Modelling and Simulation for e-Social Science (MOSES)

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1. Social Simulation as a 'Grand Challenge' for e-Social Science

- There are an abundance of simulation games relating to people, cities and societies (past, present and future)
- We pose the question of what would be the impact of transferring these simulations into a real world environment?
  - –Our specific interest is in cities and regions; so can we build simulation models of interactions between individuals, groups or neighbourhoods within large metropolitan areas?

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1. Social Simulation as a 'Grand Challenge' for e-Social Science

- The advantages of this approach are potentially substantial
  - –Big policy impact if we can develop really effective predictions
  - –Potential 'wind tunnel' or 'flight simulator' analogy: planners can gauge the effects of development scenarios in a laboratory environment
  - –Use of simulations as a pedagogic tool would allow planners to refine understanding of systemic behaviour and alternative futures: an aid to clarity of thinking and improved decision-making
- The problem is also very difficult
  - –Think of the manpower invested in the development of games like The Sims™ or SimCity™ (see illustration, which shows an idealised 'policy scenario' from this game).
  - –A solution would demand integration of data from varied sources, new methods like agent-based simulation, and powerful computational resources

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2. Progress to date

- Hydra has been developed as a demonstrator of how a simulation model might be implemented to help planners within a Grid environment
  - –Geographers refer to such models as ‘spatial decision support systems’ (SDSS) (Geertman & Stillwell, 2002)
- Hydra envisages a scenario in which planners wish to distribute facilities for care around an urban area
  - –A good practical example of this would be the desire to provide cancer screening within medical practices in preference to highly centralised hospital locations (NHS, 2000)
  - –The system might also be configured to address problems such as emergency vaccinations in response to an epidemic such as Asian Bird Flu or even smallpox (Barrett et al, 2005)

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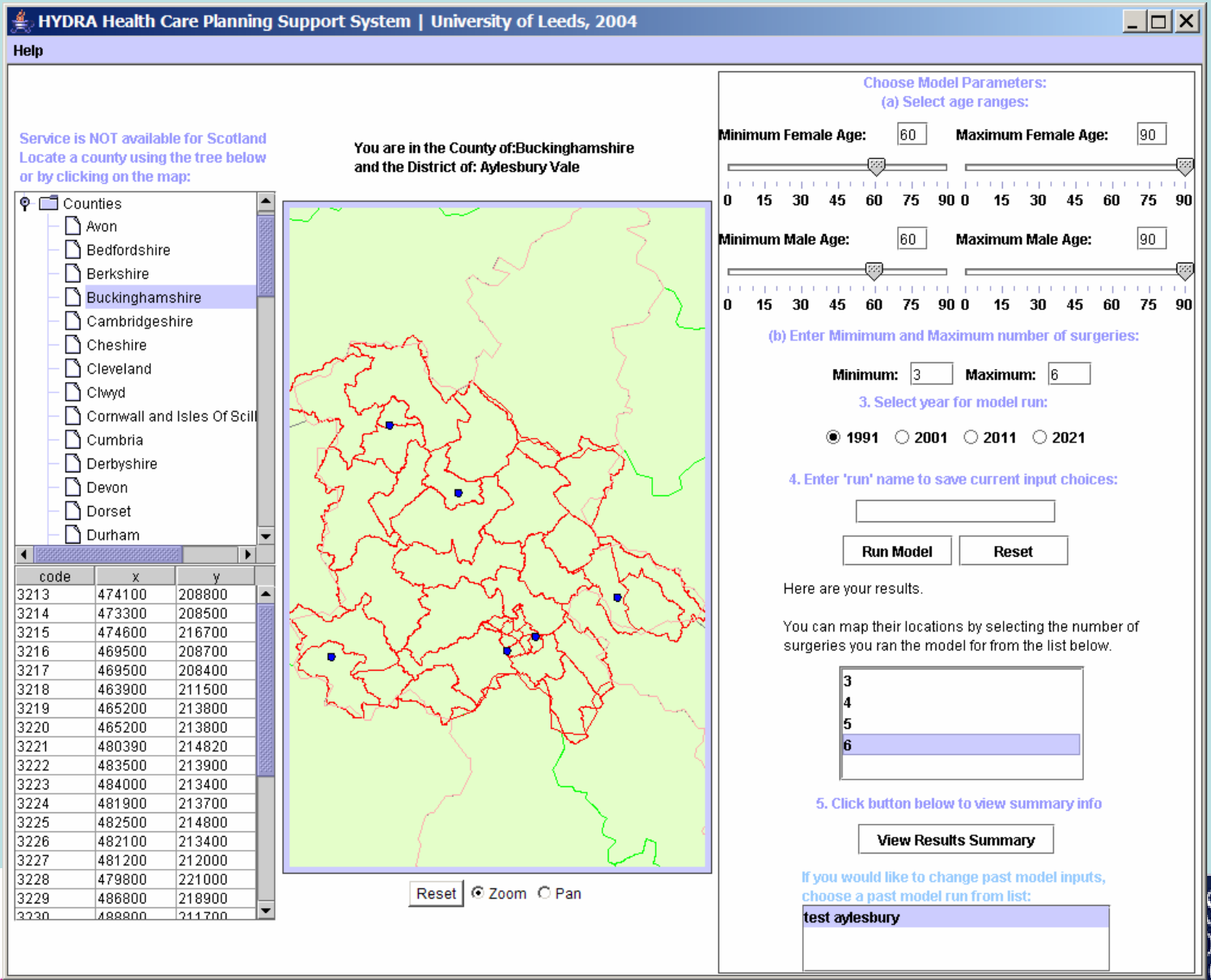
2. Progress to date

