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# Some Issues in the Construction and Validation of a Large-Scale Social Simulation Model

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# Moses:

## Modelling and Simulation for e-Social science

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

NCeSS National Centre for e-Social Science

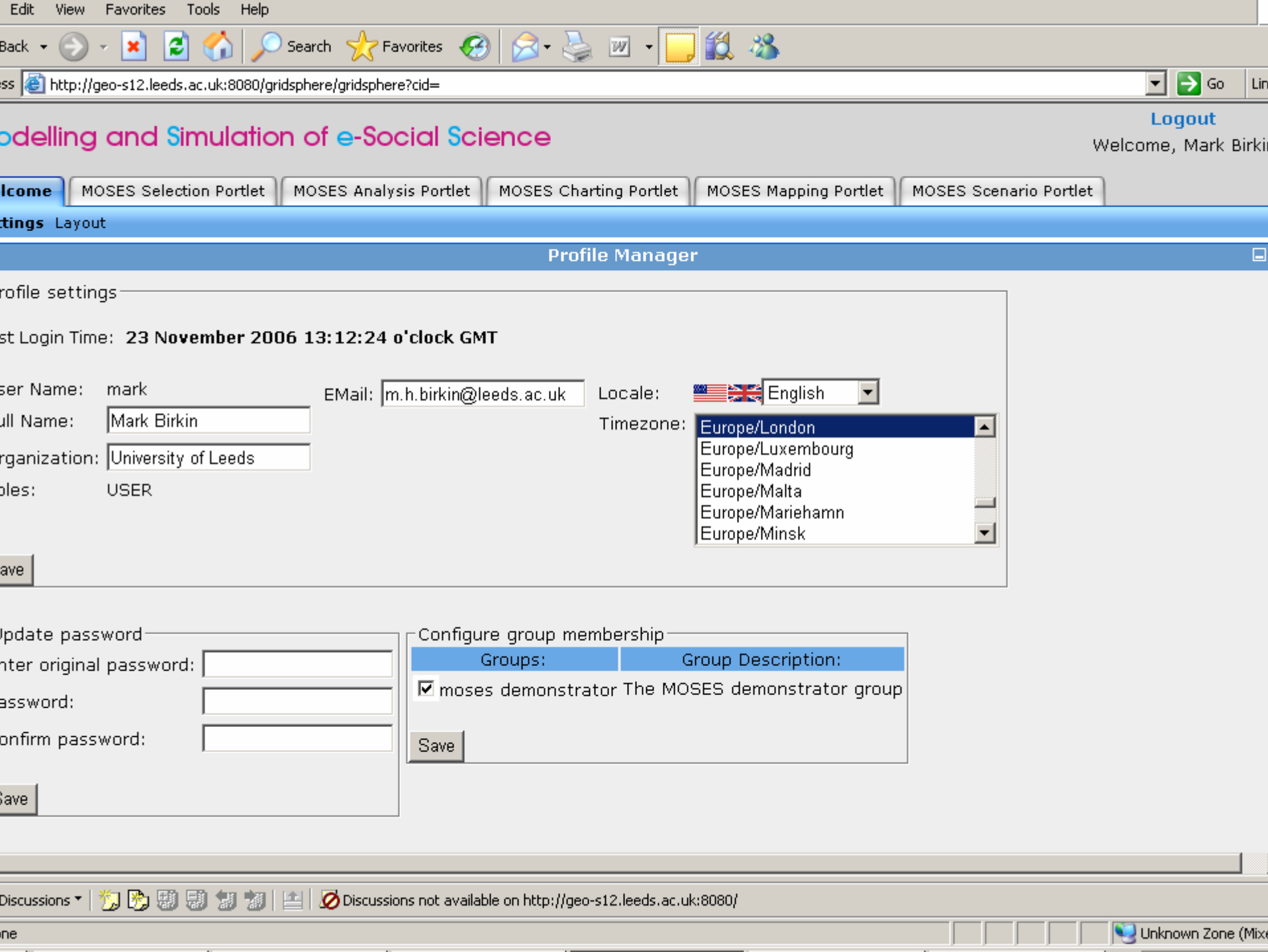
# Objectives of the Project

Build a simulation model of the UK population

Forecast the population 25 years into the future

Incorporate behaviours in the uptake of services like transport, health and housing

