Reducing the Organism? Reducing the World? a field guide

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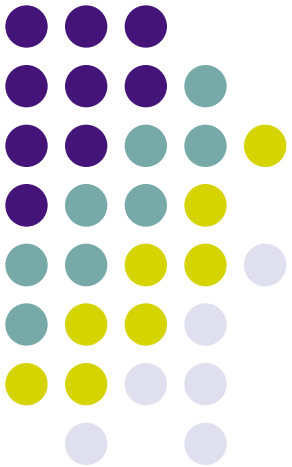
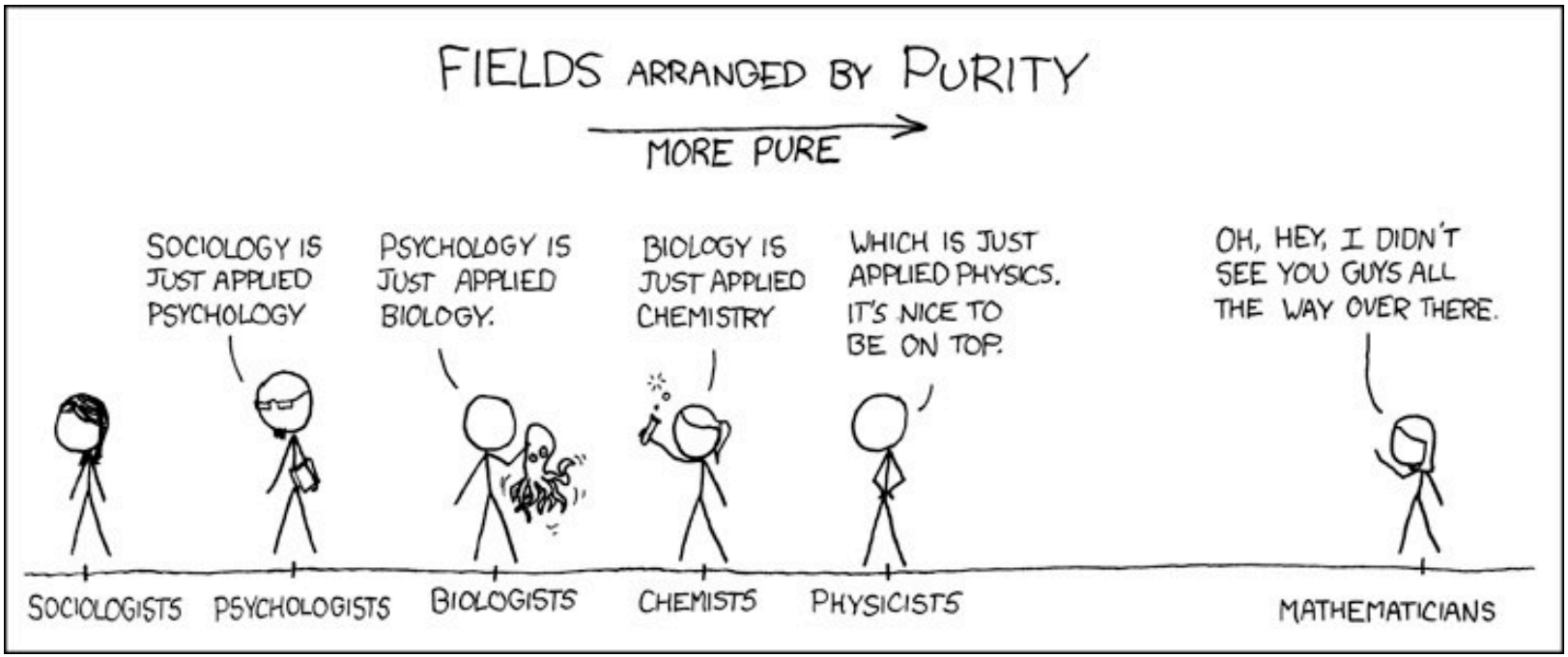


Motivating intuitions



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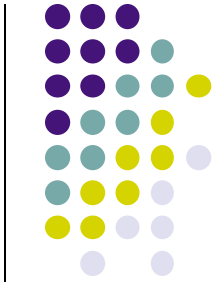
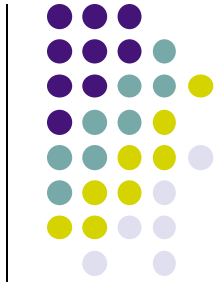
Outline



(1) Framing the issues: (anti-)reduction(ism)

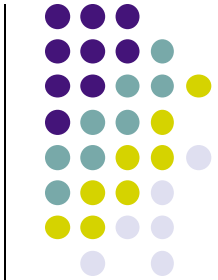
(2) The Physical Basement?

