Segmentation of Multiple Tissue Types in Regenerating Wounds

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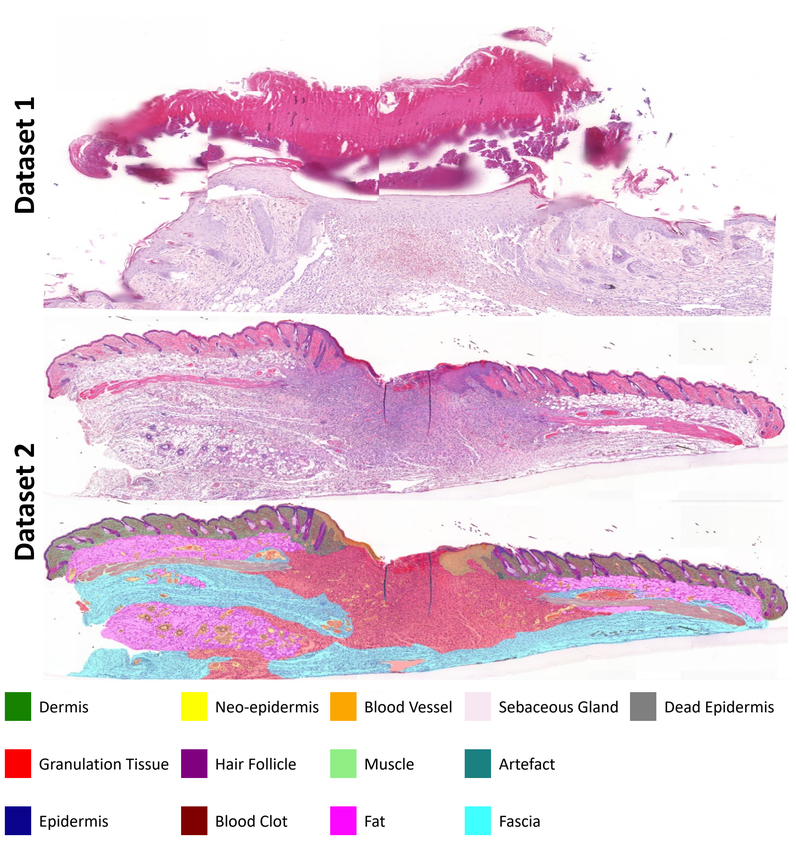
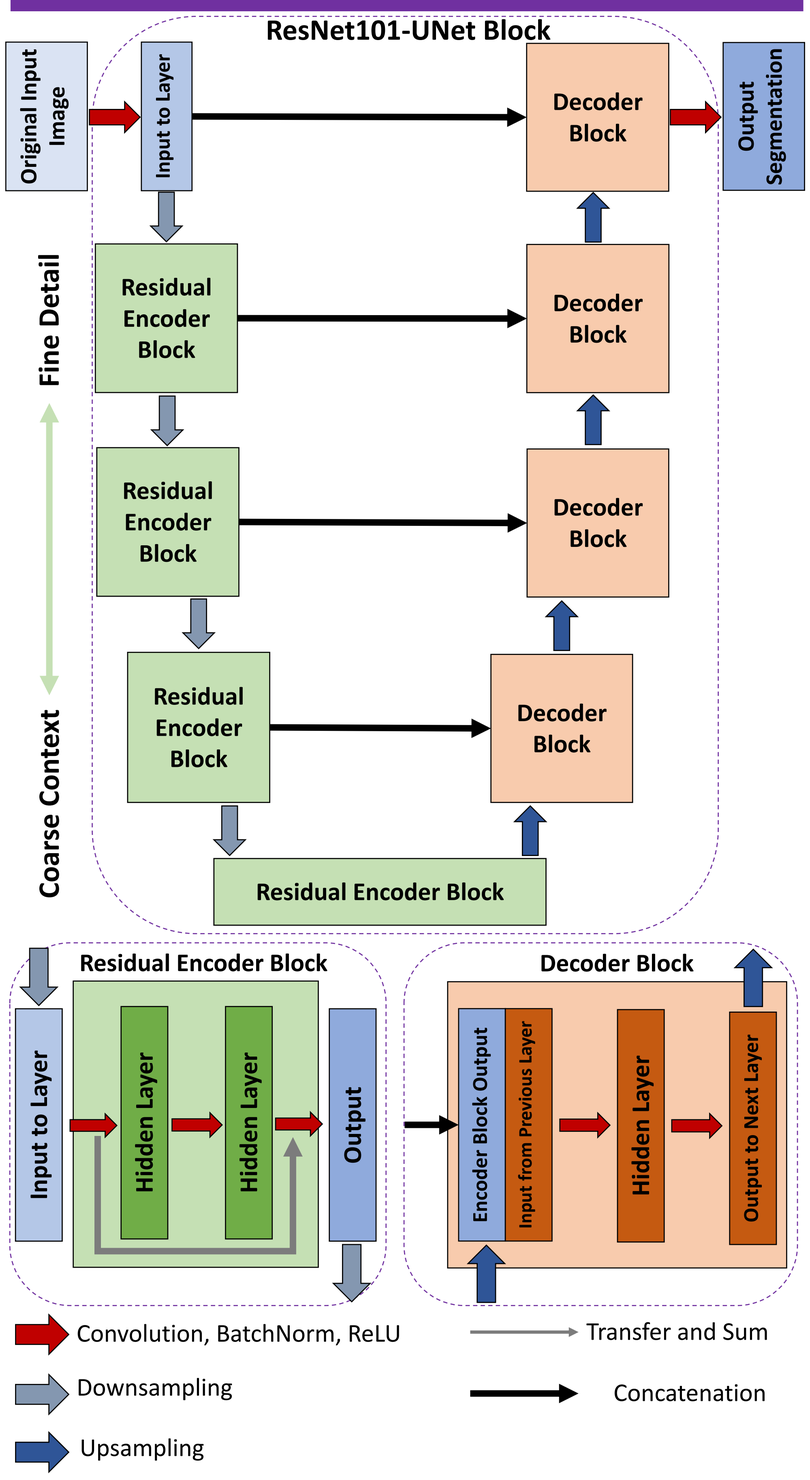
1. Introduction & Motivation

