The return of a demarcation problem:
A novel approach to rehabilitating and extending demarcation criteria by adopting a temporal logic

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Purpose

- My focus is on Sir Karl Popper's criterion of demarcation, a special instance of Ayer and Carnap's criteria.
  - In the first half, I set out a general overview of Popper's two criteria.
    - One criterion operates on the level of *systems of statements*.
    - The other criterion operates on the level of *individual statements* within the system.
    - I explain why Popper's criteria are preferable to Ayer and Carnap's.
  - In the second half (if time allowing), I improve Popper's criteria.

Two main theses

- Popper's criterion bypasses objections that assume a criterion of demarcation will include *isolated existential statements*, specifically problems of irrelevant conjunction and disjunction.
  - In sum, an apparent 'bug' is an unrecognised *feature*.
- Popper's criterion must integrate an objection raised by John Wisdom:
  - Some systems of statements are *prima facie* empirically significant (or at least empirically determinable), yet no member of the system satisfies the criterion for sentences.
  - One solution: synthetic statements may fall into one of three categories, dependent on its surrounding theoretical system: (1) empirically significant, (2) indeterminate or (3) empirically non-significant.

Alonzo Church killed the demarcationist project

- The received view: Church (and others) helped slay the demarcationist beast.
- Ayer's *criterion of prediction*: a statement is empirical *iff* 'some [observation sentence] can be deduced from it in conjunction with certain other premises without being deducible from those other premises alone'(Ayer 1946, 38-39).
  - However, is no restriction put on the 'certain other premises', therefore it includes every non-analytic sentence (Lewis 1988a).
- Ayer's *criterion of verification* fares no better: it is either trivial (all contingent statements are empirically significant) or reduces to his predictive criterion.
  - As Church (1949) showed, so long as there are three logically independent statements, *every sentence or its negation* is indirectly verifiable.

David Lewis' conclusion

- These consequences lead Lewis to claim that this will result in a 'puncture-and-patch industry' (1988b): amendments with...

  'ever-increasing complexity and ever-diminishing contact with any intuitive idea of what it means for a statement to be empirical. Even if some page-long descendent of Ayer's criterion [admitted] more than the observation-statements and less than all the statements, we would be none the wiser' (*ibid.*, 127)

Popper's two criteria

- There is another approach: Popper's two criteria: one for *systems of sentences* and one for *individual sentences.*
  - *Empirically significant theoretical systems* must be *falsifiable*: the theoretical system must contradict a possible synthetic basic statement.
    - This is a limiting case of Ayer and Carnap's criteria of confirmation/partial confirmation and verification/partial verification.
  - *Empirically significant sentences* must be *B-predictable*: a synthetic basic statement must be derivable from the sentence not present in the theoretical system alone.
    - Popper's criterion of *B*-predictability is also a limiting case of Ayer and Carnap's criteria of predictability.

Preliminaries

- Some synthetic sentences are uncontroversially empirically significant (*basic*); other synthetic sentences are presently controversial (*auxiliary*).
- Meaning postulates Π (Lutz 2015) provide the necessary tools for derivation of basic sentences from auxiliary sentences. They are treated as *analytically basic* (Hempel 1951, 71-72; Carnap 1956).

Basic statements (*B*-statements) under Popper

- A basic statement (*B-statement*) (Lutz 2012) is a statement that every member of an epistemic community would assent to through observation (Analogous to Hempel's (1966) and Quine's (1960) approaches).
  - '[I]t is a basis that is *not firm.* ... Our observational experiences are never beyond being tested; and they are impregnated with theories' (Popper 1959, addendum, 1972, 94).
- It is *uncontroversially treated as* empirically significant.
- A *B-statement* is empirically significant if it specifies the existence or nonexistence of an intersubjectively agreeable entity at a particular spatio-temporal location *k*.

Analogies to Hempel and Quine

- Any assent is relative to a time and theoretical background of an epistemic community.
- *B*-sentences can only be assented to by accepting a corresponding *auxiliary system* (*A-system*): 'Every description uses *universal* names (or symbols, or ideas); every statement has the character of a theory, of a hypothesis' (Popper 1959, 94-95).
  - The acceptance of corresponding *A*-system is necessary in order for an epistemic community to accept a *B*-statement.
- What of the criterion of falsifiability?

