Predicting Soft X-ray Emissions for Solar Flare Forecasting Using a Self-Supervised CNN Trained on Solar Dynamics Observatory Data

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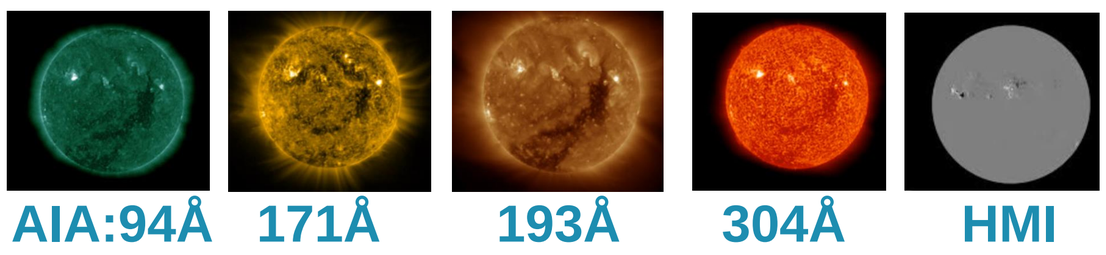
INTRODUCTION

Predicting solar flares is crucial for communications and satellite operations. Previous Machine Learning (ML) work focused on classifying flares with labels such as M and X, overlooking the continuous nature of X-ray flux.

METHODOLOGY

1. Inputs: HMI and EUV SDO (Full disk sun images)

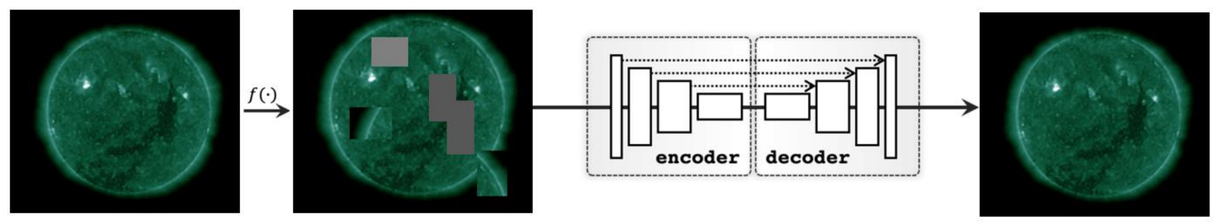
We use the sdomlv2 dataset [1].



2. Pretraining CNNs in self-supervision

Pretrain via self supervision by performing image reconstruction after image transformations [2].

For example, for AIA 94Å:



