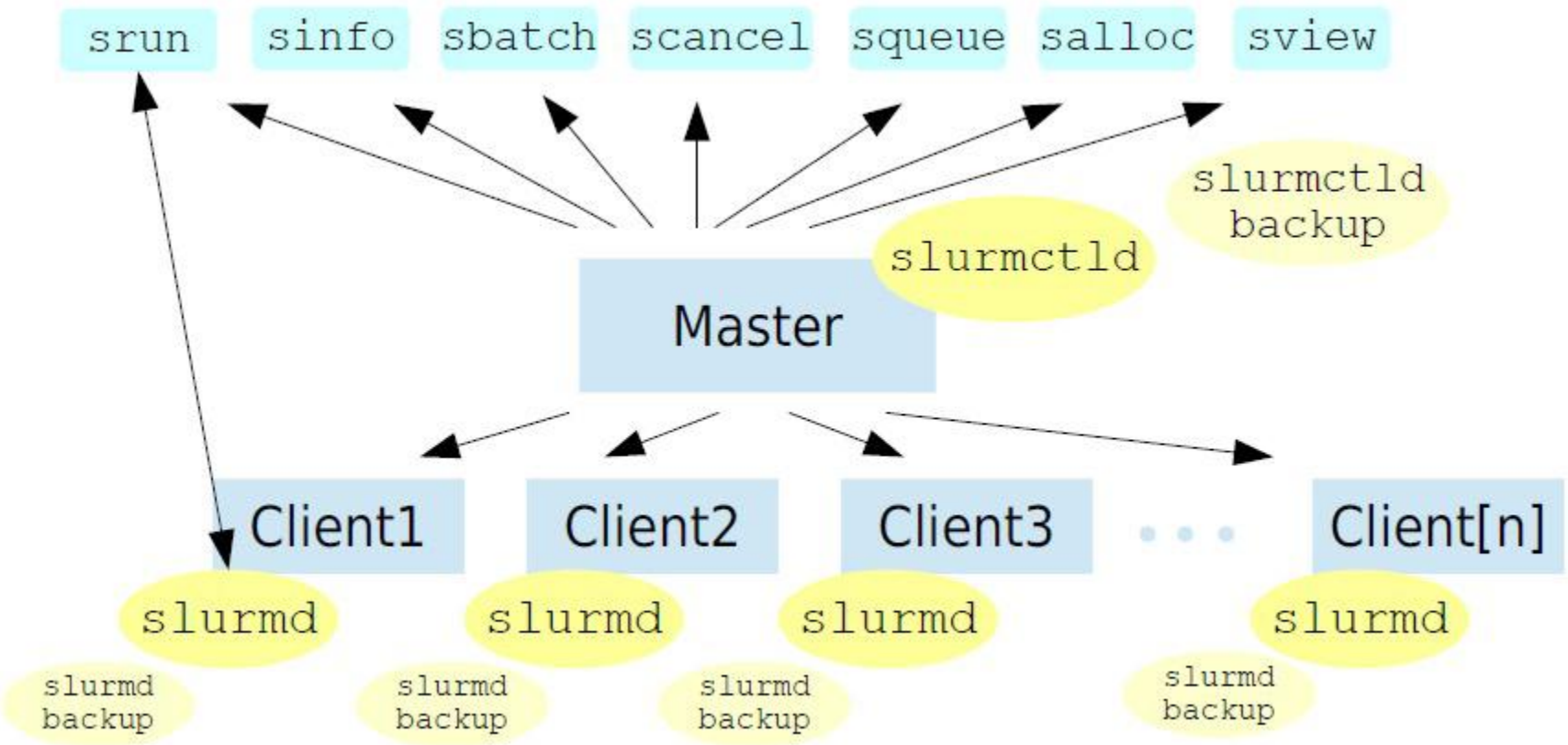
Programming Environment

- **Environment Management**
  - Environment modules are provided through Lmod, a Lua-based module system for dynamically altering environments.
- **General Usage**
  - module avail : shows a table of the currently available modules.
  - module list : shows a list of the currently loaded modules.
  - module purge : unloads all loaded modules
  - module unload : unloads module into the current environment
  - module load : loads module into the current environment

Connection

- **Login Node**
  - **1x IBM 9006-12P Login Node**
  - **1x IBM 9006-22P Login Node**
- **Connect with SSH**
  - ssh <userid>@hal.ncsa.illinois.edu
  - ssh <userid>@hal-login2.ncsa.illinois.edu
- **Connect with SFTP**
  - sftp <userid>@hal.ncsa.illinois.edu
  - sftp <userid>@hal-login2.ncsa.illinois.edu

Slurm Workload Manager



Slurm Policy on HAL

- Maximum 5 running jobs per user;
- Maximum 5 activate nodes per user;
- Maximum 16 activate GPUs per user;
- Maximum 24 hours per job.

Slurm Workload Manager

- Original Slurm command could be complex
  - srun --partition=gpu --time=24:00:00 --nodes=1 --ntasks-per-node=160 --sockets-per-node=2 --cores-per-socket=20 --threads-per-core=4 --mem-per-cpu=1200 --wait=0 --export=ALL --gres=gpu:v100:4 --pty /bin/bash

Slurm Wrapper Suite

- **Rule of Thumb**
  - Minimize the required input options.
  - Consistent with the original "slurm" run-script format.
  - Submits job to suitable partition based on the number of GPUs.

Slurm Wrapper Suite

- "swrun" Usage
  - Only 4 options
    - Partition *(required)*
    - CPUs Per GPU *(optional)*
    - Wall Time *(optional)*
    - Singularity Container *(optional)*
  - Restrictions
    - Partitions vary by GPU number (gpux1, gpux2, gpux3, …)
    - CPU Per GPU (16 <= c <= 40, default 16)
    - Wall Time (1 <= t <= 24, default 4 hours)
  - Default if selecting 1 gpu
    - gpux1(required), 16x CPUs, 19.2 GB Memory, 1x GPU, 4 Hrs

Slurm Wrapper Suite

- “swrun” Usage
  - Debug queue
    - Only need to set time to 4 hours or less on queue “gpux1/2/3/4” and “cpu”
    - Multi-nodes queue less than 4 hours still go to normal queue
  - Singularity
    - swrun -p gpux4 -s powerai -c 40 -t 24
    - “-s”: using singularity image for this job
    - “powerai”: the name of singularity image “powerai.sif”
    - export “HAL_CONTAINER_REGISTRY” to your own directory
  - Example workflow:
    - Export HAL_CONTAINER_REGISTRY=$HOME/container/pool
    - Then specify the image as above or in your batch script as
    - #SBATCH --singularity=powerai

Slurm Wrapper Suite

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    <=>
  - swrun -p gpux4 -c 40 -t 24

Slurm Wrapper Suite

- “swbatch” Usage
  - Only 7 options
    - Partition *(required)*
    - CPUs Per GPU *(optional)*
    - Wall Time *(optional)*
    - Job name *(optional)*
    - Output file *(optional)*
    - Error file *(optional)*
    - Singularity Container *(optional)*
  - Restrictions
    - Partitions vary by GPU number (x1, x2, x3, …)
    - CPU Per GPU (16 <= c <= 40, default 16)
    - Wall Time (1 <= t <= 24, default 4 hours)

Slurm Wrapper Suite

- “swbatch” example:
  - Sample run script - sample.sb vs sample.swb

```
#!/bin/bash
#SBATCH --partition=gpu
#SBATCH --time=4:00:00
#SBATCH --nodes=1
#SBATCH --ntasks-per-node=16
#SBATCH --sockets-per-node=1
#SBATCH --cores-per-socket=4
#SBATCH --threads-per-core=4
#SBATCH --mem-per-cpu=1200
#SBATCH --export=ALL
#SBATCH --gres=gpu:v100:1
python3 mnist_train_pytorch.py
```