- Manual annotation and analysis of histology whole slide images (WSI) is extremely labour intensive
- We believe that the application of deep learning (DL) methods can greatly improve analysis
- Existing DL methods have not been extensively applied to wound histology
- **This work has the potential to produce a first-in-class tool to significantly augment wound regeneration research**

2. Method – Datasets



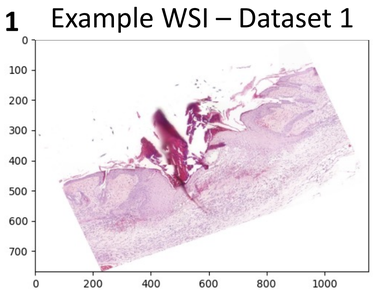
3. Method - Simplified Framework Overview



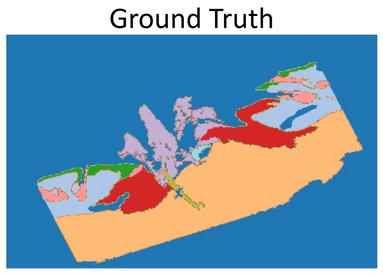
- **Initial framework consisted of a single ResNet101-UNet[1] block**
- Parameters: N=6 WSI (Box 2) training set, supervised approach, data augmentation and transfer learning (ImageNet pre-training)

