Automated 3D Labelling of Fibroblasts in SEM-Imaged Placenta Using Deep Learning

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1 - Introduction

Analysis of **fibroblasts within placenta** is necessary for research into placental growth-factors, which are linked to **lifelong health and chronic disease risk** [1].

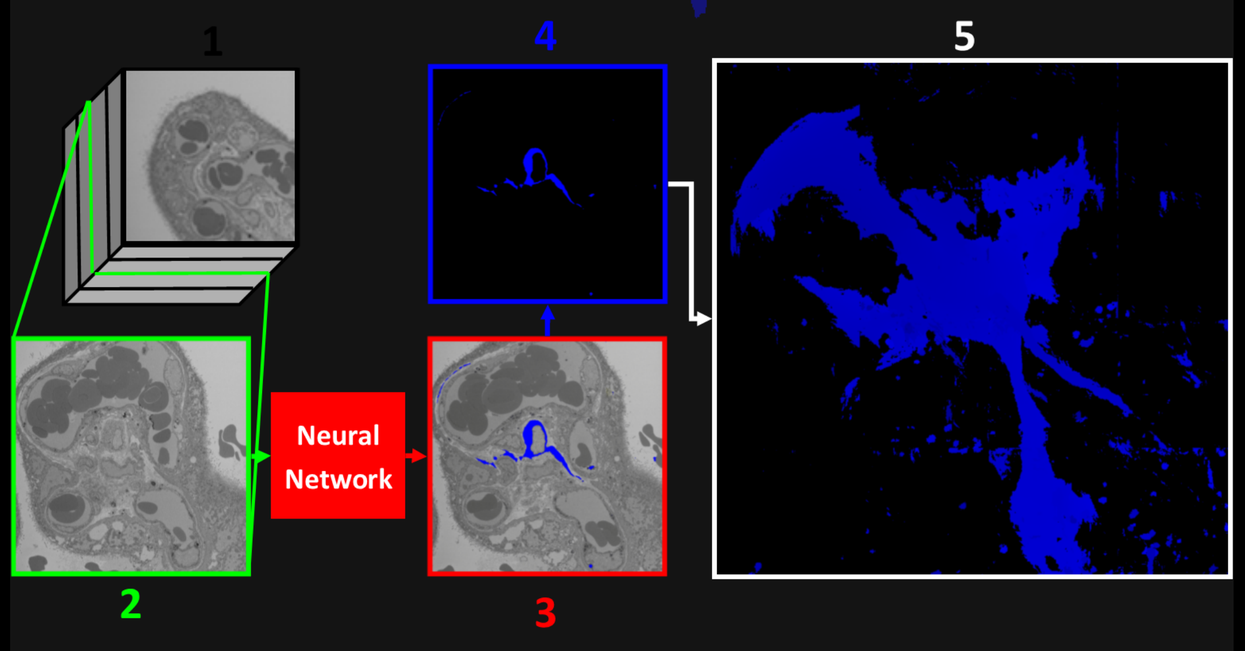
2D analysis of fibroblasts can be challenging due to the variation and complexity of their structure. 3D imaging can provide important visualisation, but the images produced are **extremely labour-intensive** to construct because of the **extensive manual processing required**.

Deep learning can be used to **automate the labelling process for faster 3D analysis**. Here, a deep neural network was trained to label a fibroblast from serial block face scanning electron microscopy (SBFSEM) placental imaging.

2 - Method

3D projections of fibroblasts within the placenta with nanoscale resolution were obtained through automated labelling of serial block face scanning electron microscopy (SBFSEM) images [2] via a neural network. This 3D image was a product of **943 2D images**.

