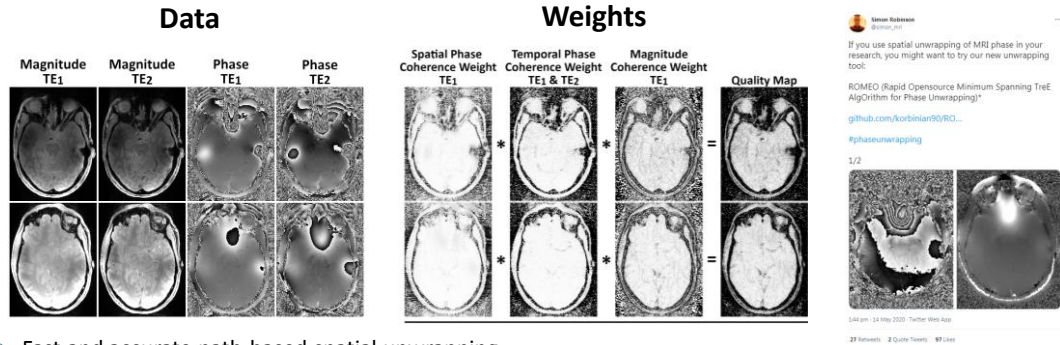# Rapid Opensource Minimum Spanning TreE AlgOrithm for Phase Unwrapping (ROMEO)

Barbara Dymerska (UCL), Korbinian Eckstein (MU Vienna), Simon Robinson (MU Vienna)

- Fast and accurate path-based spatial unwrapping
- Single-step for multi-echo, multi timepoint data
- New features, calculate B_0 "-B", remove phase offsets "--phase-offset-correction", write quality maps "-q,-Q"

ROMEO is a Rapid Opensource Minimum Spanning TreE AlgOrithm for Phase Unwrapping.

The contact authors are Barbara Dymerskia, Korbinian Eckstein and myself.

It's a fast and accurate path-based spatial unwrapping method which defines unwrapping paths through the object using up to 3 weights:

1. Spatial phase coherence weight:

$$W_i^{\theta, Spat} = 1 - \left| \gamma(\theta_i - \theta_j)/\pi \right|$$

2.   Temporal phase coherence weight:

$$W_{i,n}^{\theta,Temp} = \max\left(0\,,1 - \left|\gamma\left(\theta_{i,n} - \theta_{j,n}\right) - \gamma\left(\theta_{i,m} - \theta_{j,m}\right)\cdot TE_n/TE_m\right|\right)$$
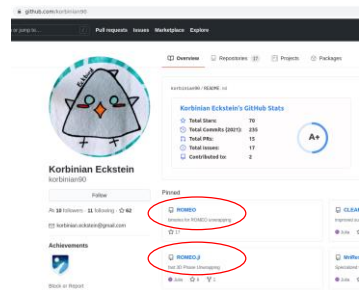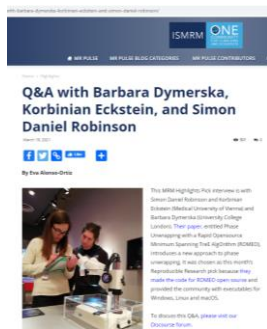
3.   Magnitude coherence weight:

$$W_i^{M1} = \left(\min\left(M_i, M_j\right)/\max(M_i, M_j)\right)^2$$

And uses template unwrapping to unwrap multi-echo data.

I'd like to point out some recent, features, like the calculation of a single B0 map from multi-echo data, the possibility to remove phase offsets and write out quality maps, which we find really useful for generating masks at ultra-high field.

ROMEO

Dymerska B, Eckstein K, Bachrata B, Siow B, Trattnig S, Shmueli K, Robinson SD. Phase unwrapping with a rapid opensource minimum spanning tree algorithm (ROMEO). Magn Reson Med. 2021 Apr;85(4):2294-2308.

Links:
https://github.com/korbinian90/ROMEO
https://github.com/korbinian90/ROMEO.jl
Harvard Dataverse. https://dataverse.harvard.edu/dataverse/ROMEO
https://onlinelibrary.wiley.com/doi/full/10.1002/mrm.28563

ROMEO appeared in MRM in October last year and was a Reproducible Research Editor's pick in April this year. It's open source and freely available in Julia on github, there i would point out both the Julia version and the compiled versions for Windows, Mac and Linux.

We have an alph implementation of this in ICE and we're talking to Kwok-shing about how best to integrate ROMEO into SEPIA.