A report for the workshop "Enhanced Urban Living through Data Analytics: Towards a techno-social theory and practice of urban management"

Dr Erica Yang, Scientific Computing Department, Rutherford Appleton Laboratory, STFC
Prof Jon Coaffee, Warwick Institute for the Science of Cities, University of Warwick
Prof Peter Fussey, Department of Sociology, University of Essex
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Context

There is growing emphasis on cities, both in the UK and worldwide. These are increasingly becoming the focal points not just for growing populations but also powerhouses of creative expression and economic activity, as well as the sites that produce and receive a range of globalising processes. However, while the trend towards increasing urbanisation seems to be accelerating, and bringing with it benefits for many, there are some significant challenges which have yet to be adequately addressed. Not least, how these environments can achieve an appropriate balance between promotion of the potential benefits and challenges to wellbeing of the inhabitants. Achieving this goal requires careful planning of the built environment, and evaluation of alternative designs to determine which comes closest to meeting various (sometimes contradictory) criteria.

Computing is widely used by civil engineers to design structures, urban planners to examine traffic flows on road networks and so on. These have been very successful, and have contributed related significantly to the development of world many of us now inhabit. However, current applications of computing tend to focus on physical elements of the environment which can be analysed using well established methods.

Background

This is a report for the interdisciplinary workshop entitled "Enhanced Urban Living through Data Analytics: Towards a techno-social theory and practice of urban management". It was funded by the STFC Global Challenge Exploration Award to facilitate the exploration of potential applications of high capability analytical computations for urban planning and management, particularly focusing on the interface between large scale analytical capabilities enabled through STFC national laboratories and those offered by social science research communities.

The aim of the workshop is to create a forum for discussion for how we might enhance urban living and urban management through research that utilises a range of integrated technological and sociological methodologies. We also seek to identify common aims and approaches and highlight any challenges and operational constraints to balancing technological and socially-focused urban visions. In this workshop, the technological potentials of high end computing for urban management and planning are considered and supplemented with expertise from social science. We believe that this could help to generate and evaluate the different configurations of key components of the urban environment (housing, open and recreational spaces, services etc.), and the management of urban populations and processes, based on the balanced understandings of how people interact with their environment and the sociological considerations that are critical to the longer term sustainability of such designs and the well-beings of the inhabitants. Such an approach, which explicitly places people not just at the very centre of the design process but treats their behaviour as a key determinant of the success (or otherwise) of the design, if feasible, be a radical and exciting departure from current methodologies.

The workshop[1] was held on 20 March 2015 at the Rutherford Appleton Laboratory. It brought together a variety of stakeholders, including

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[1] For the detailed workshop contributors, please see Appendix A.

- Practitioners from the industry
- Academics from urban geography, computer science, and sociology
- Representatives from city and county councils
- Representatives from research funding bodies - STFC and ESRC
- Researchers from STFC funded programmes from a variety of disciplines, including mathematical optimisation, computer simulation, computer systems, data analytics, visualisation
- Researchers from ESRC funded programmes from the following areas: mobility modelling, and information retrieval

The workshop was hosted by Dr Erica Yang of Scientific Computing Department from STFC, Prof Jon Coaffee of Warwick Institute for the Science of Cities from University of Warwick, and Prof Pete Fussey of Department of Sociology from the University of Essex.

Users' Priorities and Opportunities for STFC Capabilities

A. Scene setting and research horizon

Glen Noble from ESRC Urban Transformations programme highlighted the evolving landscape of research funding programme in relation to cities and urban environments. The ESRC has been invested heavily in its data infrastructure programme, represented by the Urban Big Data Centre (UBDC) based at the Glasgow University, and ESRC Business and Local Government Data Research Centre and the large grant on Human Rights and Information Technology in the Era of Big Data (both at the University of Essex). In the cities' context, issues, challenges and solutions are rarely technical or social, but both. This has led to increased funding support for cross disciplinary and cross research council funding programmes.

B. Utilising urban data

Key messages – Critical infrastructure
- Real world data analytics for critical infrastructure is very data intensive, for example, the number of physical assets can be in the order of 10s of millions
- Optimisation for cost reduction, for example, using predictive maintenance to minimise the need for major maintenance work is a key goal
- However, there is a fine balance between optimisation and resilience (via redundancy) because of the critical nature of infrastructures

Key messages – Interactions with physical spaces
- The remit of information retrieval is being extended and applied to gather information of how users interact with physical objects in the urban context
- Passive and anonymised tracking mechanisms, for example, via GPS or video, are being used in experimental systems to observe how people move within cities
- However, in a large space within a city, the challenge is to automatically gather and identify the context, which is difficult to detect or infer accurately

C. Understanding social processes in cities

Key messages – long term planning of regional developments

- In large scale master planning, it is difficult to get feedbacks – census, historical data are most typically used to produce projections
- However, to make sure the plans are robust, certain modelling and simulation technologies, e.g. transport modelling systems are used
- Plans typically take 4-5 years to make. However, monitoring and keeping up with real world situations (traffic, housing demand etc.) are hard to meet at the council level
- New types data (e.g. social media) are not being used in the planning process, due to resource constrains and uncertainties of political implications associated

