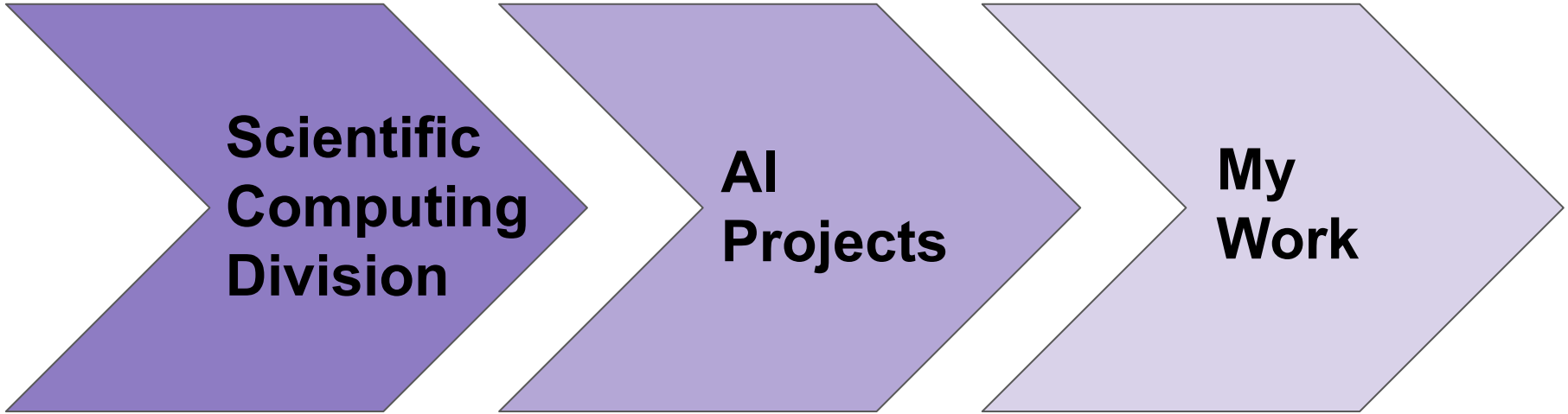
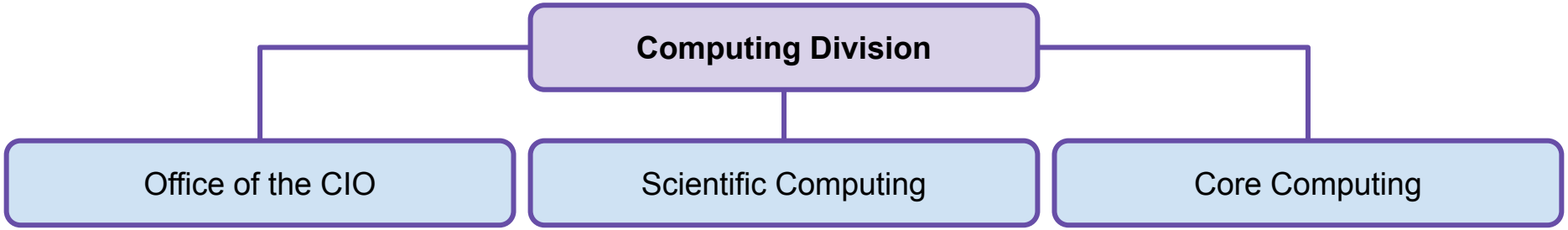
Scientific Computing Division and Me

