

Comparative realism as the best explanation of empirical and aesthetic progress^{1), 2)}

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comparative realism

the best explanation

empirical progress

aesthetic progress

- 1) Global presentation, slides 1 – 10, detailed presentation, 11 – 42.
- 2) Both presentations are heavily based on Kuipers (2009).

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Debate Realism Anti-realism

Scientific realism

- extremely metaphysical
 - there is an independent outside world
 - there are truths about that world 'beyond' language

or

- moderately metaphysical
 - there is an independent outside world
 - there are truths about that world relative to a chosen language
- = constructive realism
- + focus on nomic truths, using actual truths

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Moderate "scientific realism" in debate

Constructive realism +

Claim:

scientists aim at true (nomic) theories about a domain in a given language,

and they succeed in this from time to time

Argument:

no-miracle argument (Putnam):

the success of science would be a miracle otherwise

which is a case of Inference to the Best Explanation (IBE)

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Anti-realist arguments

- 1) Pessimistic induction (Laudan),
previously the best theories turned out to be false
hence, our present best theories will also turn out to be false

- 1) Darwinian argument against no-miracle argument:

the success of our best theories, and hence empirical progress, is due to the fact they are selected for being the best

- 1) Anti-IBE (Van Fraassen) : why should the best be true?

It might well be the best of a bad lot

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Answer: **Comparative** (constructive, nomic) realism

- A puzzling observation about analytic philosophy of science
- Comparative perspective
 - focus on comparative claims
 - closer to the (strongest) truth* (instead of true or false)

the observational truth
 the theoretical truth
 the referential truth
 the structural truth

- empirically more successful* empirical progress*
- aesthetically more successful aesthetic progress

* Notions and their relations explicated in Tutorial I

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Answer: **Comparative** (constructive, nomic) realism (2)

Core idea

whether a theory is true or false is not as interesting as

whether one theory is closer to the truth than another

cf: Newton – Einstein,

phlogiston-oxygen

Note:

- one false theory may be closer to the truth than another (false) theory
- a false theory may be very near to the truth

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Reevaluating the anti-realist arguments

- 1) Ad: Pessimistic induction (Laudan): our present best theories will also turn out to be false

OK: our present best theories may well be false,
the question is whether they are closer to the truth than previous ones
- 2) Ad: Darwinian argument against no-miracle argument: the success of our best theories, and hence empirical progress, is due to the fact they are selected for being the best

OK: but truth approximation not only explains empirical progress but also predicts it
- 3) Ad: Anti-IBE (Van Fraassen) : why should the best theory be true?

OK: but IBE should be IBT: inference to the best theory as the closest to the truth among the available alternatives

Inference to the best theory (as the closest to the truth): 2 cases

Case 1: there is only one empirically the best theory

i.e. empirical progress relative to the available alternatives

- explained & predicted by the truth approximation hypothesis
- hence, also supporting the truth approximation hypothesis

Case 2: there is more than one empirically the best theory,
i.e. there are some empirically equivalent theories

Van Fraassen: no possibility to make a truth oriented choice
so, any choice is reasonable

Counter story: McAllister + Kuipers

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Beauty and revolution in science (James McAllister, 1996)

History of science shows: aesthetic induction on non-empirical features that happen to go together with (more) empirical success, e.g.

simplicity, symmetry, visualizability

This is a logical and a psychophysical phenomenon!

We tend to find these features more and more attractive
and we tend to impose them as desirable for new or revised theories

Reinforced kind of 'mere exposure effect'

Aesthetic canon: the set of dominant aesthetic features: relative to time and area

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"Beauty as a road to the truth" (Kuipers, 2002)

Aesthetic progress defined relative aesthetic canon

aesthetic progress correlates by its nature with empirical progress

empirical progress is an indicator of truth approximation

hence, aesthetic progress is a weak indicator of truth approximation

Crucial: Success theorems

Truth approximation entails empirical progress

i.e., increase of desirable empirical features

Truth approximation weakly entails aesthetic progress

at least increase of desirable non-empirical features

Recall title:

Comparative realism as the best explanation of empirical and aesthetic progress

Comparative realism as the best explanation of empirical and aesthetic progress

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1: A puzzling observation about the realism-antirealism debate

2: Antirealist arguments to be met (based on Ladyman 2002/7)

- 2.1 Arguments from theory change,
- 2.2 Inference to the best explanation (IBE)

3: Truth approximation (TA) and empirical progress (EP), some basics for **comparative realism**, i.e. (constructive, nomic) realism guided by the comparative perspective.