Use all this as a basis for analysis of social policy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MOSES Selection Portlet
MOSES Analysis Portlet
MOSES Charting Portlet
MOSES Mapping Portlet
MOSES Scenario Portlet
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ser Name: mark
ull Name: Mark Birkin
rganization: University of Leeds
oles: USER
EMail: m.h.birkin@leeds.ac.uk
Locale: English
Timezone:
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moses demonstrator The MOSES demonstrator group
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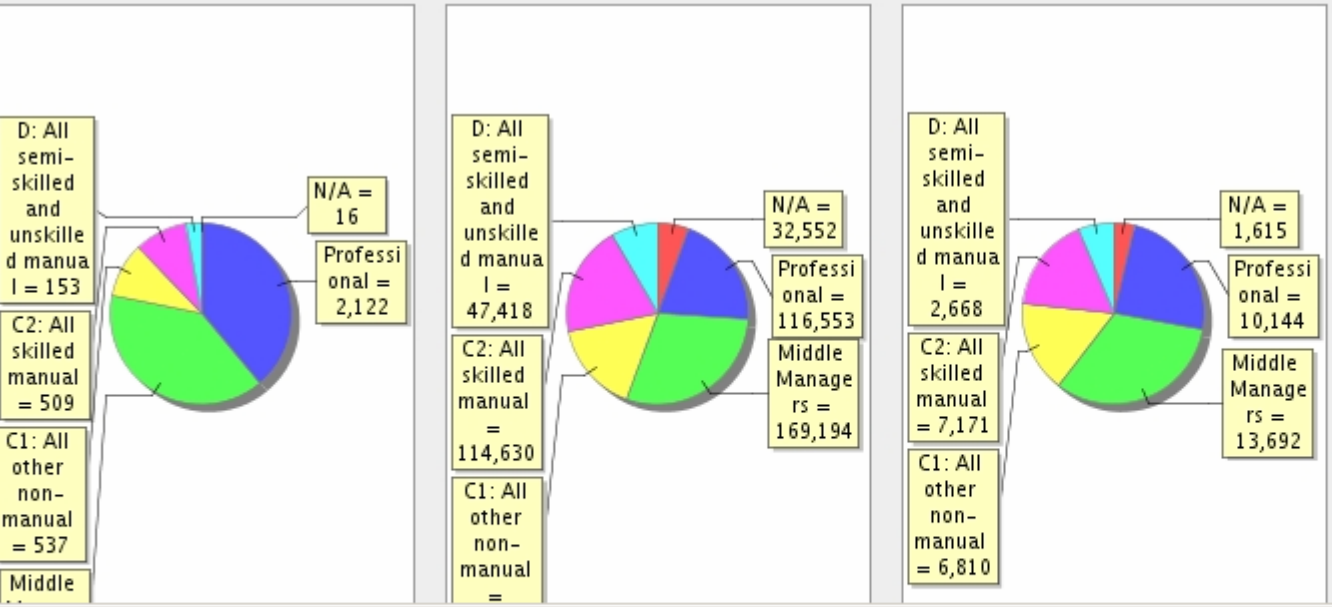
| cial Grade | N/A | No care | 1-19 hours | 20-49 hours | 50+ hours |
|---|---|---|---|---|---|
| A | 16.0 | 32552.0 | 1615.0 | 671.0 | 2388.0 |
| ofessional | 2122.0 | 116553.0 | 10144.0 | 1005.0 | 1401.0 |
| ddle Managers | 2155.0 | 169194.0 | 13692.0 | 1658.0 | 2429.0 |
| : All other non-manual | 537.0 | 92425.0 | 6810.0 | 1186.0 | 1834.0 |
| : All skilled manual | 509.0 | 114630.0 | 7171.0 | 1806.0 | 2702.0 |
| All semi-skilled and unskilled anual | 153.0 | 47418.0 | 2668.0 | 860.0 | 2281.0 |

