RELU: Integrating Spatial Data

Integrating Spatial Data on the Rural Economy, Land Use and Biodiversity

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BTO Web leading in bird research.....

Project Rationale

- Socio-economic and ecological data collected and reported in different ways
- Sustainable development of rural areas
  - Common Agricultural Policy reforms
  - Water Framework Directive
- Biological indicators in sustainable development
  - Birds as wildlife headline indicator
  - Mammals (significant public values)
- Use indicators to examine implications of agricultural change in relation to rural policy

Project Aims

1. To use genetic algorithms to spatially disaggregate agricultural census data across Britain to the 1km^2 level.
2. To integrate the disaggregated data with ecological data on mammal and bird distributions and abundance.
3. Use the data to test the hypothesis that there is a trade-off between biodiversity and economic productivity in rural areas at various scales.
4. To disseminate protocols for the integration of (grid-based) ecological and (administrative area-based) socio-economic data via the internet.

Agricultural Census

- Annual returns from farmers in June
  - Land Use
  - Livestock
  - Labour

- Available from Defra website
  - 1990, 1995, 2000-2003
  - Summary of returns at region, county, local authority and ward level
  - Some data suppressed

Biological Data

- Typically collated from data gathered by volunteers
  - Breeding Birds (BTO)
  - Mammal Surveys (University of Bristol)

- Reported as gridded data
  - Distributions (10 x 10 km)
  - Abundances (1 x 1 km)

Combining Agricultural Census and Biological Data

- Agricultural census data needs to be disaggregated to 1 x 1 km grid
- Land Cover Map of UK (1 km^2 grid)
- Use land cover to assign most probable distribution of land use within a ward

BUT THERE ARE PROBLEMS

Problems Predicting Land Use from Land Cover

- Differing areas
  - Land Use = Total area farmed within ward
  - Land Cover = Total area of ward
- Data suppression
  - Land use areas suppressed if they can be used to identify land use within a particular holding

Genetic Algorithms (GA)

- Heuristic optimisation method
- Has been applied to both socio-economic and ecological studies
- Based on processes that occur in biological systems
- “Evolve” towards an answer
- Work well in situations where deterministic methods are not applicable

Structure of a Genetic Algorithm

- Large number of candidate solutions (chromosomes) evaluated over many generations
- A fitness is assigned to each chromosome within the population
- Chromosomes with higher fitness are copied to the next generation more often than those with lower fitness
- The values of candidate solutions are recombined and changed through the genetic operators (crossover and mutation)

Application of GA to Land Use/Land Cover Conversion

- Chromosomes consist of values representing estimates of the typical proportion of a land use within a land cover class.

eg. For three land cover classes and four land uses:

0.1 0.2 0.3 0.4 0.3 0.3 0.2 0.2 0.7 0.1 0.2 0.0

Application of GA to Land Use/Land Cover Conversion

- Crossover
  - Produces new combinations of land use estimates for land cover classes
  - Restricted to points between land covers to preserve relationships between land uses within a land cover

Application of GA to Land Use/Land Cover Conversion

0.1 0.2 0.3 0.4 0.3 0.3 0.2 0.2 0.7 0.1 0.2 0.0

0.2 0.3 0.2 0.3 0.4 0.2 0.3 0.1 0.5 0.3 0.1 0.1

Crossover

0.1 0.2 0.3 0.4 0.3 0.3 0.2 0.2 0.5 0.3 0.1 0.1

0.2 0.3 0.2 0.3 0.4 0.2 0.3 0.1 0.7 0.1 0.2 0.0

Application of GA to Land Use/Land Cover Conversion

- Mutation
  - Changes estimates of land use proportions within a land cover class
  - Performed by transferring some of the proportion attributed to one land use within a land cover to another land use within the same land cover.

Application of GA to Land Use/Land Cover Conversion

0.1 0.2 0.3 0.4 0.3 0.3 0.2 0.2 0.7 0.1 0.2 0.0

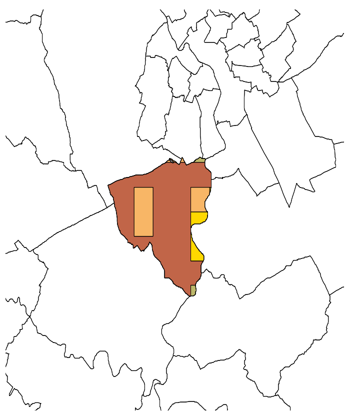
Mutation

0.3 0.2 0.3 0.2 0.3 0.3 0.2 0.2 0.7 0.1 0.2 0.0

Application of GA to Land Use/Land Cover Conversion

- Fitness of chromosomes measured by the sum of squares of the differences between the predicted land use based on land cover and reported land use from the agricultural census.
- The two most fit chromosomes in each generation are copied unchanged into the new generation
- Final estimate arrived at when no better estimates are found within a specified number of generations

Example of Land Use and Land Cover Data



	Land Cover	Area (ha)
	Arable	1426
	Improved Grass	80
	Unimproved Grass	20
	Urban	293
	Grand Total	1819

Based on Dominant Habitat in the CEH Land Cover Map (2000)

Copmanthorpe ward
Reported Land Use (ha) from Agricultural Census (2003)

Total area	1699.4		
Temporary grass area	171.1	Peas for harvesting dry area	---
Permanent grass area	294.0	Oilseed rape area	79.6
Rough grazing area	---	Linseed area	---
Woodland area	38.4	Turnips_etc area	---
Set-aside area	104.7	Other crops for stockfeeding area	---
All other land area	60.1	Maize area	25.4
Wheat area	512.8	Other arable crops area	0.0
Winter barley area	137.1	Bare fallow area	---
Spring barley area	80.8	Peas and beans area	---
Oats area	---	Allother veg and salad area	0.0
Other cereals area	---	Area under glass/plastic area	---
Potatoes area	---	Top fruit area	0.0
Sugar beet area	72.0	Small fruit area	---
Horticulture area	---	Hardy nursery area	---
Field beans area	29.2	Bulbs and flowers area	0.0

Disaggregating Land Use Data

- Results from GA analysis give probabilities that a grid cell with a known land cover is being used for a particular land use
- Each ward is converted into a 1 ha resolution grid
- A number of simulation runs are made in which the spatial pattern of land use is assigned to the 1 ha grid based on the land cover and estimated land use probabilities

Integrating Biodiversity and Land Use Data

- Workshop Jan/Feb 2005 to explore the bird and mammal survey data
- Validation of predicted land use distributions from field observations
- Statistical analysis to investigate relationships between land use and biodiversity

Closely Related RELU Projects

- **Data resources for rural sustainability research (Nigel Boatman *et al.*, CSL)**
  - **aims to explore issues of data management and integration via questionnaire of the RELU community, to identify data access and management requirements**

- **Developing spatial data for the classification of rural areas (Meg Huby *et al.*, University of York)**
  - **aims to produce a dataset of rural areas that takes account of both natural and socio-economic environment, as a basis for a new typology of rural areas**

RURAL ECONOMY AND LAND USE

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RESEARCH COUNCILS UK

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