Planning for the next generation: developing a generic social science model for UK planning in the next 10-15 years

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ABSTRACT
This study is part of a UK e-social science project, MoSeS. The research program is centered on an individual based dynamic simulation of population using a hybrid approach that tries to bring together the strength of Microsimulation and Agent based modeling, in an attempt to capture the interactions between the policy and population changes in the model and explore the opportunity to enhance simulation and modeling of social complexity. We aim to use the power of e-science technologies to create a model of the population which draws on rich attributes of individuals and households from a diverse portfolio of databases and to provide a generic framework for social scientists and decision makers with a shared interest in modeling and simulation for e-social science problems.

Keywords
Individual Based Model, Microsimulation, Agent, Complexity

1. INTRODUCTION
MoSeS is the UK e-social science node that focuses on modeling and simulation. As part of the project, this PhD research program aims to develop a hybrid spatial Micro Simulation Model (MSM) of a local and regional system in UK. Comparing to previous studies, this study attempts to provide a model of the interaction between the public policy development and the population evolution by introducing agents into the spatial MSM in the bid that it will strengthen capability of modeling the interactions and behaviors. This study aims to develop dynamic model of a population with rich attributes drawn from various sources at a fine spatial scale; to produce rich, detailed and robust forecasts of the future population and provide a generic framework for the social scientists and decision makers with an interest in e-social science modeling and simulation. This paper reports the progress made on the dynamic simulation to the current date and discusses the challenges of this research.

2. MOSES DYNAMIC MODEL
The current MoSeS Dynamic Model currently uses a population within Leeds, West Yorkshire as an example, using UK 2001 census data and BHPS (British Household Panel Survey) data. The core of the Dynamic Model is the Population Model that dynamically simulates the modeled population through various demographic processes.

2.1 Population Model
The Dynamic Model design adopts a bottom-up approach. Individuals are simulated at the ward level to retain the individual characteristics of the population within local context. The Dynamic Model provides annual projections of population by gender, single year of age and area during 2001-2031. The model projects each component of population change (births, deaths, marriage, health change and migration) separately, but each component of change affects the other components of change. Eg. Migration may increase the population of young women in an area and result in an increase in the local births etc. The Dynamic Model is driven by probabilities used in the six demographic processes. Household formation and dissolution can also be observed as a consequence of such processes. The simplified process is illustrated in Figure 1.

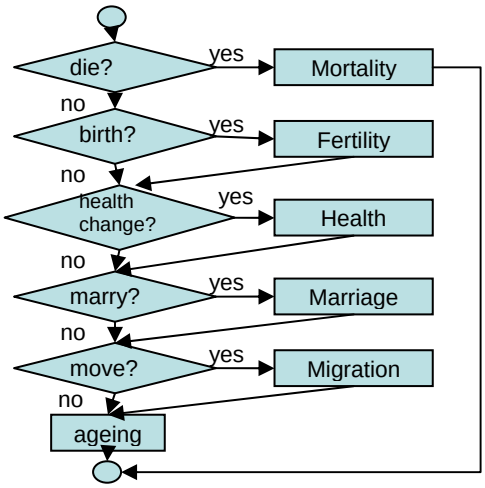

Figure 1. Population simulation process

2.2 Hybrid Modeling Approach
MSM and ABM (Agent Based Modeling) are two important approaches of IBM (Individual Based Model) that can provide characteristics at individual level for modern policy studies. MSM has been extensively applied in the public policy domains ranging from tax-benefit, pension, health to transport policies. Spatial MSM simulates virtual populations in given geographical areas so that local contexts can be taken into account when studying population characteristics and analyzing the policy impacts [1]; [2]. However, MSM are less strong in behavior modeling and most MSM only models one-direction interactions: the impact of

the policy on the individuals but not the other way around [3]; [4]; [6].

