NEXTGEN
FEDERAL SYSTEMS

Space Radiation Intelligence System SPRINTS

CCMC Workshop

June 7, 2022

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Who We Are & What We Do

NextGen Federal Systems (NextGen) is a HUBZone certified small business with a track record for providing Innovative Solutions and Services for Defense C4ISR

- NextGen practices and maintains multiple industry certifications: CMMI Level 3 and ISO 9K, 20K, 27K

CMMI SVC /3 SM
Exp. 2023-09-21/ Appraisal #6466

CMMI DEV /3 SM
Exp. 2023-09-21/ Appraisal #6466

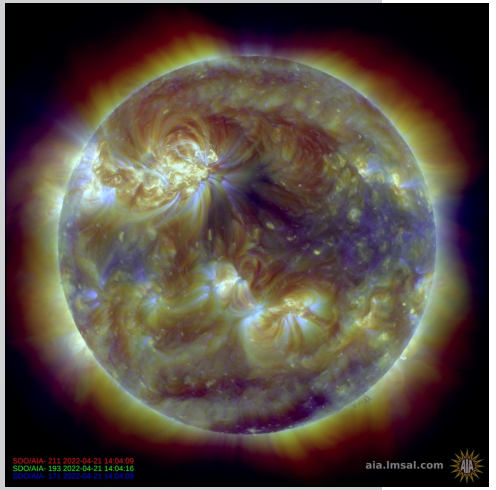
CERTIFIED ISO 9001:2015 COMPANY

- AWS Partner Network Select Consulting Partner

Inc. 5000 FASTEST GROWING COMPANIES IN AMERICA
— 6-TIME RECIPIENT —

2016	2017	2018	2019	2020	2021
#211	#440	#1096	#1703	#2437	#2191

- Services
  - Software Development
  - Systems Engineering
  - Cybersecurity
  - Test & Evaluation
  - Program Operations
- Solutions
  - Mission Planning
  - Situational Awareness
  - Multi-Domain Data Fusion
  - Architecture Modernization
  - C2 Decision Aids
  - Virtual & Augmented Reality
- Research & Development
  - Weather Impact Analysis
  - Autonomous / Swarming Drones
  - Sensor Planning
  - Artificial Intelligence
  - Machine Learning
  - Space Weather Forecasting
  - Soil Moisture Analysis



SPRINTS Framework Key Takeaways

What

An ecosystem for collaborative and repeatable space wx data processes, science and forecasting

