Climate Change and the New Economics

Eric Beinhocker

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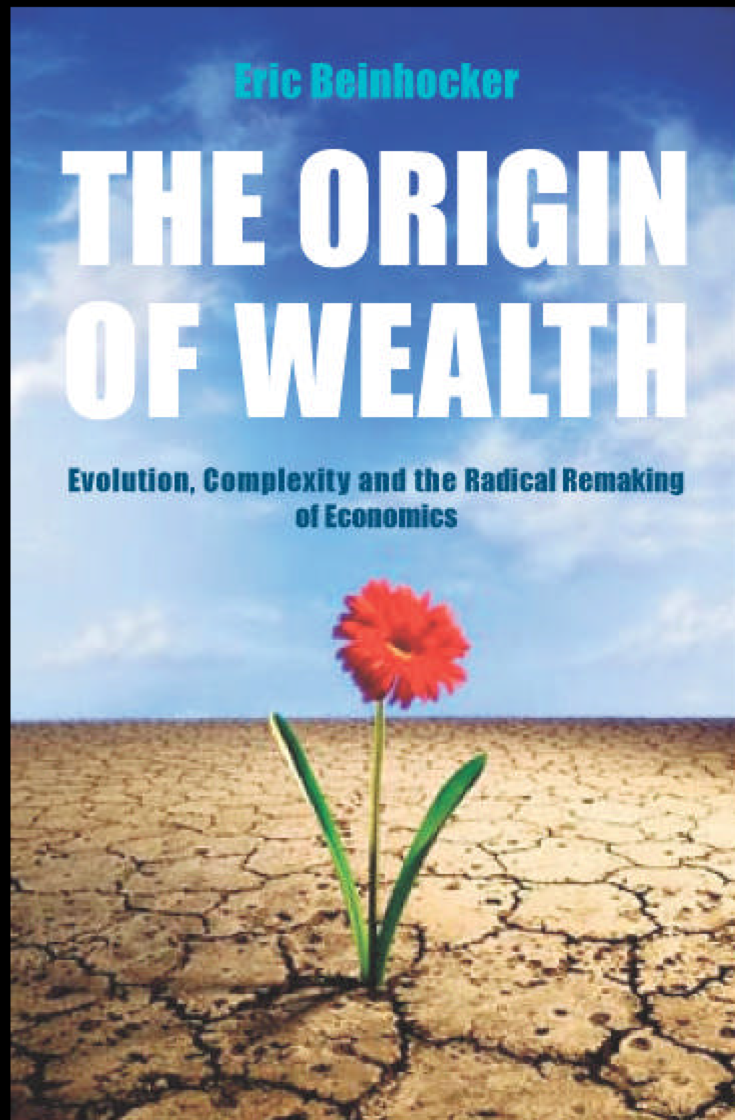
Eric Beinhocker
THE ORIGIN OF WEALTH
Evolution, Complexity and the Radical Remaking of Economics

“The ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed, the world is ruled by little else.”

John Maynard Keynes

Today’s discussion

- The three most stunning empirical facts in economics
- Characterizing the economy – what is it?
- The economy as an evolving complex system
- What does it mean for addressing climate change?

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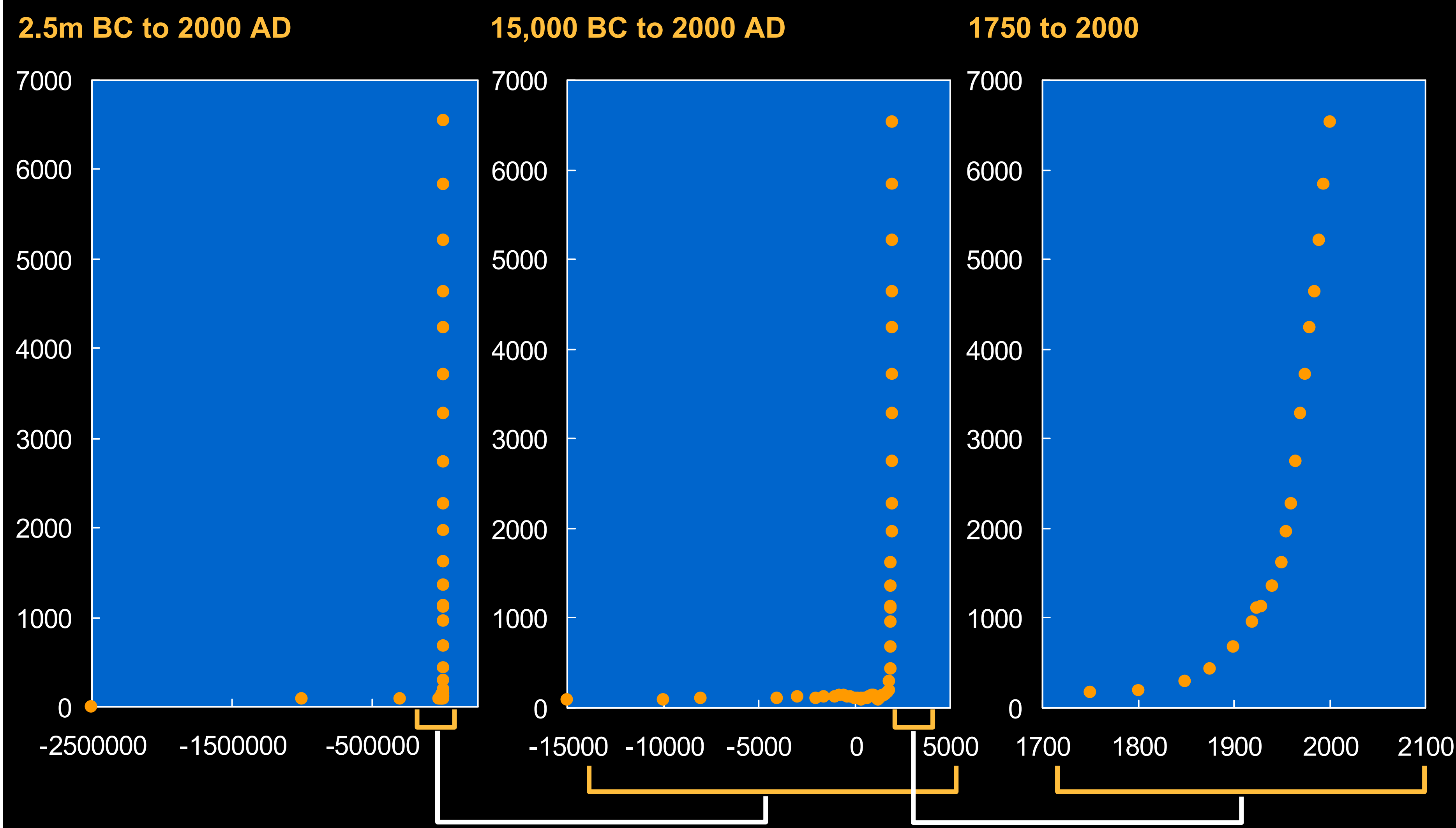
Fact no. 1 – wealth has grown explosively

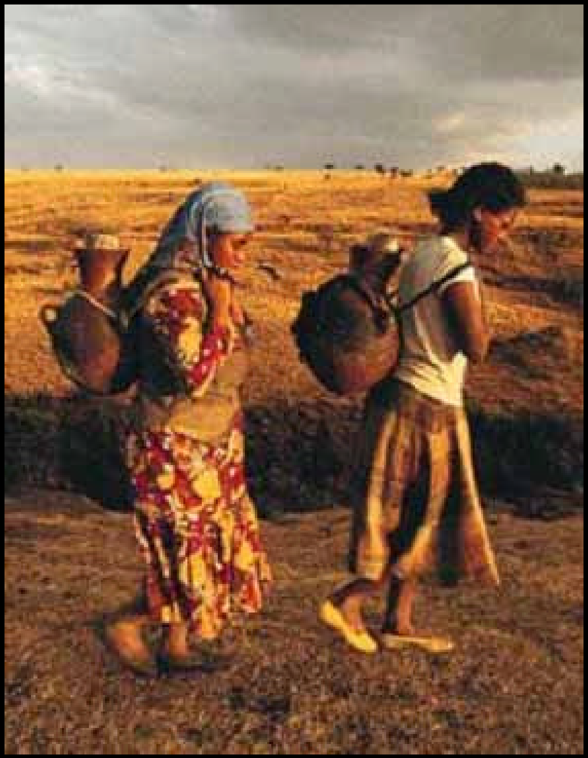
World GDP per capita, constant 1992 US$



Source: J. Bradford DeLong, U. Cal. Berkeley

Fact no. 2 – complexity has grown explosively

From . . .



