Lectures Theo Kuipers

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Düsseldorf, April 23-26, 2013

- Evening lecture: Wednesday, April 24, 18.15 – 20.00
  Comparative realism as the best explanation of empirical and aesthetic progress

Tutorials

- I Tuesday, April 23, 18.30 – 20.15
  Empirical progress and nomic truth approximation revisited
- II Friday, April 26, 14.15 – 16.00
  Nomic truth approximation by belief base revision

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Tutorials

I Empirical progress (EP) and nomic truth approximation (NTA) revisited

- Section 1: introduction
- Section 2: basic EP and basic NTA by exclusion

II Nomic truth approximation by belief base revision (BBR)

- Section 3: basic NTA by basic BBR
- Section 4: refined EP and refined NTA by exclusion
- Section 5: refined NTA by refined BBR
- Section 6: summary and prospects

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* Section 1. Introduction (1)

After 30 years, I discovered that my qualitative structuralist approach to truth approximation and empirical progress (Kuipers, 1982, 1984, 2000) can be presented in a much more general way than I always thought.

This holds in particular in the 'nomic' context, typical for theory oriented empirical science, in which we are aiming at characterizing which possibilities are nomically, e.g. physically, possible and which are not.

The definition of 'closer to the truth' can then already be conceptually motivated by assuming that the claim of a theory only excludes certain conceptual possibilities as nomic possibilities, i.e. the exclusion claim. I always thought that the inclusion claim had to be added that the not excluded possibilities were nomically possible.

The exclusion claim also suits the 'monadic' interpretation in which the focus is on instantiated versus not-instantiated 'Q-predicates'. For both contexts the weakened claim leads to conceptual simplification and streamlining of the building-block notions of truth-content and falsity-content.

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Section 1. Introduction (2)

One of the relieving consequences is that my paper in the special issue of Erkenntnis (75.2, 2011) on Belief Revision aiming at Truth Approximation (ed. T. Kuipers and G. Schurz), entitled "Basic and refined nomic truth approximation by evidence-guided belief revision in AGM-terms" is not at all as ad hoc as I remarked at the end of that paper.

Theories in that paper are primarily based on the exclusion claim. After the revision of such a theory by evidence according to the AGM-rules of belief revision, I wrongly thought to have to add the inclusion claim in order to prove conduciveness of nomic truth approximation.

By the way, this form of belief revision remains very empiricist!

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Section 1. Introduction (3)

The finding naturally leads to two one-sided kinds of empirical progress and truth approximation, viz. by exclusion and by inclusion, respectively, and one two-sided kind, viz. by combining them. As suggested already, the exclusion kind suits in particular the nomic and the monadic context.

The two-sided kind not only suits the 'propositional' context in which there is a set of logically independent elementary propositions but also the 'dichotomic' context in which, for example, the distinction between equilibrium versus non-equilibrium states is concerned.

The propositional two-sided kind amounts to the so-called conjunctive approach to truthlikeness by Gustavo Cevolani, Vincenzo Crupi, and Roberto Festa (2011). My plan to present in Tilburg (April 2012) a condense version of my formalization and generalization of that approach (Kuipers, forthcoming) opened the view on the one- and two-sided kinds of methods, suitable for different interpretations.

The crucial factor determining whether a one- or a two-sided kind is appropriate depends on whether the kind of evidence that can be obtained is 'symmetric' or 'asymmetric'. For example, whereas both equilibrium and non-equilibrium states can be produced by experiments, it is by definition only possible to realize nomic possibilities by experiment, and not nomic impossibilities. Similarly, it is by definition only possible to show instances of instantiated Q-predicates, and not of not-instantiated Q-predicates.

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* Section 1. Introduction (4)

Explicating 'empirical progress' and 'truth approximation' in the nomic interpretation should do justice to some basic instrumentalist/empiricist and realist Conditions of Adequacy.

CA-instrumentalist: the explication of 'empirical progress' should not be laden by realist notions, notably, 'the truth' and 'closer to the truth'.

CA-realist: the explication of 'truth approximation' and 'empirical progress' should be such that 1) 'truth approximation' explains 'empirical progress' and 2) 'empirical progress' supports the 'truth approximation'-hypothesis.

The first condition is important in order to convince instrumentalists that the realist intentions in the second condition pertain to their crucial notion of empirical progress.

The notion of 'estimated progress' of Niiniluoto (1987, 2011, see also his paper in the Tilburg 2012 proceedings) cannot work in this respect, for it evidently does not satisfy the first condition.

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Section 1. Introduction (5)

In the written version of the Tilburg-presentation the focus is on presenting the basic story of empirical progress and nomic truth approximation by exclusion (Section 2).

In Section 3 indications are given of some sophisticated versions: a stratified version based on the (vocabulary-relative) distinction between observational and theoretical terms, and a refined version based on a likeness relation.

Section 4 first indicates the method of inclusion as the mirror image of the method of exclusion and then presents the basic formalism for the two-sided method of inclusion and exclusion.

Tutorial I presents the basic nomic story.

Tutorial II continues with nomic truth approximation by belief (base) revision and it adds the refined version of both.

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Section 2:
The basic (nomic) story

Exclusion kinds of:

basic Empirical Progress and Nomic Truth Approximation

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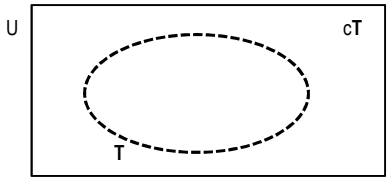
The basic story : ***simplified version*** of Kuipers (1982, 2000)

U: the universe of discourse, possibly infinite
V: descriptive vocabulary in which U and subsets of U, e.g. X, Y, R, S, are characterized
cX: the complement of X

T is a subset of U not based on V
The target of research is identifying, if possible, **T**'s boundary in V-terms, i.e. **the (explicit) truth**



Focus on the ***nomic*** interpretation, in which U represents the set of conceptual possibilities, generated by V, and **T** (c**T**) the set of nomic (im-)possibities.

