

# Computer Vision for Data Quality Monitoring

**Thomas Britton**, Torri Jeske David Lawrence Kishansingh Rajput

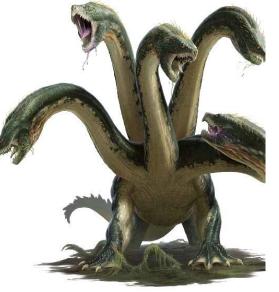


# Introducing Hydra

- Hydra aims to be an extensible framework for training and managing A.I. for near real time monitoring
  - If you need it to tell a dog from cat
     I can have hydra do that, without
     system modification, now

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Most importantly, Hydra allows me to embrace my inner sloth:

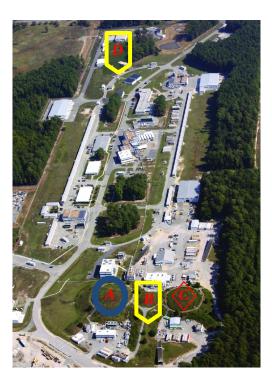


Koboldpress.com



# Deployed site wide

- Instance of Hydra deployed in <u>all</u> <u>halls</u>
  - Fully in B and D
  - In A but not being fully utilized
  - Technically in Hall-C 
    - Working to make its adoption more green-field







# Challenges

### • Differing protocols

- Not everyone is set up to provide images, or in the granularity required
- Differences in scale
  - GlueX has about a dozen plots.
     CLAS has 81
- Requires some degree of buy-in from disparate groups







# Back End

11/28/23

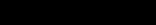
- Hydra is supported by a MySQL database which holds both training data and operational data
- Model configurations are also stored/read from the database
- Saves a snapshot of every inference and training

   A whole host of data to analyze and utilize

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Freedballing (VAN) Freedballing	1D INT(10)     10 DATETIME     Hostane VARCHAR(100)     PD INT(10)     Dott(10)     Dott(10)     Dott(10)     TransmProt NU(10)     TransmProt NU(10)     MessageCourt INT(10)     LasPhocessing Time TME	Ordinasekh MEDURUD     Ordinasekh MEDURUD     Ordinasekh MEDURUD     Ordinasekh MEDURUD     Ordinasekh MEDURUD     Ordinasek MEDURUD     Ordinasek MEDURUD     Ordinasek MEDURUD     Ordinasek MEDURUD     Ordinasek MEDURUD     Ordinasek      Ordinasekh MEDURUD	ID REFORM     DORENO     DOR	Stead D (11)     Stead VMCH4(10)     Stead VMCH4(10)     TrainingReportResponses *     O (D (11))     TrainingReportResponses *     O (D (11))     O and OCTITAE     O Lase ONTCHAE     O Lase ONTCHAE     O Lase ONTCHAE	Common III.08 Common IIII.08 Common IIII.08 Common III.08 Common III.08 Common III.08	ID INT(10)     DateTime DATETIME     DearTime DATETIME     PurPlete VARCHAR(20)     Reveal VARCHAR(20)     ModelD INT(11)     VersiciLabel VARCHAR(20)     GauckNumber INT(11)     OracitNumber INT(11)     OracitNumber INT(11)     Hoctype_ID INT(11)

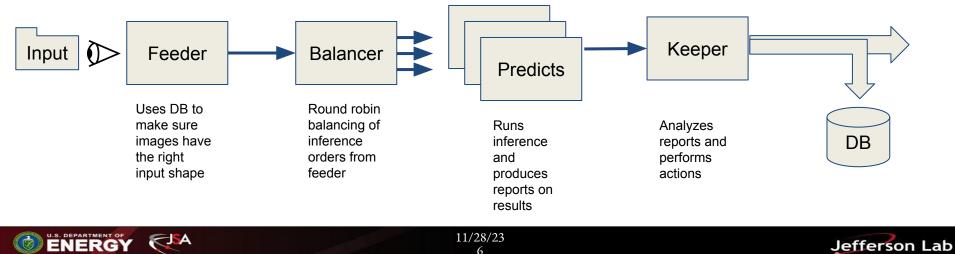




# Hydra System

- Parasitic to normal operations
   Meant to <u>aid</u> not replace!
- Feed images into the input directory and Hydra handles the rest

