Kubernetes Overview

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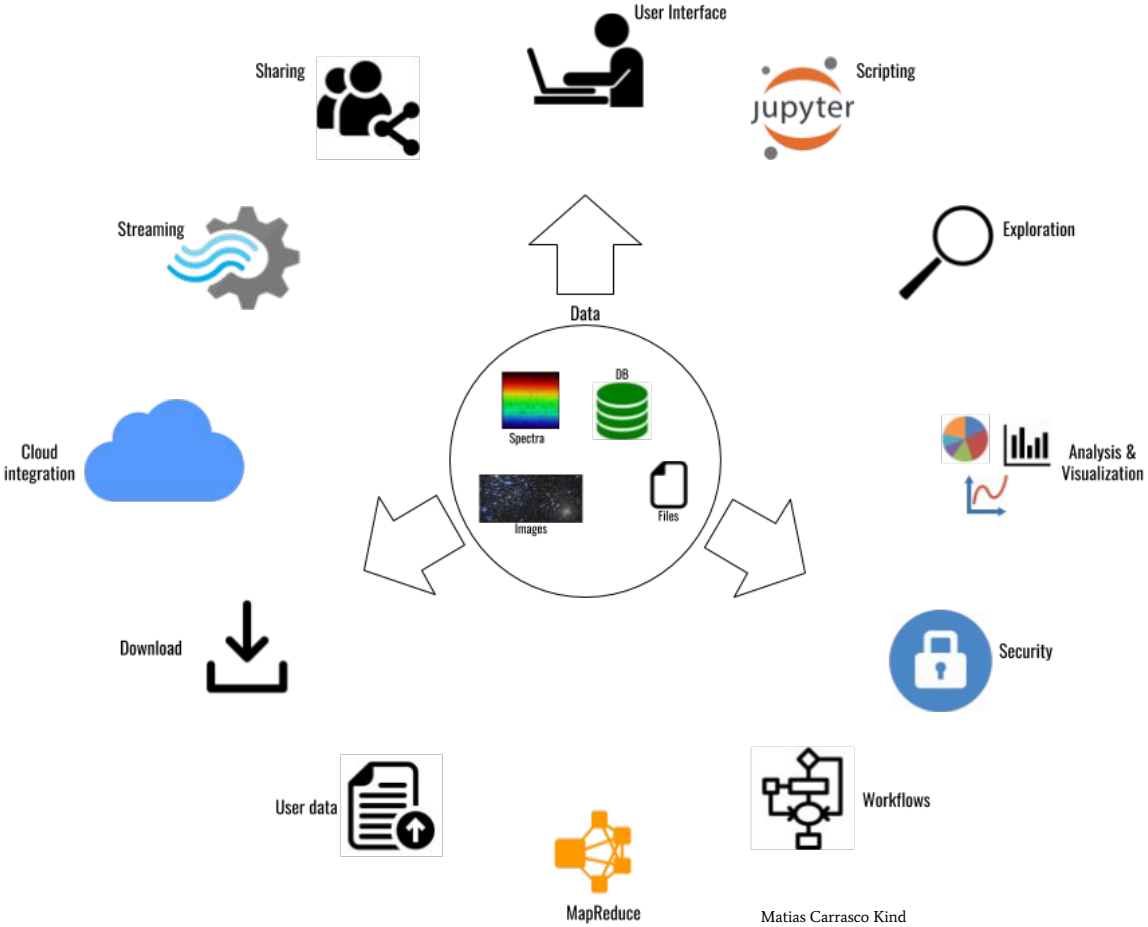
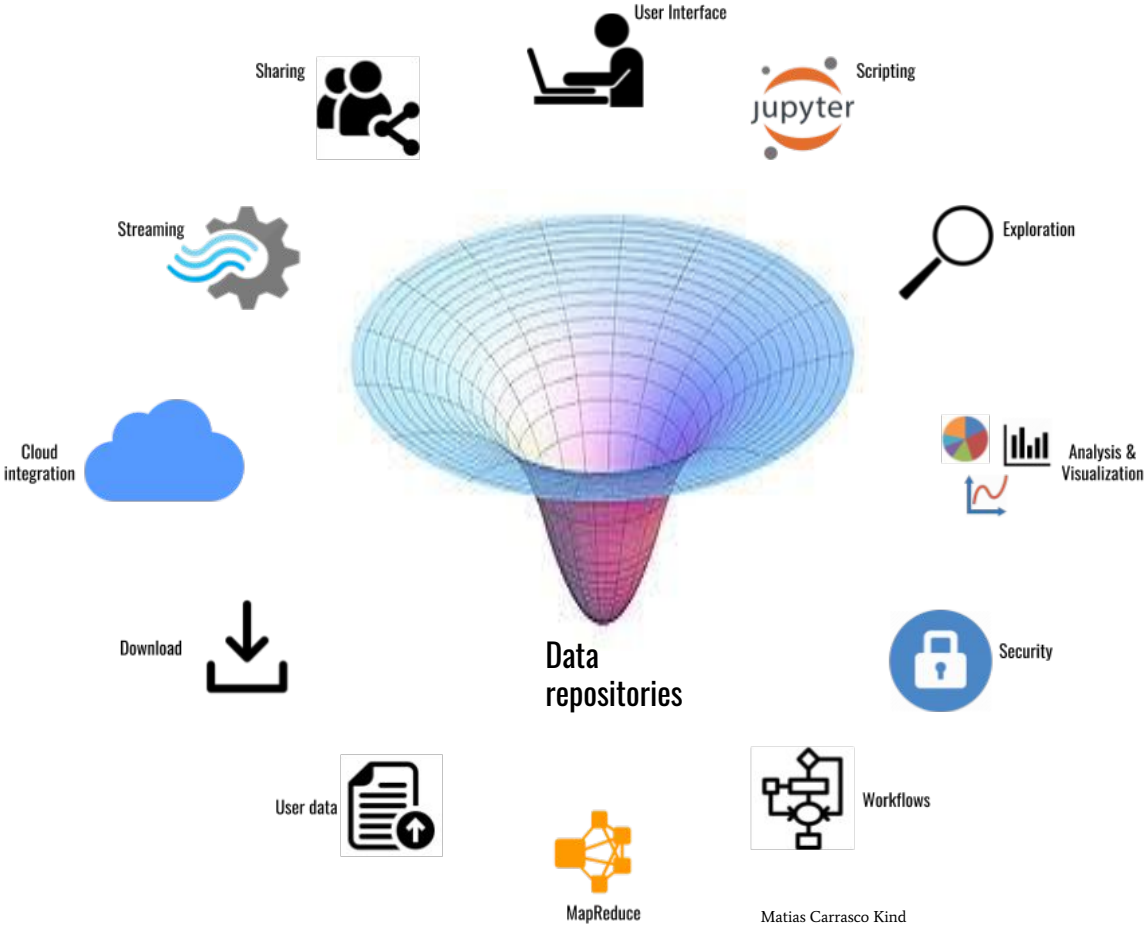
What is Data Access?



Several meanings around a central data archive, a.k.a “data lake”, “data gravity” repository with common components

- Storage
- Security
- Retrieving
- Interacting
- Modifying
- Understanding

What is Data Access?



Several meanings around a central data archive, a.k.a “data lake”, “**data gravity**” repository with common components

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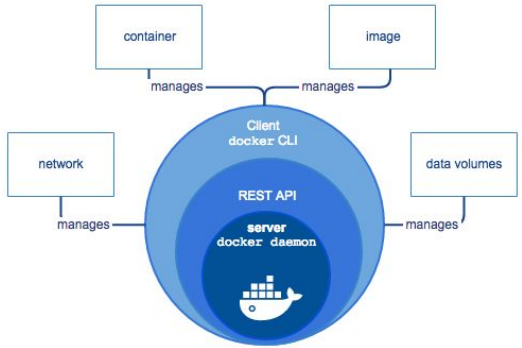
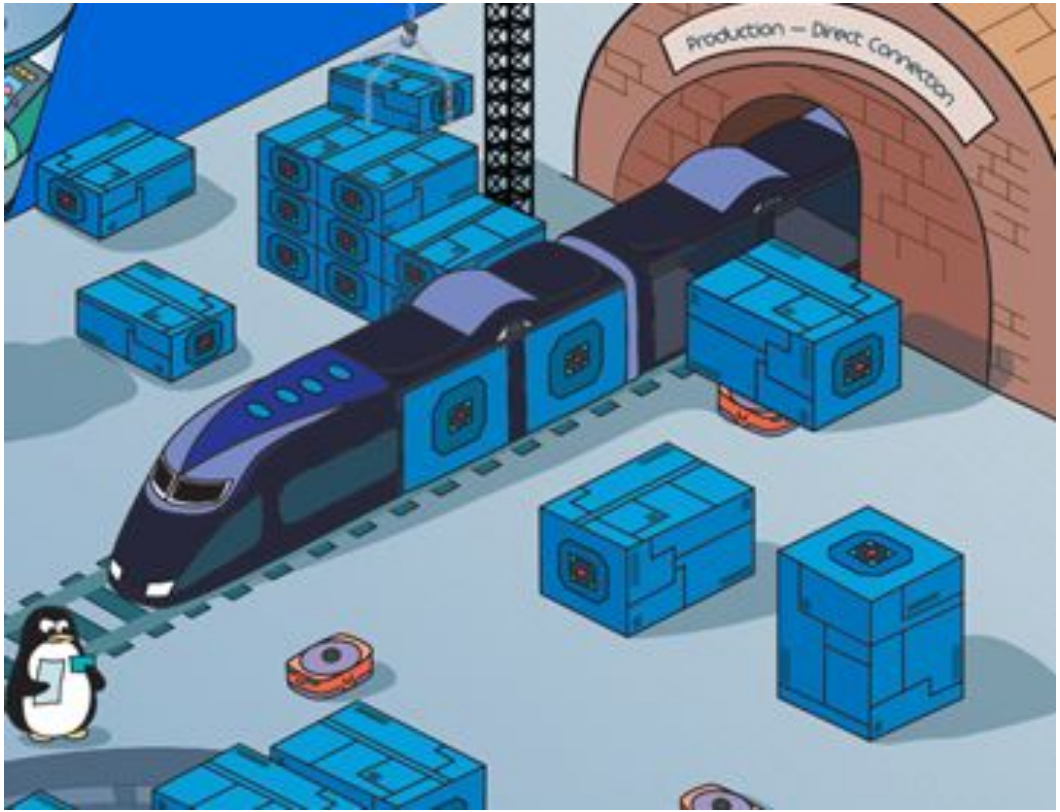
Containerization to the rescue

- It's been around for over 10 years, but popular since 2014 thanks to Docker
- Many other alternatives (rkt, kata, shifter, singularity, etc...)
- Lightweight, stand-alone, executable package of a piece of software that includes everything to run it
- Not just applications
- Software designed storage
- Software designed network



Container organization and orchestration

- We can create a container with an application inside, now what?
- Need to consider:
  - Resource needs
  - Fault tolerant
  - Load balancing
  - Storage management
  - Lifecycle
  - Service Discovery
  - Scalability

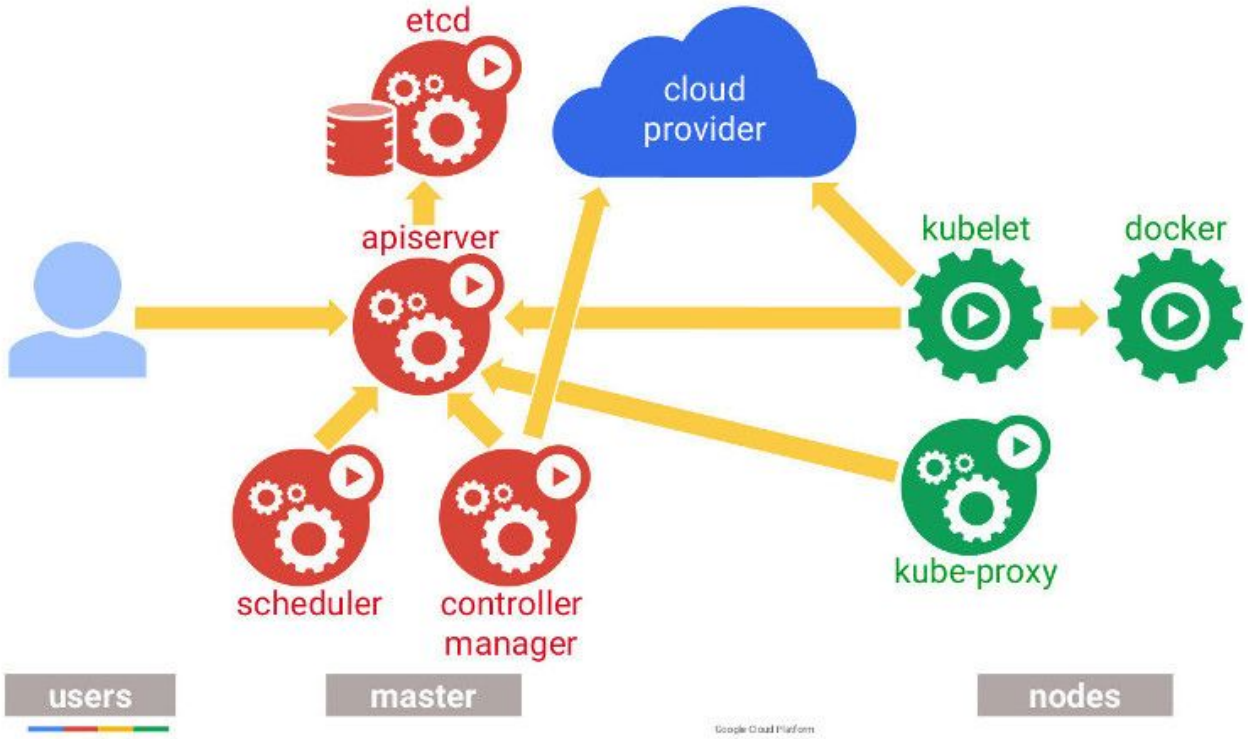


The Kubernetes Factor

- It solves all previous issues and more (not the only one but most popular)
- Open source container management and orchestration platform
- Developed by Google, made open sourced
- One of top 5 most commented open source repositories and #2 in number of pull request
- Standard within all cloud platforms
- Flexible and extensible, customize schedulers
- Is changing the cloud computing paradigm