Formalism equally suited for the ***monadic*** interpretation, in which U represents the set of Q-predicates generated by V, and **T** (c**T**) the set of (not-) instantiated Q-predicates

The basic story theories, their claim, "the truth"

• 'Theory X', or simply X, is a subset X of U, defined in V-terms, with the claim "**T** $\subseteq$ X", or equivalently "cX $\subseteq$ c**T**", e.g., all non-members of X are excluded as nomic possibilities.
  • Note that **T** is an improper theory, for not defined in V-terms
  • ***Simplification (after 30 years):***
  the strong claim "T=X" (Kuipers 1982, 2000) appears to be not necessary!!

• The second version of the claim can be formulated as a universally quantified conjunctive claim about the members of cX:

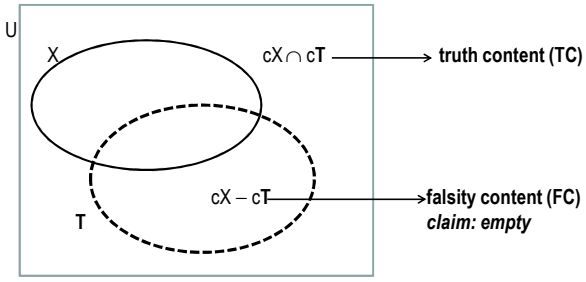
$cX \subseteq cT \equiv \forall_{u \in cX}\, u \in cT$

– each conjunct is called a *basic (b-)claim*, and cX the *domain* of the total claim
– it provides the key to the conjunctive approach of Cevolani, Crupi, and Festa (2011)

• Definition: X is ***true*** iff the claim is true, i.e. iff cX $\subseteq$ c**T**, or iff cX – c**T** = $\varnothing$, ***false*** otherwise

• Claim: there is at most one strongest true theory, called *the true theory* or simply ***the truth***, viz. the characterization of **T** in V-terms, *if it exists*, indicated by T, with non-bold 'T', i.e. the target of research!

The basic story the truth and falsity content



• Relative to the claim "cX $\subseteq$ c**T**", cX $\cap$ c**T** represents the correct b-claims, the ***truth-content***, whereas cX – c**T** represents the mistaken b-claims, the ***falsity content***

• Note that their union equals cX, the domain of the total claim, but also the Popperian ***content*** of theory X: all excluded items

The basic story basic TRUTH APPROXIMATION

Definition:
-theory Y is ***basically at least as close to*** *T*, or to the truth, as theory X, iff:

• the truth content (TC-) clause: TC(X) $\subseteq$ TC(Y): cX $\cap$ c**T** $\subseteq$ cY $\cap$ c**T**
&
• the falsity content (FC-) clause: FC(Y) $\subseteq$ FC(X): cY – c**T** $\subseteq$ cX – c**T**

- ***basically closer to the truth*** = ***basic TRUTH APPROXIMATION:***

• basically at least as close to & (*extra clause:*) at least once a ***proper*** subset

It is easy to check that the TC- and the FC-clause of 'at least as close' are equivalent to:

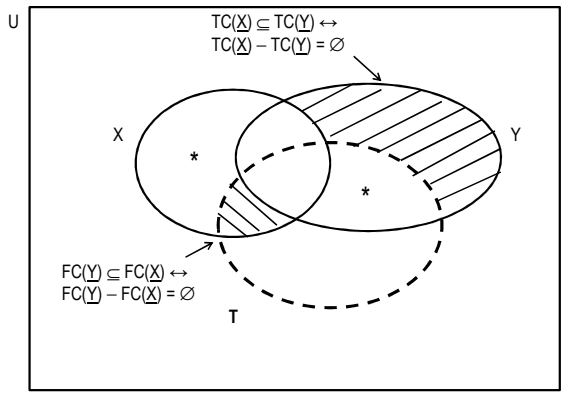
	c (X$\cup$**T**) $\subseteq$ c (Y$\cup$**T**)	resp.	cY $\cap$ **T** $\subseteq$ cX $\cap$ **T**
	Y$\cup$**T** $\subseteq$ X$\cup$**T**	resp.	**T** – Y $\subseteq$ **T** – X ←
→	Y – **T** $\subseteq$ X – **T**	resp.	**T** $\cap$ X $\subseteq$ **T** $\cap$ Y

After 30 years: the single claim "cX $\subseteq$ c**T**" already generates the two difference clauses, and hence the (basic) symmetric difference definition, viz. Δ(Y,**T**) $\subseteq$ Δ(X,**T**) (Kuipers, 1982, 2000).

Hence, the so far added 'inclusion' claim "X $\subseteq$ **T**", leading to the claim "X=**T**", is totally redundant.