(3) The Biological 1st Floor (Stueetagen)?



(1) Framing the issues: (anti-)reduction(ism)

What is a scientific reduction?



Accounting for a scientific abstraction in terms of a more basic abstraction.

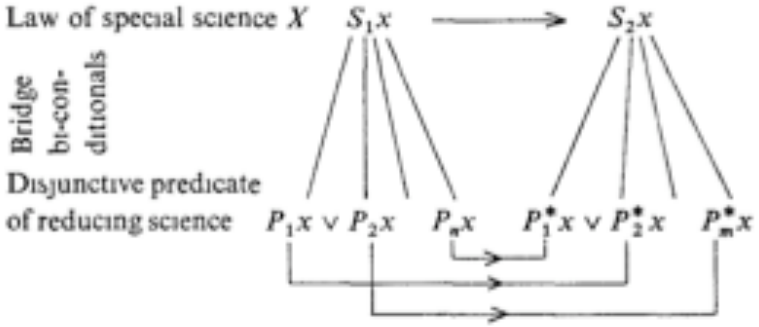
- Abstraction = (i) law, (ii) model, (iii) theory, (iv) invariance, (v) concept, (vi) principle, (vii) term.

- Abstractions are *of* (i) regularities, (ii) causes, (iii) compositional or structural relations, (iv) physical or psychological properties and forces.

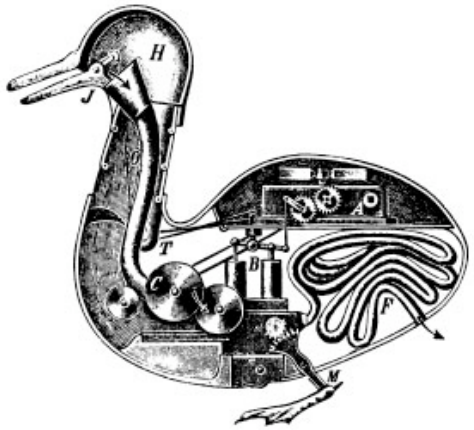
Typical categories of reduction

- Ontological
- Explanatory
- Epistemic
- Theoretical
- Conceptual
- Methodological
- Constitutive
- Physicalist

A Royal Mess!!



Fodor (1974), p. 109



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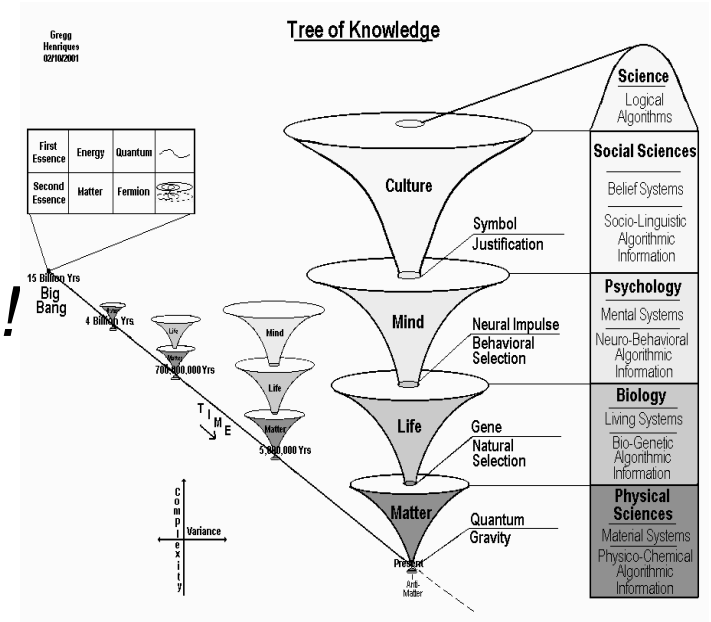
Key "transitions" (Emmeche, Køppe, and Stjernfelt 1997)

- physico-chemical to biological (debates about vitalism and self-organization)
- biological to psychological (debates about physicalism and "the hard problem of consciousness")
- psychological to sociological (e.g., debates about methodological individualism)

- N.b. *Transitions are the locus of (anti-)reduction(ism) debates!*



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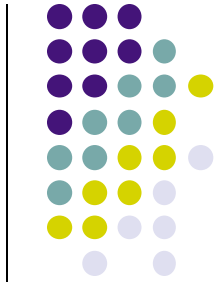


(2) The Physical Basement?