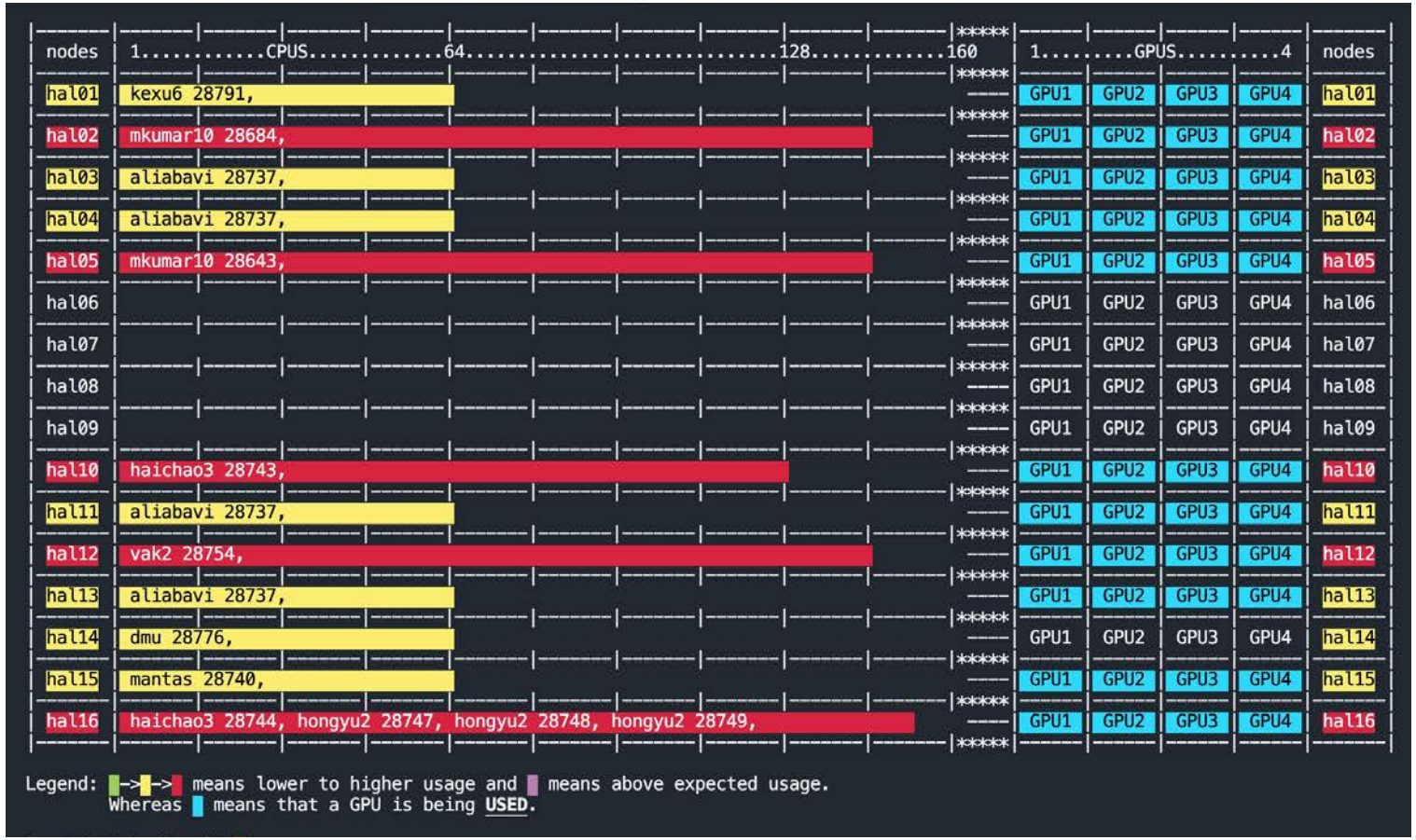
=>

```
#!/bin/bash
#SBATCH --partition=gpux1
python3 mnist_train_pytorch.py
```

  - Simply run as: sbatch sample.sb => swbatch sample.swb

Slurm Wrapper Suite

- swqueue (new): show cluster usage within terminal, color coded utilization level.



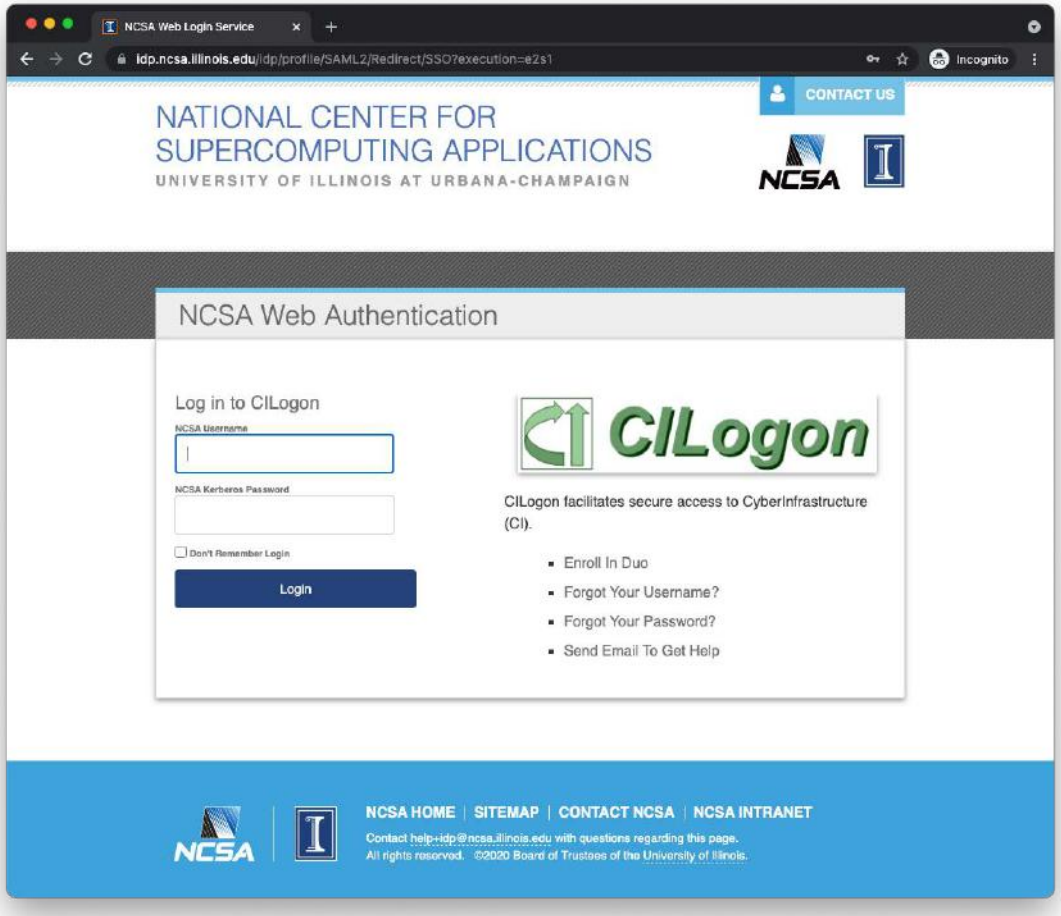
Frequently Ask Questions

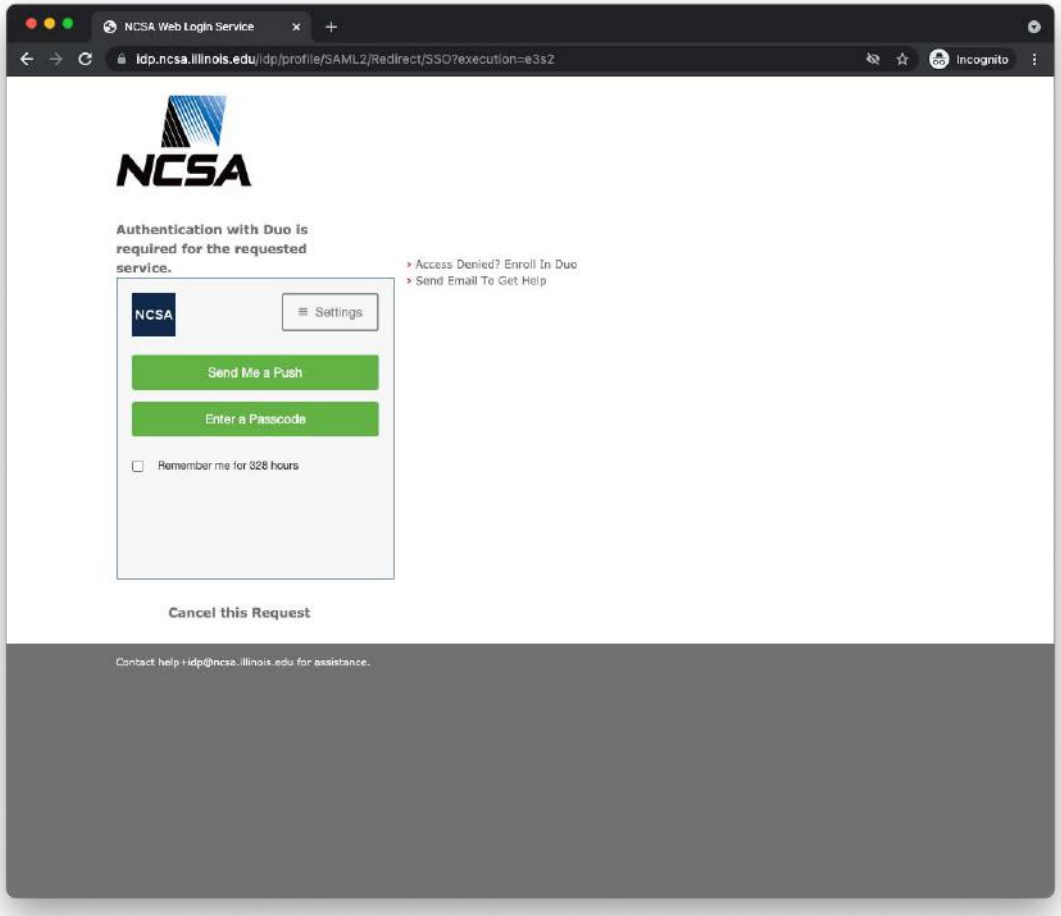
1. Why partition “gpux1” doesn’t work with “sbatch”?
   - “gpux1”, “gpux2”, … works only with slurm wrapper suite.
   - if use “sbatch”, the valid partitions include “gpu” and “cpu”.
2. Why I get “IndexError: string index out of range” error when using “swbatch”?
   - slurm wrapper suite requires some packages like pyyaml.
   - users should submit your job within the default python env.
   - check “.bashrc” to remove conda related setting.
3. Why my jobs always under queueing?
   - check jobs status with “squeue” for detailed reason.
   - check your recent usage to verify your fair share.

Open OnDemand

- We have implemented the Open OnDemand on HAL system as a web-based portal.
- The OOD service including
  - Manage data with Files app.
  - Submit and monitor jobs with Jobs app.
  - Access the cluster with Shell Access app under Clusters.
  - Utilize the Jupyter Notebook, TensorBoard and H2O-AI apps under Interactiave Apps.