$f(\cdot)$: Transformation

NL: Non-linear

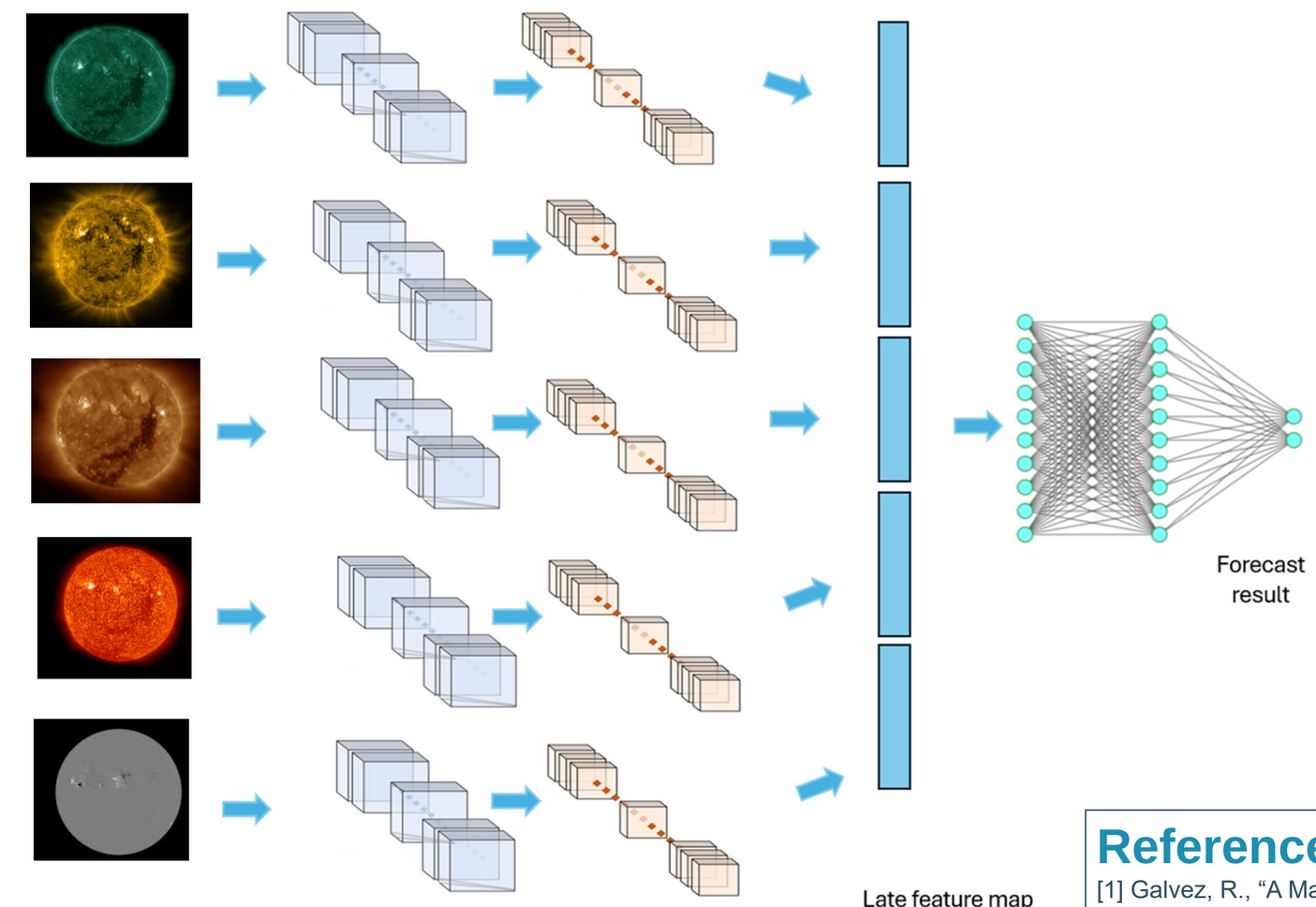
LS: Local-shuffling

OC: Outer-cutout

IC: Inner-cutout

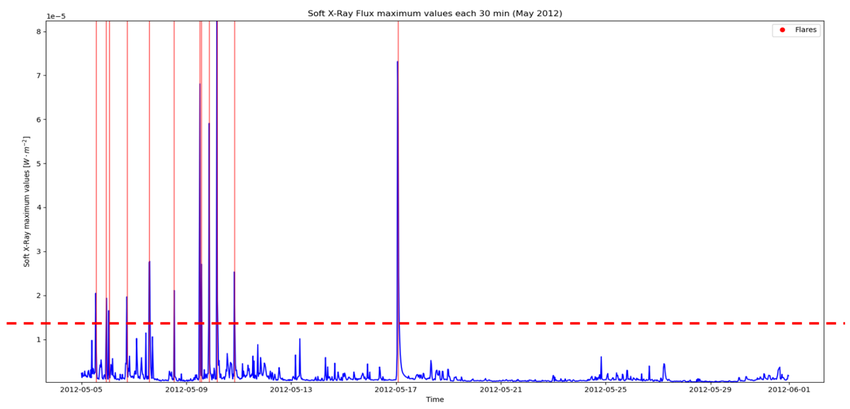
3. Predicting (Regression) Soft X-ray flux using CNNs

Attach pretrained models (encoders) and perform supervised training



4. Thresholding

Detect the flares



References

[1] Galvez, R., “A Machine-learning Data Set Prepared from the NASA Solar Dynamics Observatory Mission”, The Astrophysical Journal Supplement Series, vol. 242, no. 1, IOP, 2019. doi:10.3847/1538-4365/ab1005.

[2] Zhou et al., “Models Genesis”, Medical Image Analysis, Volume 67, 2021, https://doi.org/10.1016/j.media.2020.101840.