



# Unlocking Agents

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@ajheppenstall

# In the beginning...



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**Extended Abstracts from the 1st International Conference on GeoComputation**  
**University of Leeds**  
**United Kingdom**  
**17 - 19 September 1996**

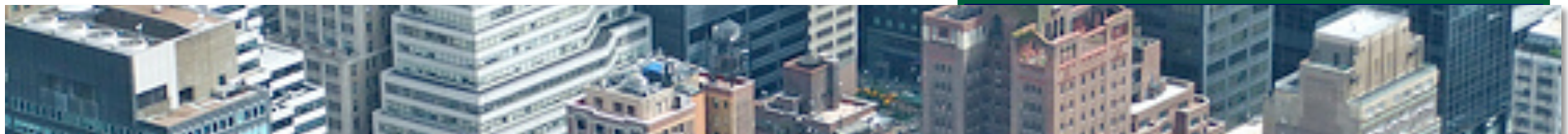
Sponsored by University of Leeds; Leeds School of Geography; GMAP Limited;  
GeoInformation International; Elsevier Science.

However, in many ways this is only the beginning of the extensive and broadly based development of a geocomputational paradigm that will over the next few decades grow in strength and expand in the breadth of applications as some exponential function of supercomputing speeds. The take-off has been delayed by **an inadequacy of high performance computing hardware, the lack of appropriate tools and technologies relevant to geography** that would need to be powered by supercomputers, and a deficiency in awareness and potential benefits to be gained. Suddenly the constraints have dissolved and we stand at the dawning of a new era of geocomputation.

# ABM – what's that then?



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<https://theconversation.com/how-big-data-and-the-sims-are-helping-us-to-build-the-cities-of-the-future-47292>



**How big data and The Sims are helping us to build the cities of the future**

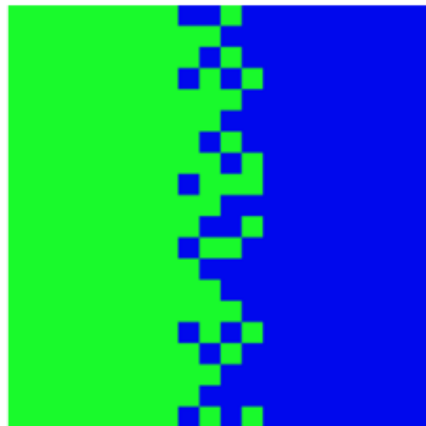
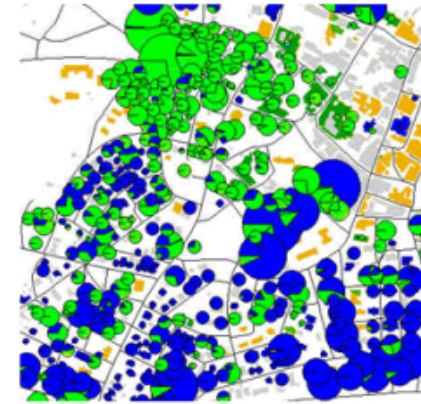
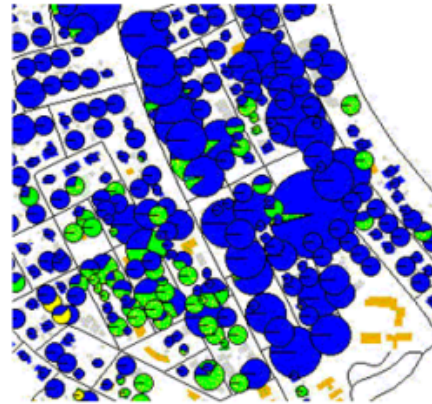
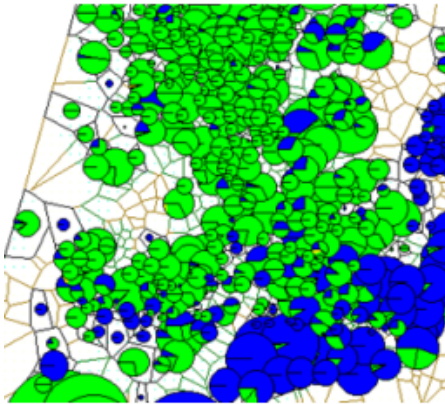
October 22, 2015 2.38pm BST



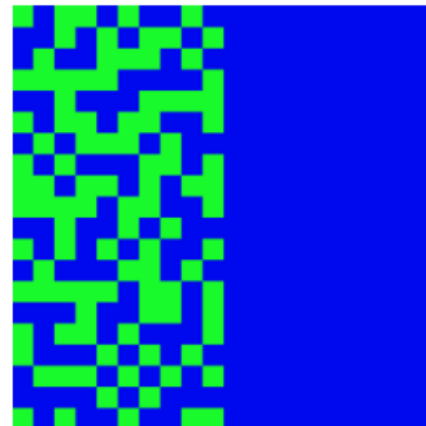
# Ethnic segregation



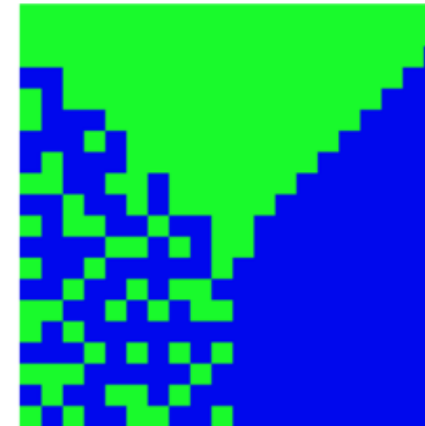
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(a)



(b)



(c)