Aleksandra Ćiprijanović

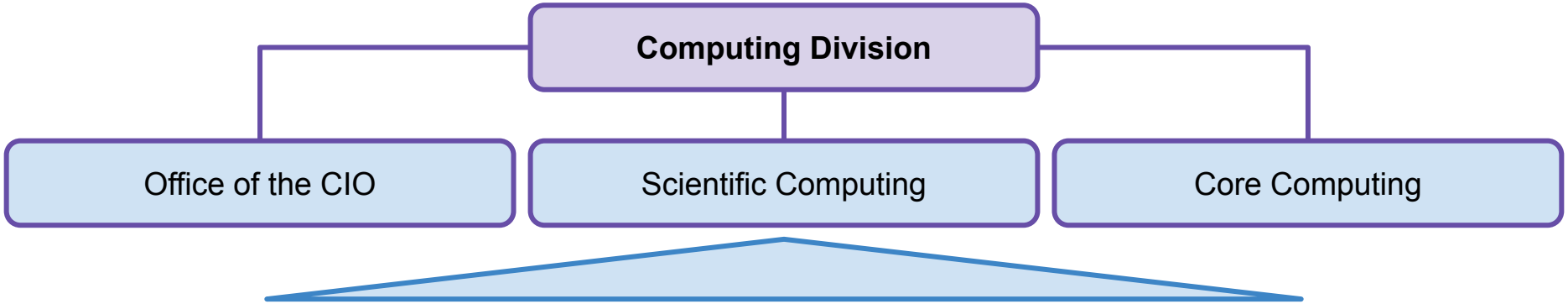
New Perspectives 2021
aleksand@fnal.gov

Talk Outline




Computing Division
Office of the CIO
Scientific Computing
Core Computing


Annual Computing Sector Picnic 2012

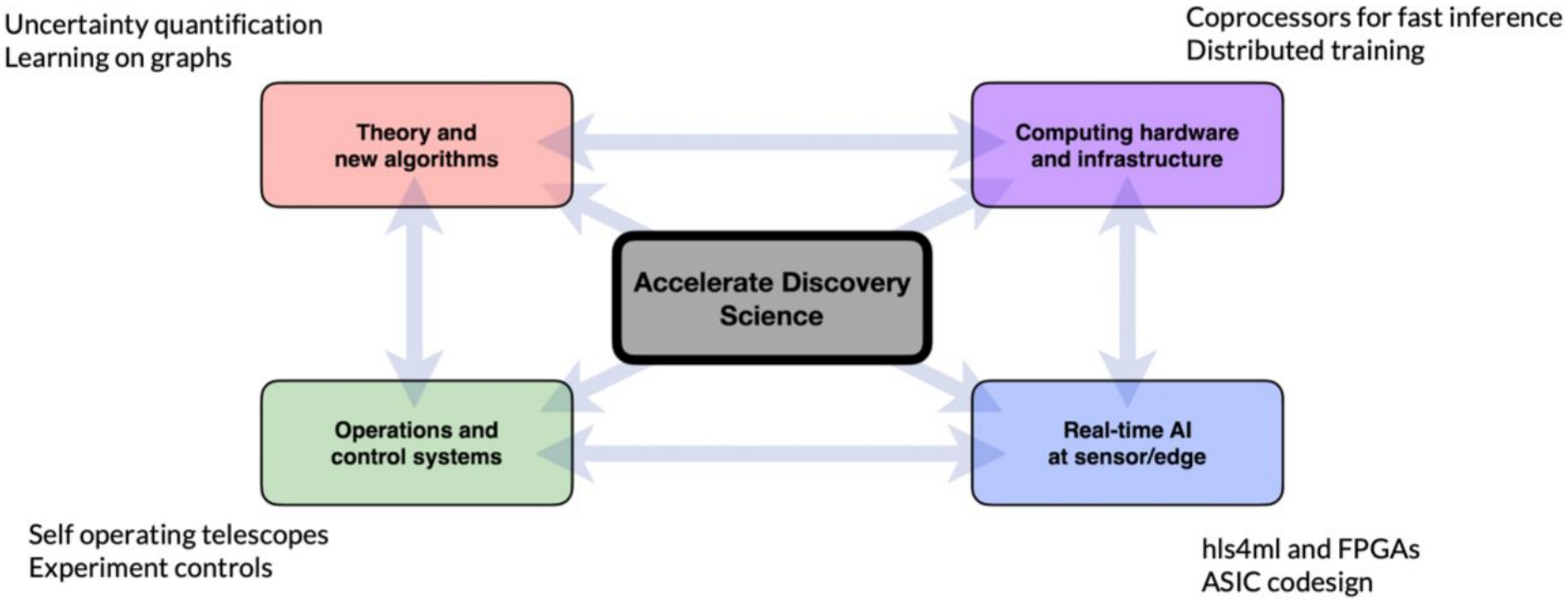


- Scientific Computing Services
- Scientific Data Services
- Scientific Computing Facilities

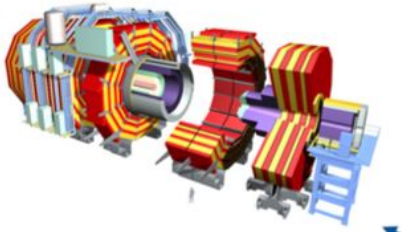
- Cross Cutting Projects & Initiatives
- AI & Software for Physics Applications
- Framework, DAQ & Electronics ...

- Deliver world-class **computing services, operations and software** engineering support to Fermilab-based experiments, astronomical surveys, CMS and the high-energy physics community at large.
- Engages in **R&D activities required to maintain or advance capabilities** of Fermilab's physics program.