## MOSES Provision of care vs Social grade for the year 2001



**portions of people with diabetes:**

e following is a breakdown of the health scenario results, based on the selected wards:

tal aggregation for all selected areas:

| e | 2001 | 2015 | 2025 |
|---|---|---|---|
| 15 | 0.24 | 0.23 | 0.2 |
| tal affected | 327.0 | 267.0 | 221.0 |
| tal population | 135660.0 | 117491.0 | 112344.0 |
| -44 | 1.51 | 1.5 | 1.47 |
| tal affected | 4211.0 | 3624.0 | 3429.0 |
| tal population | 278593.0 | 241560.0 | 232915.0 |
| -64 | 4.1 | 3.53 | 3.4 |
| tal affected | 5710.0 | 6036.0 | 5968.0 |
| tal population | 139270.0 | 171178.0 | 175710.0 |
| + | 10.35 | 10.36 | 9.62 |
| tal affected | 9013.0 | 11949.0 | 12817.0 |
| tal population | 87062.0 | 115305.0 | 133292.0 |
| ages | 3.01 | 3.39 | 3.43 |
| tal affected | 19261.0 | 21876.0 | 22435.0 |
| tal population | 640585.0 | 645534.0 | 654261.0 |

wick and Kinnay:

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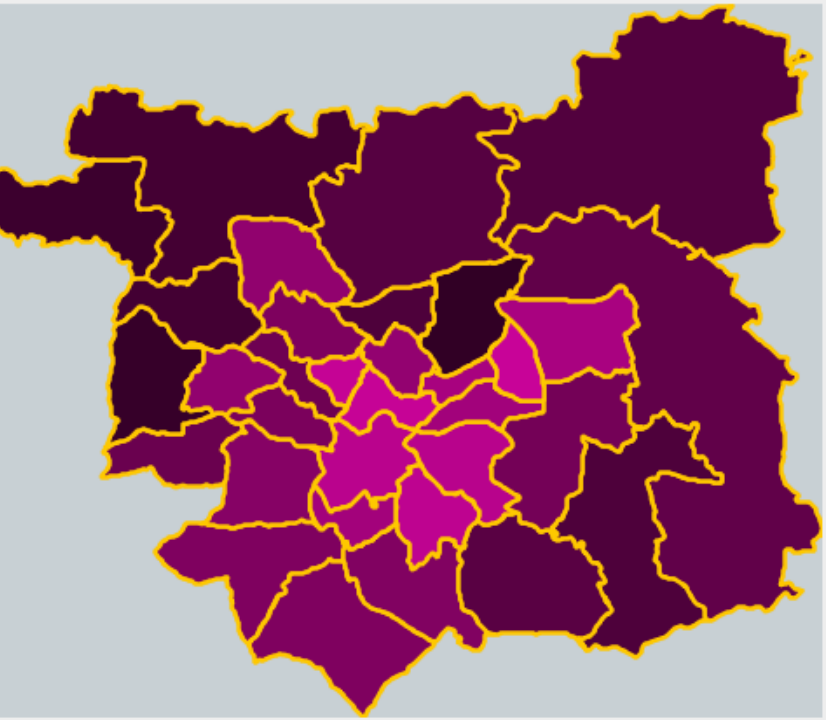
Go

SES Mapping Demonstrator

## The MOSES mapping demonstrator

lcome to the MOSES mapping demonstrator.

s portlet generates shaded maps based on various analyses performed by the MOSES Analysis portlet.
rou haven't run an analysis yet, then please do so. Else, choose an analysis from the drop-down menu below.



| Ward | Car Ownership per household |
|---|---|
| Barwick and Kippax | 1.06 |
| Pudsey North | 1.14 |
| Kirkstall | 1.03 |
| Weetwood | 1.0 |
| Horsforth | 1.11 |
| Cookridge | 0.97 |
| Middleton | 1.0 |
| Rothwell | 1.07 |
| Hunslet | 0.88 |
| City and Holbeck | 0.89 |
| University | 0.87 |
| Morley North | 1.0 |
| Richmond Hill | 0.9 |
| Burmantofts | 0.94 |
| Halton | 1.02 |
| Roundhay | 1.14 |
| Whinmoor | 0.92 |
| Moortown | 1.09 |
| North | 1.08 |