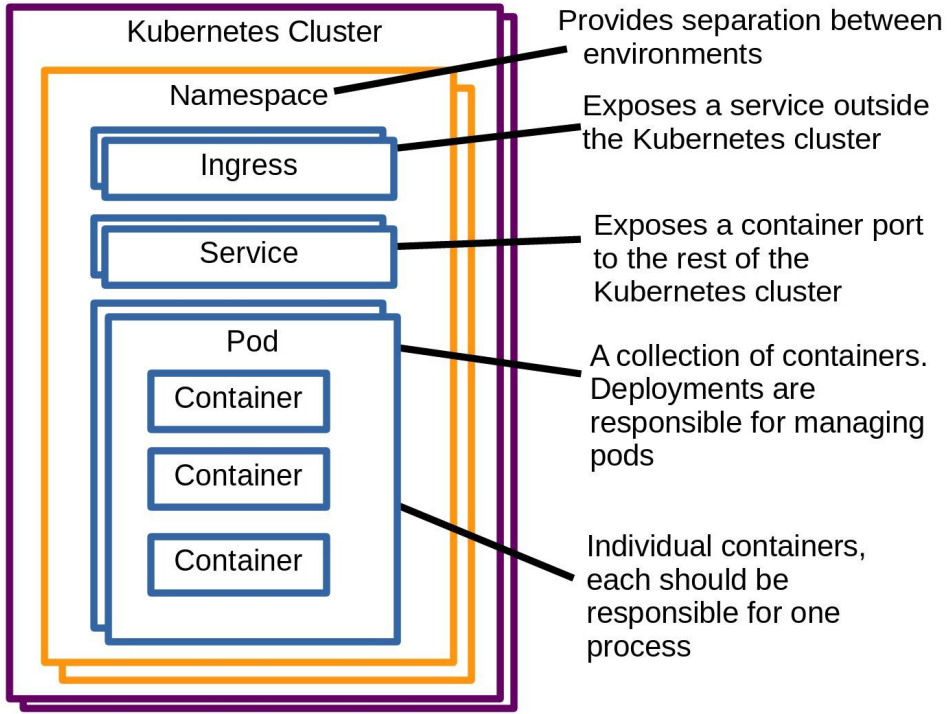
Kubernetes Overview

- Cloud democratization
- Easy deployment
- Controls most of the aspects
- Adopted at NCSA, CERN, LSST, NASA
- Edge Computing
- Scalability
- Federation
- Resource Manager

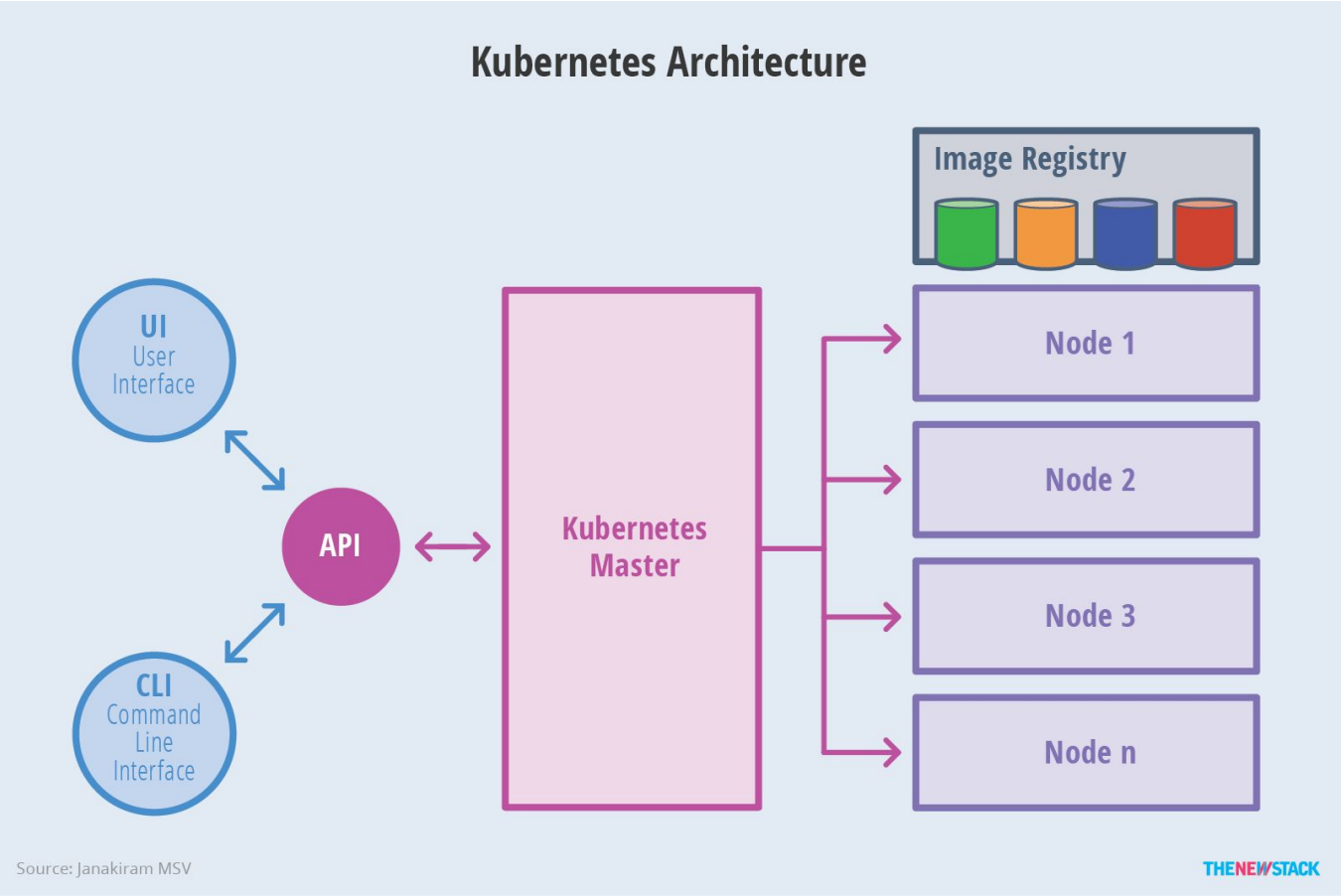


Kubernetes Key Concepts

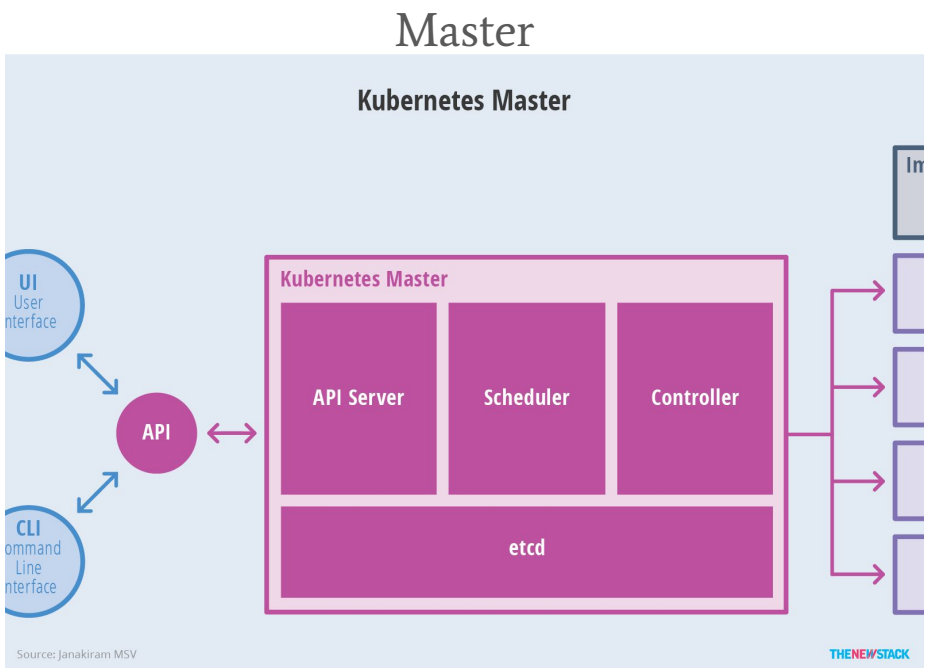
- **Pod** - A group of Containers
- **Labels** - Labels for identifying pods
- **Kubelet** - Container Agent
- **Proxy** - A load balancer for Pods
- **etcd** - A metadata service
- **cAdvisor** - Container Advisor provides resource usage/performance statistics
- **Replication Controller** - Manages replication of pods
- **Scheduler** - Schedules pods in worker nodes
- **API Server** - Kubernetes API server

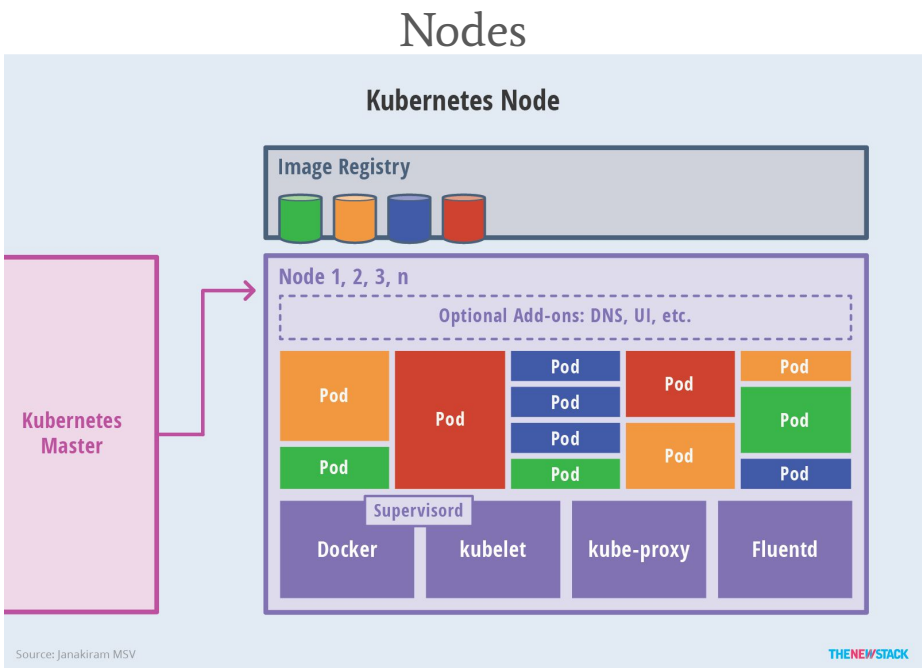


The Kubernetes Architecture



The Kubernetes Architecture





The Kubernetes Architecture

Namespaces/Labels

- Namespaces; can partition cluster in resources, users, etc. Different namespaces for different environments (prod vs devel)
- Labels: Used to select resources within the cluster or namespace, to select pods, nodes, deployments,

Users/Groups/Service Accounts

- User and Groups refer to humans running and using resources. Permissions/Roles are applied at these levels . Cluster scoped
- Service Accounts are for processes, permissions/Roles can be applied to allow a running pod to schedule another pod, etc... Namespace scoped

The Kubernetes Architecture

Roles/Cluster Roles

- Roles are namespaced scoped
  - CRUD resources namespace
  - Pods, deployments, PVC, service
  - Roles are bind to users/groups/sa
- Cluster Roles are cluster scoped
  - CRUD resources at cluster level
  - Nodes, namespaces, secrets, policy