Open OnDemand (main page)





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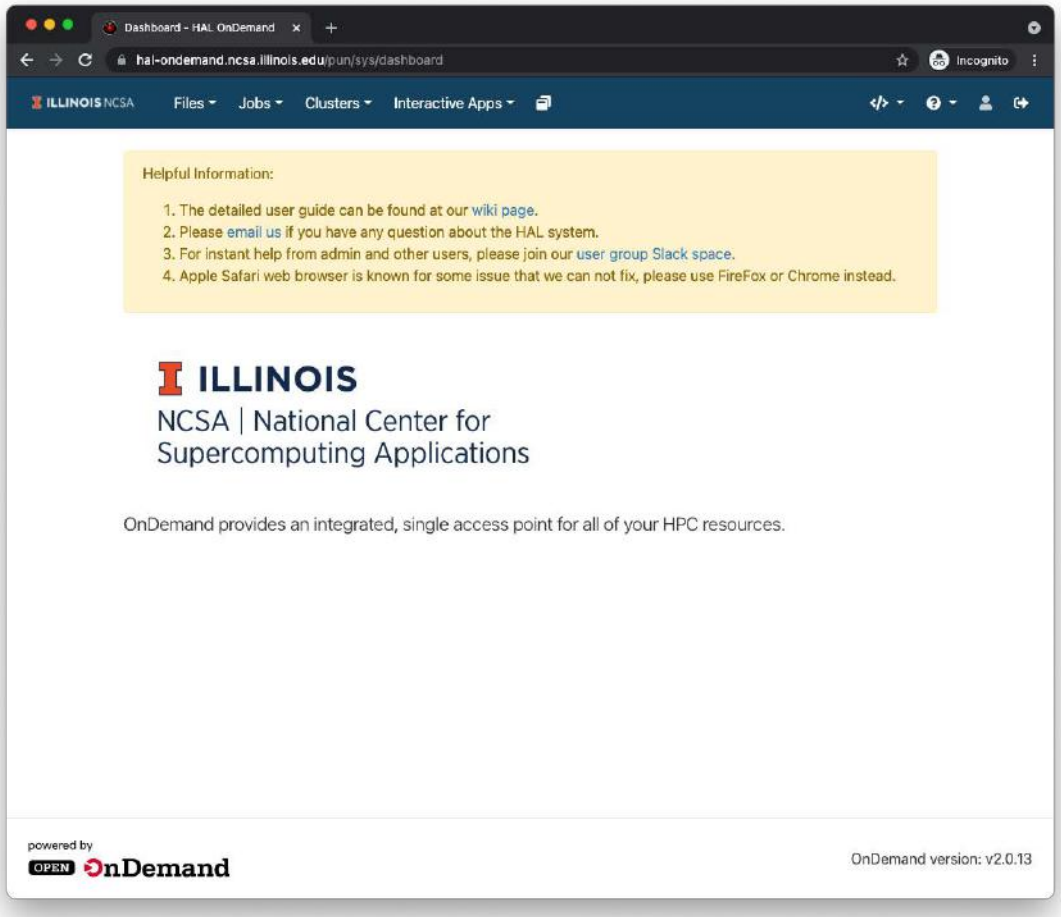
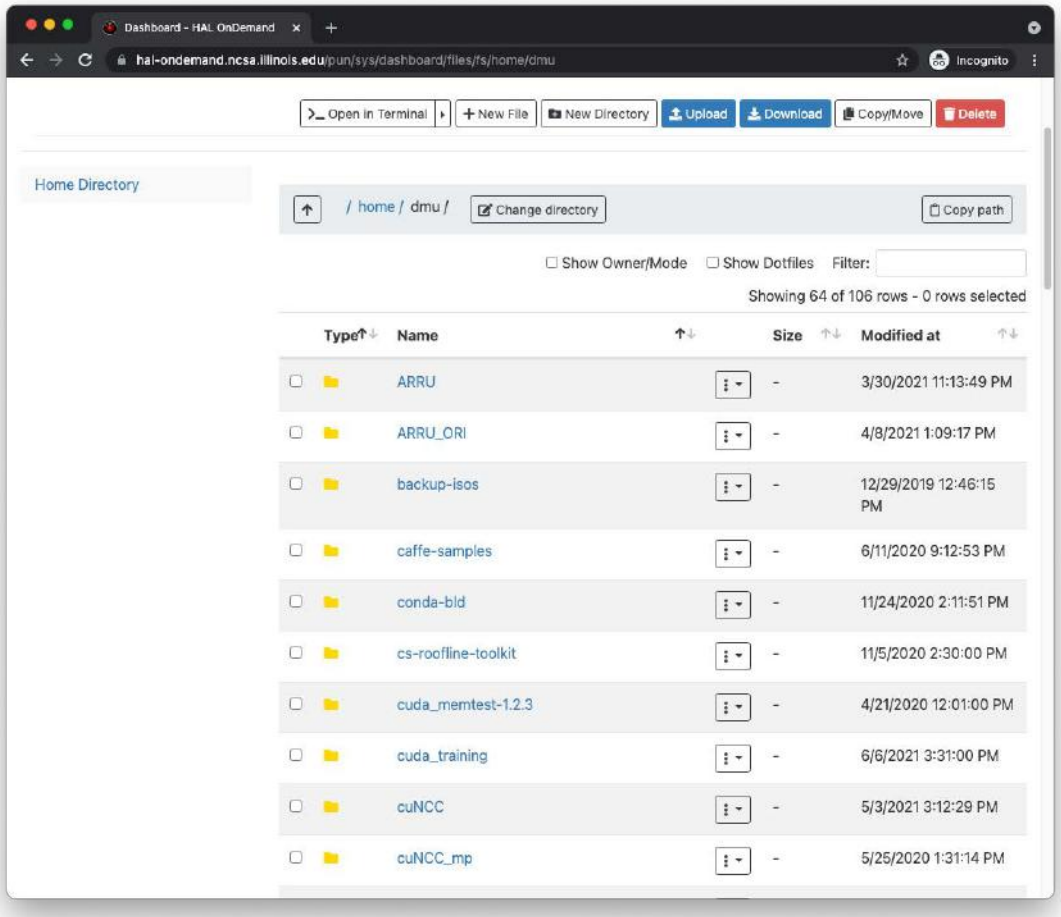


Open OnDemand (files)



Open OnDemand (main page)

Dashboard - HAL OnDemand

hal-ondemand.ncsa.illinois.edu/pun/sys/dashboard/activejobs?jobcluster=hal-rh8&jobfilter=all

ILLINOIS NCSA | Files | Jobs | Clusters | Interactive Apps

Helpful Information:

1. The detailed user guide can be found at our wiki page.
2. Please email us if you have any question about the HAL system.
3. For instant help from admin and other users, please join our user group Slack space.
4. Apple Safari web browser is known for some issue that we can not fix, please use FireFox or Chrome instead.

All Jobs | hal-rh8

Active Jobs

Show 50 entries

Filter:

	ID	Name	User	Account	Time Used	Queue	Status	Cluster	Actions
>	696	sys/dashboard/sys/jupyter-lab-rh8	minhaoj2	uiuc	08:25:08	gpu	Running	hal-rh8	

Showing 1 to 1 of 1 entries

Previous 1 Next

powered by OPEN OnDemand

OnDemand version: v2.0.13

Dashboard - HAL OnDemand

hal-ondemand.ncsa.illinois.edu/pun/sys/dashboard/activejobs?jobcluster=hal&jobfilter=all

All Jobs | hal

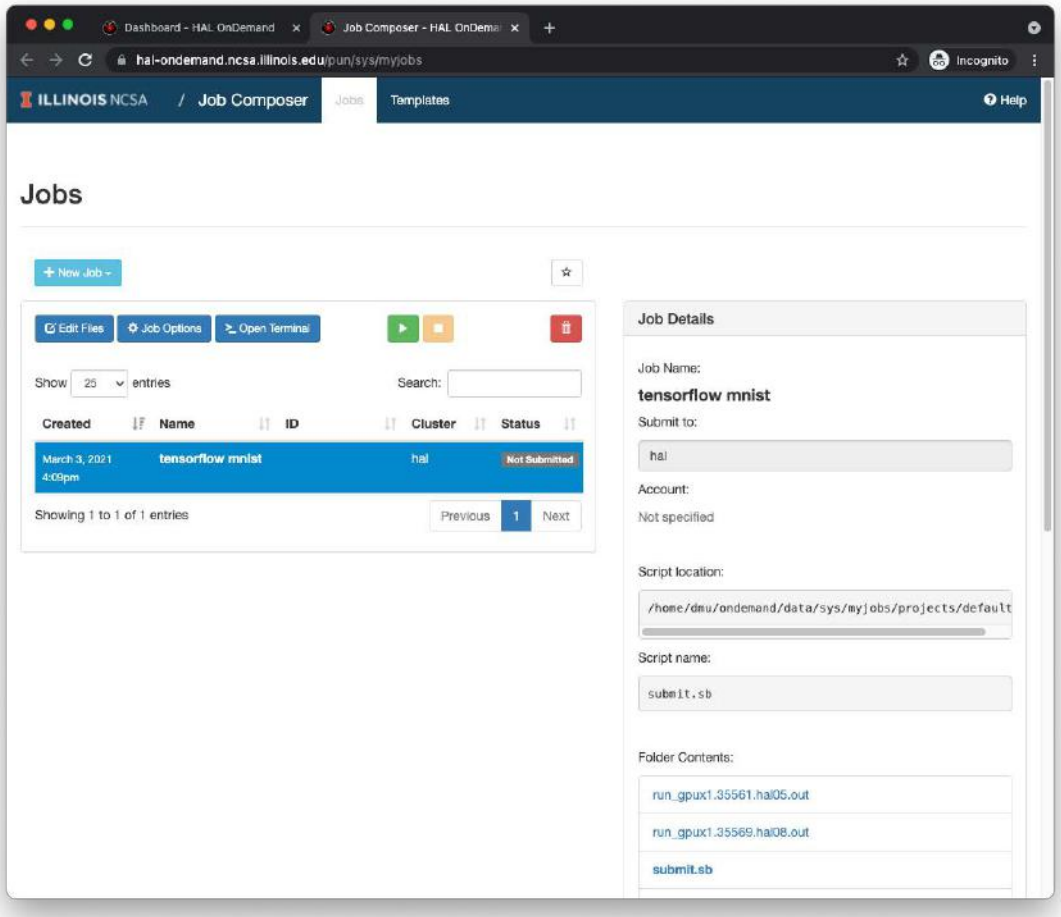
Active Jobs

Show 50 entries

Filter:

