DAFNI

casa UCL University College London

Urban Simulation Modelling

With Potential Applications Using DAFNI Resources

Michael Batty, Richard Milton

Centre for Advanced Spatial Analysis

CASA-UCL

26 June, Thursday | 9-00am – 12-00noon

m.batty@ucl.ac.uk richard.milton@ucl.ac.uk

UKRI Science and Technology Facilities Council

UKRI Engineering and Physical Sciences Research Council

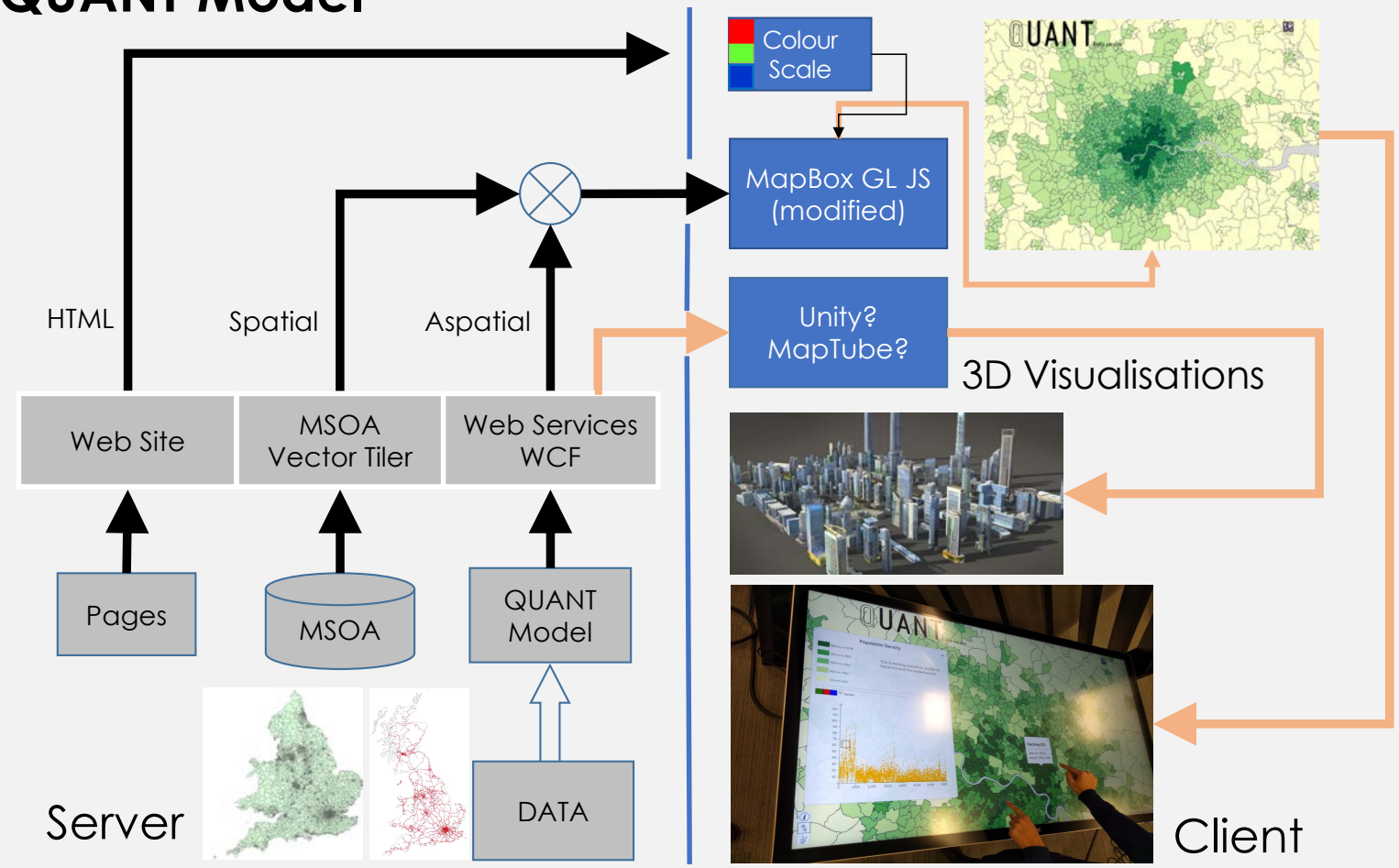
UKCRIC

Issues

- What We Do In CASA
- Our ***QUANT*** Model, funded by FCC and now by The Turing Institute
- The RAMP Initiative: Rapid Assessment of Pandemic Modelling: The Turing-***RAMP*** Model
- The ***MATSIM-EpiSim*** Model: The DAFNI Champions Project

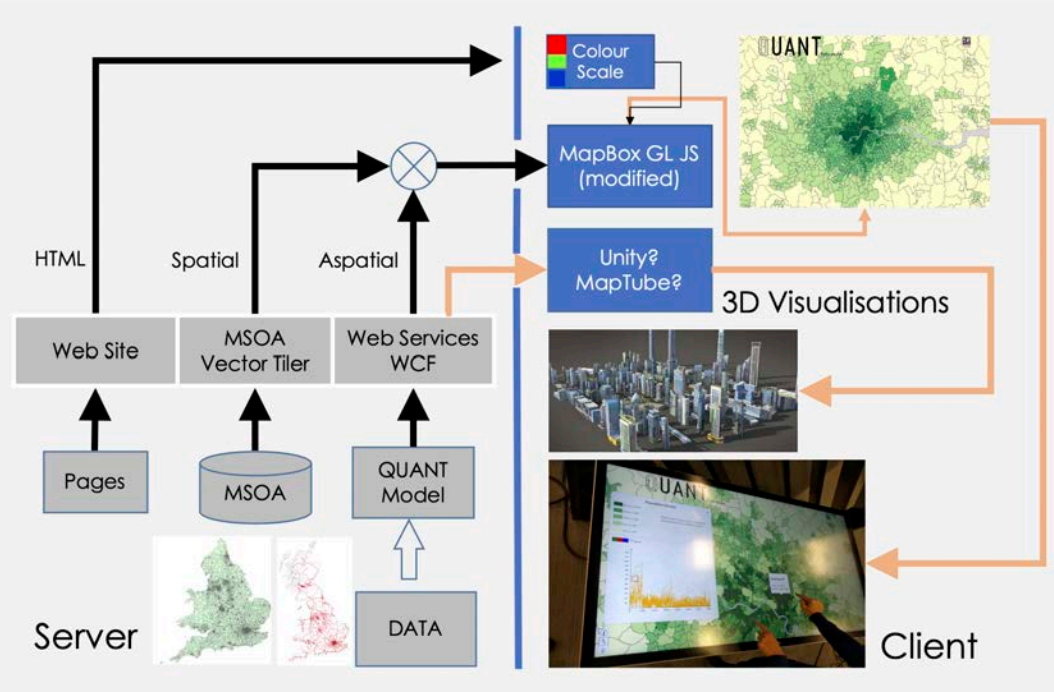
- Our focus in CASA is essentially building a science of cities. We aim to do this by developing urban simulation models a various scales from the aggregate urban-metropolitan to the most local scale at the level of building complexes.
- Our work is also strongly geared to urban planning which is to some extent the core professional expertise, although this is a highly diverse interdisciplinary group with physicists and mathematicians, geographers, computer scientists
- We have four professors, twelve or so lecturers, two teaching fellows
- We were originally a research centre when set up in 1995 but our core business is a large Masters program in Smart Cities and Urban Analytics
- We are a department in the Faculty of the Built Environment, the Bartlett

