CBIM Conference on Business and Industrial Marketing 2023

Welcome to the Secret World of Agents

How to Simulate Business Scenarios using Agent-Based Modelling

Peer-Olaf Siebers

peer-olaf.siebers@nottingham.ac.uk

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA
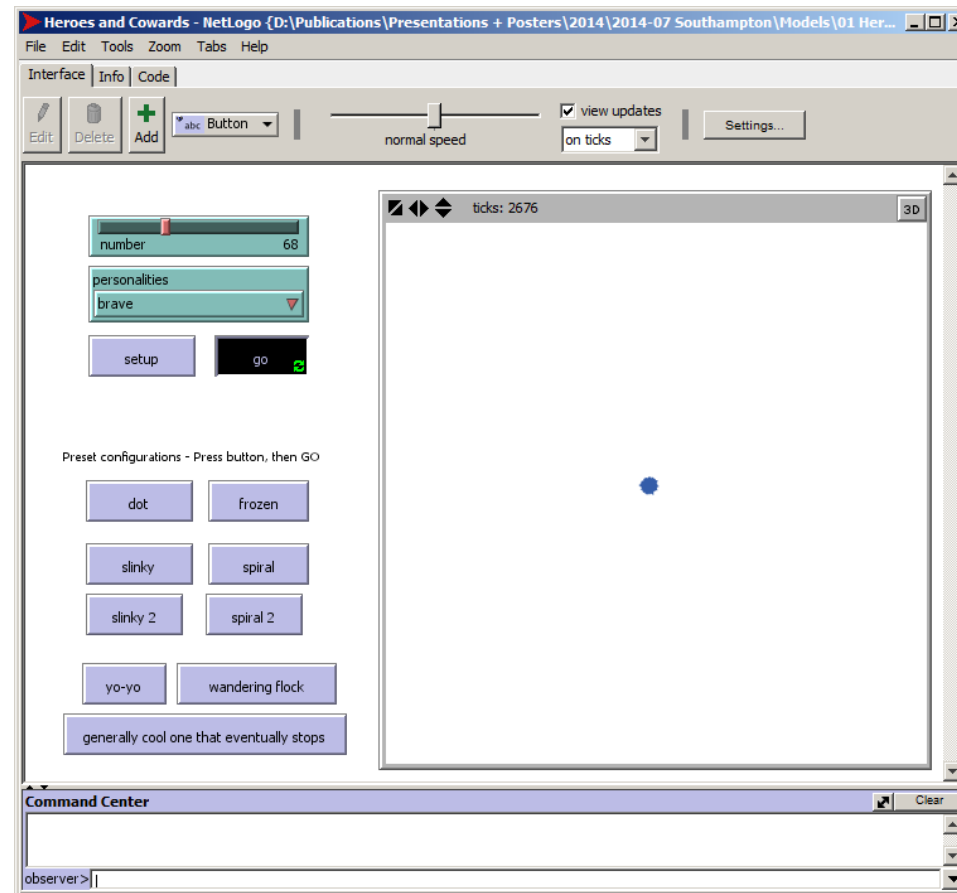
Heroes and Cowards

- Consider the following gaming scenario [Wilensky and Rand 2015]

  - 20 people scattered in a room - no communication

  - Game 1: Everyone takes on the role of a **Hero** by following a simple rule
    - Pick two participants and always locate yourself between them to shield one from the other

- What happens when everyone starts moving?

Heroes and Cowards

- Heroes and Cowards Game in NetLogo: All heroes

Heroes and Cowards

- Consider the following gaming scenario [Wilensky and Rand 2015]

  - 20 people scattered in a room - no communication

  - Game 2: Everyone takes on the role of a **Coward** by following a simple rule
    - Pick two participants and always use one to shield yourself from the other

- What happens when everyone starts moving?

