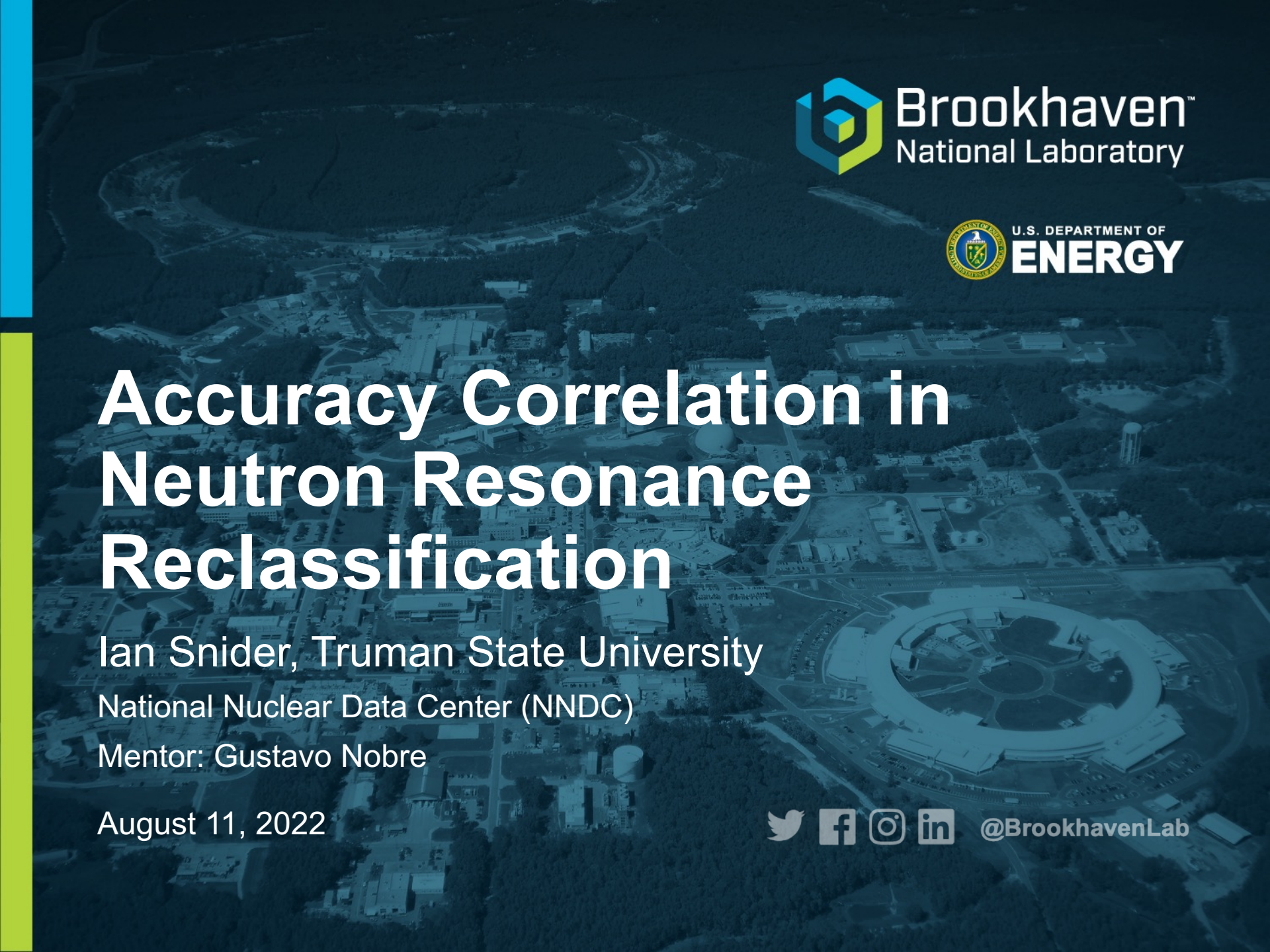

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U.S. DEPARTMENT OF ENERGY

Accuracy Correlation in Neutron Resonance Reclassification

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National Nuclear Data Center (NNDC)

