Active Region Detection in the HMI magnetograms using the Mask R-CNN technique

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For predicting solar flares, it is necessary and important to detect active regions accurately. Conventionally, active regions is detected using rule-based methods with the defined thresholds. In this study, we aimed to establish a noval prediction method that goes beyond the rule-based flare prediction method by using the Mask R-CNN technique.
We used the full-disk line-of-sight magnetograms taken by SDO/HMI from May 2010 to July 2011 for the inpbackground image, the SHARP dataset for annotation, and the SWAN dataset for labeling. We reduced the data cadence to 1 hour and used 80% for training and 20% for testing. Training is performed using Mask R-CNN, which is one of the methods of Instance Segmentation. Mask R-CNN takes the background image and the annotation for the object position in the image as input, and learns the features of the region representing the object in the image. The network can detect the bounding box and mask that indicate the location of the object in the image. The network of the Mask R-CNN is divided into a Region Proposal network (RPN), which detects the location of the object, and a recognition network that detects which object the detected region represents. Based on the feature map obtained from the Resnet51 pre-trained model, network reduce the loss functions of Class, BoundingBox, and Mask.
As a result of training, we achieved Average Precision[IoU=0.50] =0.940 with the constructed model. Since the maximum accuracy of training and detection in natural images using Mask R-CNN is about Average Precision[IoU=0.50] =0.600, we have shown that the Mask R-CNN is the very effective method even for solar magnetic images. In the future, we would like to construct a model that can predict whether the detected region actually causes a flare or not.

Keywords: Space weather, Deep learning, Image recognition, Big data

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