Kuhn‘s Notion of Scientific Progress

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„… a community of scientific specialists will do all it can to ensure the continuing growth of the assembled data that it can treat with precision and detail." Kuhn (1996 [1962], 170f)

Overview

1. Kuhn‘s notion of incommensurability
2. ‘Reduction’ between theories
3. Kuhn‘s conception of scientific progress
4. Progress as growth of empirical strength

1. Kuhn‘s notion of incommensurability

Three dimensions of incommensurability

- According to Kuhn, there are *three dimensions* of incommensurability:
  1) incommensurability of scientific standards
  2) referential or semantic incommensurability
  3) incommensurability of worldviews
- In the following we pick up the first two of these dimensions

Different semantics

- Incommensurable paradigms generally involve scientific terms that do not allow for a term by term translation.
- Such terms may **referentially overlap** with terms in the respective other theory but there are no **referentially congruent** counterparts.
- For example, the terms “phlogiston” and “air” somewhat overlap with terms of modern chemistry such as “hydrogen” and “oxygen”.
- However, there is no direct translation for “phlogiston” and “air” in modern chemistry.

Different standards

- Incommensurable paradigms generally involve also a change of scientific standards.
- That is, a newer theory may have to cover entirely **different parts of the empirical world**.
- Questions that appeared to be relevant in an older version of a theory may be ruled out and vice versa.
- For example, older varieties of physical theories tried to explain the distance between planetary orbits, whereas Newtonian physics does not take this as a relevant question at all.
- Thus, in the course of the development of science we sometimes *lose explanatory power.*

First task: find a formalization for scientific theories that takes care to these two phenomena

2. ‘Reduction’ between theories

A critique of the structuralist framework

- We pick up my critique of the structuralist framework here:
  - Christian Damböck, “Theory structuralism in a rigid framework”, Synthese DOI 10.1007/s11229-011-0009-3
  - Christian Damböck, “’Reduction’ between incommensurable theories in a rigid structuralist framework”, forthcoming.
- The structuralist conception is counterintuitive insofar as it does not allow us to make explicit **the ontological basis** of a theory. Thus, it should be replaced by a “rigid” framework, which is essentially an implementation of Bas van Fraassens notion of a **semi-interpreted language**.
- The structuralist account of reduction is both **too wide** and **too resctrictive**, in a number of respects.

Relations instead of “reductions”

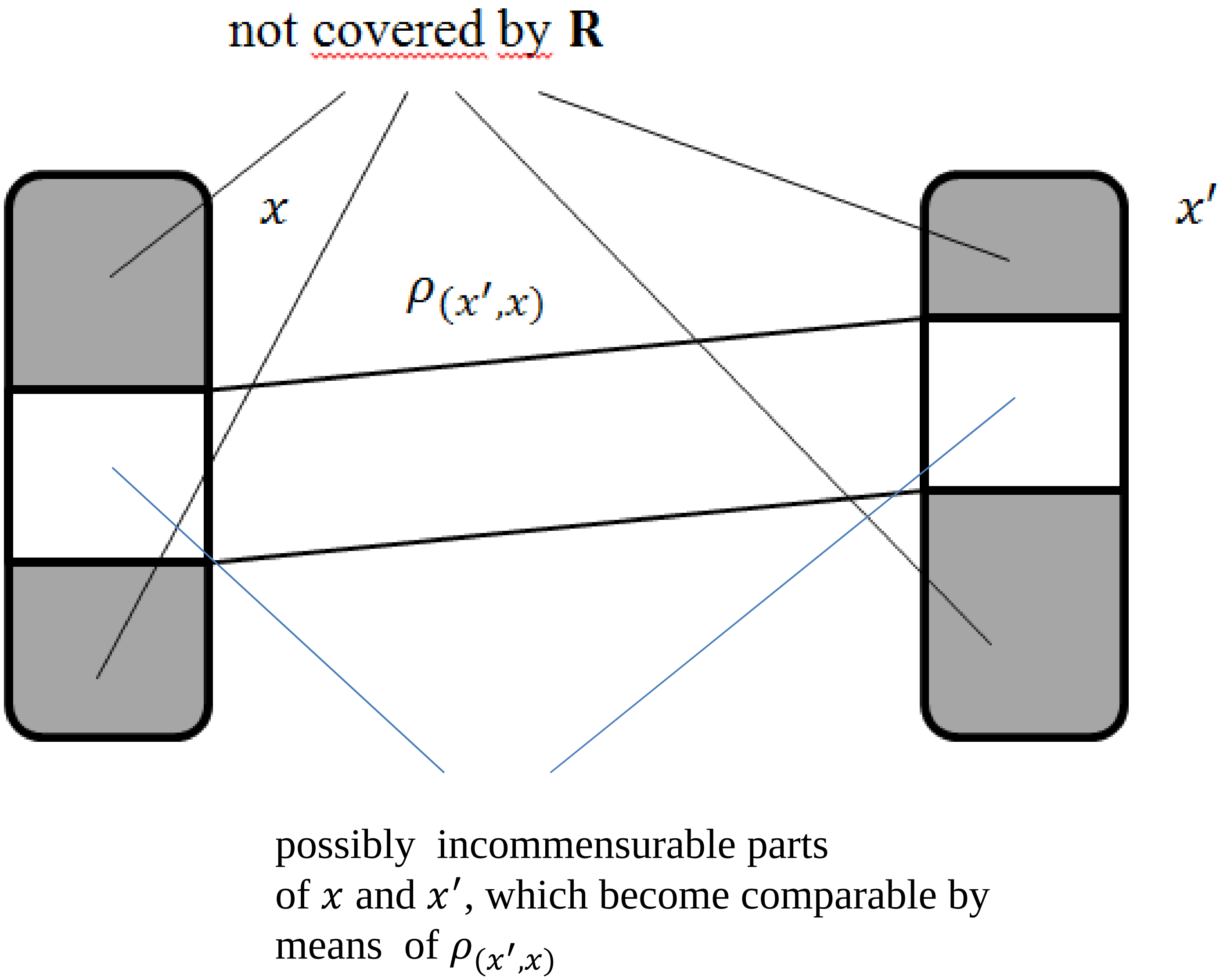
- A *relation* $\mathbf{R}$ between two theories $(\mathbb{O}, \mathcal{A})$ and $(\mathbb{O}', \mathcal{A}')$