Policies

- Pod Policy: at Cluster level to control how the pods/containers are run
  - Disabled running as root or a particular group, allow certain volumes to be mounted, limit access to port in host machine
- Network policy: how groups of pods are allowed to communicate with each other and other network endpoints. Namespaced scope, traffic control, use labels

The Kubernetes Architecture

Resource Quotas

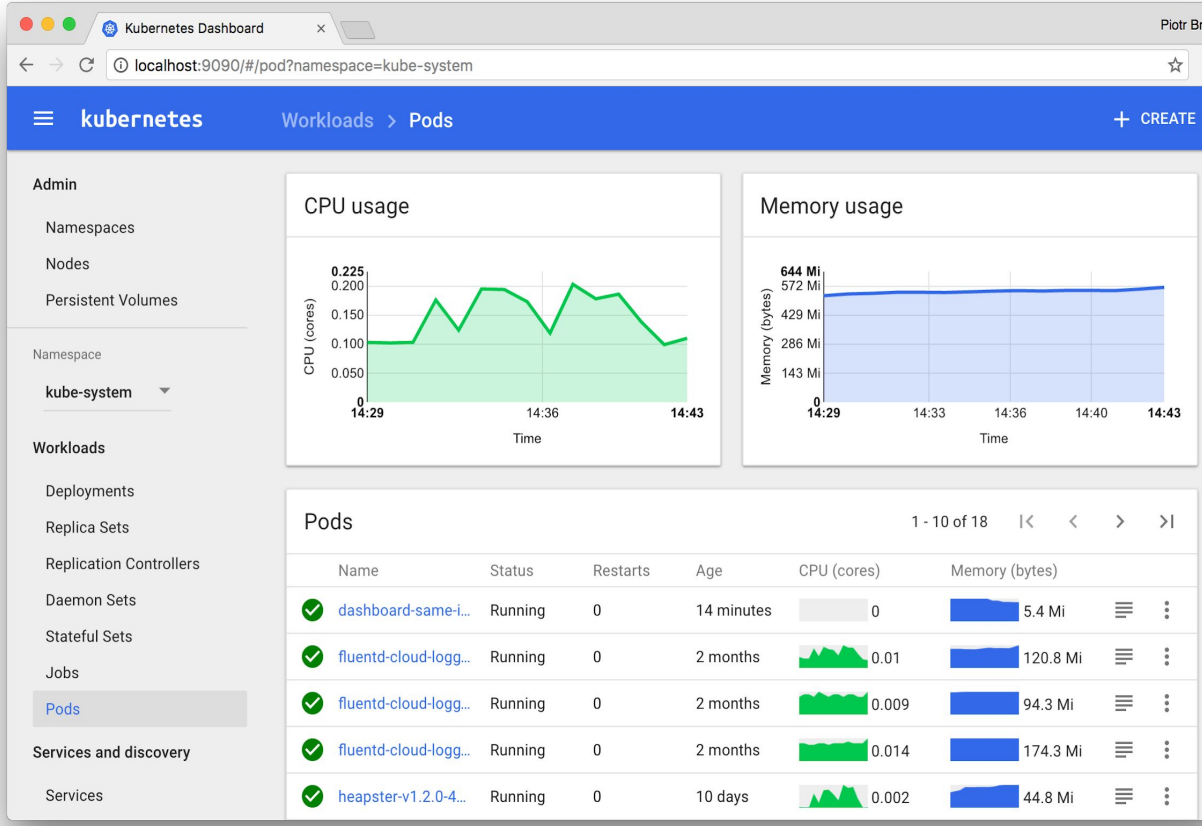
- Namespace scoped
- Limit cpu, memory, storage, etc
- Limit count of pods, deployments, claims, services, pods, etc.
- Doesn't work on nodes
- Can be updated dynamically

Node Selectors/Admission Control

- By labeling nodes, nodes can be tainted, reserved or specifically selected for scheduling
- Can enforce a set of dedicated nodes for a namespace using Admission Control
- Need to restart api server (not cluster)

Monitor

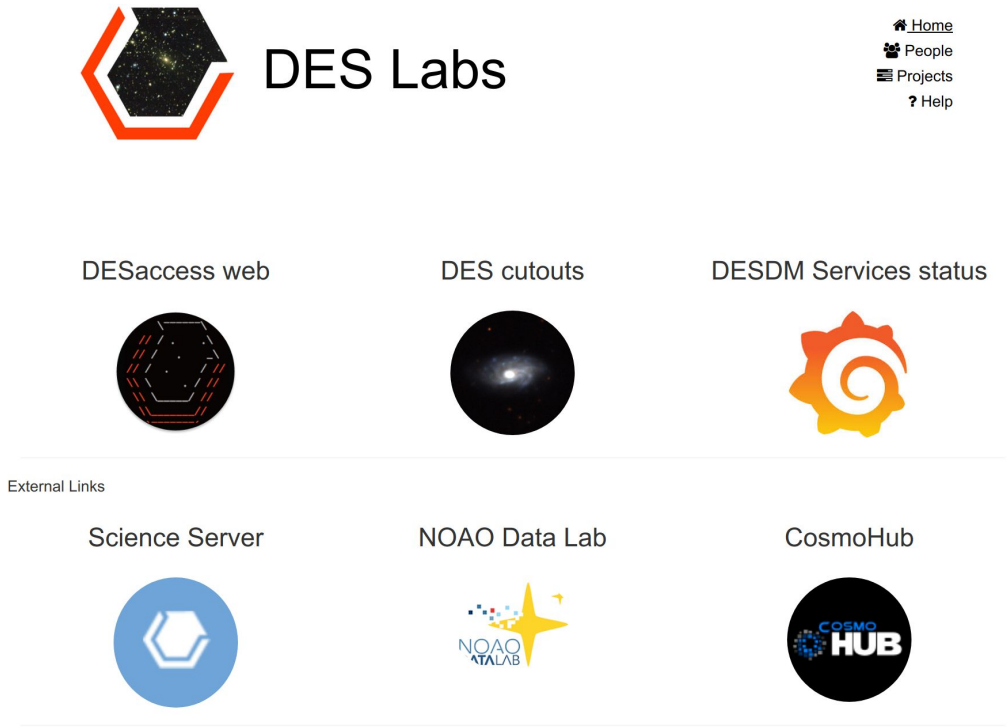
- Daemons sets can monitor nodes health, volumes
- Etcd @ master monitor use of resources, status of resources
- Controller manager monitors the status of the deployments and other resources
- Dashboard



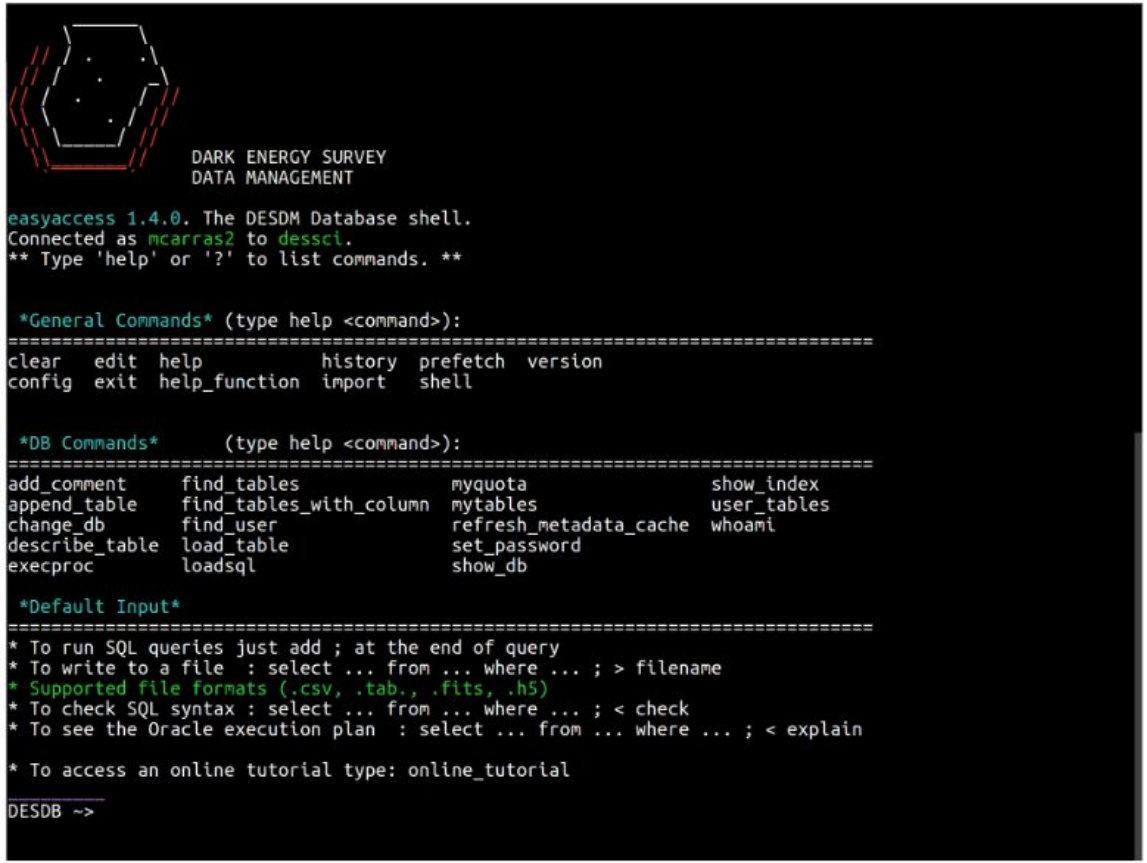
Applications

DES Labs: Collection of containerized tools for DES access

- Launched in March 2015
- Used by the Collaboration
- Running using Kubernetes at NCSA (hybrid model) since 2016
- Used for DR1 infrastructure
- Customizable



easyaccess: DES command line tool



- DES DB in Oracle
- Specifically designed for DES (internal and public)
- Enhanced SQL command line interpreter in Python
- Astronomer friendly
- Python API, web interface
- There are many other CLI and GUI clients.
- Needed a simple tool, easy to use and install
- Autocompletion
- Load/Save to hdf5, fits, csv

