

CBIM Conference on Business and Industrial Marketing 2023



# Welcome to the Secret World of Agents

How to Simulate Business Scenarios using Agent-Based Modelling



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# Heroes and Cowards

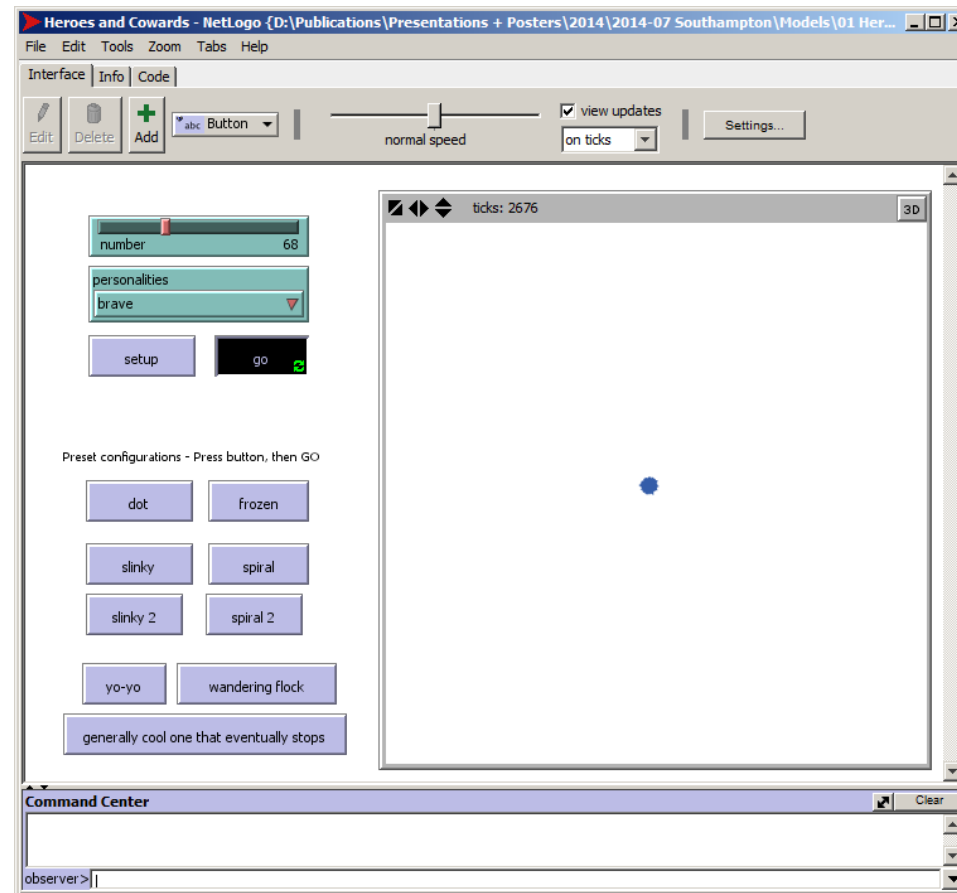
- Consider the following gaming scenario [Wilensky and Rand 2015]
  - 20 people scattered in a room - no communication
  - Game 1: Everyone takes on the role of a **Hero** by following a simple rule
    - Pick two participants and always locate yourself between them to shield one from the other



- What happens when everyone starts moving?

# Heroes and Cowards

- Heroes and Cowards Game in NetLogo: All heroes



# Heroes and Cowards

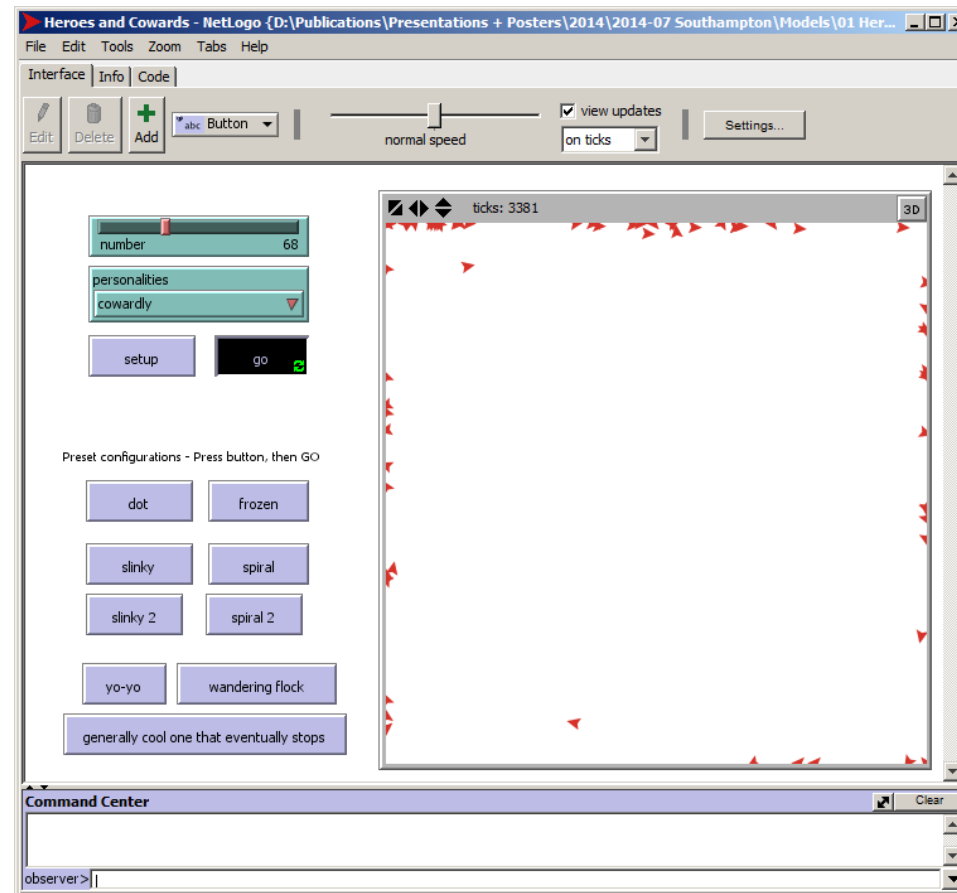
- Consider the following gaming scenario [Wilensky and Rand 2015]
  - 20 people scattered in a room - no communication
  - Game 2: Everyone takes on the role of a **Coward** by following a simple rule
    - Pick two participants and always use one to shield yourself from the other