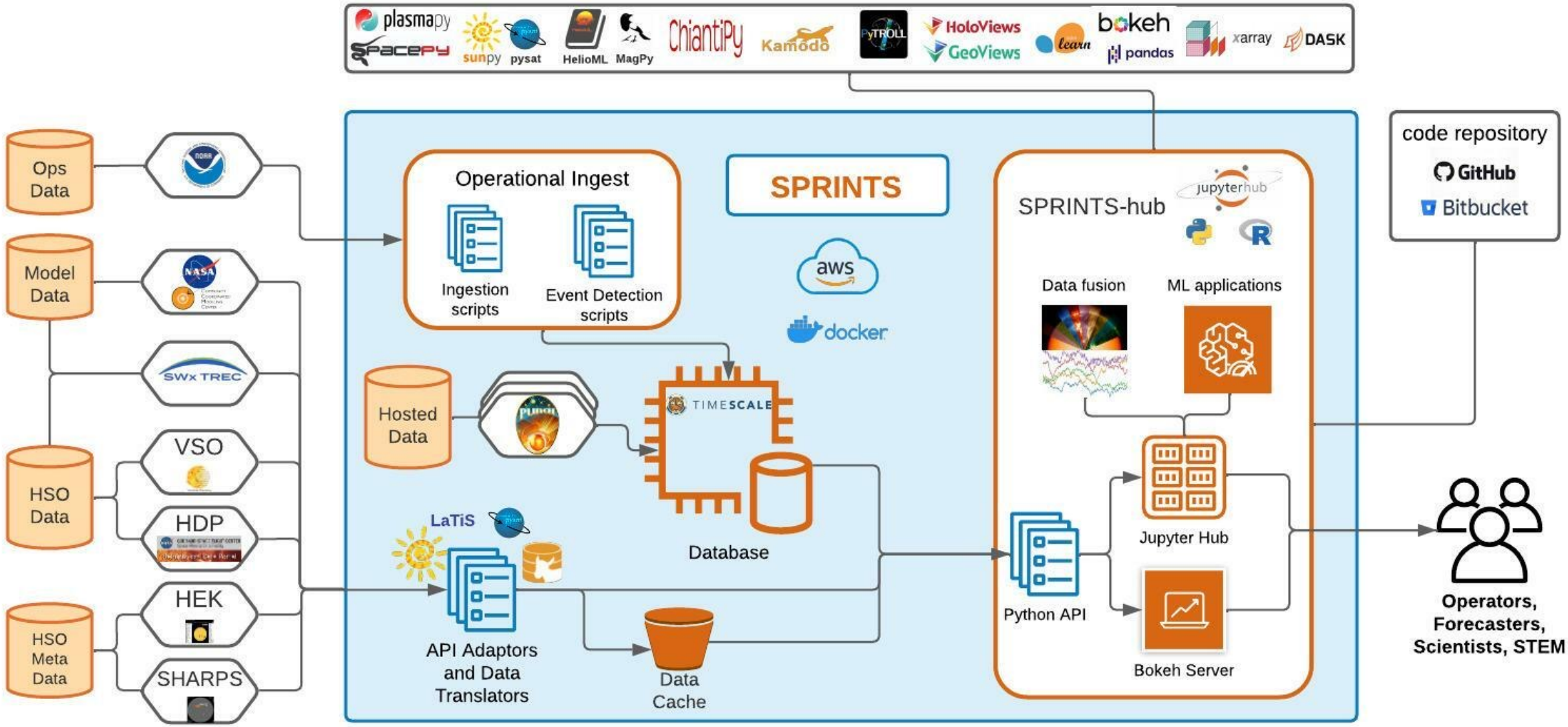
Why

Streamline space wx applications from TRL 1-4 to TRLs required required by proving grounds and testbeds

How

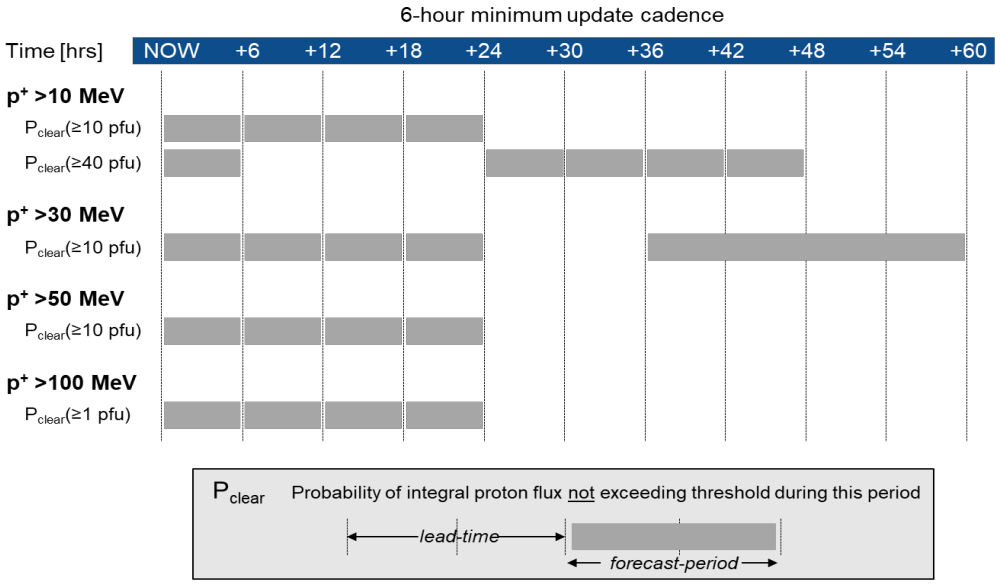
API, database, widgets, collaborative ecosystem	Timescale DB SQL, REST API, Python API, Jupyter Hub
External catalogs and files	Supports a variety of metadata
Data Fusion	Repeatable data fusion as a function of communal information, expertise and version control
Machine learning processes and models	Explore, develop, validate, and deploy
Uses additional libraries, tools, data, and models	SunPy, Kamodo, PySat, SpacePy, PlasmaPy, CCMC APIs, etc.
AWS GovCloud hosted	Can be deployed to local servers