4. Evaluation of comparative realism

- 3.1 In defense of its main claim: truth approximation provides the best, viz. default explanation and prediction of empirical and aesthetic progress
- 3.2 Comparison with other realist responses

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*S1. A puzzling observation about the R-AR debate

One important success of the first decades of (constructive) analytical philosophy was the discovery of relations as a means to solve age old problems by refined concept explication (Russell, Carnap, Beth, Hempel)

- not in the least asymmetric relations, constituting comparative concepts, e.g. 'longer than'
- among which all kinds of improvement, without perfection, e.g. 'better than ...'

In the supposedly analytic realism - antirealism debate there is almost no sign of awareness of the possible relevance of this insight

- one continues to talk about true/false theories and reference claims versus empirically (in-)adequate (= observationally true/false) theories
- retreat to 'approximately true' is of no help, for that remains basically non-comparative
- whereas transition to comparative or even quantitative approach is obvious
- to be sure, in the comparative approach theories will frequently not be comparable, it is an idealization, but for such cases the 'principle of dialectics' (= try to improve both in one stroke) and the quantitative approach are plausible concretizations

Note: In *From Instrumentalism to Constructive Realism* (2000) the latter is short for Comparative, Constructive Nomic Realism

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*S2 Antirealist arguments to be met

(based on Ladyman 2002/2007)

Summary of TA-responses:

re: Laudan's pessimistic meta-induction:

that previously successful theories turned out to be false (and even not to refer) is not a problem, the question is whether they were closer to the truth than (and referred at least as well as) their predecessor theories. Hence, similarly for currently successful theories.

re: Arguments against Putnam's no-miracles argument:

the success of science would be miraculous on anything but a scientific realist view in the sense that specific occurrences of (persistent) empirical progress would be miraculous if not, **as a rule**, due to truth approximation; this, notwithstanding the Darwinian point that, as a rule, the best theories survive because they are selected for that reason

re: Arguments (notably of Van Fraassen) against inference to the best explanation:

IBE to be explicated as: inference to the best explanation as the closest to the truth among the available explanations/theories, even among empirically equivalent theories

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* 2 comparative Conditions of Adequacy to deal with pessimistic induction and anti-no-miracles argument (S2.1)

CA1: The explications of the crucial phrases should leave room for the possibility that false theories, even with some non-referring theoretical terms, are not only (persistently) empirically more successful but even closer to the truth than and refer at least as well as other theories.

CA2: The explications should be such that 'being (persistently) empirically more successful' is, as a rule, due to 'being closer to the truth', which on its turn entails, as a rule, 'referring at least as well' and, for later purposes, 'novel predictive success'.

Or, in a plausible reformulation

CA2: The explications should be such that empirical progress is, as a rule, due to truth approximation, which on its turn entails, as a rule, referential truth preservation and novel predictive success.

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S2.1 Arguments from theory change

Laudan's anti-realist pessimistic meta-induction (according to Ladyman)

(i) There have been many empirically successful theories in the history of science which have subsequently been rejected and whose central theoretical terms do not refer according to our best current theories.

(ii) Our best current theories are no different in kind from those discarded theories and so we have no reason to think they will not ultimately be replaced as well.

So, by induction we have positive reason to expect that our best current theories will be replaced by new theories according to which some of the central theoretical terms of our best current theories do not refer, and hence, we should not believe in the approximate truth or the successful reference of the theoretical terms of our best current theories.

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TA-response

(iTA) There have been (**some, several?**) theories in the history of science **that are persistently empirically more successful than their predecessor theories**, which have **nevertheless** subsequently been rejected and whose central theoretical terms do not **all** refer according to our best current theories.

(iiTA) = (ii) Our best current theories are no different in kind from those discarded theories and so we have no reason to think they will not ultimately be replaced as well.