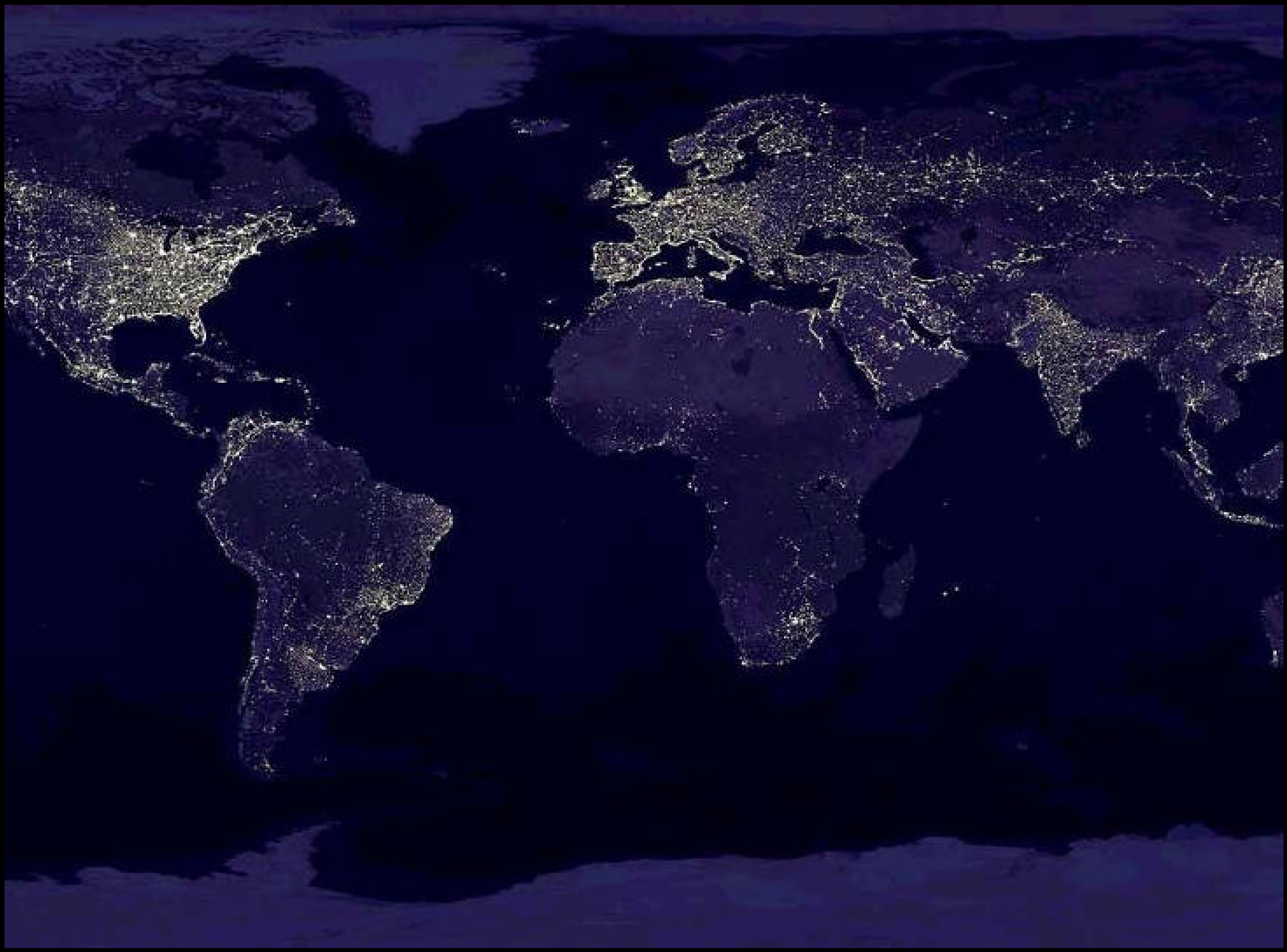
10^2 SKU economy

To . . .

10^{10} SKU economy

- Wal-Mart 100,000 SKUs
- Cable TV 200+ channels
- 275 breakfast cereals

Fact no. 3 – no one is in charge



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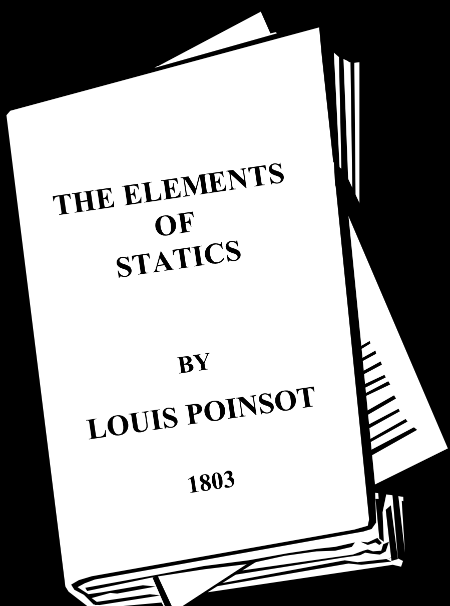
Traditional economics cannot explain key characteristics of the economy

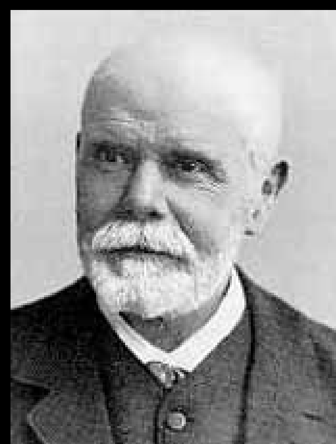
Economy viewed as an equilibrium system . . .

. . . but such a system cannot

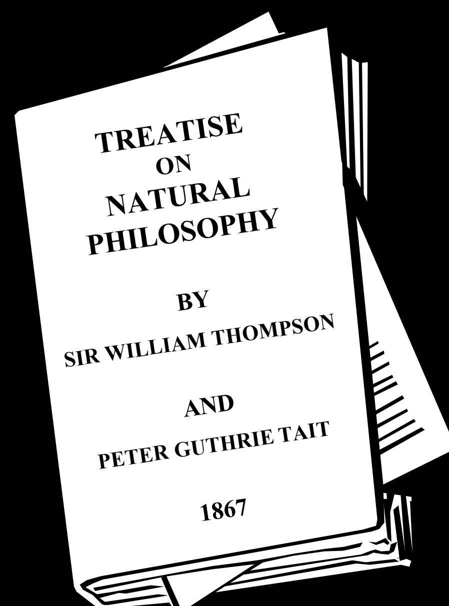
- Grow explosively
- Create novelty
- Spontaneously self-organize

The accidental history of equilibrium in economics





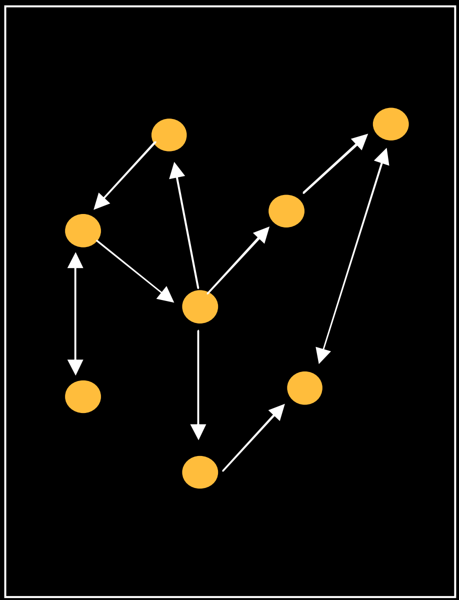
Léon Walras



William Stanley Jevons

A different explanation – the economy is a ‘complex adaptive system’