	ID	Name	User	Account	Time Used	Queue	Status	Cluster	Actions
>	56999	sys/dashboard/sys/jupyter-notebook	zl52	uiuc	00:04:48	gpu	Completed	hal	
>	56998	sys/dashboard/sys/jupyter-notebook	zl52	uiuc	00:06:23	gpu	Completed	hal	
>	57000	train	billtao	uiuc	00:03:11	gpu	Completed	hal	
>	47495	bash	lienliang	uiuc	00:00:00	cpu	Queued	hal	
>	57001	sys/dashboard/sys/jupyter-notebook	zl52	uiuc	00:00:39	gpu	Running	hal	
>	56982	sys/dashboard/sys/jupyter-notebook	shuyuez2	uiuc	05:28:46	gpu	Running	hal	
>	56936	run2	sb56	uiuc	21:12:56	gpu	Running	hal	
>	56937	run4	sb56	uiuc	21:12:56	gpu	Running	hal	
>	56990	sys/dashboard/sys/jupyter-lab	minhaoj2	uiuc	02:15:19	gpu	Running	hal	
>	56991	bash	aamirh2	uiuc	02:15:07	debug	Running	hal	
>	56989	mesrnn-train-eu-4	aamirh2	uiuc	02:17:27	gpu	Running	hal	

Open OnDemand (activate jobs)



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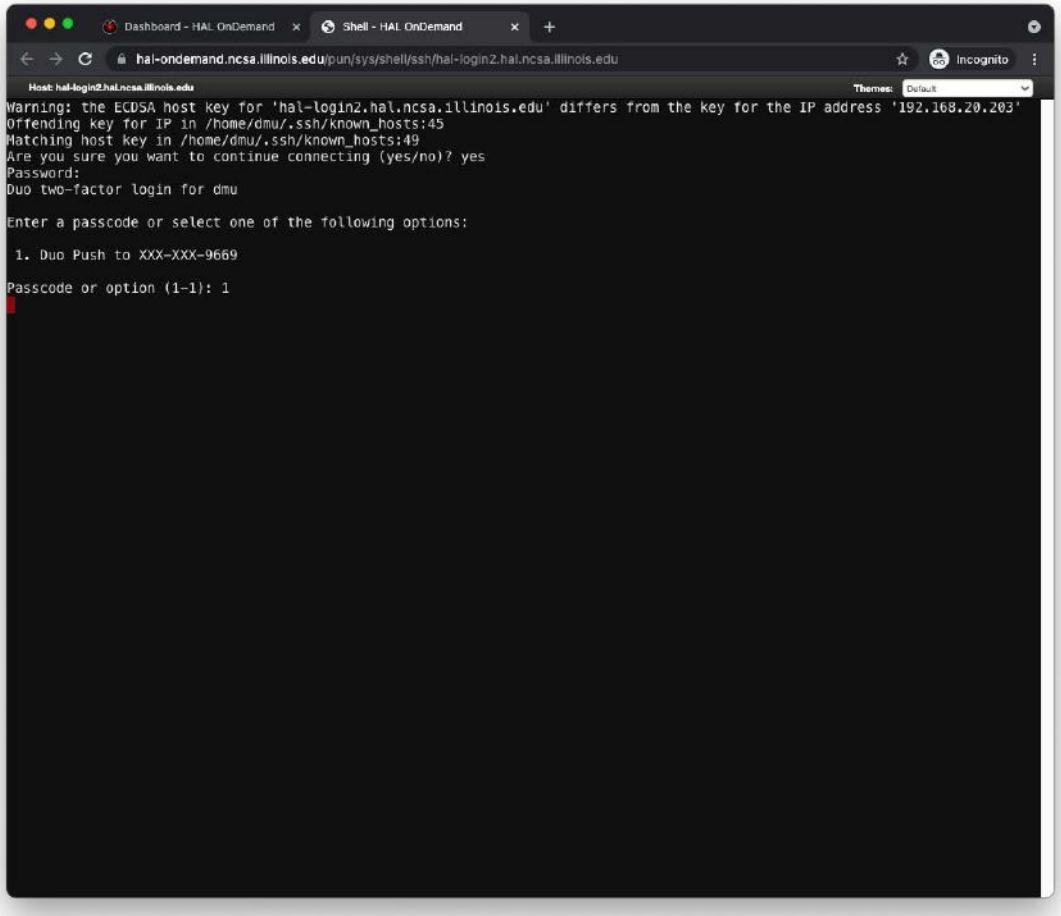

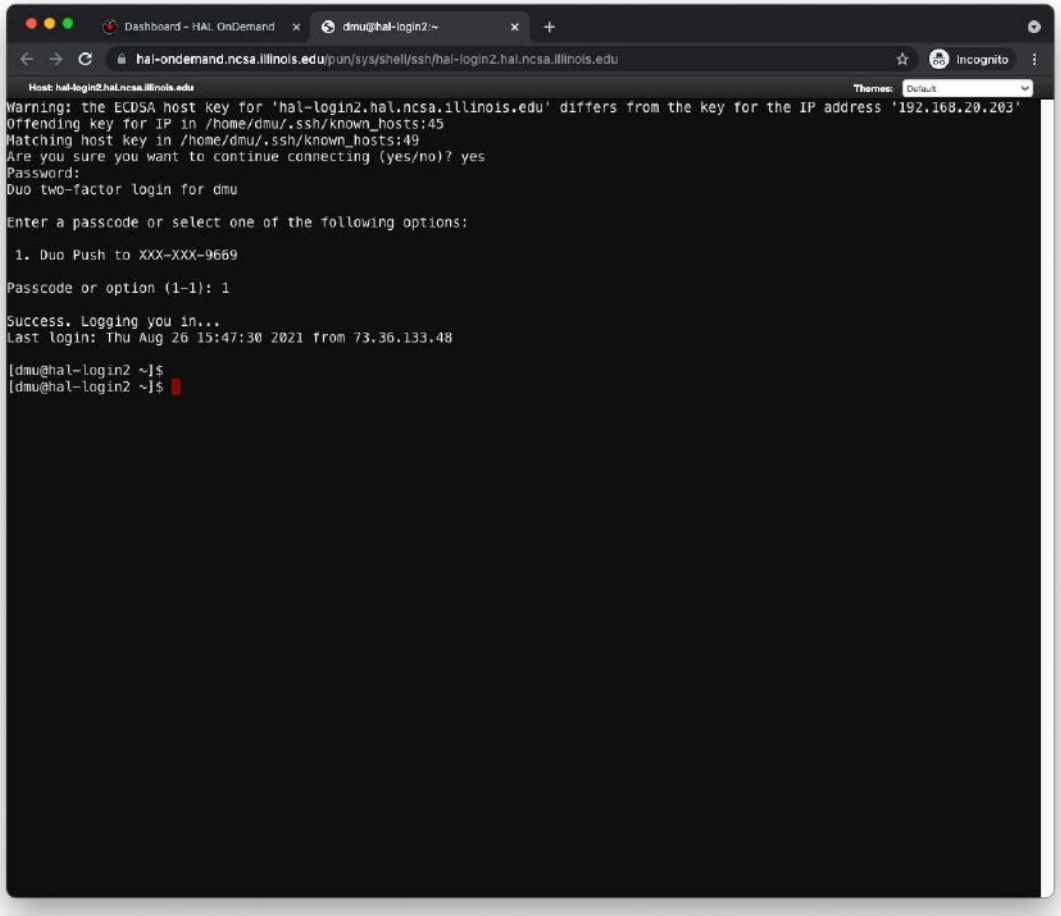

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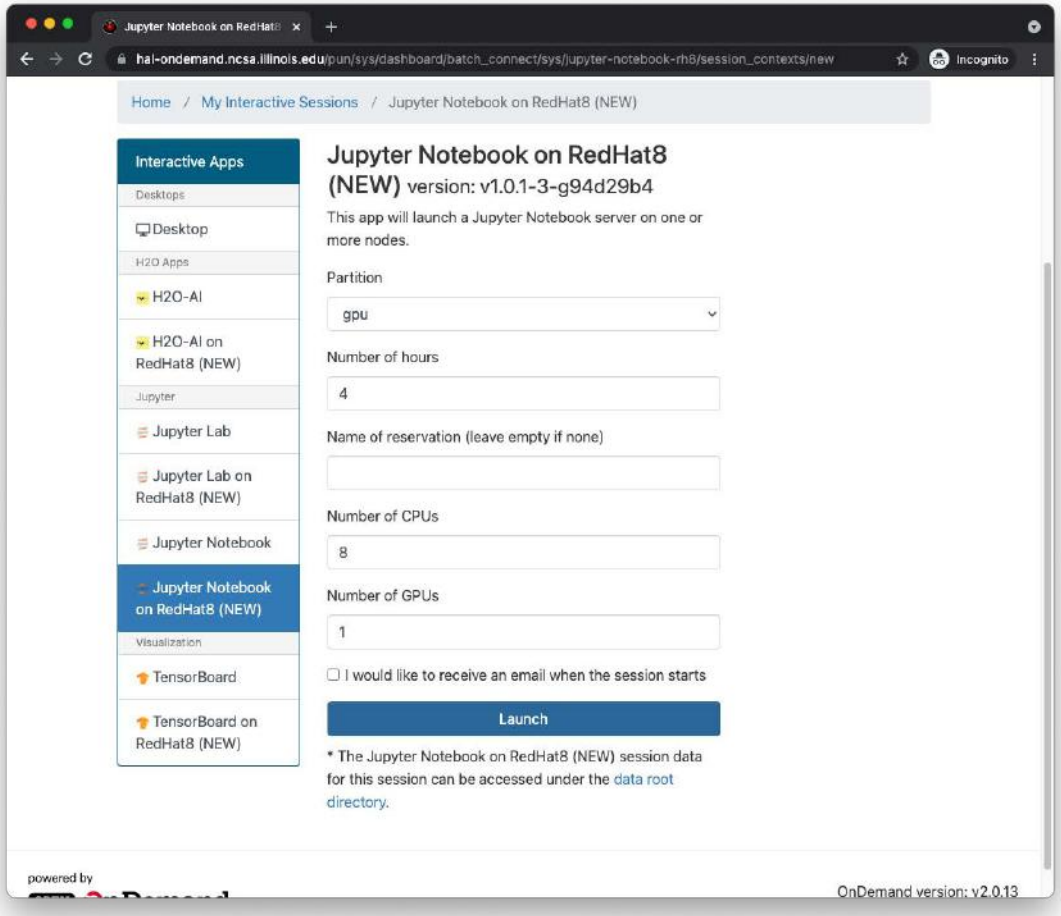