So, by induction we have positive reason to expect that our best current theories will be replaced by new theories according to which some of the central theoretical terms of our best current theories do not refer, **however we may still (instead of: and hence we should not) believe that, as a rule, our best current theories are closer to the truth than their predecessor theories and that their theoretical terms refer at least as well as those of their predecessor theories.**

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Standard realist responses to Laudan, their weaknesses, and their common antirealist rejoinder: *undermining the restricted 'no-miracles' argument*

Restrict realism

- to 'mature' theories, with the problem how to define 'mature', and/or
- to theories having novel predictive success, with the problem of how to define 'novel'

Note that comparative realism remains to take all theories seriously

Antirealist rejoinder to both (rather ad hoc) retreats

- one does not need the unrestricted inductive argument to undermine the so-called **no-miracles argument** in favor of realism, that is, "the idea that the success of science would be miraculous on anything but a scientific realist view"

- referring to the (mature) ether theory of light and the (mature) caloric theory of heat one may undermine the no-miracles argument as follows:

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Rejoinder: undermining the no-miracles argument

- Successful reference of its central theoretical terms is a necessary condition for the approximate truth of a theory.
- There are [at least two] examples of theories that (were mature and) had novel predictive success but which are not approximately true.
- [Hence,] approximate truth and successful reference of central theoretical terms is not a necessary condition for the novel-predictive success of scientific theories

So, the no-miracles argument is undermined since, if approximate truth and successful reference are not available to be part of the explanation of some theories' novel predictive success, there is no reason* to think that the novel predictive success of other theories has to be explained by realism.

* Note that this (wrongly) excludes that *p.f.* similar cases have different explanations

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Current realist responses to rejoinder

- Stretch realism by stretching the (causal) theory of reference such that the relevant abandoned theoretical terms refer after all
- Restrict realism to those theoretical claims about unobservables that feature in an *essential* way in the derivation of novel predictions

E.g. Psillos uses

- to save the ether theory as referring after all, viz.. to the electromagnetic field,
- and (II) to explain the success of the caloric theory without 'caloric' as a referring term

Claim: the comparative perspective does not need such interventions

- although even now there may be *other* good reasons for the moves,
- the comparative point is whether the abandoned theories were and are closer to the truth than their respective predecessor theories,
- which may well be the case not only for the ether theory but also for the caloric theory

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TA-versions of the rejoinder premises enabled by CA1/2 and enabling a TA-version of the no-miracles argument

- (aTA) Being closer to the truth entails, as a rule, referring at least as well and novel predictive success ('novel', now in whatever favorite sense)
- (bTA) Exceptionally there (may) have been examples of theories that (were mature and) had novel predictive success relative to their predecessor theories but which were not closer to the truth and even not referring at least as well
- (cTA) Being (persistently) more successful is, as a rule, due to being closer to the truth, even more so when novel predictive success is involved

- (aTA) and (cTA) are taken care of by CA2
- The caloric and the ether theory may well fit in aTA&cTA relative to their predecessors
- But, by '**as a rule**', (aTA) and (cTA) leave room for other exceptions (bTA) and suggest a cautious version of the no-miracles argument

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Reformulated TA-version of no-miracles argument in terms of Empirical Progress

As a rule, (persistent) empirical progress is due to truth approximation and referential truth preservation, if not referential progress

If this were not the case, the regular occurrence of (novel) empirical progress would be miraculous.

Occasionally, other, case-specific, explanations of (novel) empirical progress may be appropriate

Hence, the argument suggests that truth approximation provides a kind of *default explanation and prediction* of (novel) empirical progress

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TA-version of no-miracles argument

As a rule, (persistently) empirically more successful theories are closer to the truth than, and refer at least as well as their predecessors

If this were not the case, the regular occurrence of persistently empirically more successful theories, including some novel predictive success, would be miraculous.

Occasionally, other, case-specific, explanations of persistent empirically more successfulness, novel or not, may be appropriate

Hence, the argument suggests that truth approximation provides a kind of *default explanation and prediction* of (persistent) empirically more successfulness, including some novel predictive success

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*S2.2 Inference to the best explanation (IBE)

IBE-0: "...where we have a range of competing hypotheses all of which are empirically adequate to the phenomena in some domain we should infer the truth of the hypothesis which gives us the best explanation of those phenomena." (Ladyman)

IBE plays an important role in the defence of realism

- local applications, enabling theoretical truth and reference claims
- global application: realism is the best explanation of the overall success of scientific theorising (acc. to the no-miracles argument: even the only explanation)
 - against Darwinian counter argument, predicts & explains continued specific success
 - against charge of circularity: not 'premise circular', only 'rule circular'

However, IBE is debated in general as a rule of inference, \pm assuming as explication:

IBE-E1: If an explanation has so far proven to be the best one among the available empirically adequate theories (i.e., only true observational consequences, hence unfalsified theories), then conclude, for the time being, that

- it is true, that is, true as a hypothesis about the domain,

[- or even, it is the truth, that is, the strongest true hypothesis about the domain.]

