# Transfer Learning in Stacked LSTM's for Text Generation

Alex Fischer
University of Massachusetts, Amherst

## Stacked LSTM's

Nerve regeneration is an active area of research in the medical community. In order to test the effects of various treatments on regeneration, researchers at the Miami Project to Cure Paralysis use mice optic nerves as a model for neuron growth in general. After crushing mice optic nerves, subjecting them to various treatments, and letting them grow, they obtain 3D images of the optic nerves, specifically of the axons within the nerves. They then seek to analyze the axons, as axons in normal nerves grow in straight paths, but injured nerves feature, wavy, deformed axons.

To analyze the axons, researchers must manually trace the axons, a highly tedious and time-consuming task. Factors such as noise in the images and intersecting axons make this task exceptionally difficult for both humans and computers. The purpose of this project is to develop software that automates or substantially reduces the amount of human involvement in the process of tracing the paths of the axons. Subsequently, we would use those tracings to analyze the paths the axons take, identifying features such as branches and quantifying the deformity of the axons. To do this, we would develop a pipeline that starts with a 3D image and ends with analysis of paths of axons in the iamge, with several intermediate steps.

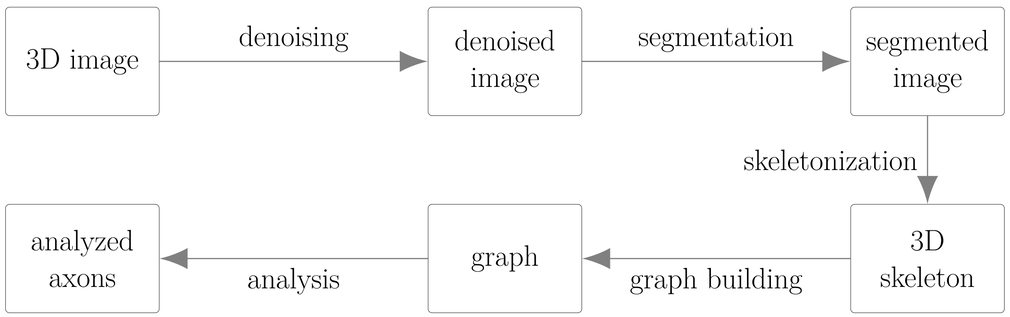


Figure 1: The proposed pipeline from a 3D iamge to analyzed axon paths.

## Denoising

- Images are noisy due to imperfect optics and uneven diffusion of marker in axons.
- Simple denoising algorithms blur images, removing small, thin

## Segmentation

- We tried several existing segmentation algorithms.
  - Thresholding based on intensity value picks up too much background noise while not having axons be sufficiently connected.
  - Graphcut [1] improved upon thresholding by picking up less noise and having axons be more connected, but was not satisfactory and was much slower than thresholding.
- Standard segmentation algorithms fail because they fail to take into account information about the structures they segment. Axons are thin and elongated, and humans use this information when manually segmenting.
- We devised our own segmentation algorithm that takes advantage of this information.

### Enhancing Thin Structures

- Examine the volume in a series of small windows: large enough to capture axons and background, but small enough so that axons are locally fairly linear.
- Fit a multivariate normal distribution to the window and compute its mean and variances.
- Compute the ratio of the variances along the first and second principal axes of the distribution. A high ratio means the window contains a thin, elongated structure in the direction of the first principal axis.
- Increase the intensity of voxels near the mean of the distribution based on the ratio of variances. If there is a higher ratio, the window is more likely to contain an axon and thus should be enhanced more.

- Thresholding the enhanced image resulted in less background noise being detected along with more plentiful axons that were better connected.

## Skeletonization

- A skeleton of a 3D object is a topological representation of its features consisting of one voxel wide segments

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## Future

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[1] Boykov