SIMULATIONS

COMPUTER SCIENCE
VS.
SOCIAL SIMULATIONS

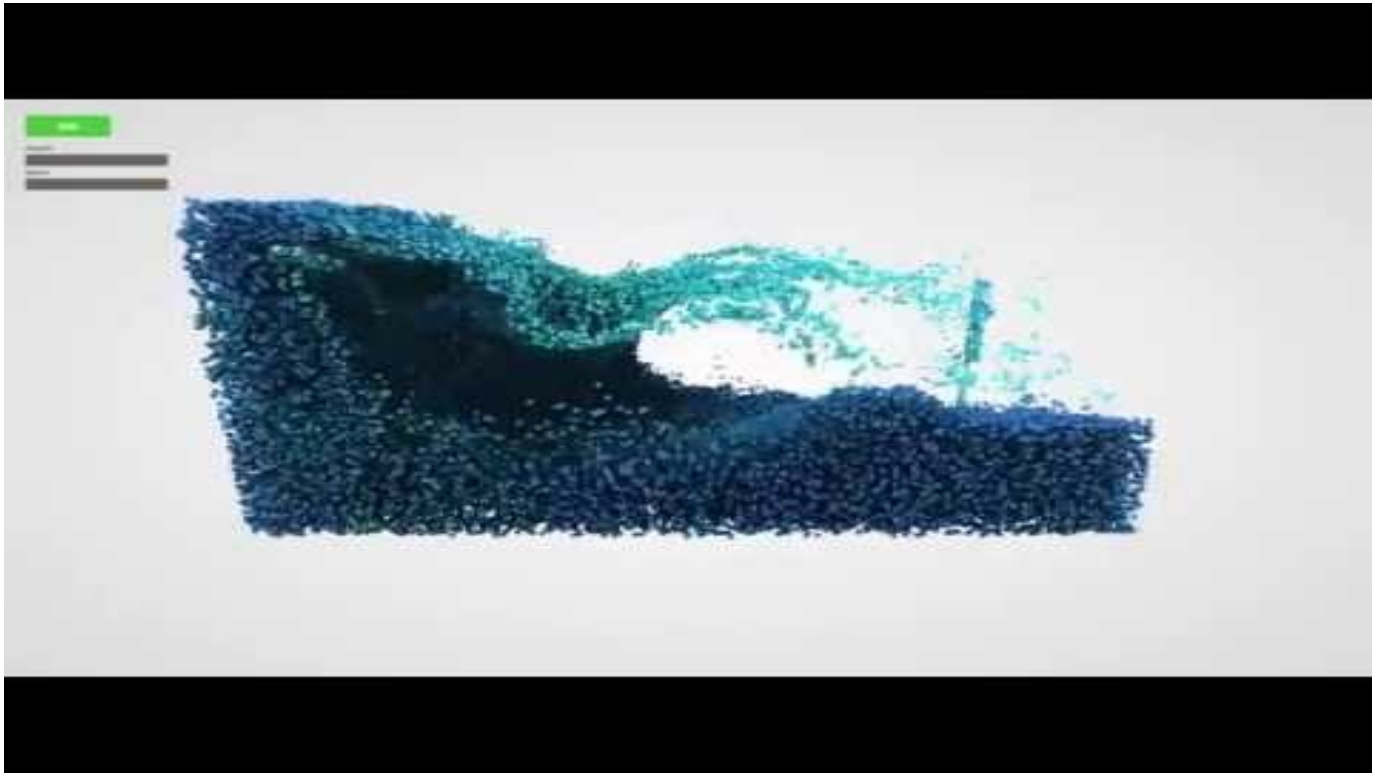
UMEÅ UNIVERSITY

Universiteit Utrecht

Simulations

- Game engines simulate a virtual world
- Physics engines simulate physical processes
- MAS are used to simulate logistics. E.g. trains, warehouses,…
- Supply chain management. Discrete Event Systems
- …

Particle based simulations



Physics based simulation

- Requirements of simulation
- Determine theories to be used
- Program objects and laws of physics based on theories
- Simulate and validate

- Can you replicate the system?
- Can you repeat every simulation run (exactly)?

