

Co-Creation of Agent-Based Simulation Models



Welcome to the Secret World of Agents



Heroes and Cowards [Wilensky and Rand 2015]

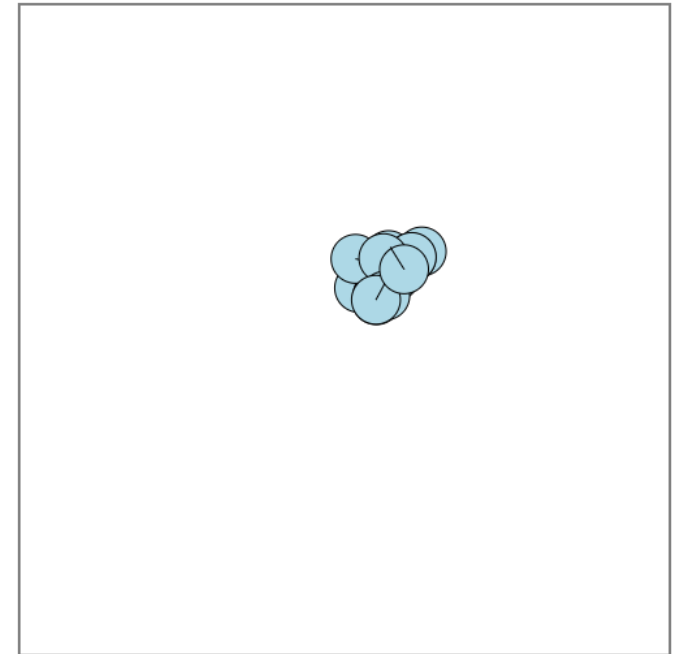
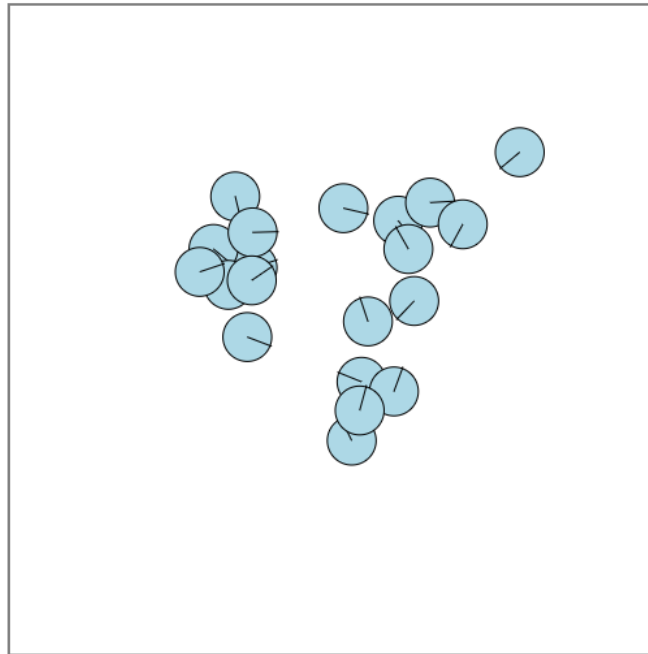
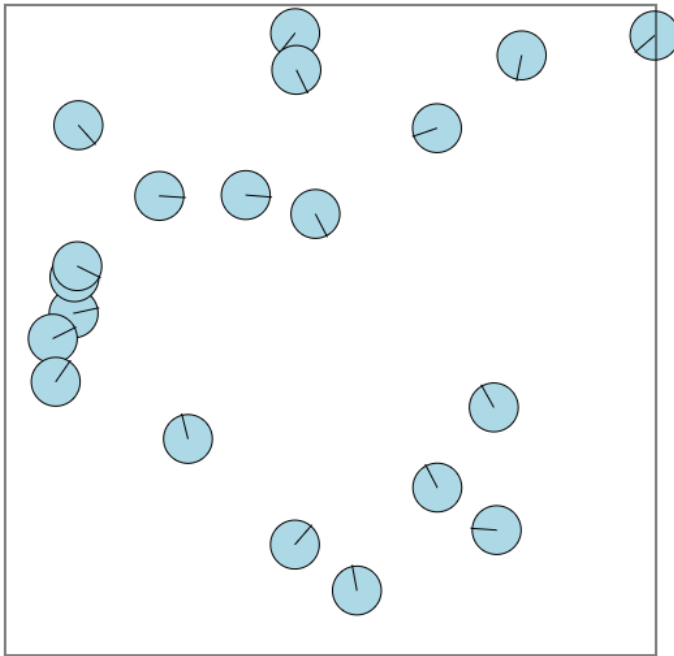
- Consider the following gaming scenario
 - 20 people scattered in a room - no communication
 - Game 1: Everyone takes on the role of a **Hero** by following a simple rule
 - Pick two participants and always locate yourself between them to shield one from the other