- 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

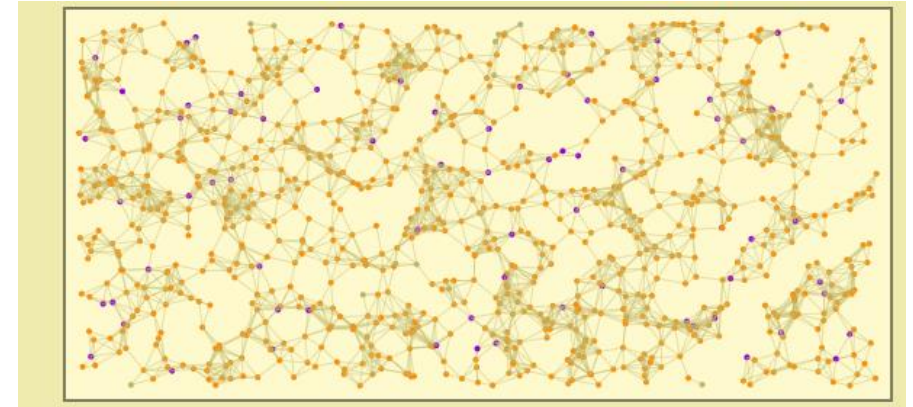
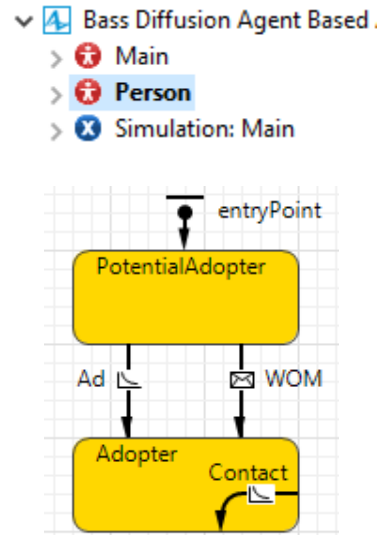
- Different flavours of ABMs [Achter et al 2022]
  - Theory driven
  - Empirical (data) driven
  - Model driven
  - Participatory