Complex

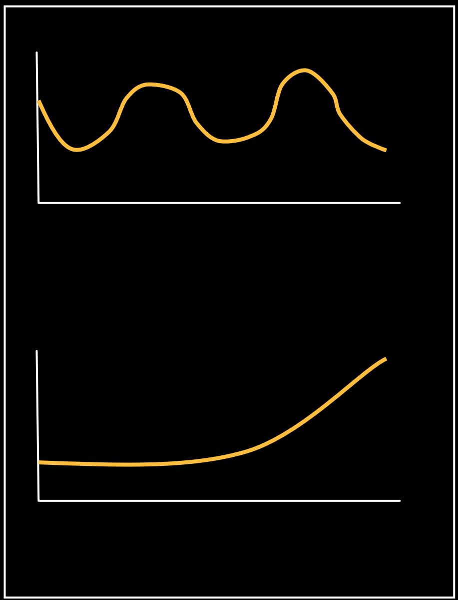


Many interacting agents and organizations of agents

Adaptive

Designs and strategies evolve over time

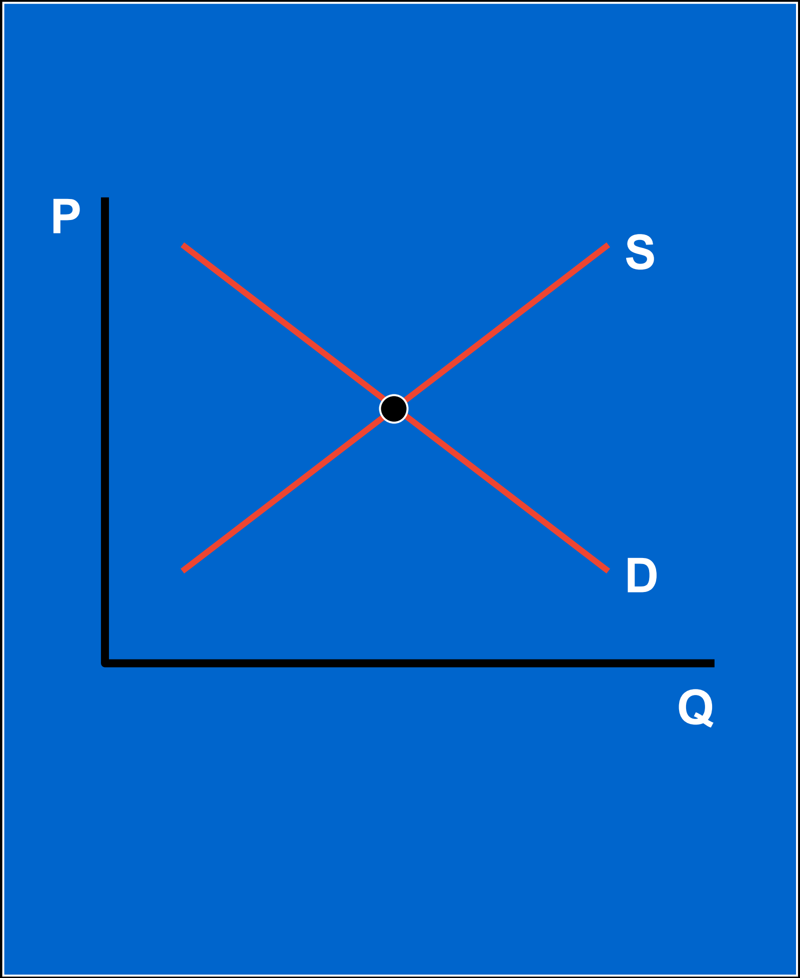
System



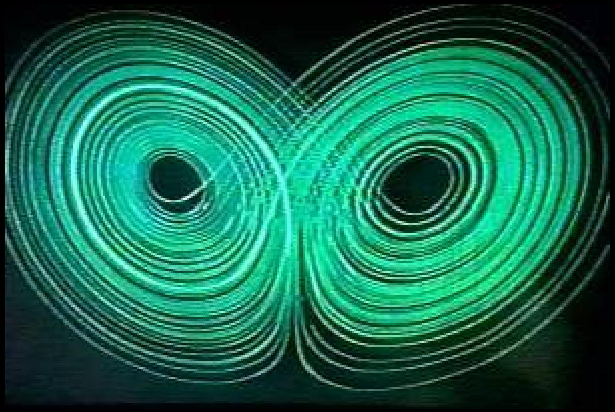
Macro patterns emerge from micro behavior

Dynamics

Traditional – fixed point attractors



Complexity – dynamic attractors

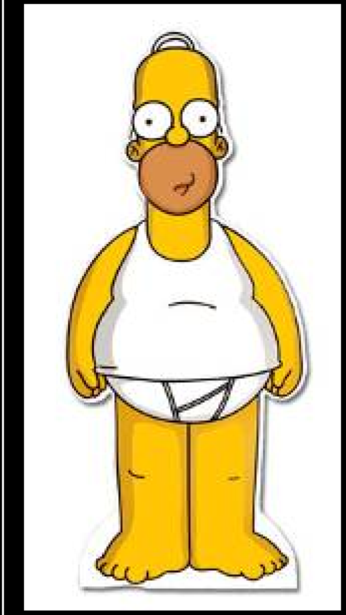


Agents

Traditional – perfect rationality

- Deductive logic
- Self-interest
- Perfect information
- Infinite computational power
- No errors, biases
- No learning

Complexity – realistic rationality



- Inductive rules of thumb
- Strong reciprocity
- Imperfect information
- Finite computing power
- Errors, biases
- Learning over time

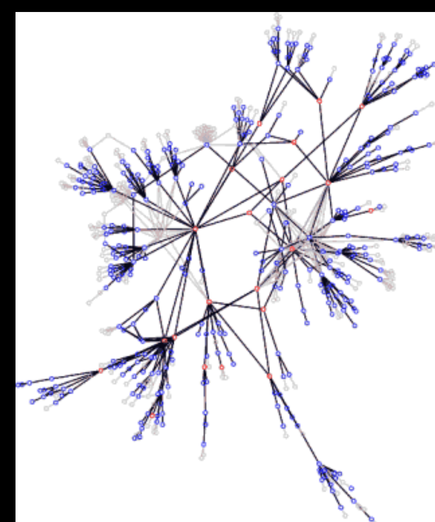
Networks

Traditional – networks don't matter

- Interactions – only via markets
- Information – prices, quantities
- Institutions – Walrasian auctions

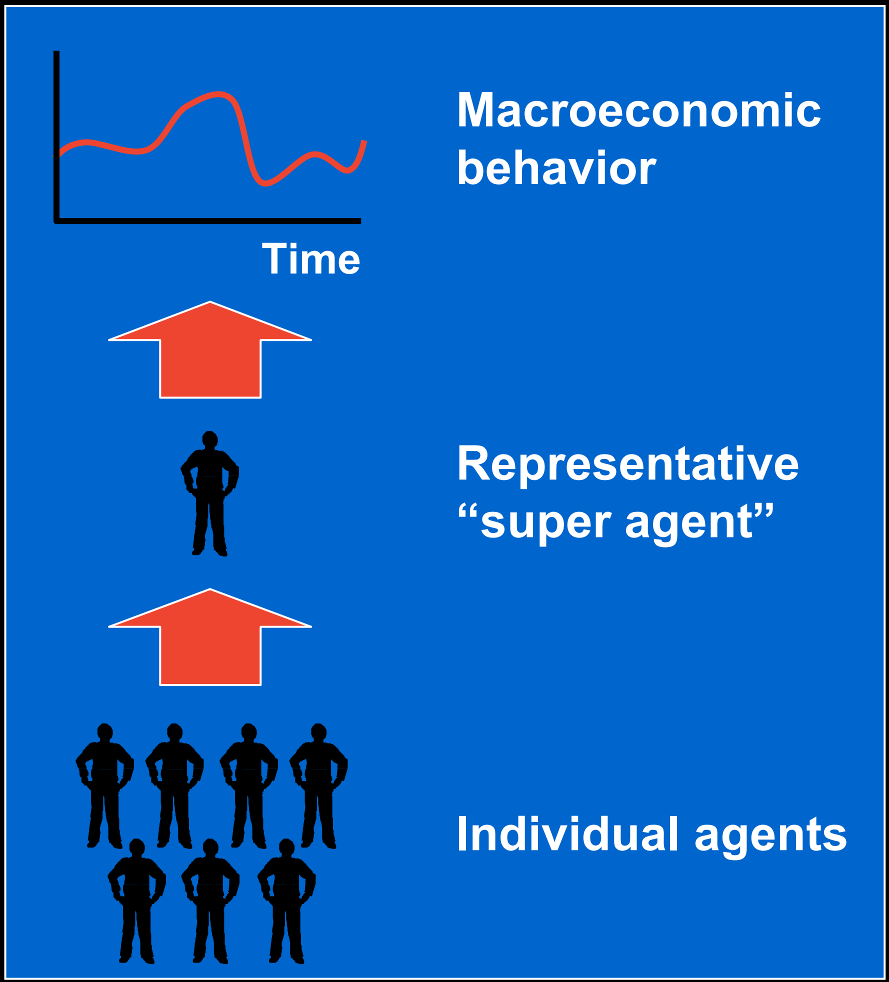
Complexity – network structures matter

- Interactions – via networks
- Information – anything
- Institutions – bilateral trade, posted prices, corporations, etc.