AI capabilities and focus areas



Fermilab



Accelerators

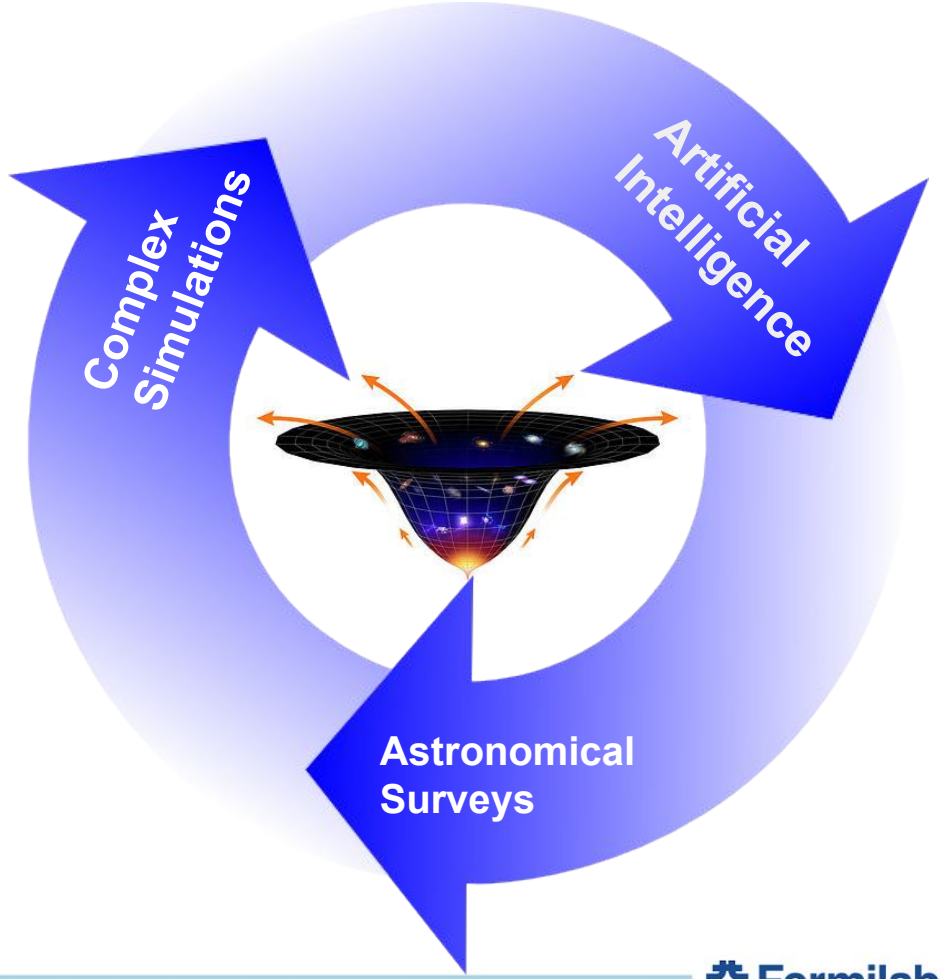
Netrunos

Astronomy

Quantum Science

My science interests

- **Formation and evolution of structure in the Universe**
- **Build robust, trustworthy and understandable AI**
- **Leverage and use all available datasets** - learn from their similarities and differences



My Projects

I

Convolutional Neural Networks

Classification of astrophysical objects and inference of the physical parameters that describe them.

II

Combining datasets and building algorithm robustness

Domain adaptation for learning domain invariant features. Building models that work in multiple data domains. Understanding adversarial robustness.

III

Object detection with R-CNNs

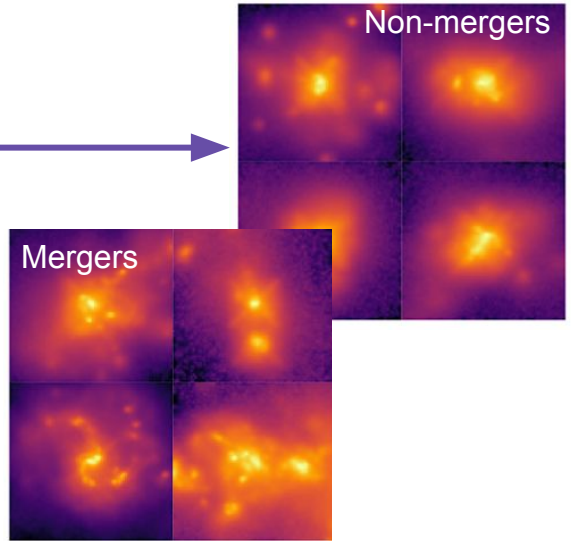
Using detection algorithms to help find low surface brightness objects in survey data or detect artifacts and other problems.

