





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

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

Current Projects: SEP Watch Potential Flare Class Dependence SEP (different Predicted CME Predicted Flare E-channels) **4** Temporal profile **Likelihood** ↓Peak flux Flare-CME Flare Association **Fluence** 'Worst case' Halo CME Projected Speed CME Speed (Assuming Halo) SEP Warning **SEP** (different **Observed CME** E-channels) **↓**Speed Temporal profile **Glass** Angular Width Peak flux *⊾*Fluence

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 realtime 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 \rightarrow Flare \rightarrow $CME \rightarrow SEP$ prediction system Active Region Helio-longitude **Active Region Location ↓**Properties Active Region Properties **Observed Flare** tive Region Helio-longitude



		N	B	C			
P1	C: 6,416 B: 5,692 N: 60,130		X: 165 M: 1,089				
P2 suc	C: 8,810 B: 4,978 N: 73,388		X: 72 M: 1,329				
Partitions ଘ	C: 5,639 B: 685 N: 34,762		X: 136 M: 1,288				
P4	C: 5,956 B: 846 N: 43,294		X: 153 M: 1,012				
P5	C: 5,763 B: 5,924 N: 62,688		X: 19 M: 971				
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Simulated Real-time Prediction



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).

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(b)

Chromospheric flare precursor;