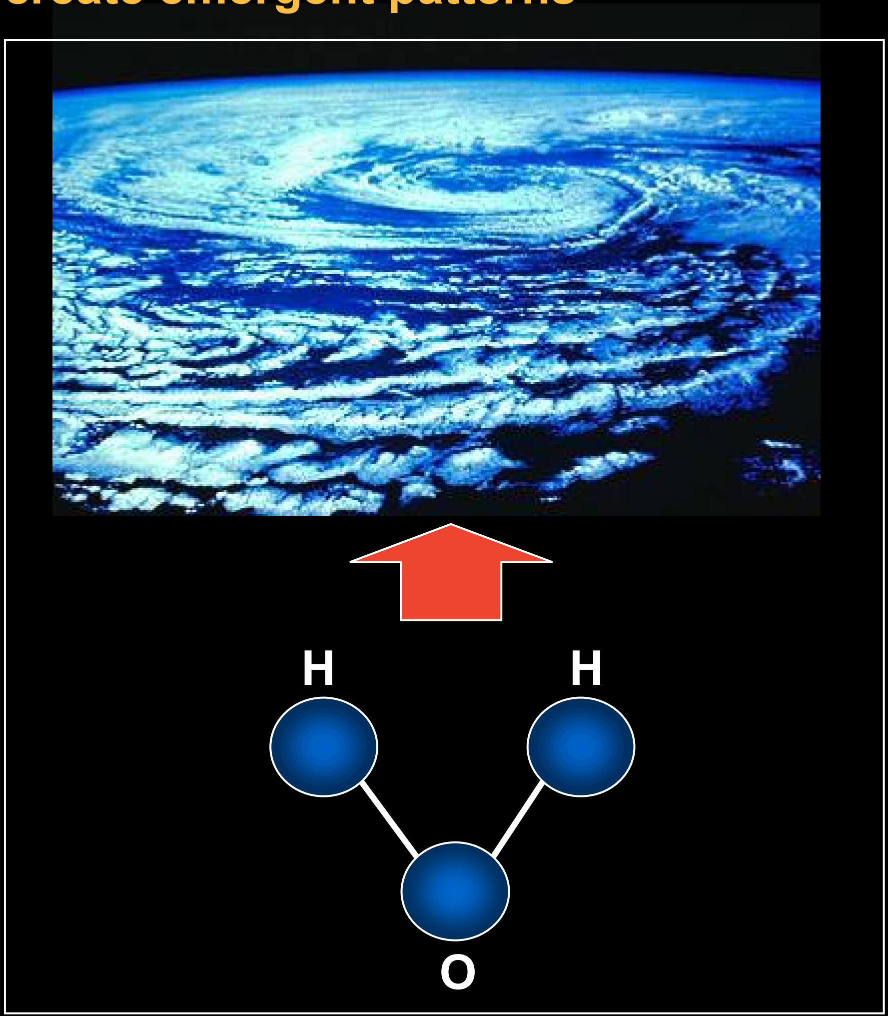


Emergence

Traditional – assumes linear additivity



Complexity – non-linear interactions create emergent patterns



Evolution

Traditional – no endogenous theory of innovation

"Add successfully as many mail coaches as you please, you will never get a railway thereby"

Joseph Schumpeter

Complexity – innovation as evolutionary search

A paradigm shift

	Traditional economics →	Complexity economics
Dynamics	Economies are closed, static, linear systems in equilibrium	Economies are open, dynamic, non-linear systems far from equilibrium
Agents	Homogeneous agents • Only use rational deduction • Make no mistakes and have no biases • Are already perfect, so why learn?	Heterogeneous agents • Mix deductive/inductive decision-making • Subject to errors and biases • Learn and adapt over time
Networks	Assume agents only interact indirectly through market mechanisms	Explicitly account for agent-to-agent interactions and relationships
Emergence	Treats micro and macroeconomics as separate disciplines	No distinction between micro- and macroeconomics; macro patterns emerge from micro behaviors and interactions
Evolution	Contains no endogenous mechanism for creating novelty or growth in order and complexity	Evolutionary process creates novelty and growing order and complexity over time

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Long history of evolutionary ideas in economics (and vice versa)

1838

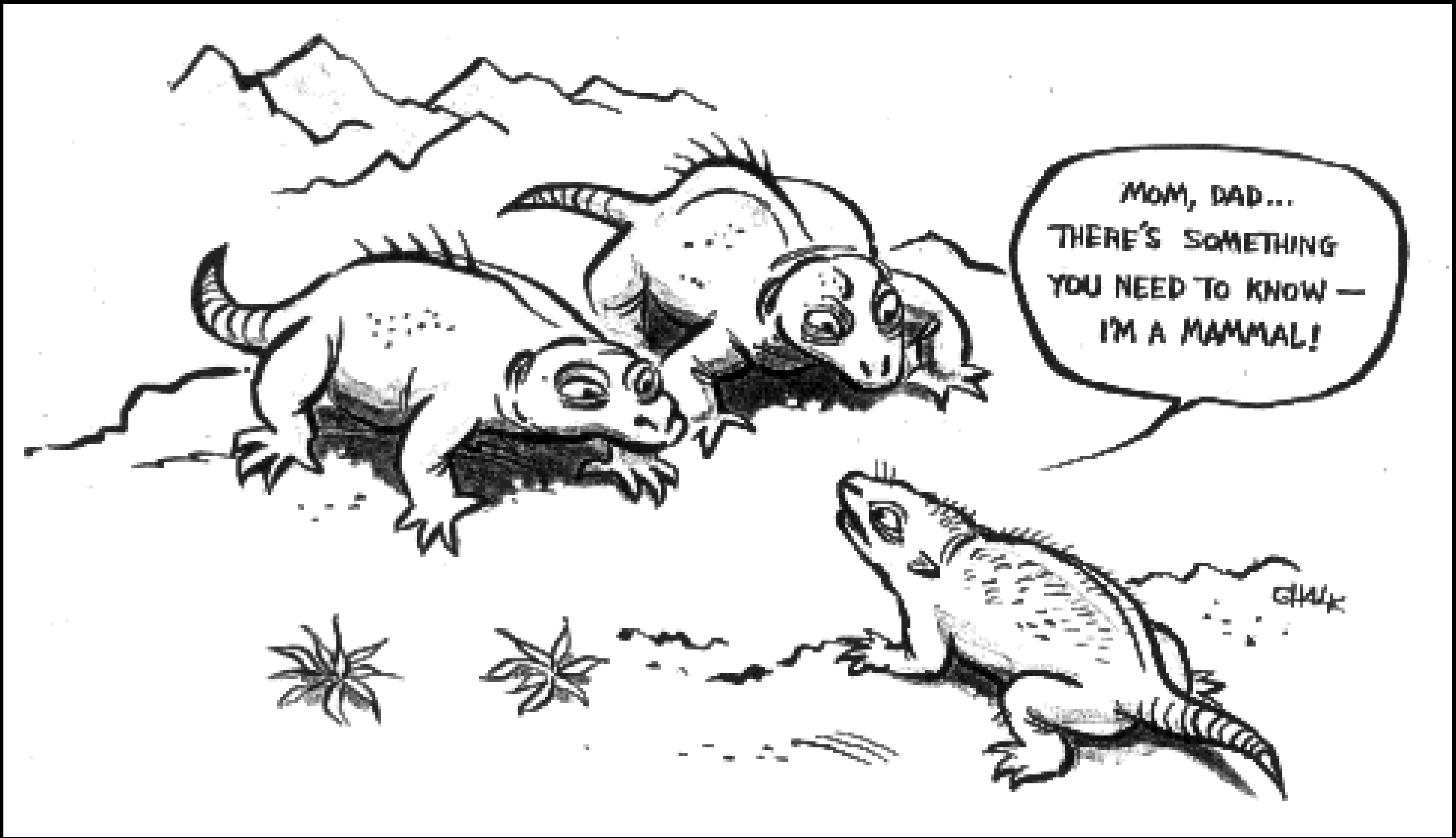
- Malthus
- Darwin
- Mandeville
- Marx
- Spencer
- Marshall
- Menger
- Veblen
- Schumpeter
- Hayek
- Nelson and Winter

1982

Problem

- Driven from a metaphor with biology
- Not built on a general computational view of evolution