- The illustration shows an application of Hydra in the district of Aylesbury, Bucks
  - –In this case, we consider a service focused on the elderly
    - •Different population groups can be selected using the sliders on the interface
  - –The network size can also be varied through the interface
  - –Planners can introduce future demographic change in order to plan ahead
  - –The results are represented on a simple map with basic geographical information systems functionality
    - •It is possible to pan, zoom, and query individual data points
  - –More detailed ‘reports’ about small area populations and services can be generated from the system



3. Hydra architecture and e-Science perspective

- Hydra has a service-oriented architecture in which the application interacts with a single Manager Service
- Individual component services are available to facilitate data retrieval, mapping, modelling, reporting, forecasting and optimisation
  - –The majority of services are local to the White Rose Grid, but the data service can interact remotely with the National Census Data Service at Manchester and HM Land Registry
- The optimisation and modelling services are accessed through Globus GT4
- Hydra can be accessed through the White Rose Grid
  - –Executables and operating instructions can be downloaded from **www.informatics.leeds.ac.uk/pages/hydra**
  - –Although Hydra is configured using single sign-on, users must also provide a valid Athens username and password in order to access UK census data

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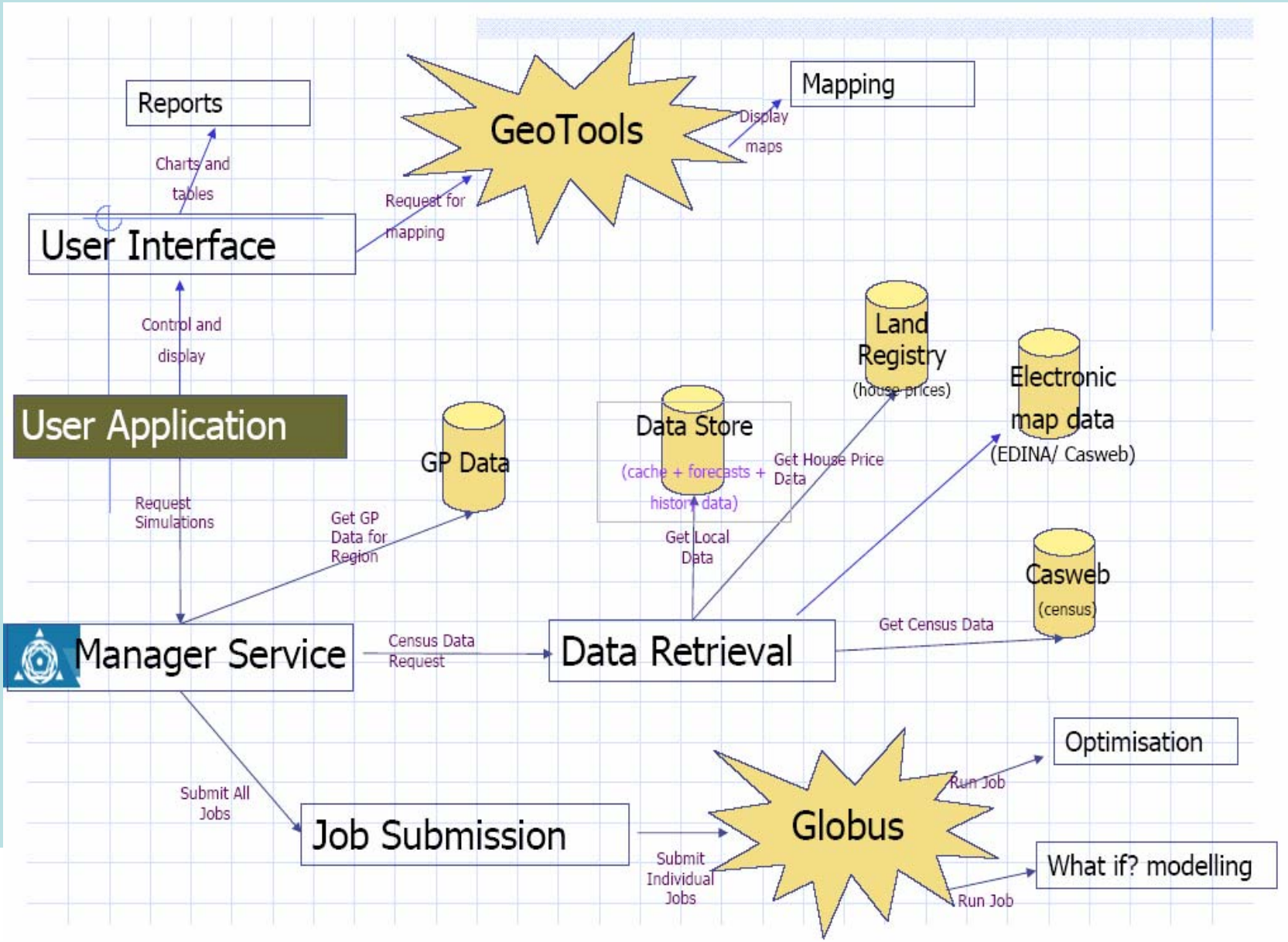
Reports
Charts and tables
GeoTools
Mapping
Display maps
Request for mapping
User Interface
Control and display
User Application
Land Registry
(house prices)
Electronic map data
(EDINA/ Casweb)
Data Store
(cache + forecasts + history data)
Get House Price Data
GP Data
Request Simulations
Get GP Data for Region
Get Local Data
Casweb
(census)
Get Census Data
Manager Service
Census Data Request
Data Retrieval
Optimisation
Run Job
Submit All Jobs
Job Submission
Globus
Submit Individual Jobs
What if? modelling
Run Job

4. Project Moses

- We seek to build upon and extend the foundations laid by Hydra in a number of ways:
  - –Through the creation of a national demographic simulation and forecasting model for policy analysis
  - –Through the application of the technology in a wider range of policy environments
  - –By extension of the component services and their integration using upgraded Grid tools