$$\mathbf{R} = \left(\rho, \left\{\rho_{(x',x)} \,\middle|\, (x', x) \in \rho\right\}\right)$$

  consists of a relation $\rho \subseteq \mathbf{M}_p{}' \times \mathbf{M}_p$ and a set of relations $\left\{\rho_{(x',x)} \,\middle|\, (x', x) \in \rho\right\}$ such that each instance $\rho_{(x',x)}$ is defined as a relation between x' and x
- Moreover, we assume that the following conditions may hold:
  - $\forall \mathrm{x}: (\mathrm{x} \in \mathbf{M}_\mathrm{p}{}' \wedge \mathrm{x} \in \mathbf{M}_\mathrm{p}) \rightarrow (\mathrm{x}, \mathrm{x}) \in \rho$
  - $\forall \mathrm{x}, x': (x', \mathrm{x}) \in \rho \rightarrow (\forall \mathrm{p}: (\mathrm{p} \in x' \wedge \mathrm{p} \in \mathrm{x}) \rightarrow (\mathrm{p}, \mathrm{p}') \in \rho_{(x',x)})$

Assets and drawbacks

- Relations allow us to specify common parts of models of incommensurable theories, in spite of the fact that these theories may use incommensurable terms.
- The latter becomes possible because we do not compare terms here but (atomic) propositions instead.
- However, (because of a change of scientific standards) there may be models that do not have counterparts in the respective other paradigm
- And there may also be parts of models that do not have counterparts in the respective other paradigm


not covered by **R**
x
x'
$\rho_{(x',x)}$
possibly incommensurable parts
of x and x', which become comparable by
means of $\rho_{(x',x)}$

Relations between theories do not explain scientific progress!

- Relations between theories allow us to take care to both changes of references of scientific terms and changes of scientific standards, i.e. our first task has been worked out, by means of this formalism
- However, relations between theories only allow us to defend the claim that there is **some continuity** in science.
- Thus, the problem of scientific progress remains unsolved (so far).

Second task: find a formalization for scientific theories that also allows us to take care to the problem of scientific progress

3. Kuhn’s conception of scientific progress

Incommensurability and progress

- Interestingly enough, Kuhn’s conception of incommensurability involves also a quite pronounced notion of **scientific progress**.
- The whole final section of *Structure* is devoted to that problem.
- So, let’s have a look at Kuhn’s conception first.