We are accustomed to thinking of evolution in a biological context

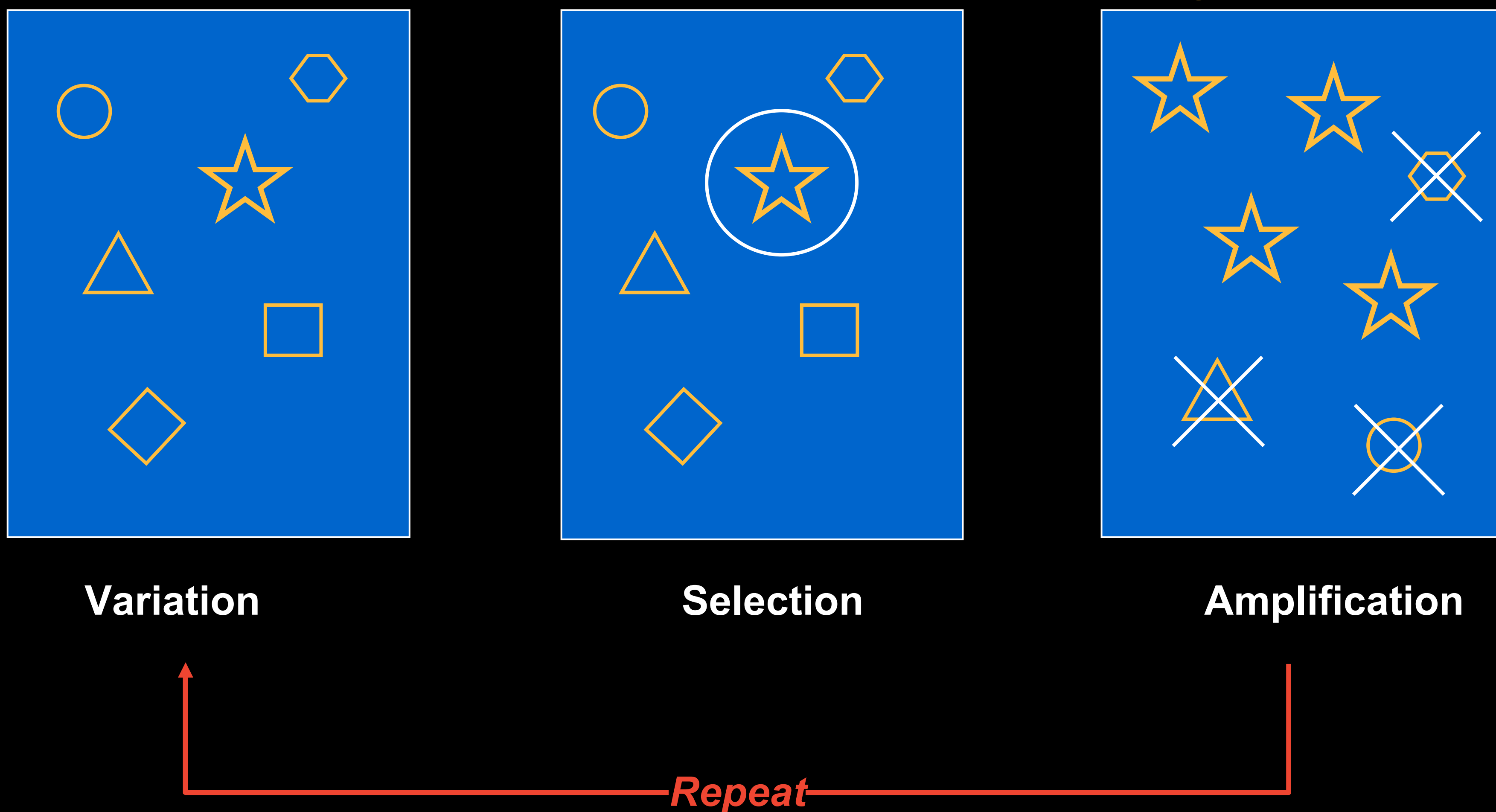


Evolution is a search algorithm for ‘fit designs’

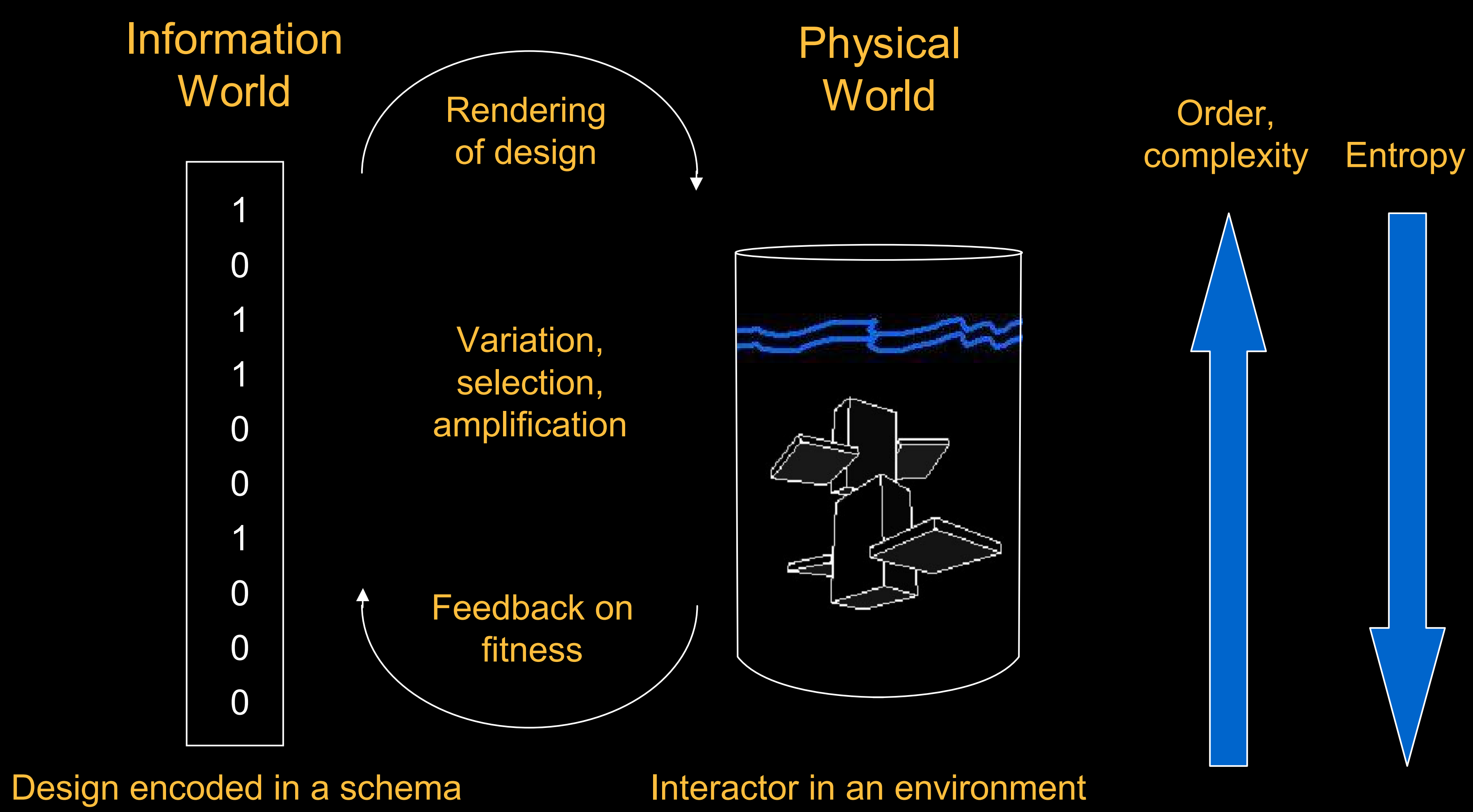
Create a variety of experiments

Select designs that are ‘fit’

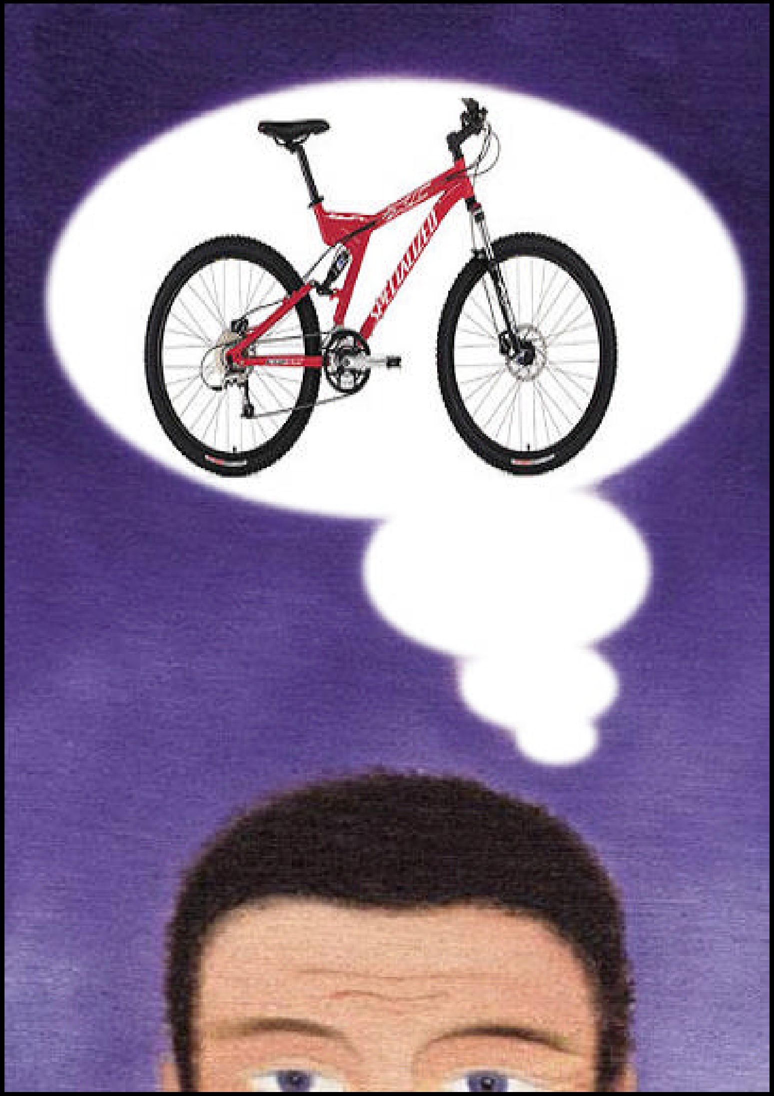
Amplify fit designs, de-amplify unfit designs



