

Identifying Criminal Cases that Use Neuroscience

Neuroscience evidence has been increasingly used in criminal cases as mitigation for defendants. Dr. Nita Farahany manually located and labelled 2,700 such cases from 2005 to 2015. Our team used document vectorization and binary classification algorithms to find cases that presented neuroscience as evidence in criminal cases from 2016 to 2018.

Micalyn Struble
ms773@duke.edu

Xiaoqiao Xing
xx63@duke.edu

Eric Zhang
eyz4@cornell.edu

Dr. Nita Farahany
farahany@duke.edu

Dr. William L. D. Krenzer
william.krenzer@duke.edu

Background

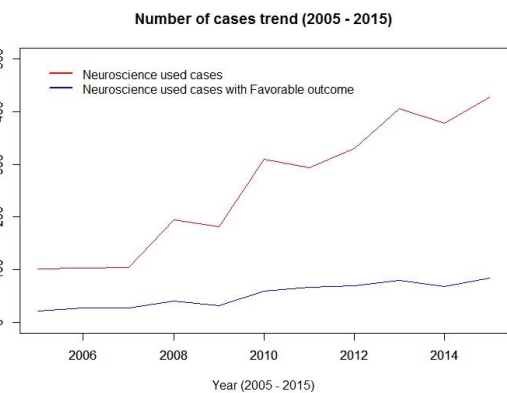


Figure 1. The number of cases using neuroscience evidence increased significantly from 2005 to 2015; within these cases, the number of cases resulting in favorable outcomes for the defendants steadily rose

Methodology

Data Collection

Downloaded cases from online legal database WestLaw using a **keyword list** made by Dr. Farahany (e.g., *brain, neuro!, EEG, fMRI*)

Feature Extraction



Model Training

Multi-Layer Perceptron (MLP) and Random Forest (RF) Classifiers

- **Capture relevant cases**: cases that use neuroscience as mitigation
- **Eliminate irrelevant cases**: cases that mention keywords in a context other than mitigation
- Optimize **precision** for irrelevant cases + **recall** for relevant cases to confidently remove irrelevant cases

MLPClassifier Classification Report

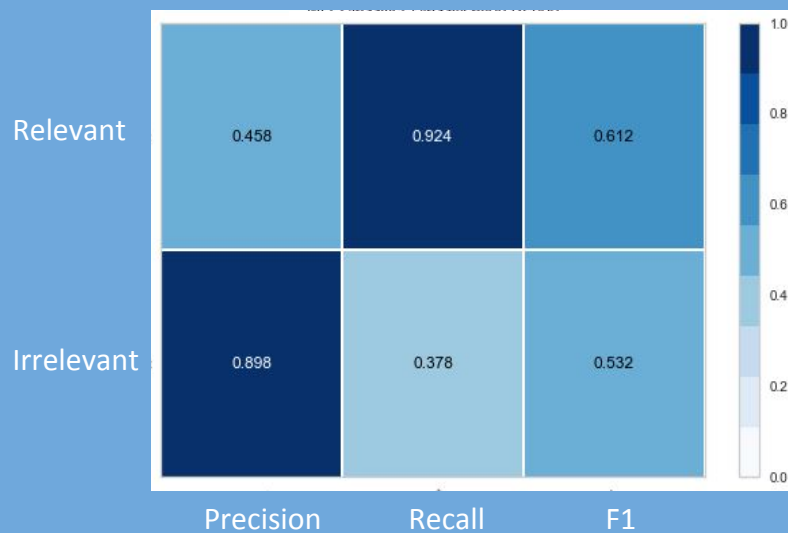


Figure 2. Evaluation for MLP
Training set: 2012-2014 cases
Test set: 2015 cases

RandomForestClassifier Classification Report

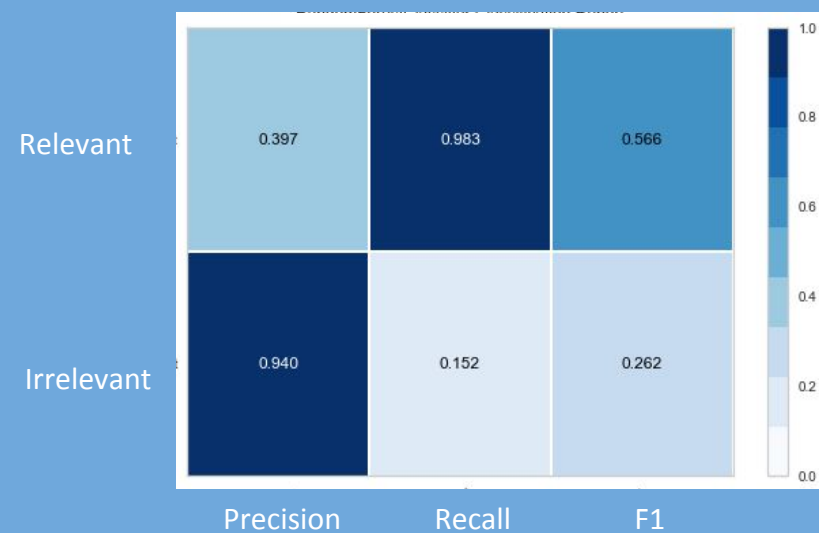


Figure 3. Evaluation for RF
Training set: 2012-2014 cases
Test set: 2015 cases

Results

- Capture relevant cases: cases that use neuroscience as mitigation
- Tested on 2,716 cases from 2016 and verified predicted labels for 809 of them
- Precision for irrelevant cases and recall for relevant cases **remained relatively high**, so we remain optimistic that both models can be used in the future