- Example with Algodoo (www.algodoo.com)

Crowd simulation

- Big-scale exercises (>500 people) are impractical
  - Has big impact on environment and surroundings
  - Costs considerable amount of time
  - Tests performed on a few scenarios only
- Crowd simulation is needed for
  - Simulations of the real world
    - Improving crowd flow, predicting crowd pressures, planning evacuation routes
  - Improving the immersion/realism in virtual worlds

Game worlds

Rebuilding of train station

Love Parade, Duisburg, 2010
21 deaths
510 injuries

Evacuation in sports stadiums

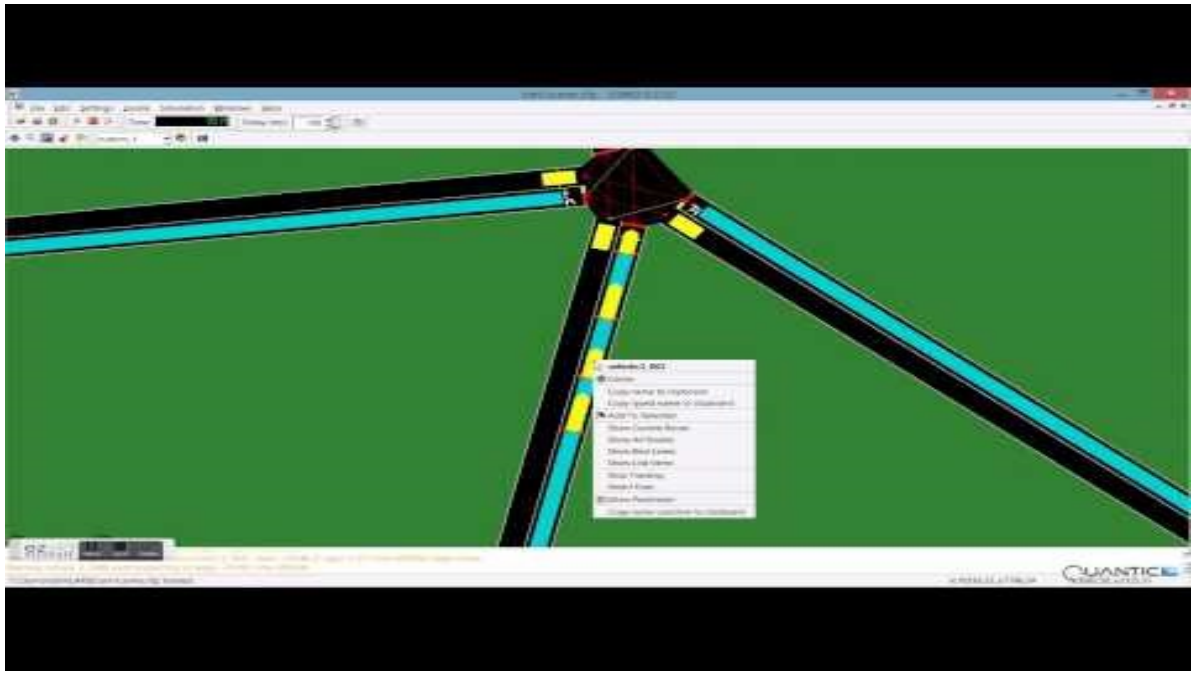
A computational model of human navigation

Challenge: Unify *dispersed* models for *realistic*, individual, small group, and collective human movements in *interactive*, *heterogeneous* environments.

- Dispersed models
  - Agent-based: individuals, but problems with high densities
  - Flow-based: no individuals, but good for high densities
- Realistic movements
  - Comprise collaboration, smooth and energy-efficient movement, collision avoidance, and dealing with unrealistic congestions.
- Interactive environment
  - Geometry can change dynamically, and the crowd has to react.
- Heterogeneous environment
  - People need to take logical, distinct, and realistic paths over heterogeneous terrains in the environment.