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*Objections to IBE

General objections (TK)

- (1) restricted to unfalsified theories
hence, no possibility of progress by false, but less false, theories
- (2) asymmetry
'the best available' versus 'true/the truth' simpliciter
- (3) lack of justification of the conclusion
 - (3.1) if there is just one empirically the best theory available
 - (3.2) let alone when there are empirically equivalent (EE-)theories among empirically the best ones (i.e. in case of strong underdetermination)

Ad. (3.2): Specific objections Van Fraassen against IBE wrt EE-theories

- (i) The Argument from Indifference
- (ii) The Argument from the Best of a Bad Lot
- (iii) The argument from Bayesianism

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*CA's derived from the objections to IBE

CA3: An explication of IBE should also deal with the case that all available theories are false or even have been falsified (3.1), it should be symmetric between the formal nature of the premise(s) and the conclusion (3.2), and the (truth-related) conclusion should have some analytical justification or allow some empirical justification (3.3), when there is only one best theory available (3.3.1) [, when there are EE-ones (3.3.2)]

IBE-E2: If an explanation has so far proven to be empirically the best one among the available theories, then conclude, for the time being, that it is the closest to the truth among the available theories.

- This explication satisfies CA3.1 and CA3.2.
- Section 4 will indicate to what extent CA1/2 are satisfied and hence CA3.3.1, for that is essentially implied by CA1/2
- It does not yet take EE-best theories into account, hence, does not yet meet CA3.3.2

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*Evaluation of specific objections Van Fraassen (3.2) against IBE wrt EE-theories

(i) The Argument from Indifference

- ... since there are many ontologically incompatible yet empirically equivalent theories, we have no reason to choose among them and identify one of them as true. ...[or, for that matter, as closer to the truth]
- *rejected, for disqualifies any role of non-empirical criteria as truth indicators*

(ii) The Argument from the Best of a Bad Lot

- ... we are to think that the collection of hypotheses that we have under consideration will include the true theory. The best explanatory hypothesis we have may just be the best of a bad lot, all of which are false.
- *plausible, taken care of by CA3.1*

(iii) The argument from Bayesianism

- ...any rule for the updating of belief that goes beyond the rules of Bayesian conditionalisation [...] will lead to probabilistic incoherence.
- plausible, to be respected*

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*Reformulating CA3.3.2 in detail

CA4 (re (i)): As far as EE-explanations are concerned, an explication of IBE should only take those (non-empirical \neq_{aest}) aesthetic criteria, *if any*, into account for which there are empirical or analytical reasons (Kuipers, 2002), however weak, to assume that they are truth-conducive in the field, constituting the *aesthetic canon* (McAllister).

CA5 (re (iii)): In a probabilistic version of an adequate explication of IBE "EE-updating" of the relevant belief should remain within the confines of Bayesian conditionalisation

- a merely probabilistic version makes only sense for unfalsified theories.
- however, probabilistic estimation of the distance from the truth (Niiniluoto), using Bayesian updating, is generally applicable

Note: IBE-E2 trivially satisfies CA4 and CA5 when there are no EE-best theories

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*Including empirically equivalent theories

IBE-E3:

[(3.1) (=IBE-E2). If a particular explanation has so far proven to be empirically the best one among the available theories, then conclude, for the time being, that it is the closest to the truth among the available theories]

(3.2) If some empirically equivalent explanations have so far proven to be empirically the best ones among the available theories, and if among them there is one that is according to the relevant aesthetic canon the best one, then conclude, for the time being, that it is the closest to the truth among the available theories

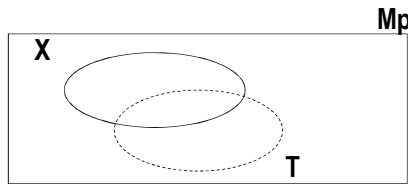
- (3.2) satisfies, like (3.1), CA3.1, CA3.2
- Section 4 will indicate to what extent it satisfies CA3.3.2, that is, CA4 & CA5

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S3: Truth approximation (TA), some basics for comparative realism, without O-/T-terms distinction

Theory $\langle Mp, X, T \rangle$ or, simply, theory X, given $\langle Mp, T \rangle$

- Mp : set of conceptual possibilities, from a fixed vocabulary
- $X \subseteq Mp$: set of models
- $T \subseteq Mp$: (unknown) set of nomic possibilities in the domain = "the (nomic) truth"
- weak claim: " $T \subseteq X$ " ("X is true"), strong claim " $T=X$ " ("X is the truth")
- Hence, "the truth" is the strongest true theory about a given domain in a given vocabulary