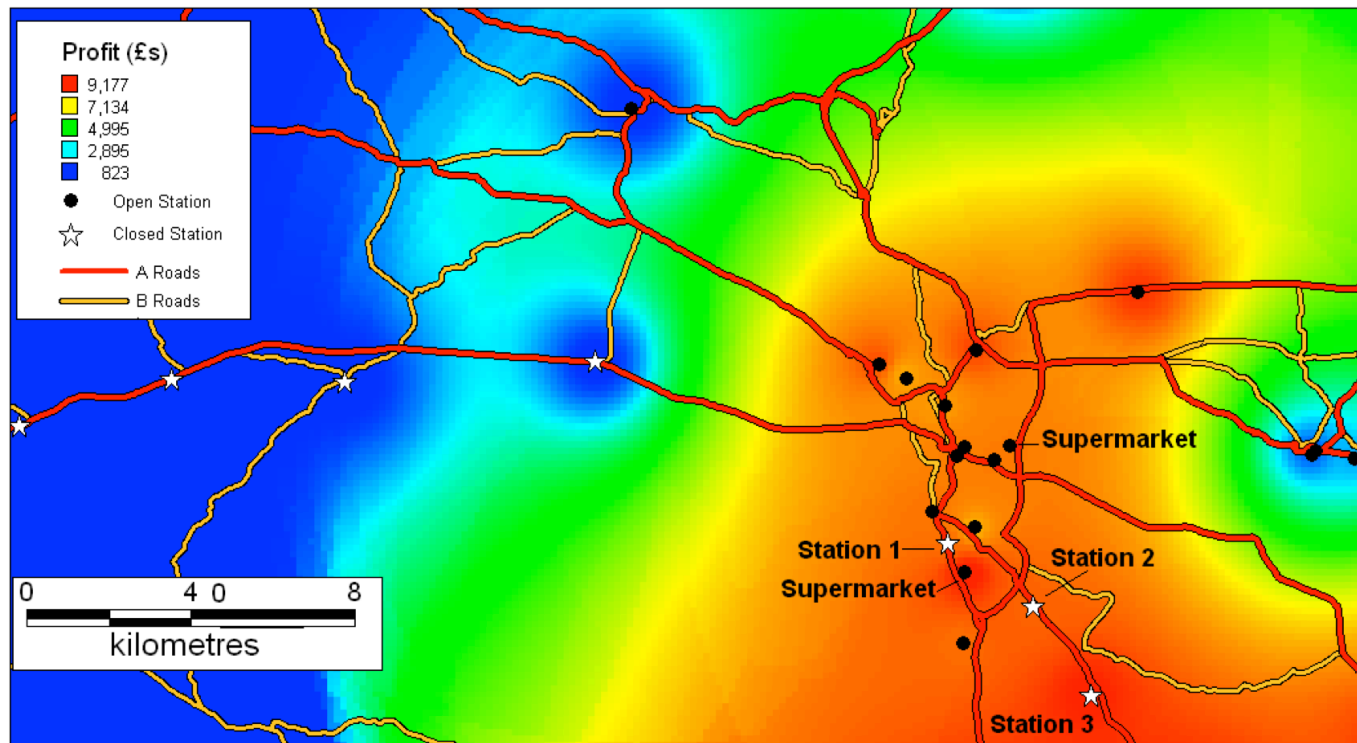
Hatna, E. and Benenson, I. (2002) Entity-based modeling of urban residential dynamics: the case of Yaffo, Tel Aviv. EPB: 491 - 512



# Petrol price modelling



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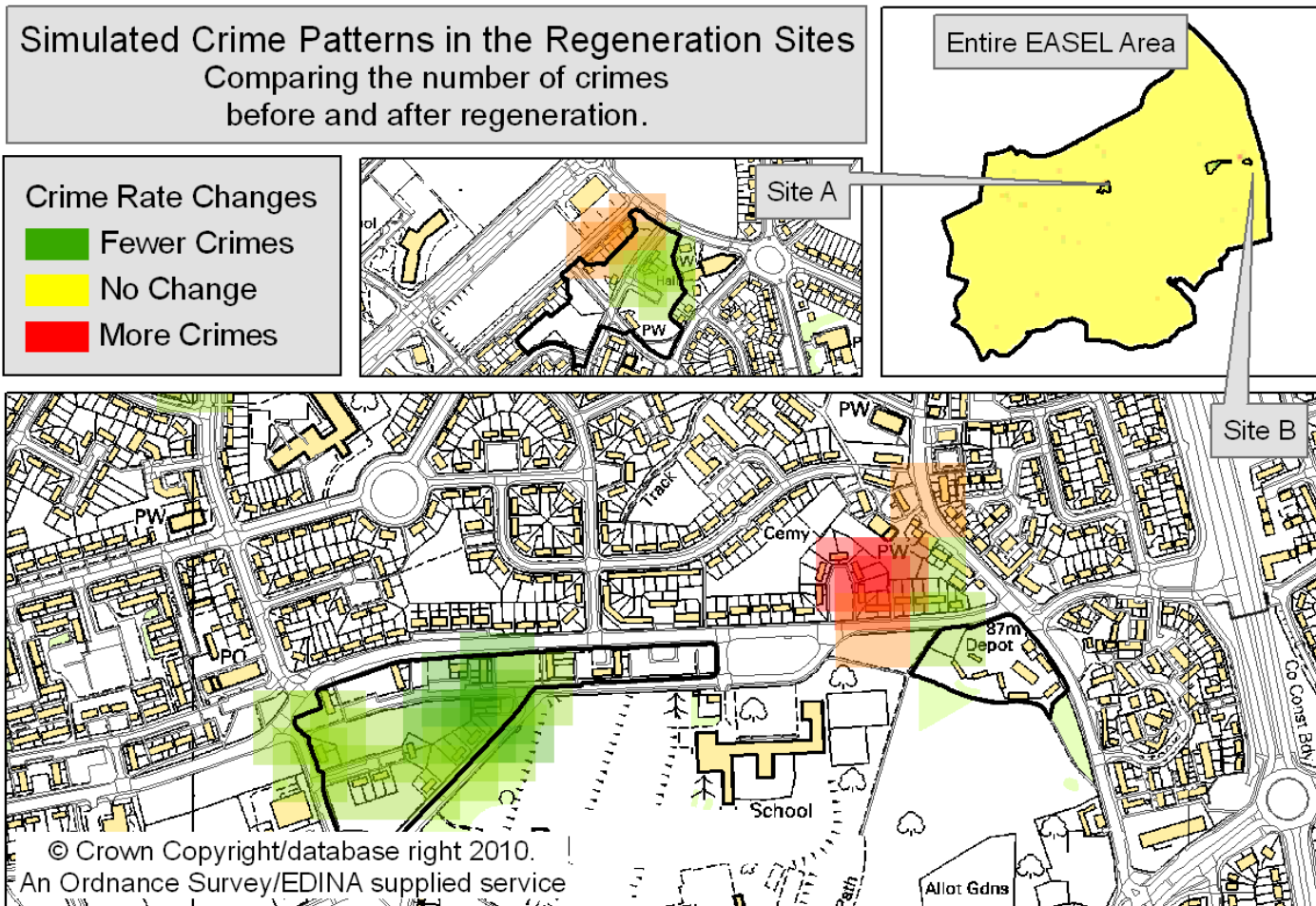


