

SWx TREC Deep Learning Laboratory: Advances in Machine Learning for Space Weather

Space Weather Technology, Research & Education Center

University of Colorado at Boulder

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Allison Liu, Cody Feldhaus,
James Craft, Chris Pankratz



Grand Challenge

UNIVERSITY OF COLORADO BOULDER

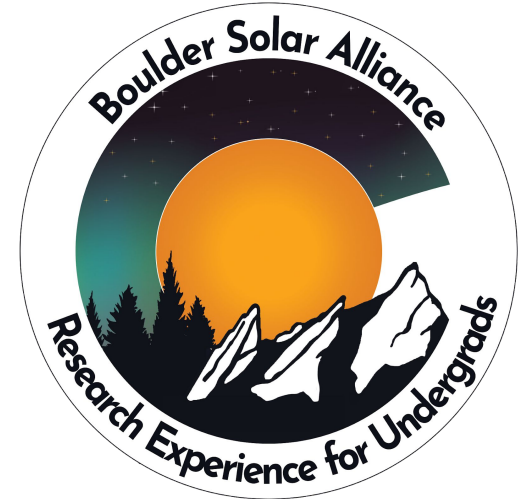
SPACE WEATHER CENTER



Who I am...



Deep Learning Laboratory



Deep Learning Lab Updates

Projects:

- Solar flare prediction
- GNSS scintillation prediction

New Hardware! Lambda Hyperplane 8xA100 AMD

- Processor: 2x AMD EPYC 74F3 (24 cores, 3.2 GHz)
- GPUs: 8x NVIDIA A100 SXM4 Tensor Core GPU (80GB) with NVLink/NVSwitch
- Memory: 2 TB ECC RAM (32x 64GB 3200 MHz - total of 32 slots)
- Extra Storage: 6x 15.36 TB | U.2| NVMe



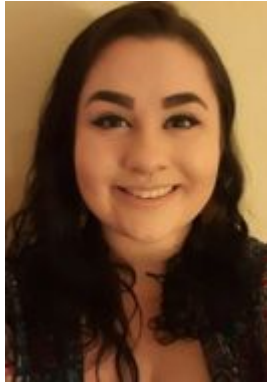
The Students

Current



Allison Liu

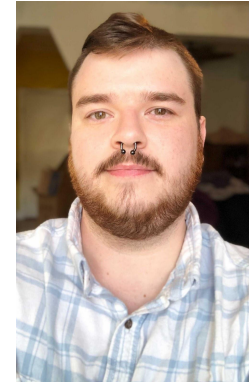
Former



Katy Luttrell



Pranav Subramanian



Cody Feldhaus



Kody Newman

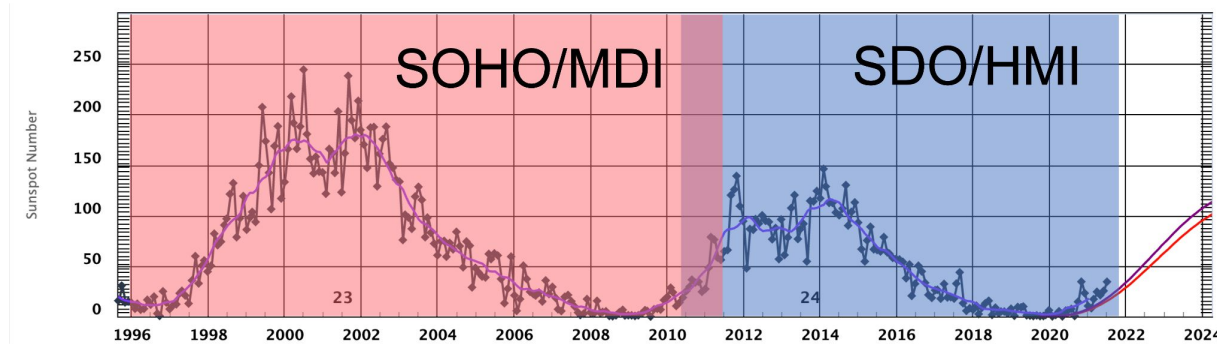


Justin Cai



Maxine Hartnett

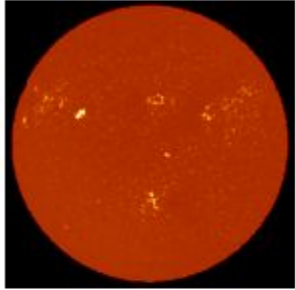
Data Augmentation - Generative Adversarial Networks