ABM is used to strengthen the capability for behavior modeling, which is important for complex demographic processes such as Marriage and Migration. It allows us to study the interactions between the policy and population at both macro and micro levels, as well as in both directions. It can also provide insight into the structure and effects of policies and understanding and modifying behavior and interaction patterns [5].

3. PROGRESS AND PROBLEMS

MoSeS Dynamic Model v1.0 has been released and the initial analysis of 30 years' simulation results has been carried out. The population change over time such as the ageing pattern can be observed from population pyramids generated by the microsimulation to facilitate high level decision making.

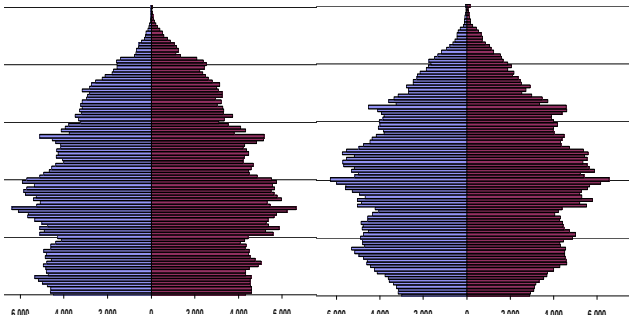

Figure 2 Leeds population change

However, limitations were found when analyzing the tactical decision support need at the ward level. For instance, in wards where student migration has a great impact, the microsimulation failed to reproduce the student population renewal. A hybrid approach combining ABM techniques is therefore adopted to strengthen the modeling of such subtlety of the local migration patterns and the behavior modeling of the student migrants.

By applying rules to different types of "student agents", the model presents a better reflection of the observed student population in wards of Leeds. Instead of students scattering around the whole city and even some over-representation of student population in suburban areas, the hybrid model projection indicates that students tend to live around the universities in the city center. Due to the replenishment of student population each year, the population stays younger in these areas (Figure 3 and 4).

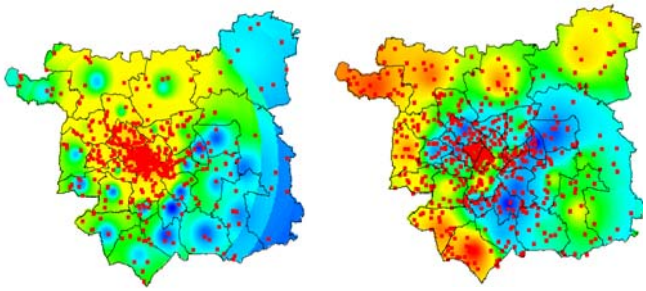

Figure 3 Leeds students: observed and MSM result

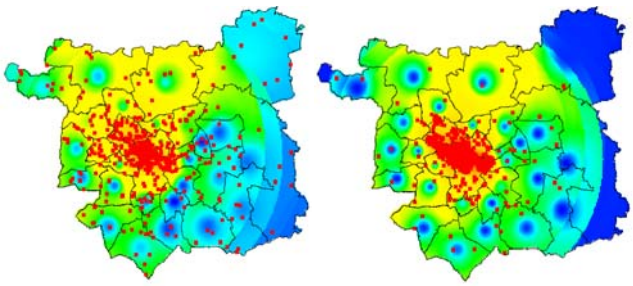

Figure 4 Leeds students: observed and ABM result

4. FUTURE WORK

MoSeS Dynamic Model v1.0 has been used to simulate more than 720,000 individuals of Leeds for 30 years, each with over 100 attributes drawn from different data sources.

Initial analysis has been conducted on the simulation results. We want to learn from the base scenario runs and identify further development so it reflects the reality and various policy scenarios.

The next challenge would be to consider more sophisticated interactions between individuals and between individuals and their environment (eg. housing market) during more complex demographic processes such as Marriage and Migration.

We expect the fine tunes of the individual based model to lead to better representations and forecasts of the UK population, thus provide a generic framework for strategic planning and various research interests in e-social science modeling and simulation.

5. ACKNOWLEDGMENTS

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