The QUANT Model



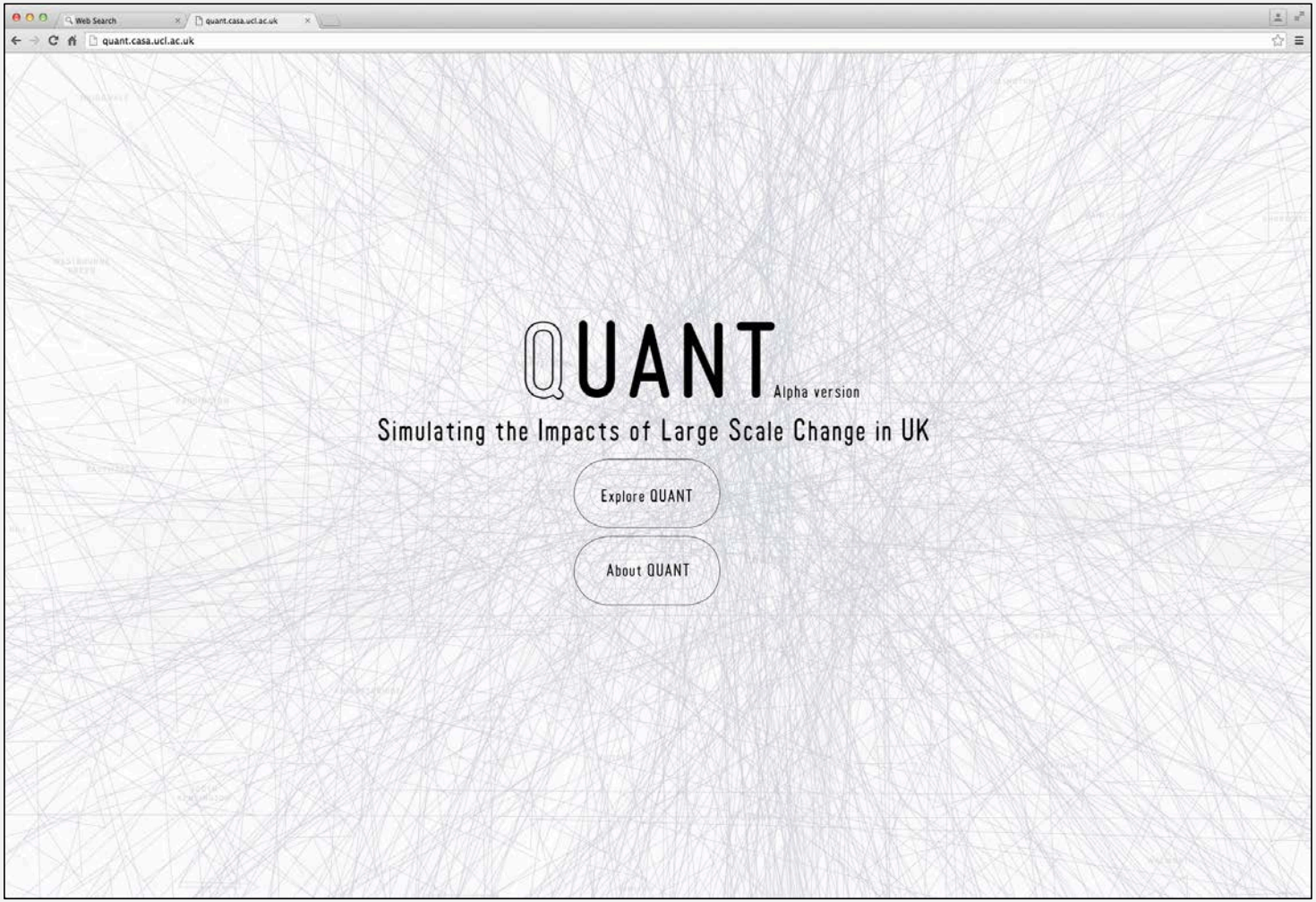
DAFNI UCL Hardware

5x Nvidia V100 GPU



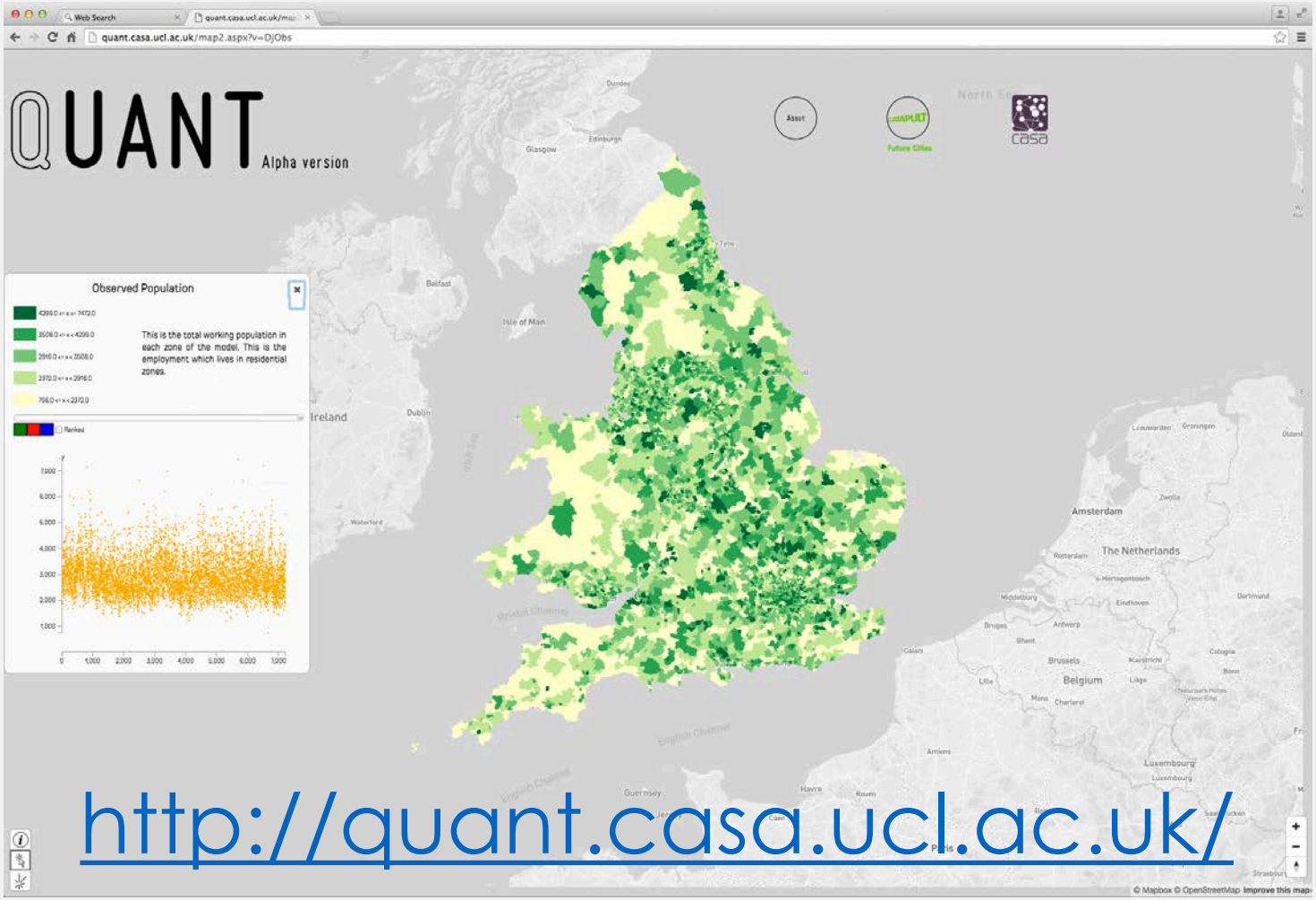
DAFNI UCL Hardware

6x Visualisation Workstations

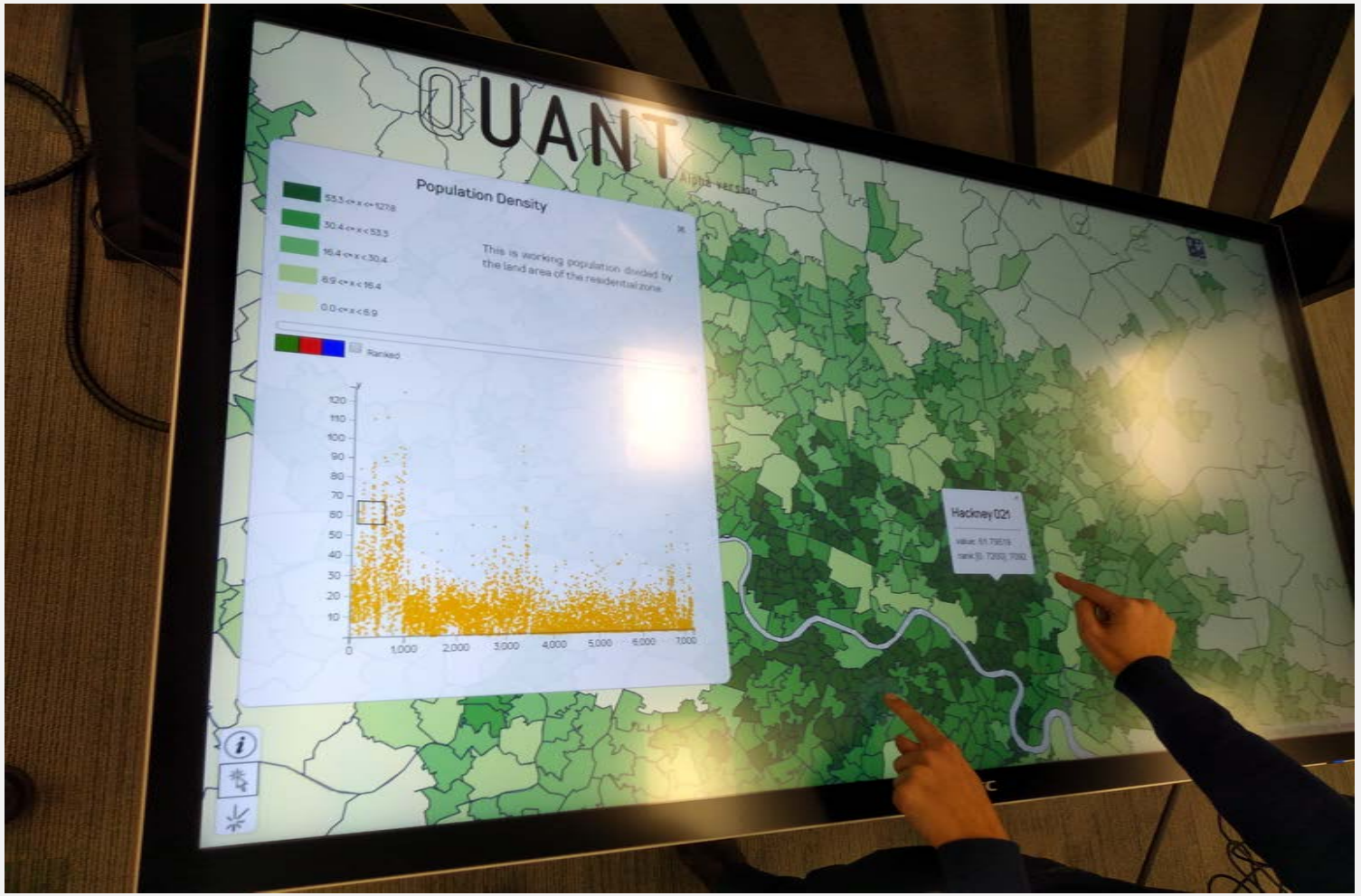


Urban Simulation Modelling With Potential Applications Using DAFNI Resources

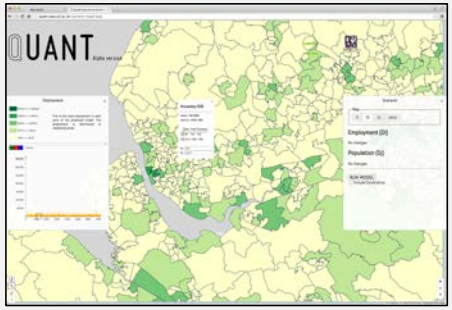
Urban Simulation Modelling With Potential Applications Using DAFNI Resources

