



# Abstract: mlVIRNET

## Improved Deep Learning Registration Using a Coarse to Fine Approach to Capture all Levels of Motion

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While deep learning has become a methodology of choice in many areas, relatively few deep-learning-based image registration algorithms have been proposed. One reason for this is lack of ground-truth and the large variability of plausible deformations that can align corresponding anatomies. Therefore, the problem is much less constrained than for example image classification or segmentation. Nevertheless, several methods have been presented in the last years which aim to mimic iterative image registration methods by training a convolutional network which predicts the non-linear deformation function given two new unseen images. However, these algorithms are still limited to relatively small deformations.

To overcome this shortcoming, in our work [1] we present mlVIRNET - a multilevel variational image registration network. We proposed to compute deformation fields on different scales, similar to iterative methods. Starting on a coarse grid with smoothed and down-sampled versions of the input images a deformation field is computed which is subsequently prolonged on the next finer level as a initial guess. Hereby, a coarse level alignment is obtained first that typically captures the large motion components and which is later improved on finer levels for the alignment of more local details.

We validated our framework on the challenging task of large motion inspiration to expiration lung registration using large image data of the multi-center COPDGene study. We have shown that our proposed method archives better results than the comparable single level variant. In particular with regard to the alignment of inner lung structures and the presence of foldings. Moreover, we demonstrated the transferability of our approach to new datasets by evaluating our learned method on the publicly available DIRLAB dataset and showing a lower landmark error than other deep learning based registration methods.

## References

1. Hering A, van Ginneken B, Heldmann S. MIVIRNET: multilevel variational image registration network. In: International Conference on Medical Image Computing and Computer-Assisted Intervention. Springer; 2019. p. 257–265.