Heroes and Cowards

- Heroes and Cowards Game: All cowards
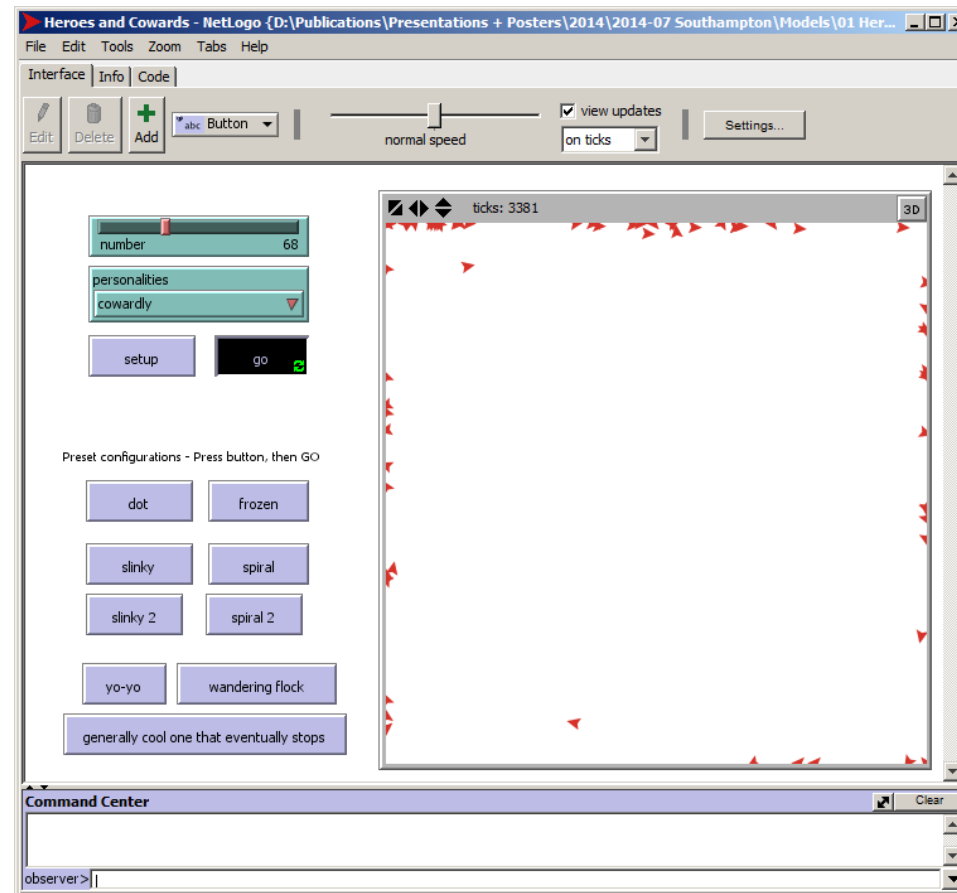
Agent-Based Modelling

- Agent-Based Modelling

  - A complex system is represented by a **collection of agents** that are programmed to **follow some behaviour rules** and the **system properties emerge** from its constituent agent interactions

    - Useful for studying social and economic phenomena
    - Employs a bottom-up approach
    - Captures the dynamics of a system over time
    - Captures emergent phenomena at the macro level

  - Agents can represent individuals, households, firms, organisations, nations ...

When to Use Agent-Based Modelling

- When the problem has a **natural representation as agents** - when the goal is modelling the behaviours of individuals in a diverse population

- When entities have **relationships with other entities**, especially **dynamic relationships**

- When it is important that entities have **spatial or geo-spatial aspects** to their behaviours

- When it is important that entities **learn or adapt**, or populations adapt

- When entities engage in **strategic behaviour**, and anticipate other entities' reactions when making their decisions

[Siebers et al. 2010]

Building and Validating Agent-Based Models

- **Different purpose of ABMs** [Edmonds et al 2019]

  - Prediction
  - Explanation
  - Description
  - Theoretical exploration
  - Illustration
  - Analogy
  - Social interaction

# Building and Validating Agent-Based Models

- ## Different flavours of ABMs [Achter et al 2022]

  - Theory driven
  - Empirical (data) driven
  - Model driven
  - Participatory

Building and Validating Agent-Based Models

- Building an ABM (OR/MS)
  - Identify active entities (agents)
  - Define their states and behaviour
  - Put them in an environment
  - Establish connections
 - Test the model

    AnyLogic Help (2013)
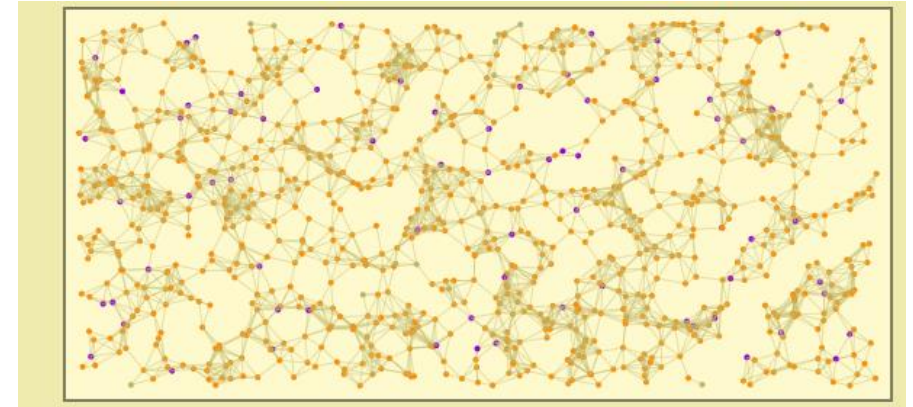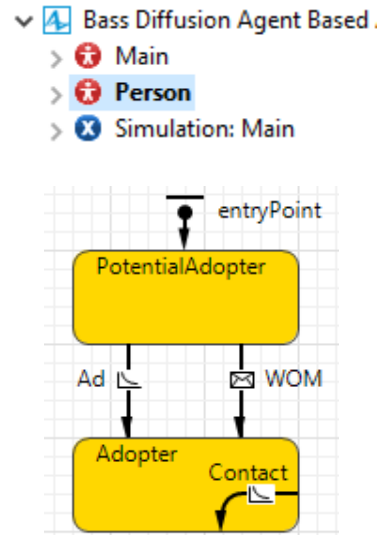
- Validating an ABS
  - Validation at micro level
    - Testing the behaviour of agents at individual level
  - Validation at macro level
    - System behaviour is an emergent property
    - Plausibility check of emerging patterns at system level (e.g. via comparison to observations)

