IIT KHARAGPUR

INTER IIT TECH MEET 10.0

25-27TH MARCH 2022

ISRO'S WEB-BASED AUTOMATIC IDENTIFICATION OF SOLAR BURSTS IN X-RAY LIGHT CURVES

Cosmic sources in the sky, including our star, the Sun, burst intermittently in the X-ray energy band of the electromagnetic spectrum. The burst amplitude and the duration vary depending on the source and the cause of the burst. The observed burst has a fast rise and slow decay pattern/shape with variable rise and decay times. An automatic identification system for such data will further simplify the analysis process and the associated scientific investigation of these bursts.

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PROBLEM STATEMENT

Build a stand-alone web-based application using open-source software(s) to identify and categorize X-ray bursts. Given data will include long-duration X-ray light curves as well. Parameters like the rise and decay time, peak flux, duration of bursts, etc., must be derived. False detection should be minimum, and all bursts must be detected.

The problem can be broadly categorized into two parts:

1. Developing a statistical/machine learning model to cover the mentioned parameters.
2. Deploying it efficiently to a stand-alone application and web-based tool (no additional APIs used).

The web-based tool should visualize the light curve data, feature a GUI for light curve distribution visualization, analyze wavelets, display particular portions of distributions as time series: confirming burst occurrence, etc.

BASIC REQUIREMENTS

- Light curves of X-ray source(s) will be provided, with many outbursts and systematic variations in the background. The tool should be designed to accept any X-ray light curve with a defined format. It should allow different input file formats – like ASCII, FITS, and XLS.
- The model should identify the bursts and their properties (as listed in the problem statement) along with the time of occurrence. Classification of the bursts is to be done, and the use of fit parameters should be justified. Classification criteria is open for innovation.
- The tool should be developed completely using open source (Python/Perl etc.) software.
- Additionally, the teams must use the available data and prove the efficiency of the system w.r.t. minimal false alarms and maximal true signatures.
- The teams must bring out the limitations of the method(s) used in the tool and possible enhancement later through research.

DATA SOURCES

ISRO's PRADAN website for Solar X-ray data: https://pradan.issdc.gov.in
Register to get into the data archive of Chandrayaan-2 payload data. After registering and logging in, go to XSM (X-ray Solar Monitor) where required data and manuals to read and use the data are present. The lightcurve data of XSM is the required input for this analysis.

SOFTWARE SPECIFICATIONS

- Should be deployed as a web-based application and also as a stand-alone application.
- The tool should be distributed under GPL or any other open source license.
- Should use only open source, Python is desirable.

SUBMISSION

MID EVALUATION: CODES AND DOCUMENTATION- 150 POINTS

Teams will be required to submit their codes and documentation files (a detailed documentation explaining the codes and instructions for code deployment) in a github repository.
Due Date - 18th March

FINAL PRESENTATION- 100 POINTS

All participating teams would be required to give a 10 min presentation followed by a 5 min Q&A session of their proposed solutions. Dates will be informed later.
The ppt for final presentation has to be submited by **24th March, 11:59 pm.**

EVALUATION

Evaluation criteria

1. For statistical/machine learning model: (30%)

- Detection of the maximum number of bursts with fewer false detections for a given duration
- Identification and classification of the fit parameters alongwith their explanantions (like the rise time, peak flux, decay time constant) and its accuracies: good accuracy and goodness of fit for many bursts
- A validation data set will be run for all the codes developed, and the results will be compared with expected values along with time and space complexity

2. For the web-based/stand-alone application: (70%)

- Ease of use of the GUI as well as the open-source codes developed
- A good manual – ease of use by a third party not knowing computational aspects
- Compatibility of the tool – should be able to install in all Linux environments without any patch up
- Adaptability to take any format input data (FITS, ASCII, CDF, etc.)
- Concise and clear documentation, including inferences derived for the sample data, should be available along with the codes for user demonstration

Note: Physical explanation for the use of fit parameters and the classification criteria will be prioritized for final evaluation.

Send your submissions at this email: submissions@interiit-tech.org

References:
1. Gryciuk et al., Solar Physics, 292, 77, 2017
2. Aschwanden and Freeland, Astrophysical Journal, 754, 112, 2012

Team size for this event is maximum 6 participants.
Participation awards shall be awarded to all participants.