Key messages - Social science perspectives on data issues

- Does data speak for themselves? From social science's point of view, it is important to understand and systematically investigate the inherent assumptions and limitations of data analytics approaches.
- There is a need to be aware of what is revealed by specific data collection and analysis practices and what remains concealed. Overcoming this is key to the optimisation of urban processes for the benefit of all across social groups.
- What are the hindrances (regulatory, ethical, data currency, commercial sensitivity, degrees of confidence in the data etc.) to collecting this information? How can they be addressed?
- Are we too worried about privacy? Are we too obsessed about privacy, i.e. using private/personal images or data for analytical purposes? However, counter arguments present the view that (a) other rights are freighted on issues of privacy (i.e. violations of privacy may incur violations of other rights such as mobility or association) and (b). that privacy is not the ethical/social cost of data collection and analysis (e.g. restrictions on access to credit or services)..

D. Advancing new computational techniques

Key messages – capabilities from STFC national labs

- Fine mathematical libraries exist to solve large scale optimisation problems for systems with millions of variables
- Data is important to mathematicians to derive and validate optimisation strategies
- Optimisation builds atop of mathematical modelling, in other words, if models are incorrect, for example, based on certain types of data, and hence, incorporating certain types of bias, optimisation in itself will not identify or address such problems
- Codes for urban flow modelling (e.g. traffic flow, environmental pollution, flooding) are now moving onto petascale software development: these codes can exploit large scale parallel processing architectures to produce complex simulation scenarios
- Large scale display and visualisation technologies can provide the infrastructure underpinning needed to solve urban challenges, for example, via urban command and control centres for urban traffic control and monitoring
- STFC national laboratories have significant experience in designing, building, and deploying real time TB scale analytical systems that can be adapted to address the analytics challenges in the urban context

- End-to-end and cross silo data sharing and integration are important components of the systems for STFC national labs. These could be potentially significant for the urban systems.
- Applications of these large scale analytical systems in the urban context are
  - Analysis of critical infrastructure, predictive maintenance, and mobility pattern analytics in smart cities
  - Complex urban systems that require a spectrum of perspectives that involve manipulation and processing of diverse data streams/sources
  - Near real-time decision making and what-if scenarios feedback mechanisms to equip city planners with better tools and methodologies to quantify and evidence their decisions

E. Challenges of balancing social and technical urban visions

Key messages from city practitioners
- From city governors' point of view, there is a need to understand and design interventions based on how cities work as complex adaptive systems, particularly, how they evolve over time. This would allow decisions to be based on the most cost-effective pathways to outcomes

Key messages from a social resilience perspective
- Need to bring the social and techno understandings of cities under one umbrella
- Need to balance the quest for optimisation, efficiency needs of cities with resilience of cities, its citizens
- Need to understand the social implications of smart cities and social resilience

Moving forwards

This workshop has started a useful dialogue between social scientists and computer scientists and illuminated a range of cross-disciplinary issues in the urban management context. However, they are very different communities: both have a vast range of established research methodologies and approaches. Whilst the participants are enthused by the prospect of a jointly developed integrated approach to address urban challenges, more work needs to be done to make that happen. This is critical as many urban challenges we face can no longer be captured, understood, and addressed in an isolated fashion from a single discipline. The longevity nature of urban issues demand integrated technological and sociological methodologies that can be understood, elaborated, and taken forward by both. As highlighted throughout the workshop discussion, there is an urgent need to establish a common framework and a jointly developed research agenda to facilitate trans-disciplinary interactions so that not only the aims, languages, and approaches between the disciplines but also those across different stakeholders (e.g. research and industry, and research and city administrations) can be better understood and communicated.

Acknowledgement

Appendix: Workshop Contributors

A. Scene setting and research horizon
- Bryan Edwards, STFC Futures Programme -- a current perspective from RCUK urban debate
- Glen Noble – Economic and Social Research Council - City and Urban portfolio manager

B. Utilising urban data
- Jason Allan IBM Senior Managing Consultant
- Katarzyna Sila-Nowicka, Urban Big Data Centre, Glasgow University
- Yashar Moshfeghi, Urban Big Data Centre, Glasgow University

C. Understanding social processes in cities
Social process tends to be forgotten/under-represented

- Tom Rice, Planning Policy Officer, Science Vale planning and development, South Oxfordshire District Council and Vale of White Horse District Council -
- Pete Fussey, University of Essex

D. Advancing new computational techniques
Data analytics – questions – how operational issues emerge from the urban context

- Tyrone Rees - SCD/STFC, Large scale optimisation
- Stefano Rolfo - SCD/STFC, Modelling and Simulation
- Srikanth Nagella - SCD/STFC, large scale visualisation and infrastructure
- Erica Yang, SCD/STFC, Advanced Data Analytics

E. Challenges of balancing social and technical urban visions

- Jon Coaffee, University of Warwick
  Richard Kenny, Head of Strategy, Birmingham City Council