Accounting for Scientific Progress

- Administrative:
  - All papers due December 18th 9am *absolute* latest —grades due at noon on the 18th!
  - I will be available every day between now and the 18th ...
  - Please try to turn in drafts of final papers next week ...
- Why Truth or Probability of Truth Will not do the Job
  - Is truth an *achievable* goal (all our theories have been false)?
  - How can one (*known*) false theory be "better than" another?
- Enter Verisimilitude (Closeness to the Truth)
  - Why truth/logic based accounts will not work.
  - Toward of a Statistical Account of Verisimilitude
  - Advantages of a Statistical Approach to Verisimilitude

Re-Cap from Last Time

- Scientific Realism is a two-part thesis:
  1. Science aims to give us, in its theories, (perhaps, *inter alia*) a literally true story of what the world is like.
  2. Acceptance of a scientific theory involves the belief that it is true.
- Van Fraassen's *Constructive Empiricist* account says science aims to give us theories which have *true empirical models*, and acceptance of a theory is belief that the empirical models of the theory are true.
- One alternative (*naïve Bayesianism*) says that science aims to give us the *most probably true* theories possible, and that acceptance of a theory involves judging it to be most probable (among alternatives).
- A *Verisimilitude* approach says science aims to give us theories which are as *close to the truth* as possible, and that acceptance of a theory involves judging it to be closest to the truth (among alternatives).
- I will argue that Verisimilitude approaches are the most promising ...

Challenges to Scientific Realism

- *Is truth an **achievable** goal?*
  - Are we *capable* of constructing *literally true* theories of the way the world is? All of our past-best scientific theories have turned out to be false, and there is every reason to think that our current best theories are also false (and will be superseded by another theory).
  - Even if we were *capable*, could we ever be in a position to *know* that we had *succeeded*? Thus, should we think that our currently accepted theories are *literally true*? Won't future science do *better*? [I think we *can* know one model is *closer to the truth* than another.]
- *Does truth provide a metric of **partial** success?* When we say Newton's theory is "better than" Kepler's, we do *not* mean that Newton's is true and Kepler's is false — they are *both* false! [*Probability of truth could* play this role, but *does it*? Do we really think Copernicus' model is *more probably true* than Ptolemy's?]

Moving Constructive Empiricism Will Not Help

- VF's Constructive Empiricism still maintains that the goal of science is *truth*. Granted, it is now only truth of the *empirical models* of our theories, but it is *still truth* nonetheless. Same old problems remain ...
- The reason we know Copernican and Ptolemaic theories of planetary motion are false, is that we know their *empirical models* are false!
- Thus, how can we say that one false empirical model is "better than" another, if the arbiter of "goodness" is their *truth*?
- Also, how can we now say (knowing everything that we do) that the Copernican (empirical) models are *more probably true* than the Ptolemaic models? After all, we *know* (as certainly as we can know anything in science) that both sets of empirical models are *false*!
- So, even a Bayesian version of Constructive Empiricism will not be able to explain the progression of scientific theories, which we all agree proceeds through one *empirically* false theory after another ...

What We Want From an Account of Scientific Progress

- We need (at least) the following things:
  1. Our account must be able to handle historical cases like Copernicus and Ptolemy. We must be able to say that one empirically false theory can be "better than" another empirically false theory. And, these judgments should match-up with our clear intuition.
  2. Our account should *not* render judgments which are *language variant*. That is, our judgments of progress should not depend on the *language* in which the theories and models are expressed.
  3. Our account pf progress should be *epistemologically accessible* to us. That is, we will need a story about how we can come to know (or have reliable beliefs that) progress is being (or has been) made.
  4. Our account must not appeal to anything "deeply metaphysical" which an empiricist may not want to accept (*i.e.*, it should not depend on anything which transcends *possible* experimental results).

Enter Verisimilitude — Popper's *Semantical* Logical Theory

- Karl Popper, once a staunch scientific realist, eventually realized that truth (or probability of truth) will not found an account of scientific progress. For this reason, he moved to a *verisimilitude* account.
- Verisimilitude is "closeness to the truth." Popper wanted a measure of "closeness to the truth" based solely on the notions of logic, and good-old-fashioned *truth*. Popper's logical proposal was as follows:

(*) p is closer to the truth than q iff (i) p has all the true consequences that q has, (ii) q has all the false consequences that p has, and either (iii) p has some true consequences that q lacks, or (iv) q has some false consequences that p lacks.