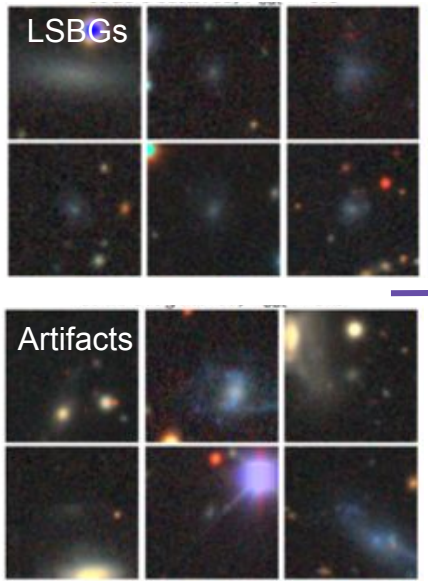
My Projects

I

Convolutional Neural Networks

- Using deep learning (CNNs) to **distinguish between merging and non-merging galaxies**, which are crucial for understanding of galaxy evolution.
- We show it is **possible even for very distant galaxies**!





- Using deep learning to **distinguish low surface brightness galaxies (LSBGs) from artifacts** in DES data.
- Crucial for building their catalogues, LSBGs might be the most numerous type of galaxies!

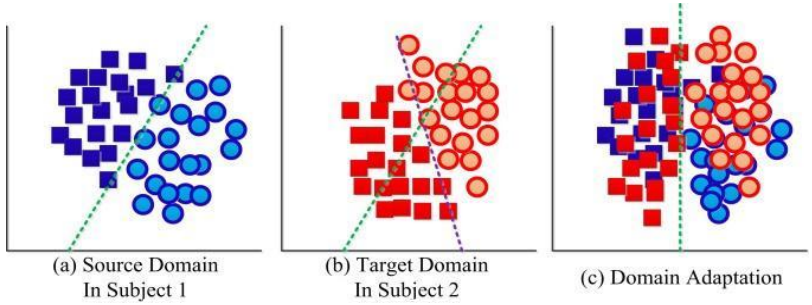
"DeepMerge": Ćiprijanović et al. 2020.
"DeepShadows": Tanoglidis et al. 2020.

Fermilab

My Projects

II

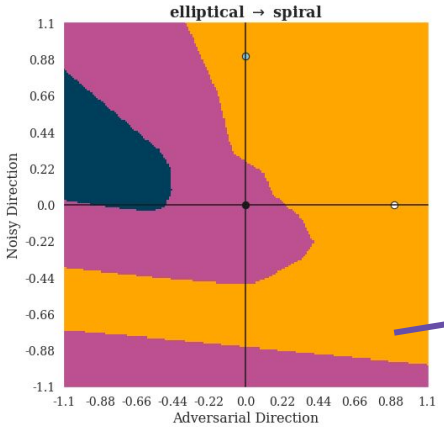
Combining datasets and improving algorithm robustness



- **Domain adaptation methods** allow us align data distributions and find common decision boundary.
- We can use **combine knowledge from simulation with** new and unlabeled **observations from astronomical surveys**!

You heard more in from Kathryn Downey the previous talk !

"DeepMerge II":
Ćiprijanović et al. 2021.



- Exploring latent space of the model, and how observational effects like **noise can cause errors in predictions**.

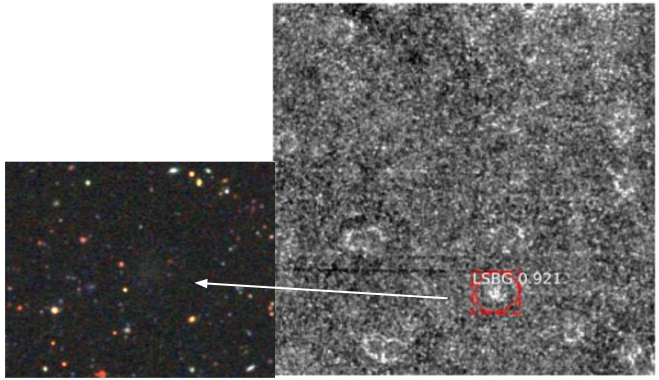
Fermilab

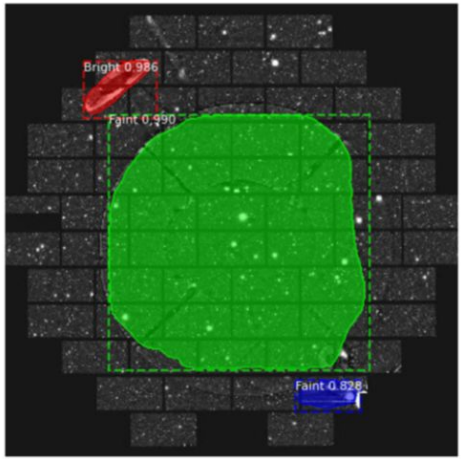
My Projects

III

Object detection with R-CNNs

- Using **Mask R-CNNs used for object detection** and masking to search for hard-to-find **LSBGs**, as well as **ghosts** and other problematic artefacts **in DES data**.