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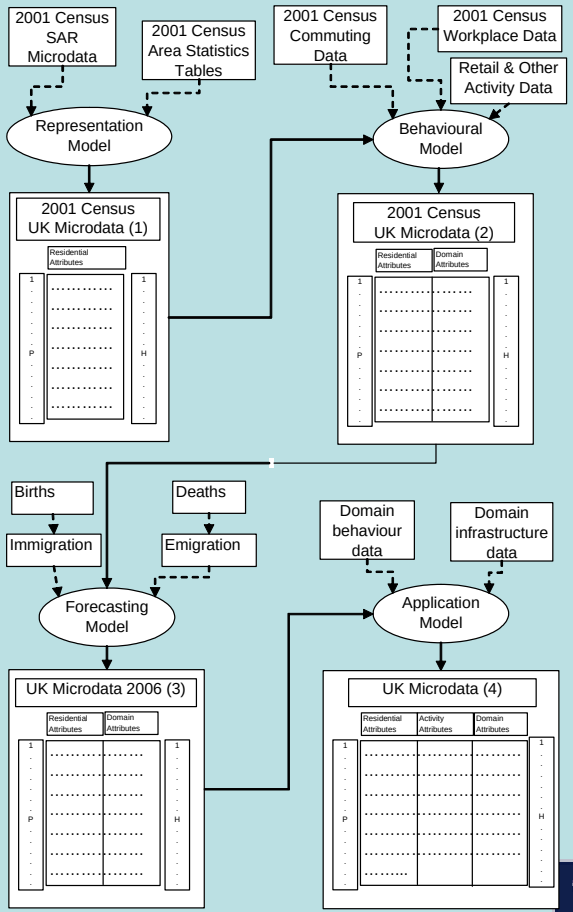
4.1 Demographic Simulation and Forecasting

- The demographic simulation model will be constructed through a four stage process (see illustration):
  - –Population reconstruction
  - –Behavioural modelling
  - –Activity modelling
  - –Forecasting
- Whilst researchers have begun to explore individual ('agent-based') models for whole countries by sub-system (Raney et al, 2003), and more integrated models for single cities (Waddell et al, 2003) we believe that Moses is currently unique in seeking to provide a model which is both national and integrated
  - –Substantial methodological challenges will include the need to model the interaction between social and geographical networks, and the need for flexible aggregation between individual and market-level processes



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4.2 Applications

- We are intending to demonstrate the importance of Moses in relation to policy scenarios from health, business and transport
- Health
  - –An indicative scenario would be to provide perspectives on medical and social care within local communities for a dynamic and ageing population
- Transport
  - –Possible scenarios here might concern the sustainability of transport networks in response to demographic change and economic restructuring: for example, what kind of transport network is capable of sustaining the ‘Northern Way’
- Business
  - –The strands here might include the impact of diurnal population movements on retail location and profitability; or the impacts of a changing retirement age on personal wealth and living standards

A computer-generated impression of Criterion Place, Leeds. How might a major new office development affect future transportation and health care requirements in the city?

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4.3 Moses and the Grid

- Successful prosecution of the Moses research agenda demands Grid for a number of reasons
  - –The project calls for integration of data from a wide variety of sources (for example, demographics with business, transport and health data). Perpetual regeneration of the constituent databases is a substantial and generic barrier for SDSS
  - –Our models will demand significant computational resources to support scenario-building
    - •We may seek to visualise the outputs from our simulations in new ways, for example in collaboration with the GeoVUE e-social science project
  - –Policy problems will typically involve collaboration between a variety of agencies (e.g. highways, economic development, academic or independent consultant, housing developer or local planning department for the Northern Way scenario)
    - •Various online government initiatives (such as Government Connect) may also demand greater exposure to the outputs of this process amongst local communities
    - •However applications must also respect the integrity of constituent data which could often be highly confidential, such as patient records within a health planning scenario

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5. The Future of Moses

- The Moses project is still at a relatively early stage, although we believe that the Hydra demonstrator has demonstrated proof-of-concept in relation to a number of underlying principles
- If successful, the project could demonstrate substantial value in the Grid to policy-makers in both the governmental and private sectors
- The project will benefit from an improving e-social science infrastructure in the UK, for example the ability to access census or map data which is genuinely grid-enabled
- Through the diversity of our applications, we hope to engage the interest of social scientists in health, business and transport as well as geography; and we see clear potential for the engagement of others with interests such as criminology, social policy or political science

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