Agent-based modelling of value chains

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Outline

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- (Very brief) Introduction to Agent-Based Modelling
- Agent-Based Modelling of Value Chains
- Application to Agricultural Context
- Next Steps

Agent-based modelling

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- Represents heterogeneous interacting individuals explicitly
    - Systemic observations are seen as ‘emerging’ from these
        - Complex systems basis
        - Traditional formal approaches not capable of capturing emergent structure
- Sometimes represents a physical and/or dynamic ecological environment

(Traditional) Economics and ABM

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- Out-of-equilibrium dynamics
- Psychologically or theoretically plausible decision-making
- Feasibility of spatially explicit modelling
- Social networks, social interaction
- Fewer constraints imposed by method

Example: Biodiversity incentives

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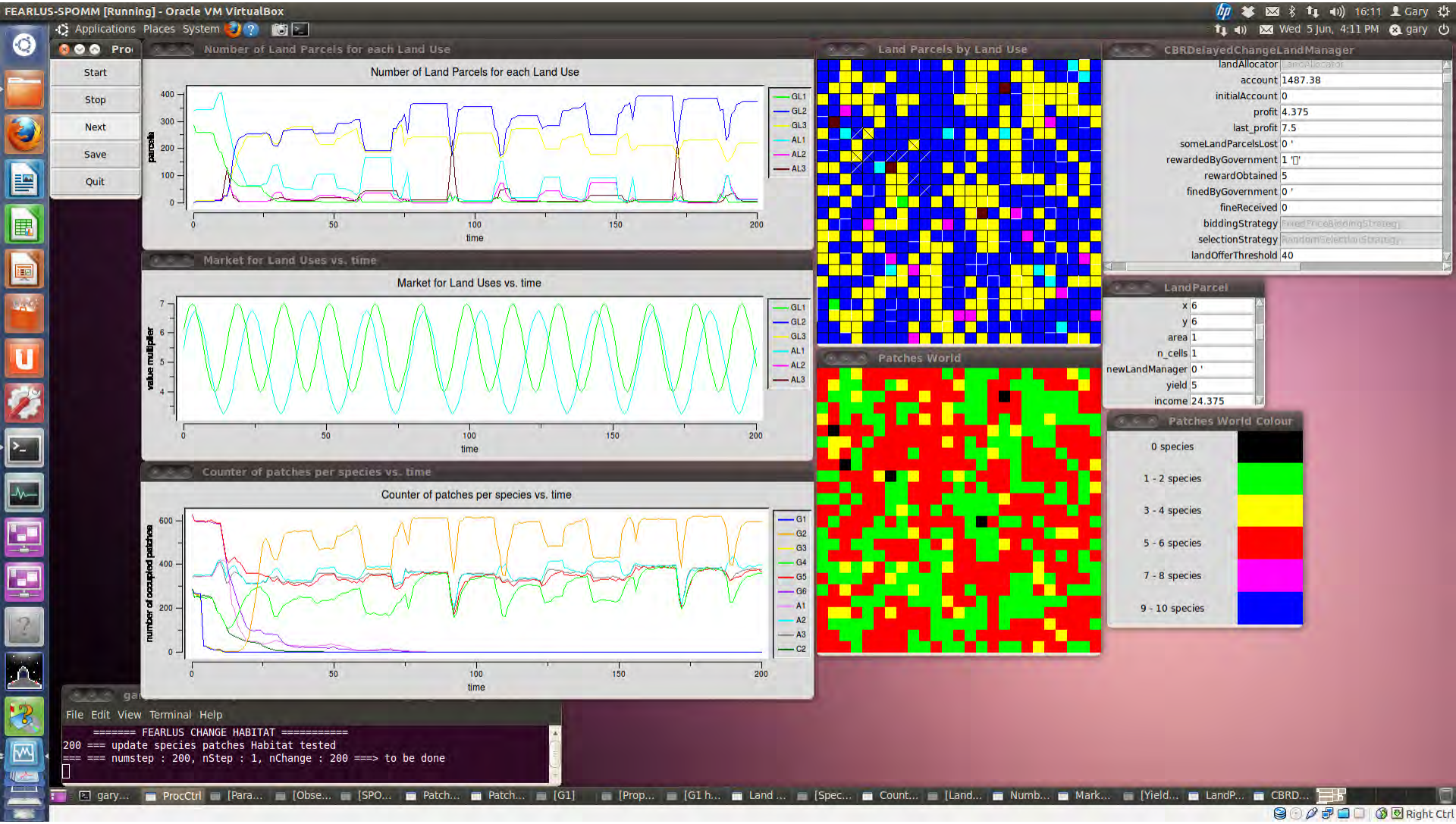
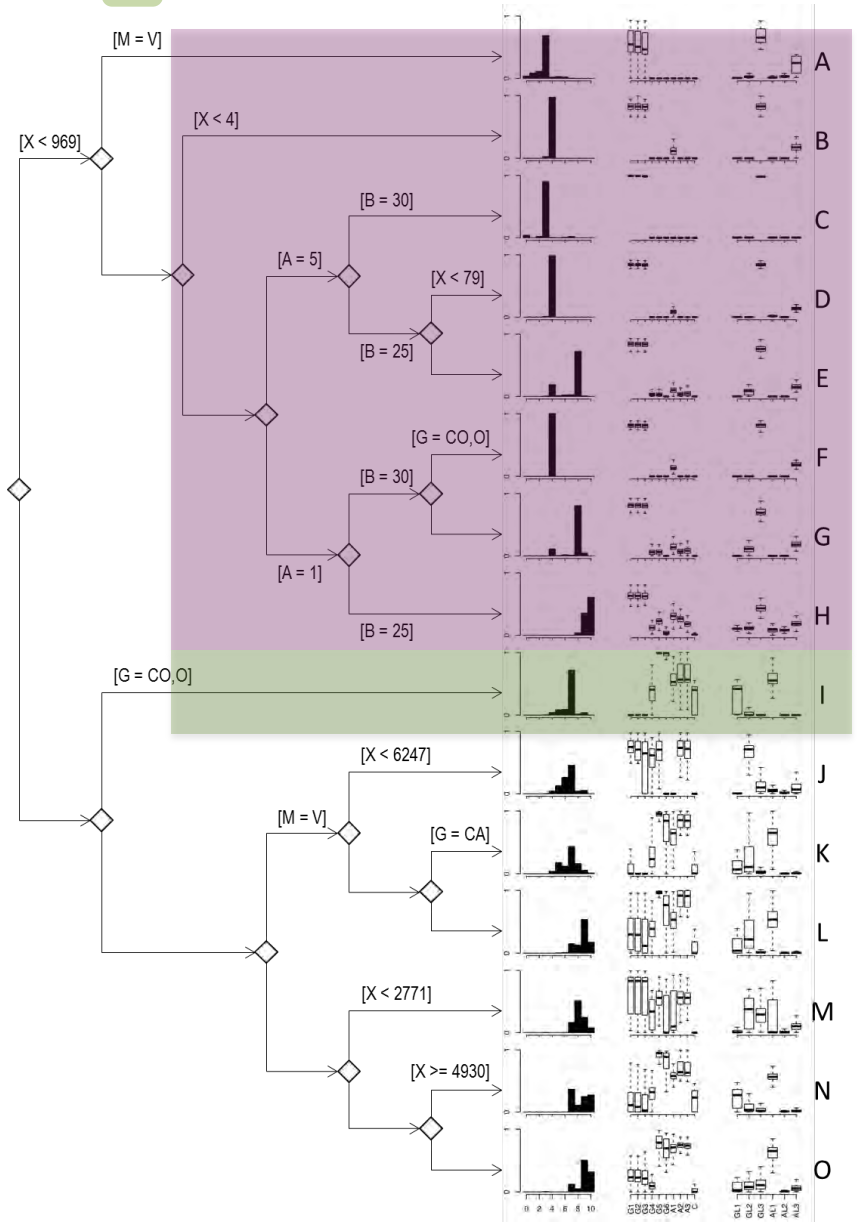


