The Space Weather Prediction Effort at GSU: Many Projects in Parallel, Within a Unified Architecture.

Petrus C Martens, Rafal A Angryk, The Data Mining Lab Members

GSU Data Mining Lab, a truly interdisciplinary collaboration between GSU Computer Science and Solar Physics, consisting of ~ 20 graduate students and 8 faculty. Founded in 2014 by Profs. Angryk (CS) and Martens (Solar)

Our Objective:

Produce the best possible machine learning space hazard forecasting algorithm

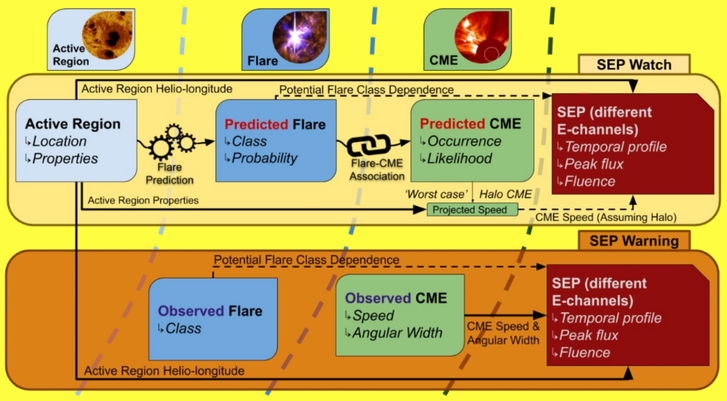
Our Method

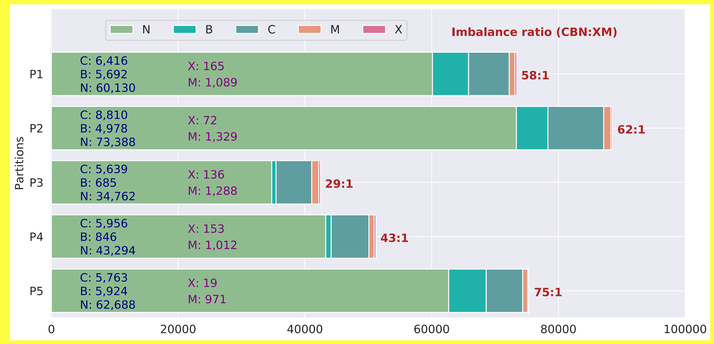
Conduct multiple small focused research projects in parallel – typical professors and graduate students from both computer science and solar physics on one project.

Each project falls under one of the categories on the right and is an indispensable part of the final integrated space weather prediction system

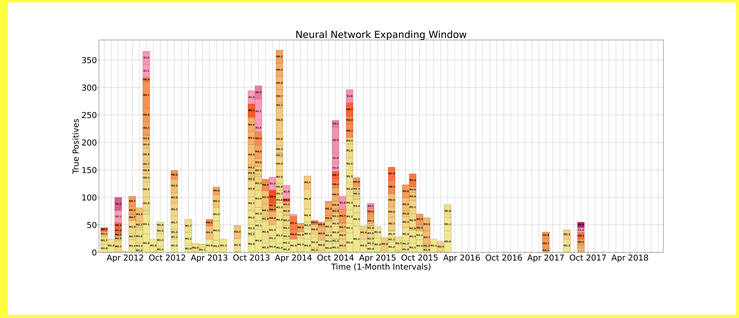
Current Projects:

1. Produce highest quality data benchmarks for ML training and testing: thoroughly vetted and cross-correlated; *poster Rotti*
2. Address weaknesses in ML methods for solar activity: class imbalances, synthetic time series, isolate outliers, improved performance measures, optimal training windows, simulated real-time predictions; *posters Goodwin, Kempton, Ali, Sadykov*
3. Go beyond traditional VMG preflare magnetic field predictor data: chromospheric wave precursors (*poster Chaturmutha*), filament chirality, morphology of polarity inversion lines, EUV precursors, McIntosh and Hale AR classes, world-wide muon detector network data (*poster Mubashir*), improve VMG limb data with AIA imagery
4. Combine the above into an integrated Preflare → Flare → CME → SEP prediction system

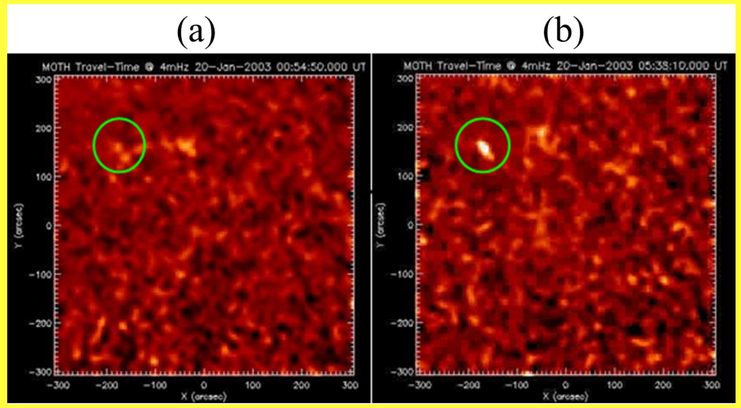




SWAN benchmark flare distribution



Simulated Real-time Prediction



Chromospheric flare precursor; several hours warning

For the Future: integrate simulation codes with ML techniques – ML can "steer" numerical simulations in real time, simulation results can "guide" ML approaches (e.g. decision trees).

Acknowledgements: GSU space weather research is supported by grants from NASA under several programs, including FINESST and SWR2O2R, a contract with SRAG, and by two NSF CSSI grants, as well as by the GSU Next Gen Program.