What is in the physical basement?

(1) *Physical laws* written as analytical differential equations

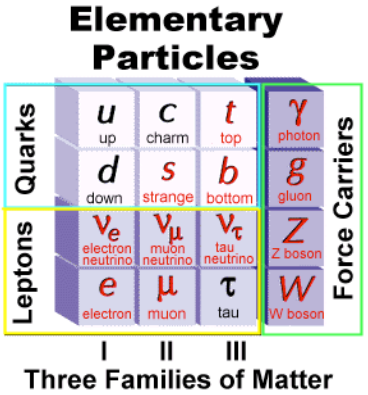
$$\nabla \cdot \mathbf{D} = \rho_f$$

$$\nabla \cdot \mathbf{B} = 0$$

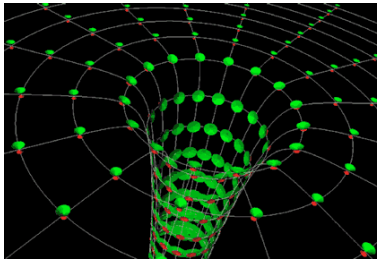
$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{H} = \mathbf{J}_f + \frac{\partial \mathbf{D}}{\partial t}$$

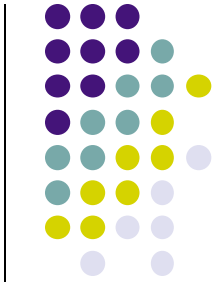
(2) *Fundamental particles-waves* described by physical theory



(3) Basic *invariances*, and *embedding space-time dimensions*



In the basement: glorious and lit



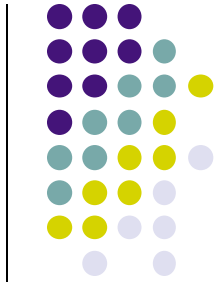
… if we discover a complete theory, it should in time be understandable in broad principle by everyone, not just by a few scientists. Then we shall all, philosophers, scientists and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason -- for then we should know the mind of God. (Hawking, *A Brief History of Time*, p. 193)

In the basement: untidy and dark I

- One of the most striking aspects of physics is the simplicity of its laws. Maxwell's equations, Schrödinger's equation, and Hamiltonian mechanics can each be expressed in a few lines. The ideas that form the foundation of our worldview are also very simple indeed: The world is lawful, and the same basic laws hold everywhere. Everything is simple, neat, and expressible in terms of everyday mathematics, either partial differential or ordinary differential equations.
- *Everything is simple and neat—except, of course, the world*. (Goldenfeld and Kadanoff 1999, p. 87)

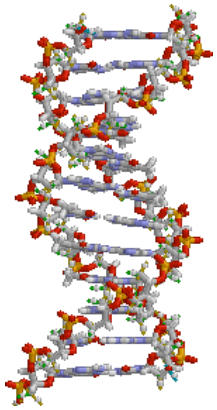
In the basement: untidy and dark II

- The main fallacy in this [unificationist, fundamentalist] kind of thinking is that the reductionist hypothesis does not… imply a "constructionist" one: The ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe. In fact, the more the elementary particle physicists tell us about the nature of fundamental laws, the less relevance they seem to have to the very real problems of the rest of science, much less to those of society.
- The constructionist hypothesis breaks down when confronted with the twin difficulties of scale and complexity. (Anderson 1972, p. 393)



(3) The Biological 1st Floor (Stueetagen)?

Genes?



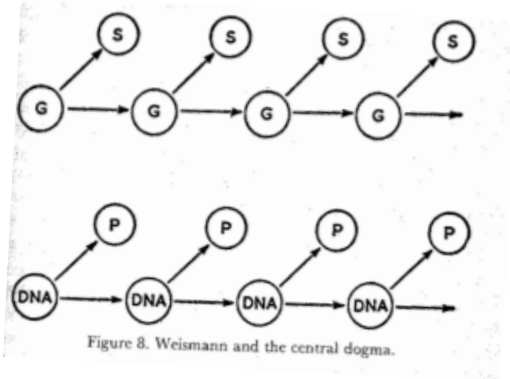


Figure 8. Weismann and the central dogma.