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@BrookhavenLab

The Project

- Classifying **neutron resonances** is hard
  - Misclassifications/missing resonances
  - Often irreproducible
- What is a **neutron resonance**?
  - Incident energy from a neutron approaches the energy level of an excitation state of a nucleus.
- Use **machine learning** to identify and reclassify incorrect neutron spin assignments

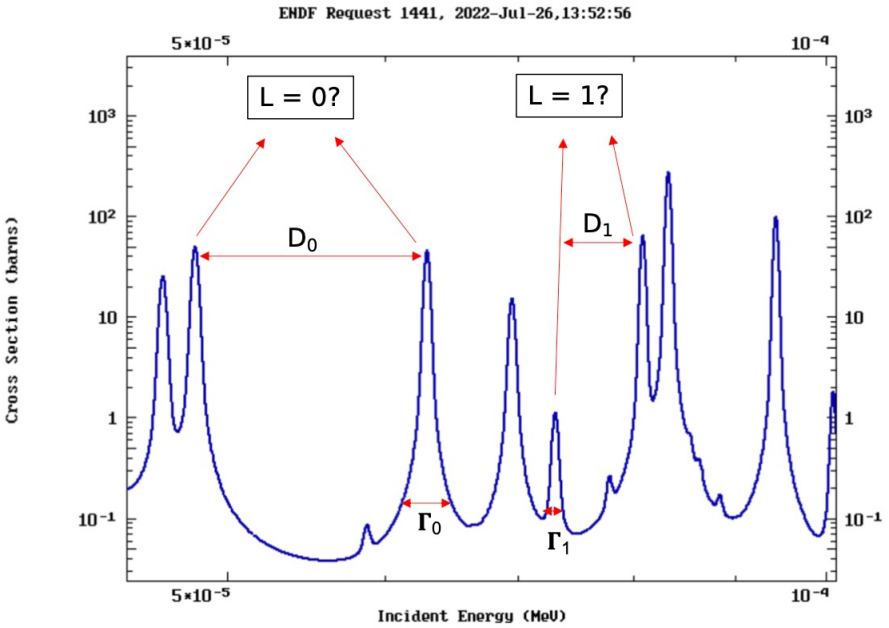

Figure 1: Snippet of nuclear cross section plot for In-115 neutron capture. D and Γ are the resonance spacing and mean width, respectively. **Source:** Multi-platform EXFOR-CINDA-ENDF **Credit:** V. Zerkin, IAE-NDS,1999-2022

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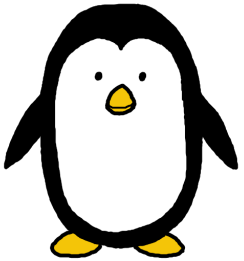
Machine Learning & BRR



(Bayesian Resonance Reclassifier)

Example of “alpha” hyperparameter:

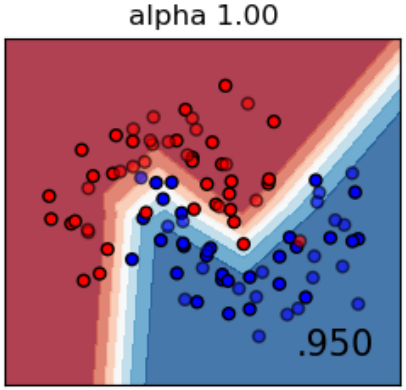


Figure 2: Visual of regularization
Source: Scikit-learn 1.17.4. Regularization **Credit:** Scikit-learn

- With less regularization, the red and blue regions would be heavily constrained

- Learn patterns & make predictions
- **Python** library “Scikit-learn”
  - hyperparameters
- Train algorithm with synthetic data
- **Purposely misassign** synthetic resonances
  - “percent misassignment”

Methods

- **Polarized** In-115 for validation data
  - Can accept given spin assignments as accurate
- **Validating training accuracy**
  - Observe correlation between training and validation accuracies
- Validating with **percent misassigned resonances**
  - Validate with an imperfect data set, more representative of reality
- **Iterative reclassification**
  - Start with an initial validation data and perform successive reclassifications