SPRINTS Architecture



Origins of SPRINTS

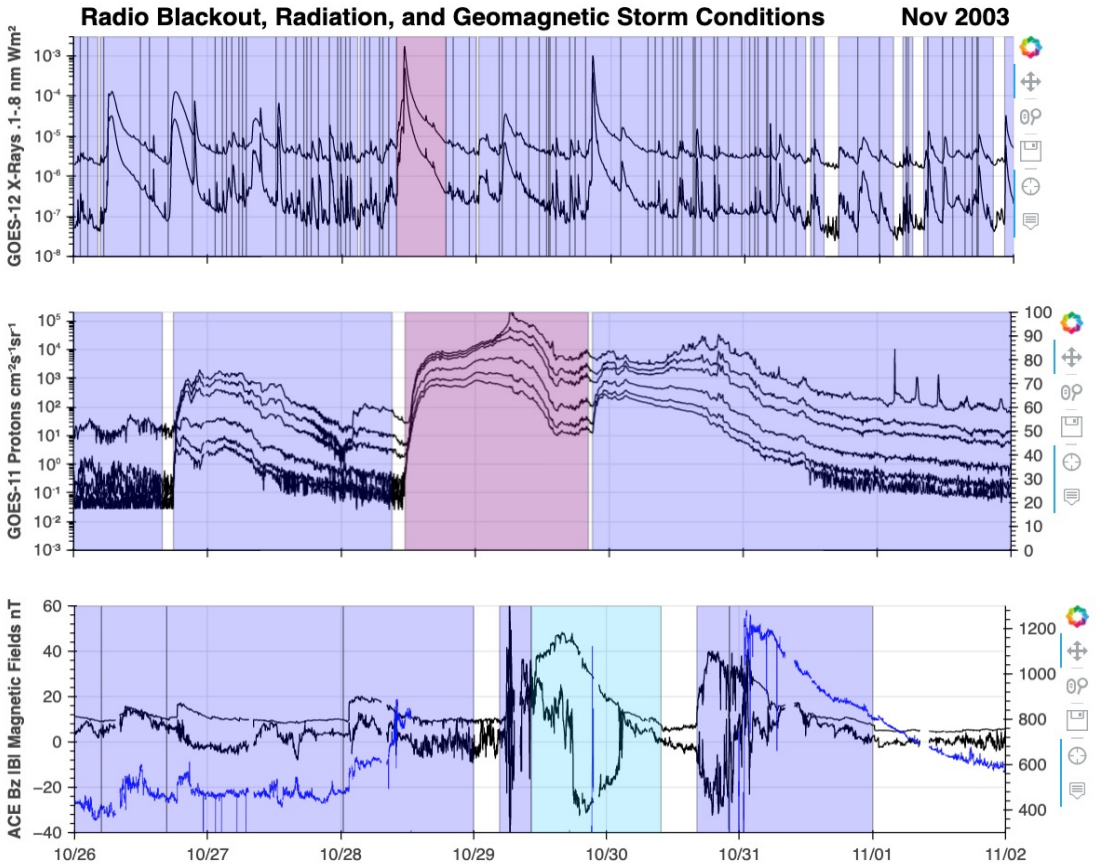
- Built to predict flare, SEPs and CMEs
- Couple with
  - MagPy (MAG4) flare forecasting
  - SEPSTER SEP forecasting
- Primary Objective: Predict the AFRL SEP forecast requirements
  - 10@10
  - 10@40
  - 30@10
  - 50@10
  - 100@1



AFRL SEP Forecasting Requirements

How is SPRINTS used and developed for SEP forecasting?

