Learning Diffeomorphic and Modality-invariant Registration using B-splines

Huaqi Qiu @ MIDL 2021 (paper 34)

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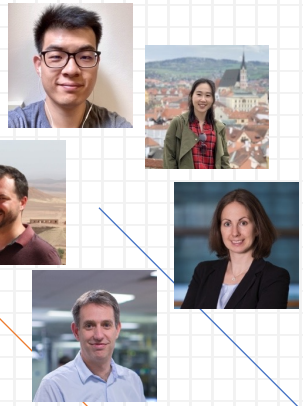

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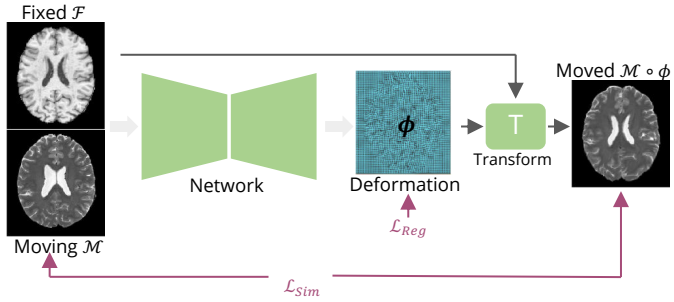
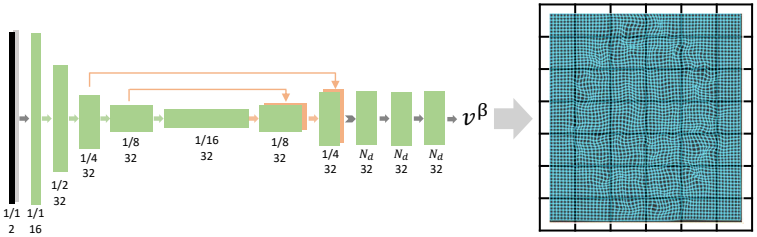
Code on GitHub

Introduction & Method

- Deep learning image registration (DLIR)
  - Learning amortized optimisation
  - Can use **intensity-based image similarity** as loss to train the networks in an *unsupervised* fashion

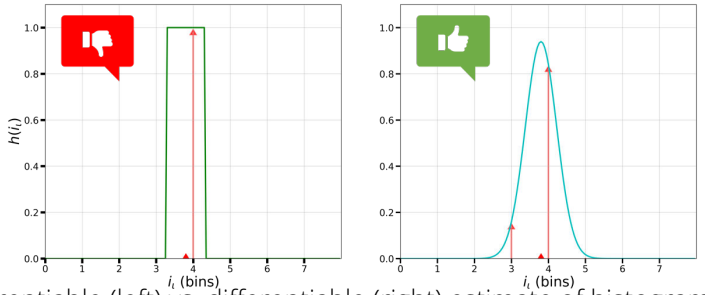


- Diffeomorphic **B-spline Free-form Deformation (FFD)** parameterised by **fully convolutional network**
  - B-spline FFD + stationary velocity field (SVF)
  - Network + FFD: parameter efficient & intrinsically smooth



CNN + B-spline FFD parameterised transformation

- Training DLIR with **differentiable Mutual Information** loss
  - Robustly applicable to a wide range of image modalities
  - Differentiable intensity distribution estimation using the classic Parzen Window method



Non-differentiable (left) vs. differentiable (right) estimate of histogram

Experiments & Thoughts

- Tasks:
  - 3D Brain MR inter-subject registration (T1-T1, T1-T2)
  - 2D Cardiac MR intra-subject registration

- Results vs. baselines:
  - **Less accurate but significantly faster** than traditional pair-wise iteratively optimised B-spline FFD + SVF algorithm
  - **Comparable accuracy and regularity but faster** and uses **less parameters** than full-resolution "dense" networks
  - Mutual information performed **comparable** to Localised Normalised Cross Correlation (LNCC) similarity on our tasks

- B-spline SVF and Mutual Information module code **available to plug-and-use**