The basic story basic TRUTH APPROXIMATION

theory Y is ***basically at least as close to T***, or to the truth, as theory X



empty:

due to TC-clause

due to FC-clause

closer to
extra: non-empty:

at least one of the two * areas

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The basic story basically (empirically) MORE SUCCESSFUL

or ***potential*** basic EMPIRICAL PROGRESS (Kuipers, 1984, 2000)

Asymmetric data R/S, at a certain moment, for nomic and monadic interpretations

R: realized possibilities (e.g. realized physical possibilities)
S (⊇ R): strongest law induced on R (cS e.g. induced physical impossibilities)

cX ∩ R = cX – cR = R – X: the ***rejected content*** RC(X)
cX ∩ cS = c(X ∪ S): the ***accepted content*** AC(X)

Definition:
- 'Y is basically at least as successful as X', relative to R/S: RC-clause + AC-clause

cY∩R ⊆ cX∩R RC(Y) ⊆ RC(X) ↔
↔ R – Y ⊆ R – X all realized counterexamples of Y are counterexamples of X
&
cX∩cS ⊆ cY∩cS AC(X) ⊆ AC(Y) ↔
↔ S∪Y ⊆ S∪X all induced laws entailed by X are entailed by Y

-'basically more successful': basically at least as successful & at least once a ***proper*** subset

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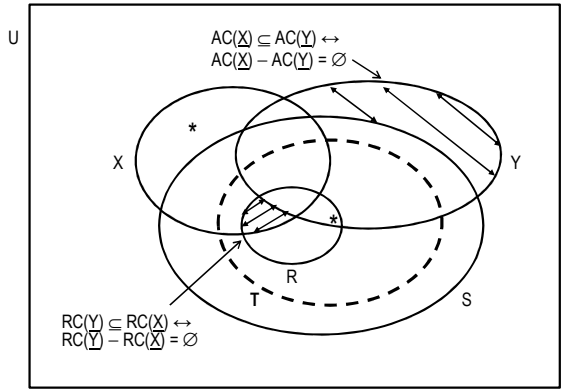
The basic story basically (empirically) MORE SUCCESSFUL

Y is **basically at least as successful** as X, relative to R/S



empty:

due to RC-clause

due to AC-clause

'more successful
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The basic story: the SUCCESS THEOREM

Connection: basic Truth Approximation and ***potential*** basic Empirical Progress

Preparation

Correct Data (CD-)hypothesis: no mistakes in our empirical evaluation of the data

R ⊆ **T** ⊆ S i.e., (CD-i) R ⊆ **T** & (CD-j) **T** ⊆ S

Lemmas:
(j1) AC(X) ⊆ TC(X): cX ∩ cS ⊆ cX ∩ cT
(j2) AC(X) ∩ TC(Y) ⊆ AC(Y): (cX ∩ cS) ∩ (cY∩ cT) ⊆ cY∩ cS
(i1) RC(X) ⊆ FC(X): cX – cR ⊆ cX – cT
(i2) RC(Y) ∩ FC(X) ⊆ RC(X) (cY – cR) ∩ (cX – cT) ⊆ cX – cR

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The basic story: the SUCCESS THEOREM

Connection: basic Truth Approximation and ***potential*** basic Empirical Progress

Success Theorem: Assuming the CD-hypothesis,

(a) if Y is basically at least as close to the truth as X, Y is basically at least as successful
(b) if Y is basically closer to the truth than X, Y will become basically more successful

Proof (a): formally: trivial or conceptually:

a ('by R') rejected b-claim of Y is (CD-i) a false b-claim of Y, which is (FC-clause) a false b-claim of X, and hence is a rejected b-claim of X

or $RC(Y) \subseteq_{(i1)} FC(Y) \subseteq_{FC\text{-}clause} FC(X)$ and hence, by (i2), $RC(Y) \subseteq RC(X)$

&

an ('by S') accepted b-claim of X is (CD-j) a true b-claim of X, which is (TC-clause) a true b-claim of Y, and hence is an accepted b-claim of Y

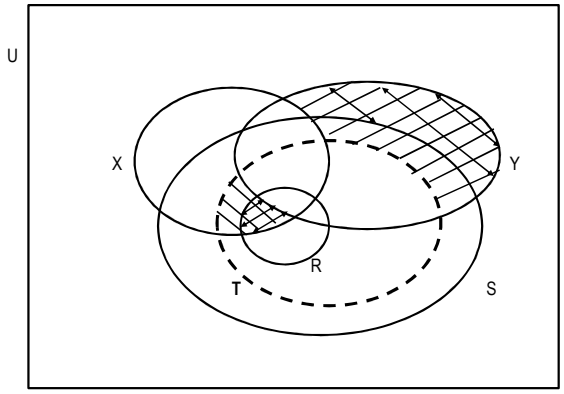
or $AC(X) \subseteq_{(j1)} TC(X) \subseteq_{TC\text{-}clause} TC(Y)$ and hence, by (j2), $AC(X) \subseteq AC(Y)$

Proof (b): sooner or later a nomic possibility in $(Y \cap T) - X$ will be realized or a nomic impossibility in $X - (Y \cup T)$ will be induced.

The basic story 'proof' of the SUCCESS THEOREM, part (a)

basically at least as close entails basically at least as successful:

AC-clause: ↖↗ empty RC-clause ↙↘ empty



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The basic story basic EMPIRICAL PROGRESS

- 'basically more successful' suggests:
- **Comparative Success Hypothesis** (CSH), to be tested:

  Y (is and) remains basically more successful than X
- **Rule of Success** (RS):

  When Y has so far proven to be basically more successful than X,
  i.e. when CSH has been 'sufficiently confirmed' to be accepted as true,
  eliminate X in favor of Y, at least for the time being.
- Core idea of **basic Empirical Progress**:

  acceptance of CSH and subsequent application of RS
- Note that this definition of EP does not depend on that of 'closer to T' and only in a restricted sense on T, i.e. via the CD-hypothesis.
- Hence, **CA-instrumentalist** is satisfied.

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The basic story

Connection: basic Truth Approximation (TA) and basic Empirical Progress (EP),
i.e. the satisfaction of **CA-realist** (TA explains EP and EP justifies TA)

Recall: according to the Success Theorem, TA entails, hence (default) explains, EP

Hence, Empirical Progress abductively suggests the Truth Approximation (TA-) hypothesis:
Y is basically closer to the truth than X
The TA-hypothesis is also to be tested by testing CSH, for it entails CSH!