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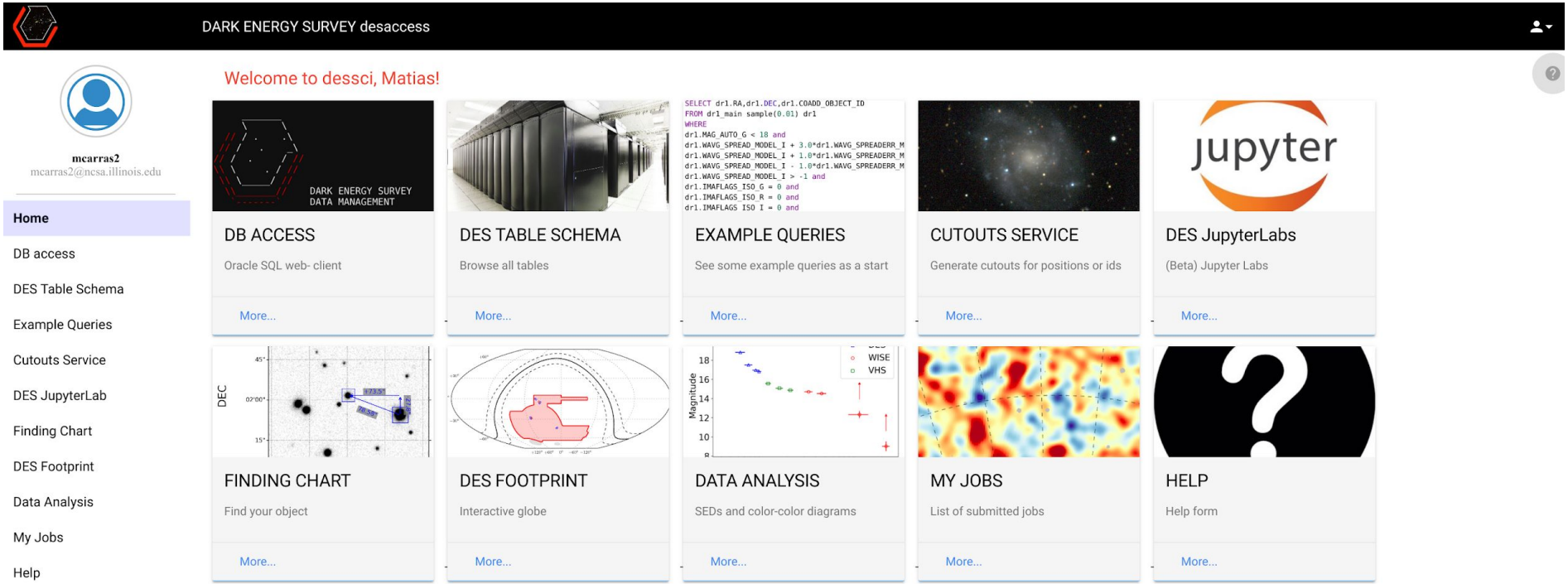
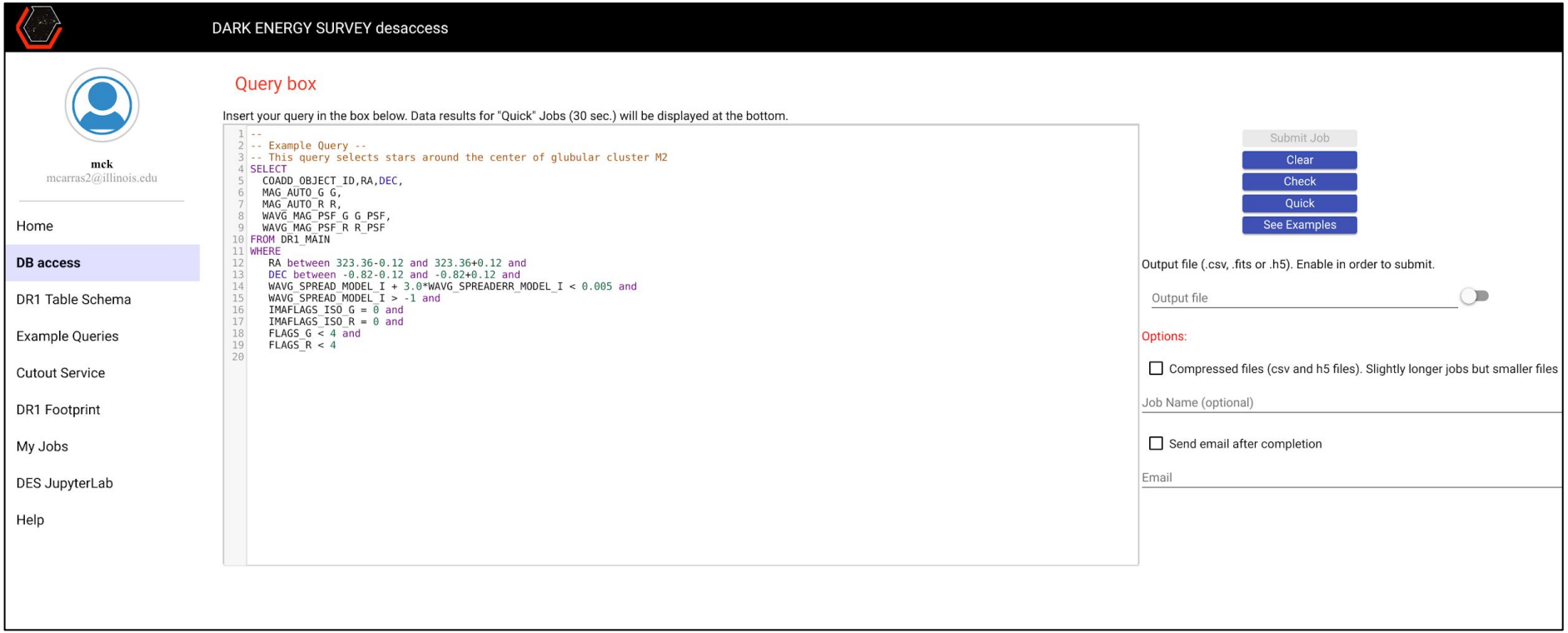
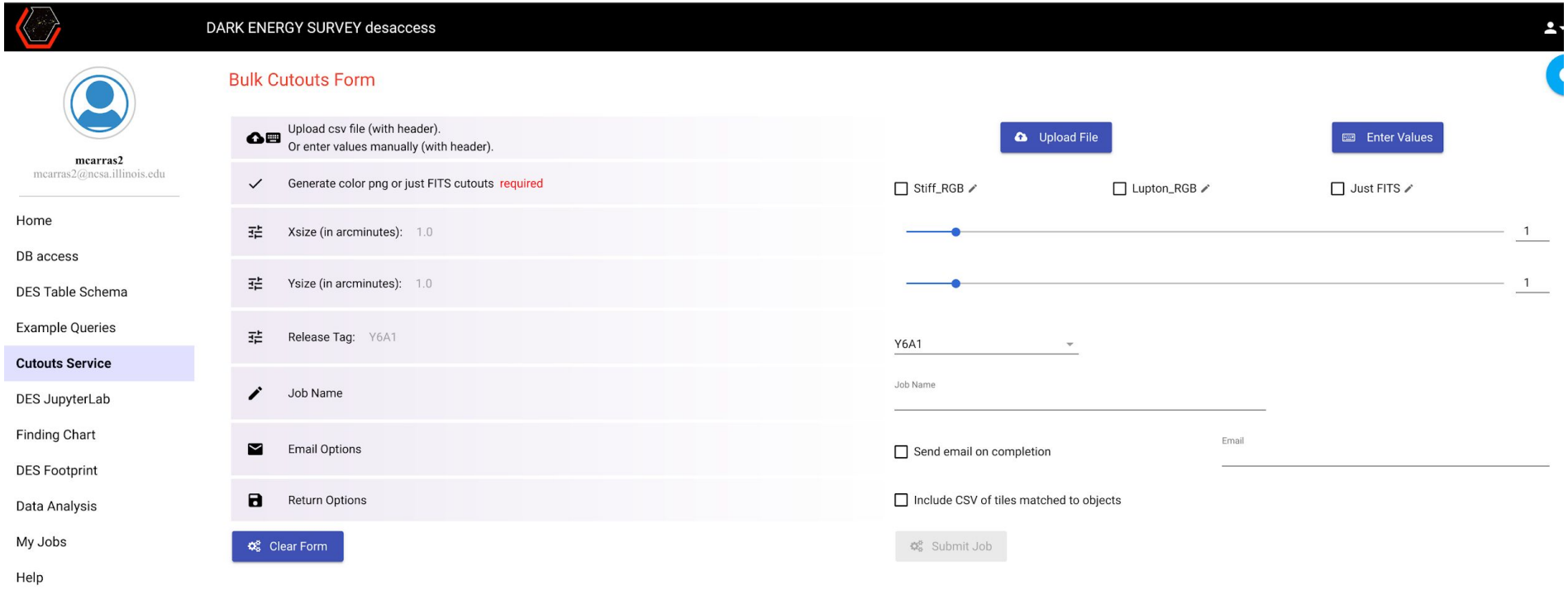
Services options for user (independent containers)



DB access: SQL Interface, quick and job submission



Cutouts Service: Get image cutouts from given positions



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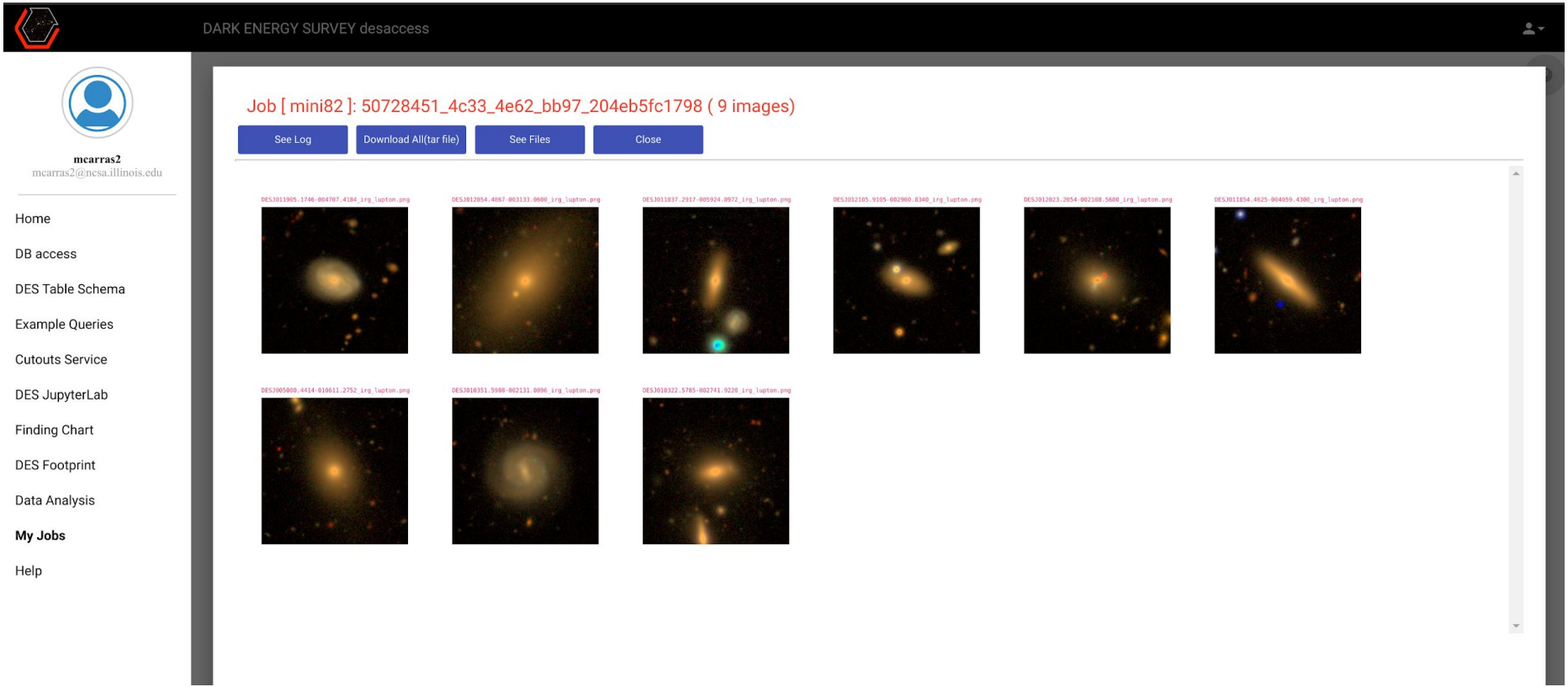
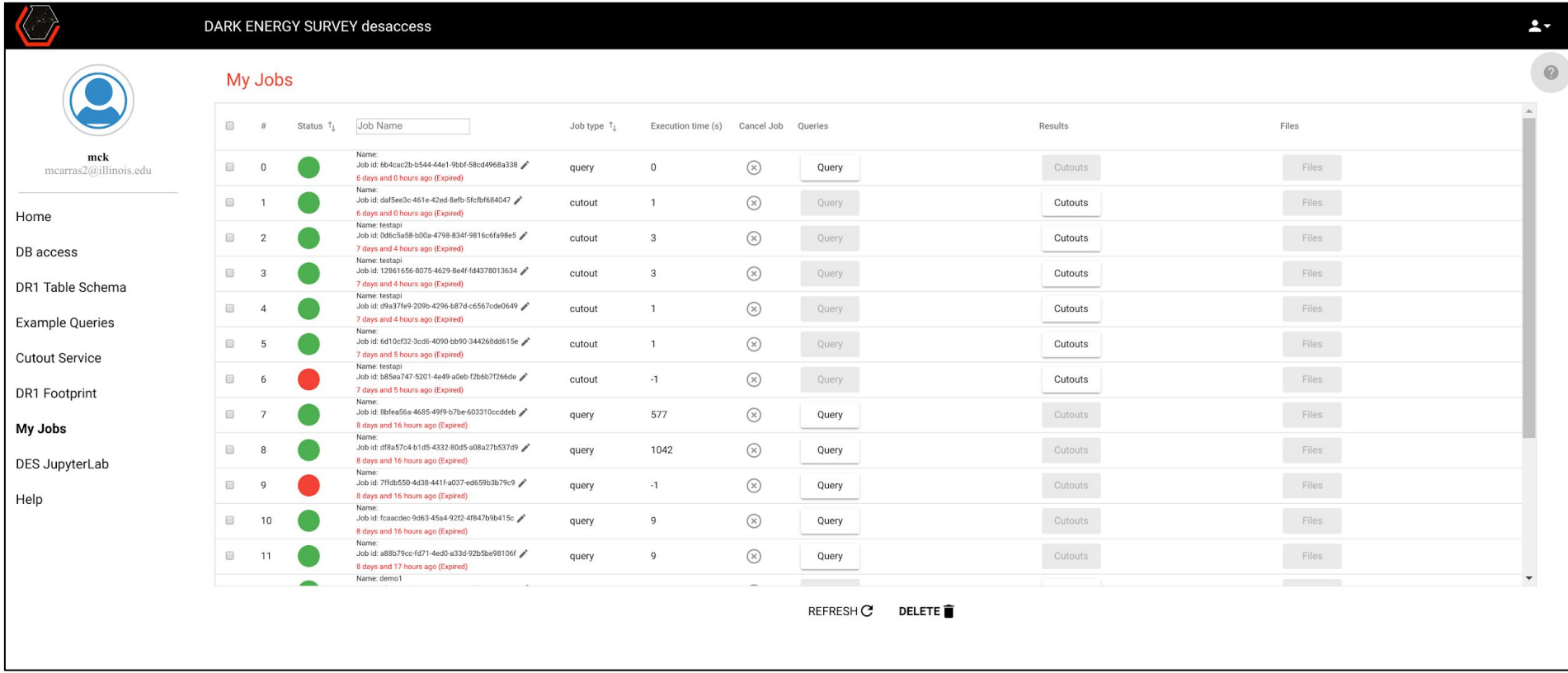
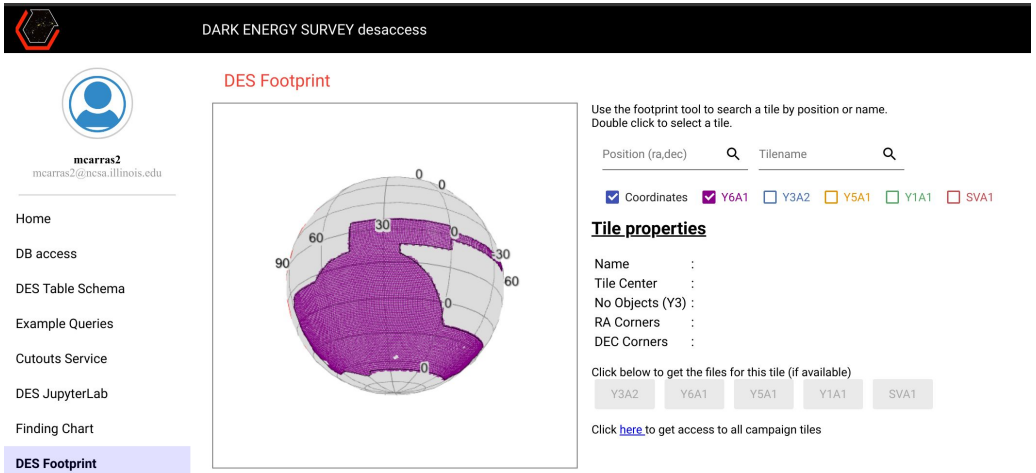
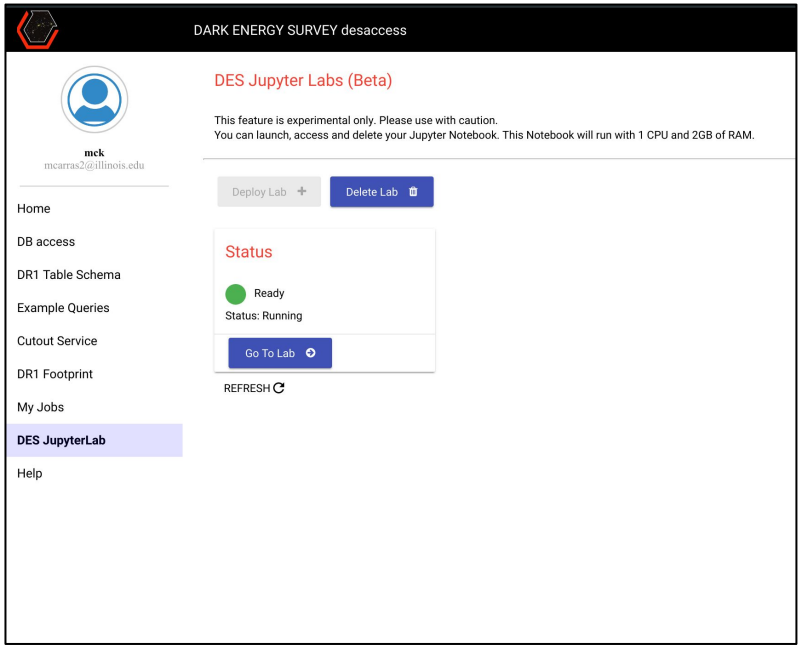