Results

Validating Training Accuracy

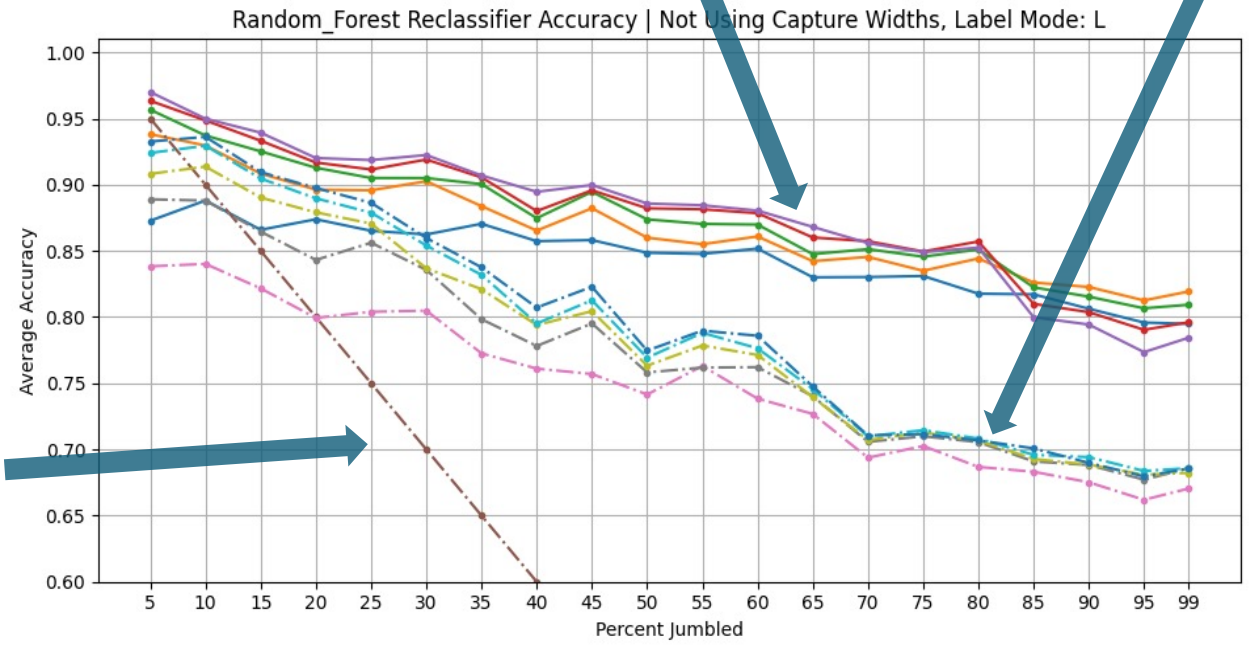
- A good correlation means predictable validation accuracy
- Validation and training lines **diverge at high percent misassignment**
- Each accuracy point is an **average of 500 cycles**

Notice two groups of accuracies:

Solid line: Validation (real)

Dashed line: Training (synthetic)