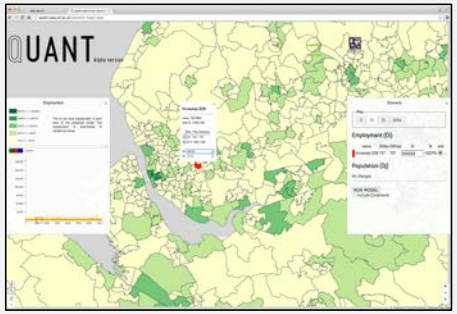


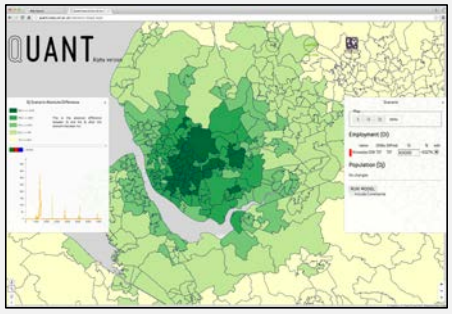
Urban Simulation Modelling With Potential Applications Using DAFNI Resources

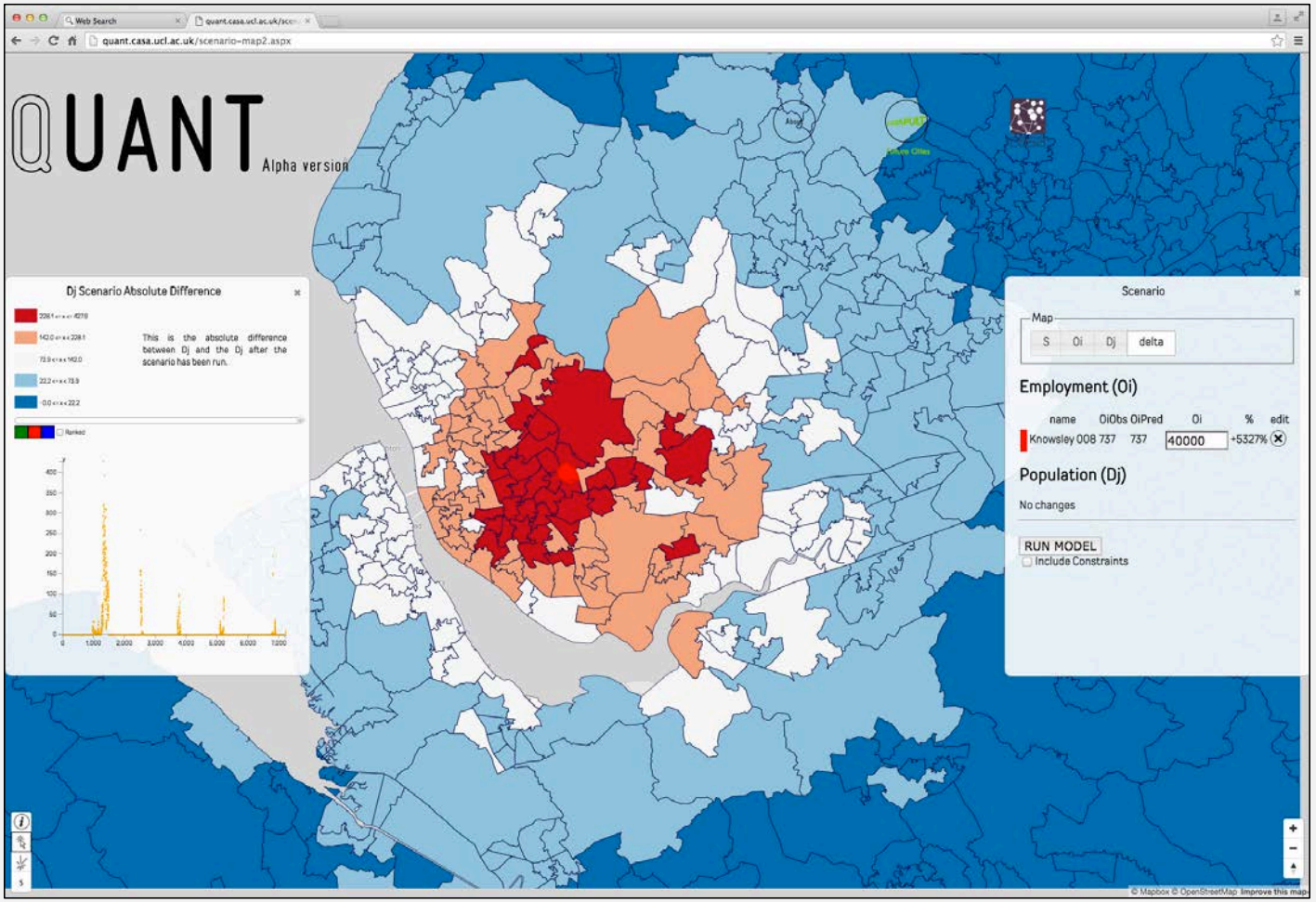


Urban Simulation Modelling With Potential Applications Using DAFNI Resources



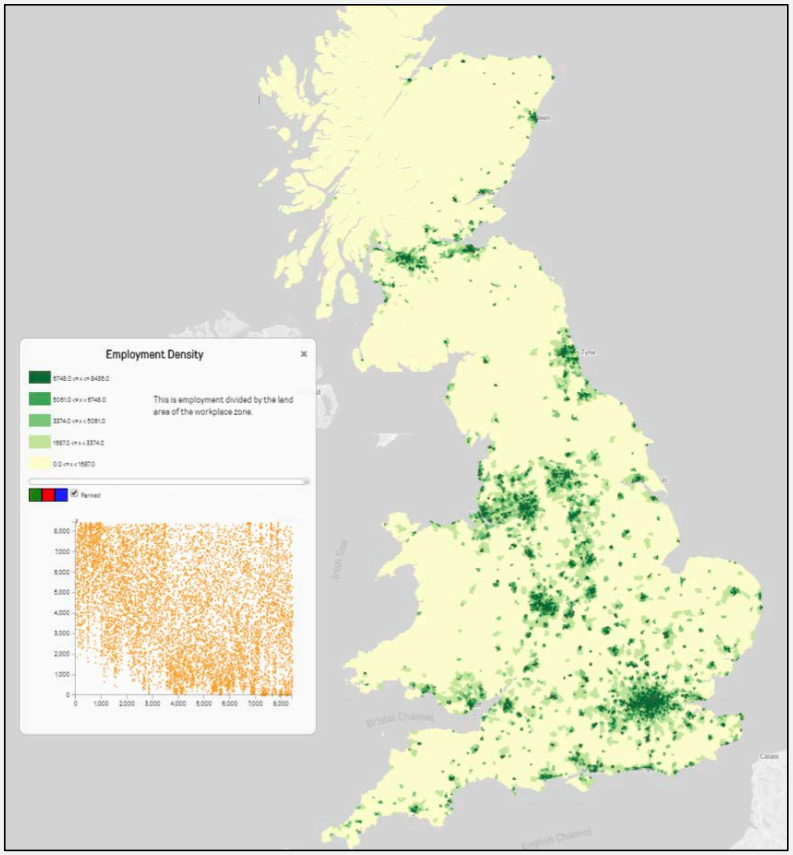




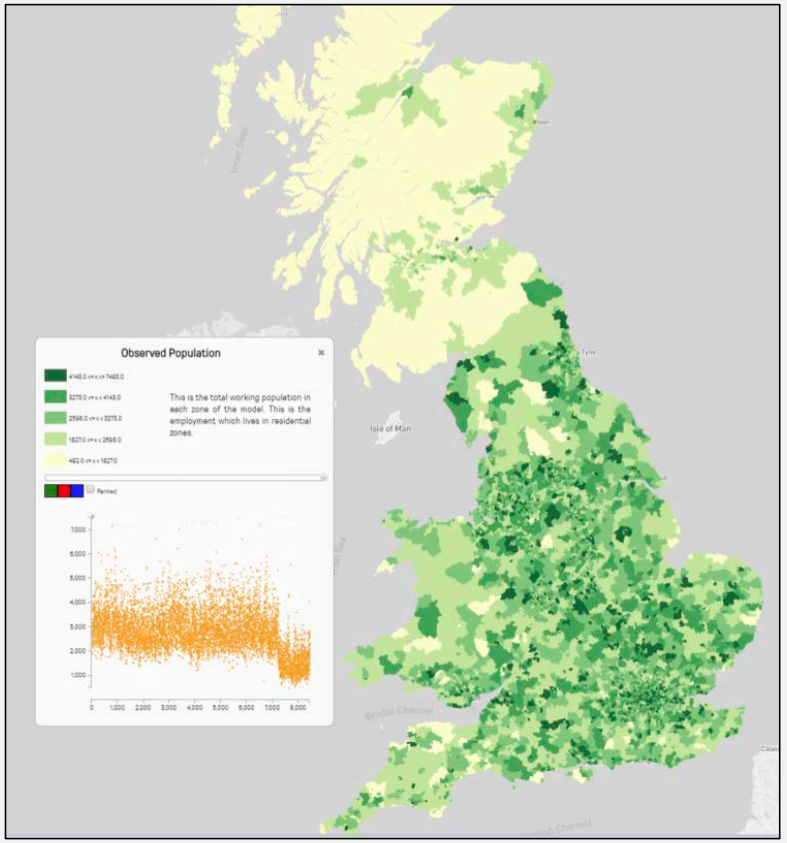