Auxiliary systems (*A*-systems) and falsifiability

- *Auxiliary systems* (*A-systems*) are sets of auxiliary statements (*A-statements*) and *B*-statements.
  - In virtue of being an *A*-system, not all members of the set are are reducible to *B*-statements (Popper 1959, 256).
  - Using Lutz's (2012) formalism, we have the following…

- An *A-system* is *falsifiable* in *L* iff

$$A \cup B \cup \Pi \vDash \bot.$$

- Textual evidence for this interpretation is extensive: '… we can indeed falsify only *systems of theories*' (Popper 1983, 187; cf. 1959, 18).
- '[Falsifiability] applies to *theoretical systems* rather than to statements picked out from the context of a theoretical system' (1983, 178).

Dummett

- Michael Dummett (1976 124-126) recognised this key feature of *B*-predictability:
  - 'The fundamental notion for the account of the linguistic act of assertion [of *B*-sentences] is, thus, that of the *incorrectness* of the assertion... By making an assertion, a speaker rules out certain possibilities; if the assertion is unambiguous, it must be clear which states of affairs he is ruling out and which he is not... we know [a theoretical system is falsifiable] when we know how to recognize that it has been falsified'.
  - Sadly, Dummett concludes in a footnote that he does 'not feel at all sure that this approach is correct' and (as far as I know) does not pursue it.

Bypassing the Duhem problem

- Popper notes: 'there is no routine procedure, no automatic mechanism, for solving the problem of attributing the falsification to any particular part of a system of theories' (1983, 189).
  - There is no problem of distribution of blame, so no Duhem problem.
- Is there a satisfactory rule to determine if a *synthetic auxiliary statement* entails a *synthetic basic statement*?
- A satisfactory rule solves one tacking problem (the problem of irrelevant conjunction).

The second criterion of demarcation

	Auxiliary	Basic
Analytic	• If there are no meaning postulates to reduce to analytically true basic sentences or contradictory sentences, presently meaningless (hence: empirically non-significant).	• If meaning postulates, analytic, or contradictory sentences, treated as empirically non-significant.
Synthetic	• *Which* sentences are empirically significant and *why*?	• Uncontroversially empirically significant

The criterion of *B*-predictability

Popper (1959, 65-66; cf, 95) says that in order to be *B*-predictive:

> '... the theory [must] allow us to deduce, roughly speaking, more empirical singular statements than we can deduce from the initial conditions alone. ... A theory is to be called [*B*-predictive] if it divides the class of all possible basic statements unambiguously into the follow two non-empty subclasses. First, the class of all those basic statements with which it is inconsistent (or which it rules out, or prohibits): we call the the class of the *potential falsifiers* of the theory; and secondly, the class of those basic statement which it does not contradict (or which it "permits").

Empirical significance of auxiliary statements

- Following Lutz's (2012) formalism, an auxiliary statement (*A-statement*) α is *B-predictive* in *L iff* for any set {*B*} of *B*-statements, any set {*A*} of an *A*-system and for any *B*-statement β,

$$\{A\} \cup \{B\} \cup \alpha \cup \Pi \vDash \beta$$
$$\{A\} \cup \{B\} \cup \Pi \nvDash \beta$$
$$\alpha \cup \Pi \nvDash \bot$$

- *A*-statements that do not entail any *B*-statements are empirically non-significant.
- *A*-statements that do entail at least one *B*-statement are empirically significant.

Quick summation

- The conjunction of the criteria of falsifiability and B-predictability are (so Popper thought) both necessary and sufficient to bypass the tacking problem:
  - It is possible to determine which members of a system are not empirically significant and which members of a system are empirically significant.
  - Since we are operating on the level of sentences rather than on the level of (Carnap's) theoretical frameworks, if an empirically non-significant statement should be appended, *what of it*?
    - Not analogous to Carnap's question of whether a theoretical system is 'cured' of infection (metaphysics).
    - Analogous to whether some cells within an 'organism' are alive (i.e. contains empirically significant content).

An aside: *B*-predictability is similar to Ayer's criterion

- Hempel (1965, 106) phrases the demarcation criterion as follows: 'a sentence S has empirical import if from S in conjunction with suitable subsidiary hypotheses it is possible to derive [B-statements] which are not derivable from the subsidiary hypotheses alone'.
  - ***N.B.*** Hempel is providing a gloss of *Ayer's* criterion of predictability.
  - Ayer's criterion, however, fails to specify which are 'suitable subsidiary hypotheses'.