Messages passed via 0MQ allowing for more distributed deployment



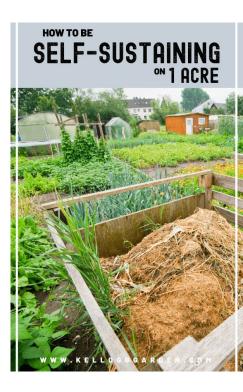
## Self-sustaining

11/28/23

- The goal is to provide a system which is more or less self-sustaining
  - Further Education

ENERGY

- Unbiased, configurable, sampling
- Unconfirmed, Bad examples
- How is a model performing?
   If labeling is up-to-date we can leverage the unbiased selection to compute a trailing accuracy





# Self-sustaining cont.

- Possible to trigger retrainings based on changes in the running accuracy
   Other conditions?
- Developing methods to enable better administration of the Hydra system
   Monitoring Hydra

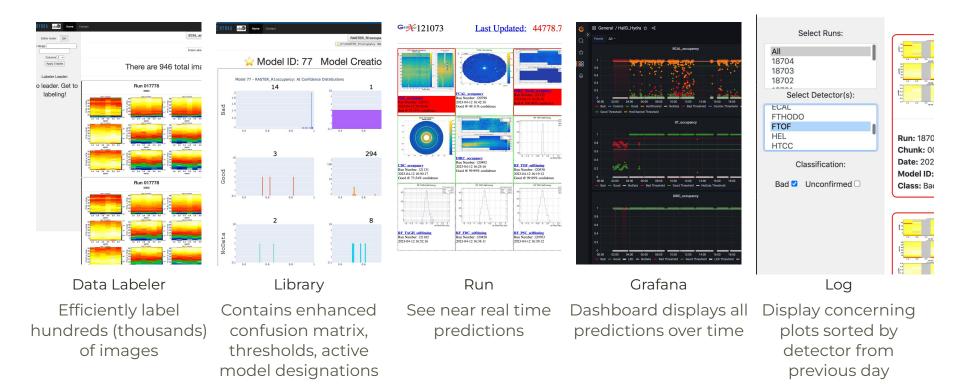






### **HYDRA**: Front End

#### Web based for user convenience.



### HYDRA: Data

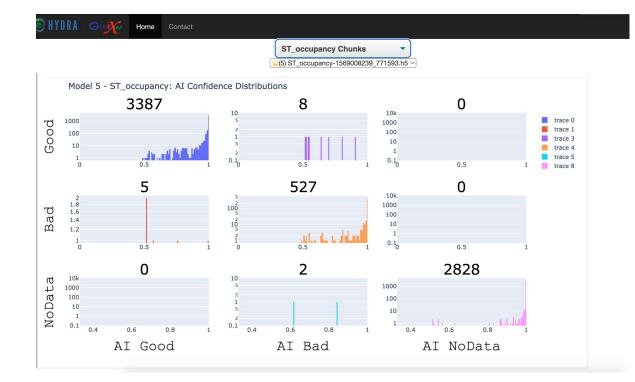
### Labeler

Efficiently label multiple monitoring plots. Labels and images are automatically uploaded to database.



### HYDRA: Library

Visualize model performance, thresholds, active models, etc.