Urban Simulation Modelling With Potential Applications Using DAFNI Resources

Employment Density



Population Counts

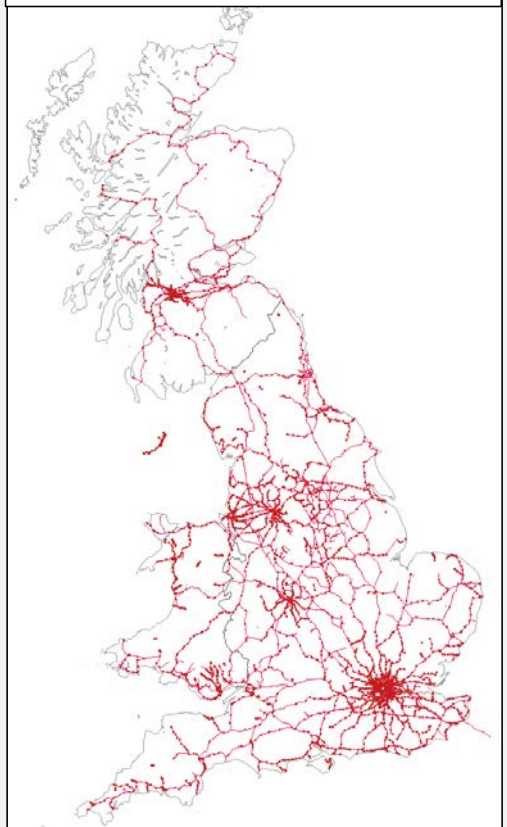


Urban Simulation Modelling With Potential Applications Using DAFNI Resources

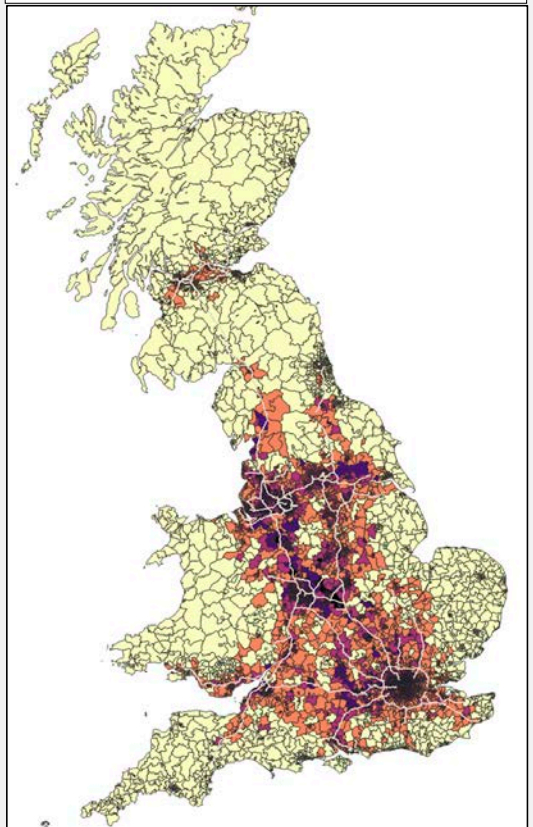
- And at the global scale where local capacity matters

