SEGMENTATION OF TUBULAR NETWORKS IN PANCREAS*

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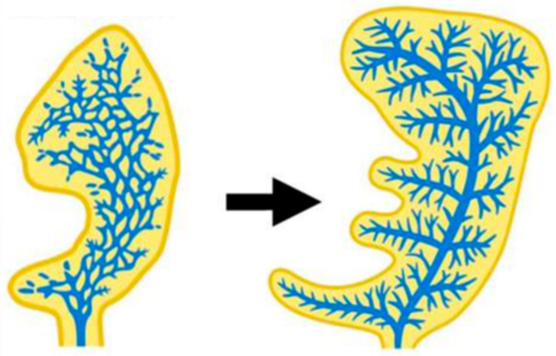
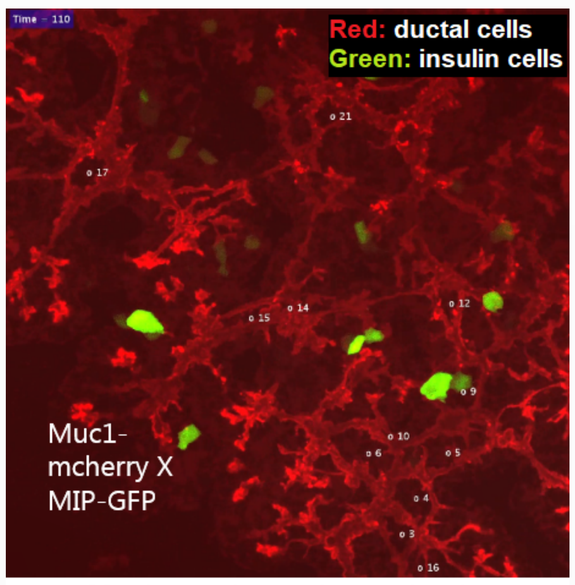
Abstract

- The transportation system in a mature pancreas has a branched tree-like structure, which is derived from a network of loops that must rearrange and close during embryonic stage.



Pancreas development during embryonic day 14.0 to 17.5

- Recent biological research suggests that there might be a connection between appearance and closure of network loops and creation of insulin-producing cells.



Maximum intensity projection

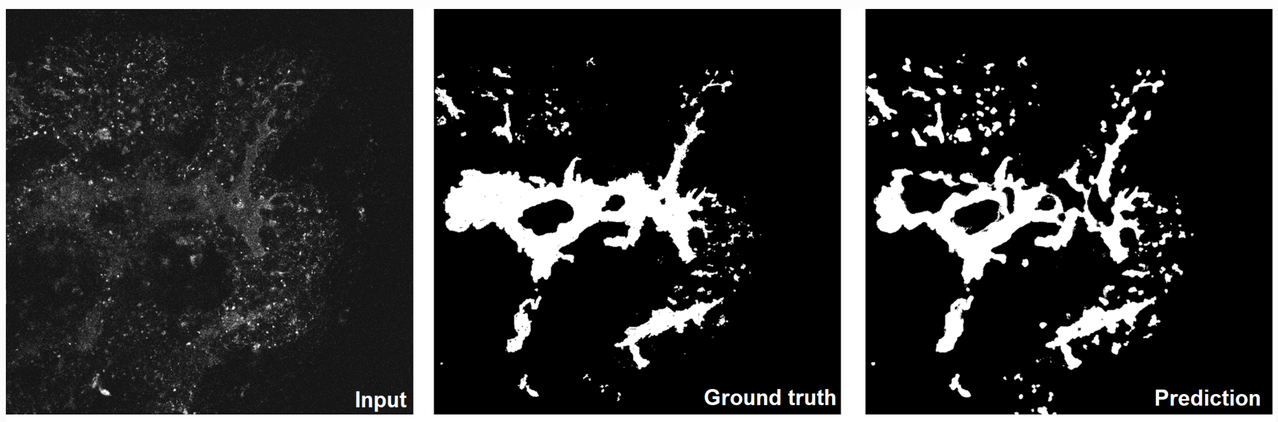
- Thus to make the analysis of the structure easier, we first need to do image segmentation.

