Scope: Structural Continuity Preservation Network

1. General Info

Project Title: Scope: Structural Continuity Preservation Network

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2. Project Abstract

The goal of this project is to investigate how the continuity of shapes and structures can be preserved in a deep neural network. To that end, we need to look into evaluation of continuity and the enforcerers of continuity. The project is preferred to be implemented using the MONAI framework [7].

3. Background and Motivation

The continuity of shapes in medical imaging is an important aspect that often is not investigated in pure computer vision techniques. In a biological structure, organs are not separated, but the network does not have any obligations to make sure that this continuity is preserved, and if an occlusion or noise causes the organ to be separated, there is no guarantee that the wholeness of the organ would be preserved. For instance, in vascular images, the veins are in the shape of a tree, that in a 2D image, they have visual overlaps, and it might confuse the network. In this project, we want to implement some techniques using graph and tree structure to overcome this issue.

4. References

[1] Tetteh, G., Efremov, V., Forkert, N. D., Schneider, M., Kirschke, J., Weber, B., ... & Menze, B. H. (2020). Deepvesselnet: Vessel segmentation, centerline prediction, and bifurcation detection in 3-d angiographic volumes. Frontiers in Neuroscience, 1285.

[2] Livne, M., Rieger, J., Aydin, O. U., Taha, A. A., Akay, E. M., Kossen, T., ... & Madai, V. I. (2019). A U-Net deep learning framework for high performance vessel segmentation in patients with cerebrovascular disease. Frontiers in neuroscience, 13, 97.

[3] Iyer, K., Najarian, C. P., Fattah, A. A., Arthurs, C. J., Soroushmehr, S. M., Subban, V., ... & Figueroa, C. A. (2021). Angionet: a convolutional neural network for vessel segmentation in X-ray angiography. Scientific Reports, 11(1), 1-13.

[4] Shin, S. Y., Lee, S., Yun, I. D., & Lee, K. M. (2019). Deep vessel segmentation by learning graphical connectivity. Medical image analysis, 58, 101556.

[5] Garcia-Uceda Juarez, A., Selvan, R., Saghir, Z., & Bruijne, M. D. (2019, October). A joint 3D UNet-graph neural network-based method for airway segmentation from chest CTs. In International workshop on machine learning in medical imaging (pp. 583-591). Springer, Cham.

[6] https://simvascular.github.io/

[7] https://monai.io/

5. Technical Prerequisites

- Good background in machine learning, deep learning
- Good skills in Python
- Good skills in PyTorch

- Familiar with MONAI (optional)

6. Benefits:

- Weekly supervision and discussions
- Possible novelty of the research
- The results of this work are intended to be published in a conference or journal

7. Work-packages and Time-plan:

* The dates are adopted from the previous year and are not finalized yet.

	Description	#Students	From	To
WP1	Familiarizing with the literature.	4	06.11	13.11
WP2	Familiarizing with the required frameworks. Come up with a detailed time-plan (gantt)	4	13.11	20.11
WP3	Evaluating the continuity in previous SOTA	4	20.11	27.11
WP4	Implementing the graph based method	4	27.11	13.12
WP4	Comparison to related work + Preparing midterm presentation	4	13.12	20.12
M1	Intermediate Presentation II	4	20.12	
WP6	Improving the graph based method	4	20.12	15.01
WP7	Evaluation and Comparison to SOTA + Testing in [5] (optional)	4	15.01	01.02
WP8	Final Presentation and Documentation	4	01.02	26.02
M2	Final Presentation	4	07.02	