- Example: electric circuit

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Basic Definition: Y is *closer (more similar)* to T than X (and, hence, Y amounts to truth approximation relative to X)

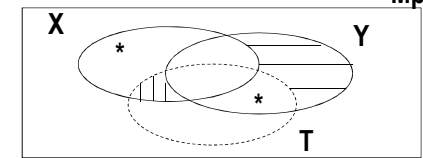
$$\equiv \text{empty: } Y - T \subseteq X - T$$

$$\text{III: empty: } T - Y \subseteq T - X$$

- * at least once a proper subset

Or, equivalently, in terms of symmetric differences: $T \Delta Y \subset T \Delta X$

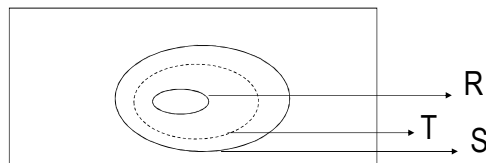
NB: recent finding (after 30 years): this definition can already be motivated in terms of the truth- and falsity content, relative to the weak, exclusion-, claims " $T \subseteq X$ " and " $T \subseteq Y$ ":



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Success Theorem, preparation

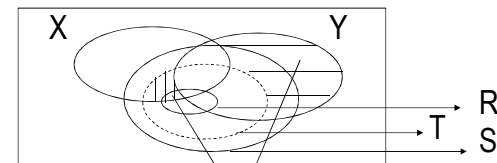
- R: set of realized possibilities (at a certain time)
- S: strongest law induced on the basis of R
- Assuming no (descriptive and inductive) mistakes: $R \subseteq T \subseteq S$



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Success Theorem

- Def: $\langle Y, R/S \rangle$ is (empirically) *at least as successful* as $\langle X, R/S \rangle$ iff $X \cap R \subseteq Y \cap R$ (instantially) & $S \cup Y \subseteq S \cup X$ (explanatorily)
- **Success Theorem:** if no mistakes, i.e. $R \subseteq T \subseteq S$, then "closer to the truth" entails "at least as successful"



smallest shaded areas empty due to at least as successful
emptiness entailed by largest shaded areas empty

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Consequences

- Comparative Success Hypothesis: “Y remains more successful than X” =>
- Instrumentalist Rule of Success: *If Y persistently remains empirically more successful than X, replace, for the time being, X in favor of Y*
- = Empirical Progress (EP) (instantial + explanatory progress) =>
- Functional for basic Truth Approximation (TA)
 - the ‘closer to the truth’- or TA-hypothesis predicts and explains empirical progress
 - it cannot be the reverse
 - if not closer to the truth, there is a specific burden to explain the purported empirical progress as resulting from an unhappy test history of the comparative success hypothesis

In sum:

TA provides the *default explanation and prediction* of empirical progress

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[Concretizations of basic TA]

Refinement, enabling TA by idealization and concretization

- based on ternary relation of “structurelikeness”
- leading to the first realistic examples

Partial domain specification

- leading to M_d and $T_d \subseteq M_d$, $T_d = \pi(T)$ (π : projection $M_p \rightarrow M_d$)
- enabling explicit domain definitions, hence domain comparisons, hence truth approximation by domain change

Quantitative TA

- basic: $|T \Delta Y| < |T \Delta X|$
- general ‘distance from the truth’ definition of Ilkka Niiniluoto

Probabilistic TA

- leading to TA by (a kind of) likelihood comparison

Stratification, see next slide

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Concretizations of basic TA: O/T-stratification

- based on a (theory-relative) distinction of observational and theoretical terms
 - $T_t \subseteq M_p$, set of nomic theoretical (cum observational) possibilities, the theoretical truth
 - M_{pp} : set of *partial* conceptual possibilities, $T_o \subseteq M_{pp}$
 - $T_o \subseteq M_{pp}$, set of nomic observational possibilities, the observational truth
 - the observational truth is the ‘projection’ of the theoretical truth: $T_o = \pi(T_t)$
 - empirically equivalent (EE-)theories: $\pi(X) = \pi(Y)$
 - the referential truth: conjunction of correct implicit (non-)fiction claims
- enabling definitions of ‘closer to the observational, referential, theoretical truth’, that is, ‘observational, referential, theoretical truth approximation’