Asynchronous Jobs: Job status, jobs name

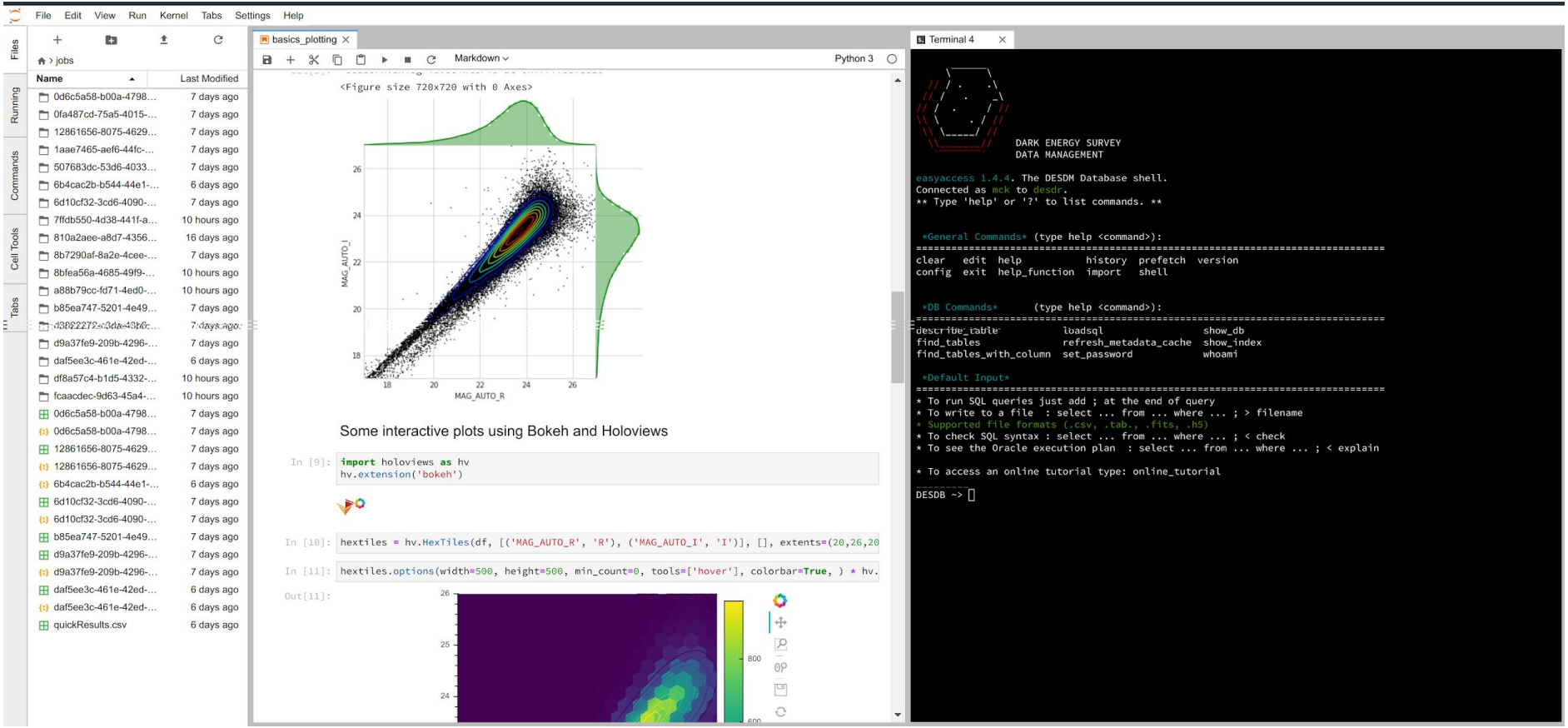


Footprint and Jupyter Labs: Exploring the data

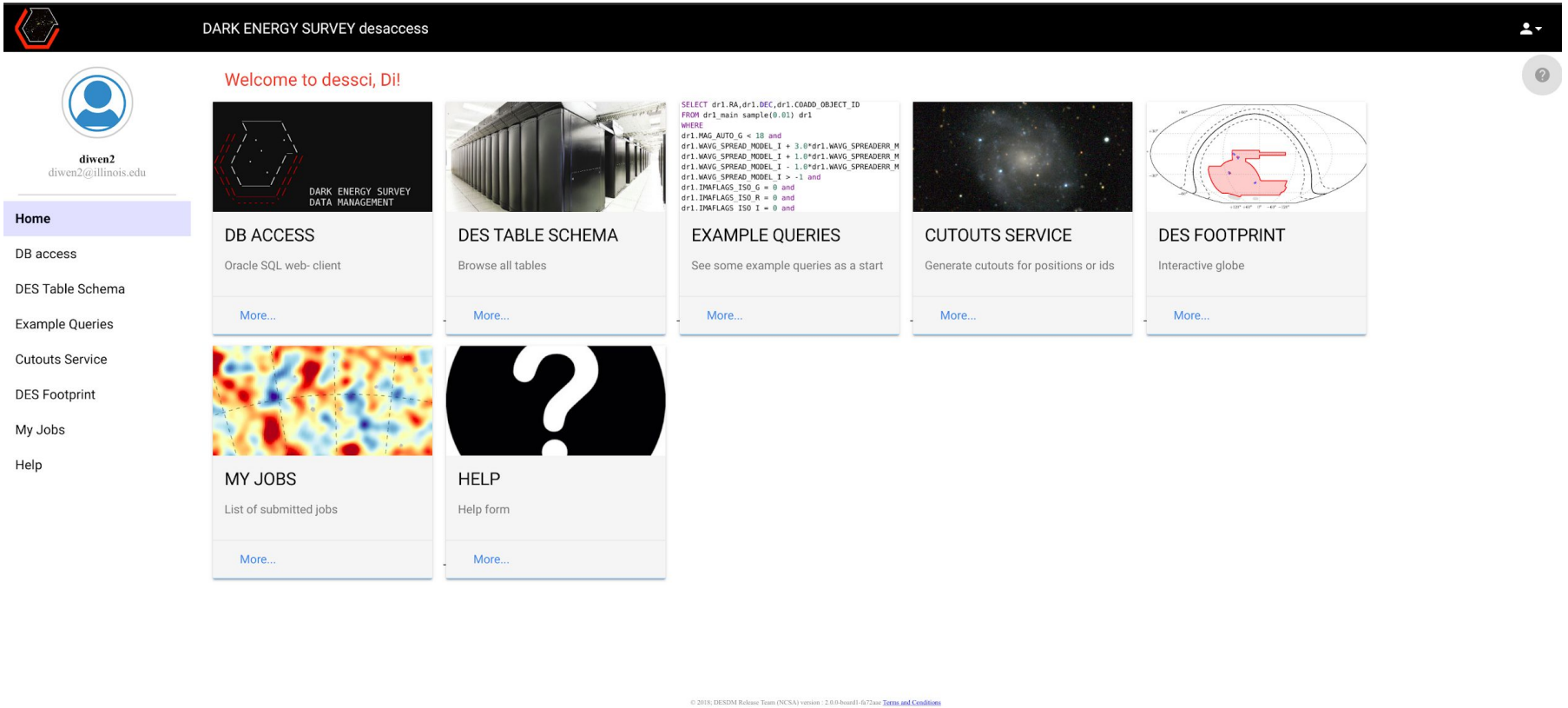




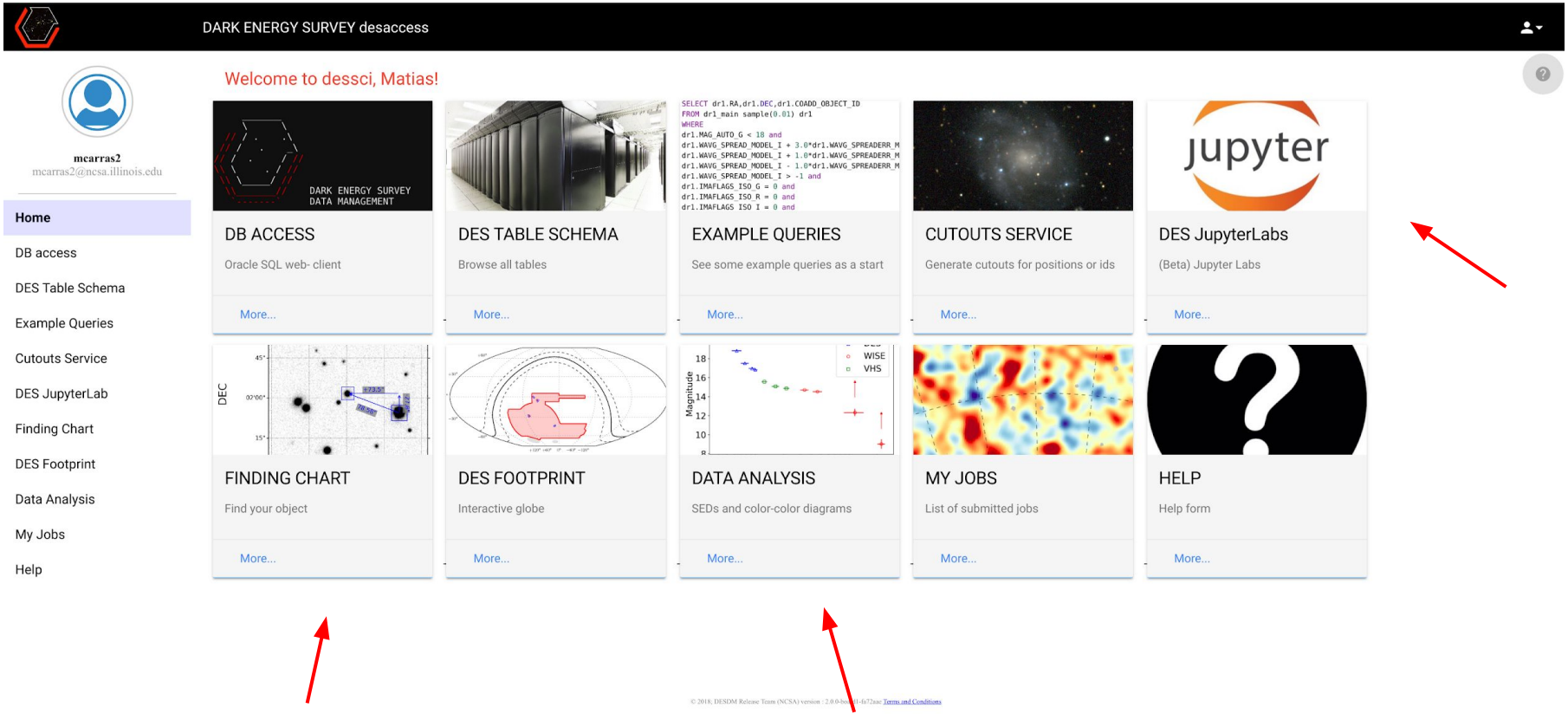
Labs with access to jobs, easyaccess, api