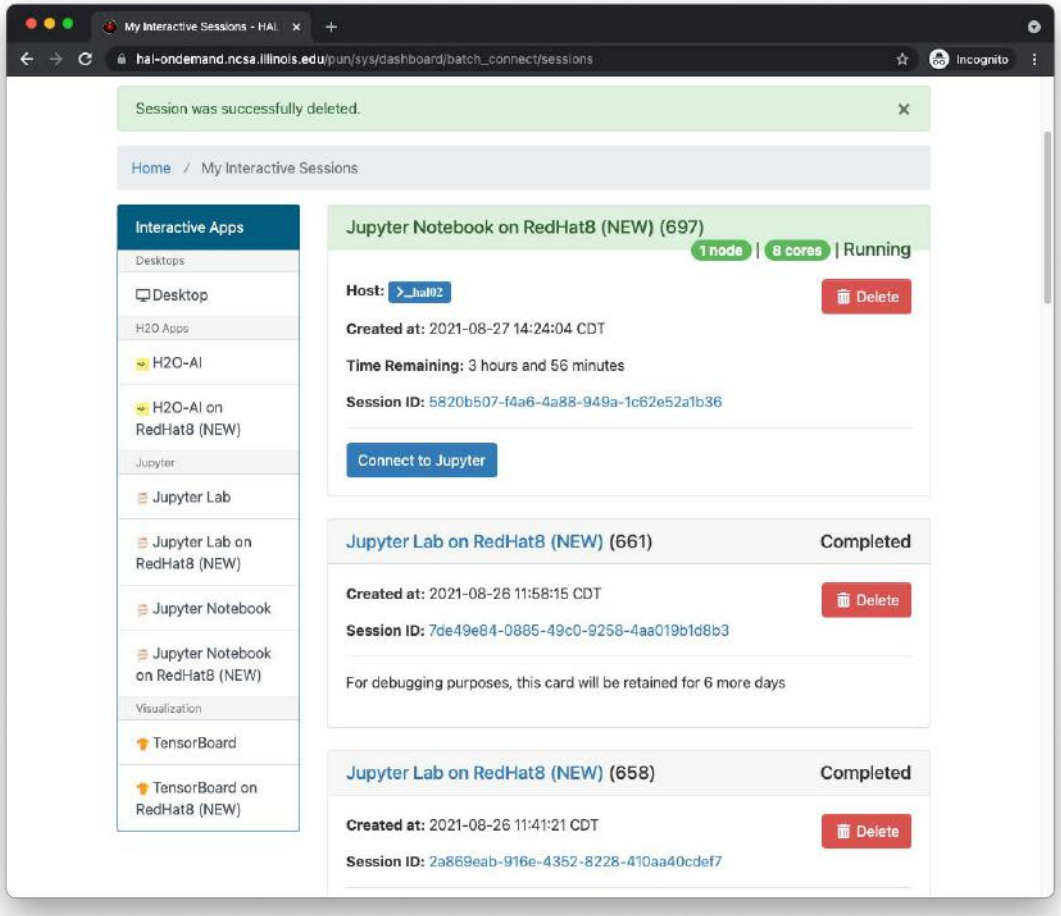

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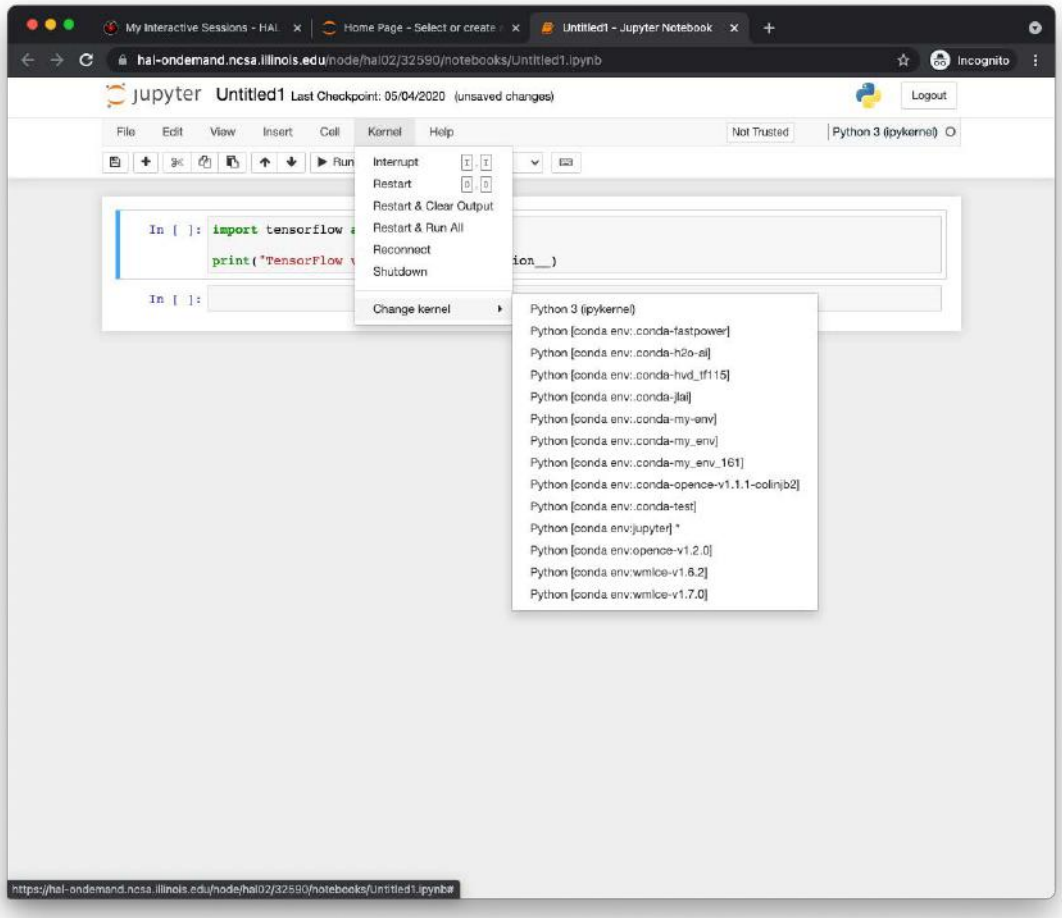

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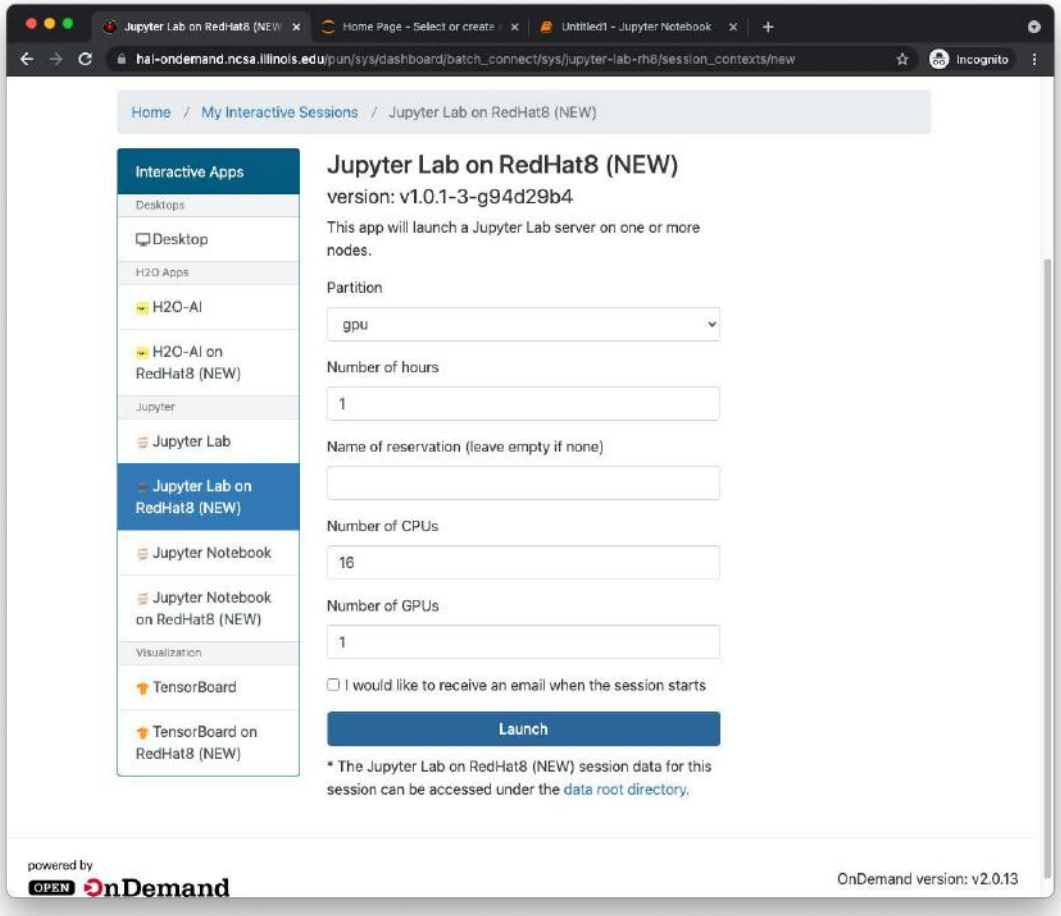

