

MathSys MSc individual project

R.S.MacKay

Community detection

Implement and test the “repeated expander decomposition” method of Saranurak in arxiv:1812.08958 (plus possibly its refinement in arxiv:2005.02369, which allows for time-dependent changes in the network) for hierarchical community detection.

This could lead to a PhD on testing of my hierarchical aggregation method for computing least cost paths in a network, or mean first-passage times for Markov flows, or selfish traffic flow. For Markov flows see

RS MacKay, JD Robinson, Aggregation of Markov flows I: theory, *Phil Trans Roy Soc A* 376 (2018) 20170232

and the tests done using MCL clustering by

Sharpe D, Wales DJ, *J. Chem. Phys.* **151**, 124101 (2019)

For least cost paths there are already efficient implementations of Dijkstra’s algorithm, but the problem becomes harder if some negative edge weights are allowed (with the proviso that there is no negative cycle) and I think my (unpublished) method might have advantages then. For selfish traffic flow, I described my aggregation method some years ago, but it is not published.

We’d need to identify an external partner depending on the desired application. I talked with Camvit (a satnav consultancy) many years ago about the least cost path method, and to Birmingham City Council about selfish traffic flow.

Alternatively, I posed various other network projects during MA933 and in my Network Science talk on 15 February, e.g.

design of assessment networks to apply

RS MacKay, R Kenna, RJ Low, S Parker, Calibration with confidence: A principled method for panel assessment, *Roy Soc Open Sci* 4 (2017) 160760

trophic analysis, extending

RS MacKay, S Johnson, B Sansom, How directed is a directed network? *RSOS* 7 (2020) 201138 <https://doi.org/10.1098/rsos.201138>

analysis of tensor products, following

RS MacKay, Robustness of Markov processes on large networks, *J Difference Eqns & Applns* 17 (2011) 1155–67.

Inference of Gibbsian processes, as I added to 10F+.pdf for MA933.