What is Science?
What is Art?

Richard P. Gabriel

Bill Knott

Prefrontal lightningbolt too lazy to chew the sphinx's loudest eyelash
Not even if it shushes you with a mast of sneers
Down which grateful bankvault-doors scamper
Because of a doublejointedness that glows in the dark
Like a soliloquy of walnuts
Numbed by beaks of headless measuringtape
So the lubriciousness can tower in peace
Like a buzzsaw trapped in a perfumery of shrugs
Lemon
Or lime
Only a maze can remember your hair of buttered blowguns

—Nights of Naomi

Eric Allen et al

$$\Phi; \Delta; \Gamma \vdash \mathtt{x} \in \Gamma(\mathtt{x}) \text{ [GT-Var]} \qquad \frac{\Phi; \Delta \vdash \mathtt{T} \text{ ok} \quad \Phi; \Delta; \Gamma \vdash \mathtt{e} \in \mathtt{S}}{\Phi; \Delta; \Gamma \vdash \mathtt{(T)e} \in \mathtt{T}} \text{ [GT-Cast]}$$

$$\frac{\Phi \vdash \mathtt{T} \textit{ includes } \mathtt{init}(\overline{\mathtt{S}}) \quad \Phi; \Delta; \Gamma \vdash \overline{\mathtt{e}} \in \overline{\mathtt{S}} \quad \Phi; \Delta \vdash \mathtt{T} \text{ ok}}{\Phi; \Delta; \Gamma \vdash \mathtt{new\ T(}\overline{\mathtt{e}}\mathtt{)} \in \mathtt{T} \textit{ annotate } \mathtt{[}\overline{\mathtt{e}} :: \overline{\mathtt{S}}\mathtt{]}} \text{ [GT-New]}$$

$$\frac{\textit{fields}(\mathtt{N}) = \overline{\mathtt{T}}\ \overline{\mathtt{f}} \quad \Phi; \Delta; \Gamma \vdash \mathtt{e} \in \mathtt{T} \quad \Delta \vdash \mathtt{T} <: \mathtt{N} \quad \Delta \vdash \mathtt{P} <: \mathtt{N} \text{ and } \mathtt{f}_i \in \textit{fields}(\mathtt{P}) \text{ implies } \mathtt{P} = \mathtt{N}}{\Phi; \Delta; \Gamma \vdash \mathtt{e.f}_i \in \mathtt{T}_i \textit{ annotate } \mathtt{[e :: N]}} \text{ [GT-Field]}$$

$$\frac{\Phi; \Delta \vdash \overline{\mathtt{T}} \text{ ok} \quad \Phi; \Delta; \Gamma \vdash \mathtt{e}_0 \in \mathtt{T}_0 \quad \Phi; \Delta; \Gamma \vdash \overline{\mathtt{e}} \in \overline{\mathtt{R}} \quad \textit{mtype}(\mathtt{m}^{\mathtt{c}}\ \textit{bound}_{\Delta}(\mathtt{T}_0)) = \mathtt{P.<}\overline{\mathtt{X}}\ \mathtt{extends}\ \overline{\mathtt{N}}\ \mathtt{with}\ \overline{\P\mathtt{I}\diamond}\mathtt{>}\ \mathtt{S\ m(}\overline{\mathtt{U}}\ \overline{\mathtt{x}}\mathtt{)} \quad \Delta \vdash \overline{\mathtt{T}} <: [\overline{\mathtt{X}} \mapsto \overline{\mathtt{T}}]\overline{\mathtt{N}} \quad \Phi \vdash \overline{\mathtt{T}} \textit{ includes } [\overline{\mathtt{X}} \mapsto \overline{\mathtt{T}}]\overline{\P\mathtt{I}\diamond} \quad \Delta \vdash \overline{\mathtt{R}} <: [\overline{\mathtt{X}} \mapsto \overline{\mathtt{T}}]\overline{\mathtt{U}}}{\Phi; \Delta; \Gamma \vdash \mathtt{e}_0\mathtt{.m<}\overline{\mathtt{T}}\mathtt{>(}\overline{\mathtt{e}}\mathtt{)} \in [\overline{\mathtt{X}} \mapsto \overline{\mathtt{T}}]\mathtt{S} \textit{ annotate } \mathtt{[e}_0 \in \mathtt{P]}} \text{ [GT-Invk]}$$

