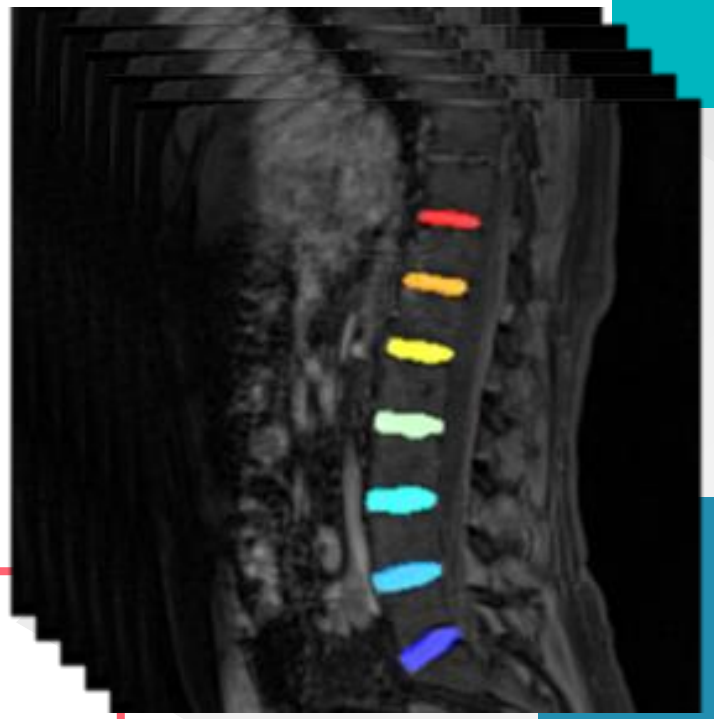
IVDM3Seg

Computational Methods and Clinical Applications for Spine Imaging
Intervertebral Disc Segmentation Challenge 2018

Team gyhcuhk
Yunhe Gao
yhgao@link.cuhk.edu.hk



CSI 2018

01

Method

This part briefly descripts the work pipeline of our method

Task

4 Modality Dixon Series

Multi-Modality

The challenge provides four-modality Dixon series, which can be fully utilized to provide more information.

IVD Segmentation

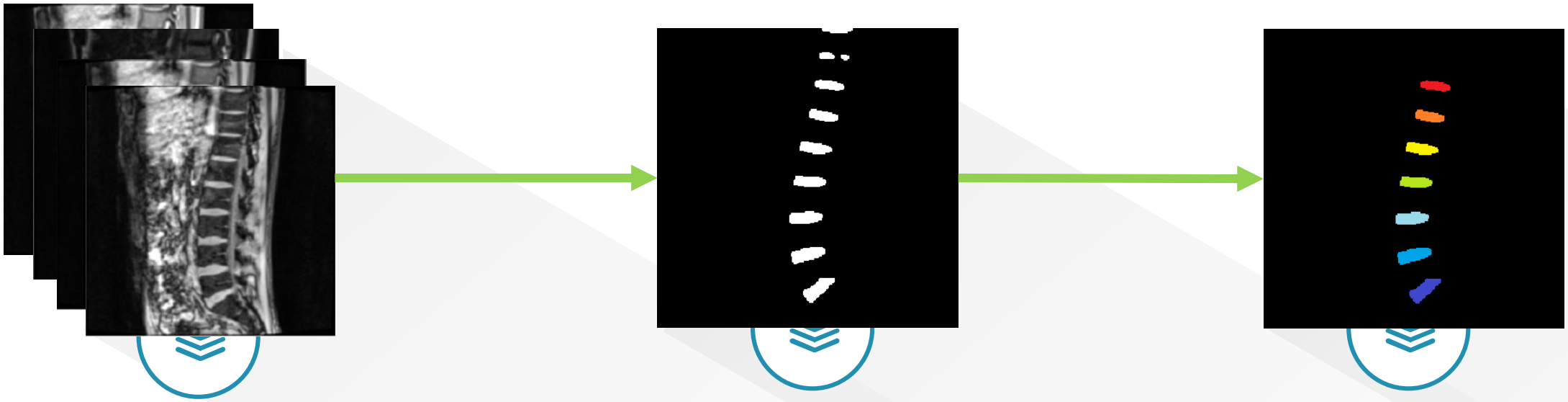
Output the binary mask of the 7 IVDs.

IVD Localization

Output the location of each disc, which can be obtained by calculating the morphological center of the mask of each disc.

