Ways of using a computer

Question: What is the probability of getting at least one pair in a hand of five cards drawn from a standard deck of 52 cards?

- Calculator: 0.49
- Enumerator: 0.49
- Simulator: 0.51 (200), 0.48 (2000), 0.49 (20000)

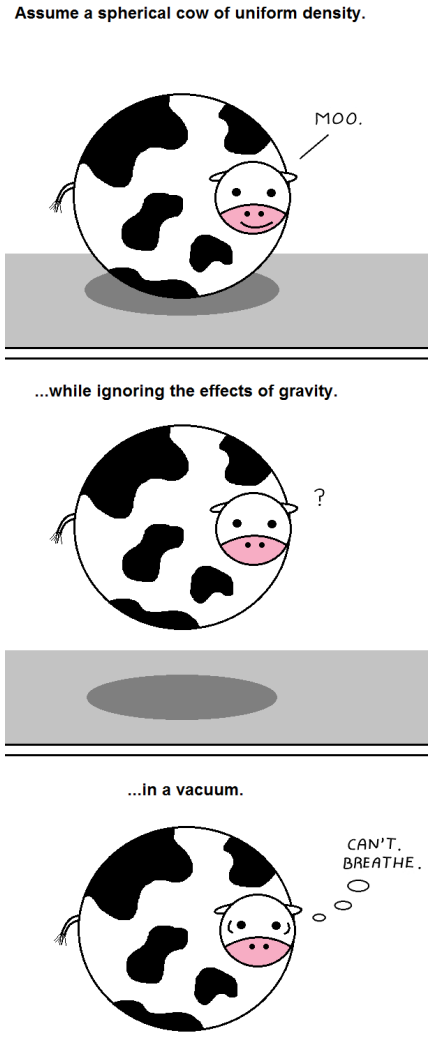
DAVIDSON

Ways of using a computer

- For statistical purposes, Economists will often use a computer as a simulator (to do Monte Carlo simulations).
- But for solving theoretical models, economists have conventionally used a computer primarily as a calculator.
- However, many if not most *realistic* economic models are "intractable" and cannot be solved by conventional methods

DAVIDSON

Unrealistic but common assumptions

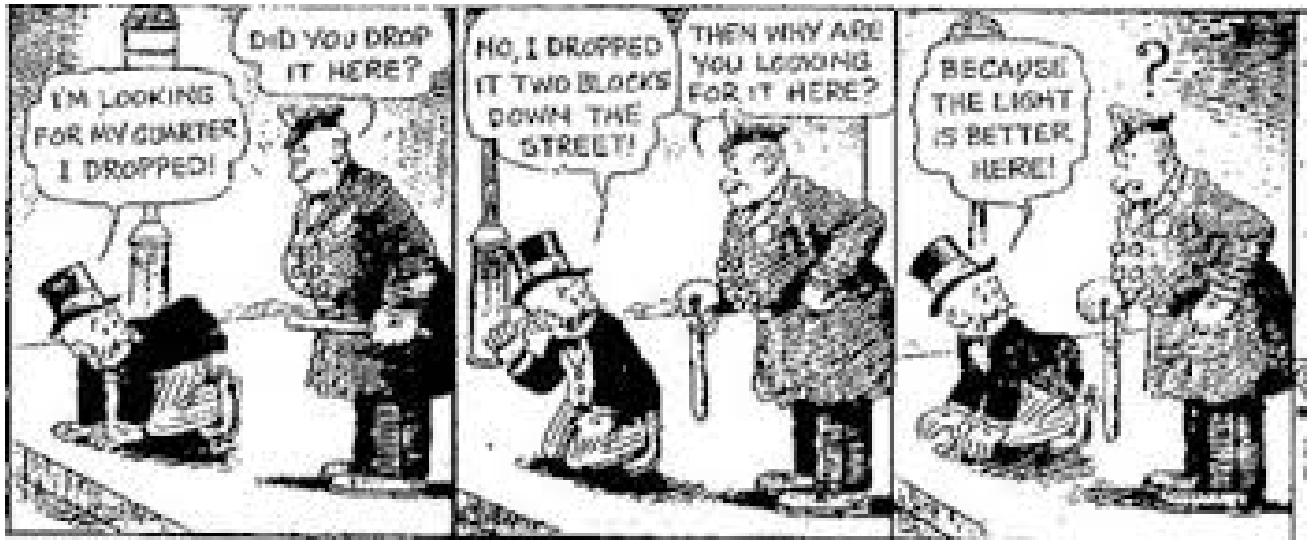


- Unrealistic utility functions.
- Unrealistic optimizations.
- Unrealistic information and expectations frameworks.
- Unrealistic levels of homogeneity and unhelpful degree of aggregation.
- Steady-states, fixed points, equilibriums all of which may only be applicable in the 'long run.'

DAVIDSON

My objections

- Why Assume When Simulations Possible
- Economy Greater than Sum of Parts



DAVIDSON

Emergent Phenomena, Complex Systems, Complex Adaptive Systems

1. Irreducibility – whole has features not apparent in parts; e.g., temperature and phase in physics, conscious thought from neurons, efficient markets from individual transactions. We need to know about the system and interactions of parts
2. A complex system is a system composed of many components which may interact with each other. Complex systems are systems whose behavior is intrinsically difficult to model due to the dependencies, competitions, relationships, or other types of interactions between their parts or between a given system and its environment. (Wikipedia)
3. Complex Adaptive Systems are complex in that they are dynamic networks of interactions, and their relationships are not aggregations of the individual static entities, i.e., the behavior of the ensemble is not predicted by the behavior of the components. They are adaptive in that the individual and collective behavior mutate and self-organize corresponding to the change-initiating micro-event or collection of events. (Wikipedia)

DAVIDSON

Agent-Based Computational Economics

1. Use the computer to create simulations of artificial economies or societies
2. In each simulation there are many computer-generated individuals (called “agents”) who are programmed to behave like human beings (or other economic entities) in the real economy.
3. The consequences of the actions and interactions of these agents are then studied to analyze the economic issue.

- Formally, computational study of economic processes modeled as dynamic systems of interacting agents

DAVIDSON

Agent-Based Computational Economics

- ABM has a long history in natural sciences – from ecology to astrophysics, simulation-based studies are commonplace
- ACE rapidly gaining popularity, especially since 2008.
- ACE is particularly suitable to model complex systems where agents' interactions combine to produce unexpected outcomes
- ACE models exist in the frontiers of Macroeconomics, Urban Economics, Finance, Industrial Organization, etc.

DAVIDSON

ACE: Strengths

- Study emergent behavior (traffic jams, recessions, polarization, etc.)
- Study dynamic behavior.
- Study complex models with multiple equilibria.
- Study network-based models.
- Study realistic models in terms of assumptions related to human behavior and its heterogeneity

DAVIDSON

ACE: Weaknesses

- More suitable for theoretical models that explain phenomena rather than empirical models that estimate correlations or produce numerical forecasts. (exceptions e.g. EURACE, Bank of England Housing Model)
- Too much modelling freedom?
- Curse of dimensionality
- Profusion of results

DAVIDSON

Example 1: Segregation in Cities

- Thomas Schelling, 1971 (Nobel Prize, 2005) pioneered ACE
- Even a small degree of racial preference could lead to almost complete racial segregation in a city.
- Analytical solution does not capture tipping points, dynamics, and characteristics of common outcomes.
- A brief demonstration

DAVIDSON