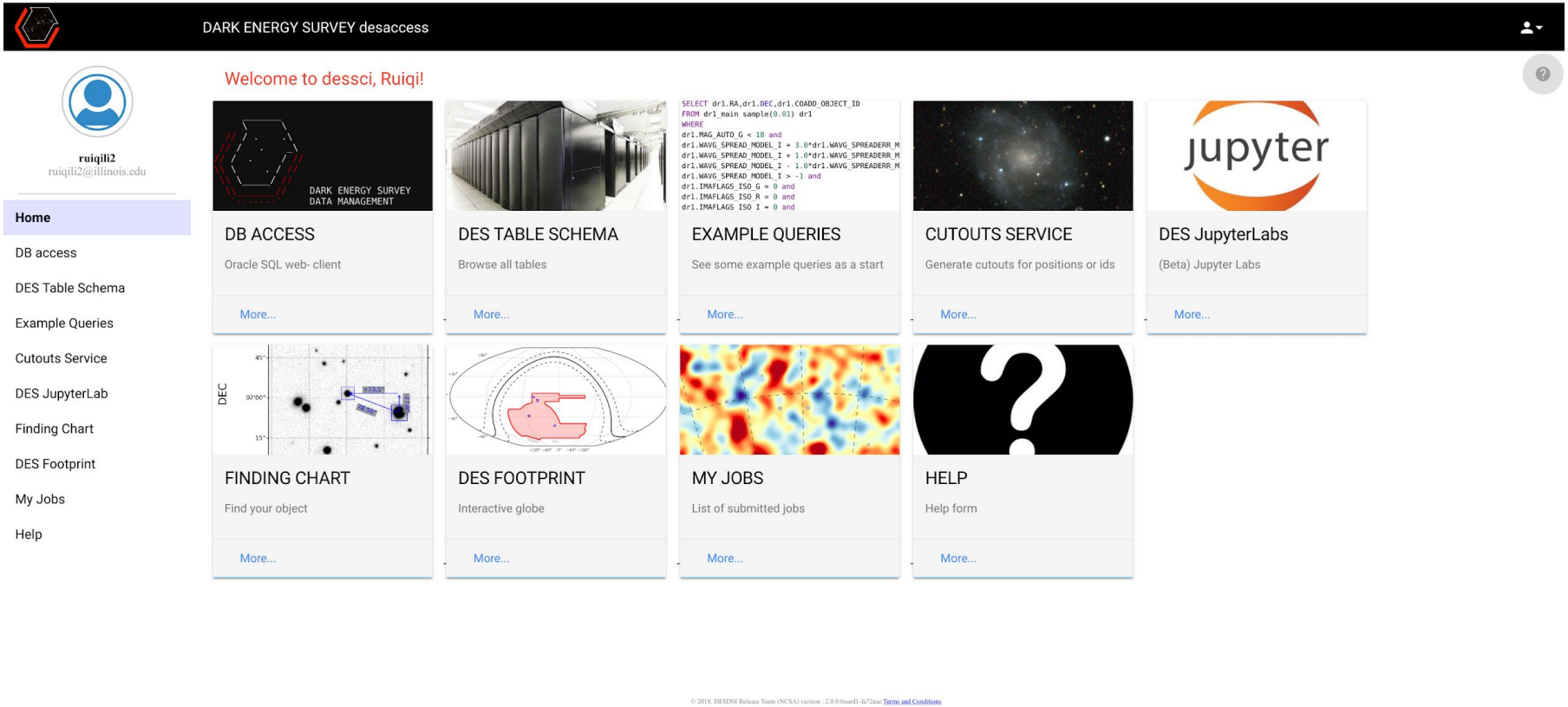
Services can be customized (limited user view)



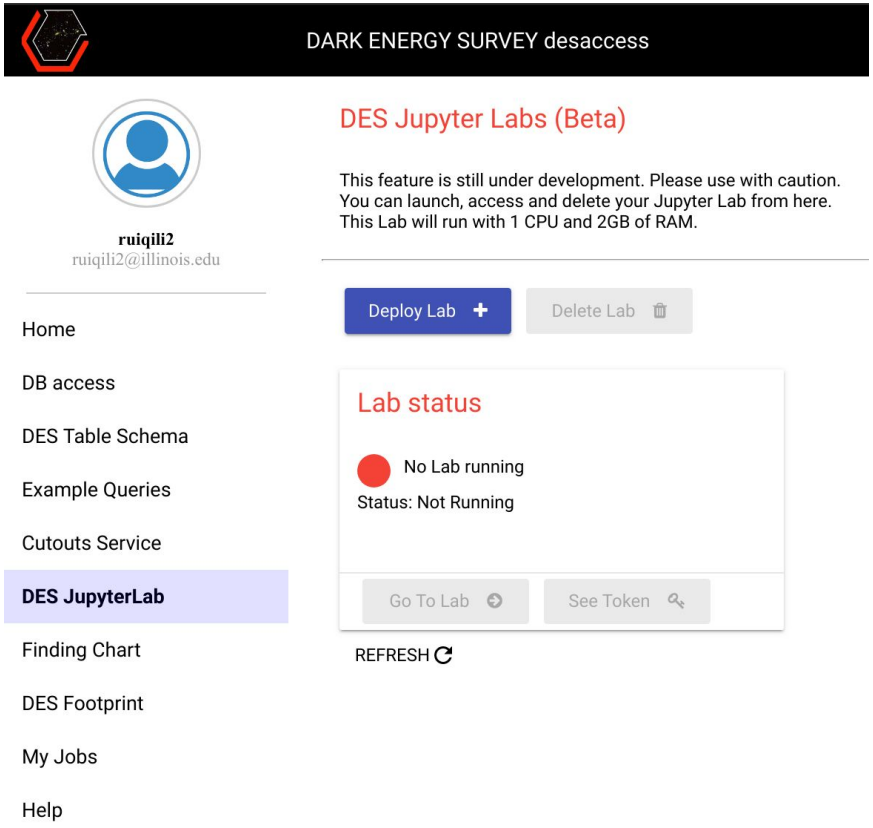
Services can be customized (advanced user view)

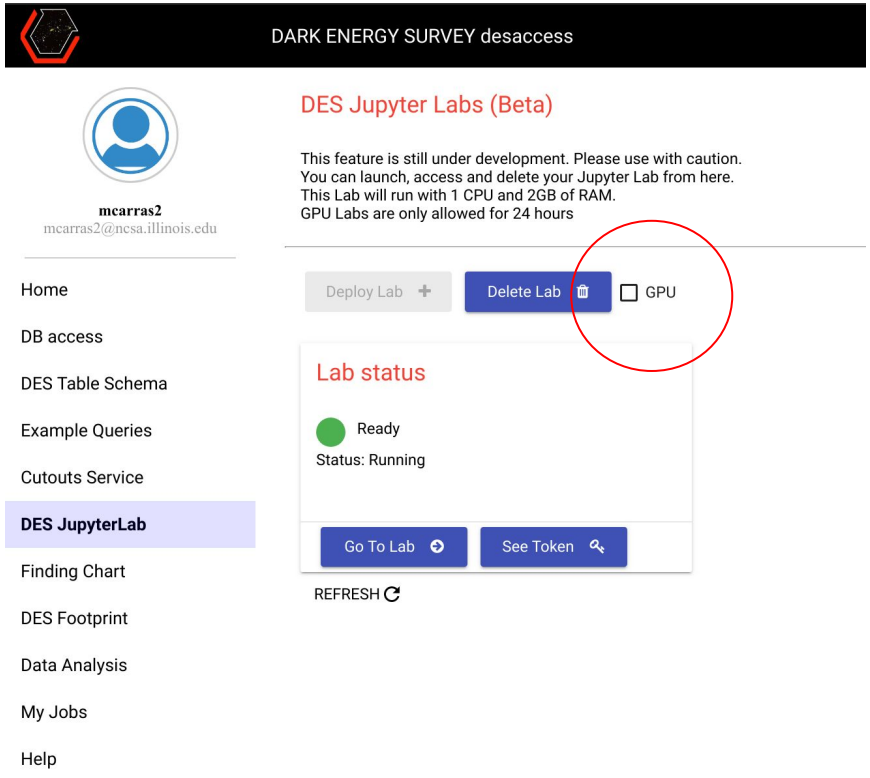


Services can be customized (default user view)