1. Data is Findable, Accessible, Interoperable, and Reproducible (FAIR); Analysis- and ML-Ready
2. Machine-learning workflows make it possible to have a new model and deploy it within 1-2 days
3. Deployable forecasts integrated into user-customizable dashboards and machine to machine products



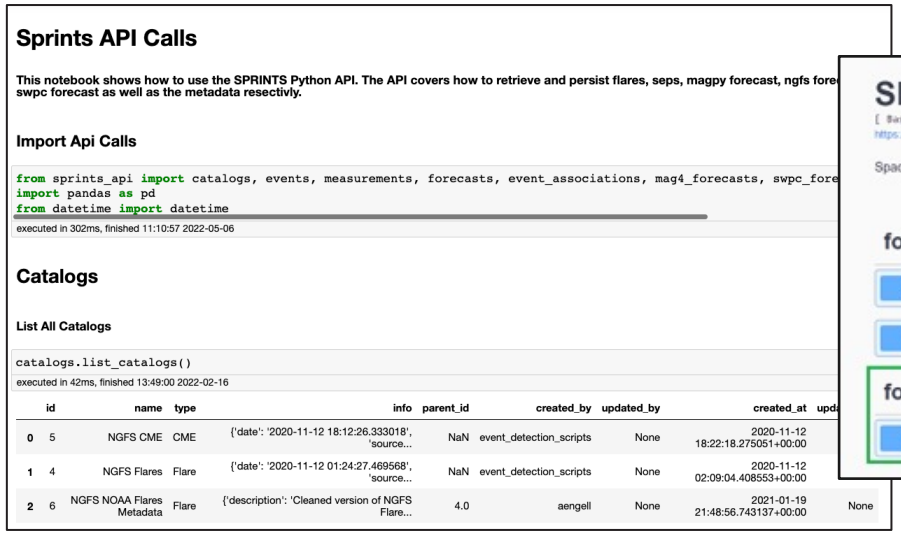
Data Curation Process

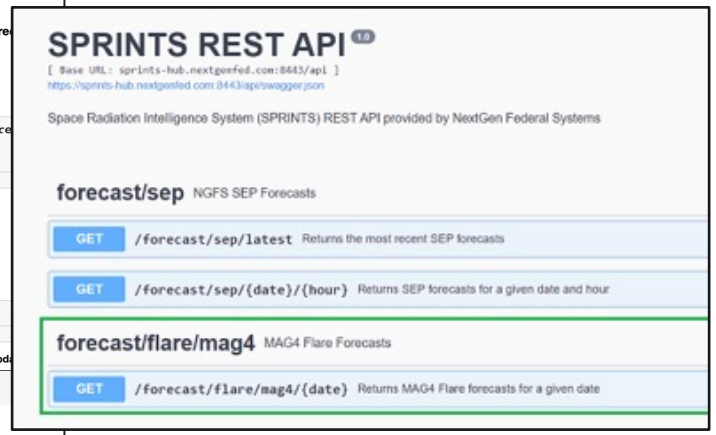
1. GOES primary and secondary instruments 1986-present (thanks Hazel Bain!)
2. Event catalog assimilation (e.g., SWPC, NASA, Papaionnou et al, 2017, Belov, Richardson, S. Johnson, LMSAL)
3. Improvements and version control with the support of dashboard-database tooling
   - Science crowd-sourced event catalogs and associated event catalogs!!!

