Applying Machine Learning Methods to Classify High-Resolution Medical Microscopy

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Introduction

- Many computer vision tasks require processing very high resolution images.
- Current state-of-the-art models are unable to operate on such data directly due to computational and memory requirements.
- It has become common practice to reduce the size of the image before passing it into the network, which leads to the loss of information contained in the data.
- One approach splits the data into patches and processes them separately, but this wastes resources on potentially unimportant patches and requires per patch labeling.

Method

- Attention-based Deep Multiple Instance Learning.
  - Multiple Instance Learning (MIL) takes advantage of weakly labeled data by assigning one label per a bag of patches.
  - To avoid wasting resources on uninformative patches. An attention mechanism is implemented to learn which patches are most useful to the classification problem.
- MNIST Bags
  - Using the MNIST Database of handwritten digits. We create bags of a random amount of samples, where the bag is given a positive label if it contains an arbitrary digit.
  - These bags are then tested on the deep MIL model.
- Hematoxylin and Eosin (HE) Colon Cancer Dataset
  - More practically, a high resolution whole-slide image of a variety of tissues is split into patches and the whole slide represents a bag in this application.
  - The bag is then labeled positive if any of the patches contain epithelial cells.
- We test the Attention based MIL on the two datasets and evaluate their performance.

Data

For our experiments, we utilize both the MNIST dataset as a base example and the HE colon cancer whole-slide images. The colon cancer data consists of 100 HE images that are then split into 27x27 patches. These patches form a bag with a positive label if any of the patches contain epithelial cells.

Results

During the MCREU program, we were able to replicate the MNIST bags dataset and get results that match the work in Ilse et al., 2018. As for the colon cancer dataset, we are still in the process of implementing the final model.

Conclusions

- Attention based deep neural networks can prioritize important image patches, reducing resource waste.
- Improved performance over traditional models.
- Decreased overall computation complexity.

Future Work

- In the fall, we plan to finish the model for the HE images and evaluate its performance.
- Explore the application of attention-based models on other forms of high resolution data.

References

1. Katharopoulos and Fleuret. Processing Megapixel Images. https://arxiv.org/pdf/1905.03711.pdf.
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