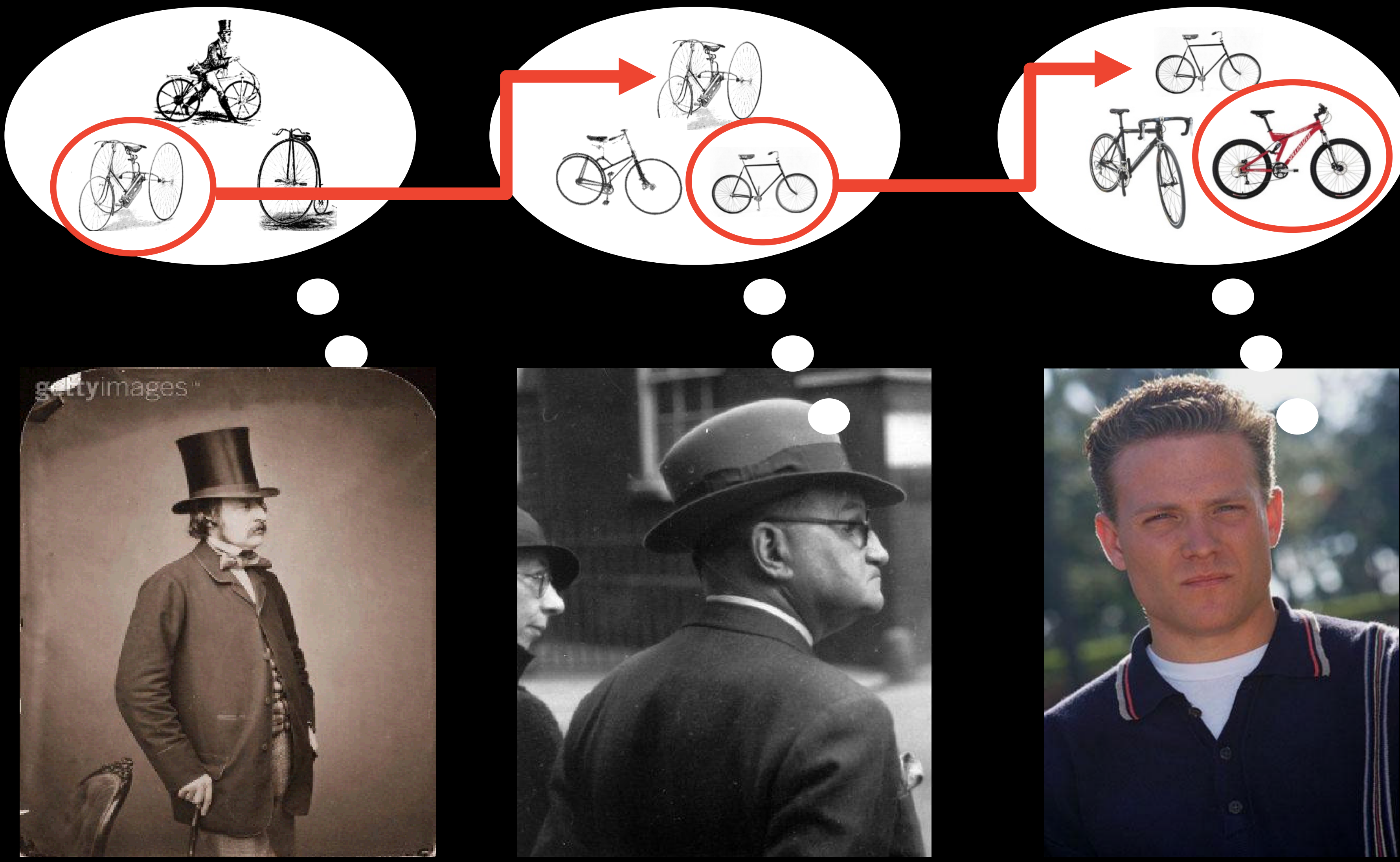
Evolution creates complexity from simplicity



Who designed the modern bicycle?

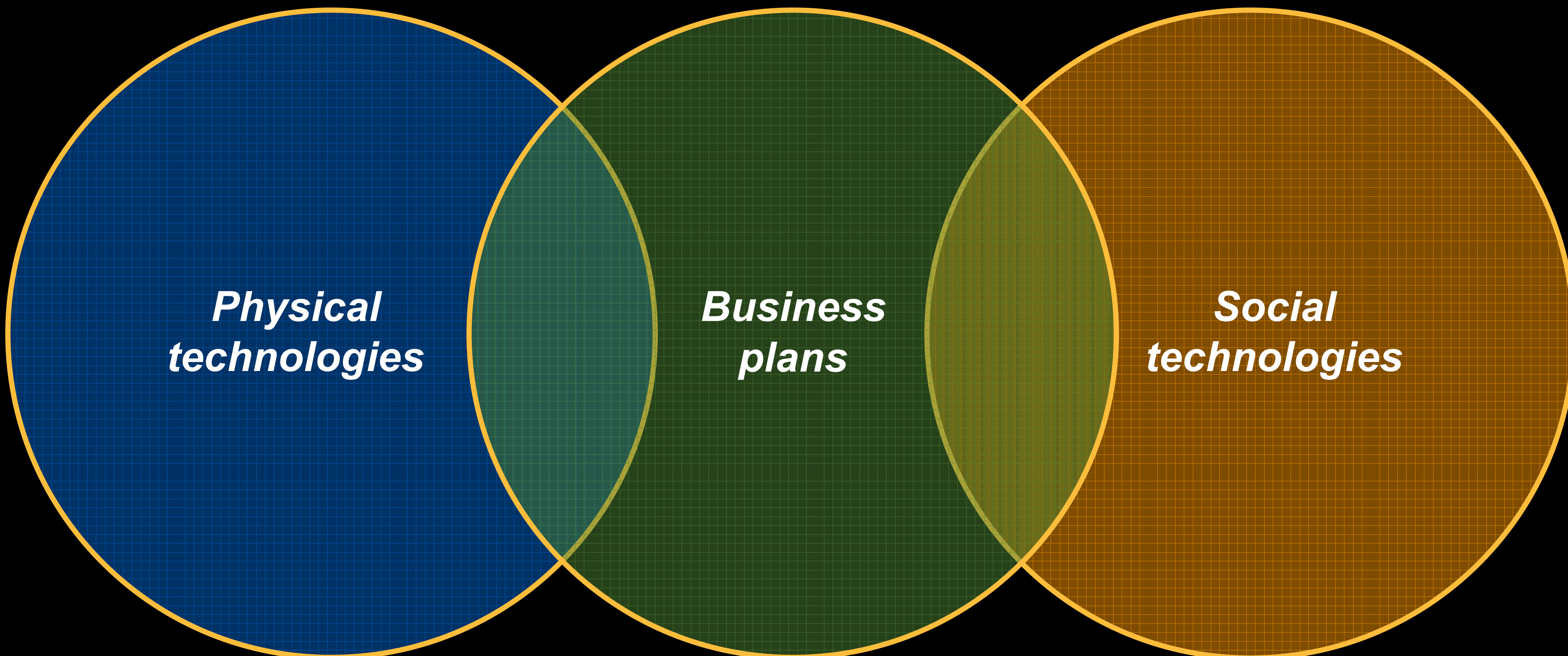


The reality – evolution through ‘deductive-tinkering’



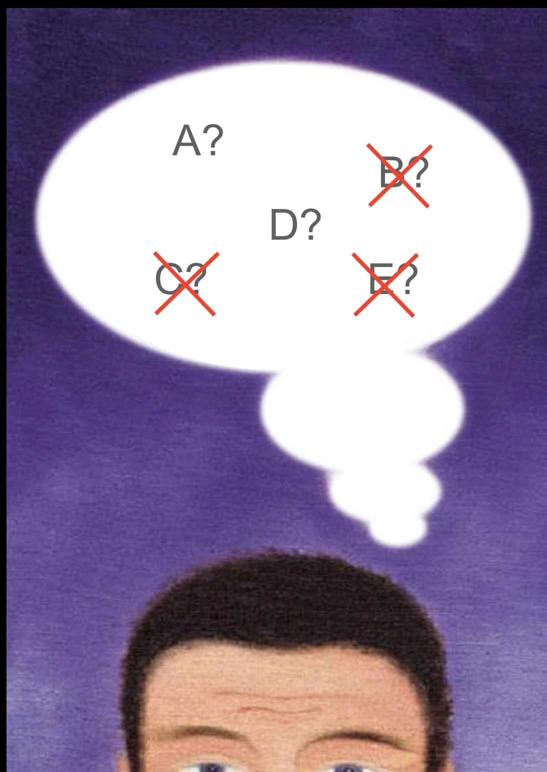
Technologies evolve

Economic evolution occurs in three ‘design spaces’