- What happens when everyone starts moving?

Heroes and Cowards

- Heroes and Cowards Game: All heroes



Heroes and Cowards

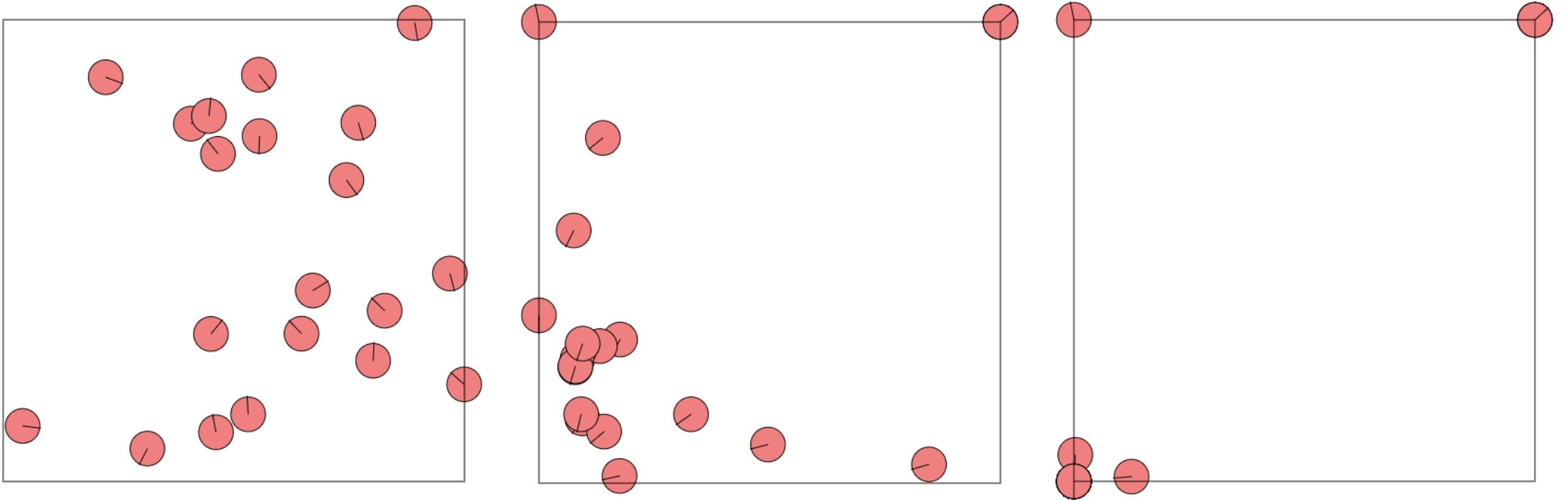
- Consider the following gaming scenario
 - 20 people scattered in a room - no communication
 - Game 2: Everyone takes on the role of a **Coward** by following a simple rule
 - Pick two participants and always use one to shield yourself from the other



- What happens when everyone starts moving?