Reverse consequences of the Success Theorem: Empirical Progress not only suggests the TA-hypothesis, but also justifies it to the following extent:

- first, it is still possible that Y is basically closer to the truth than X, which would be explained by the TA-hypothesis in view of the Success Theorem
- second, it is impossible that Y is basically further from the truth than X (and hence X basically closer to the truth than Y), for otherwise, so shows the Success Theorem, Y could not be basically more successful
- third, it is also possible that Y is neither basically closer nor basically further from the truth than X, in which case, however, another specific explanation has to be given for the fact that Y has so far proven to be basically more successful, e.g. by biased choice of experiments

Hence: Empirical Progress justifies "Inference to the Best Theory as the closest to the truth" (IBT), i.e. acceptance of the TA-hypothesis, at least for the time being.

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NB: IBT is a sophisticated version of IBE (Inference to the Best Explanation)

Intermezzo, recall: Tutorials

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Recap of the basic nomic story (1)

U: the set of conceptual possibilities
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T is a subset of U not based on V, representing the nomic possibilities, hence c**T** the nomic impossibilities
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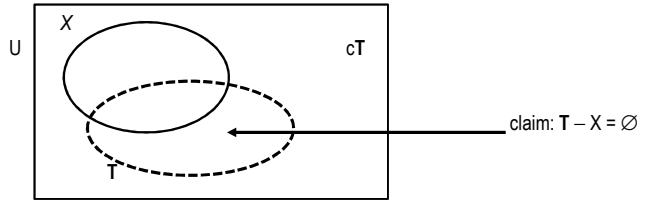

Theory X: subset X with claim **T** ⊆ X or, equivalently, cX ⊆ c**T**

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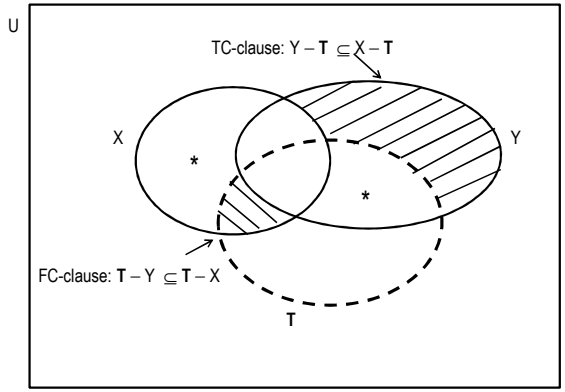
Recap of the basic nomic story (2)

theory Y is ***basically at least as close to*** T, or to the truth, as theory X
Y – **T** ⊆ X – **T** **&** **T** – Y ⊆ **T** – X



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Recap of the basic nomic story (3)

Asymmetric data R/S, at a certain moment

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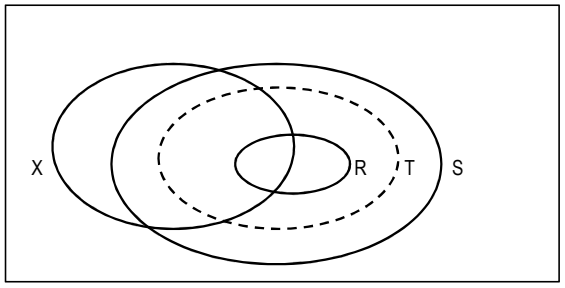

Task: How to revise theory X in the face of R and S such that the revision is closer to the truth as X, or at least more successful than X?

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Section 3: basic NTA by basic BBR (1)

- (Recall:) The second version ($cX \subseteq c\mathbf{T}$) of the claim of a nomic theory, $\mathbf{T} \subseteq X$, can be formulated as a universally quantified conjunctive claim about the members of cX:

  $cX \subseteq c\mathbf{T} \equiv \forall_{u \in cX} u \in c\mathbf{T}$

  – each conjunct is called a *(negative) basic (b-)claim*: u is a nomic impossibility

  – cX is called the *(negative) domain* of the total claim

- Such negative (and positive) claims provide the key to the conjunctive approach to verisimilitude of Cevolani, Crupi, and Festa (2011)
- In addition they have built a bridge between this conjunctive approach and AGM-Hansson belief base revision (BBR, see Hansson, 1999).
- In the present context the confrontation of a theory X with evidence R/S is a confrontation of the basic claims of X with rejected (negative) b-claims provided by R and accepted (negative) b-claims provided by S.
- Belief revision is usually built up in 'Levi-style': here, first (domain) contraction, by dropping rejected b-claims, followed by (domain) expansion, by adding accepted b-claims.

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basic NTA by basic BBR (2)

- Basic claims of X: $cX \subseteq c\mathbf{T} \equiv \forall_{u \in cX} u \in c\mathbf{T}$
- Basic claims provided by R: $R \subseteq \mathbf{T} \equiv \forall_{u \in R} u \in \mathbf{T} \equiv \forall_{u \in R} u \notin c\mathbf{T}$
- Basic claims provided by S: $\mathbf{T} \subseteq S \equiv cS \subseteq c\mathbf{T} \equiv \forall_{u \in cS} u \in c\mathbf{T}$

- *Contraction* of X by R amounts to dropping the negative b-claims of X, rejected due to R, i.e., $\forall_{u \in cX \cap R} u \in c\mathbf{T}$. The remaining claim then concerns the 'contracted' domain cX–R, hence $cX \cap cR = c(X \cup R)$, which corresponds to the (exclusion) claim of theory $X \cup R$.
- *Expansion* of X by S amounts to adding the extra negative b-claims of S relative to X, i.e., $\forall_{u \in cS - cX} u \in c\mathbf{T}$. The resulting claim then concerns the 'expanded' domain $cX \cup cS$, i.e. $c(X \cap S)$, and hence corresponds to the (exclusion) claim of theory $X \cap S$
- *Revision* of X by R/S leads then, in the Levi-order, first to theory $X \cup R$, then to theory $(X \cup R) \cap S$, with 'revised' domain $c[(X \cup R) \cap S]$.
- Note that the reverse order leads to: $(X \cap S) \cup R$, which is equivalent, assuming $R \subseteq S$

