SIMULATION

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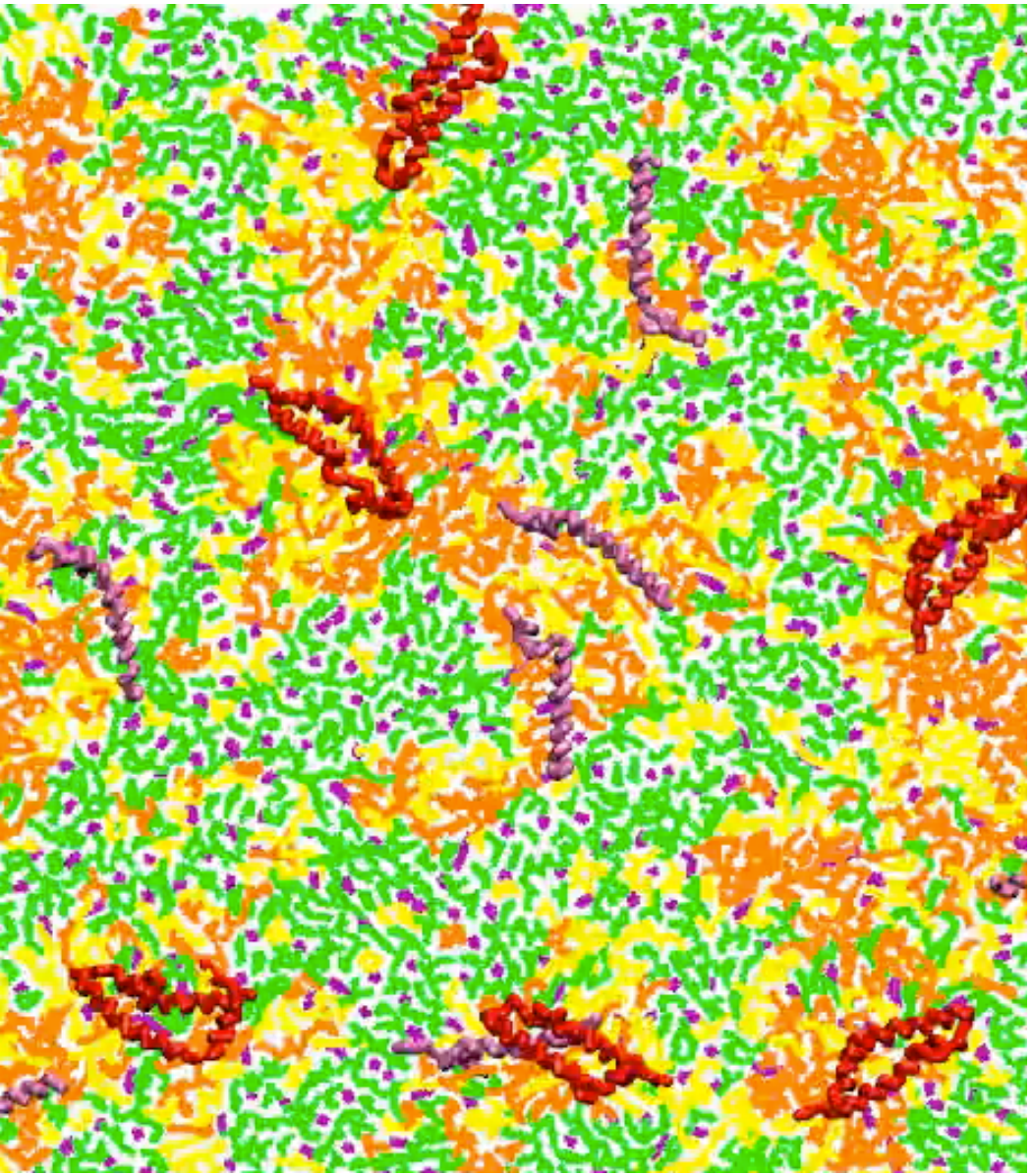