Road, v=3.5M, e=8.4M

Rail, v=3165, e=10,269



Social distancing



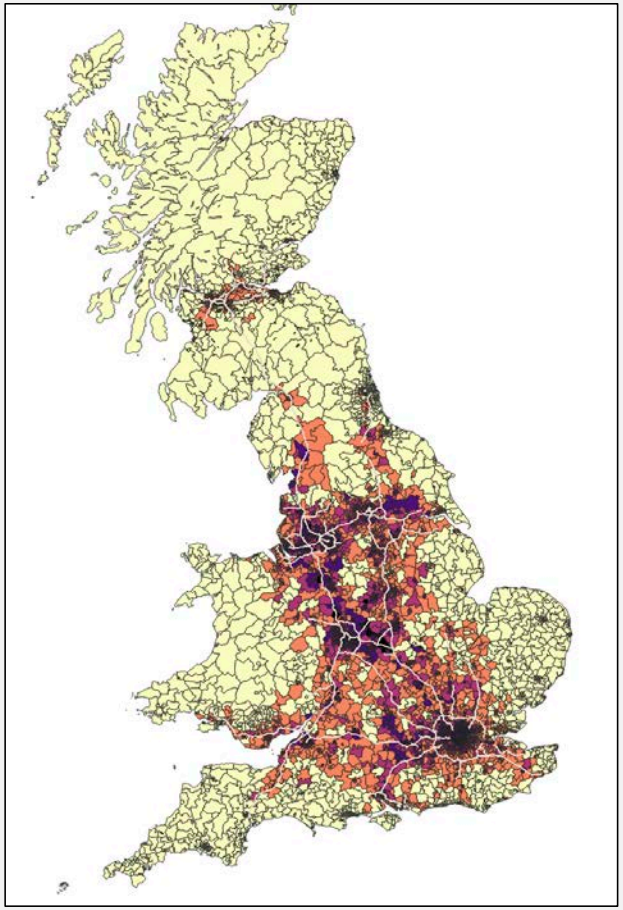
Keeping Rail to a Capacity of 15% for Social Distancing

$$T_{ij}^{k} = O_i \frac{D_j^{obs} \exp(-\beta^k d_{ij}^k)}{\sum_k \sum_j D_j^{obs} \exp(-\beta^k d_{ij}^k)} \qquad k = 1,\ k = 2,\ k = 3 \qquad road, rail, bus$$

Check

to see if total trips by rail are less than 15%
If not, we increase the travel cost on the rail
We essentially add a small value to d_{ij}^k and
Reiterate with new distance on rail

Ultimately we get the system balanced with massive gridlock on the highways and dramatic decreases in overall road accessibility across the urban areas of the country



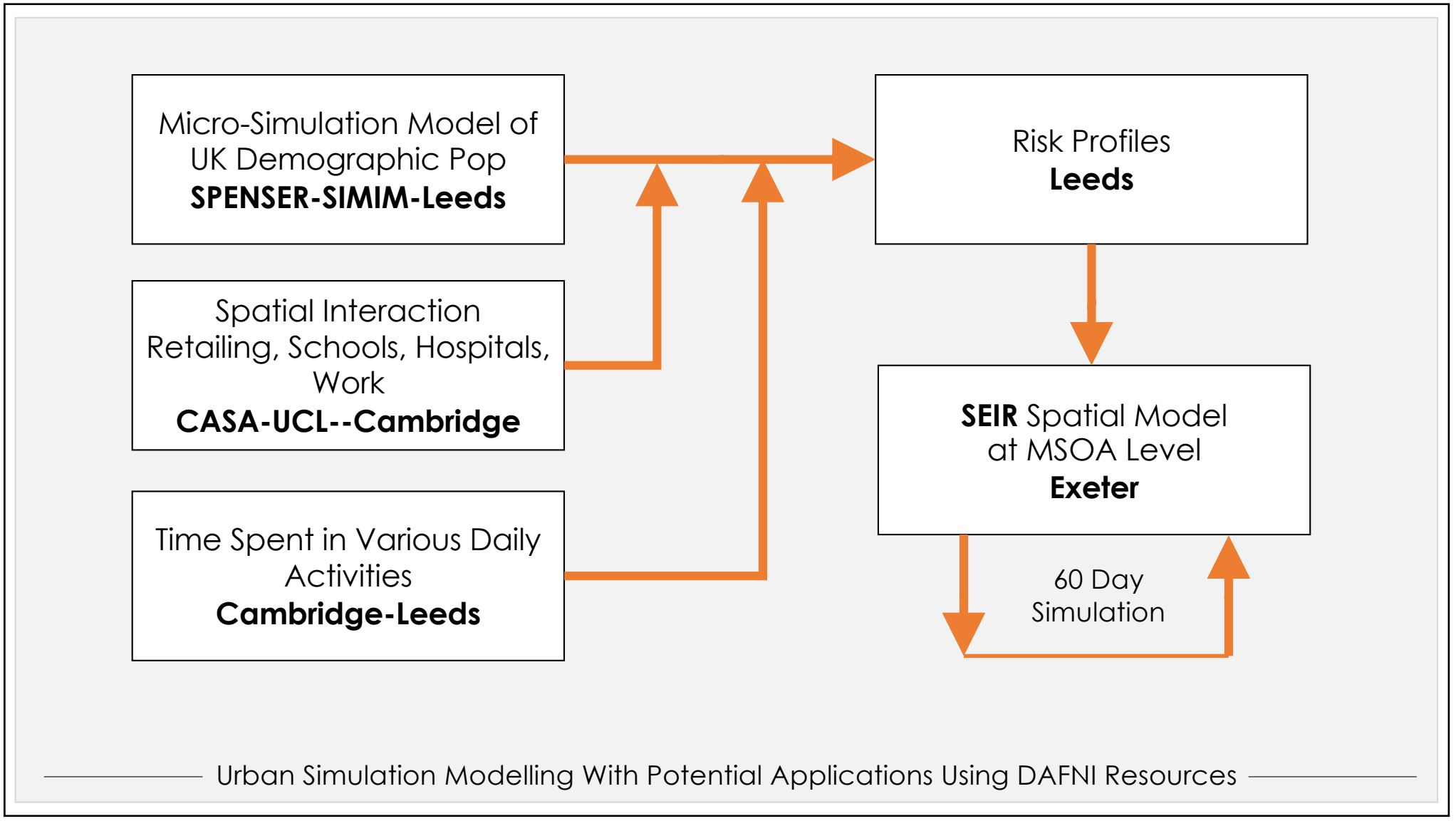
Problems of Porting This Model to DAFNI

- This is a highly visual model designed to enable urban planners and policy analysts to engage in running many scenarios on the fly with instant turnaround
- The model is web based and covers the whole country therefore it has to operate for any planner anywhere developing a scenario and getting instant feedback.
- The data inputs for a scenario are simple numerical and graphic using point and click
- It is hard to divide the model into workstreams following the conventional pattern of input data, model run, visualization
- The model has to appear seamless for those who run it because urban planners in practice are skeptical about the whole idea of modelling