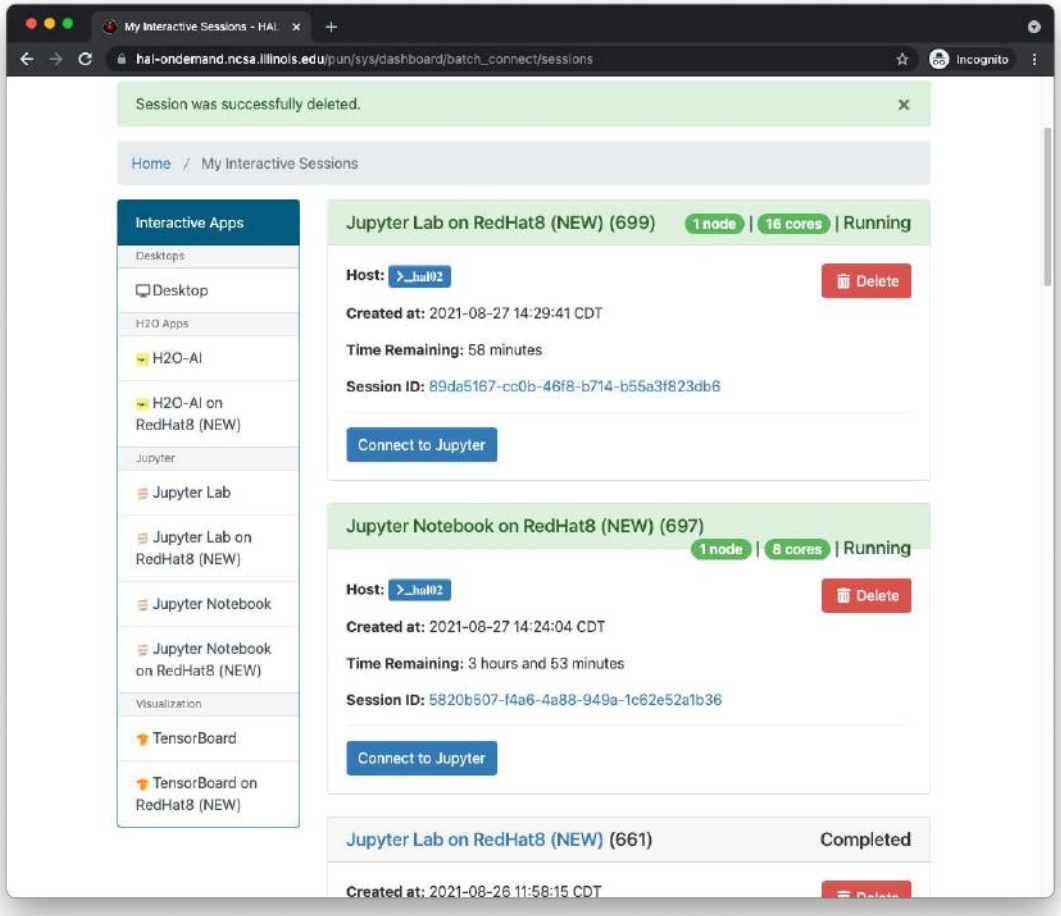

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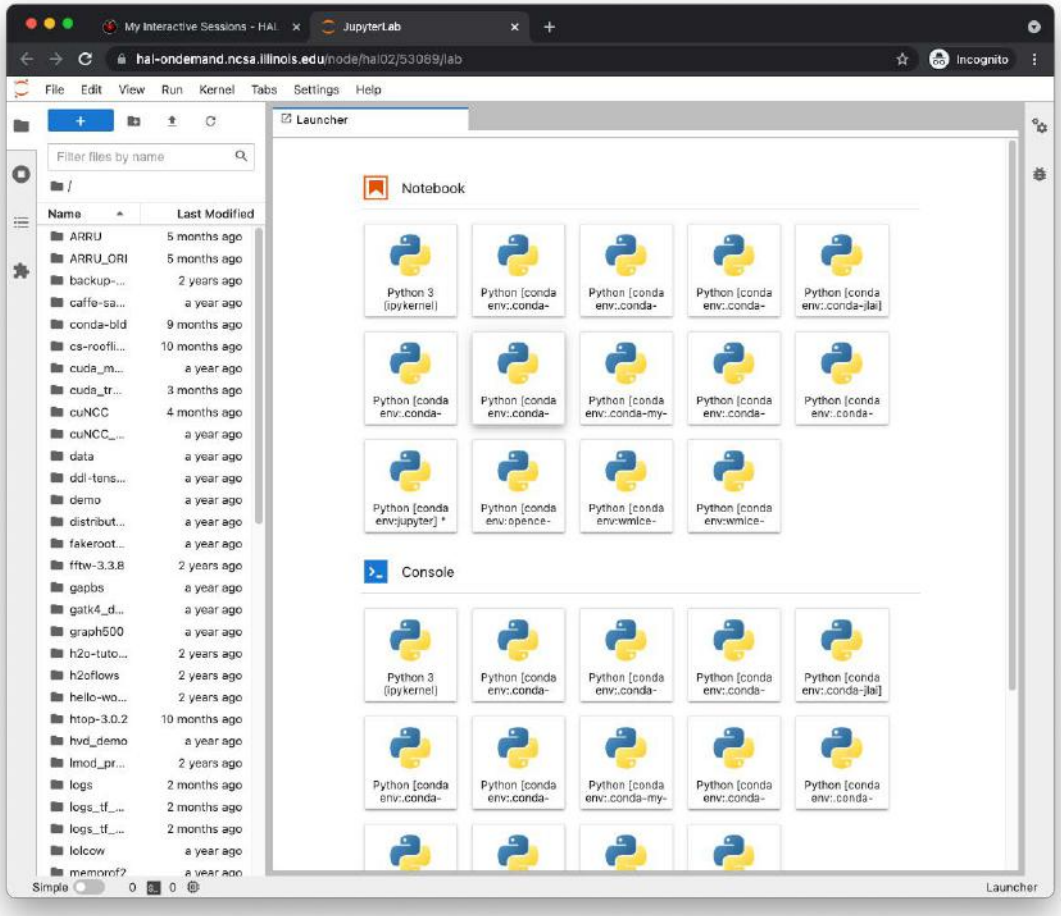