OUTLINE

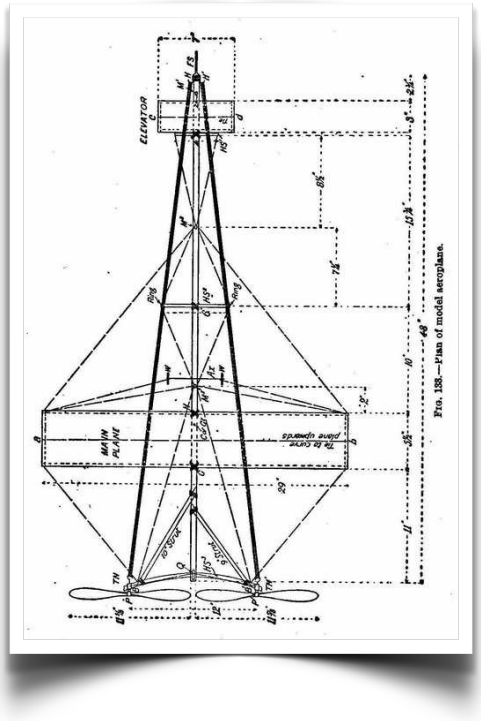
- What is simulation?
- The uses of simulation
- Some history
- The special features of social simulation

SIMULATION

Social simulation is the idea that one can build a computer program that models the behaviour of some social phenomenon.

MODELS

- Model aeroplanes
- Statistical models
- Natural science models
  - atoms an balls
  - cells an biological factories
- Social science models
  - cognitive models
  - econometric models
- Computational models



WHY SIMULATE?

- Compare:
- Verbal description
  - Imprecise, allows gaps and inconsistencies
- Mathematical description
  - Rigorous, a heterogeneous* and non-linear models are difficult to analyze
- Computational model
  - Rigorous, can model multi-level, heterogeneous models, permits experimentation

* Many different kinds of objects (people, organisations, etc.)

SIMULATION AS A PARADIGM

- Process analysis
  - not just at one moment in time
- Abstraction
  - not descriptive
- Macro and micro
  - not atomistic
- Experimental
  - not observational

AN EXAMPLE

- How do people find marriage partners?
- Strategy 1:
  - keep looking until you find someone who matches your ideal.
- Strategy 2:
  - look only until someone good enough come along
- What are the implications of these methods?

A SIMULATION

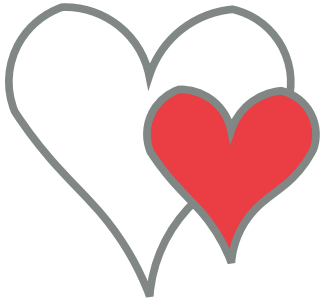
- A random sequence of "people" each with 'suitability scores'
- Agent cannot look ahead in time
- Once discarded, it is not possible to return to a potential mate (perhaps because they have been selected by someone else).
- Range of suitability scores not known

PASSIBLE STRATEGIES AND THEIR CONSEQUENCES

- Ignoring search costs, mutual choice, and assuming that you know how many applicants there are:
  - Optimal strategy for 100 candidates:
    - look at first 37 applicants;
    - remember best score among these 37;
    - select the first applicants from 38th onwards
    - with a score greater than this score.
  - Optimal number is lie (37%) - and the best applicant is found 37% of the time.

NOW YOU TRY IT...