Heppenstall, A.J., Evans, A.J. and Birkin, M.H. (2006) Using hybrid agent-based models to model spatially-influenced retail markets. JASSS 9(3)

# Simulating Crime



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Malleson N, Heppenstall A, See L, Evans A, (2013), "Using an agent-based crime simulation to predict the effects of urban regeneration on individual household burglary risk" Environment and Planning B

# Spread of Information and Movement



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<https://www.youtube.com/watch?v=plsu9wqKc3Q>

**Crooks, A.T.** and Wise, S. (2013), GIS and Agent-Based models for Humanitarian Assistance, *Computers, Environment and Urban Systems*, 41: 100-111





Manley, E., Cheng, T, Penn, A. and Emmonds, A. (2014) A frame-work for simulating large-scale complex urban traffic dynamics through hybrid agent-based modelling. CEUS 44: 27 - 36

# Cooler application...



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The image is a composite. The left portion is a movie poster for 'The Lord of the Rings: The Two Towers'. It features a large, green, armored figure (a Uruk-hai) in the foreground, looking towards a massive army of soldiers marching along a path in a dark, stormy landscape. The text 'INSIDE THE EFFECTS' is overlaid in the upper right of the poster. At the bottom, it says 'THE LORD OF THE RINGS' and 'THE LORD OF THE RINGS: THE TWO TOWERS IN'. Below the poster, there is a line of small copyright text: '© 2002 NEW LINE PRODUCTIONS, INC. THE LORD OF THE RINGS, THE TWO TOWERS AND THE CHARACTERS, EVENTS, ITEMS AND PLACES THEREIN ARE TRADEMARKS OF THE SAUL ZAENTZ COMPANY D/B/A TOLKIEN ENTERPRISES UNDER LICENSE TO NEW LINE PRODUCTIONS, INC. ALL RIGHTS RESERVED.'

The right portion is a screenshot of a web browser window titled 'The Lord of the Rings - Microsoft Internet Explorer'. The page is titled 'MASSIVE SIMULATOR'. It features a dark background with a green wireframe grid. Several green triangles are scattered across the grid, representing units in a simulation. On the right side, there is a 'Simulator Controls' panel with three buttons: 'RUN BATTLE' (a yellow play button icon), 'PAUSE' (a white pause button icon), and 'RESET' (a white circular arrow icon). Below the controls, there are two buttons: 'NEW SIMULATION: ADD AN ELF' and 'ADD AN ORC'. At the bottom right, there is a 'CLOSE THIS WINDOW' button with a red 'X' icon. At the bottom left of the browser window, there is a 'TERMS OF USE' link and a small 'Celine K' logo.



And just because...



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# Popular...



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## Mesa: Agent-based modeling in Python 3+

build passing coverage 58%

Mesa is an Apache2 licensed agent-based modeling (or ABM) framework in Python.

## GeoMason: GeoSpatial Support for MASON

Evolutionary Computation Laboratory and the Center for Social Complexity



Alison J. Heppenstall  
Andrew T. Crooks  
Linda M. See · Michael Batty *Editors*

## Agent-Based Models of Geographical Systems

 Springer

# NetLogo



# Towards the future



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# SpatialOS

Created by **IMPROBABLE**

[SIGN UP](#)

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SpatialOS is a distributed operating system that enables developers to build massive, detailed simulations across thousands of machines in the cloud.