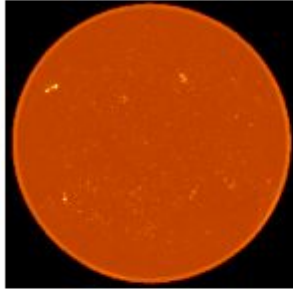
Courtesy of
Allison Liu

GAN results - see Allison's poster for more info

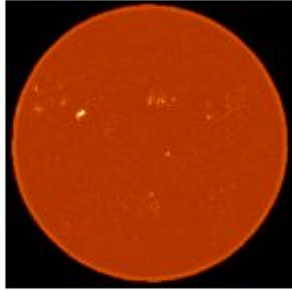
MDI



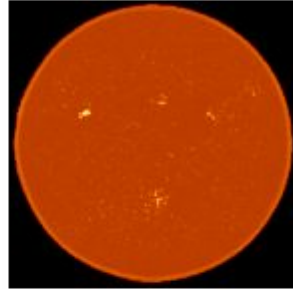
Pix2Pix



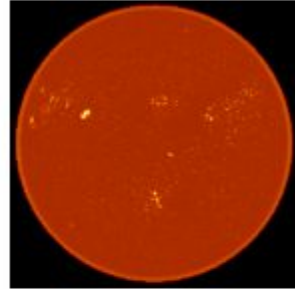
CycleGAN



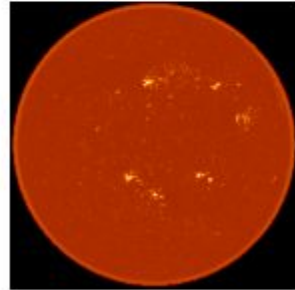
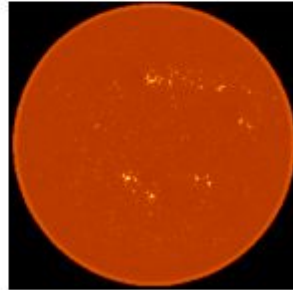
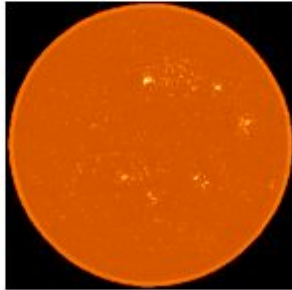
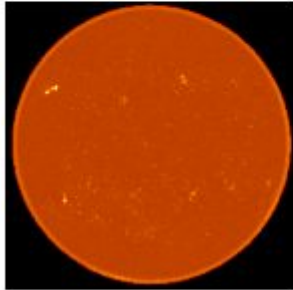
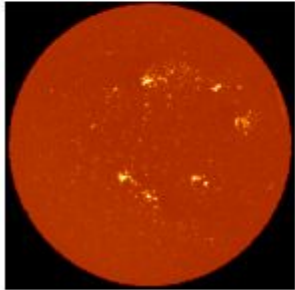
CUT



HMI



2010/09/04 ~19:12:00



2011/02/12 ~04:48:00

Explainable Artificial Intelligence (XAI)

Accountability.
Responsibility.
Transparency.

XAI (Silly) Example

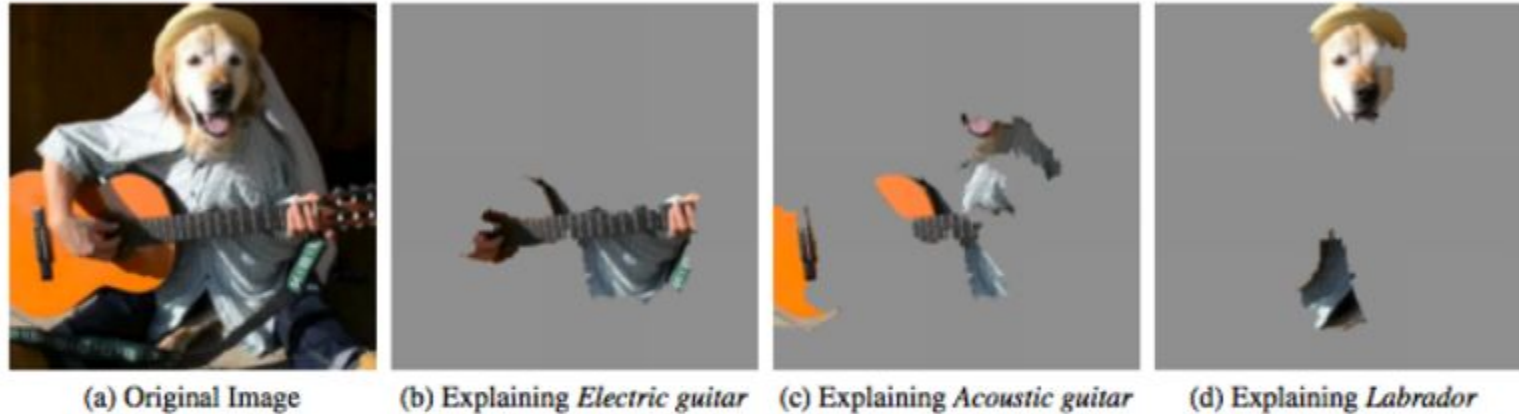


Figure 4: Explaining an image classification prediction made by Google's Inception network, highlighting positive pixels. The top 3 classes predicted are "Electric Guitar" ($p = 0.32$), "Acoustic guitar" ($p = 0.24$) and "Labrador" ($p = 0.21$)