The RAMP Initiative

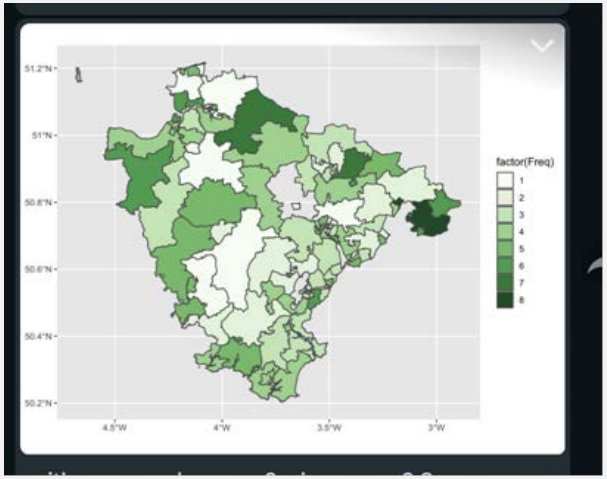
- RAMP means Rapid Assessment of Pandemic Modelling
- Its is a Royal Society Initiative run out of Cambridge and involves the Newton Institute, SPI-M and SAGE. It is able to respond to SAGE
- It has several tasks – the one I lead is ***Human Dynamics in Small Spaces*** which is all about movement of people in small spaces and the transmission of the virus. This is more about modelling inside buildings
- The task in question here is led by Mark Birkin of the Turing Institute and Leeds and is in ***Urban Analytics***
- It is building a spatial pandemic model by putting together several different model types – demographic micro-simulation, spatial interaction (jobs, schools, shops, hospitals), and spatial SEIR modelling, all developed previously and adapted to this challenge

- The model will ultimately be a national model of the spatial pandemic which is open source, already with bits available on Github which synthesize the
- *Microsimulation model of the UK Demography* called **SPENSER** from Leeds (already in part in DAFNI from Nic Lomax)
- *Retail, schools and hospital spatial interaction models* from CASA-UCL
- *Journey to work models* from the Martin Centre Cambridge
- *Epidemiological SEIR model* from Exeter
- These components essentially feed the epidemiological model with demography and spatial interactions and generates risk profiles which determine infections amongst the wider susceptible population. These risk factors are spatial at the usual scale we use in the UK which is the MSOA
- The model is currently validated & working for Devon.