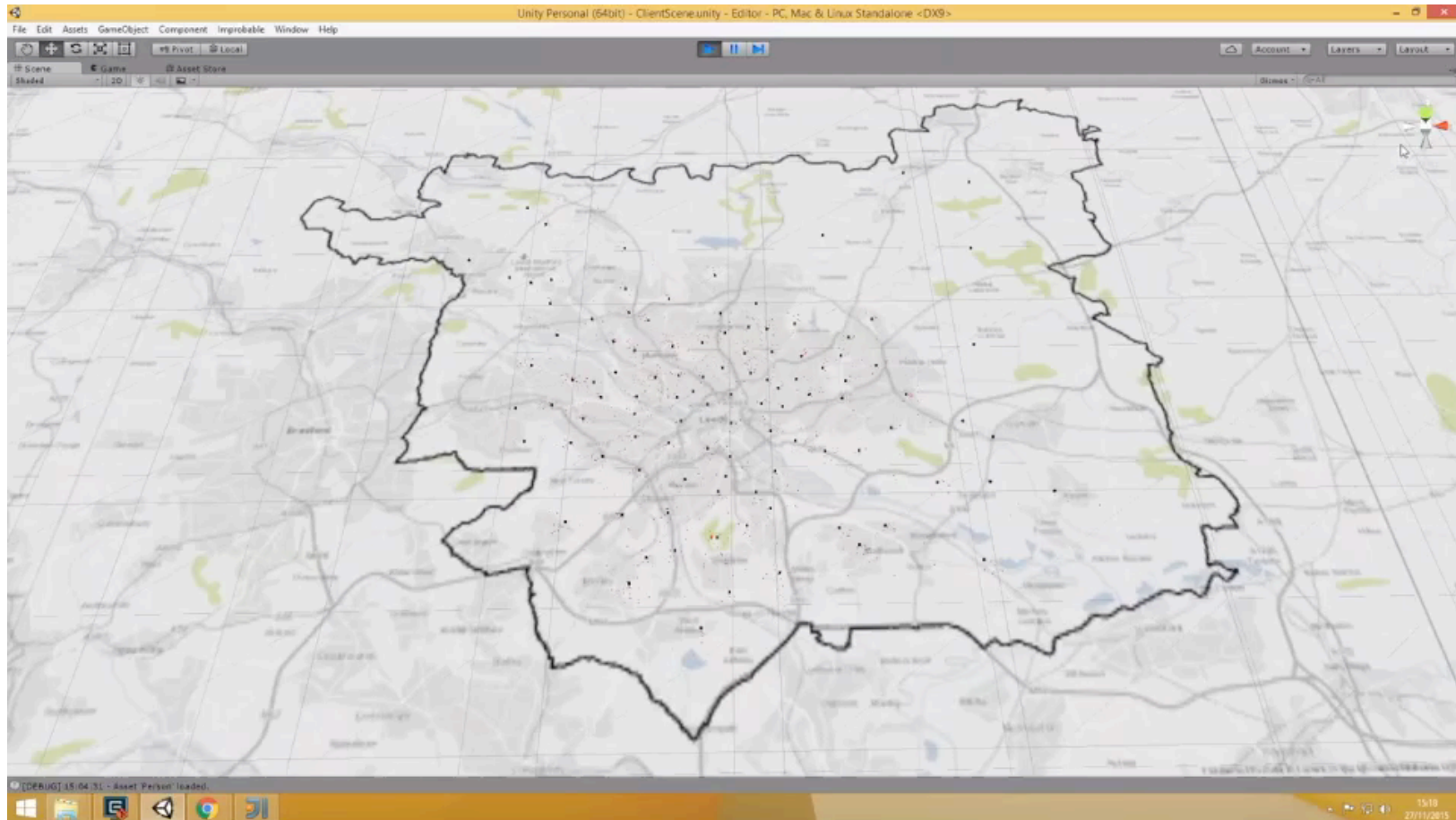
It transforms how we look at complex systems in areas as diverse as city management, defence, economics and entertainment, enabling a new class of applications and businesses for the future.

<http://improbable.io>

# SURF (Simulating Urban Flows)



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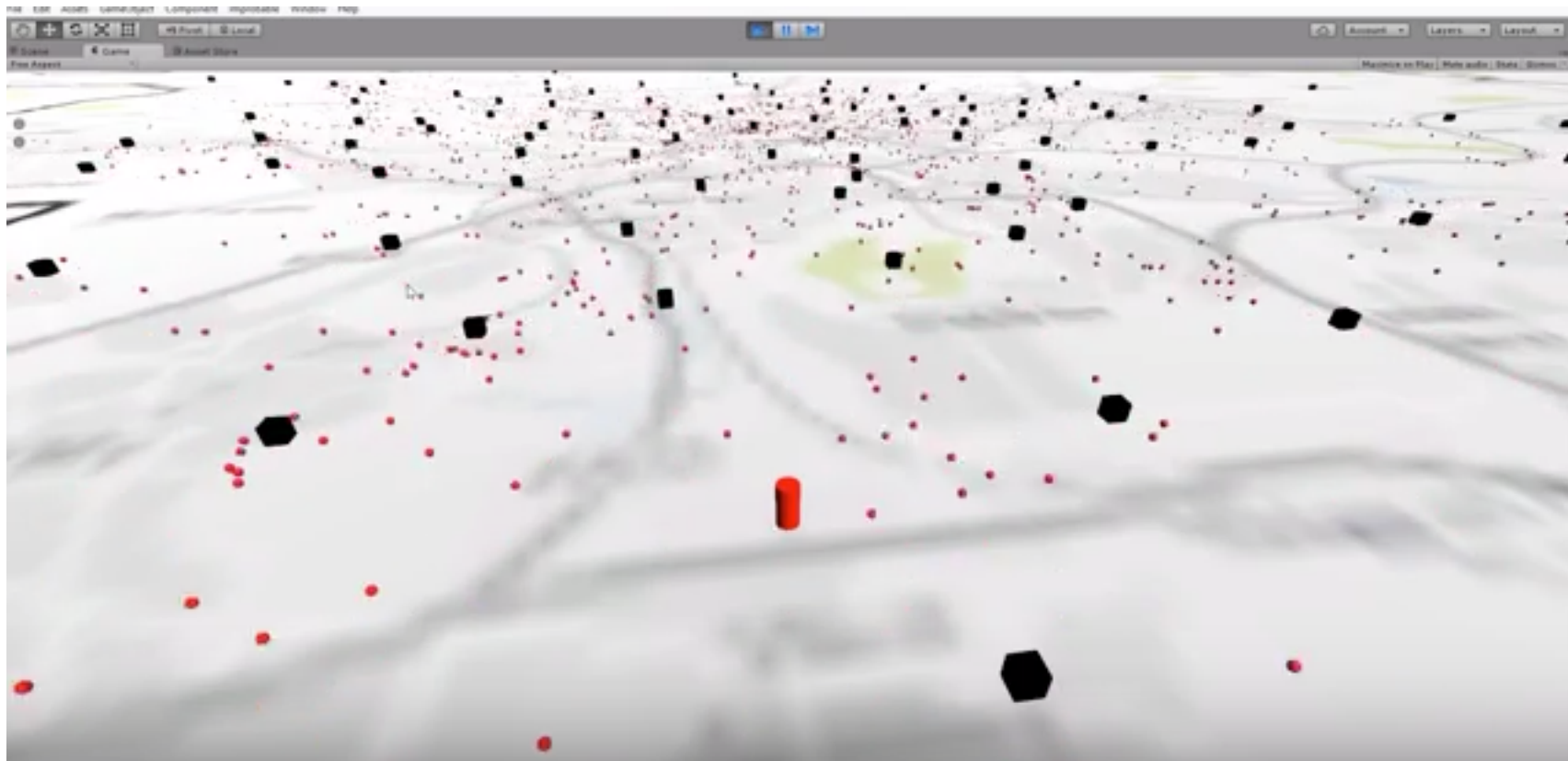
<http://surf.leeds.ac.uk>



