**Using Deep Learning Methods to**

**Detect Elements in Choropleth Maps**

Automatically understanding a map image by machines is a challenge in the era of artificial intelligence. This paper aims at automatically detecting map elements in choropleth maps, which can be further utilized to understand a map image in general. Specifically, if we want to know the theme of a choropleth map (e.g. adult obesity rate map), we need to first find the title of the map and then conduct semantic analysis on the title. In this study, deep learning based object detection methods, including Faster Region-based Convolutional Neural Network (Faster R-CNN) and You Only Look Once (YOLO), will be applied to detecting map titles and legend areas of choropleth maps. Faster R-CNN and YOLO are among the most commonly used object detection methods today. Faster R-CNN is the first end-to-end deep learning detector with high detection accuracy, while YOLO is the first one-stage detector in deep learning era with no need to generate region proposals before detection, saving a good deal of computing costs. For both detectors, the input data is choropleth map images, and the output is locations and sizes of bounding boxes in the images and the corresponding object classes, i.e. map title or legend. More than 1000 choropleth map images with either map titles or legends will be collected using Google Images or from other sources. Each of the two methods will be evaluated by mean Average Precision (mAP) and frame rate (number of images processed per second) for detection accuracy and speed respectively. For the expected results, the mAP of Faster R-CNN should be higher than YOLO’s, while both of them can generate accurate bounding boxes for detected map elements. And the frame rate of YOLO will be significantly larger than that of Faster R-CNN. According to the expected results, conclusions will be made that both detection methods are able to detect elements in choropleth map images accurately and that comparing the two detectors, Faster R-CNN outperforms YOLO in detection accuracy, while YOLO is more efficient in detection speed.