Pipeline

The brief pipeline of our approach



Four Modality Input

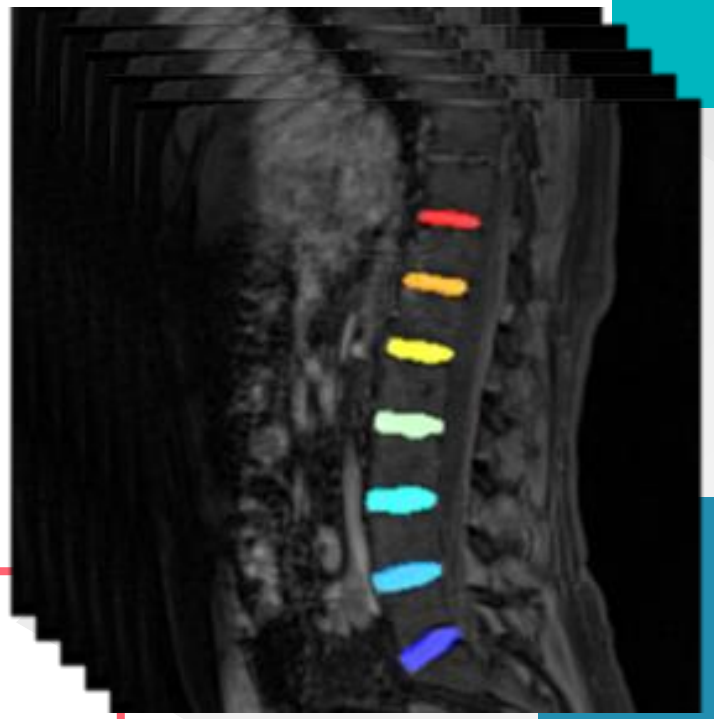
Concatenate four modality images together as the input of network.

Segmentation Network

Output the binary mask of IVDs. However, it will predict more than 7 discs due to the similarity between lumber and thoracic discs.

Localization Network

Distinguish the 7 IVDs from other thoracic discs, and output labels as 1-7 from bottom to up.