#	id	Start	End	lat	lon	nar
30	185716	10/28/2003	10/28/2003	6	53	10484
31	185717	10/28/2003	10/28/2003	NaN	NaN	NaN
32	185718	10/28/2003	10/28/2003	NaN	NaN	NaN
33	185719	10/28/2003	10/28/2003	NaN	NaN	10488
34	185720	10/28/2003	10/28/2003	-16	-8	10486
35	185721	10/28/2003	10/28/2003	NaN	NaN	NaN
36	185722	10/28/2003	10/28/2003	NaN	NaN	NaN
37	185723	10/28/2003	10/29/2003	NaN	NaN	NaN
38	185724	10/29/2003	10/29/2003	NaN	NaN	10486

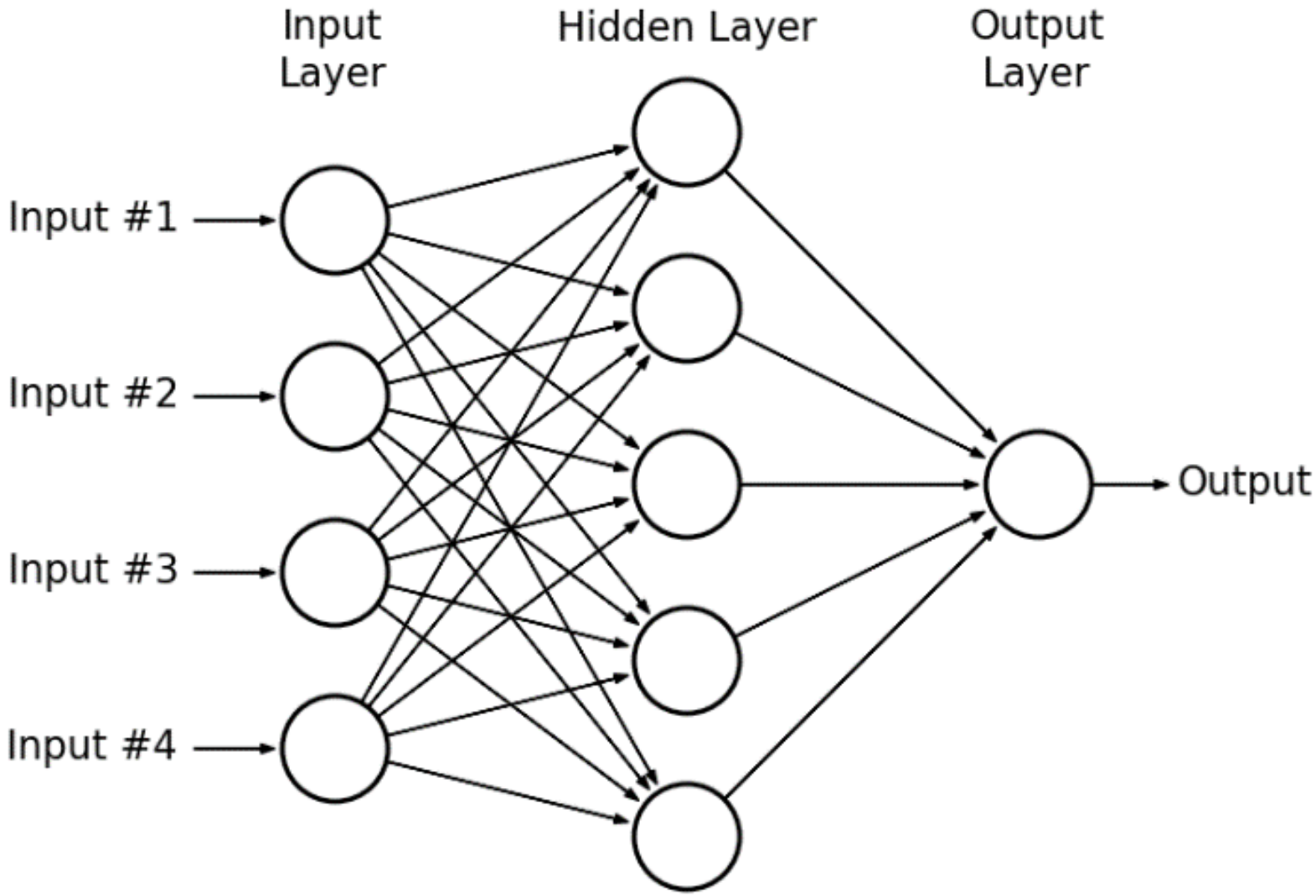
#	ID	Start	End	Associated Flare
0	265840	10/22/2003 10:25	10/26/2003 15:55	NaN
1	203798	10/26/2003 17:55	10/28/2003 09:05	185692
2	203799	10/28/2003 11:25	10/29/2003 20:15	185720
3	203800	10/29/2003 21:00	11/02/2003 00:50	185736
4				