In case the video doesn't work...



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<http://surf.leeds.ac.uk>

But...



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Improvements: replicability and transparency

BUT what about:

**Identifying, representing and evaluating**  
key “behaviours”?

- What is it we are trying to evaluate? Behaviour? Processes? Something easy to quantify?
- What metrics should we use?
- What spatial scale? What time scale?

-No ABM in policy. Why?

- Poor evaluation, no confidence levels, abstract behaviour.

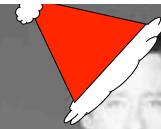




"Hey wait a minute! My Big Data analysis says  
I'm one gift short..."



# BIG DATA





Data required at every stage:

- Understanding the system
- Calibrating the model
- Validating the model

But high-quality data are hard to come by

- Many sources are too sparse, low spatial/temporal resolution
- Censuses focus on *attributes* rather than *behaviour* and occur infrequently
- Also need data from numerous scales (e.g. pattern oriented modelling; Grimm et al. 2005)

Understanding social behaviour

- How to estimate leisure times / locations?
- Where to socialise?

# Crowd-Sourced Data for Social Simulation



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## Movement towards use of massive data sets

- Fourth paradigm data intensive research (Bell et al., 2009) in the physical sciences
- “Crisis” in “empirical sociology” (Savage and Burrows, 2007)

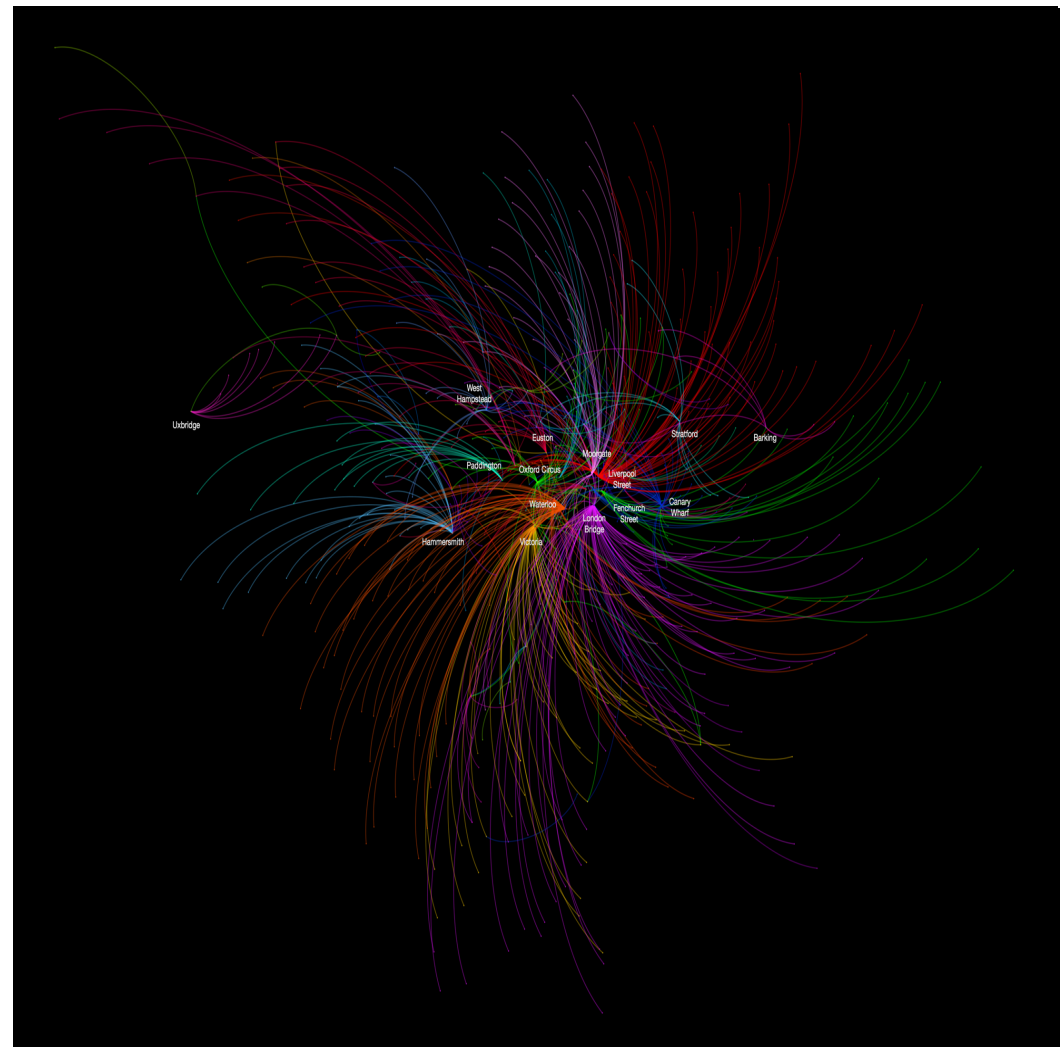
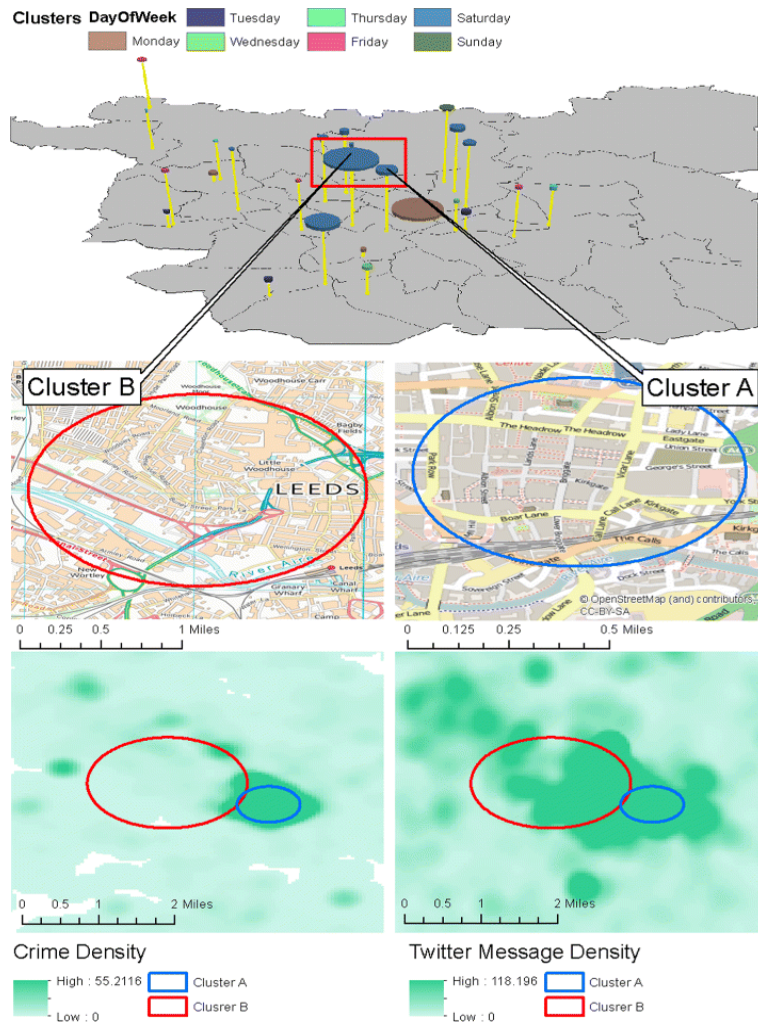
## New sources