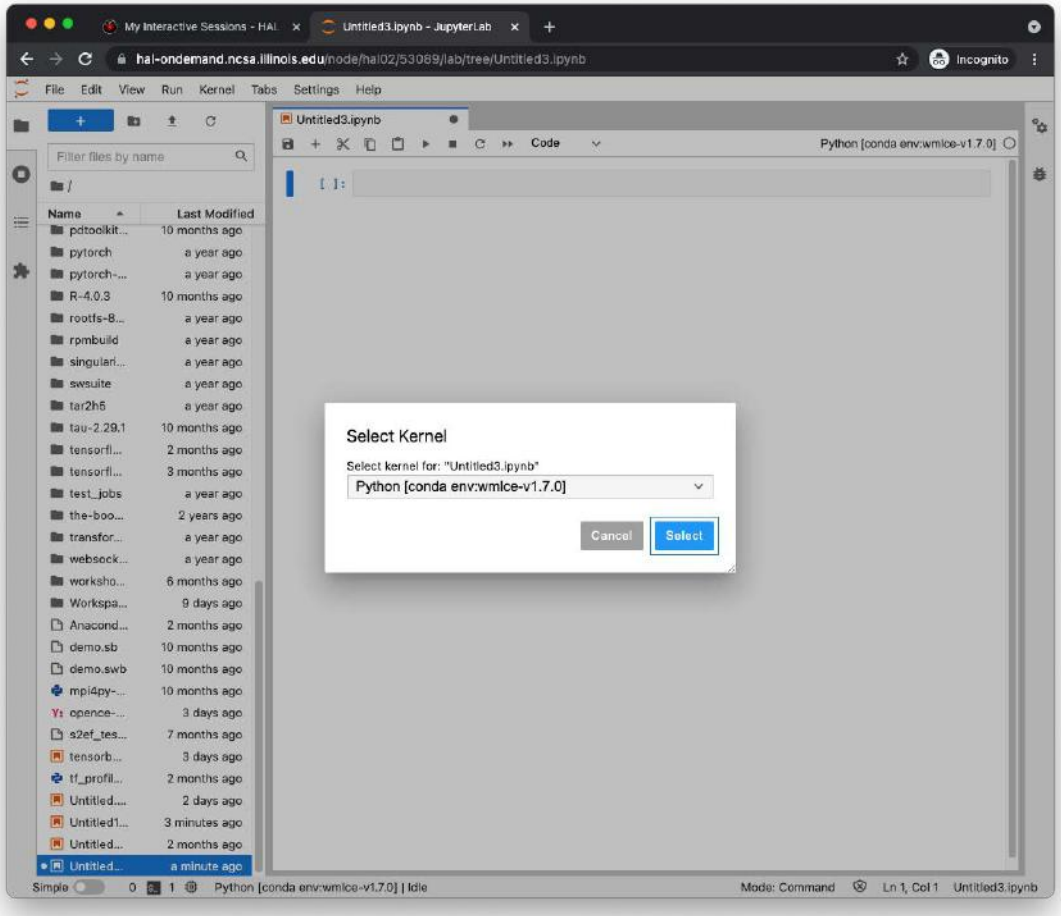

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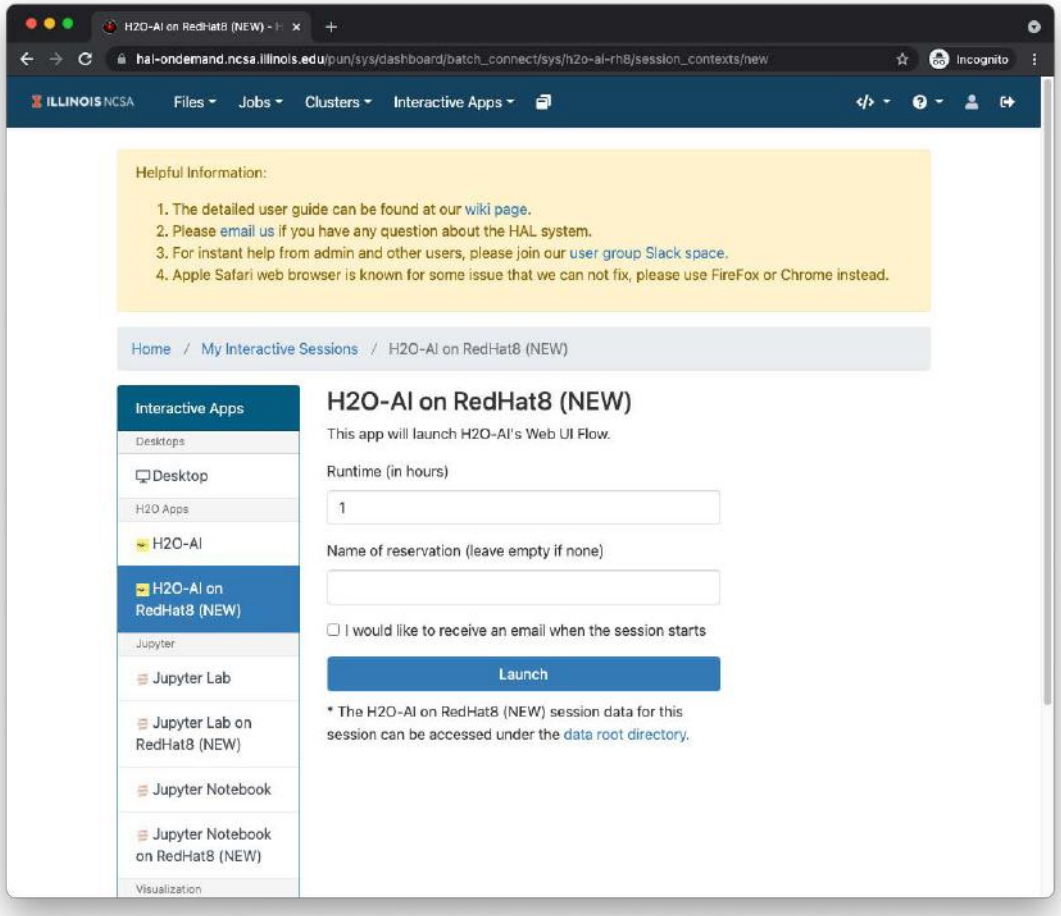
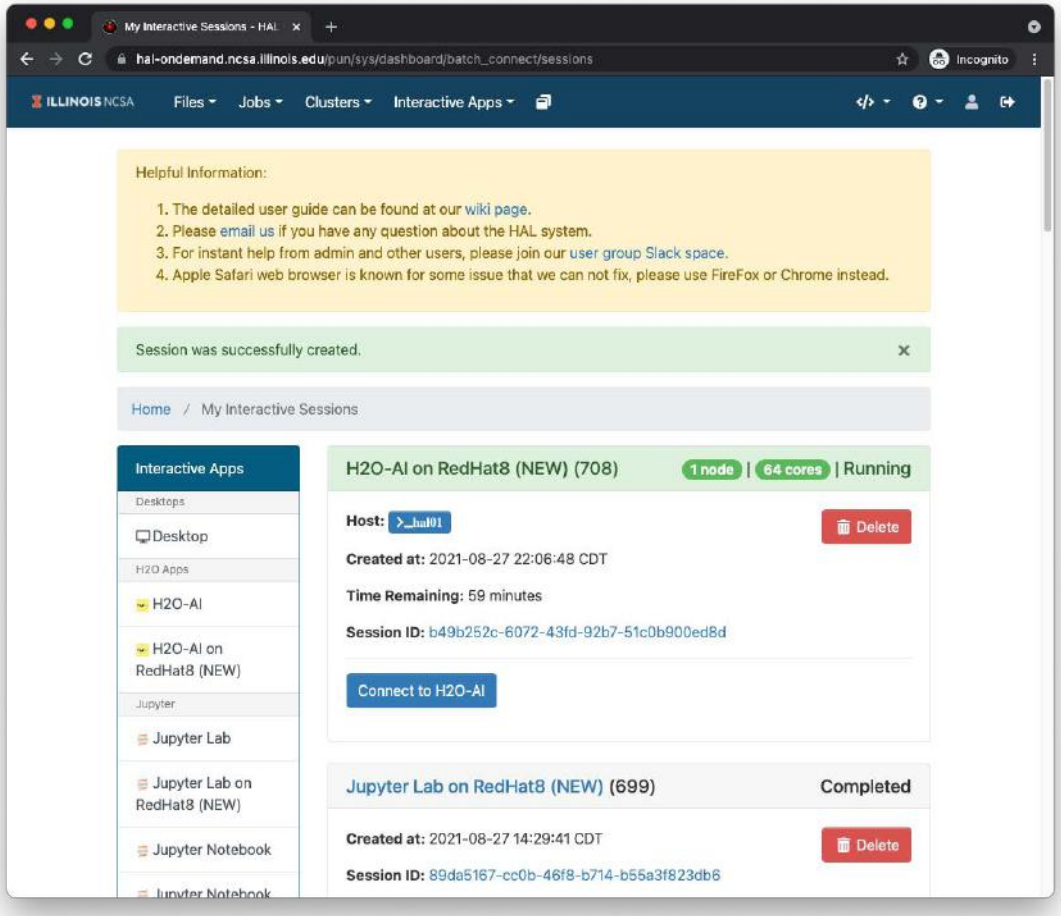
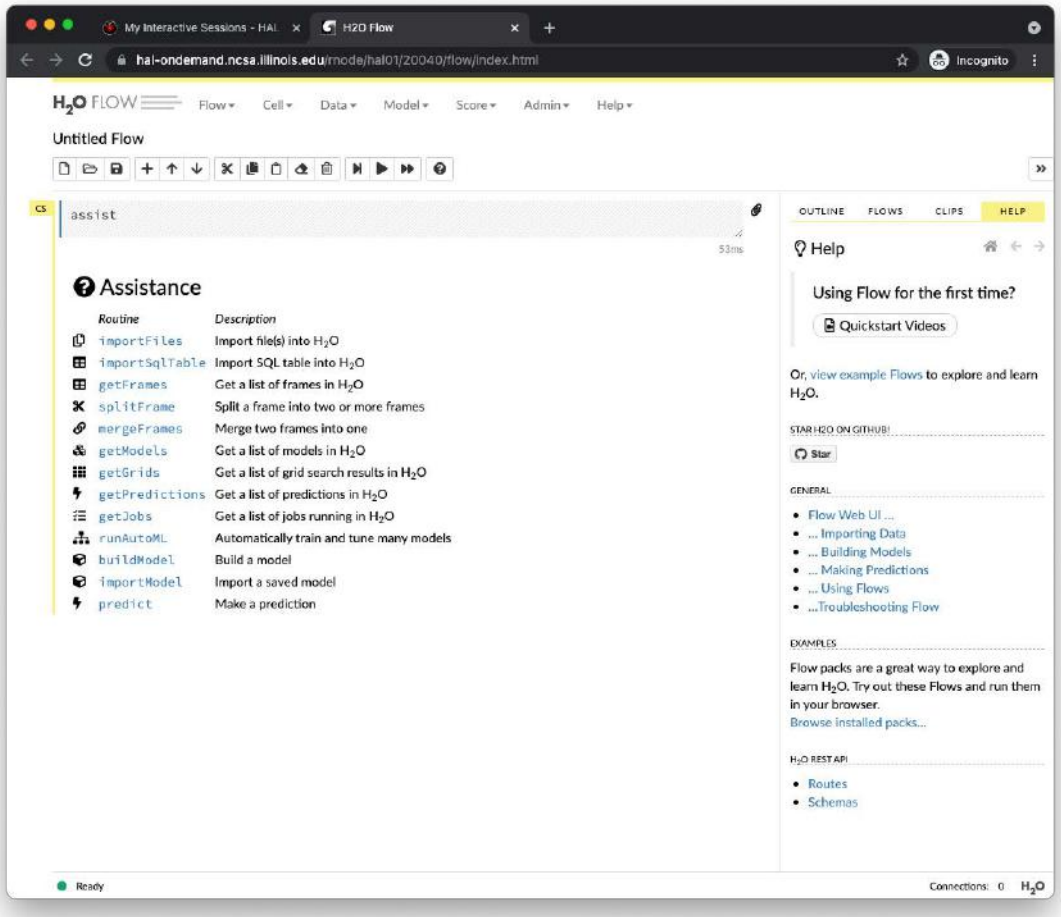