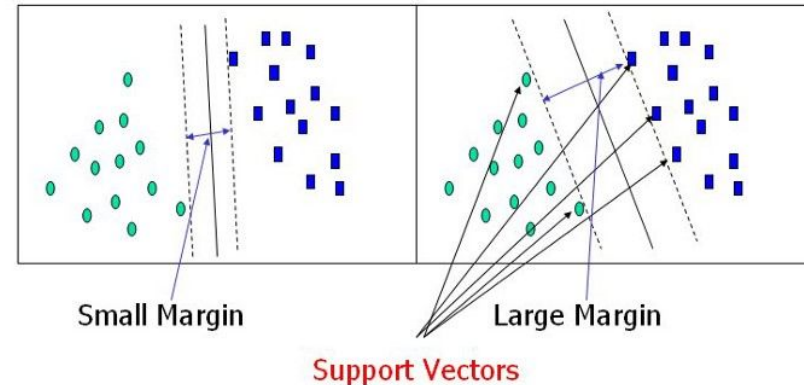
Image credit: <https://homes.cs.washington.edu/~marcotcr/blog/lime/>

LIME for Solar Flare Prediction

Data: Magnetogram Data, Solar Dynamics Observatory Helioseismic and Magnetic Imager (SDO/HMI)

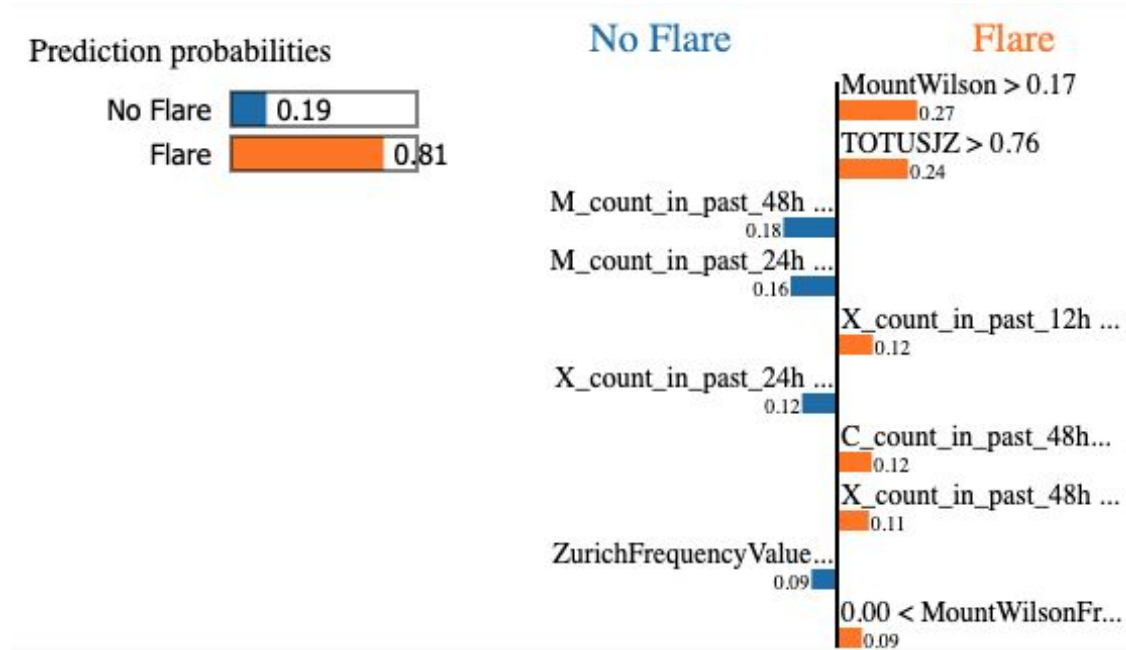
Features: SHARP: Space-weather HMI Active Region Patches, Feature Engineering from Past Research

Model: SVM: Support Vector Machine



<https://towardsdatascience.com/support-vector-machine-introduction-to-machine-learning-algorithms-934a444fca47>

LIME Output



TOTUSJZ: Total unsigned vertical current

Credit: Cody Feldhaus

Poster Session Info

NG45B: Machine Learning in Space Weather V Poster
Thursday, 16 December 2021; 16:00 - 18:00 CST
Convention Center Poster Hall, D-F

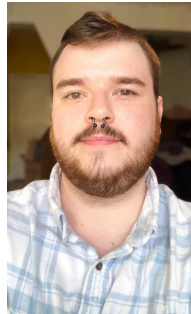
Data Augmentation of Magnetograms for Solar Flare Prediction using Generative Adversarial Networks

Allison Liu



Explainable Artificial Intelligence for Solar Flare Prediction

Cody Feldhaus



Classification of Solar Flare Magnitudes Using SDO/AIA Movies with 4D Convolutional Neural Networks

Kiera van der Sande