4. Results - Initial Framework Segmentation of Datasets 1 & 2

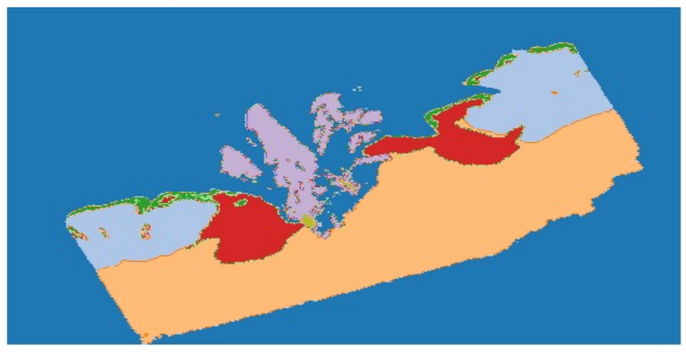
1 Example WSI – Dataset 1



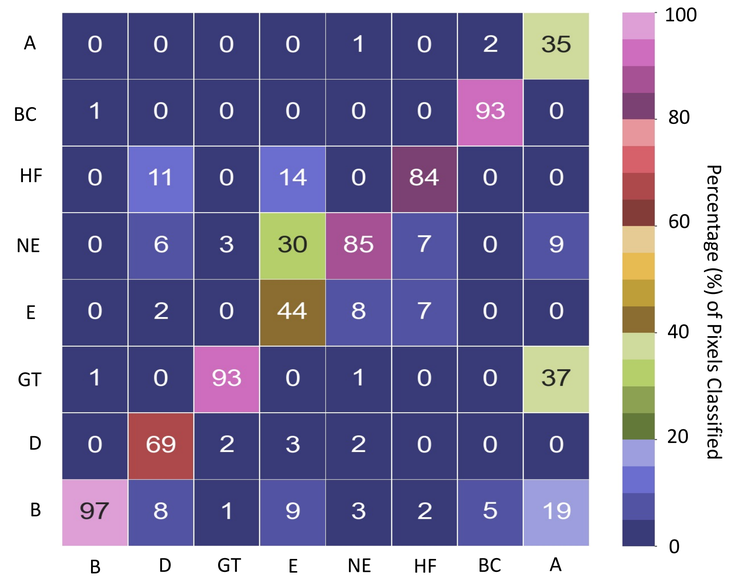
Ground Truth



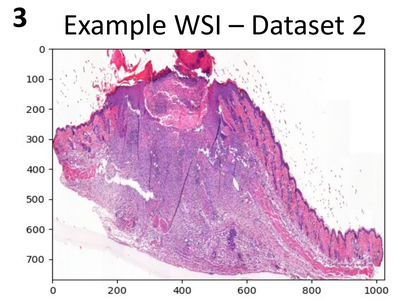
Segmentation Mask | mIoU 0.449



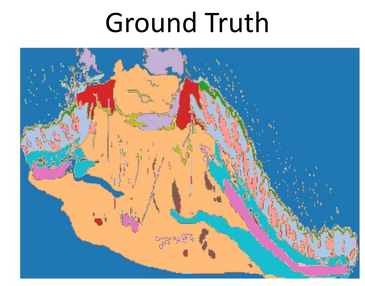
2



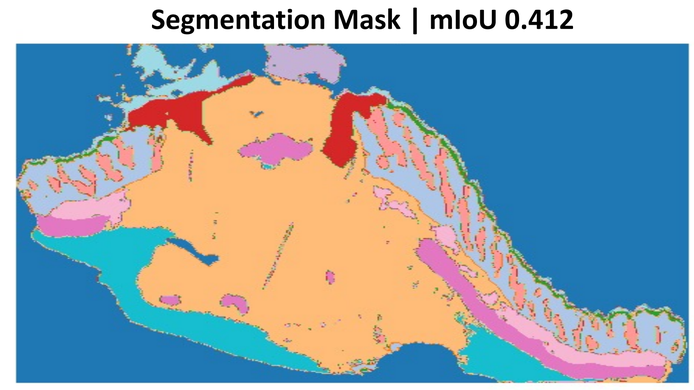
3 Example WSI – Dataset 2



Ground Truth



Segmentation Mask | mIoU 0.412



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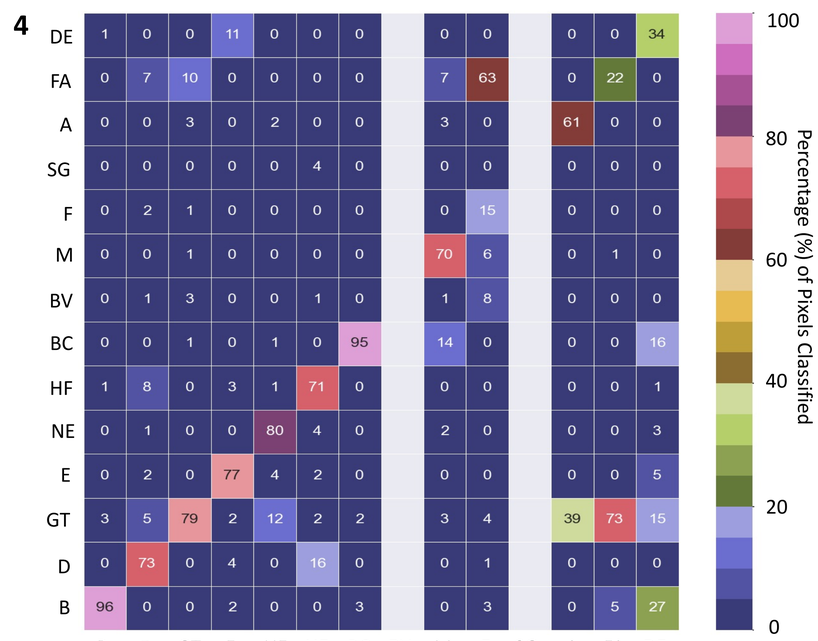


