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Case ID:M19-194L^
Published: 2/26/2020

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Fine Tuning of Convolutional Neural Networks for Biomedical Image Analysis

Deep convolutional neural networks (CNN) are tremendously successful in a variety of applications ranging from computer vision to signal processing. There is increasing interest in applying CNN to biomedical image analysis, but success is impeded by the lack of large annotated datasets in biomedical imaging. Expert annotation is tedious, time consuming and expensive and the diseases are scarce in the datasets. There is a need to reduce the cost of annotation so that CNNs can be applied in biomedical imaging analyses.

Researchers at Arizona State University have developed methods to reduce annotation costs by integrating active learning and transfer learning into a single framework to use CNN for medical image analyses. These methods work with a pre-trained CNN to find worthy samples for annotation and gradually enhances the CNN via continuous fine-tuning. These methods have been evaluated in several different biomedical imaging applications, pulmonary embolism detection, polyp detection, colonoscopy frame classification and carotid intima-media thickness measurements, and have shown that the cost of annotation can be cut by at least half compared with random selection.

These methods enable the usage of fine-tuned CNNs for medical imaging applications that cut the cost of annotation, perform faster and utilize less resources to have an important impact on computer-aided diagnoses.

Potential Applications

- Medical image analyses
  - Pulmonary embolism detection
  - Colonoscopy polyp detection
  - Carotid intima-media thickness measurements
  - Colonoscopy frame classification

Benefits and Advantages

- Better “noisy” label handling

- Reduced computation time for selecting training images
- Integrates active learning into fine-tuning CNNs in a continuous fashion – amicable to biomedical image analysis
- Cuts annotation costs dramatically
- Groups of pixels or patches can be labeled independently of the entire image
- Faster analysis times
- Does not require initial seed labeled samples
- Incrementally improves the learner rather than repeatedly re-training
- Utilizes less computational and memory resources
- Does not require extensive expert annotations

Zhou et al - CVPR 2017

Zhou et al - CVPR Poster 2017

Tajbakhsh et al - IEEE Trans Med Imaging 2016

For more information about the inventor(s) and their research, please see

Dr. Liang's departmental webpage