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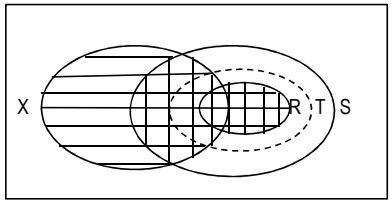
basic NTA by basic BBR (3)

- Shaded areas here indicate complements of domains of (nomic) theories!
- *Contraction* of X by R leads to $X \cup R$: horizontally shaded area
- *Subsequent Expansion* of $X \cup R$ by S leads to $(X \cup R) \cap S$, in addition vertically shaded area.



- It is easy to see that theory $(X \cup R) \cap S$ is *maximally successful*, that is, $R \subseteq (X \cup R) \cap S \subseteq S$
- And even that it is *closer to the truth* than theory X, assuming X not maximally successful, i.e. R–X and/or S–X are non-empty, for $T - (X \cup R) \cap S \subseteq T - X$ and $(X \cup R) \cap S - T \subseteq X - T$
- Hence: basic NTA by basic BBR

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So far:

basic exclusion kinds of

- Empirical Progress (EP)
- Nomic Truth Approximation (NTA)
- NTA by Belief Base Revision

Similarly: there are also basic inclusion kinds, based on the claim: $X \subseteq \mathbf{T}$

Hence, there exist two basic one-sided kinds.

Moreover: there exists one basic two-sided kind, combining an exclusion and an inclusion claim to two disjoint sets.

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Section 4:
The refined (nomic) story

Exclusion kind of:

refined Empirical Progress (EP) and refined Nomic Truth Approximation (NTA)

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The refined story: preliminaries

The basic exclusion kind of NTA by BBR has a plausible refined kind.

However, the basic inclusion kind has a refined kind primarily by mirroring ('complementing') the refined exclusion kind.

The basic inclusion kinds of EP and NTA have a plausible refined kind.

However, the basic exclusion kinds have refined kinds primarily by mirroring ('complementing') the refined inclusion kinds.

In both cases, the mirroring requires a lot of 'complement-thinking'.

Unfortunately, starting from the basic exclusion kinds of EP and NTA, as we did in this presentation, we have first to continue with their mirrored refined kinds and to conclude with the relatively more plausible refined kind of NTA by BBR.

NB: Looking back, my previous work, based on the strong claim, the basic story was primarily guided by intuitions related to the exclusion claim and the refined story by intuitions related to inclusion claim.

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*The refined story:

refined EMPIRICAL PROGRESS and refined TRUTH APPROXIMATION

Refined truth approximation, as presented in (Kuipers, 2000), is a (qualitative) likeness approach to truth approximation. The simplification leaves this the same.

It is based on a three-place 'similarity' or 'likeness' relation on a set of items U[1].

s(x,y,z) y is at least as similar (close) to z as x

When s(x,y,z) holds, y is also said to be, qua kind of item, *between* x and z.

s(.,.,.) is supposed to satisfy some plausible 'minimal (s-)conditions'[2].

We need not assume that all pairs of items are comparable by being related by some intermediate item. Hence we define: x and z are *related*, r(x,z), iff ∃y s(x,y,z).

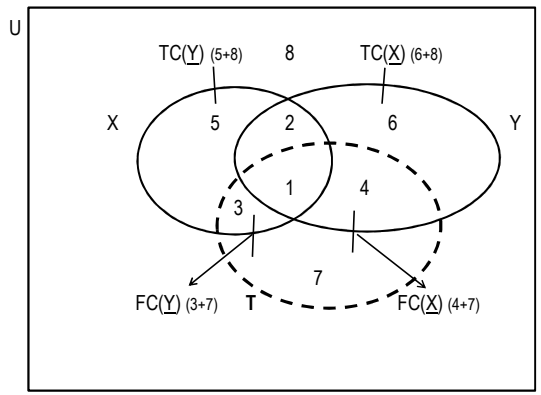
Finally, we say that s is *trivial* if: for all x, y, and z s(x,y,z) iff x=y=z.

1) In the present nomic presentation (e.g. Kuipers, 2000, ch. 10) s is a ternary likeness relation between structures.

2) They are: centered, centering and conditionally left and right reflexive. s is centered iff s(x,x,x) and centering iff s(x,y,x) implies x=y. s is conditionally left/right reflexive if s(x,y,z) implies all kinds of left and right reflexivity, i.e., s(x,x,y), s(y,x,z), s(y,y,z) and s(x,y,y), s(x,z,z), s(y,z,z), respectively.

