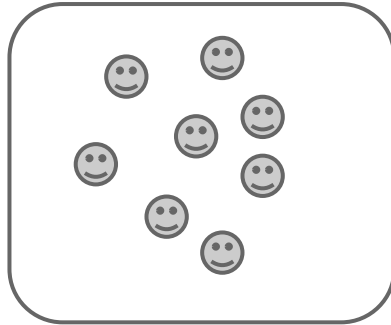


# **Simulation and Self-Organization**

Thomas Breuel

**big picture**

# modeling vs simulations



complex real-world system



experimental observations

agents and their interactions



abstractions and simplifications



bulk approximations

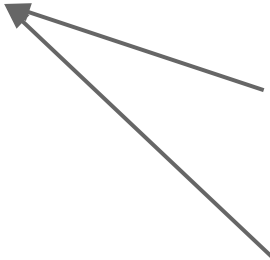


continuous models

MATH SOLUTIONS



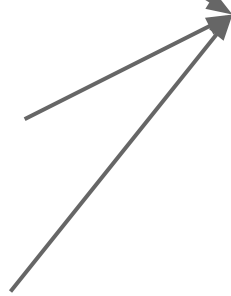
PREDICTIONS



SIMULATION



PREDICTIONS



# styles of models

**simplified agents, interactions:** economic agent models, intelligent agent models

**bulk approximations:** cellular automata, difference equations, graph models

**continuous approximations:** differential equations

**big questions about  
complex issues**

**ask big questions**

Sources and consequences of inequality.

# OXFAM

*Wealthy elites have co-opted political power to rig the rules of the economic game, undermining democracy and creating a world where the 85 richest people own the wealth of half of the world's population*

*We cannot hope to win the fight against poverty without tackling inequality. Widening inequality is creating a vicious circle where wealth and power are increasingly concentrated in the hands of a few, leaving the rest of us to fight over crumbs from the top table.*

# OXFAM policies

straightforward:

- refrain from using their wealth to seek political favors
- make public all the investments

uncertain consequences:

- support progressive taxation
- use tax revenue to provide universal healthcare, education and social protection for citizens
- demand a living wage in all companies they own or control



# Adam Smith

*The proud and unfeeling landlord views his extensive fields, and without a thought for the wants of his brethren, in imagination consumes himself the whole harvest ... [Yet] the capacity of his stomach bears no proportion to the immensity of his desires ... the rest he will be obliged to distribute among those, who prepare, in the nicest manner, that little which he himself makes use of, among those who fit up the palace in which this little is to be consumed, among those who provide and keep in order all the different baubles and trinkets which are employed in the economy of greatness; all of whom thus derive from his luxury and caprice, that share of the necessaries of life, which they would in vain have expected from his humanity or his justice... The rich... are led by an invisible hand to make nearly the same distribution of the necessaries of life, which would have been made, had the earth been divided into **equal** portions among all its inhabitants, and thus without intending it, without knowing it, advance the interest of the society...*

## **two views**

**Shared:** The rich are greedy and don't care about the rest of humanity.

**Adam Smith:** It doesn't matter because they simply coordinate economic activity that benefits everybody else.

**OXFAM:** People are thrown into poverty because the rich own everything.

# who is right?

- Is inequality a result of efficient market forces or “rigging the rules”?
- Does more inequality actually make the rich better off at the expense of the poor? (zero-sum assumption)
- Is Adam Smith right that the greed of the rich benefits society as a whole?
- Would a more equal distribution of wealth result in better outcomes?
- Are the proposed policies effective?


# classical mathematical economics

- make lots of assumptions
- reduce this to simple linear models or differential equations
- draw conclusions

doesn't convince anybody who didn't believe in the result in the first place

# breaking this down further

Is inequality a result of efficient market forces or “rigging the rules”?

- How effective can “rigging the rules” be?
- What are observable effects of “rigging the rules”?
- Are there alternative explanations for inequality than “rigging the rules”? 

# alternative explanations

Simple agent simulations have let us identify sources of inequality without “rigging the game”:

- income growth with age and demographics
- competitive markets

Next step: quantify these and look for how much they account for observed inequality.

# policy issue: inequality

- complex problem of huge economic and political relevance right now
- simple political and policy statements break down into a large set of complex assumptions
- we can test and discuss many of these assumptions qualitatively and quantitatively through economic and agent simulations
- particularly important: test the consequences of proposed policies

# simulation for big questions

politics, economics

- climate change
- health care reform
- stimulus
- debt
- racism
- crime
- ...

science, engineering

- product simulation
- in silico medicine
- intelligence
- pattern formation
- computation and physics
- ...



# **simulation for microeconomic questions**

- How risky is my investment portfolio?
- Which markets should company expand to?
- Where/how should we place our ads?
- What is the cost/benefit of social network marketing?