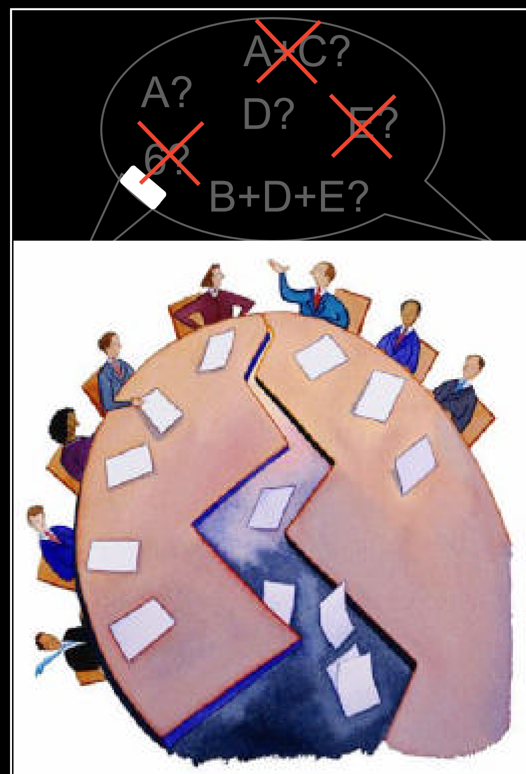


Business plan evolution works at three levels

Individual minds



Organizations



Markets

BORDERS

Waldenbooks

BARNES & NOBLE

WATERSTONE'S

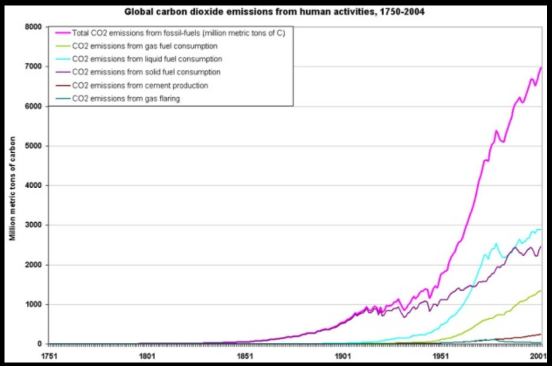
Independent booksellers

What would economic evolution look like?

- Bursts of innovation/ punctuated equilibrium

- Spontaneous self organization

- Decreasing local entropy/ increasing order



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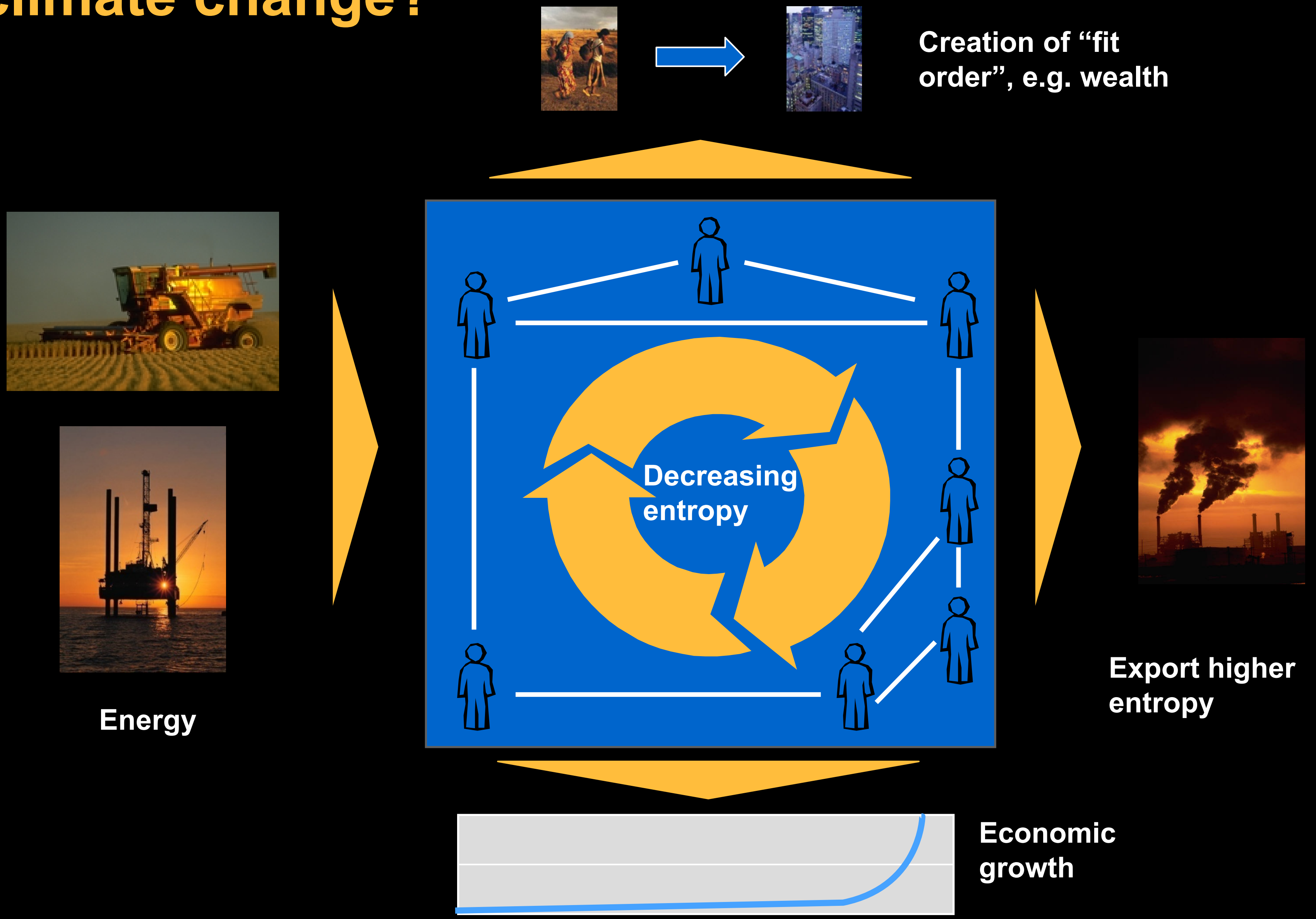
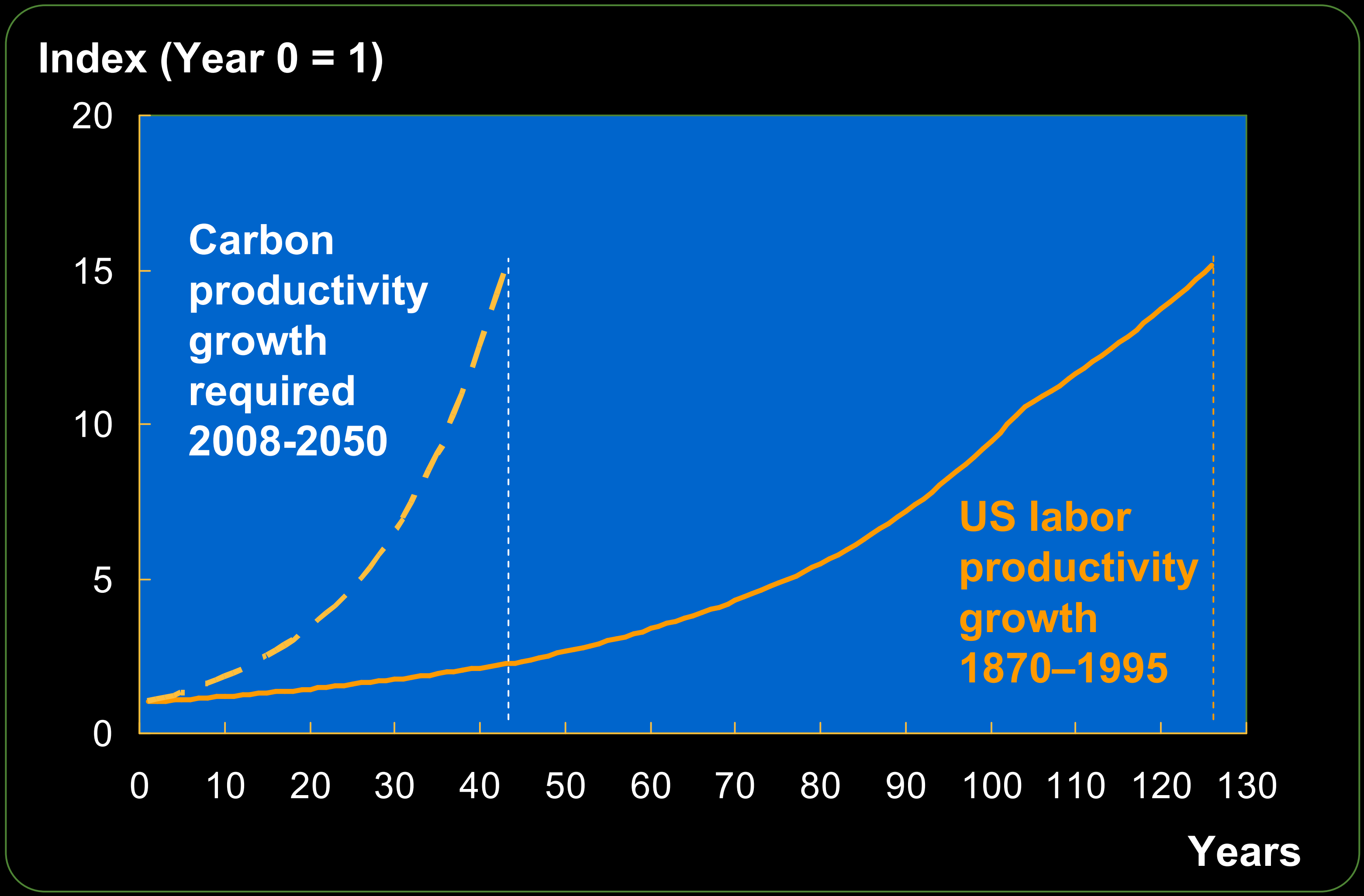
Climate change requires new economic methodologies