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

Building and Validating Agent-Based Models

- Modelling proactive customer/staff behaviour in a department store scenario
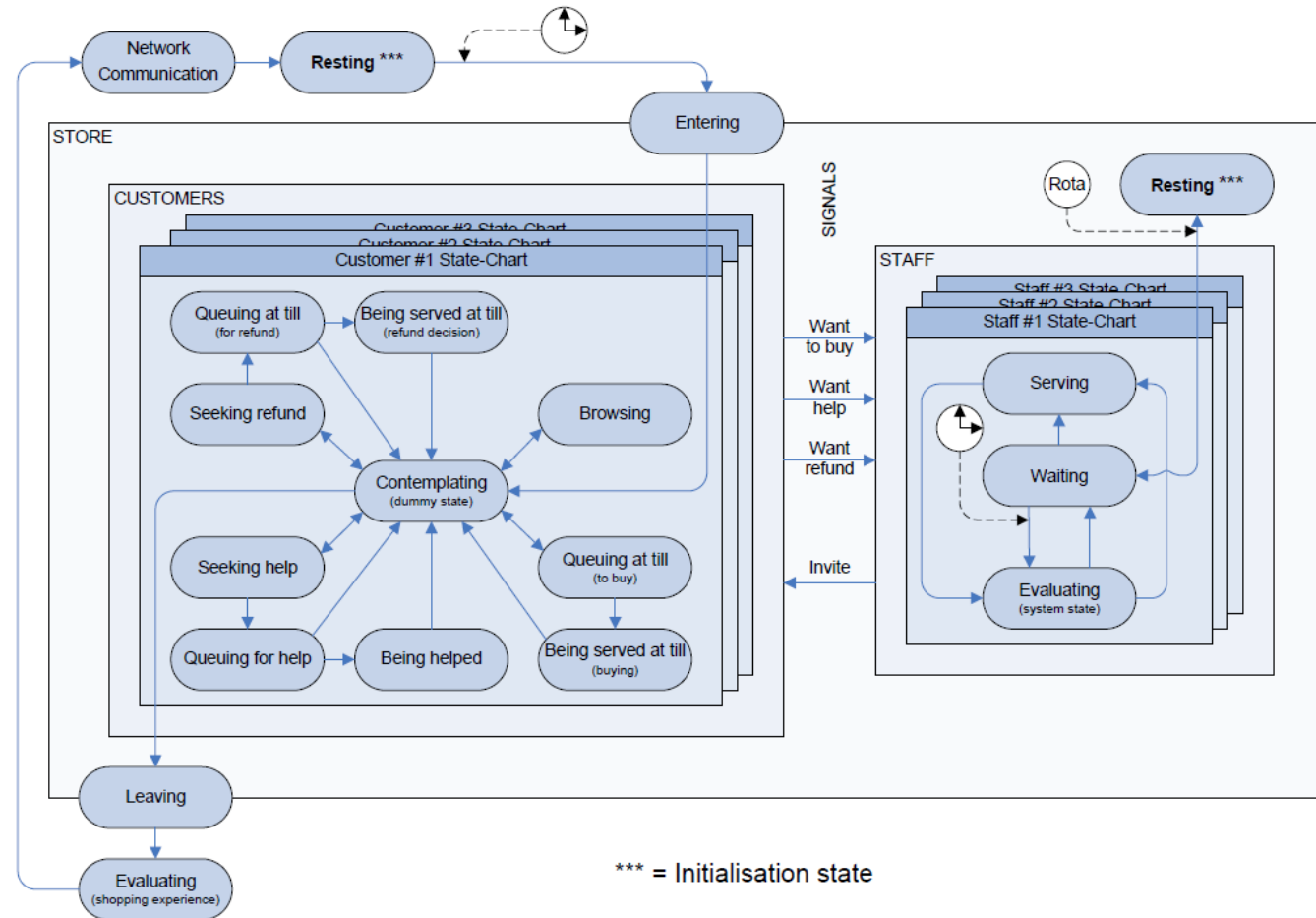
Siebers and Aickelin (2011)

