Funded by
the European Union

ARCAFF

Active Region Classification and Flare Forecasting

Paul Wright, Shane Maloney, Sophie Murray, Peter Gallagher *(DIAS)*
Anna Massone, Michele Piana, Valentina Candiani, Sabrina Guastavino *(University of Genova)*
Tamas Kiss, Gabriele Pierantoni, Gabor Terstyanszky *(University of Westminster)*
Robert Lovas, Attila Farkas *(Sztaki; Institute for Computer Science and Control)*

DIAS
Institiúid Ard-Léinn Bhaile Átha Cliath | Dublin Institute for Advanced Studies

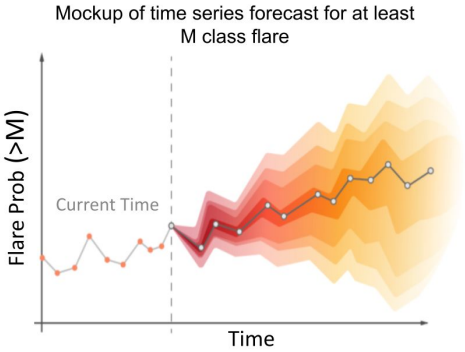
Università di Genova

UNIVERSITY OF WESTMINSTER

SZTAKI

Overview: Work Packages

- Active Region (AR) Classification Network – **ARCCnet**
  - AR Detection with full-disk magnetograms
  - AR Classification (Hale / Zurich)
- Point-in-Time (PiT) Flare Forecasts – **PinTFF**
  - Given observations from a single time (e.g. Magnetogram & EUV) generate a 24 hour forecast flare probability
- Time-series (TimS) Flare Forecasts – **TimSFF**
  - Given a times series of observations forecast time series of flare probabilities (e.g. every 3 hours for next 24 hours)
- Deploy models to run and publish predictions
  - Solar Monitor, CCMC, PITHIA-NRF



Overview: Open Science

- Code releases will be public on GitHub: github.com/arcaff
  - Datasets, Software (Python packages with documentation), and Research Findings
  - Dataset generation tools & DataLoaders will allow for easy benchmarking & direct comparison of models
- Continuous Integration and Deployment (CI/CD)
  - CI/CD to automate testing and up-to-date documentation, expanding to deployment shortly
- MLOps Integration
  - We will be integrating Machine Learning Operations (MLOps) tools such as MLFlow and Weights & Biases to enable experiment tracking, collaboration, and allow researchers to validate our results.
- Model Deployment and Monitoring
  - Continuous monitoring will allow us to track performance metrics and detect data/concept drift.

By releasing datasets, software, and research findings,
we aim to actively encourage researchers to validate, and build upon our work.

ARCAFF & SolarMonitor: Future Integrations

SolarMonitor.org currently provides flare forecasts, however…

- ARCAFF results will seamlessly integrate with SolarMonitor 2
  - Active region classifications (at each time-step, vs. daily classification)
  - Flare probabilities (in addition to existing SM predictions)
- Website & API to allow direct user access to real-time ML model inference
  - Continuous monitoring and validation (MLOps)
  - Ability to integrate additional models
- Model Deployment and Monitoring
  - Continuous monitoring will allow us to track performance metrics and detect data/concept drift.

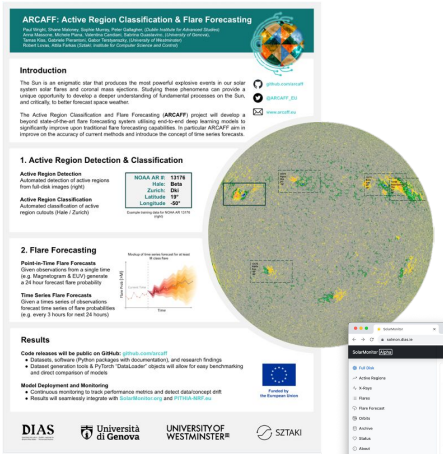
Goal: Provide users with easy access to real-time machine learning inference through a widely-used, familiar, user-friendly interface (SolarMonitor). When combined with continuous model monitoring and performance ranking, we aim to provide a comprehensive and reliable flare forecasting system for solar physicists and operational space weather forecasters.

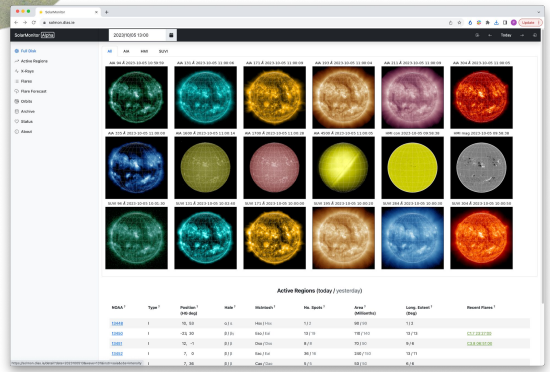
Summary

1. **ARCAFF**: github.com/arcaff, @arcaff_eu
   EU-funded end-to-end machine learning pipeline for state-of-the-art solar flare predictions, with anticipated deployment on SolarMonitor, CCMC, PITHIA-NRF, etc.

   Our poster is on Zenodo: **zenodo.org/record/8405846**

2. SolarMonitor
   version 2.0 is currently in alpha (solmon.dias.ie) and welcome feedback from the community.





Paul Wright pjwright@cp.dias.ie