No reclassification line



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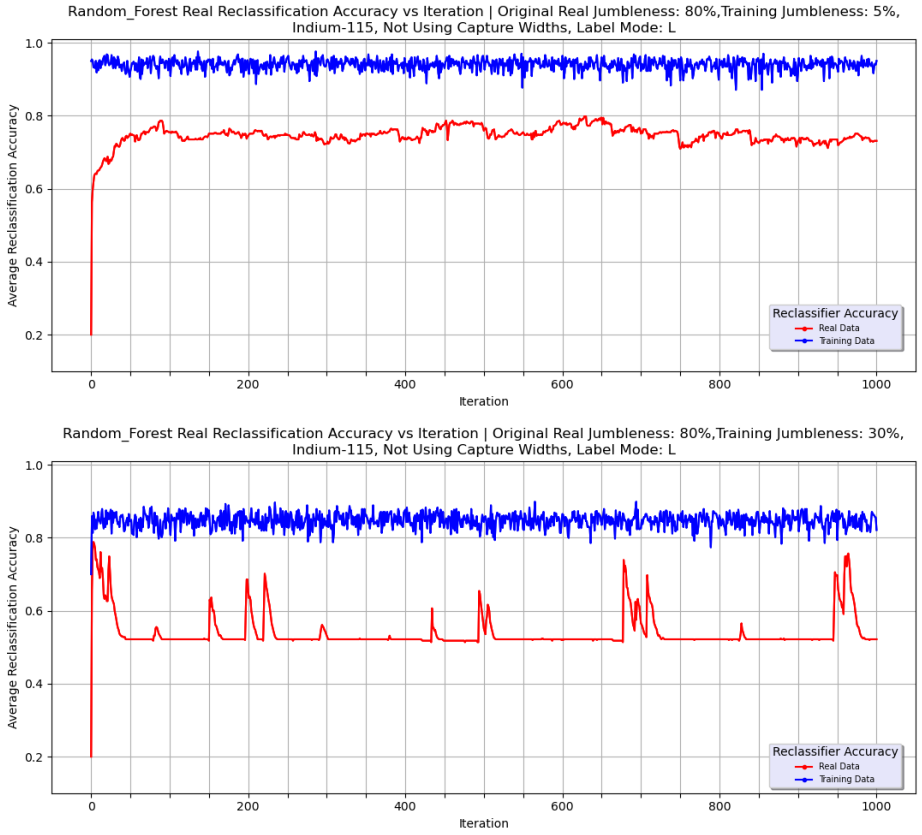
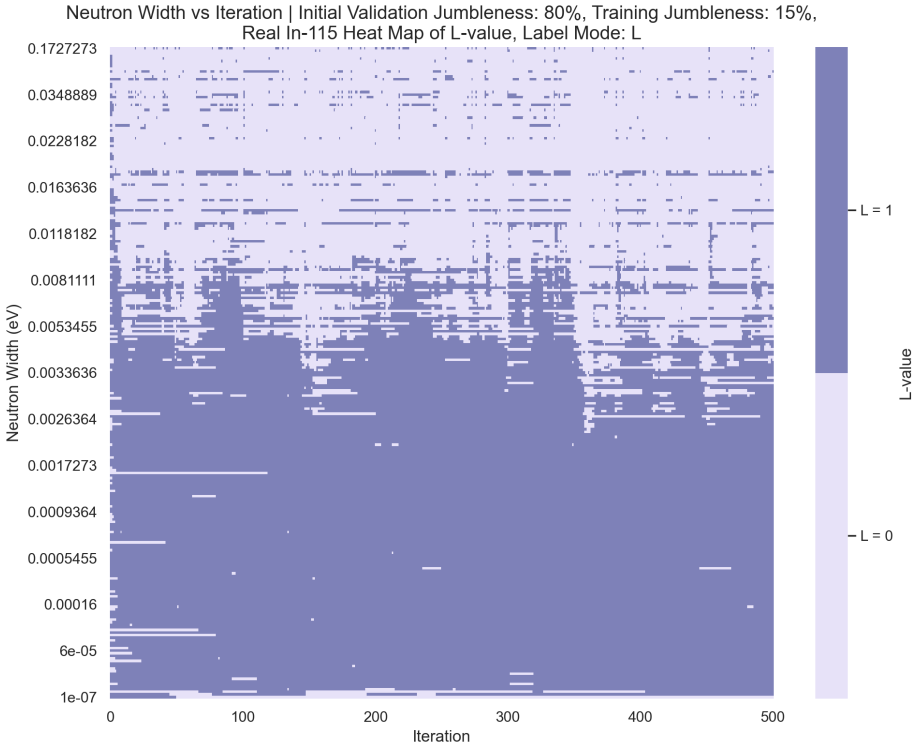
Iterative Reclassification

- Start with an initial validation percent misassignment
  - Ex: 80%
- Currently **cannot average cycles**
  - Sporadic behavior
- **Convergence**
  - Easily converges with low values of training percent misassignment
  - Strange accuracy spikes as training percent misassignment is increased



Future Work

- Iterative Reclassification
  - Examine **specific reclassified resonances**
    - Ex: Mostly L = 0 at larger neutron widths
  - Create a file from properties of multiple cycles



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Acknowledgements

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