# 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)

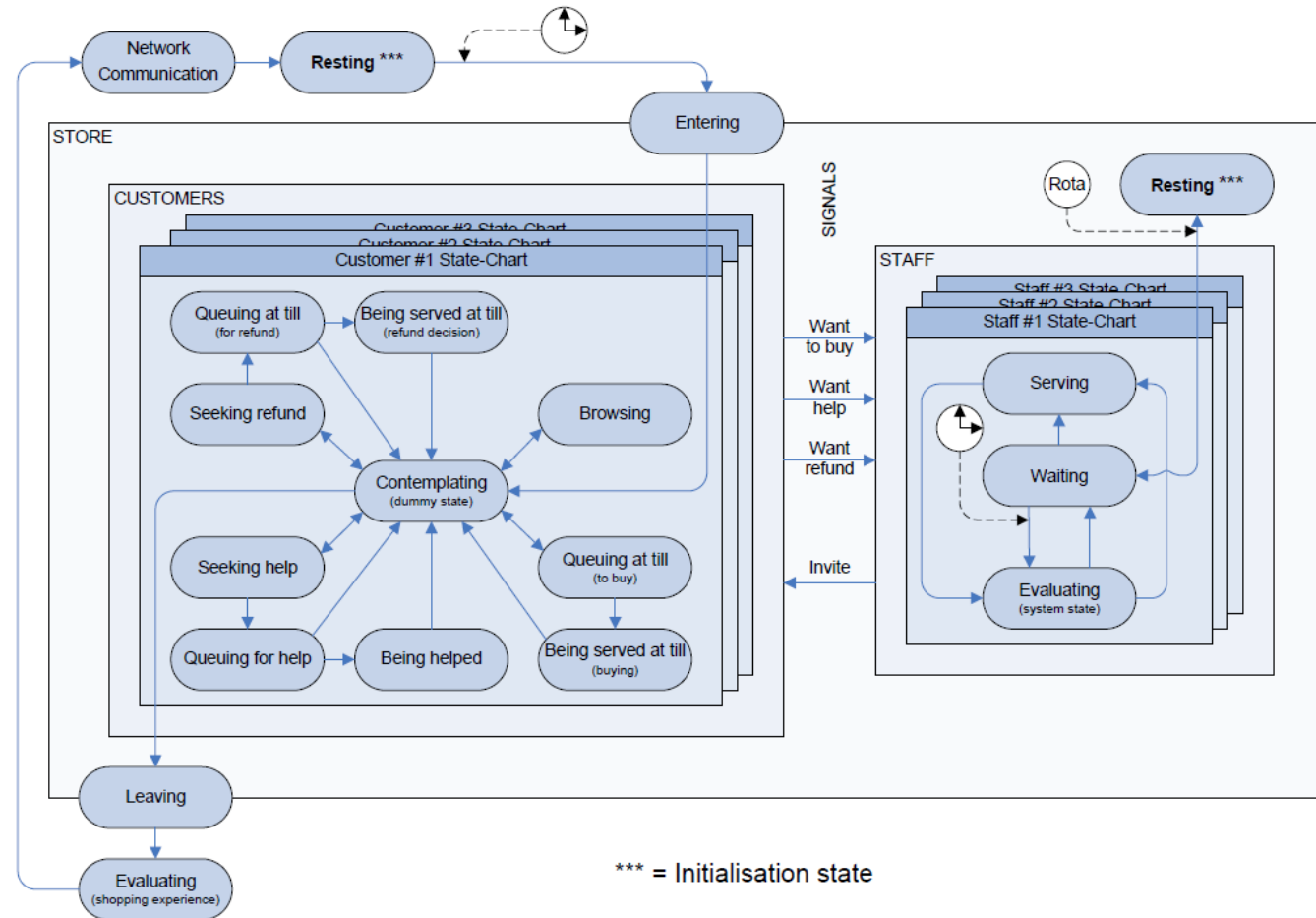


- Validating an ABS

- 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)

# 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]

The 'Engineering Agent-Based Social Simulation Toolkit' v2023-05-01

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Overview

This toolkit helps people from academia, non-governmental organisations, governmental organisations, and industry, to jointly develop conceptual agent-based models in a structured way for the purpose of better understanding and simulating systems where humans and their behaviours and decisions play a key role. At its heart, the toolkit uses a well established co-creation framework, namely the EABSS framework (Siebers and Kluegl 2017).

Following the guidance under "Training Workshop" (below) will teach people interested in this toolkit the basic concepts of agent-based modelling and they will gain some knowledge about how to develop conceptual agent-based models with the help of the EABSS framework.

**Engineering Agent-Based Social Simulations**

Analysis → Design → Output

Knowledge

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

README.md

## AgentPy - Agent-based modeling in Python

pypi v0.1.5 license BSD-3-Clause docs passing JOSS 10.21105/joss.03065

AgentPy is an open-source library for the development and analysis of agent-based models in Python. The framework integrates the tasks of model design, interactive simulations, numerical experiments, and data analysis within a single environment. The package is optimized for interactive computing with `IPython`, `IPySimulate`, and `Jupyter`.

Please cite this software as follows:

```
Foramitti, J., (2021). AgentPy: A package for agent-based modeling in Python. Journal of Open Source Software, 6(62), 3065, https://doi.org/10.21105/joss.03065
```

Installation: `pip install agentpy`

Documentation: <https://agentpy.readthedocs.io>

JOSS publication: <https://doi.org/10.21105/joss.03065>

Discussion forum: <https://github.com/JoelForamitti/agentpy/discussions>

Tutorials and examples: [https://agentpy.readthedocs.io/en/latest/model\\_library.html](https://agentpy.readthedocs.io/en/latest/model_library.html)

Comparison with other frameworks: <https://agentpy.readthedocs.io/en/latest/comparison.html>



# 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

File Edit View History Bookmarks Tools Help

Business and Management Mo X +

www2.econ.iastate.edu/tesfatsi/abusines.htm

## ACE Research Area: Business and Management Systems

Last Updated: 16 January 2023

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**Table of Contents:**

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ACE Website  
Online ACE Course (Self-Study eBook)

▶ **Basic Issues**

- Impact of marketing strategies on consumer behaviour
- Impact of management practices on store productivity
- Comparing different marketing strategies for multi-channel (physical and electronic) stores

<http://www2.econ.iastate.edu/tesfatsi/abusines.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/>

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