Heroes and Cowards

- Heroes and Cowards Game: All cowards



Heroes and Cowards

- Micro level decision making within each player

```
if(strategy==1){ // act heroic
    x=(friend.getX()+enemy.getX())/2;
    y=(friend.getY()+enemy.getY())/2;
}else{ // act cowardly
    x=friend.getX()+((friend.getX()-enemy.getX())/2);
    y=friend.getY()+((friend.getY()-enemy.getY())/2);
}
moveTo(x,y);
```

Social Simulation and Agent-Based Modelling

- Social Simulation (formal definition)
 - Studies **socio-economic phenomena** by investigating the social macrostructures and **observable regularities** generated by the behaviour and relationships between individual **social agents**, and between agents and **the environment** in which they act.
 - Employs a bottom-up approach
 - Captures the dynamics of a system over time
 - Captures emergent phenomena at the macro level
- Agent-Based Modelling (formal definition)
 - 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
 - Agents can represent individuals, households, 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

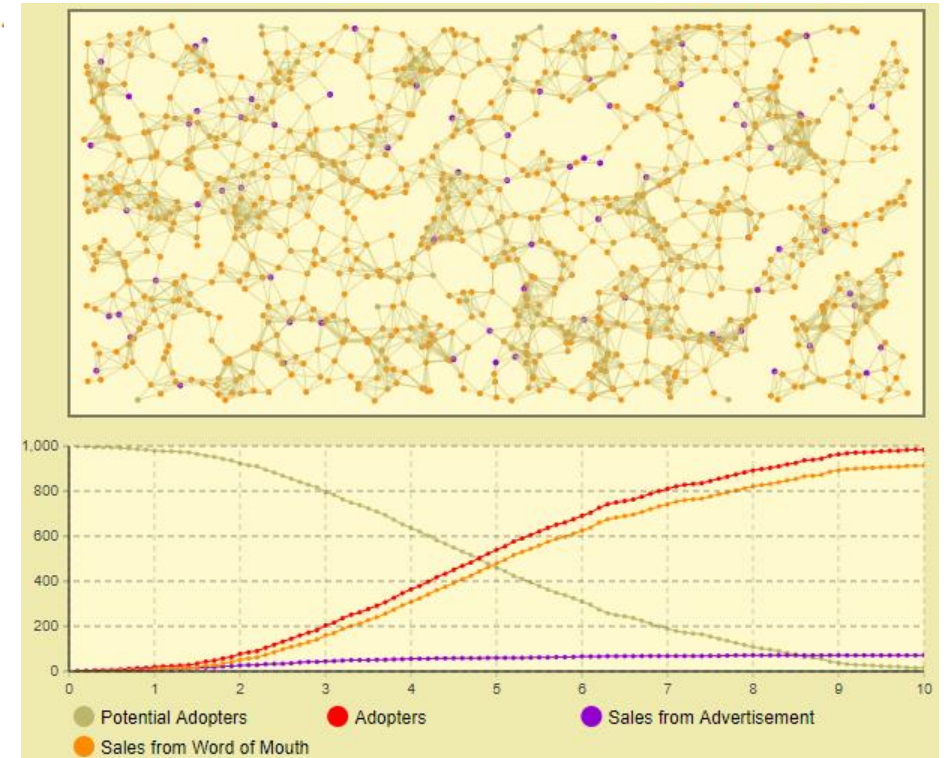
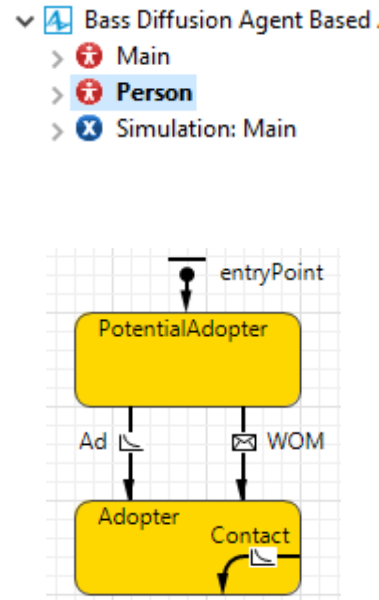
Building and Validating Agent-Based Models