Discussions Discussions not available on http://geo-s12.leeds.ac.uk:8080/

one Unknown Zone (Mix

| Target Population | Prevalence / Incidence Data | Examples of Data Sources[1] | Examples of some questions to consider |
|---|---|---|---|
| Older People (OP) | Limiting long term illness<br>Physical Disability<br>Limiting Long-Term Illness (LLTI)<br>Sensory Impairment<br>Cardiovascular Disease (eg stroke / heart attack)<br><br>Ethnicity | Census 2001<br>DoH – Health Survey for England 2004<br>Health Survey for England 2000 (DOH)<br>Census 2001 (Theme Table 06)<br>Ageing: Scientific Aspects (House of Lords)<br>Public Health Observatories<br>Policy Research Institute on Ageing & Ethnicity | Can self-reported limiting long term illness be validated against other data sources?<br>Does the profile for LLLI correlate with other data eg morbidity data?<br>Which wards / localities have the most OP with LLTI?<br>Is their a correlation with the distribution of services eg home care, equipment and adaptations, hospital admission data.<br>Can a small area analysis validate the city-wide picture?<br>Is there any correlation between the current distribution of services and the proximity to District centers (eg for shopping) and health care facilities.?<br>Is there any significance in the age, geographical distribution) of people who attend day centers for older people?<br>What is the likely impact for service delivery arising from the projections for growth in ethnic minority population, (both in numbers and the age profile of the projected increases in numbers)?<br>What is the current and future likely level of co-dependency among older couples. |

[1] Full references, together with a list of other sources, can be found at Appendix A.

# Methodology

The simulation is constructed from 20 million households and 60 million people, represented as individual entities with several hundred characteristics

Despite the apparent complexity, this is the most efficient and most accurate way to represent and manipulate a large and diverse population

# Methodology: Example Calculation

10,000 zones

10 age groups

10 occupations

5 household types

5 levels of health status

4 levels of educational attainment

4 ethnic categories

- already have an array with 400 million elements!

# Methodology

Representation of the population as a list of individuals also has advantages for modelling dynamic processes; and for merging information from diverse sources e.g. longitudinal surveys (BHPS, Health Survey for England…)

Technique of spatial microsimulation now well established as a policy analysis tool

