Prototype Firma Thames Model

Design and methodological issues

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The issue

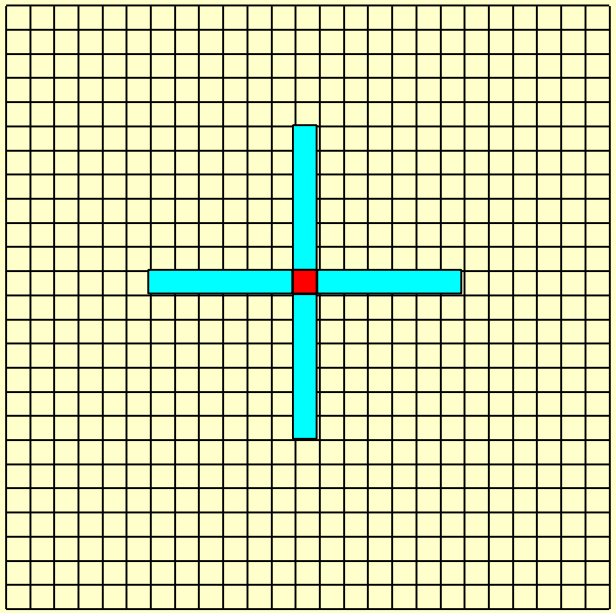
- Identify the conditions in which it is feasible to reduce water consumption by exhortation
- Role of word-of-mouth communication

Prototype model: agent motivation

- Agents of three broad types though none are identical with any of the others
  - One type listens primarily to government
  - One type decides on basis of interaction with neighbours
  - One type pleases primarily own self

The physical analogy

- Consumer agents placed at random on toroidal grid
- Can “see” other consumers in limited number of nearby cells



Modelling judgement, experience and "world view"

- Each agent has criteria
  - for evaluating rules of behaviour
  - for evaluating other agents
- Qualitatively represented -- *e.g.*:
  - Closely similar consumption habits of agents
  - Behaviour observed in neighbours

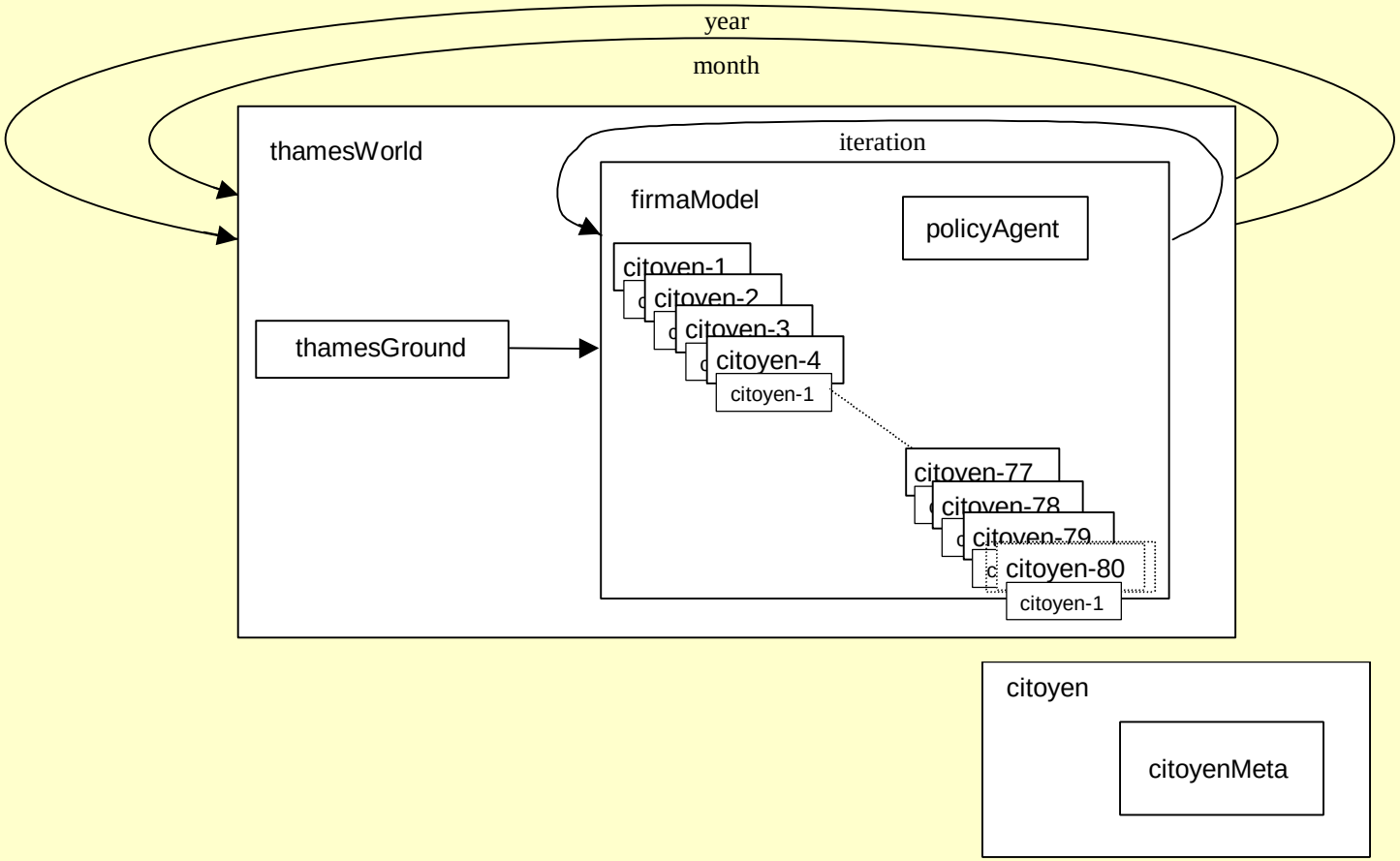
Rules of behaviour judged by provenance

- invented by oneself
- observed behaviour of other agents
- behaviour suggested by “authority”