#### Enhanced confusion matrix

Each cell contains Al confidence distribution and total counts

### HYDRA: Run

Watch predictions in real time from anywhere

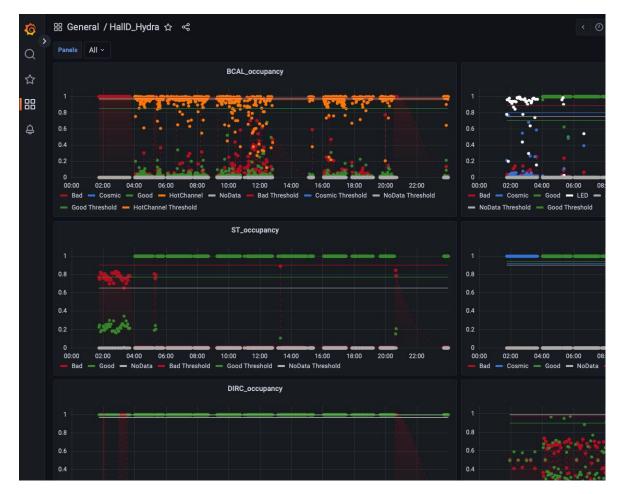
GradCAM visualizations are optional

#### 🕑 HYDRA 🤊 Guile 120262 Last Updated: 5.00 second(s) ago showing 13 / 13 frames CDC Occupat 6 10 15 20 25 30 35 40 45 **BCAL** occupancy FDC occupancy Run Number: 121174 **CDC** occupancy Run Number: 120262 2023-04-12 09:42:27 Run Number: 120924 2023-04-12 09:42:39 Good @ 80.23% confidence 2023-04-12 09:38:25 Acceptable @ 78.08% confidence Good @ 89.65% confidence **RF TOF Self timing** unt of fa125 itrigger time errors **DIRC** occupancy fa125 itrig FCAL occupancy Run Number: 121266 **RF TOF** selftiming Run Number: 121013 Run Number: 120810 2023-04-12 09:41:48 Run Number: 120397 2023-04-12 09:29:04 2023-04-12 09:38:13 LED @ 94.99% confidence 2023-04-12 09:40:36 Good @ 99.28% confidence Cosmic @ 55.65% confidence Good @ 99.99% confidence RF TAGH Self timing **RF FDC Self timing** RF PSC Self timing COF SatDets' relined PSOFF SelfLets1 retires Entries 36697 Mean -0.001674 Etd Dev 9.57206 Ditoles 5170771 Mean -0.001124 Did Dev 8.07645 Entries 225051 Mean -0.001835 Did Dev 8.67467 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 $\Delta t$ (First Pair) (ns -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 At (First Pair) (n -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 (First Pair) (ns **RF TAGH selftiming RF FDC** selftiming **RF PSC selftiming** Run Number: 120638 Run Number: 120838 ERun Number: 120299 2023-04-12 09:33:50 2023-04-12 09:38:00 2023-04-12 09:40:12 10

### HYDRA:

Grafana Dashboard

Look at any prediction over time.



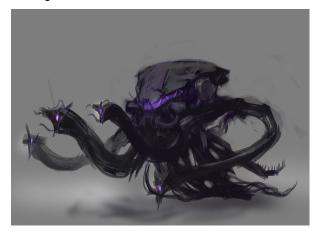
### HYDRA: Log

See 'Bad' or 'Unconfirmed' images from previous runs, separated by detector. Easily identify when a particular problem started



# Other Future Hydra developments

- <u>Siamese model(s)</u>
  - Two step processing
    - First a generic anomaly approach
    - Second is a diagnostic step in the face of anomalies
- <u>Masking</u>
  - Ability to ignore parts of an image in inference
    - known/accepted problems aren't considered
- <u>Kubernetization</u>
  - Use Kubernetes for easier maintenance/deployment
- <u>AI human interface improvements</u>
  - Enable non AI experts to maintain/manage the hydra system



Chang Woo Lee





Hydra alarmed on the FA125 itrig errors. Indeed, during run 101072 after about 8.8 M events, the error occurred. We immediately ended the run and restarted R 101073. The error had cleared. Kudos to Thomas, Naomi and Hydra!

p.s. We plan to change the SD board within the next hour.

HydraRun also saw the FDC problem, which I probably would have missed inspecting it by eye.

Hydra alarm on fa125\_itrig during Run 101076

Questions?



Jefferson Lab