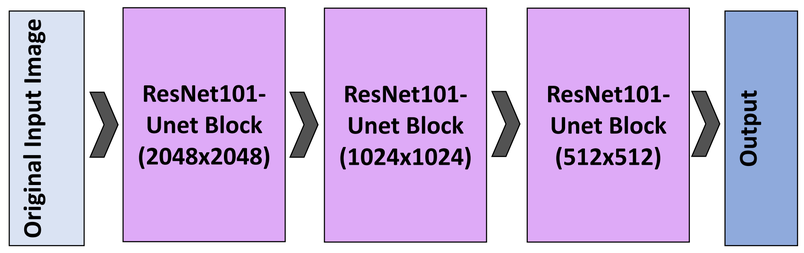
D Dermis; NE Neo-epidermis; BV Blood Vessel; SG Sebaceous Gland; DE Dead Epidermis; GT Granulation Tissue; HF Hair Follicle; M Muscle; A Artefact; E Epidermis; BC Blood Clot; F Fat; FA Fascia

5. Discussion - Comparison of Datasets 1 & 2 Segmentation Results

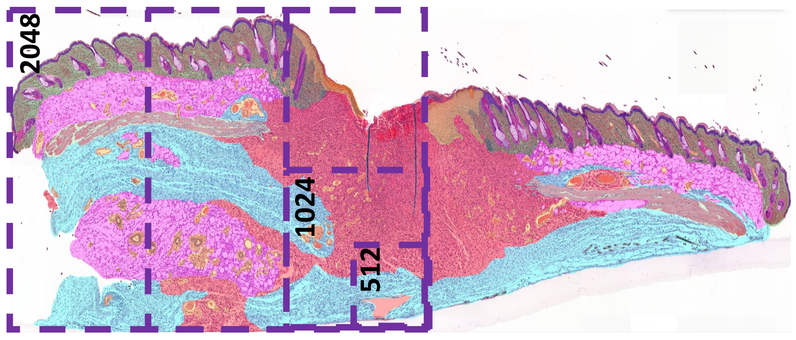
- Accurate segmentation for dataset 1 (**mIoU 0.449**) - 8 classes (6 key tissue types, artefacts and background)
  - Dominant tissue types accurately segmented (>60%) – dermis, granulation tissue and blood clot
  - Some less dominant tissue types also accurately segmented (>80%) – neo-epidermis and hair follicle
- Accurate segmentation for dataset 2 (**mIoU 0.412**) - 14 classes (12 key tissue types, artefacts and background)
  - Dominant tissue types accurately segmented (>70%) – dermis, granulation tissue and blood clot
  - Some less dominant tissue types accurately segmented (>70%) – neo-epidermis, hair follicle and muscle
- **Performance maintained between datasets for same initial framework, despite dataset 2 possessing increased complexity with 6 further classes**

6. Future Development - Hierarchy of Tiles Framework (HTF)

- Further development to optimise the framework to segment 14 classes in dataset 2
- **Proposed framework consists of three ResNet101-UNet[1] blocks (Box 4) in sequence**



- Parameters: N=8 WSI (Box 2) training set, WSI tiled inputs, decreasing tile size with 50% overlapping stride, supervised approach, data augmentation and transfer learning (ImageNet pre-trained)



- **We hypothesise that this approach will improve fine detailed information capture (i.e. less dominant tissue type classes) whilst maintaining global context of the wound**

7. Conclusion

- We demonstrate that our initial framework produces accurate segmentations for dominant and some less dominant tissue types (Box 4 & 5)
- Further optimisation is required to enhance our framework's performance for less dominant tissue types
- **Refined hypothesis: HTF will improve segmentation performance for less dominant tissue types (Box 6)**
- **To the best of our knowledge, we apply DL methods to segment and analyse tissue histology WSI holistically form the first time**
- Our results present strong groundwork for future development and application of DL-based tools in wound healing research

Acknowledgement, Disclosure and References

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