Limited to two criteria: falsifiability and *B*-predictability

1. β_1 is necessarily a member of a falsifiable theoretical system in order to be *B*-predictive:
   a. Consequently, β_1 in conjunction with its negation, β_2, leads to a contradiction (and therefore β_1 is not an irrelevant conjunct).
2. β_1 is (trivially) *B*-predictive.

$$\{A\} \cup \beta_1 \cup \beta_2 \cup \Pi \vDash \bot$$
$$\{A\} \cup \beta_1 \cup \Pi \vDash \beta_1$$
$$\{A\} \cup \Pi \nvDash \beta_1$$
$$\beta_1 \nvDash \bot$$

Basic systems (*B*-systems)

- *B*-statements cannot be assented to in isolation (Popper 1959, §22).
  - There must be a corresponding *basic system* (*B-system*).
- A *B*-system describes a world-state localised in a particular space-time-region *k*.
- The *B*-system is itself *B*-predictive.
- The *B*-system includes a large number of *A*-statements. A matter of *degree* and specificity, not type.

$$\{A\} \cup \{B\} \cup \beta_1 \cup \Pi \vDash \bot$$
$$\{A\} \cup \{B\} \cup \beta_2 \cup \Pi \vDash \beta_2$$
$$\{A\} \cup \Pi \nvDash \beta_2$$
$$\{B\} \cup \Pi \nvDash \bot$$

A summary

- *A*-statements:
  - *B*-predictive
  - Necessarily members of an *A*-system
  - *A*-systems are falsifiable
- *B*-statements:
  - *B*-predictive
  - Necessarily conjoined with *B*-systems and *A*-systems
  - *B*-systems are falsifiable
- Meaning postulates Π link *B*-systems to *A*-systems

To recap

	Auxiliary	Basic
Analytic	Empirically non-significant	Empirically non-significant
Synthetic	Iff member of a falsifiable system and *B*-predictive, empirically significant Otherwise, 'metaphysical'	Iff member of a falsifiable system and *B*-predictive, empirically significant (*Isolated existential statements?*)

An objection from ill-fit

- But what of *isolated existential statements*? For example, 'There exists a unicorn', 'There exists atoms', 'There exists cats on mats'...
- They *appear to be* synthetic basic statements, but...
  - Are not *B*-predictive (no specified space-time region k).
  - If isolated, are not members of a *B*-system, and therefore not a member of a falsifiable system (although if a member of a *B*-system, may be a *logical consequence* of a *B*-statement).

What about isolated existential statements?

- Kneale (1974, 207): 'there is a strange departure from the ordinary use of words in … denying that [isolated] existential statements can ever deserve the… title [of empirical significance]. … Indeed, if the word "empirical" is to be applied at all to propositions… , there is a much better case for applying it to those which may be *established* empirically…'.
  - This is the *problem from ill-fit* faced by Carnap (related to Frege's *paradox of analysis*): any explication does not capture our intuitive concepts, thus the explication must be rejected.

Removing motivations for isolated existential statements.

- A conjecture: it isn't the verifiability/confirmability criteria *per se* that produces the problems that plagued Ayer and Carnap's criteria; it is the *inclusion* of isolated existential statements that leads to the problems of irrelevant disjunction and conjunction.
- We may think, like Carnap, that the negations of empirically significant sentences must *also* be empirically significant.
- Consequently, since isolated existential statements are the negations of universal statements, they are empirically significant.
  - Again, we are not dealing with Carnap's linguistic frameworks; we're categorising *sentences*, not *linguistic frameworks*.

Isolated existential statements are not *B*-predictive

- An existential statement is *B*-predictive only insofar as it is a member of the consequence class of a falsifiable system (Popper 1983, 185; 1974, 1038).
- If isolated existential statements *are* a logical consequence of a falsifiable system, still *not B*-predictive, for its inclusion makes no predictions about a spatio-temporal region *k* (*ibid.* 1983, 161).
- Popper (*ibid.* 48) concludes: 'On the basis of the criterion of demarcation... I shall therefore have to treat strictly existential statements as non-empirical'.