- 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

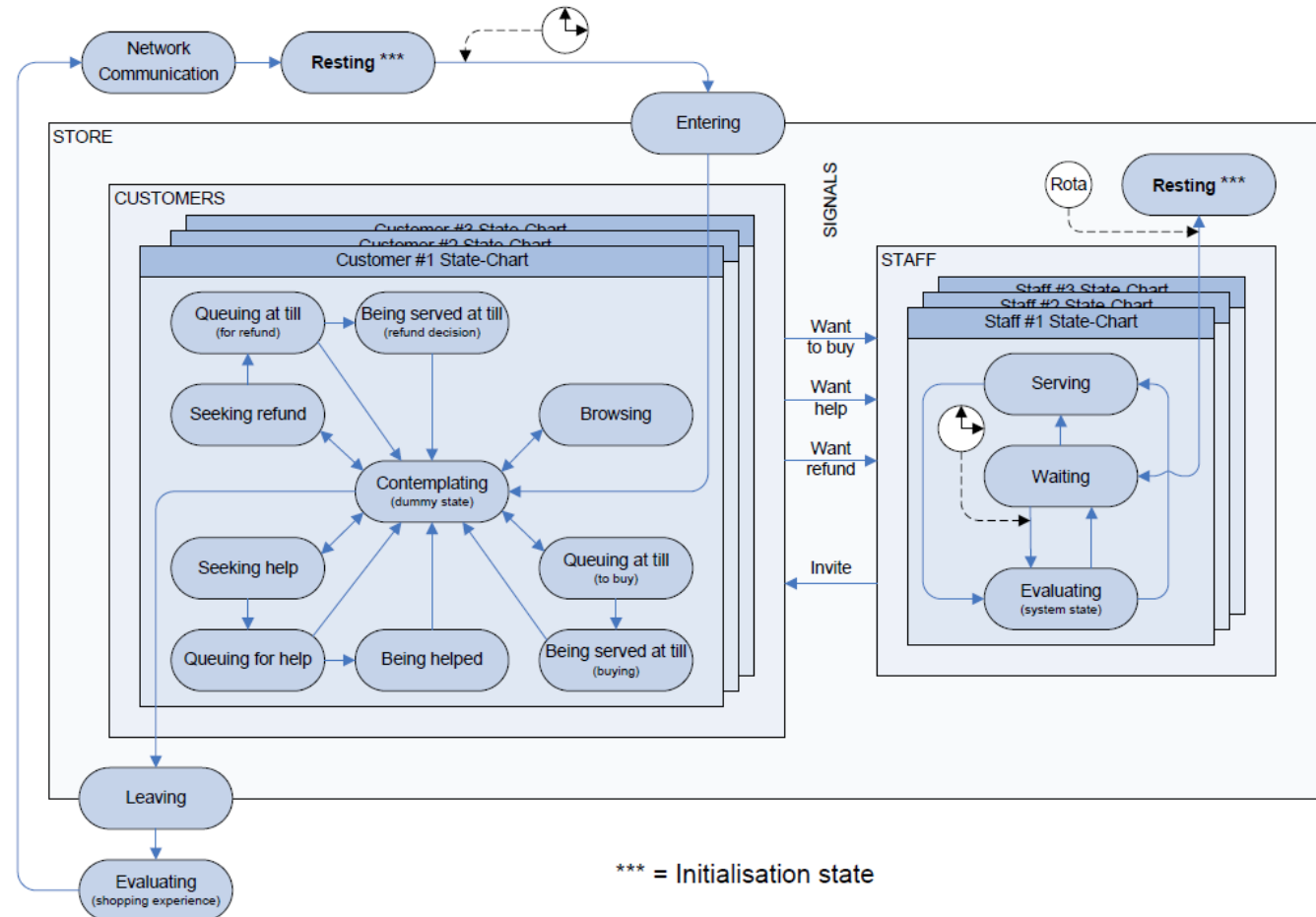
AnyLogic Help (2013)