Simulating trains or traffic

SUMO (open source traffic simulator)



New: vehicles contain drivers

- Drivers have preferences, motivations, …
- Drivers can make mistakes
- Trains have passengers
- Passengers can transit between trains
- …

- We use Multi Agent Systems to implement these simulations

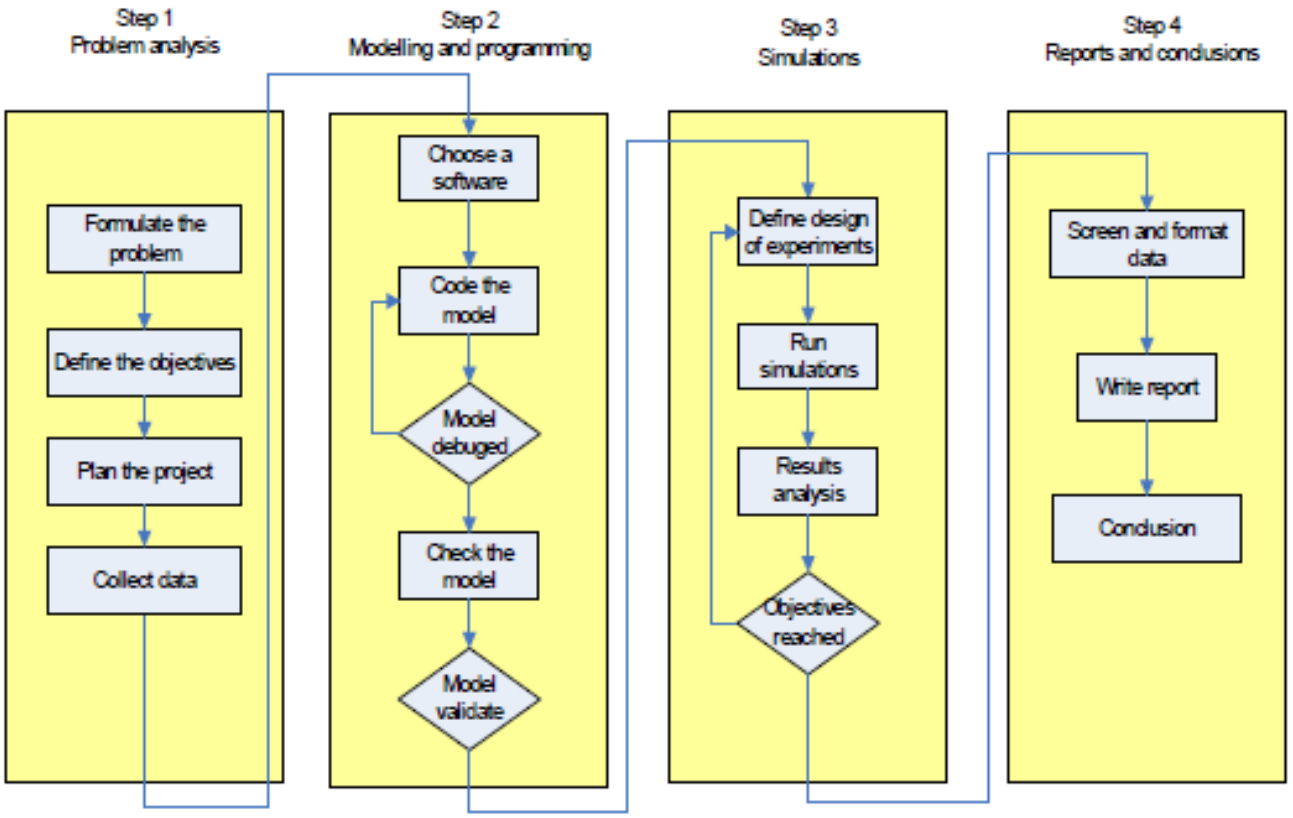
- What is the purpose of these simulations?
- Can we still replicate every simulation?
- What are the consequences if we cannot?

Simulations for supply chains

- Rules on how goods and money are exchanged
- From physical to logical
- Emphasis on strategic behavior
- Game theory

- What is the purpose of these simulations?
- Can agents learn from experience?
- How “real” are the simulations?
- Do people follow the rational rules from game theory?