Challenges

- The structure is hard to detect even by human expert due to high noise and low contrast in live imaging.
- Moreover, annotating a 3D structure on a computer screen, which can only show 2D slides, is quite difficult. So our model has to cope with limited amount of labels.

Experiment

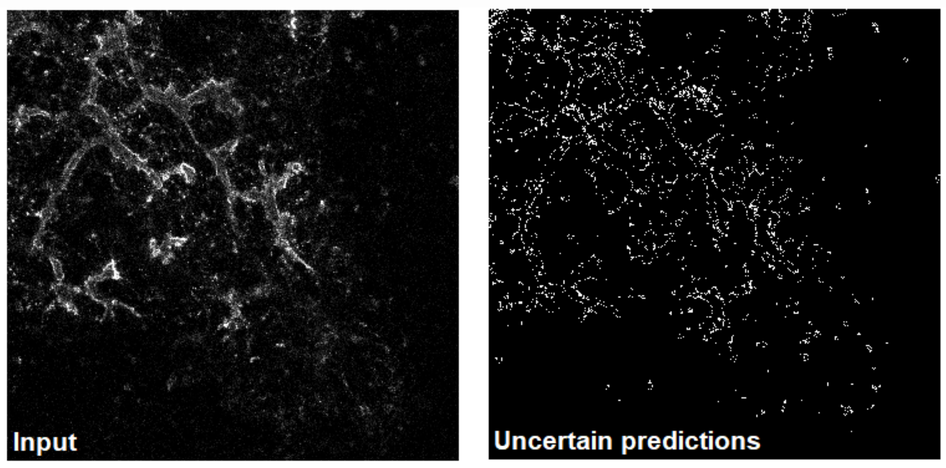
- 3D U-Net has been accepted as standard model for volumetric image segmentation.
- It has downsampling and upsampling paths, composing of 3D Convolution layers, Max Pooling, Transposed Convolution, and skip connections.



Trained on 60 3D images with an architecture going 18 layers deep including 3 Transposed Convolution layers.

Active learning

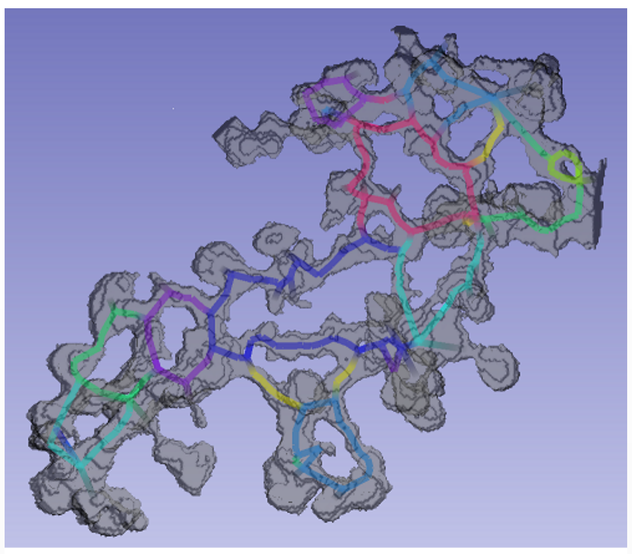
- As the manual labeling is costly, a useful annotation requires close collaboration between the machine learner and biologist.
- Active learning is the setting in which the machine determines which data points should be labeled so as to use the human annotations efficiently.



The uncertain predictions from a Random Forest classifier show that the model is most uncertain about the edges and the loops.

After segmentation

- Once we are satisfied with the segmentation, we are going to reduce the representation to centerlines and use graph theory approaches to detect the loops.
- As our main biological priority is detection and tracking of loops, we are keen to customize our algorithm to emphasize correct segmentation in areas where loops exist.



Loop detection on the 3D model

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