- Social media
  - Facebook, Twitter, Flickr, FourSquare, etc.
- Volunteered geographical information (VGI: Goodchild, 2007)
  - OpenStreetMap
- Commercial
  - Loyalty cards, Amazon customer database, Axcion, mobile phones, Oyster cards, etc.

# Ambient Populations and popular underground stations



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Malleson and Andersen (2015)

Acknowledgement: Ed Manley <http://urbanmovements.co.uk>



# Problems with Big Data



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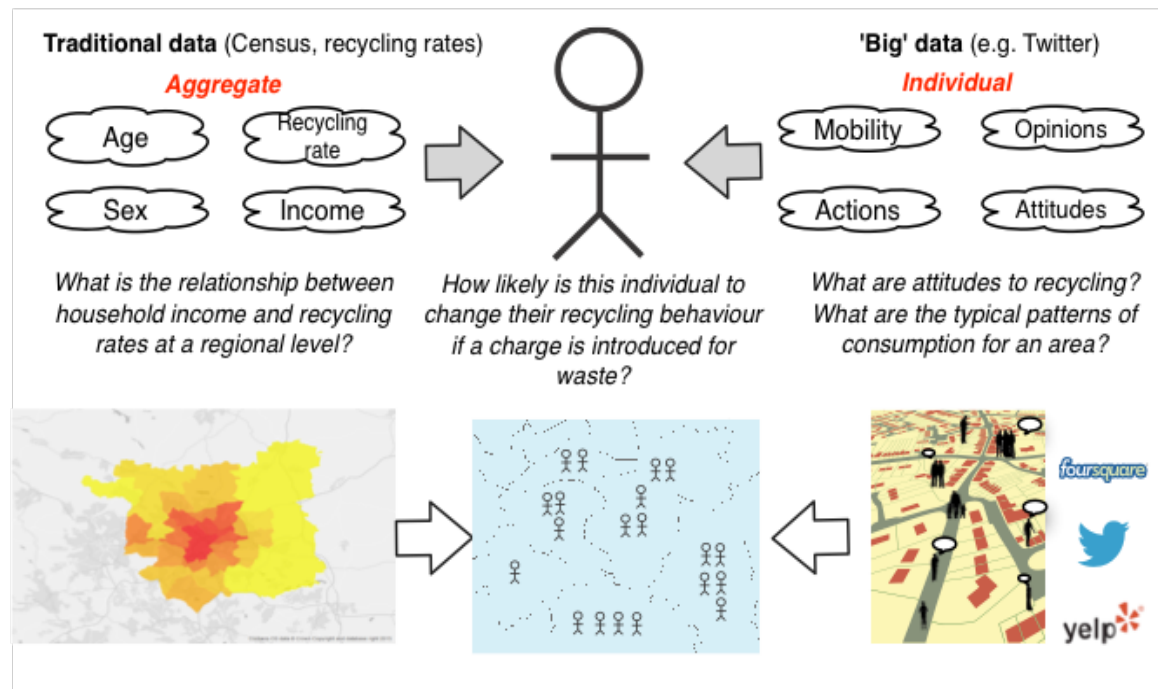
- Data handling and processing
- Analysis tools
- Bias: Which groups of people are absent from the data?
- Reliability: How accurate are GPS coordinates? Can you derive a person's intended meaning from short texts?
- Ethics...



