Reductionism

Preliminary Remarks

- There is a plurality of theories and sciences. This was as true in the past as it is now.
- What sort of relations, if any, exist between sciences and between theories?
- Answering this question can help answer other important questions. For example:
  - Is there progress in science?
  - Can we get any help in finding the next best theory?

Reductionism

- *Reductionism* is a popular answer to the question what sort of relations exist between theories and between sciences.
- The main intuition behind reductionism is that a theory or science can be replaced by another without significant loss.
- Why be a reductionist?
  - Ockham's razor
  - ontological, epistemological, explanatory and methodological progress?
- Synchronic vs. Diachronic Reductions

The Classical Model: Nagel (1)

- Nagel (1961) focuses on the explanatory aspect.
- To reduce a theory T_2 to a theory T_1 is to explain everything that T_2 explains with T_1.
- Nagel accepts the D-N model of explanation, so for him explanations are deductively valid arguments.

Premises: Reducing science/theory/law/statement

Conclusion: Reduced science/theory/law/statement

The Classical Model: Nagel (2)

- T_2 reduces to T_1 *if and only if* the following two conditions hold:

  (1) Condition of Connectibility: For every theoretical term 'M' that occurs in T_2 but not in T_1, there is a theoretical term 'N' that is constructible in T_1 such that for all objects *x, x* has M, if and only if *x* has N.

  (2) Condition of Deducibility: T_2 must be derivable from T_1.

The Classical Model: Nagel (3)

- Two types of Reduction:

  (1) *Homogeneous*: The vocabulary of the reduced theory is either included in the reducing theory OR can be defined in terms of its vocabulary.

  (2) *Inhomogeneous* or *Heterogeneous*: The vocabulary of the reduced theory is neither included in the reducing theory nor can be defined in terms of its vocabulary.

  In other words, at least one term in the vocabulary of the reduced theory is not found in, and cannot be defined in terms of, the vocabulary of the reducing theory.

The Classical Model: Nagel (4)

- But: Inhomogeneous reduction fails the conditions of derivability and connectibility!!!

  T_1 does not entail T_2

- Nagel's solution: The reducing theory must be supplemented with bridge laws.
  T_1 & B_1 entail T_2 (NB: T_1 does not entail B_1)

- *Bridge laws*: These connect the vocabulary of the reduced and the reducing theory so that derivability is achieved.

Examples

Homogenous Reduction:

a. Galileo's law of free fall *to* Newton's laws

b. Kepler's laws of planetary motion *to* Newton's laws

NB: *In both cases, additional assumptions required*!!!

Inhomogeneous Reduction:

Thermodynamics *to* Statistical Mechanics

Take Boyle-Charles law: $pV = kT$ (law in thermodynamics)

Bridge law: $\langle E \rangle = 3/2\ kT$

Temperature is connected with mean kinetic energy of molecules for gases via the bridge law. Boyle-Charles law can then be deduced *if additional statistical assumptions are made*.

Problems

- Actual reductions are at best approximate (see examples above).

- The condition of connectibility is almost never satisfied in actual cases.

- What is the status of bridge laws?
  - Analytic? Then, surely, bridge laws can be concocted to save the day…
  - Synthetic? Then, surely, we must be able to test them…

Food for Thought

- How does Nagel reply to these objections? Do you find his arguments convincing?

Reading

- Nagel, E. (1974) ‘Issues in the Logic of Reductive Explanations’, in Curd and Cover, pp. 905-921.