- As it turns out, (*) has the consequence that *no false theory can be closer to the truth than any other false theory.* So, Popper's (semantical) logical theory of verisimilitude violates our desideratum #1. For a simple proof of this, see the lecture notes webpage.
- Other logical approaches were then tried by Popper's students ...

Syntactical Logical Approaches to Verisimilitude

- Pavel Tichý (a follower, and critic, of Popper) proposed a *syntactic* logical approach to verisimilitude which begins with a language $\mathcal{L}$ containing n basic sentences. Each complex sentence in $\mathcal{L}$ will be a conjunction of the basic sentences (or their negations).
- For instance, if $\mathcal{L}$ contains three basic sentences a, b, and c, then there will be eight propositions expressible in $\mathcal{L}$. These will be $a \,\&\, b \,\&\, c$, $a \,\&\, b \,\&\, {\sim}c$, ... , ${\sim}a \,\&\, {\sim}b \,\&\, {\sim}c$ (*i.e.*, 8 rows of truth-table for a, b, and c). Each of these eight conjunctions will be called a *constituent* of $\mathcal{L}$.
- Tichý defines the *distance from the truth* of a constituent $\delta(\cdot)$ as the number of false primitive sentences in the constituent. So, if the truth is $a \,\&\, b \,\&\, c$, then $\delta(a \,\&\, b \,\&\, {\sim}c) = 1$ and $\delta(a \,\&\, {\sim}b \,\&\, {\sim}c) = 2$, *etc.*
- $\delta(\cdot)$ is extended to arbitrary sentences $\mathfrak{s}$ of $\mathcal{L}$ as *the average distance from the truth of the constituents of the disjunctive normal form of* $\mathfrak{s}$.
- David Miller showed Tichý's definition is *language variant* ...

David Miller's Results About Determinism and Predictive Accuracy

- One can use Tichý's approach to measure the *predictive accuracy* of a *theory.* If we understand the *predictions* of a theory as its *logical consequences*, then a *theory's predictive accuracy* can be judged by "how far" the predictions of the theory are from what we observe.
- For reasons we have already seen, this kind of account will lead to a *language relative* account of the predictive accuracy of a theory.
- What Miller shows is that (1) if theories make predictions by *entailing* observations, and (2) if our observations are *veridical* (*i.e.*, that there are *no errors* in our observations), then (virtually) *any* account of predictive accuracy will *either* be language variant, *or* incapable of saying that one false theory is more predictively accurate than another.
- So, if deductivism (or determinism + no errors in observation) is assumed, then *no* theory of *empirical verisimilitude* (*i.e.*, predictive accuracy) can satisfy both of our desiderata #1 and #2!

Statistical **Accounts of Predictive Accuracy/Verisimilitude I**

- Think of all (empirical) data as being generated by a true *probability distribution* t. And, assume that we have obtained *approximating distributions* t' using our data. We can define a metric $\mu(t)$ of the *closeness* of an approximating distribution t to the true one t'.
- The simplest way to think of $\mu(t)$ is as the distance between two curves: the true curve t, and the approximating curve t'.
- The assumption that the data have some *stochastic* element is *not* (necessarily) a metaphysical assumption. This is plausible simply because there will always be *observational errors*.
- The assumption that the data contain some "noise" is *crucial* here — without it, we cannot get of the ground. This is because, in the absence of error (or stochasticity), we are back to *deductivism*, and we face Miller's Dilemma: either we'll be incapable of saying one false theory is closer to the truth than another, *or* our claims will be *language relative*.

Statistical **Accounts of Predictive Accuracy/Verisimilitude II**

- Now: take the goal of science to be to obtain the μ-closest approximations t' to t that it can, given its evidence and resources.
- This kind of stochastic or statistical verisimilitude approach has been championed by Forster and Sober in the last few years. [See my links to Forster's recent survey papers on the lectures webpage.]
- This has several advantages over other accounts:
  - μ does not have problems of traditional measures. It is *not* language variant, and it *can* say one false t' is closer to t than another.
  - There is a well-developed statistical theory which tells us how to *estimate* μ using *actual data* (there's an *epistemology* here!).
  - One can reconstruct historical examples (*e.g.*, Forster has done the Copernicus *vs* Ptolemy example, and others) using *actual historical data* — and estimates of μ give the right answers about progress.