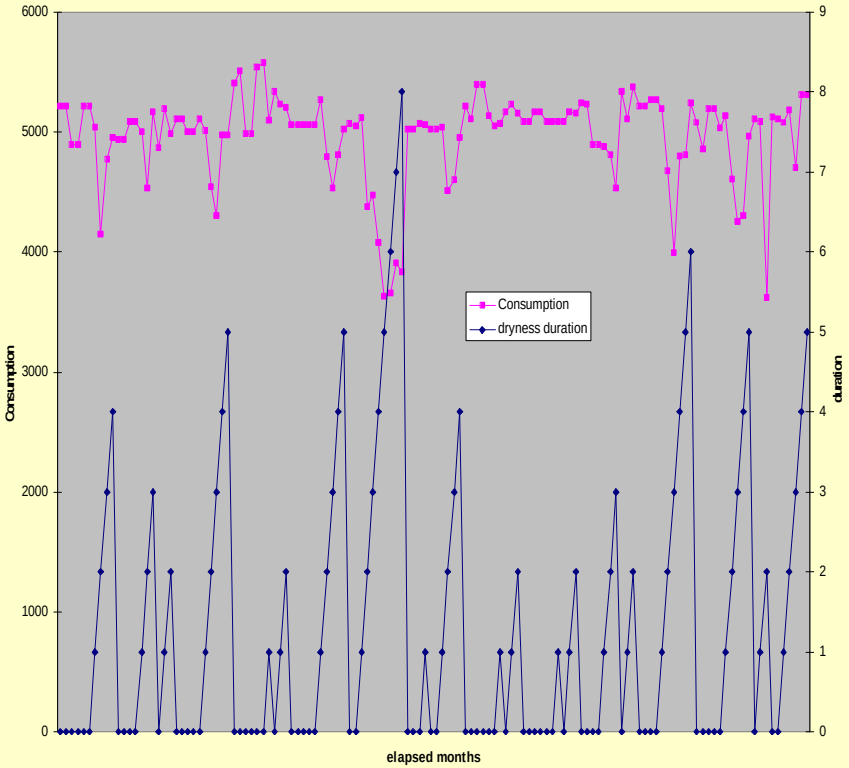
Other consumers judged by similarity to self

- Suggested by *consistency principle*
- People like best those with whom they agree the most
- People agree the most with those whom they like the best

Model structure



Results



- policyAgent suggests rules reducing frequence and amount of consumption during “dry” months
- Hierarchy-accepting citizens likely to conform
- Sociable citizens influenced by neighbours – some of whom conform to authority
- Individualist citizens can be influenced by enough weight of neighbour behaviour

Lessons from previous models

- Agents such as the *citoyens* are metastable
  - The change behaviour or choices periodically under pressure
  - Not responsive to small changes in environment
- Systems characterised by sudden changes
- System changes mainly of small magnitude; relatively few of larger magnitudes

Experience from statistical mechanics

- Standard examples are avalanches, earthquakes, sunspots
  - Modelled in statistical mechanics as self-organised criticality
  - Few analytical (mainly simulation) results
- Result of
  - metastable components
  - component interaction
  - slow but persistent drivers (*e.g.* energy inputs)

Social and mechanical systems

- Similarities
  - Component (agent) metastability
  - Component (agent) interaction
- Difference
  - Reaction of components to system drivers changes
    - Stable statistical relationship between depth of snow and avalance size
    - Response of public to exhortations to save water changed by behaviour of exhorters -- leaks issue

Design of prototype: the issues

- Validation
- Ability to extend and elaborate model
  - Modularity
- Ease of stakeholder comprehension
  - Encapsulation

Validation as description

- Validation is the demonstration that a model is a "good" representation of its target system
  - Comparison of qualitative focus group or survey data with agents' "judgements"
  - Comparison of numerical output with statistical data
  - Interaction with stakeholders

Compositional design

- Agents represent actors and institutions at coarser and finer grain
- By encapsulating code representing actors and institutions in agents, easier to have alternative agents representing same (e.g.) institutions
  - Fine grained agents representing real institutions or individuals can be modelled by coarse grained representations of same institutions or individuals
- Agents containing agents: organisations contain departments; departments contain actors

Purpose of compositional design

- More coarse grained models can be related directly to behaviour of more fine grained models
  - Agents in more coarse grained models are themselves less detailed models of agents in more fine grained models
  - Consistency of behaviour across grains is essential
- Agents at every grain of analysis should be kept sufficiently simple that stakeholders (and modellers!!) can understand their behaviour
  - More detailed descriptions obtained from finer grained representations of parts of model.

Natural extensions

- Compare consumer behaviour with and without policy agent
- Elaborate the behaviour of the policy agent
  - Base representation on stakeholder descriptions
- Closer integration of water model with social model
- Simulate extreme events
  - Mechanism implemented for Firma project