Stratified TA-theorems and -conjectures

- Conditional Projection Theorem + Success Theorem
- crucial for the main claim below:
Truth approximation provides the (stratified) default explanation and prediction of empirical progress of theories and of aesthetic progress of EE-theories

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*S4. Evaluation of comparative realism

PM: Main claim: truth approximation provides the default explanation and prediction of empirical and aesthetic progress

CA1 up to CA3.3.1 (IBE-E3.1): wrt empirical progress

- analytical justification by TA-theorems
 - roughly: TA is default explanation and prediction of empirical progress
- empirical justification: by variant of bootstrap testing, see below

CA4 & 5 = CA3.3.2 (IBE-E3.2) wrt EE-theories

- empirical justification of aesthetic criteria being truth-conducive in the field
 - ‘aesthetic testing’: bootstrap testing IBE by later (e.g. microscope) OUD (Observable-Unobservable Distinction)-shifts of previously EE-theories (Douven)
 - ‘aesthetic induction’ on cases of empirical progress (McAllister/Kuipers)
 - both contributing to the relevant ‘aesthetic canon’, in probabilistic versions to be taken into account in the (expert) prior distribution, and only so
- subsequent analytical justification by TA-theorems and -conjectures

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*TA-theorems and -conjectures

Success Theorem:

observational truth approximation entails empirical progress,
hence, empirical progress is as a rule, due to observational truth approximation
if not, in the long run, new experiments will break the empirical progress conclusion

Projection-cum-Success Theorem:

theoretical truth approximation entails explanatory progress and, as a rule, instantial
progress, both, as a rule, including some novel predictive success
if not merely instantial progress, the worse theory has *extra lucky* observational hits

Reference Conjecture:

theoretical truth approximation entails, as a rule, referential truth preservation
if not, the worse theory has *extra lucky* referential claims

Aesthetic Conjecture:

theoretical truth approximation by EE-theories entails increase of truth-conducive
properties, and hence, as a *weak* rule, aesthetic progress
if not, aesthetic testing and induction prove to have their limits

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Terminological equivalencies:

Empirical progress = instantial + explanatory progress = persistently empirically more successful

Closer to the truth =

closer to the strongest true theory about a given domain in a given vocabulary

Truth approximation = getting closer to the truth

Closer to the theoretical truth = theoretical truth approximation

Closer to the observational truth = observational truth approximation

Closer to the referential truth = referential truth approximation

Aesthetic progress (according to relevant aesthetic canon), in particular among EE-theories =
increase of desirable-aesthetic properties and decrease of undesirable ones,

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*S4.2 Review and extension of comparison with other realist responses to antirealism

Preliminary remarks:

- there are, of course, no compelling reasons neither for experiential/
inductive/ theoretical skepticism nor for comparative realism
- however, Van Fraassen's "What is rational to believe includes anything
that one is not rationally compelled to disbelieve" is a license for all kinds
of wishful thinking, blocking a 'good reasons' debate

Review: realist responses already dealt with in the full paper:

restrict realism to

'mature' theories

theories with 'novel' predictive success

'essential' parts/aspects of theories

stretch realism by

stretching underlying (causal) theory of reference

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*Extension of comparison

Other realist responses by restricting realism:

- entity / referential realism
 - motivated by idealizational scientific practice
 - unnecessary retreat for this important practice
 - for idealization followed by concretization is an important form of TA
- structural realism
 - motivated by frequent referential failures
 - unnecessary retreat in view of the possibility of referential truth approximation

Re: the argument from multiple models: realism about what? (Roger Jones, 1991)

- e.g. at least four EE-versions of classical mechanics
- cf. the argument from indifference against IBE
- to be dealt with by IBE-E3.2; 'realism about what' depends on prevailing 'aesthetic
canon' (dealing with ontological/epistemological/methodological/pragmatic aspects)

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Hierarchy of epistemological positions, nomic + comparative or not

Q0: independent natural world?	No ⇒ ontological idealism
↓ Yes: ontological realism	
Q1: true claims about it possible?	No ⇒ epistemological skepticism
↓ Yes: epistemological realism	- experiential skepticism
	- inductive skepticism
Q2: beyond the observable?	No ⇒ theoretical skepticism
↓ Yes: scientific realism	- instrumentalism
	- constructive empiricism
Q3.1: beyond reference?	No ⇒ referential realism
	⇒ entity realism
Q3.2: beyond structures?	No ⇒ structural realism
↓ 2 x Yes: theory realism	
Q4: ideal conceptualization?	No ⇒ constructive realism
↓ Yes: essentialistic realism	

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