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Active learning-based domain adaptation for annotation-efficient cerebellum segmentation

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Segmentation of the human cerebellar cortex from histological data has been considered a challenge due to its convoluted structure, and the numerous artifacts caused by sectioning or staining. The high resolution BigBrain model (Amunts et al., 2013) enables to overcome the lack of detail occasioned by the limited number of sections in existing datasets, and the large BigBrain data is ideal for developing AI solutions for segmentation. One would normally need a large number of annotated labels for deep learning-based models such as Convolutional Neural Networks (CNNs) to perform accurate segmentation. However, anatomical annotation needs expert-level knowledge, and a sheer volume requirement on the annotation would hinder the application for cerebellum segmentation.

In this work, we seek to leverage domain adaptation on existing annotated cerebellum data from the Allen Brain atlas (https://atlas.brain-map.org) to ease the demand for annotations of BigBrain. Here we demonstrate how we pre-train a segmentation model for the cerebellum on the existing Allen Brain labels and generate pseudo labels for our BigBrain data to train a new segmentation model. The Dice loss between the predicted segmentation results and pseudo annotations will serve to pick 50 data with the highest loss to conduct manual annotations, which will then be used to train the final segmentation model.

Our proposed framework aims to combine active learning with domain adaptation for an annotation-efficient cerebellum segmentation.

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