The possession of a genetic map and the DNA sequence of a human being will transform medicine. … When we have a detailed genetic map… we will find sets of genes for such conditions as heart disease, susceptibility to cancer, or high blood pressure. Along with many other common afflictions, these will turn out to have multiple genetic origins in populations, as will such mental conditions as schizophrenia, manic-depressive illness, and susceptibility to Alzheimer's disease. (Gilbert 1992, p. 94)

Three types of reduction (Sarkar 1992)

- ***Theory Reduction***

  "construe reduction as a relation between theories" (p. 172)

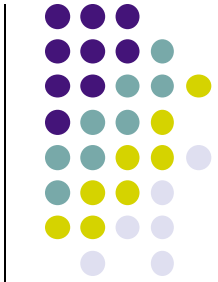
  e.g., classical genetics ("fruit-fly genetics") to molecular genetics

- ***Explanatory Reduction***

  "construe [reduction] as a relation of explanation in the sense that the reduced entity is explained by the reducing entity no matter whether these entities are theories, laws, empirical generalizations or even individual observation reports" (p. 170)

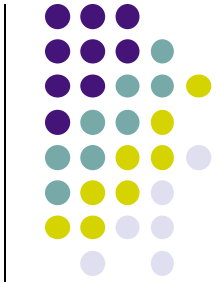
- e.g., molecular biology mechanism to biochemical mechanisms
- ***Constitutive Reduction***
- "upper-level (intuitively larger) systems are composed of lower-level (intuitively smaller) systems and conform to the laws governing the latter." (p. 171)
- e.g., token physicalism (explored by Fodor (1974))

Two types of reduction (Winther 2009a)



- ***Mathematical Reduction***
- "deriving the mathematical models of the reduced theory from those of the reducing theory", "embedding the models of the reduced theory into the models of the reducing theory"
- e.g., quantitative morphological and developmental models to gene regulatory networks
- ***Mereological Reduction***
- "a theoretical representation of higher-level parts of a system is explained in terms of a theoretical representation of lower-level parts (and lower-level relations) of that system"
- e.g., mechanistic explanations of development (qua part-whole explanations, Winther 2009b, forthcoming)

Why does reduction fail? On respecting limits!



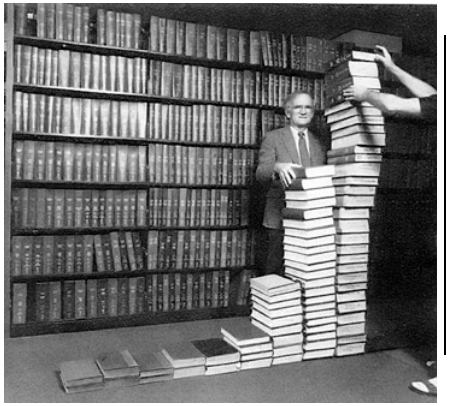
Analyses:

- Janus-faced philosophical problems of (i) multiple realizability and (ii) context-dependence. Fodor (1974)
- "failures of aggregativity." Wimsatt (2007)
- "downwards causation." Emmeche, Køppe, and Stjernfelt (1997)

Examples (Scott 2004):

- *emergent structures, processes, and organization* (e.g., tornadoes, hurricanes, organisms, schools of fish, cities)
- *chaos* (e.g., strange attractors, the butterfly effect – sensitivity on initial conditions)
- *threshold phenomena* (electrical wall switch, tipping points including global climate situation)

Bibliography



- Anderson PW. (1972). More is Different. *Science* 177: 393-396.
- Emmeche C, Køppe S, Stjernfelt F. (1997) Explaining Emergence: Towards an Ontology of Levels. *Journal for General Philosophy of Science* 28: 83-119.
- Gilbert W (1992) A vision of the grail. In*: The Code of Codes: Scientific and Social Issues in the Human Genome Project* (Kevles DJ, Hood L, eds), pp. 83-97. Cambridge, MA: Harvard University Press.
- Goldenfeld N, Kadanoff LP. (1999). Simple Lessons from Complexity. *Science* 284: 87-89.
- Hawking S. (1988). *A Brief History of Time*. New York: Bantam Book.
- Sarkar S. (1992). Models of Reduction and Categories of Reductionism. *Synthese* 91: 167-194.
- Scott A. (2004). Reductionism Revisited. *Journal of Consciousness Studies* 11: 51-68.
- Wimsatt WC. (2007). *Re-Engineering Philosophy for Limited Beings. Piecewise Approximations to Reality*. Harvard University Press.
- Winther RG. (2009a, forthcoming). Schaffner's Model of Theory Reduction: Critique and Reconstruction. *Philosophy of Science* 76.
- Winther RG. (2009b, forthcoming). Part-Whole Science. *Synthese*.