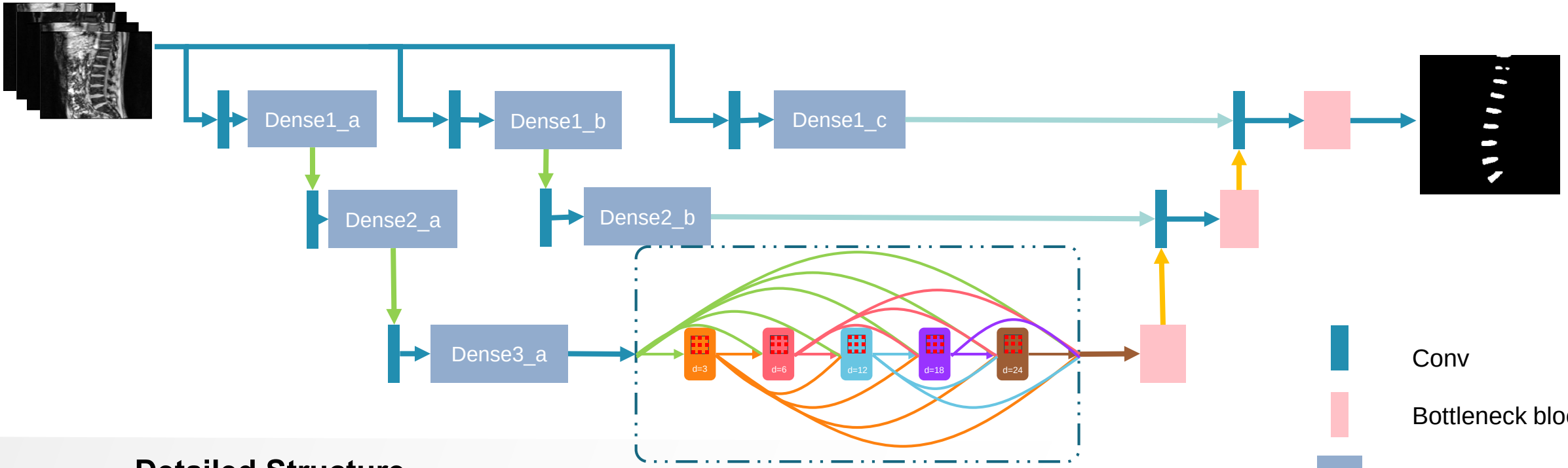
02

Detailed Structure

The detailed structure of Segmentation and Localization Network

Segmentation Network

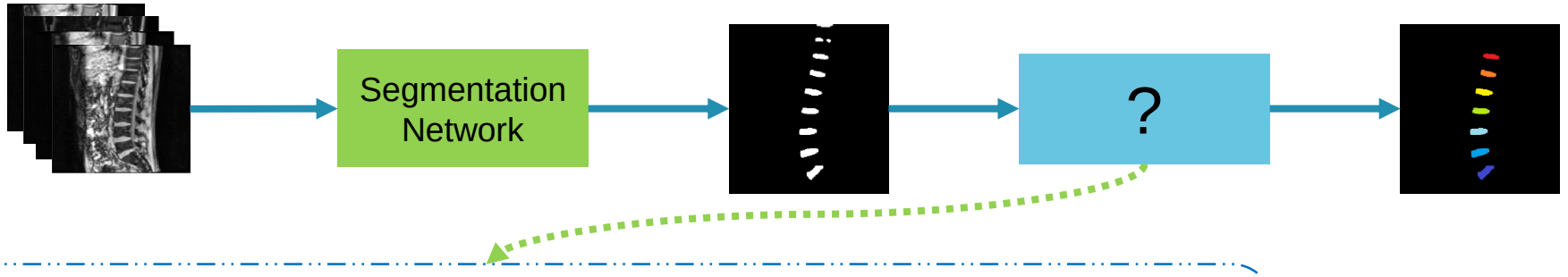
The detailed structure of segmentation network