http://www.youtube.com/watch?v=G0LGZMkauFw

Example cont'd: analysing results



- Below a threshold of government expenditure, the market drives outcomes, and species richness is lower
- Above the threshold, policy is the main driver
  - Outcome based incentives seem more robust to other influences (market, input costs, aspirations)

[Polhill, Gimona and Gotts, 2013, Environmental Modelling and Software]

Example in supply chain context

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- Van Dyke Parunak et al. (1998, LNAI 1534) compare AB and traditional (ODE) models for supply chains
  - ABMs easier to build and use to represent discrete decision making
  - Separation of interaction and physical space possible
    - No constraints on social network topology
  - Validation at micro and macro levels can be done
    - See also Moss and Edmonds (2005) Am J. Soc.
  - Better support for ‘what-if’ scenarios
    - Largely because of more natural representation

Various examples of ABM in supply chains

- Often quite specifically focused on manufacturing and processing environment; managing stock levels, logistics, managing risk:
  - Julka et al. (2002) Comp. Chem. Eng.
  - Kaihara (2003) Int. J. Prod. Econ.
  - Giannakis & Louis (2011) J. Purch. Supply Mgt.
- Models often theoretical rather than tailored to case studies. Exceptions:
  - Rouzafzoon & Helo (2016) Ind. Mgt. Data. Sys.: application to heath service supply chain
- Very few cases in agricultural / bioeconomy sector
  - But, e.g. Hidayat & Marimin (2014) Int. J. Supply Chain Mgt.: Palm oil

Application to Agriculture

- Agents are businesses in the agricultural value chain
    - (Would be better to think of value networks/webs/graphs)
- Interactions comprise exchange of capital
    - Money, goods
    - Also: knowledge, experience, tokens of cultural identity and group inclusion
    - Also: ‘circularity’ – exchanges of ‘unwanted’ materials
- Mediated through space and spatially situated undertaking of activities
- ABM well-suited to handling this kind of complexity