- 40 possible partners
- 37% of 40 is 14.8 ≈ 15



THE MATE SEARCHING GAME

56	116	149	217	117	81	308	193	78	239
85	15	294	110	219	275	151	310	191	75
110	21	23	132	259	264	194	59	273	239
166	254	136	100	172	30	172	288	128	276

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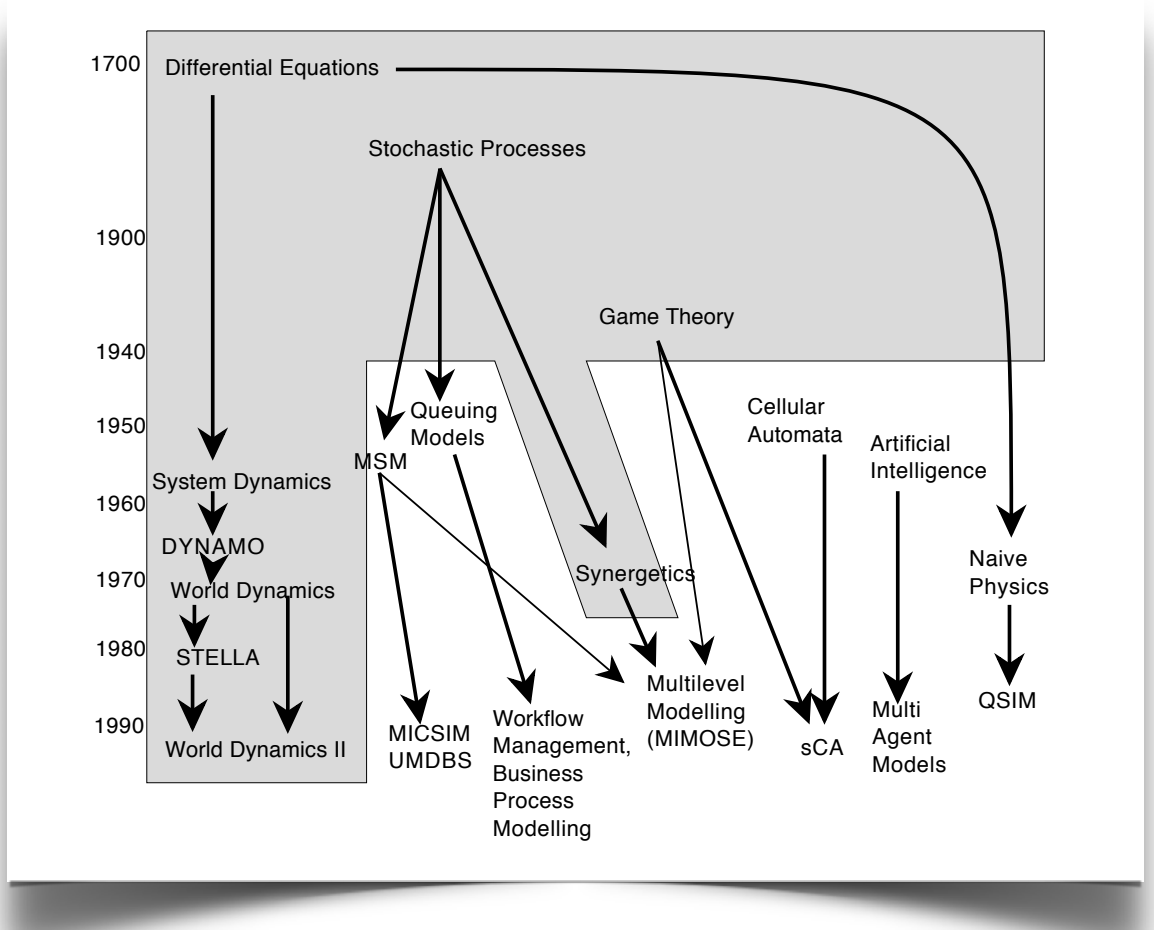
MORE STRATEGIES

- Todd and Miller show that one doesn’t need to know the number of 'applicants' /mates: just evaluate the first 12 to find the score you should aim for; this gives the best average success.
- But this doesn't take into account your mate's views about you.