Reasons for rejecting isolated existential statements

- Isolated existential statements are necessarily consistent with any and all possible B-statements, both existential and non-existence statements.
  - The acceptance of the B-statement, 'There does not exist an X at spatio-temporal locations k_1, k_2, ..., k_n' does not entail the rejection of 'There exists an X'.
- Isolated existential statements that are inconsistent with one another are also consistent with any and all possible B-statements:
  - For example, 'There exists at most one tree on Mars that bears only red fruit' versus 'There exists at most one tree on Mars that bears only green fruit'.
- These features are shared with paradigmatic metaphysical theories, such as the multiple versions of idealism and materialism.

John Wisdom's criticism

- As a consequence, John Wisdom (1963; 1968) notes there may exist an *A*-statement that is not *B*-predictive, yet nevertheless says something that is *empirically decidable*: an *A*-statement may be falsified by an *A*-system (1963, 306).
- Wisdom: 'empirical theories are, in Popper's manner, observation-refutable [*B*-predictive]; certain others may be theory-refutable'. (1968, 66)
- *Empirical decidability* is (presumably) weaker than Popper's criteria of falsifiability and *B*-predictability: the statement is, in a sense, *A*-predictive (contradicts an *A*-system), but *not B*-predictive.
- But isolated existential statements are (presumably) empirically decidable!
- A question: are empirically decidable statements *also* empirically significant?

An example from astronomy

- Take the theory T_1: 'All planets are in an epicycloid orbit'.
- Present astronomical theory entails T_2: 'All planets are in an elliptical orbit'.
  - Consequently, $T_1 \cup T_2 \cup \Pi \models \bot$
- T_1 and suitable auxiliary hypotheses entail E: 'There exists a planet in an epicycloid orbit'.
  - Thus, $E \cup T_2 \cup \Pi \models \bot$
- Therefore, at least one isolated existential statement is empirically decidable.
- If we are to include theories that are empirically decidable, how can we exclude isolated existential statements that are empirically decidable?

Indexed to the epistemic community

- Wisdom alludes to a solution: 'one can't tell *a priori* that [an *A*-system] is irrefutable as a rule... you have to have considerable inspiration to find a method of testing [an *A*-statement] at all, and until you have found one you may think it is untestable and irrefutable, until some method of testing turns up'.
- Consider: the *apparently* metaphysical theory of Humean supervenience was empirically significant *all along:* some interpretations of QM entail nonlocality, which is at odds with Humean supervenience.
  - Therefore Humean supervenience turns out to be *B*-predictive.
- Consider: the eventual transformation of Ancient Greek Atomism into modern-day atomic theory through the addition of auxiliary statements.

Indexing

- Satisfaction of both criteria of falsifiability and B-predictability are indexed to a community's current epistemic predicament: both are constrained by their present imaginative, technological and physical limitations.
- For example, φ will be empirically significant *if...*

$$\varphi \cup \psi \cup \beta_1 \cup \Pi \vDash \bot$$

$$\mathbf{F}[(\varphi \cup \psi \cup \Pi \vDash \beta_2) \cup (\psi \cup \Pi \nvDash \beta_2)]$$

$$\varphi \cup \psi \cup \Pi \nvDash \bot$$

$$\varphi \cup \Pi \nvDash \bot$$

One approach: intuitionist logics

- Lutnley (1988) and Milne (1991) propose reasons to adopt a Brouwerian logic similar to Dummett's reasons.
- But it can also be done with a temporal logic:
  - Popper said, 'a hypothesis can only be empirically *tested* --and only *after* it has been advanced'.
  - A different view: an *A*-statement can only be empirically *significant* only *after* it has been advanced, it is *B*-predictive, and belongs to a theoretical system.

Another approach: temporal logic

- We use a form of temporal logic:
  - A statement is *empirically significant* so long as the conditions for *B*-predictability have been advanced.
  - A statement is *possibly empirically significant* if the condition of *B*-predictability has not been advanced and it is *logically possible* for the condition to be advanced at some future time.
  - Consequently, isolated existential statements, analytic statements and contradictory statements are empirically non-significant, for it is not possible to advance a condition of *B*-predictability.

Another possible (modal) approach

1. If S presently knows P is a member of a falsifiable system and P is B-predictive, S knows P is empirically significant.
2. If S knows P is possibly B-predictive, S knows P is possibly empirically significant.
3. If S presently knows P is not possibly B-predictive, S knows P is and will always be empirically non-significant.

Thank you for your time.

Copy of slides and additional information are available at:

http://nathanoseroff.blogspot.co.uk

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