Towards implementation

- Agent-based models allow us to represent plausible modes of decision-making
  - Case-based reasoning (Aamodt & Plaza, 1994) represents decision-making of experts
  - Decisions based on experience in similar situations
    - Case-base (store of experience) is an explicit representation of Bourdieusian concept of embodied cultural capital (knowledge)
    - Can apply to decisions about activities to undertake and whom to exchange what capital with
    - Localization within contextually-situated agent allows explicit representation of specialized local knowledge

Conceptual model

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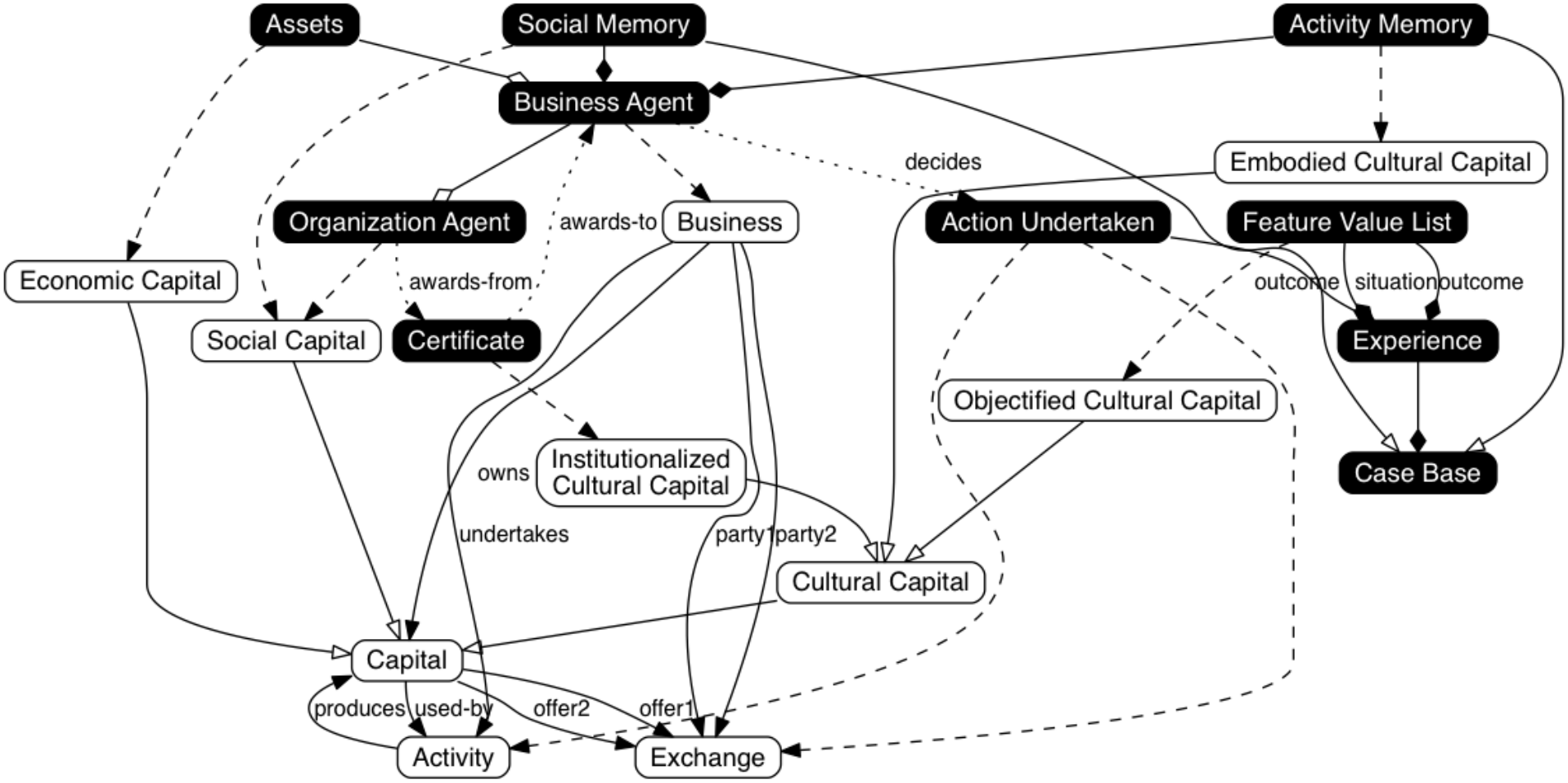

Transforming value networks

- Changing systems requires overcoming existing path-dependent lock-ins:
    - Infrastructure
    - Knowledge, experience, expertise
    - Social organisation
    - Regulation
- Some are easier to overcome than others

Next steps

- Implement model in NetLogo
- Data acquisition and import
    - Critical: schema and database of activities agents can choose among
- Calibration and validation
- Explore scenarios
    - Contextual driving variables outwith control
        - Climate change, global markets
    - Policy options that can be controlled
        - Incentives, regulations

BIOSMART

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How to manage the transition to a "smart" bioeconomy

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