Progress without truth

- The crucial point of Kuhn’s notion of scientific progress is the claim that there may be scientific progress without the presence of a scientific *telos*, i.e., without an absolute truth science is aiming at.
- Kuhn compares the turn of the picture of the sciences involved here with the turn of the picture of biological species as initiated by **Darwin** a century before:

"For many men the abolition of that teleological kind of evolution was the most significant and last palatable of Darwin's suggestions. The *Origin of Species* recognized no goal set either by God or nature. Instead, natural selection, operating in the given environment and with the actual organisms presently at hand, was responsible for the gradual but steady emergence of more elaborate, further articulated, and vastly more specialized organisms. [...]

The analogy that relates the evolution of organisms to the evolution of scientific ideas can easily be pushed too far. But with respect to the issues of this closing section it is very nearly perfect. The process described in Section XII as the resolution of revolutions is the selection by conflict within the scientific community of the fittest way to practice future science. The net result of a sequence of such revolutionary selections, separated by periods of normal research, is the wonderfully adapted set of instruments we call modern scientific knowledge. Successive stages in that developmental process are marked by an increase in articulation and specialization. And the entire process may have occurred, as we suppose biological evolution did, without benefit of a set goal, a permanent fixed scientific truth, of which each stage in the development of scientific knowledge is a better exemplar." Kuhn (1996 [1962], 172f.)

Progress as the evolutionary aspect of the sciences

- The analogy with Darwin has also a second perspective.
- Kuhn does not hesitate to claim that the whole of the sciences appear to be entirely evolutionary, as soon as we start to analyze them in terms of scientific progress.
- How can this happen?

Revolution = conceptual
Evolution = empirical

- Revolution takes place **at the conceptual side** (only). New paradigms involve a change of scientific standards, scientific terms and worldviews. In other words, paradigms are “in our heads”.
- However, **at the empirical side**, all that happens in science is of an entirely evolutionary nature. In that respect, science is not at all a conceptual thing but is concerned with “nature” (p. 168), “nature in itself” (p. 169)

A new paradigm will be accepted by the scientific community, only if it fulfills the following two requirements:

“First, the new candidate must seem to resolve some outstanding and generally recognized problem that can be met in no other way. Second, the new paradigm must promise to preserve a relatively large part of the concrete problem-solving ability that has accrued to science through its predecessors.” Kuhn (1996 [1962], 169)

„Problem solving“ is an empirical task

- In the context of the last section of structure Kuhn turns to an aspect of puzzle solving, which is not of a conceptual but of an entirely **empirical** nature.
- Now, problem solving, is a matter of coming closer to „nature in itself“.
- However, this „approximation to nature“ is not a process of coming closer to the truth.
- Rather, we come closer to „nature in itself“ here, only insofar as newer theories cover larger amounts of empirical data.

4. Progress as growth of empirical strength

Continuity extended

- Relations between theories, in the sense of section 3, allow us to identify **common empirical grounds**
- Consider two incommensurable paradigms, say, phlogiston theory and modern chemistry.
- Then, an accurate historical understanding of both theories will allow us to identify **corresponding models** of them.
- Moreover, an accurate historical understanding will also allow us to identify **corresponding empirical data**.
- That is, appearances of “phlogiston” and “air” will be identified with the corresponding appearances of “hydrogen”, “oxygen” and the like.
- **This is essentially all we need in order to formulate a proper Kuhnian conception of scientific progress!**