Typical CS simulation



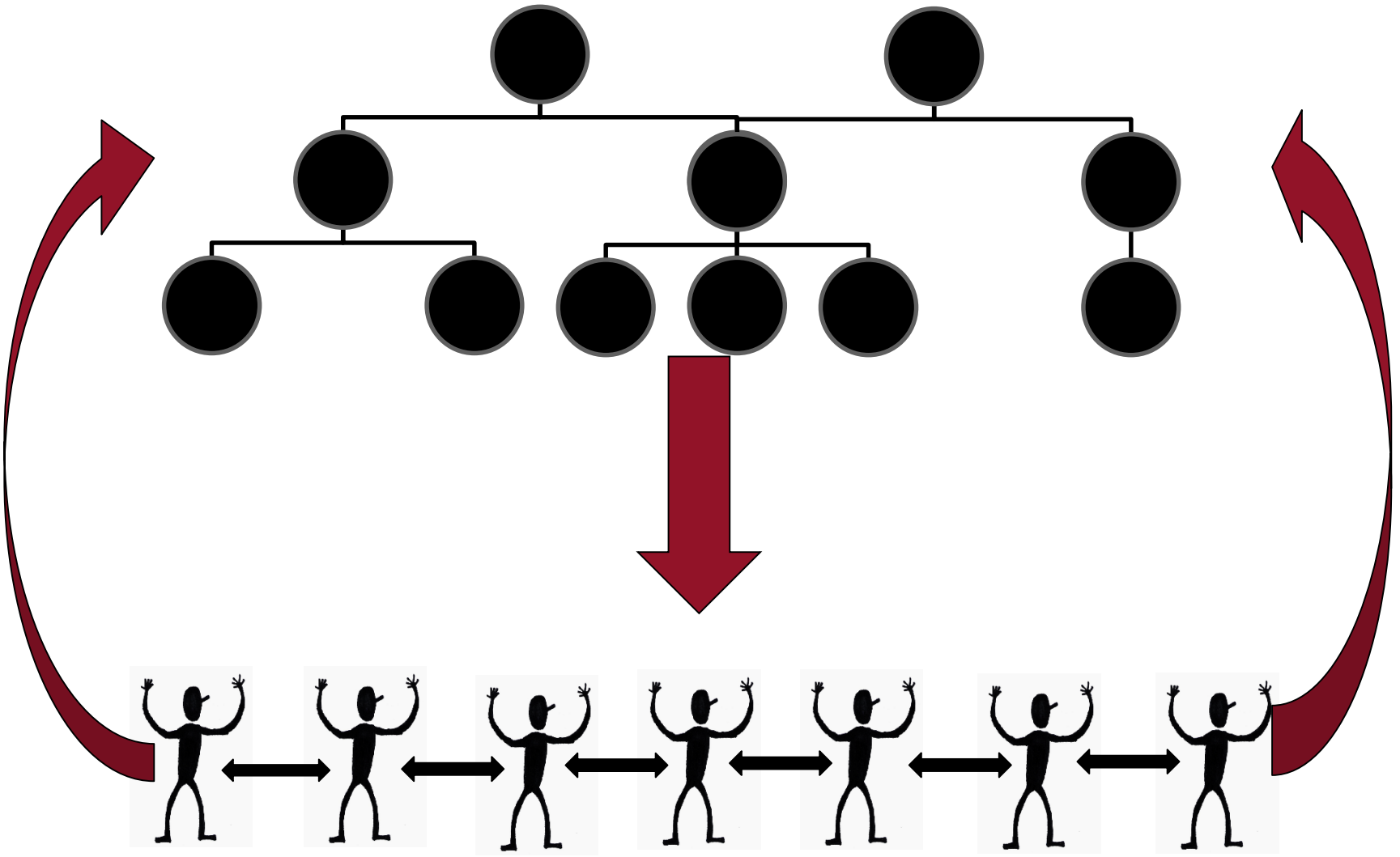
Simulations in CS

- People are there only sometimes
- Bodies of characters are usually only physics based
- People act “rational”. I.e. follow a theory that indicates the outcome of a decision given the input situation