- Validating an ABS
 - System behaviour is an emergent property
 - Validation at micro level
 - Plausibility check of emerging patterns at system level (e.g. comparison to observations)

Building and Validating Agent-Based Models

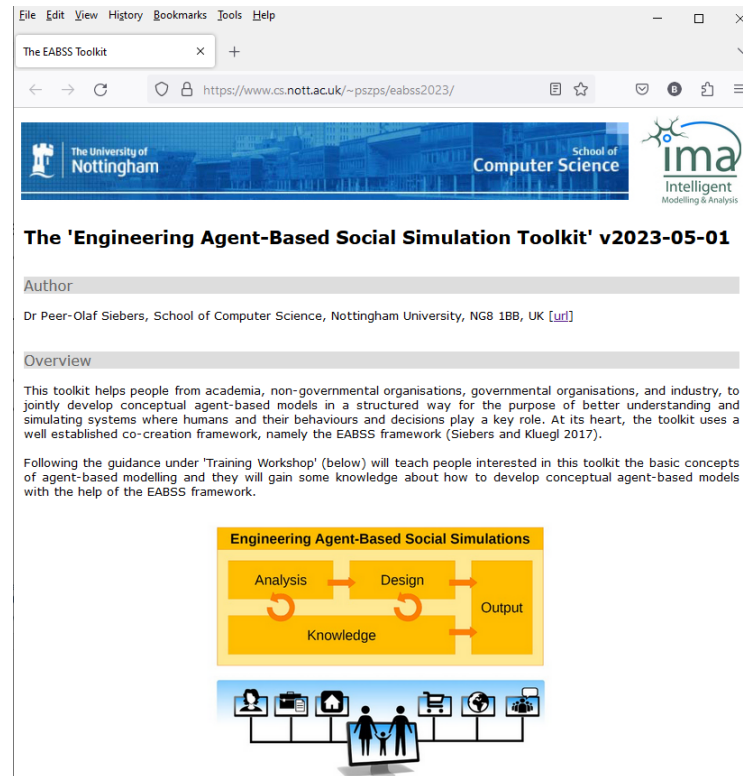
- Modelling proactive customer/staff behaviour in a department store scenario



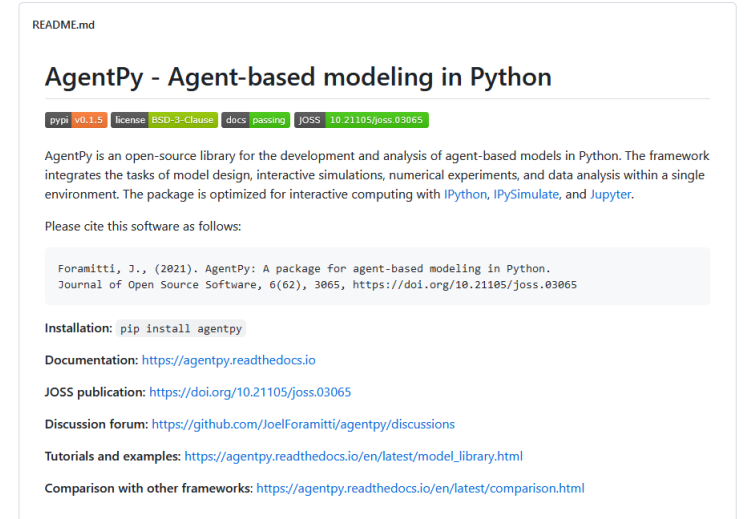
Siebers and Aickelin (2011)

Agent-Based Modelling and Simulation Tools

- Design
 - EABSS [Siebers and Klügl 2017]
- Implementation
 - NetLogo
 - AnyLogic
 - Gama
 - AgentPy
- Documentation
 - ODD [Grimm et al 2020]
 - RAT-RS [Achter et al 2022]
 - EABSS [Siebers and Klügl 2017]



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



References

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