#	assoc_id	flare_event_id	sep_event_id	Start	End	lat	lon	nar
0	160	185692	203798	10/26/2003 16:56	10/26/2003 21:14	2	38	10484
1	161	185720	203799	10/28/2003 09:45	10/28/2003 18:34	-16	-8	10486
2	162	185736	203800	10/29/2003 19:32	10/30/2003 01:47	-15	2	10486





Modeling: Multi-layer perceptron



Overall Results (non-temporal)

AFRL req.	HSS	POD	FAR
10@10	0.58	0.56	0.34
10@40	0.73	0.59	0.00
30@10	0.66	0.56	0.17
50@10	0.80	0.67	0.00
100@1	0.89	0.80	0.00

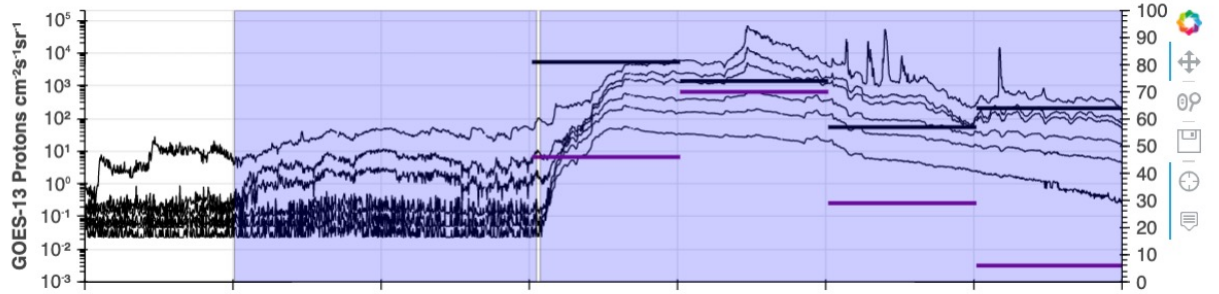
	SEPs	
AFRL req.	Train	Test
10@10	163	18
10@40	108	12
30@10	82	9
50@10	57	6
100@1	93	10

CCMC SEP Challenge Results (All-Clears)

Date	10@10 24hr Thresh: 56%	100@1 24hr Thresh: 26%
03/07/2012	✅ 81%	✅ 46%
05/17/2012	✅ 72%	22%
07/12/2012	✅ 82%	46%
04/11/2013	15%	4%
01/06/2014	NA	NA
01/07/2014	✅ 69%	✅ 29%
07/14/2017	60%	✅ 9%
09/04/2017	45%	✅ 8%
09/06/2017	✅ 96%	86%
09/10/2017	✅ 98%	✅ 96%

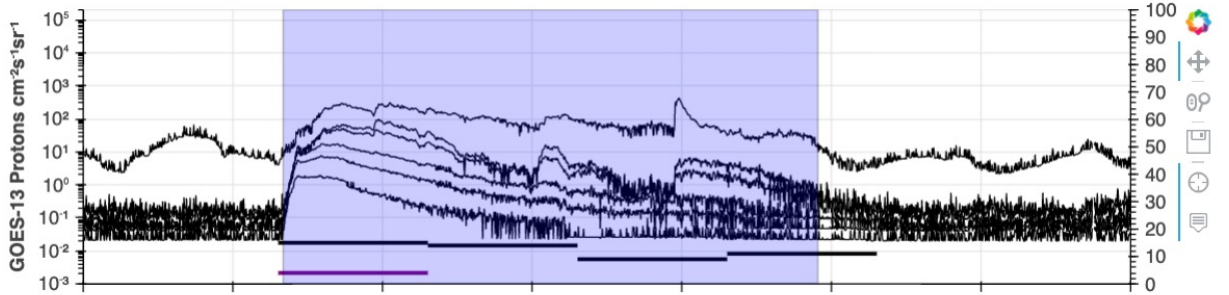
The MLP model never trained on any of the challenge events!