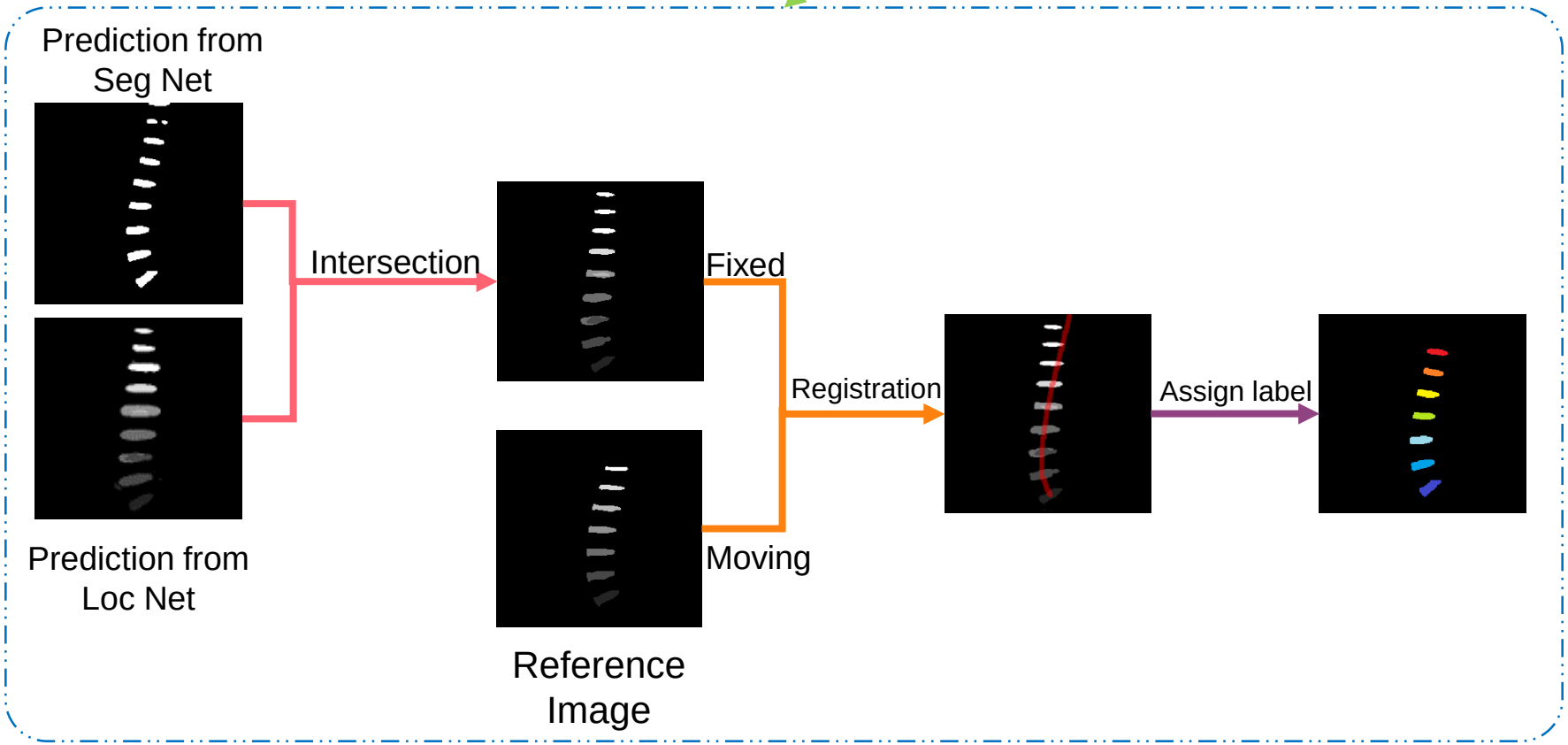


Detailed Structure

- A **2D** fully convolutional neural network with **Encoder-Decoder structure** which is similar to U-Net, and uses DenseNet as the backbone network.
- As the performance of U-Net baseline is quite high, we address the difficulty of this task as the precise segmentation of the boundary region of the IVDs.
- Our network only **down-samples for 2 times**, and then use Atrous Spatial Pyramid Pooling (ASPP) to ensure a large enough receptive field.

Localization Network



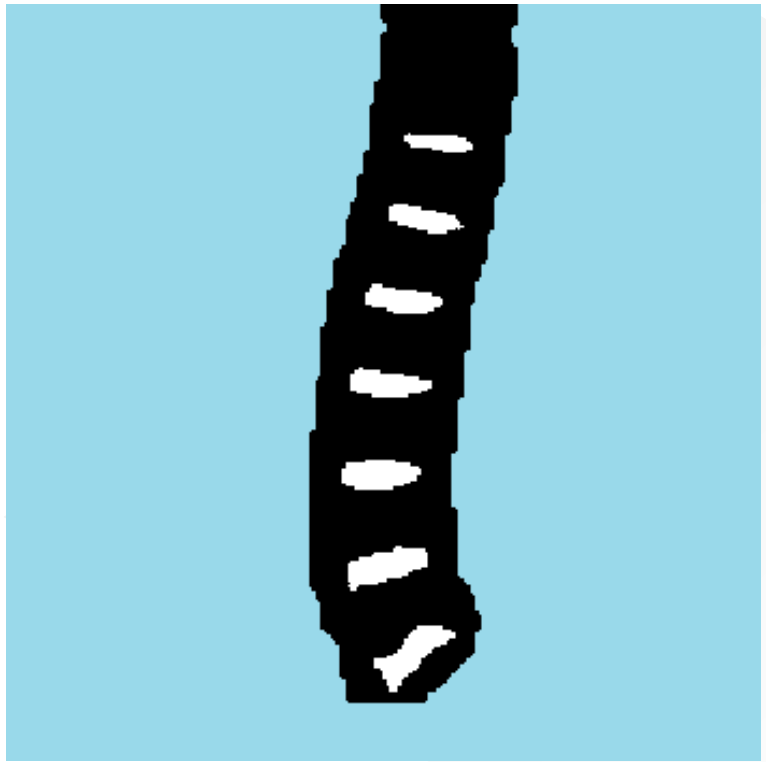


Detailed Structure

- A **V-Net,** trained to do **multi-class** 3D segmentation.
- Distinguish different discs is quite difficult, the result of localization network is not stable enough.
- Further use **registration** to improve robustness.

Training Strategy

Additional strategy that can further boost the performance



The ground true label used for training

Assumption:

- The spine part of the entire input image is useful for the segmentation of IVDs.
- Region outside the spine is useless background that may confuse the network from accurate segmentation.

Training Strategy:

- Generate the spine mask by calculating convex hull of the disc labels after some dilations.
- Use the spine mask combined with the disc labels as ground true to train the segmentation network, i.e. ignore the loss in blue region while training.
- Use **Cross-Entropy loss** first and then **Focal loss**

Reference

Ronneberger, Olaf, Philipp Fischer, and Thomas Brox. "U-net: Convolutional networks for biomedical image segmentation." *International Conference on MICCAI*. Springer, Cham, 2015.

Yang, Maoke, et al. "DenseASPP for Semantic Segmentation in Street Scenes." *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2018.

Milletari, Fausto, Nassir Navab, and Seyed-Ahmad Ahmadi. "V-net: Fully convolutional neural networks for volumetric medical image segmentation." *3D Vision (3DV), 2016 Fourth International Conference on*. IEEE, 2016.

THANKS

We really appreciate the support that organizer offers during the challenge.

If interested about this work , please contact:
Yunhe Gao: yhgao@link.cuhk.edu.hk