THE USES OF SIMULATION

- Understanding
- Prediction
- Tool
- Training
- Entertainment
- Formalisation
- Discovery

A HISTORY OF SOCIAL SCIENCE SIMULATION

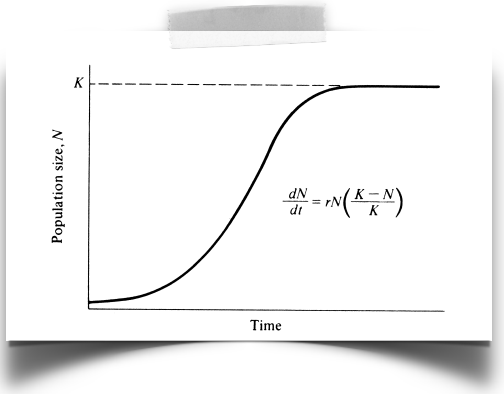


SOCIAL SIMULATION: SPECIAL FEATURES

- Non-linearity
- Complexity
- Emergence
- Self-organization
- Bounded Rationality

NON-LINEARITY

- Linear: effect on a dependent variable is proportional to the sum of a set of independent variables
- Non-linear:
  - E.g. Verhulst logistic population growth equation
  - Sensitive to Initial conditions
  - Typical of many predator/prey systems



COMPLEXITY

- Simple behavior and simple rules can yield very complex organization.
  - Sand pile
    - Chaotic avalanches
    - Predictable side angles
  - Ants
  - Human organizations

EMERGENCE

- Physical and biological examples
  - temperature
  - ant's nests
- Self-organizing social systems
  - the 'Mexican wave'
  - traffic jams

EMERGENCE

a phenomenon is emergent if …

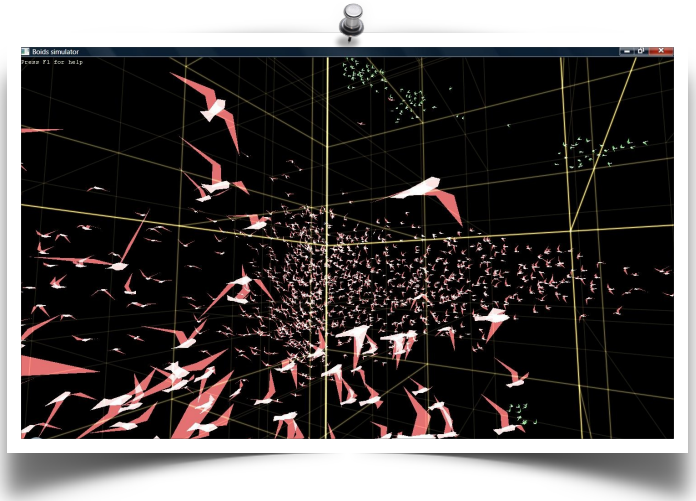
it requires new categories to describe it that are not required to describe the behavior of the underlying components

SECOND-ORDER EMERGENCE

- Institution emerges from the action of the agents
- Agents are influenced by the institution

SELF-ORGANIZATION

- Global organization that appears without central planning from the actions of individual agents e.g.
  - Flocks and boids
  - Markets
  - The internet



BOUNDED RATIONALITY

- While some earlier economists' models assumed rationality (including complete knowledge, infinite computational ability, etc.), since Herbert Simon (1954), the assumption is of bounded rationality.
- Implies:
  - Local information
  - Limited capacity to process information

SPATIAL LOCATION

- Human interactions are affected by their spatial locations
- Local interactions are more important than distant ones

A SIMULATION CLASSIFICATION

- System dynamics
- Microsimulation
- Queuing models
- Multi-level simulation
- Cellular automata
- MULTI-AGENT MODELS
- Evolutionary models

A SIMULATION CLASSIFICATION

Chapter	*Number of levels*	*Communication between agents*	*Complexity of agents*	*Number of agents*
3 System dynamics	1	No	Low	1
4 Microsimulation	2	No	High	Many
5 Queuing models	1	No	Low	Many
6 Multilevel simulation	2+	Maybe	Low	Many
7 Cellular automata	2	Yes	Low	Many
8 Multi-agent models	2+	Yes	High	Few
9 Learning models	2+	Maybe	High	Many