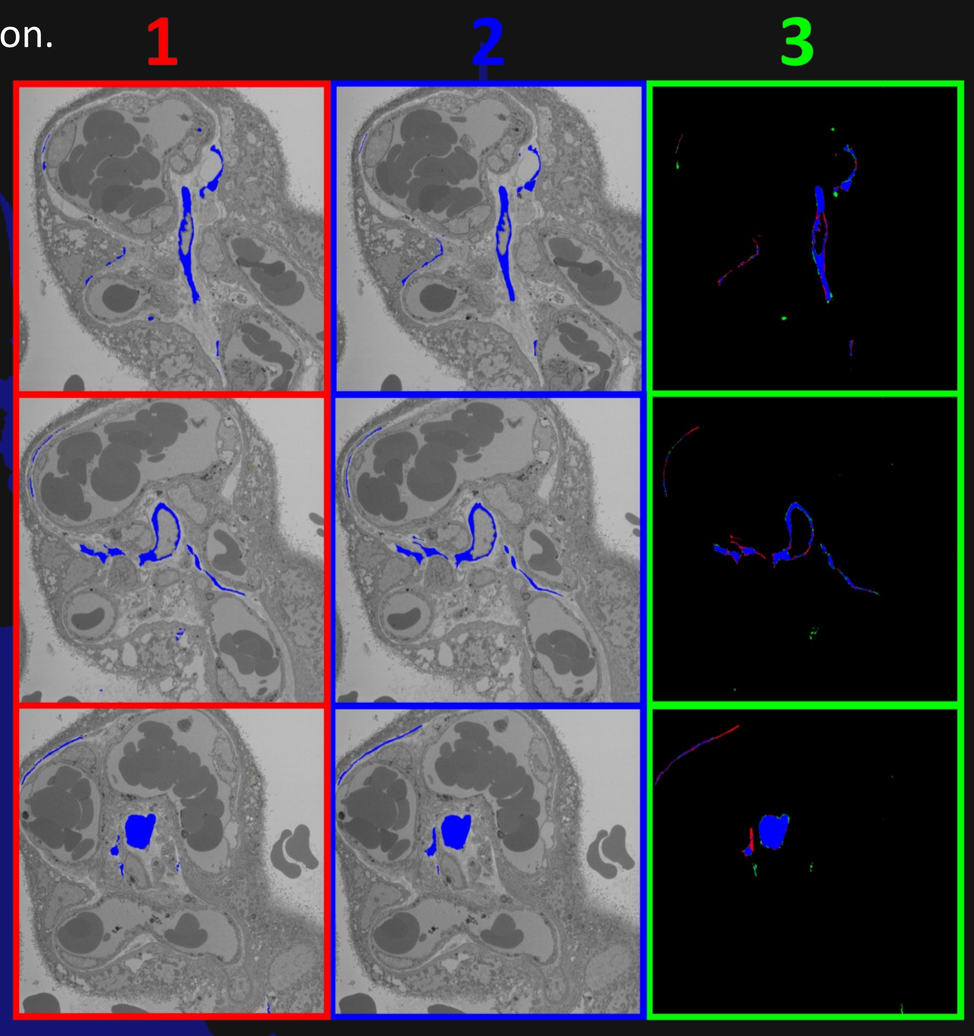
The neural network architecture for transforming a 2D SEM image into a labelled image was an altered variant designed specifically for image-to-image translation [3]. This network was trained on **half of the stack** images.



From a 3D stack (1), an unlabelled 2D SEM image of the placenta (2) was input into the network. These 2D images were **labelled by the network** (3). Here, an image from near the middle of the stack, 452, has been labelled blue where a fibroblast was present. The label has then been extracted from the rest of the image (4). These labels were collectively **3D projected** to form an image of a whole fibroblast (5), where the z-axis is perpendicular to the page.

3 - Results

The neural network achieved **greater than 98% pixel accuracy**, where the automated and manual pixel value are the identical, across all testing images. In the **third column (3)**, the difference between **automated (1)** and **manually (2)** labelled images was plotted for easier visual comparison.



4 - Conclusion & Future Work

This study labelling fibroblasts demonstrates how **deep neural networks can be used for labelling of complex structures** from SBFSEM stacks, allowing for accurate 3D projections with a significant **reduction of up to several months of dedicated time** required for image processing, therefore overcoming a current drawback to efficient 3D imaging of micro and nanoscale cell structures.

Future work is focussed on **labelling a larger range of cell types** and determining the minimum number of labelled images per stack needed for accurate automated labelling.

Literature Cited & Acknowledgement

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