Social simulation

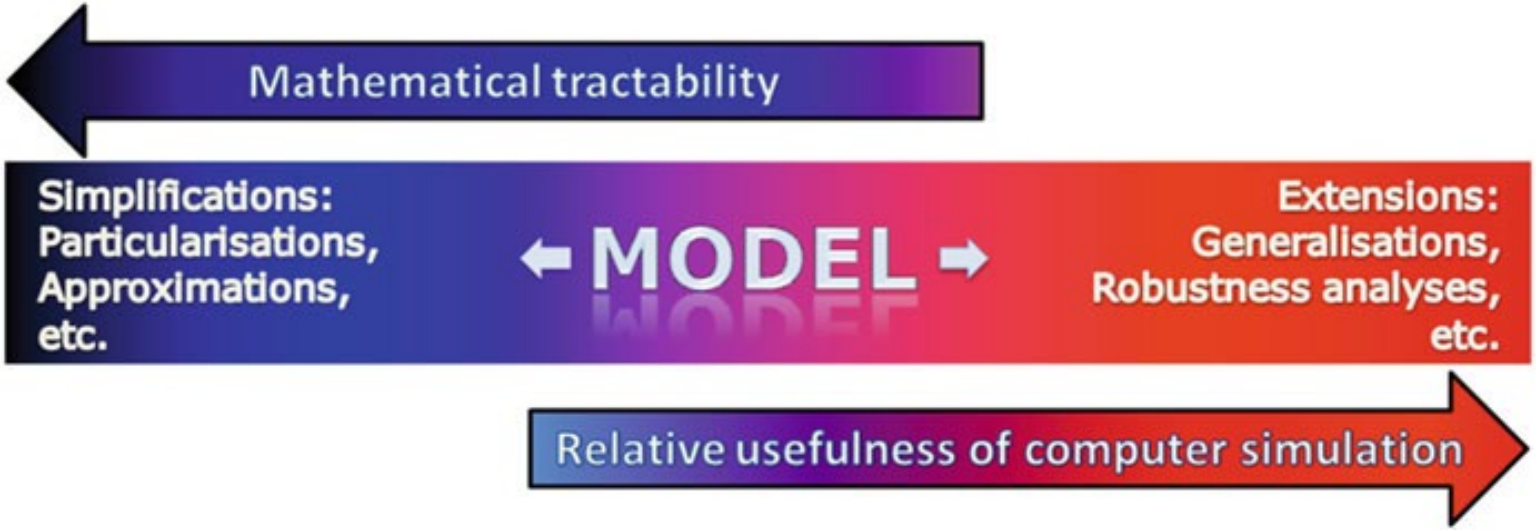
- People's choices depend on the behavior or choices of other people.
- (note: game theory assumes a simultaneous move, which is possibly repeated)
- In game theory usually "equilibrium" is seen as desirable. Is this happening in reality?
- Change focus from individual choice to interactions between individuals
- Change focus from voluntary interaction to any type of interaction

Micro motives, Macro behaviour



Social simulation

- Simulation is only interesting when analytical tools are not available or are too limited



Not too simple, not too complex

- Definitions, functions, theories are choices.

- E.g. individuals choose the action that maximizes a certain utility function.
- Given a utility function this becomes "easy" and "predictable".
- Which utility function should be taken?

- If we simplify too much, the results of the simulation do not give any new insight.
- If we make things too complex it is completely unclear how results can be explained.

Not too simple, not too complex

- How do you know what is too simple or too complex?

- Hypothesis,
- Compare with literature,
- Experience,
- Trial and error

- Agile like approach:
  - Start quick with simulation
  - Feedback on problem and definitions
  - Extend the implementation
  - Reiterate “until you are done”

People in the loop

1. Modeling individual decision making is never finished, correct, valid,…
2. People adapt, learn and react to the influences of other people
3. Direct through interactions,
4. Indirect through the emerging structures
5. Thus the decision process is by definition never stable
6. We cannot observe the decision making process, only the outcomes.
7. Thus we cannot directly compare the model with the reality.
8. We can only approximate, but this is situation dependent. i.e. by adding more aspects to the model it will not necessarily be a better approximation.