PM: The basic story basic TRUTH APPROXIMATION

'|' connects two areas that form conceptually a unit



Definition 'Y basically closer to the truth than X': 3 + 6 empty and 4 or 5 non-empty

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The refined story: *refined TRUTH APPROXIMATION*

Definition:

- ***Y* is refined at least as close to the truth as *X*** iff

(ir) $\forall_{x \in cX} \forall_{z \in cT}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$ strengthened TC-clause
$\forall_{x \in cX - (cY \cup cT)} \forall_{z \in cT}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$ & 6=TC(X)–TC(Y)=∅
$\forall_{x \in (Y \cap T) - X} \forall_{z \in cT}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$ & ,,,,
$\forall_{x \in 4=FC(X) - FC(Y)} \forall_{z \in cT}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$ & ,,,,
all extra mistakes of X are 'improved' by Y* & ,,,,

(iir) $\forall_{y \in cY - (cX \cup cT)} \exists_{x \in cX - cT} \exists_{z \in cT - cX} s(x,y,z)$ weakened FC-clause
$\forall_{y \in (X \cap T) - Y} \exists_{x \in T - X} \exists_{z \in X - T} s(x,y,z)$
$\forall_{y \in 3=FC(Y) - FC(X)} \exists_{x \in X - T} \exists_{z \in T - X} s(x,y,z)$ [pm 3=FC(Y)–FC(X)=∅]
all extra mistakes of Y are useful in improving X

- **refined closer to the truth** = ***refined TRUTH APPROXIMATION:***
refined at least as + (extra clause) failure of a reverse claim

* i.e. improved by a less severe false b-claim or even a true b-claim

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The refined story: *comparison basic vs refined TRUTH APPROXIMATION*

Definition:

- ***Y* is refined at least as close to the truth as *X*** iff

(ir) $\forall_{x \in cX} \forall_{z \in cT}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$ strengthened TC-clause
$\forall_{x \in cX - (cY \cup cT)} \forall_{z \in cT}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$ & 6=TC(X)–TC(Y)=∅
$\forall_{x \in (Y \cap T) - X} \forall_{z \in cT}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$ & ,,,,
$\forall_{x \in 4=FC(X) - FC(Y)} \forall_{z \in cT}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$ & ,,,,
(iir) $\forall_{y \in cY - (cX \cup cT)} \exists_{x \in cX - cT} \exists_{z \in cT - cX} s(x,y,z)$ weakened FC-clause
$\forall_{y \in (X \cap T) - Y} \exists_{x \in T - X} \exists_{z \in X - T} s(x,y,z)$
$\forall_{y \in 3=FC(Y) - FC(X)} \exists_{x \in X - T} \exists_{z \in T - X} s(x,y,z)$ [pm 3=FC(Y)–FC(X)=∅]

To compare it with the basic definition we represent the latter in a similar way

(ib) $cX \cap cT \subseteq cY \cap cT$ $[\leftrightarrow Y - T \subseteq X - T \leftrightarrow 6=TC(X)–TC(Y)=\emptyset]$
(iib) $cY - cT \subseteq cX - cT$ $[\leftrightarrow (X \cap T) - Y = \emptyset \leftrightarrow 3=FC(Y)–FC(X)=\emptyset]$

- The refined definition reduces to the basic one when s is trivial.
- (ir) strengthens (ib) and (iir) weakens (iib).

- (ir) states that every comparable pair, one of cX and one of c**T**, has an 'intermediate' in cY.
- (iir) states that if Y makes 'new mistakes', they are 'useful'.

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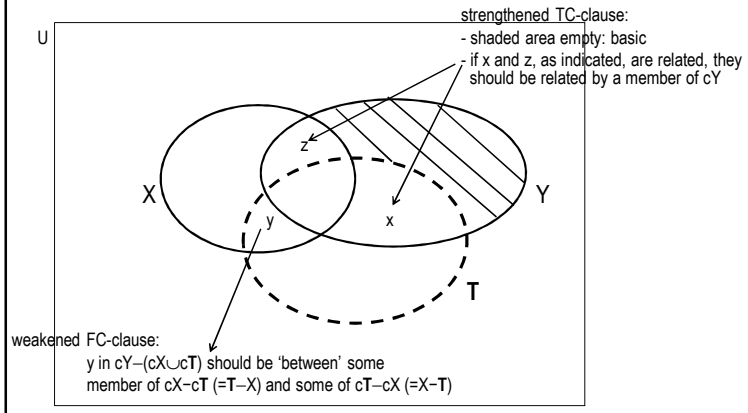
The refined story *refined AT LEAST AS CLOSE TO THE TRUTH*



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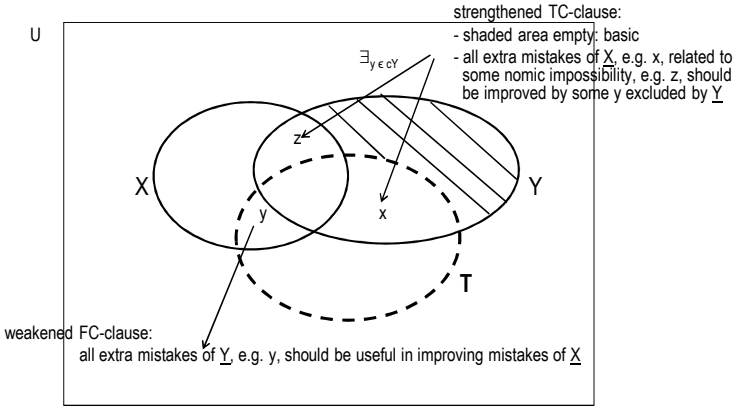
*The refined story *refined AT LEAST AS CLOSE TO THE TRUTH*



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The refined story: *refined EMPIRICAL PROGRESS*

Phrased in terms of asymmetric, e.g. nomological or monadic data R/S
Definition:

- Y is refined at least as successful as X, relative to R/S, iff

(ir-sf)	$\forall_{x \in cX}\forall_{z \in cS}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$	strengthened AC-clause
	$\forall_{x \in cX - (cY \cup cS)}\ \forall_{z \in cS}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$	& $AC(X)–AC(Y)=\emptyset$
	$\forall_{x \in (Y \cap S)-X}\ \forall_{z \in cS}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$	& ,,,,
	$\forall_{x \in RC(X)-RC(Y)}\ \forall_{z \in cS}\ r(x,z) \rightarrow \exists_{y \in cY} s(x,y,z)$	& ,,,,
(iir-sf)	$\forall_{y \in cY-(cX \cup cR)}\ \exists_{x \in cX}\ \exists_{z \in cR-cX} s(x,y,z)$	weakened RC-clause
	$\forall_{y \in (X \cap R)-Y}\ \exists_{x \in cX}\ \exists_{z \in X-R} s(x,y,z)$	
	$\forall_{y \in RC(Y)-RC(X)}\ \exists_{x \in cX}\ \exists_{z \in X-R} s(x,y,z)$	[pm $RC(Y)–RC(X)=\emptyset$]

- Y is refined more successful than X, relative to R/S*, iff*
refined at least as & (extra clause) failure of a reverse claim

The refined definition reduces in a similar way to the basic one when s is trivial
Similar paraphrases and claims can be made as in the case of refined truth approximation

Core idea **refined Empirical Progress**: acceptance of adapted/refined CSH (Comparative Success Hypothesis) and subsequent application of adapted/refined RS (Rule of Success)

*The refined story

CONNECTION: refined TRUTH APPROXIMATION and refined EMPIRICAL PROGRESS

Refined Success Theorem:
assuming correct data,
'refined at least as close to the truth' entails 'refined at least as successful'
+ 'refined closer to the truth' will sooner or later lead to 'refined more successful'

NB if $(X \cap R)–Y \neq \emptyset$ and cR is convex, i.e., if x, z ϵ cR and s(x,y,z), then y ϵ cR, the condition $\exists_{x \in cX}$ in (iir-sf) can be strengthened to $\exists_{x \in cX-cR}$ ($\equiv \exists_{x \in R-X}$) without loosing the theorem

As in the basic case, the reverse consequences of the theorem can be summarized by:
being persistently refined more successful is conducive for refined truth approximation

Hence, again:
refined Empirical Progress justifies "inference to the best theory as the closest to the truth",
i.e., acceptance of the refinedTruth Approximation hypothesis,
at least for the time being.
In sum: **CA-instrumentalist** (rEP not laden with rTA) and
CA-realist (rTA explains rEP and rEP justifies rTA)
are again satisfied.

*Section 5: refined NTA by refined BBR (1)

A previous attempt (Kuipers, 2011) to dovetail refined nomic truth approximation and belief revision, still assuming the strong claim (X=T) of theories, was based on a refined form of belief revision, notably partial meet revision, using Adam Grove's spheres approach (Grove, 1988) and Wlodek Rabinowizc's similarity foundation of it (Rabinowicz, 1995).

But that dovetail attempt was said to be unsatisfactory because of an ad hoc feature, already in its basic form. Starting with the exclusion claim, it had in the end to add the inclusion claim. In view of the simplification result this paper needs to be re-evaluated.

The present paper takes the perspective of belief *base* revision and the refined form below remains inspired by Grove's spheres approach and Rabinowizc's similarity foundation of it.

However, it is formally similar to, but not equivalent to, so-called partial meet revision.
The nested spheres are situated around the non-excluded possibilities or possible worlds as in the case of Grove, but in that case on a higher level.

Hence, at this moment one challenge that the paper leaves is to clarify the precise relation between the, in itself plausible (I hope), definition of refined belief base revision and the B*B*R-form of partial meet belief revision.

refined NTA by refined BBR (2)

- Likeness foundation of spheres and the connection with the ternary likeness relation

- Not all of Grove's sphere axioms are very plausible
- Wlodek Rabinowizc (1995) provided plausible foundations in terms of a 4-place similarity relation:
  sim(x,y;u,v) x is at least as close (similar) to y as u is to v
  satisfying four plausible conditions and one Limit Assumption

- Def: $w \leq_X v$ iff $\forall v' \in X \exists w' \in X\ sim(w',w;v',v)$
  X has as similar representatives of w as of v

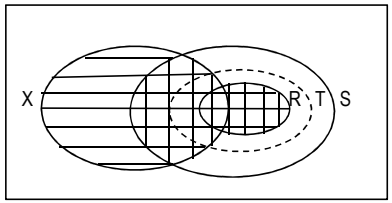
- Def: Y is a *sphere* around X iff (i) if $X \neq \Phi$ then $Y \neq \Phi$
  (ii) $\forall w\ \forall v \in Y$ if $w \leq_X v$ then $w \in Y$

- Plausible connection between s and sim:
  – s(x,y,z) iff sim (y,z;x,z) y is at least as similar to z as x (is to z)

refined NTA by refined BBR (3)

PM: the basic revision of $\underline{X}$ by R/S

- *Contraction* of $\underline{X}$ by R leads to $\underline{X \cup R}$: horizontally shaded area
- *Successive Expansion* of $\underline{X \cup R}$ by S leads to $\underline{(X \cup R) \cap S}$, in addition vertically shaded area.



Assuming $R \subseteq S$, $(X \cup R) \cap S = (X \cap S) \cup (R \cap S) = (X \cap S) \cup R$.

Note that if X and S do not overlap, the result is just $\underline{R}$, hence no explicit trace of $\underline{X}$ is left. Moreover, R is a very accidental set, depending on the so far performed experiments. Hence, $\underline{R}$ can hardly be seen as a lawlike theory.

To solve these inconveniences, I borrow the idea of Grove to postulate nested spheres around X, satisfying a number of conditions, notably, that X is the smallest and U the largest sphere.