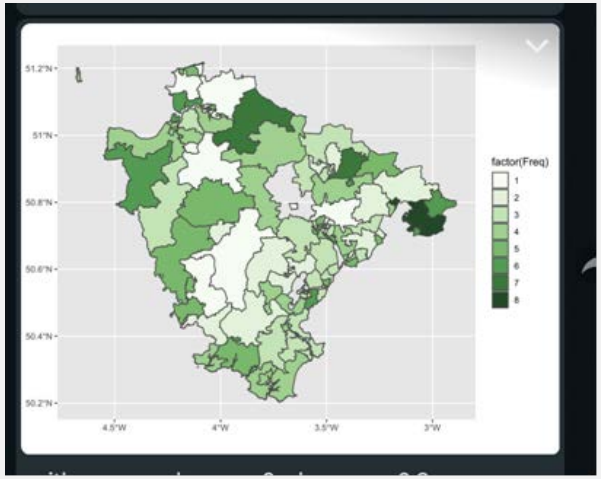


Urban Simulation Modelling With Potential Applications Using DAFNI Resources

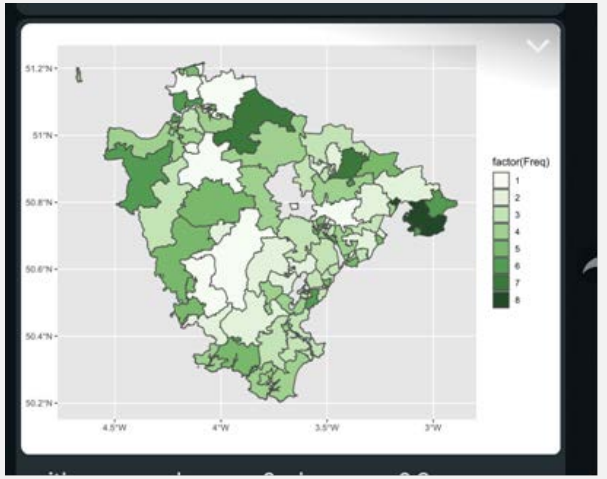
Infections

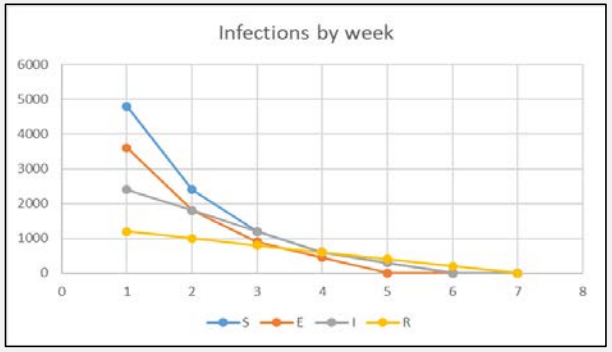


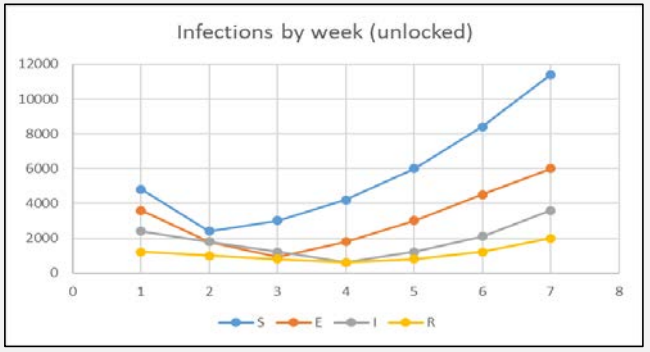
Observed Mortalities



Predicted Mortalities

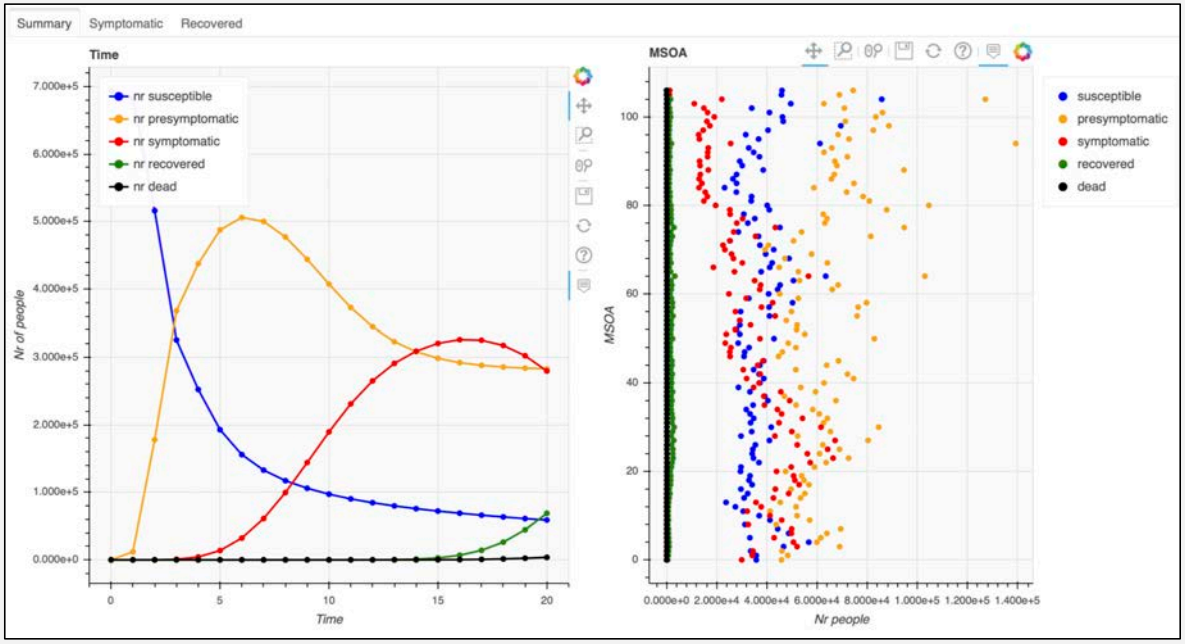


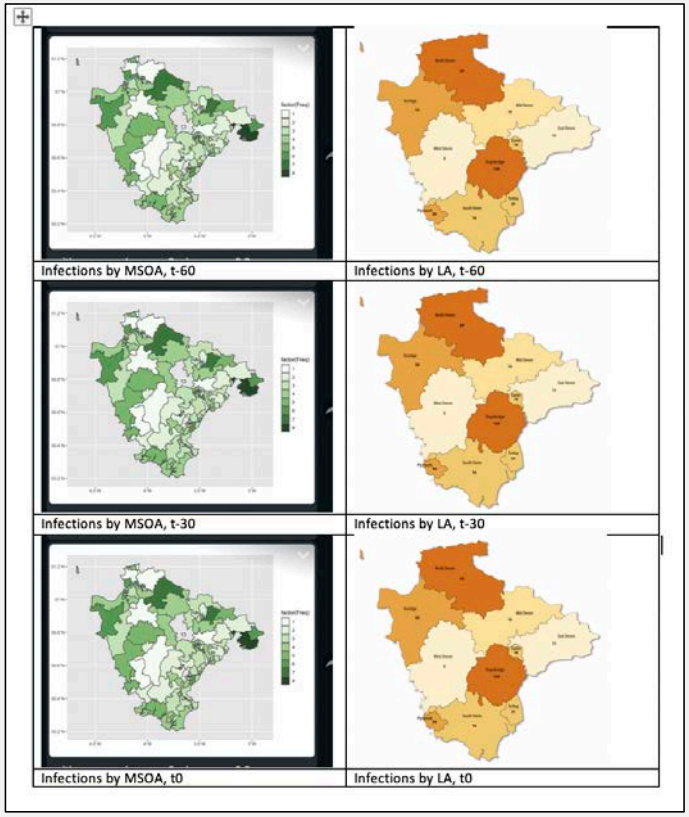




Urban Simulation Modelling With Potential Applications Using DAFNI Resources

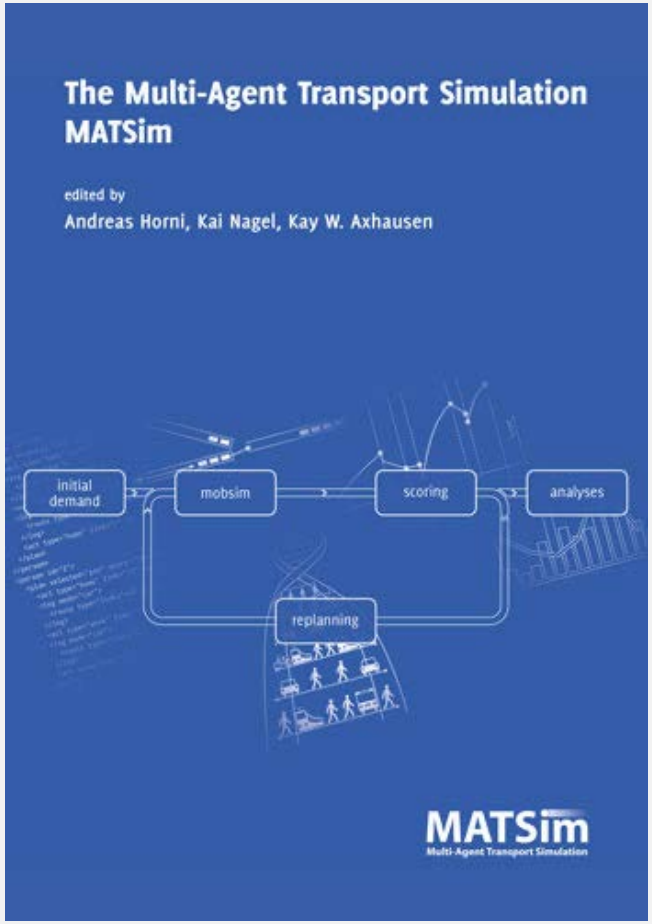
The 60 Day Simulation





The MATSIM-EpiSim Model: The DAFNI Champions Project

- We have a DAFNI Champions award to *Juste Raimbault* who has a background in ABM and microsimulation. He is familiar with **SPENSER** and also with **MATSIM-EpiSim** from TU Berlin and ETHZ.
- We hope to use this project to examine how a version of MATSIM might be ported to DAFNI. We have experience of running MATSIM for a European project about 4 years ago.
- The RAMP Initiative might potentially involve the Arup version of MATSIM-EpiSim and this has emerged since we applied to the DAFNI Champions award.
- We also hope to use the Champions project to take the RAMP UA model and port this to DAFNI – as it is open source then this should be straightforward



Serras, J, Bosredon, M, Zachariadis, V, Vargas- Ruiz, C, Dubernet, T and Batty, M. 2016. London. In: Horni, A, Nagel, K, and Axhausen, K W (eds.) ***The Multi-Agent Transport Simulation MATSim***, pp. 447– 450. London: Ubiquity Press. DOI: http://dx.doi.org/10.5334/baw.73.

DAFNI

casa University College London

UCL

Michael Batty (m.batty@ucl.ac.uk)

Richard Milton (richard.milton@ucl.ac.uk)

Juste Raimbault (j.raimbault@ucl.ac.uk)

UKRI Science and Technology Facilities Council

UKRI Engineering and Physical Sciences Research Council

UKCRIC