# Unlocking agents...unlocking big data (BD)



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There is a need to exploit BD to unlock the potential of ABM, but also for ABM to leverage more out of BD. By building ABMs with BD, we can simulate society, across many application areas, in terms of who, where, what and why?

# Only Geographers can save the world



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“So many of the world's current issues – at a global scale and locally - boil down to geography, and need the geographers of the future to help us understand them. Global warming as it affects countries and regions, food and energy security, the degradation of land and soils from over-use and misuse, the spread of disease, the cause and consequences of migration, and the impacts of economic change on places and communities. These are just some of the challenges facing the next generation, which geographers must help solve”.

Michael Palin, Guardian, 18/08/11

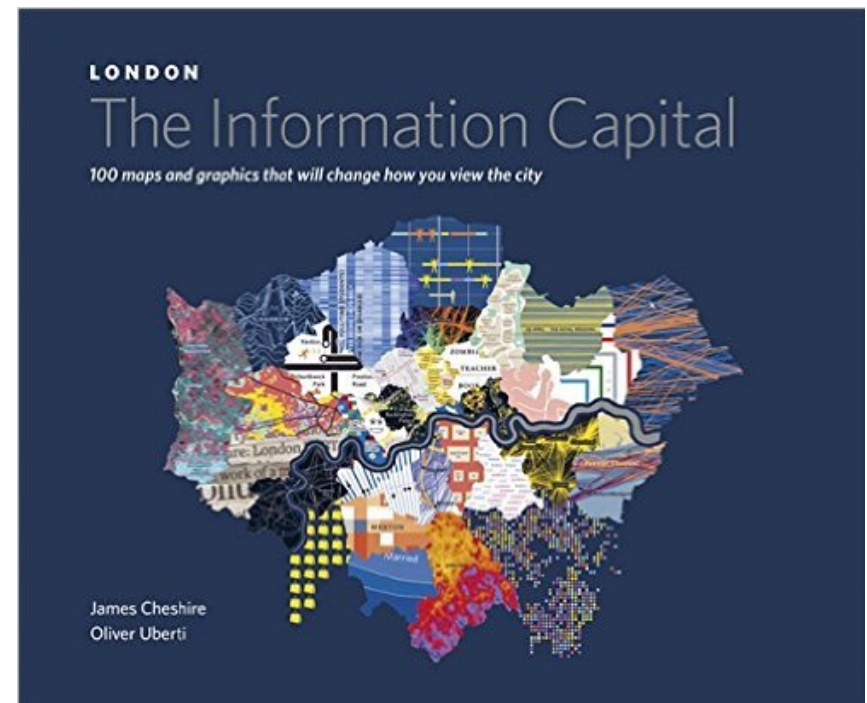


# Skills? Knowledge?



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- Coding
- Statistics
- Web-GIS
- Infographics
- Complexity
- Philosophy (Ethics)
- Oh yes, and some Geography

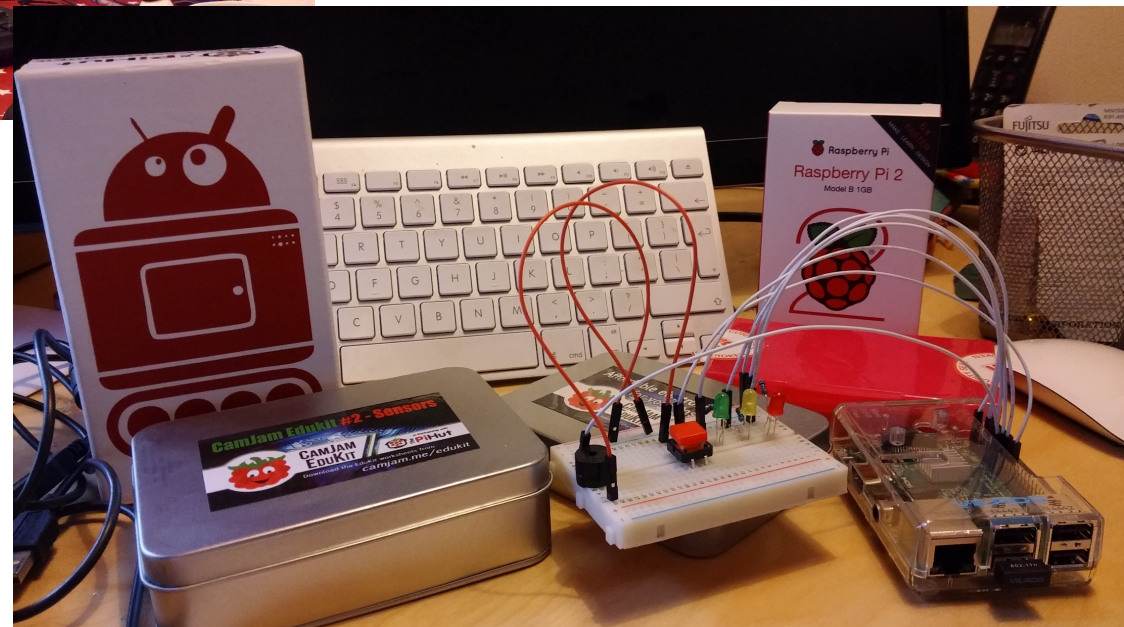




# How we teach: bottom-up...



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# ...and top down



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## GEOG3150 - GIS, Geocomputation and Geoplanning - Semester 2

[Home](#) [Lectures](#) [Practicals](#) [Seminars](#) [Project](#) [Resources](#)

### Welcome to GEOG3150 Semester 2

This website is for Semester 2 of GEOG3150 - GIS, Geocomputation and Geoplanning.