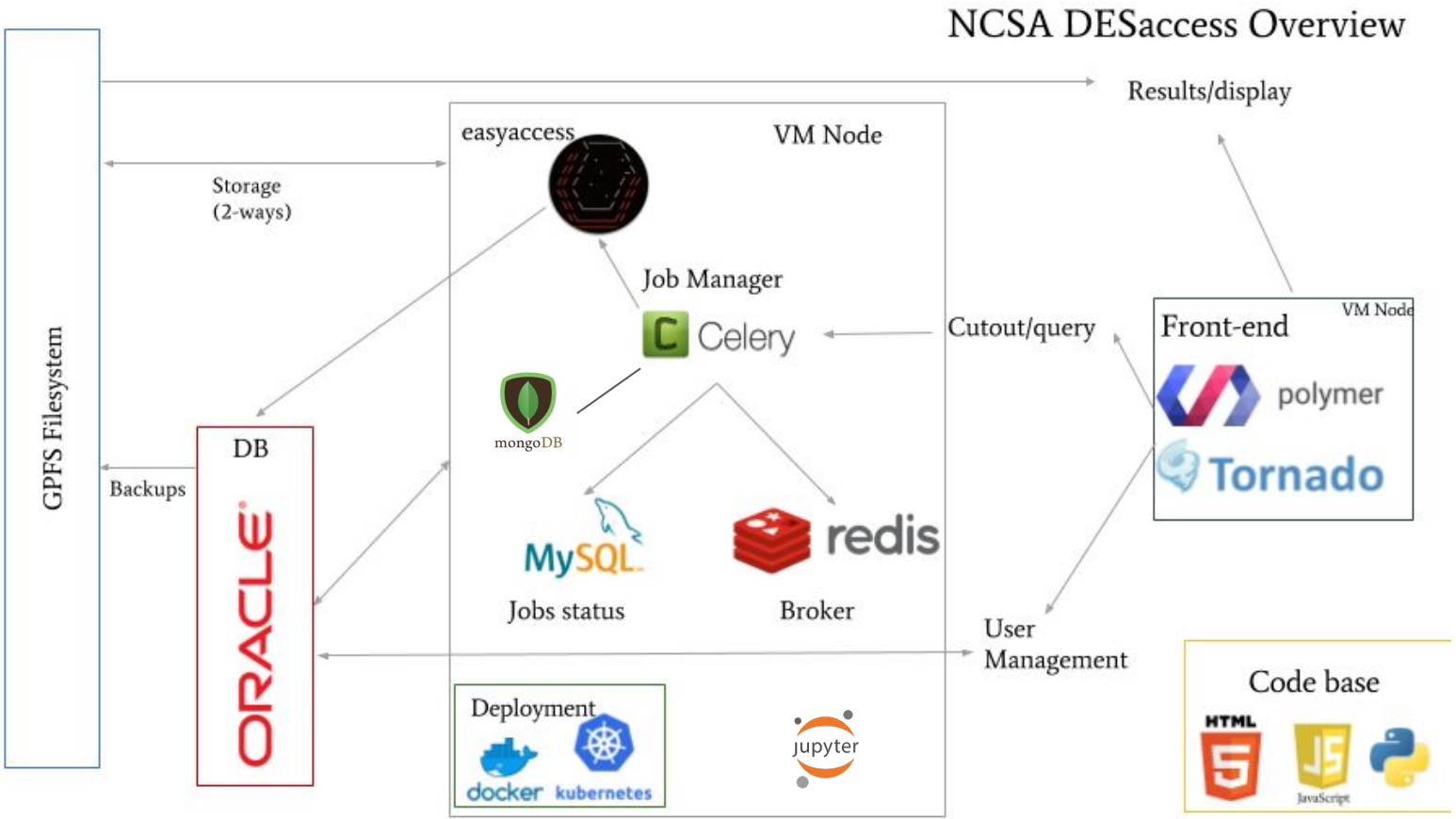


Special options for Jupyter Labs: Deploy on GPU Nodes

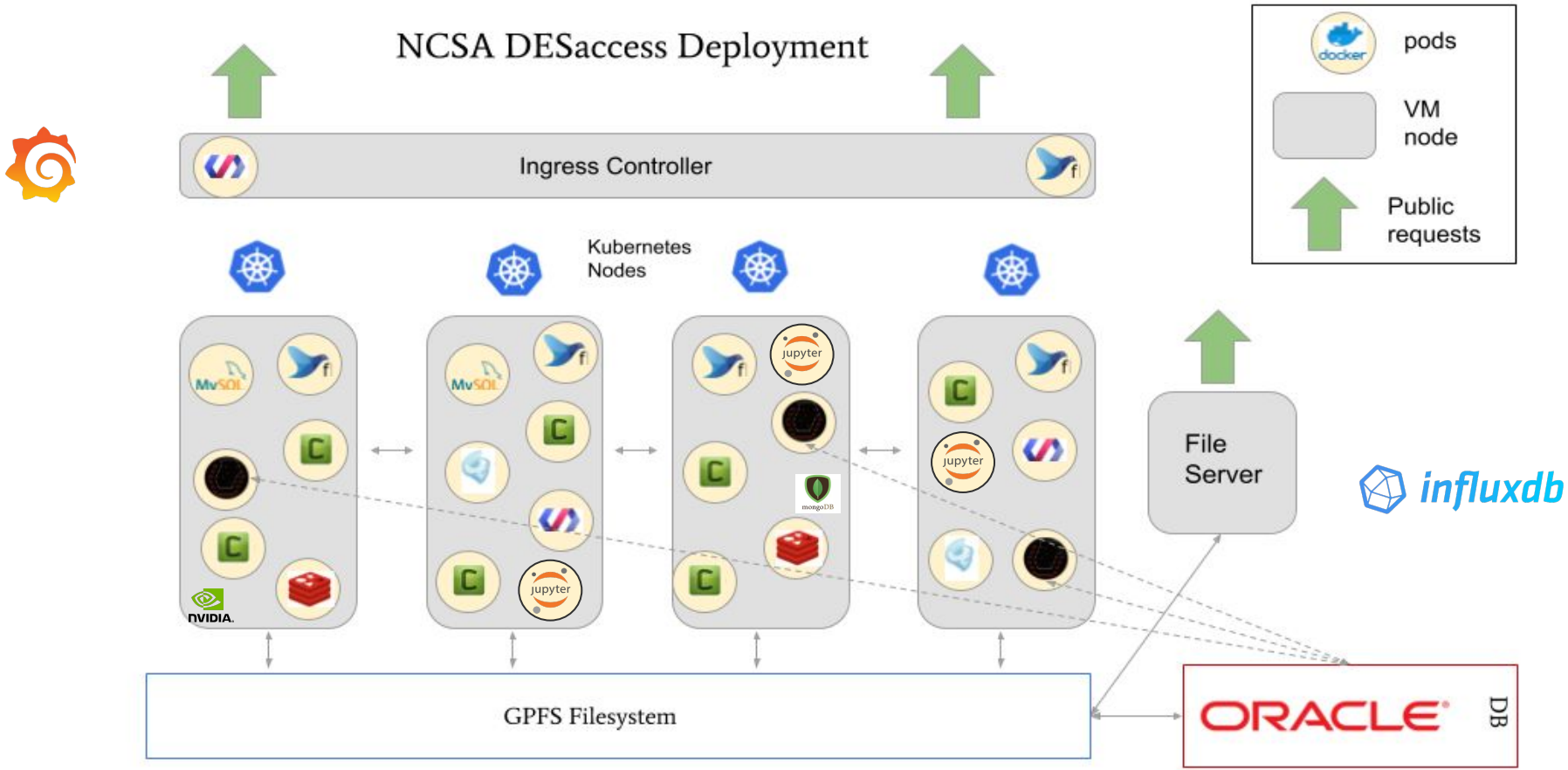




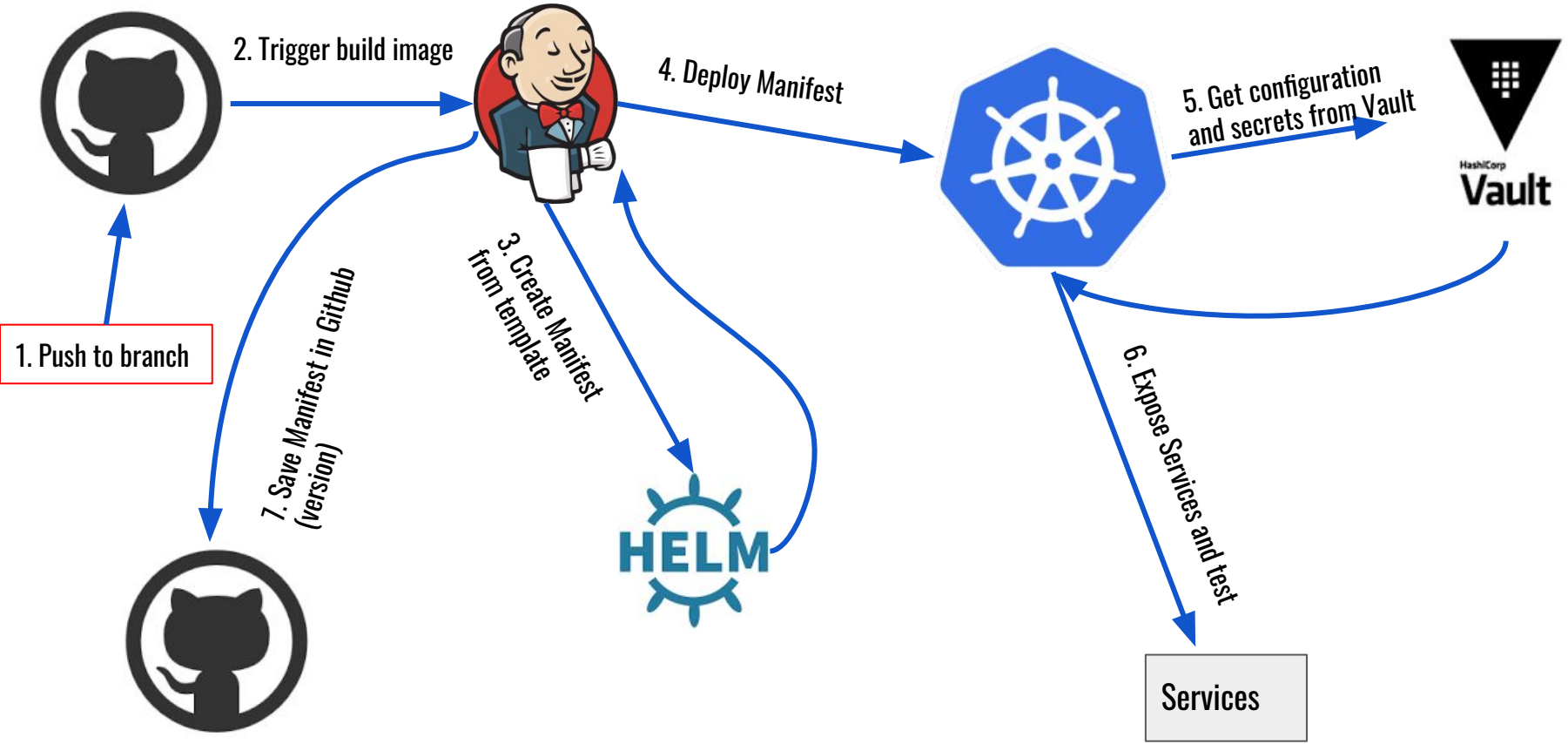
NCSA DESaccess: Technology Overview



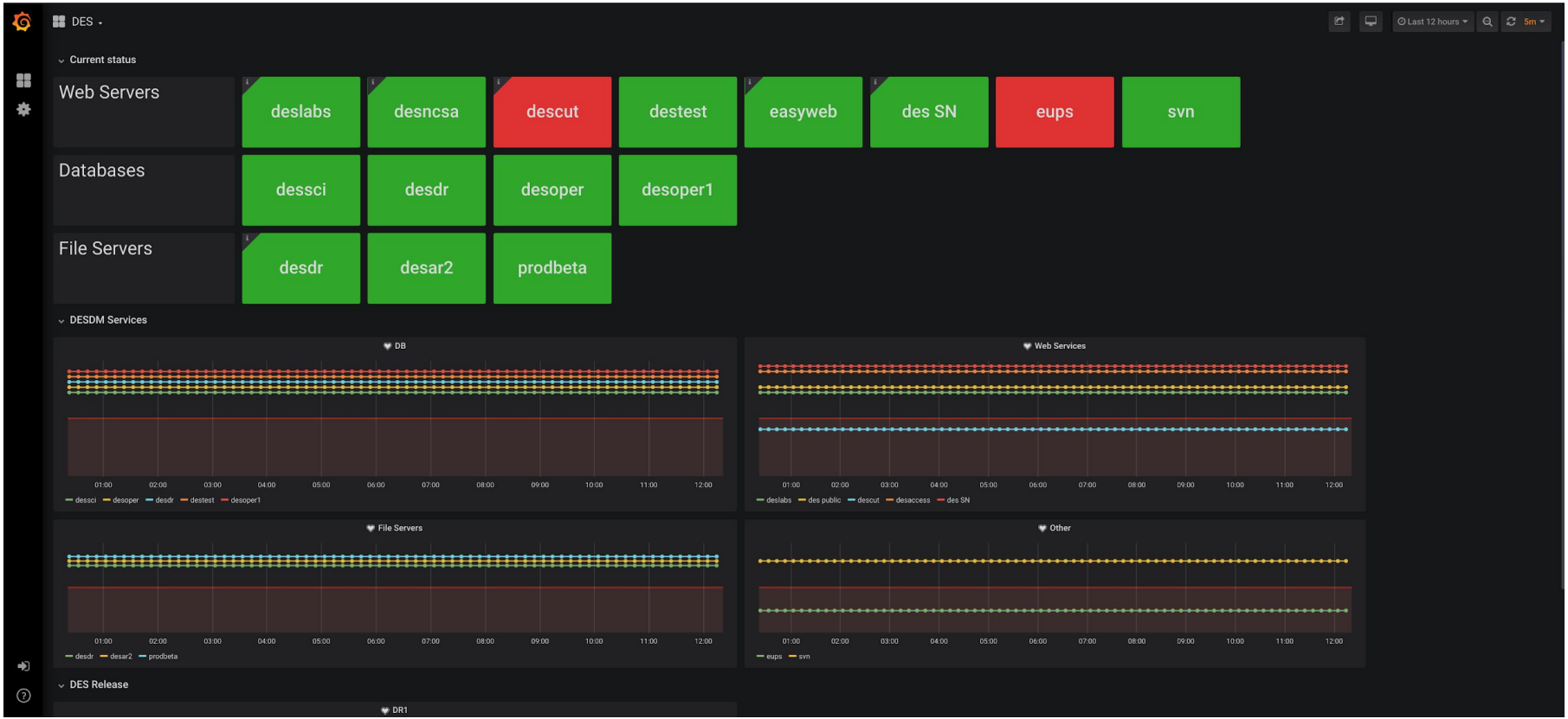
NCSA DESacces: Deployment (Hybrid)