✅ ✅



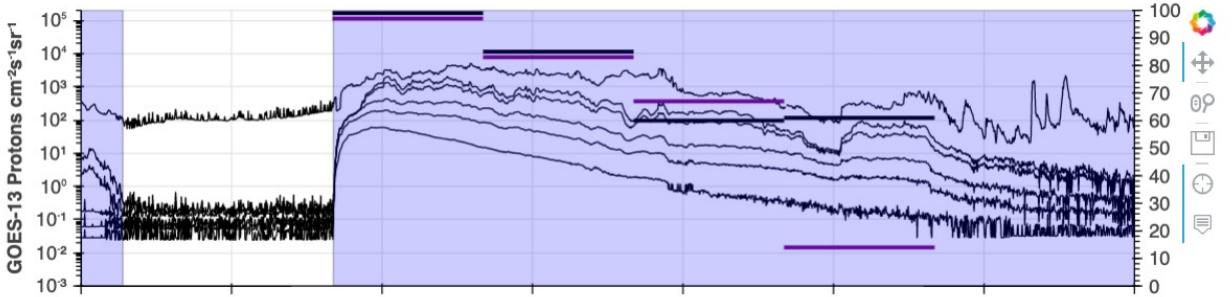
March 7, 2012

15% 4%



April 11, 2013

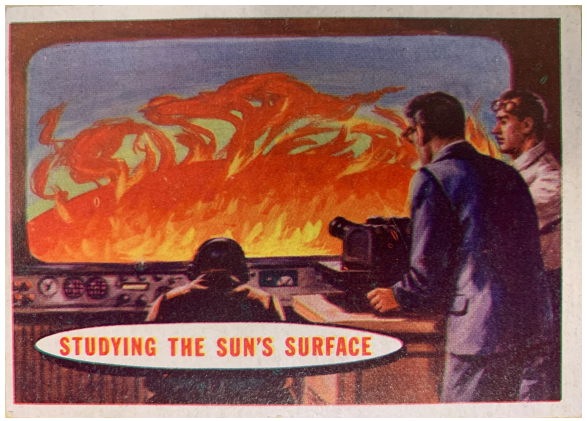
✅ ✅

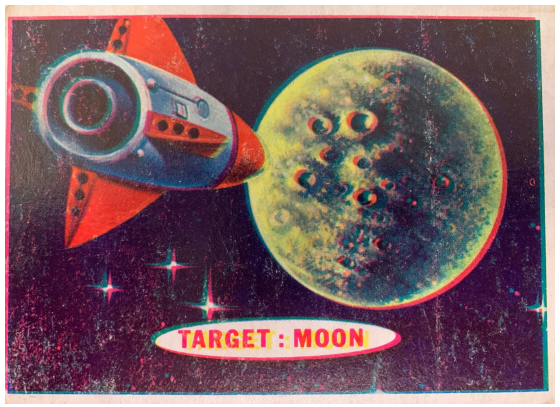


September 10, 2017

What's Happening Now

- Forecasts will soon be available on the CCMC SEP Scoreboard!
  - Models following
- Coupling with MagPy and SEPSTER
- Time-series ML
  - >2.2, >5, >5.2, >30 and >60 MeV (Space Force requirements)
- HITS proposal award: extend open-source libraries to make it more practical to work with large quantities of remotely accessed heliophysics data: Bokeh, Filesystem Spec (fsspec), Kerchunk
- Working transition opportunities to make available to community
  - Framework to HelioCloud
  - Space Force SET4D environment





1957 Topps Space Cards