Use the links above to navigate to relevant parts of the course. Also see:

- [Course Outline](#)
- [Contacts](#)

(Don't use Internet Explorer)



### Reading List

The reading list for the course, which will be updated as the course progresses, is available

### Twitter

GEOG3150 has a [Twitter account](#). You can tweet to the account to ask questions about information about the course.

You can also follow the lecturers' personal twitter accounts

[Follow @GEOG3150](#)

[Follow @nickmalleon](#)

[Follow @ajheppenstall](#)

### Programming for Social Scientists

Welcome! These are materials associated with the 'Programming for Social Scientists' Summer School. You're very welcome to work through them independent of that. There's ~70 hours of materials/practicals. The lectures teach Java, and the practicals demonstrate this by building a basic Agent-Based Model. The Summer School uses these materials, but also offers a week-long period of support, two days of which are given over to developing your own code. We're not sure of the details for the 2016 School yet, but feel free to email [Andy Evans](#) if you want to be sent details later.

#### Software you'll need before the first practical, and tutorials

Even if you have these, check these pages and make sure you know how to use them fully:

Command Prompt  
Windows Explorer  
JDK  
Notepad++  
Firefox/Chrome

#### Welcome!

Though this isn't a MOOC, and we can't offer online support to non-attendees, we're always pleased to see who is using the materials and hear how we can make things more useful. If you're working through the materials, please do feel free to join the Facebook group below.

[Facebook group](#)  
[Extra materials](#)  
[Feedback form](#)

#### Info

[Course overview & Staff](#)  
[Why Java?](#)  
[Hacking sessions](#)  
[Extra materials & Tech](#)  
[Evening sessions & Social](#)  
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[Helpful links](#)  
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[Practice pieces](#)  
[Course cookbook](#)  
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Signing between lectures and practicals

Day one

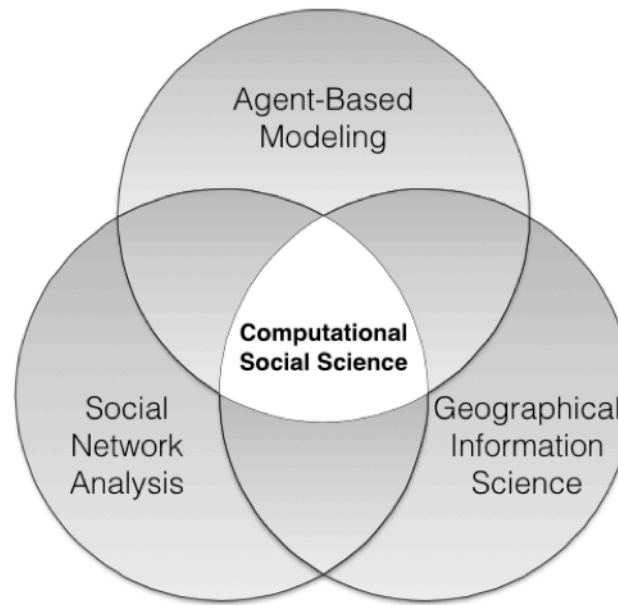
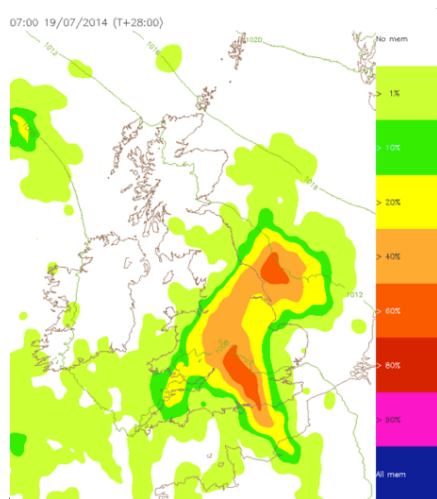
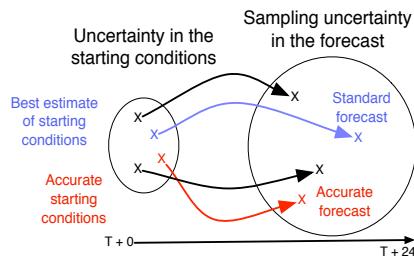
Introduction

Practical

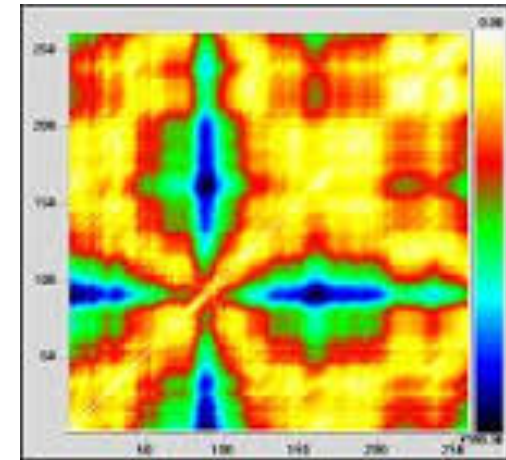
# Repositioning of Geocomputation?



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[www.gisagents.org](http://www.gisagents.org): Andrew Crooks



## Urban Data Science Toolkit

A collection of projects for urban spatial analysis and simulation

San Francisco, CA <http://www.udst.org/> [udst@autodesk.com](mailto:udst@autodesk.com)





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**“I find your lack of faith disturbing”**

**Thank you!**