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Bayes in Space: A Bayesian Deep Learning approach for Coronal Temperature estimation

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The Corona, the outermost layer of the Sun, is a region of intense activity and showcases various solar phenomena that affects the thermal distribution of its constituting plasma. The study of the temperature distribution across the corona is essential in understanding different heating mechanisms that lead to the strikingly high temperatures reached by the corona. This distribution can be estimated using photometric observations in multiple bandpasses by imaging surveys like the Atmospheric Imaging Assembly onboard the Solar Dynamics Observatory. However, each bandpass covers a range of plasma temperatures and cannot be estimated directly through these observations. The temperatures can be estimated by inverting the intensity or number of photons hitting the detector through the channel passband. We propose an uncertainty based deep learning approach to generate Differential Emission Measure (DEM) maps from solar images, that contain information of the amount of thermal plasma emitted by the solar corona along a line-of-sight at a certain temperature. A machine learning approach consists of training a neural network to read AIA images from multiple bandpasses and develop their DEM maps across a range of temperatures as output. While this network can be designed to provide real, non-negative DEM value for each input intensity, it can disrupt the DEM map if it is unsure of its predictions and gives out a wrong output. We introduce an uncertainty in deep learning methods for obtaining the DEM maps from AIA images by incorporating Bayesian techniques like variational dropout and bayes by backdrop, and compare these approaches.

Primary author: BALODHI, Nikita (Northumbria University, Newcastle)

Co-author: Dr MORTON, Richard (Northumbria University, Newcastle)

Presenter: BALODHI, Nikita (Northumbria University, Newcastle)

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