Abstract: Estimation of the Principal Ischaemic Stroke Growth Directions for Predicting Tissue Outcomes

Christian Lucas[1], Linda F. Aulmann[2], André Kemmling[3], Amir Madany Mamlouk[4], Mattias P. Heinrich[1]

[1]Institute of Medical Informatics, University of Lübeck, Lübeck
[2]Department of Neuroradiology, University Hospital UKSH, Lübeck
[3]Department of Neuroradiology, Westpfalz Hospital, Kaiserslautern
[4]Institute for Neuro- and Bioinformatics, University of Lübeck, Lübeck
lucas@imi.uni-luebeck.de

The estimates of traditional segmentation CNNs for the prediction of the follow-up tissue outcome in strokes are not yet accurate enough or capable of properly modeling the growth mechanisms of ischaemic stroke [1]. In our previous shape space interpolation approach [2], the prediction of the follow-up lesion shape has been bounded using core and penumbra segmentation estimates as priors. One of the challenges is to define well-suited growth constraints, as the transition from one to another shape may still result in a very unrealistic spatial evolution of the stroke. In this work, we address this shortcoming by explicitly incorporating vector fields for the spatial growth of the infarcted area. Since the anatomy of the cerebrovascular system defines the blood flow along brain arteries, we hypothesise that we can reasonably regularise the direction and strength of growth using a lesion deformation model. We show that a Principal Component Analysis (PCA) model computed from the diffeomorphic displacements between a core lesion approximation and the entire tissue-at-risk can be used to estimate follow-up lesions (0.74 F1 score) for a well-defined growth problem with accurate input data better than with the shape model (0.62 F1 score) by predicting the PCA coefficients through a CNN [3].

References

1. Winzeck S, Hakim A, McKinley R, et al. ISLES 2016 and 2017-benchmarking ischemic stroke lesion outcome prediction based on multispectral MRI. Front Neurol. 2018;9:679.
2. Lucas C, Kemmling A, Bouteldja N, et al. Learning to predict ischemic stroke growth on acute CT perfusion data by interpolating low-dimensional shape representations. Front Neurol. 2018;9:989.
3. Lucas C, Aulmann LF, Kemmling A, et al. Estimation of the principal ischaemic stroke growth directions for predicting tissue outcomes. MICCAI BrainLes. 2019;.

T. Tolxdorff et al. (Hrsg.), *Bildverarbeitung für die Medizin 2020*,
Informatik aktuell, https://doi.org/10.1007/978-3-658-29267-6_29