From	To
Cost-benefit analysis	Risk models that account for fat tails and time irreversibility
Utility view of time preference	Hyperbolic discounting
Perfect rationality view of behavioral change	Cognitively realistic view of behavioral change
Static view of technology and institutions	Evolutionary view of technology and institutions
No physical constraints	Constrained by energy and entropy
General equilibrium models	Agent-based models that capture time dynamics, nonlinearities

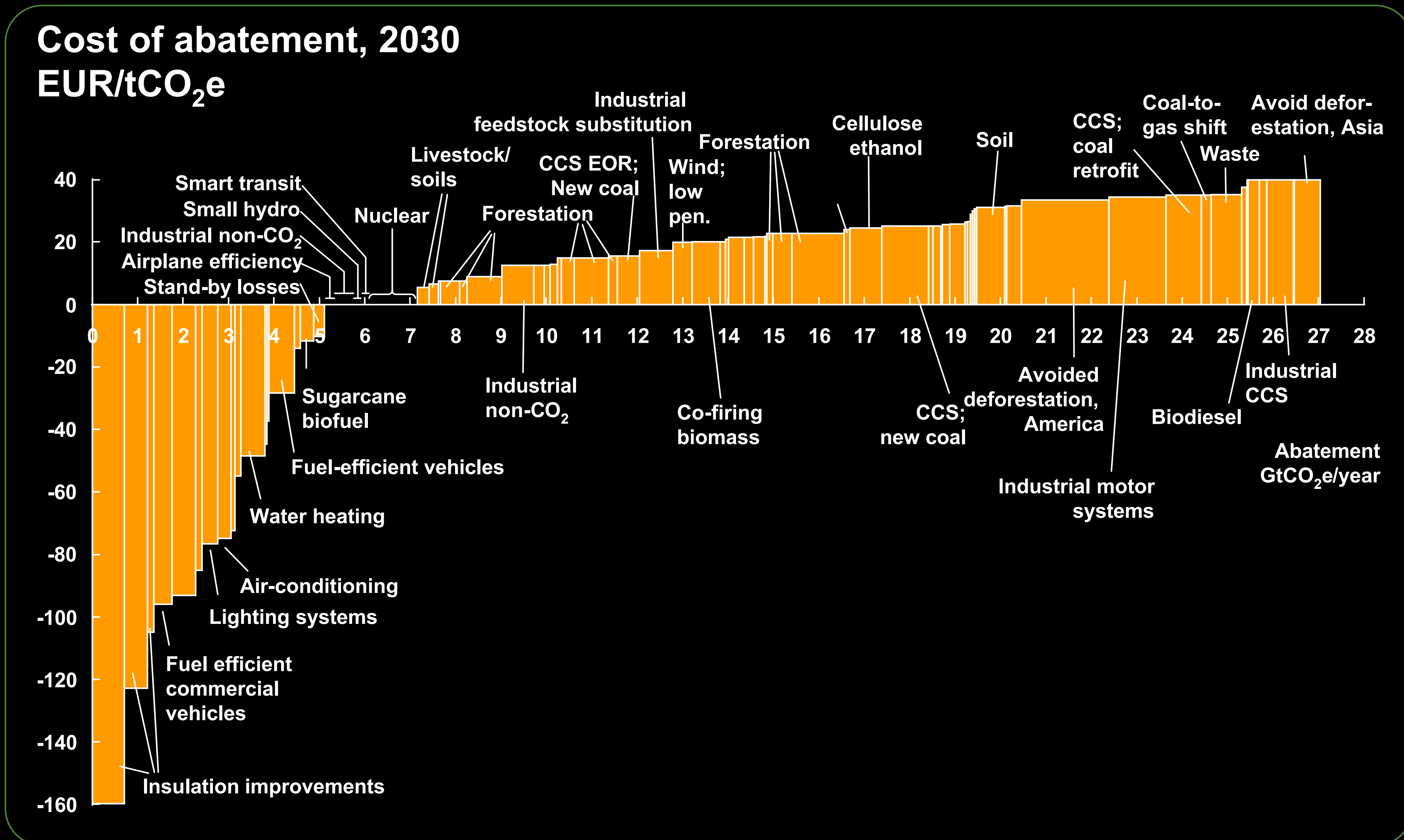
How might a ‘complexity economist’ think about climate change?



A carbon productivity 'revolution' is required – three times faster than the Industrial Revolution



McKinsey cost curve shows where opportunities exist for improving carbon productivity



Harnessing economic evolution in climate policy?

Stimulate rapid evolution of low carbon economy

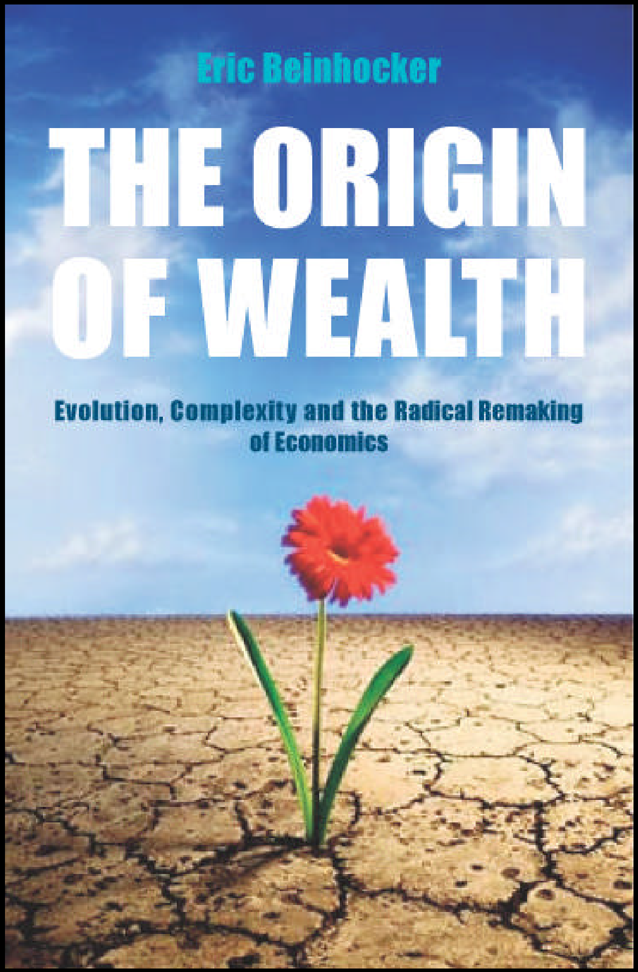
- Set GHG limits as constraint in economic fitness function
- Improve carbon information
- Create incentives/institutions for "portfolios" of technology experiments—do not pick winners
- Address market failures (e.g. energy efficiency)—markets necessary but not sufficient
- Harness what is known about behavior (e.g. strong reciprocity)
- Other???

Final thought…

“Evolution is cleverer than we are”

Orgels’ second law

Thank you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