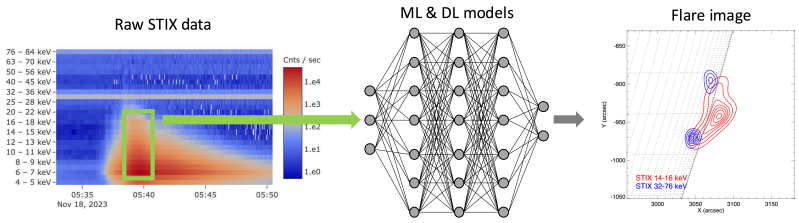
Fachhochschule Nordwestschweiz

ML Alg | Data Science

25HS_I4DS23: Real-Time Imaging of Solar X-ray Flares with Machine Learning

			Priority 1	Priority 2
Advisor:	Säm Krucker	**Work scope:**	P5 oder P6	---
	Paolo Massa	**Team size:**	2er Team	---
Languages:	German or English			
Study course:	Computer Science and Data Science			

Initial situation



The Spectrometer/Telescope for Imaging X-rays (STIX) is a solar X-ray telescope on board ESA's Solar Orbiter mission, launched in February 2020 [1]. Designed, built, and operated by FHNW, STIX observes the X-ray radiation emitted by solar flares, i.e., large explosions occurring on the surface of the Sun. To date, STIX has collected a large dataset of flares, consisting of more that 80'000 events [2].

STIX does not directly observe images, but images are reconstructed from the STIX using sophisticated algorithms. While effective, these traditional methods are computationally intensive and typically require up to a minute to generate a single image. To address this limitation, researchers at FHNW have recently developed a Deep Learning (DL) approach to reconstruct STIX images in real time. This model provides images of solar flares in a fraction of a second; however, the process still relies on reading and calibrating the raw STIX data, and this a step remains a bottleneck in the overall efficiency of the pipeline

Objective

We propose to implement and train a Machine Learning (ML) model for fast calibration of the raw STIX data. This model, coupled with the recently developed DL method, will allow us to do imaging in real time.

Problem statement

The goal is to develop an ML model which reads the raw STIX data and provides an estimate of the flare location on the solar surface. This position is utilized to calibrate the raw STIX data, which are fed into the existing DL model for image reconstruction. The overall pipeline is shown the figure above.

Technologies/Technical emphasis/References

The STIX data is available online from the STIX webpage [4] and existing phyton tools can be used to read the STIX data [4]. In case of a P6 project, the resulting pipeline for real-time imaging will be implemented and tested on the STIX data center [4]. This pipeline will allow scientist to perform preliminary analysis using a web-based platform.

[1] https://www.esa.int/Science_Exploration/Space_Science/Solar_Orbiter
[2] https://github.com/hayesla/stix_flarelist_science/tree/main
[3] https://arxiv.org/abs/2408.16642
[4] https://datacenter.stix.i4ds.net/
[5] https://soar.esac.esa.int/soar/
[6] https://github.com/TCDSolar/stixpy

Note

This is a cutting-edge science project that will be carried out within an international team. No prior knowledge of the physics of the Sun is required. Please note that most of the STIX documents are in English, but the thesis may be written in German or English.