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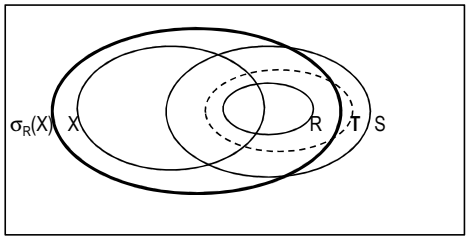
*refined NTA by refined BBR (4)

Let $\sigma_R(X)$ indicate the smallest sphere around X covering R and define *refined contraction* of $\underline{X}$ by R as the corresponding (exclusion) theory $\underline{\sigma_R(X)}$.*

Since $\sigma_R(X)$ is a superset of X and R, $\underline{\sigma_R(X)}$ is a further weakening of $\underline{X}$ than resulting from basic contraction, viz. $\underline{X \cup R}$, i.e. it drops still more b-claims. In terms of the domains: $c\sigma_R(X) \subset c(X \cup R) \subset cX$

NB: a 'sphere-less' alternative could be to use the 'convex (closure of the) union' of X and R



As in standard B(B)R, I do not see a reason to change the definition of (successive) *expansion* by S, leading to $\underline{\sigma_R(X) \cap S}$, hence with a larger domain, viz. $c[\sigma_R(X) \cap S]$

In view of this it is plausible to define *refined revision* of $\underline{X}$ by R/S, in Levi-order, as first refined contraction of $\underline{X}$ by R, leading to $\underline{\sigma_R(X)}$, followed by expansion by S, leading to $\underline{\sigma_R(X) \cap S}$.

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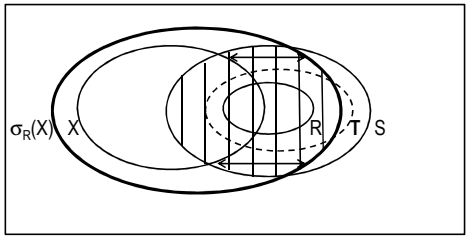
*refined NTA by refined BBR (5)

- *Refined Contraction* of $\underline{X}$ by R leads to $\underline{\sigma_R(X)}$, the bold ellipse
- *Successive Expansion* of $\underline{\sigma_R(X)}$ by S then leads to $\underline{\sigma_R(X) \cap S}$, vertically shaded area.
- Again it is easily seen that $\underline{\sigma_R(X) \cap S}$ is *maximally successful*, that is, $(R \subseteq \underline{\sigma_R(X) \cap S} \subseteq S)$



- But now it is not automatically *at least as close to the truth* as theory $\underline{X}$, for it may well exclude more than desirable, indicated by double arrows
- However, assuming R–X and/or S–X are non-empty, it is easily provable to be *more successful* and hence, due to the Refined Success Theorem, *potentially closer to the truth*

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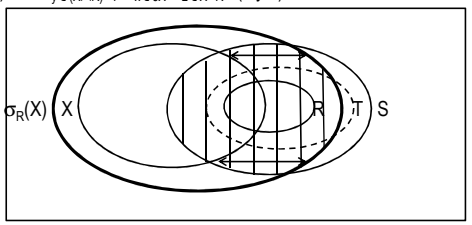
refined NTA by refined BBR (6)

- *Proof* (ir-sf) $\forall_{x \in cX} \forall_{z \in cS}\ r(x,z) \rightarrow \exists_{y \in cY}\ s(x,y,z)$ & $AC(\underline{X})$–$AC(\underline{Y})=\varnothing$

  $\forall_{x \in (Y \cap S)-X} \forall_{z \in cS}\ r(x,z) \rightarrow \exists_{y \in cY}\ s(x,y,z)$ & $(cX \cap cS)$–$(cY \cap cS) = \varnothing$ & $c(XUS)$-$c(YUS) = \varnothing$

  trivial for $cS \subseteq cY$ and $\forall_u \forall_v s(u,v,v)$ & trivial for $XUS \supseteq YUS = S$

  (iir-sf) $\forall_{y \in (X \cap R)-Y} \exists_{x \in cX} \exists_{z \in X-R}\ s(x,y,z)$ trivial, for $(X \cap R)-Y = \varnothing$



- This completes the one-sided, exclusion story

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*Section 6: Summary and prospects
Two one-sided kinds and one two-sided kind of EP/NTA/BBR

1a) EP and TA by exclusion, i.p. suitable for nomic and monadic interpretation:

- roughly: more rightly excluded items and less wrongly excluded items
- also: more true consequences and less 'strongly false' consequences
- content-approach (Zwart, 2001)
- refinement conceptually complicated
- allows (basic) TA by (basic) belief revision, and refinement is plausible

"Complementing' the exclusion story leads to the inclusion story

1b) EP and TA by inclusion, also suitable for nomic and monadic interpretation:

- model (building) approach or likeness approach (Zwart, 2001)
- roughly: more rightly included items and less wrongly included items
- basic kind essentially obtainable by mirroring 'exclusion' in terms of appropriate complements
- refinement is conceptually plausible
- allows (basic) TA by (basic) belief revision, refinement is conceptually complicated

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*Two one-sided kinds and one two-sided kind of EP/NTA/BBR

2) Two-sided EP and TA: the combination, amounting to the so-called conjunctive approach, of Cevolani, G., Crupi, V., Festa, R., (2011), "Verisimilitude and Belief Change for Conjunctive Theories", Erkenntnis, 75.2.

- i.p. suitable for the propositional and the dichotomic interpretation, notably actual truth, resp. (non-) equilibrium, i.e. interpretations with symmetric data
- roughly: more correctly excluded and more correctly included items
  (= less incorrectly excluded and less incorrectly included items)
- allows (basic) TA by (basic) belief revision
- refinement of both fairly plausible

Question 1: how are the two one-sided approaches related to (nomic) intuitions of philosophers of science and of scientists?

Question 2: what about a mixed two-sided nomic approach: combining basic exclusion with refined inclusion?

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