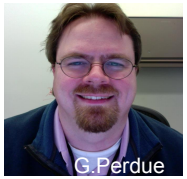


"DeepGhostbusters": Tanoglidis et al. *in preparation*

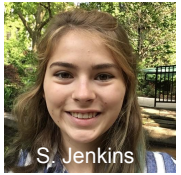
Fermilab

Big thanks to all my amazing collaborators!

Fermilab

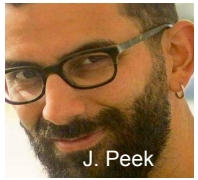


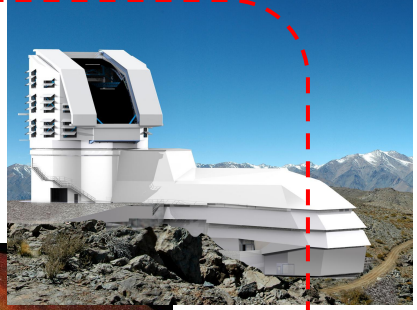
University of Chicago

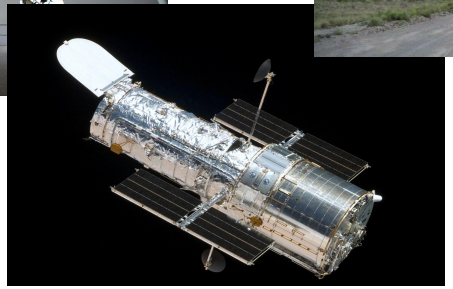


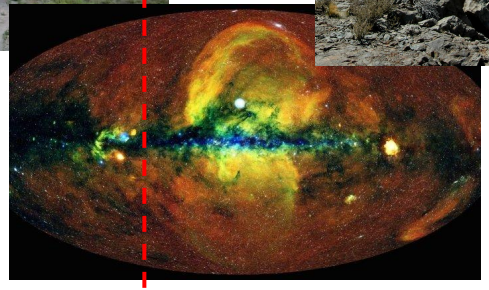
Argonne, Oakridge

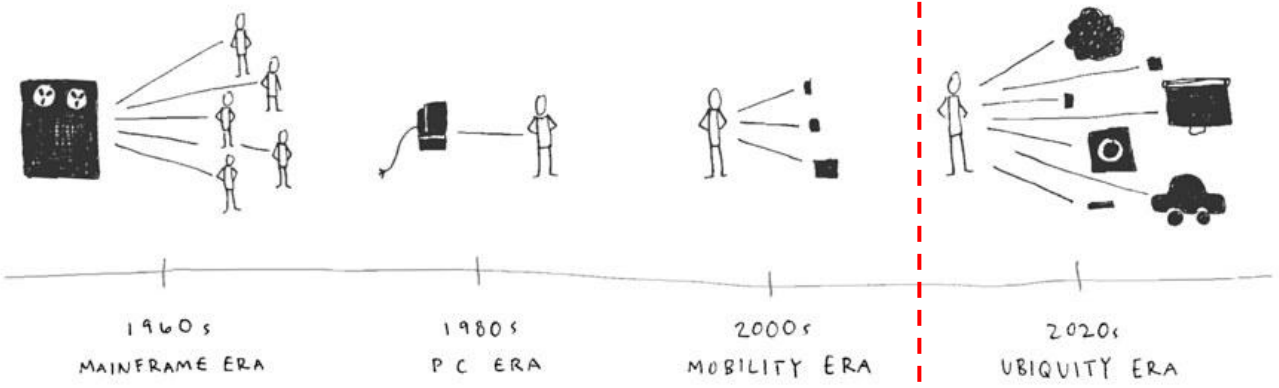
Space Telescope Science Institute











Once computer
Thousands of users

One computer
One user

Several computers
One user

Thousands of computers
One user

Are we alone?

Exoplanets, search for life

How did we get here?

Stars and elements, galaxies and their history, structure formation

How does our Universe work?

The extremes of nature, dark matter and dark energy

Thank you!

aleksand@fnal.gov