Open OnDemand (activate jobs)



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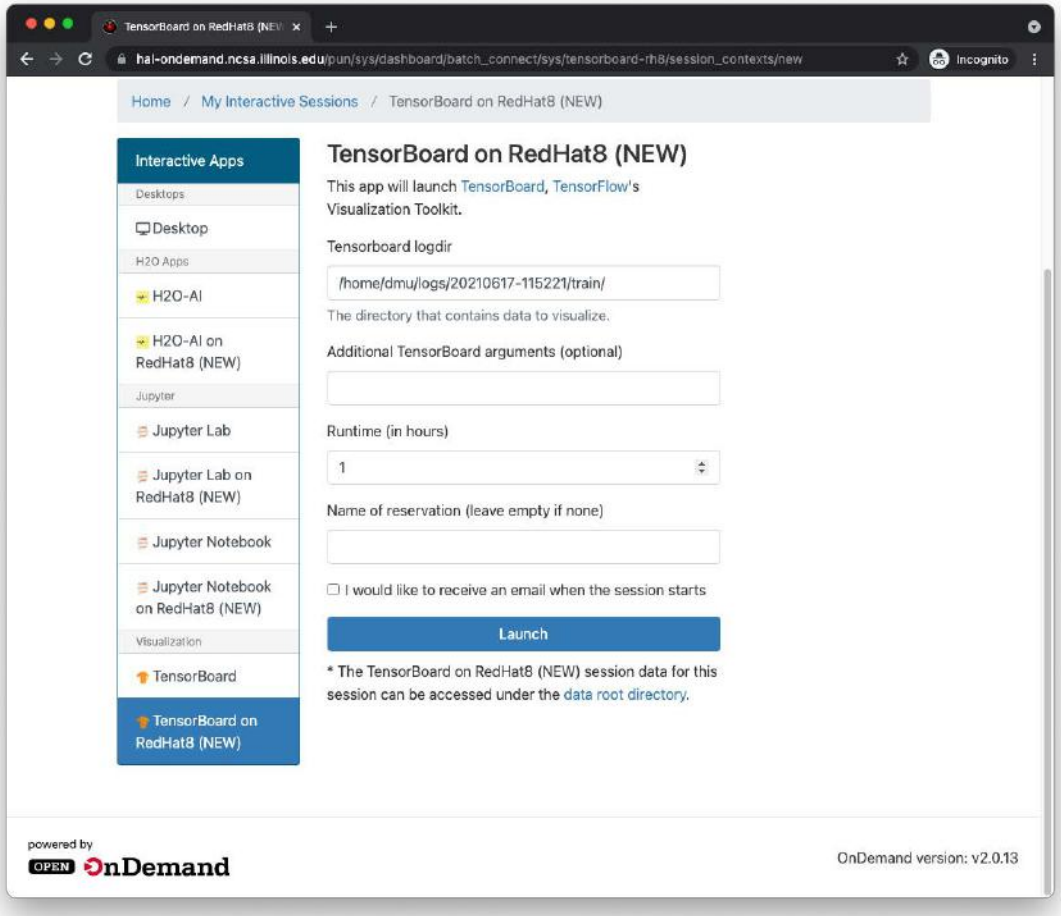

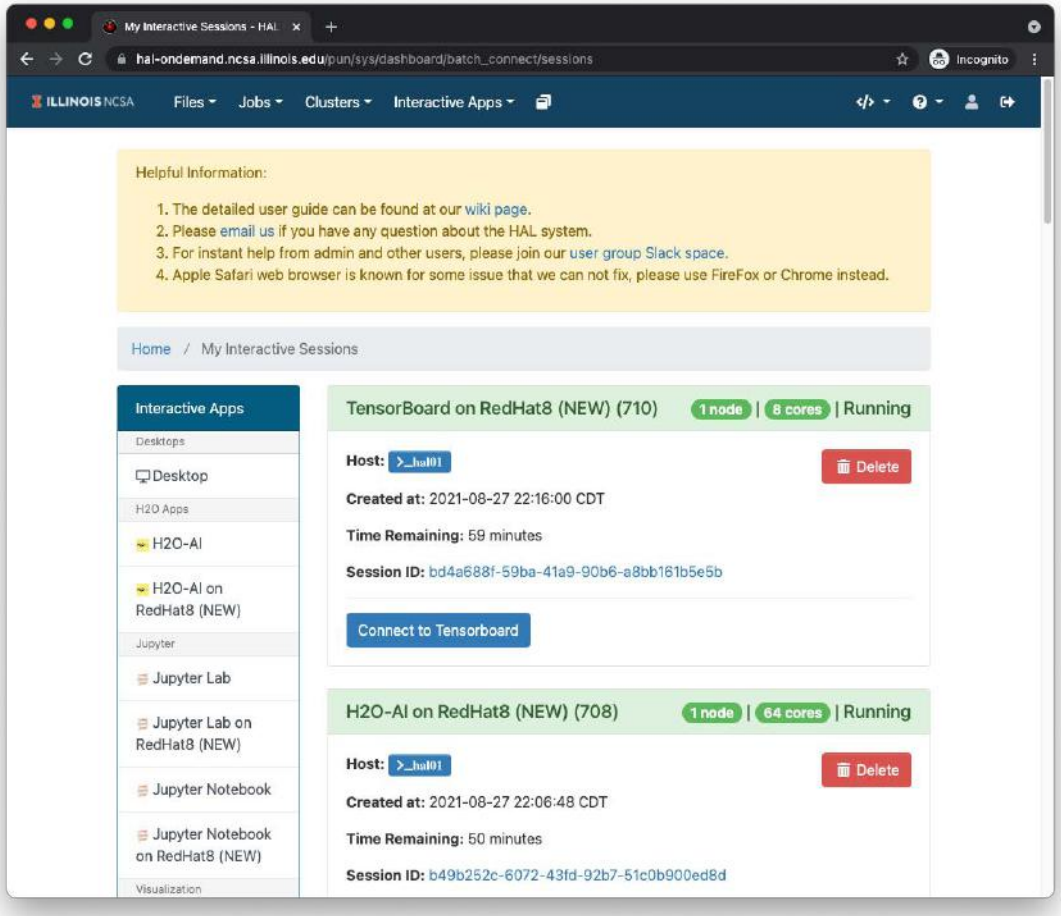

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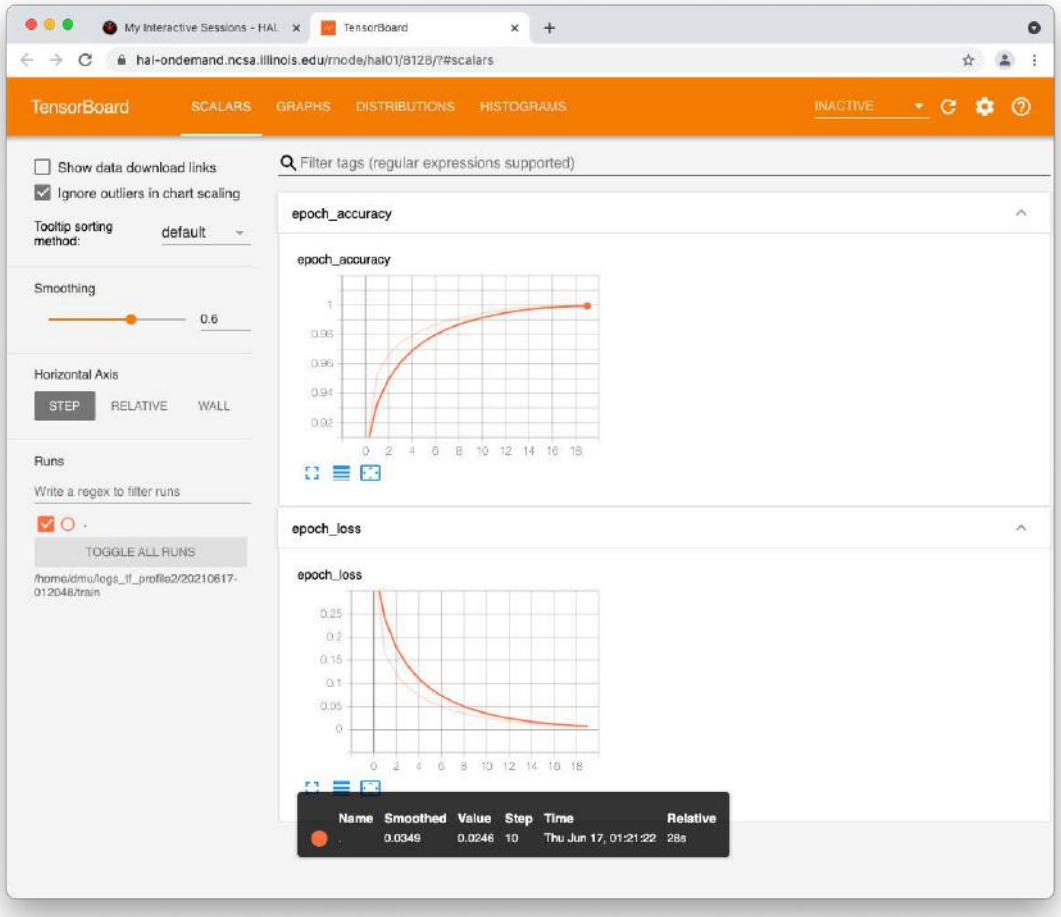

- Hands-on Demo Time
  - uiuc_5

THANK YOU FOR YOUR TIME !

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