# Spatial Microsimulation

Examples:
- Corsim
- DynaCan
- Sverige
- Pensim
- Natsem
- Smile
- EuroMod

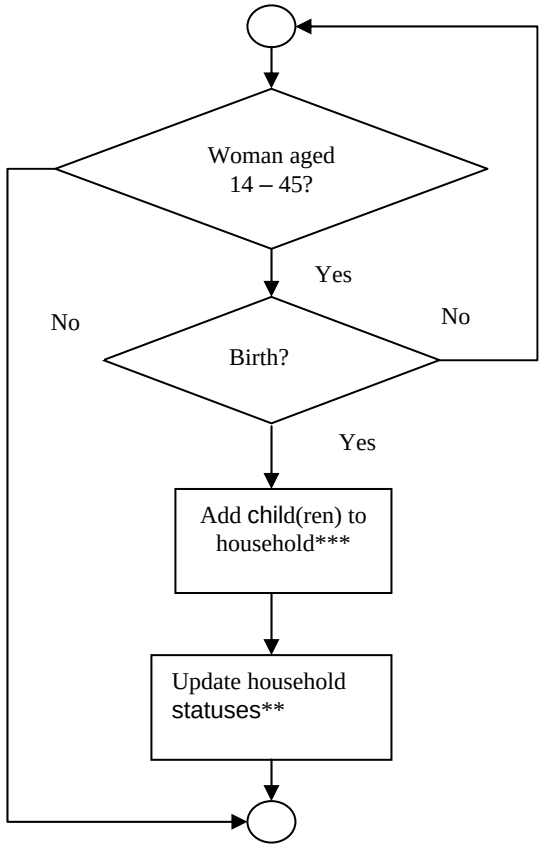
# Spatial Microsimulation

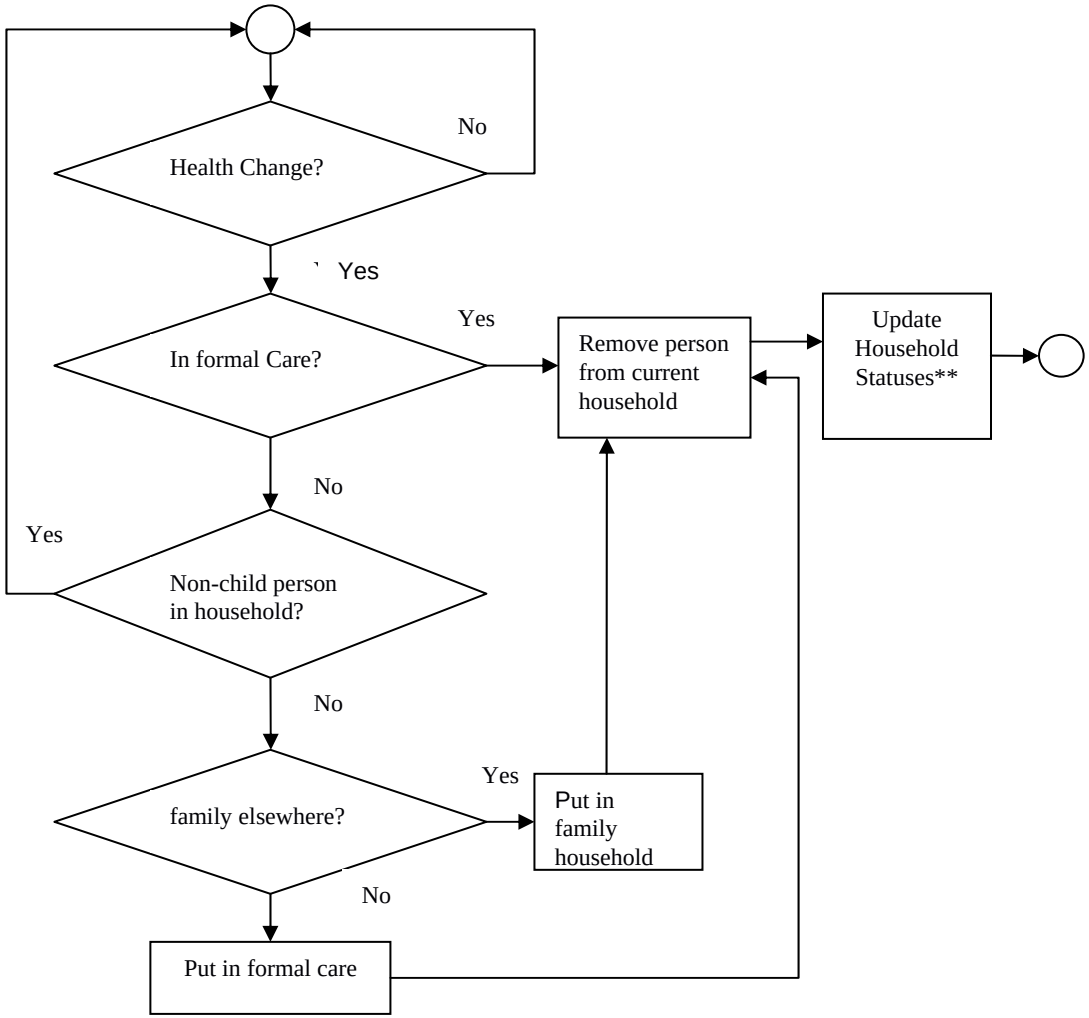
Individual entities usually treated as discrete and non-interacting within the simulation