Agent-Based Modelling and Simulation Tools

- ## Design
  - EABSS [Siebers and Klügl 2017]

- ## Implementation
  - NetLogo
  - AnyLogic
  - AgentPy

- ## Documentation
  - ODD [Grimm et al 2020]
  - RAT-RS [Achter et al 2022]
  - EABSS [Siebers and Klügl 2017]

https://www.cs.nott.ac.uk/~pszps/eabss2023/

B2B Related Example [Watkins and Hill 2008]

A Simulation of B2B Decision Making in a Relationship Marketing (RM) Context

- Goal:
  - Develop an ABM of a market that emerged from the interactions between different types of firms (sellers and buyers) who applied different RM approaches.

- Approach
  - Within the ABM, selling agents operate in complex environments, using RM approaches that may or may not be uniformly distributed inside their organisations

    - The model considers a diverse combinations of buyer traits that impact buyer decisions as well as seller profitability

    - RM is operationalised based on pricing tactics that show differences between asking prices and post-exchange value

Resources

http://www2.econ.iastate.edu/tesfatsi/abusiness.htm

Special Issue on **Multi-Agent Simulation as a Novel Decision Support Tool for Innovation and Technology Management**

https://www.worldscientific.com/toc/ijitm/10/05

Conclusion

- Lots of opportunities for applying ABM in B2B modelling

- Use the EABSS to get you started

Picture Source: https://andreakihlstedt.com/are-you-afraid-to-open-doors-of-possibility-fear-not/

The University of
Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

References

- References

  - Achter S, Borit M, Chattoe-Brown E, Siebers PO (2022). RAT-RS: a reporting standard for improving the documentation of data use in agent-based modelling. International Journal of Social Research Methodology, 25(4): 517-540.

  - Edmonds B, Le Page C, Bithell M, Chattoe-Brown E, Grimm V, Meyer R, Montañola-Sales C, Ormerod P, Root H, Squazzoni F (2019). Different modelling purposes. Journal of Artificial Societies and Social Simulation, 22(3)6.

  - Grimm V, Railsback SF, Vincenot CE, Berger U, Gallagher C, DeAngelis DL, Edmonds B, Ge J, Giske J, Groeneveld J, Johnston AS (2020). The ODD protocol for describing agent-based and other simulation models: A second update to improve clarity, replication, and structural realism. Journal of Artificial Societies and Social Simulation, 23(2)7.

  - Siebers PO, Macal CM, Garnett J, Buxton D, Pidd M (2010). Discrete-event simulation is dead, long live agent-based simulation! Journal of Simulation, 4(3): 204-210.

  - Siebers PO, Aickelin U (2011). A first approach on modelling staff proactiveness in retail simulation models. Journal of Artificial Societies and Social Simulation, 14(2)2.

  - Siebers PO, Klügl F (2017). What software engineering has to offer to agent-based social simulation. Simulating Social Complexity: A Handbook, 81-117.

  - Watkin A, Hill RP (2009). A simulation of business-to-business decision making in a relationship marketing context. Industrial Marketing Management, 38(8): 994-1005.

  - Wilensky U, Rand W (2015). An introduction to agent-based modeling: modeling natural, social, and engineered complex systems with NetLogo. Mit Press.

Bibliography

- Bibliography

  - Balaban MA, Mastaglio TW, Lynch CJ (2016) Analysis of future UAS-based delivery. In: Proceedings of the 2016 Winter Simulation Conference (WSC), Washington, DC, USA.
  - Gómez-Cruz NA, Saa IL, Hurtado FFO (2017). Agent-based simulation in management and organizational studies: A survey. European Journal of Management and Business Economics, 26(3): 313-328.
  - Helo P, Rouzafzoon J, Gunasekaran A (2018). Service supply chain design by using agent-based simulation. Practices and Tools for Servitization: Managing Service Transition, 387-403.
  - Lieder M, Asif FM, Rashid A (2017). Towards Circular Economy implementation: An agent-based simulation approach for business model changes. Autonomous Agents and Multi-Agent Systems, 31: 1377-1402.
  - Onggo BS, Foramitti J (2021). Agent-based modeling and simulation for Business and Management: A review and tutorial. In: Proceedings of the 2021 Winter Simulation Conference (WSC), Phoenix, AZ, USA.
  - Sulis E, Taveter K (2022). Agent-Based Business Process Simulation: A Primer with Applications and Examples (Springer).
  - Wilkinson IF, Young LC (2013). The past and the future of business marketing theory. Industrial Marketing Management 42(3): 394-404.