Formalism extended

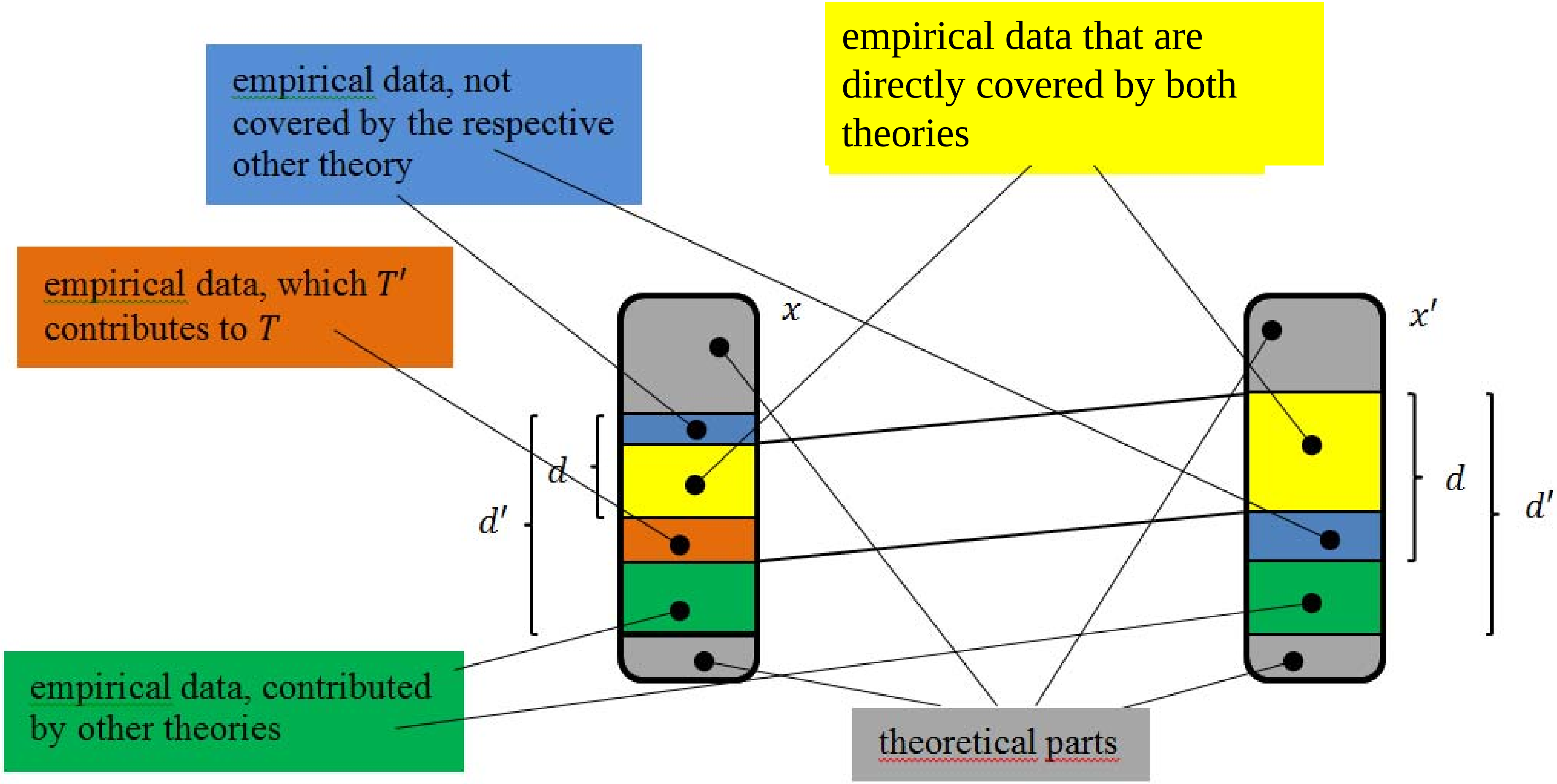
- Consider the different **historical instances of a scientific theory $\boldsymbol{T_1, \ldots, T_n}$**
- We define **a predicate $\boldsymbol{d}$** that ranges over the content of models and identifies all these of their parts that are corroborated, in the respective context, by means of suitable empirical data.
- d represents **the empirical content** of a theory, as being acknowledge in the course of its development.
- There also may be relations $\mathbf{R}_{i-j}$, which may describe the relations between the respective theories T_i and T_j
- Exactly all d-parts of T_i and T_j are associated with **their counterparts** in the respective other theory (provided that such counterparts exist).

d': the empirical strength of a theory

- On the basis of the function d and the respective relations $\mathbf{R}_{i-j}$ we define the function d', which may identify

  all these parts of a model of a theory that either form d-parts of the actual theory or have counterparts in other theories that form d-parts there.

- Intuitively, d' represents **the empirical strength** of a theory.


empirical data, not covered by the respective other theory
empirical data that are directly covered by both theories
empirical data, which T' contributes to T
x
x'
d
d'
d
d'
empirical data, contributed by other theories
theoretical parts

A Kuhnian notion of scientific progress

- Kuhn's claims from the final section of *Structure* can be reformulated in the following way:
- Science growth without any teleological commitment, simply by means of a growth of the empirical strength of theories.
- The progress of science is formally expressed by means of the formula:

$$d'(T) \ll d'(T')$$

whenever T is earlier than T'.

Conclusions

- Kuhn claims that the puzzle solving capacities of theories are responsible for scientific progress only insofar as these puzzles are directly concerned with **„behavior of nature“** (p.168) and not with mere theoretical problems.
- He further claims that later theories are **better** only because they allow us to provide a more fine-grained and more accurate picture of „behavior of nature“.
- There is only one dimension of science that allows us to identify the latter as **progressive in an unequivocal way**, namely, empirical progress.