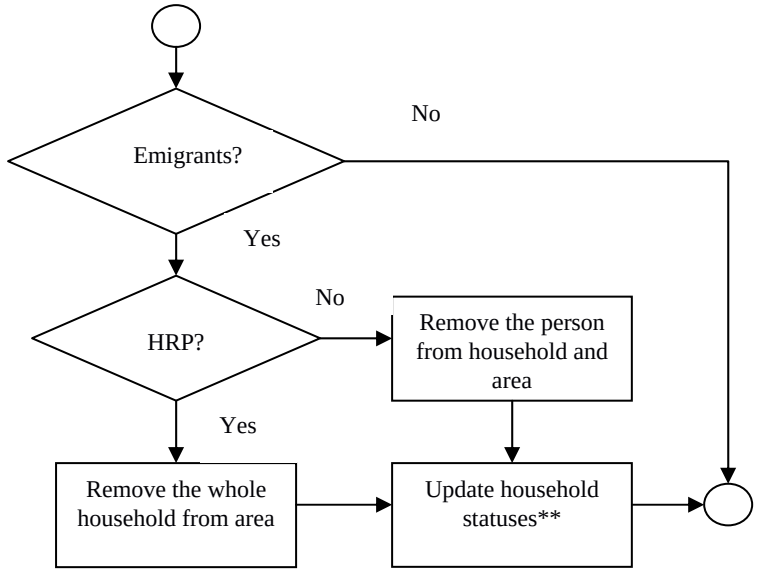
This level of independence is unrealistic for the purpose of modelling many social and demographic processes e.g household formation and dissolution; informal care

Therefore it seems logical to assume that the simulation has at least some characteristics of a **multi-agent system**

- Tend to refer to Moses as a **hybrid** between micro- simulation and a multi-agent system


Woman aged 14 – 45?
Yes
No
Birth?
No
Yes
Add child(ren) to household***
Update household statuses**


Health Change?
No
Yes
In formal Care?
Yes
Remove person from current household
Update Household Statuses**
No
Yes
Non-child person in household?
No
family elsewhere?
Yes
Put in family household
No
Put in formal care


Emigrants?
No
Yes
HRP?
No
Remove the person from household and area
Yes
Remove the whole household from area
Update household statuses**

# Methodology

Building a model to represent 60 million individuals and their interactions is not difficult with current computational resources

But **getting it right** is still a considerable challenge

Question of **validation** is therefore a key concern

# Two Questions about MAS

Is it possible to build reasonable models with 60 million agents?

Is it possible to calibrate MAS for policy applications?

- Models as exploration, communication and learning. Embrace complexity
  - Pahl-Wostl & Brugnach (2006)
- Strategic modelling. Simplify complexity
  - Popper, Lempert, Bankes(2005)

# Two Questions about MAS

## Is it possible to build reasonable models with 60 million agents?

- Yes, although the level of detail which can be maintained is debatable (e.g. Parry, 2006)

## Is it possible to calibrate MAS for policy applications?

- It has to be!

# Validation of the simulation

Useful to distinguish between the baseline model and the dynamic model

There are some difficult challenges in validating the baseline model

But the problems of validating a dynamic model are an order of magnitude harder again

In essence, because of the dimensions of the **uncertainty** in the problem

# Baseline Model

If we have reasonable sources of data about individuals and about the population, then we can view this as an optimisation problem

But with issues:

- What are the most appropriate variables for the optimisation?
- Is there a single baseline?
- How reasonable are the data sources?
- Etcetera!

# Dynamic model validation

Some suggested approaches:

- Update the model from 2001 to 2007 and compare with known trends
  - Problem: current data is not complete
- Benchmark the model to 1991 and calibrate the model to 2001
  - Problem: data inconsistencies; baseline model 16 years out of date
- Run the model backwards from the present to 2001/1991
  - Problem: substantial extra burden of model development

# Dynamic model

The concept of the funnel of reliability is reasonably well-known, for example in health care planning

Errors at t-zero will result from uncertainty in the structure and parameters of the models

These errors will propagate into the future?

- And will in turn be impacted by changing behaviours and policies

# Dynamic model validation

None of the approaches is adequate for the problem of errors/ uncertainty

- All contingent on a single dynamic model

Need some kind of framework for the evaluation of the robustness of the forecasts

- Could evaluate the behaviour of the model against intuitive criteria – but this is a cop out!
- One possibility would be to invert the usual chain of ‘what if?’ simulation

# Dynamic model validation

## Traditional ‘what if?’ approach

- Given an assumed set of behaviours, what policy response yields the best outcome?

## Inverted ‘what if?’ approach

- What is the range of behaviours over which a recommended policy response is known to be the best outcome?
- Are some policies more robust in the face of uncertainty than others?

# Conclusions

There are a huge number of problems to overcome in trying to build realistic social simulation models and it feels as though we are trying to solve most of them in this project!

Any advice, tips and offers of assistance would be gratefully received