NCSA DESaccess: CI/CD



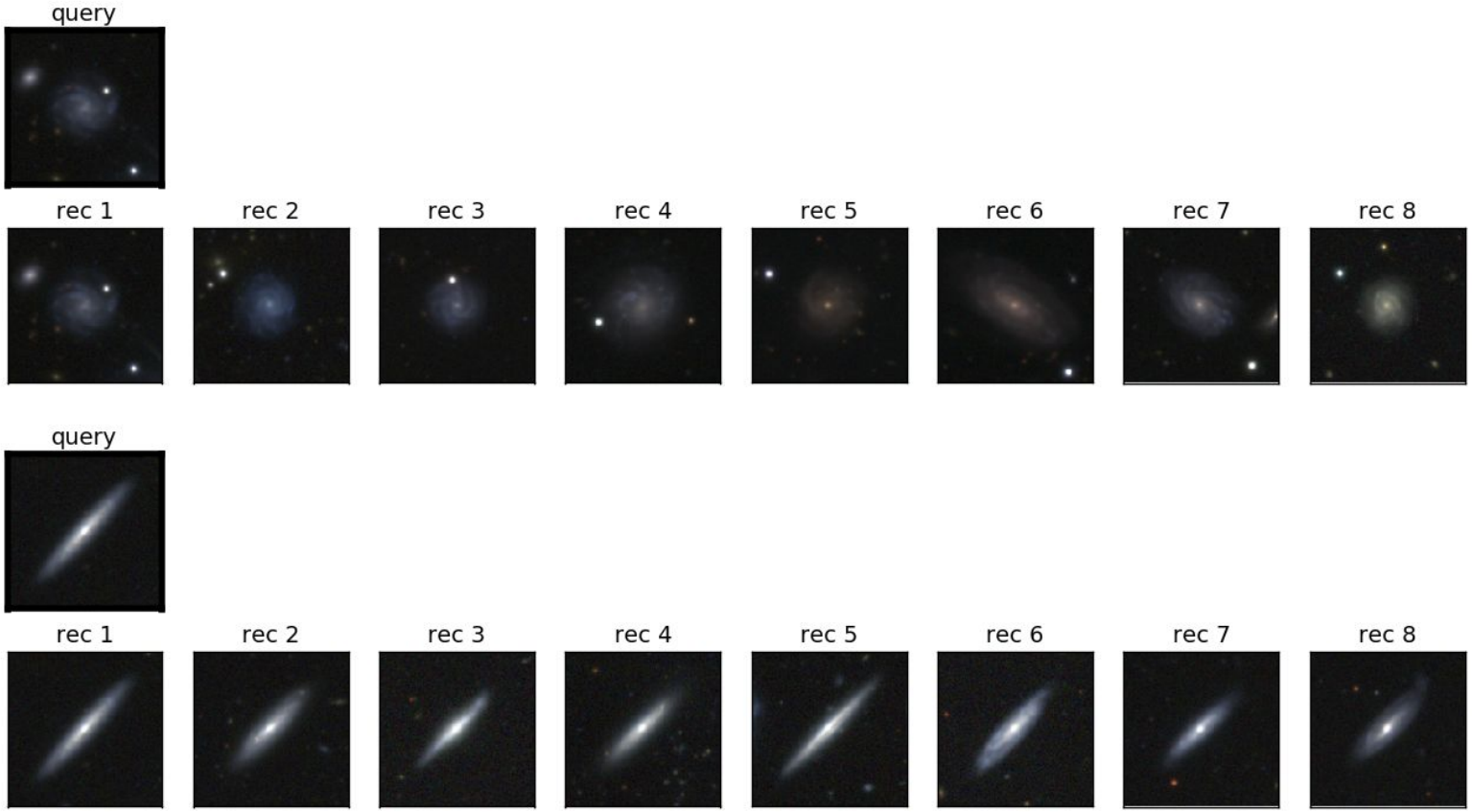
NCSA DESaccess: Monitoring



Other Services

- Other Services being integrated, easy to configure and to expand
- Can expand to the cloud when needed
- Each service is an independent application
- Working on: Automatic registration and service discovery
- Image exploration tool to visualize and classify thousands of images
- Similarity and anomality searches
- Others...

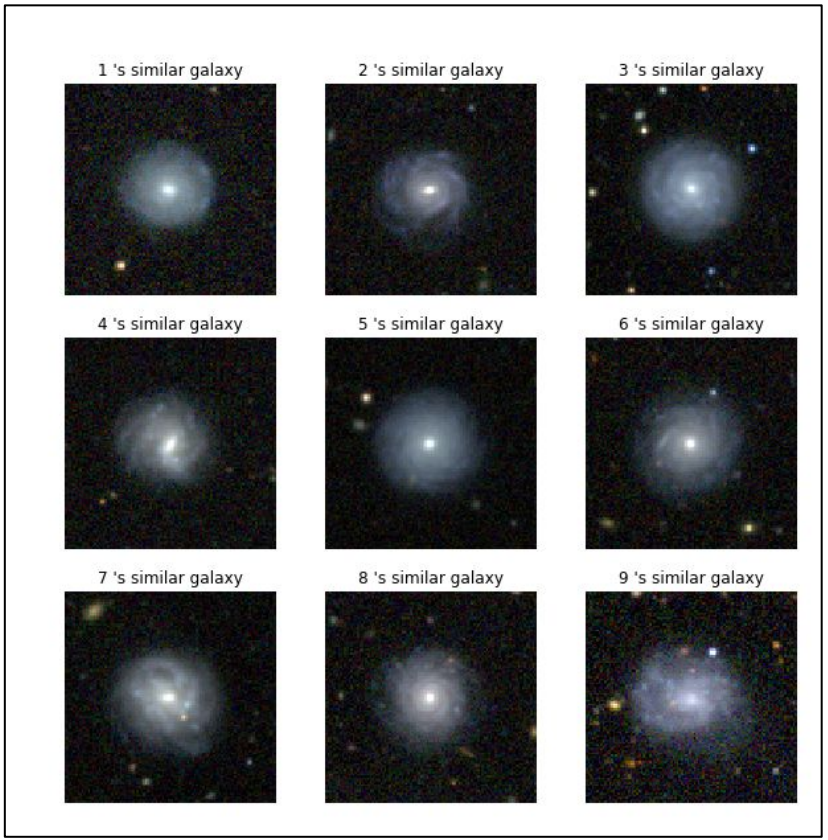
Galaxy selection and similarity search

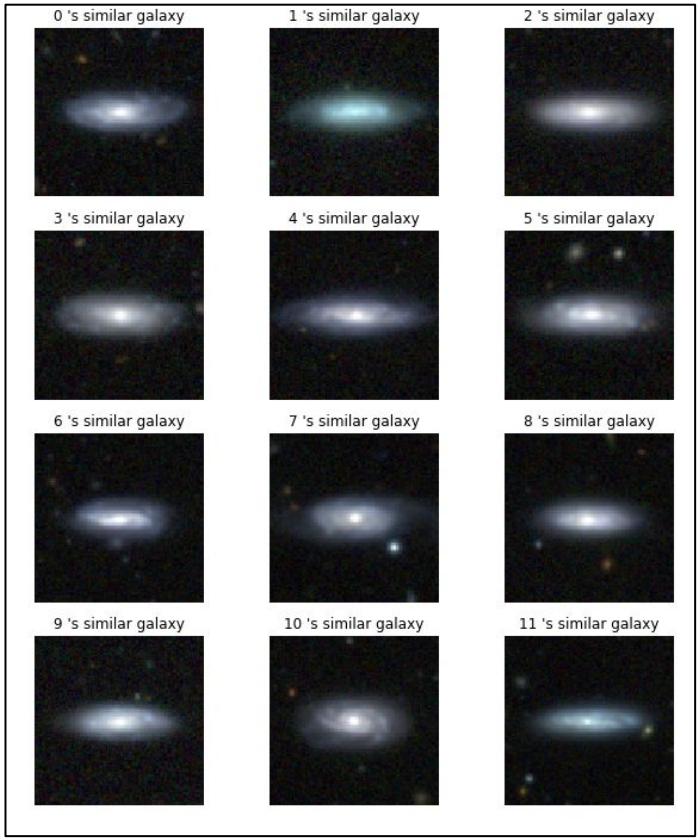


Compress images from 200x200 to 50 or less, for fast search

Bowen, Carrasco-Kind, et al. in prep.

Galaxy selection and similarity search



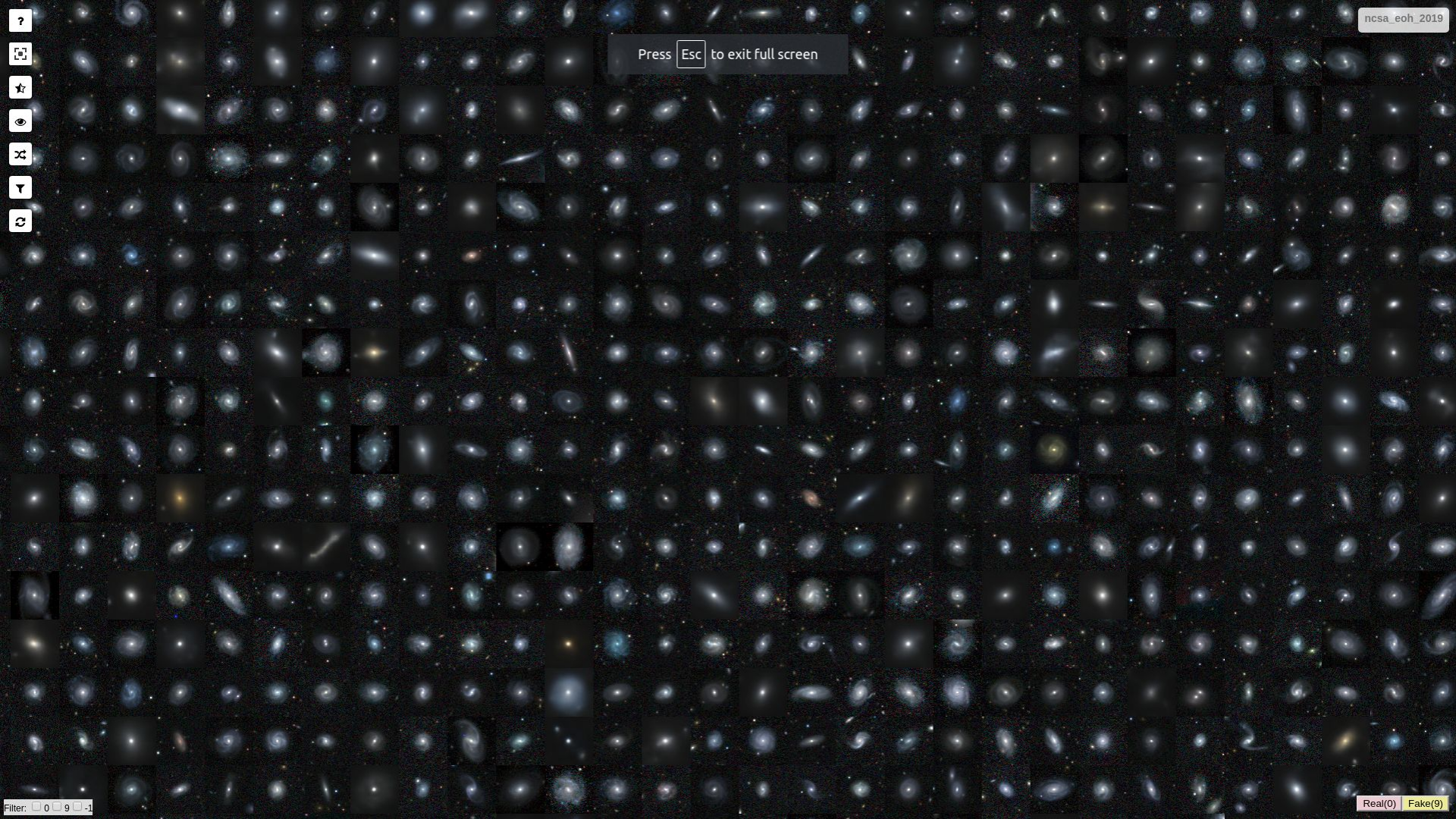


Bowen, Carrasco-Kind, et al. in prep.

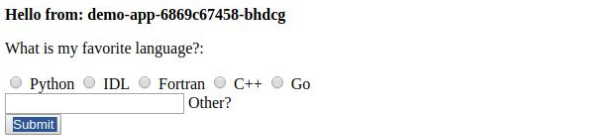
Galaxy Image Exploration and Classification

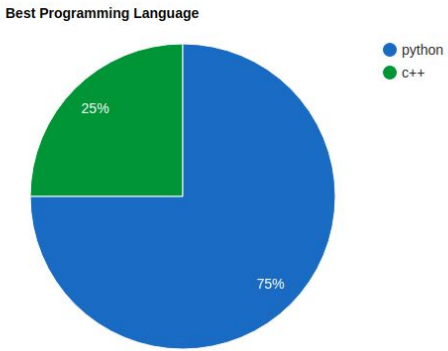
- Image Exploration
- Resize is done dynamically
- Quick Classification/Label
- Works fine with 10,000 images
- Individual classifications are saved and aggregated
- Keyboard control

https://github.com/mgckind/cutouts-explorer


Press Esc to exit full screen
ncsa_eoh_2019
Filter: 0 9 -1
Real(0)
Fake(9)

Demo!





Simple app with MySQL Back end

- Service
- 2 Deployments
- Ingress Rule
- PVC and PV
- Secrets

https://github.com/mgckind/container_demo

Thank you!

Questions?

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