MLPClassifier Classification Report

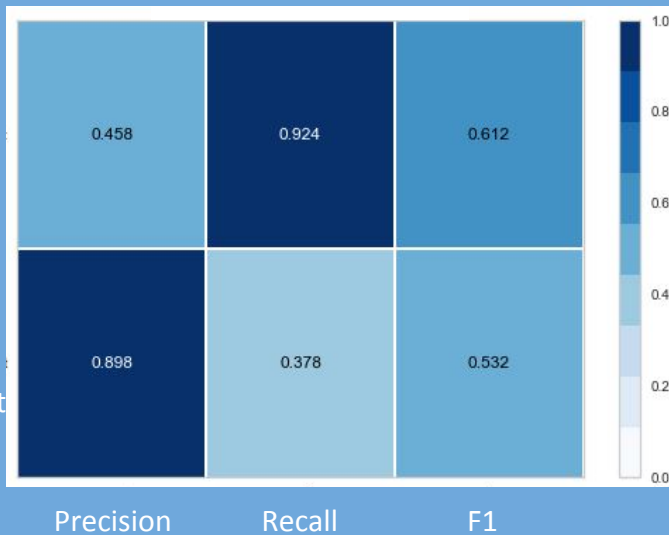


Figure 4. Results for MLP
Training set: 2012-2015 cases
Test set: 2016 cases

RandomForestClassifier Classification Report

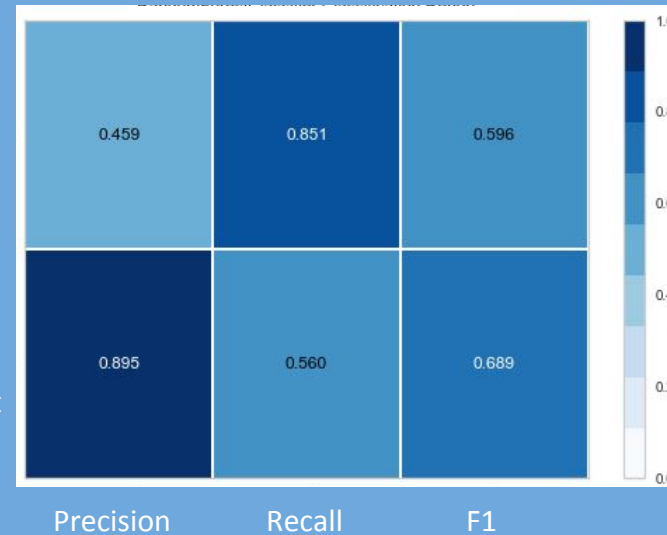


Figure 5. Results for RF
Training set: 2012-2015 cases
Test set: 2016 cases

Receiver operating characteristic for MLP (2016 Test)

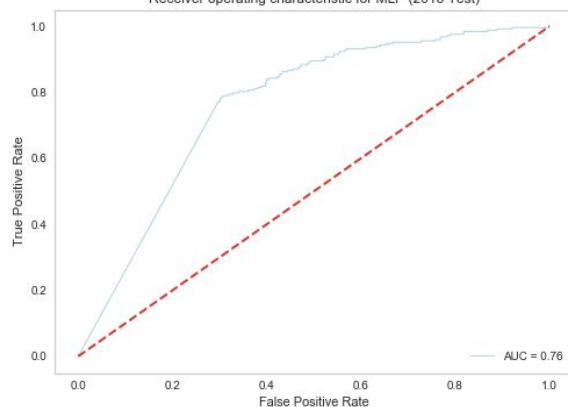


Figure 6. ROC curve for MLP on 2016 cases

Receiver operating characteristic for RF (2016 Test)

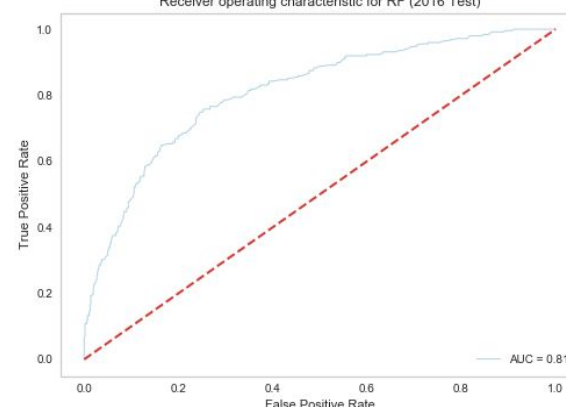


Figure 7. ROC curve for RF on 2016 cases

Future Work

- Capture relevant cases: cases that use neuroscience as mitigation
- Refine binary classification algorithms for cases from 2017 and 2018
- Automate the variable extraction process (e.g., year, court level, nature of evidence)

Acknowledgements

- Thank you to our project leads, Dr. William L.D. Krenzer and Dr. Nita Farahany for their patience, and guidance.
- Thank you to Jane Bahnson, Kirsten Bleiweiss, and Colleen Berryessa for their assistance and enthusiasm.
- Thank you to Dr. Paul Bendich, Ariel Dawn, and the Rhodes Information Initiative for this opportunity.