$$\frac{\Delta \vdash \overline{\mathtt{R}} <: \overline{\mathtt{S}} \quad \Phi; \Delta \vdash \mathtt{T} \text{ ok} \quad \Phi; \Delta \vdash \overline{\mathtt{S}} \text{ ok} \quad \Phi \vdash \mathtt{T} \textit{ includes } \mathtt{init}(\overline{\mathtt{S}}) \quad \Phi; \Delta; \Gamma \vdash \overline{\mathtt{e}} \in \overline{\mathtt{R}}}{\Phi; \Delta; \Gamma \vdash \mathtt{new\ T(}\overline{\mathtt{e}} :: \overline{\mathtt{S}}\mathtt{)} \in \mathtt{T}} \text{ [GT-Ann-New]}$$

$$\frac{\textit{fields}(\mathtt{N}) = \overline{\mathtt{T}}\ \overline{\mathtt{f}} \quad \Phi; \Delta \vdash \mathtt{N} \text{ ok} \quad \Phi; \Delta; \Gamma \vdash \mathtt{e} \in \mathtt{T} \quad \Delta \vdash \mathtt{T} <: \mathtt{N}}{\Phi; \Delta; \Gamma \vdash \mathtt{[e :: N].f}_i \in \mathtt{T}_i} \text{ [GT-Ann-Field]}$$

$$\frac{\Phi; \Delta \vdash \overline{\mathtt{T}} \text{ ok} \quad \Phi; \Delta; \Gamma \vdash \mathtt{e}_0 \in \mathtt{T}_0 \quad \Phi; \Delta; \Gamma \vdash \overline{\mathtt{e}} \in \overline{\mathtt{R}} \quad \textit{mtype}(\mathtt{m}^{\mathtt{c}}\ \mathtt{O}) = \mathtt{P.<}\overline{\mathtt{X}}\ \mathtt{extends}\ \overline{\mathtt{N}}\ \mathtt{with}\ \overline{\P\mathtt{I}\diamond}\mathtt{>}\ \mathtt{S\ m(}\overline{\mathtt{U}}\ \overline{\mathtt{x}}\mathtt{)} \quad \Delta \vdash \overline{\mathtt{T}} <: [\overline{\mathtt{X}} \mapsto \overline{\mathtt{T}}]\overline{\mathtt{N}} \quad \Phi \vdash \overline{\mathtt{T}} \textit{ includes } [\overline{\mathtt{X}} \mapsto \overline{\mathtt{T}}]\overline{\P\mathtt{I}\diamond} \quad \Delta \vdash \overline{\mathtt{R}} <: [\overline{\mathtt{X}} \mapsto \overline{\mathtt{T}}]\overline{\mathtt{U}}}{\Phi; \Delta; \Gamma \vdash \mathtt{[e}_0 \circ \mathtt{O].m<}\overline{\mathtt{T}}\mathtt{>(}\overline{\mathtt{e}}\mathtt{)} \in [\overline{\mathtt{X}} \mapsto \overline{\mathtt{T}}]\mathtt{S}} \text{ [GT-Ann-Invk]}$$

Imre Lakatos

- Demarcation problem: When is one theory better than another, where science is at one end of the scale and pseudoscience at the other.
- Positivism, elitist authoritarianism, epistemological anarchism, inductivism, conventionalism, falsification, research programmes

Positivism

- Positivism: "the view that serious scientific inquiry should not search for ultimate causes deriving from some outside source but must confine itself to the study of relations existing between facts which are directly accessible to observation"

  —Wikipedia

- Logical positivism: "Philosophy should provide strict criteria for judging sentences true, false and meaningless."

  —Wikipedia

Élitist Authoritarianism

- The idea that the demarcation problem is for a jury of accepted scientists to judge which work is scientific and which isn't
- OOPSLA and all scientific disciplines operate this way
- Peer review

Epistemological Anarchism

- There are no demarcation lines.
- There is no such thing as progress, only fashion.
- Anything goes.
- Science as propaganda.

Inductivism

- A statement is scientific only if it is provable from facts.
- Need to go from a fact (this is a computer) to a proposition ("This is a computer").
- Need to show that something that is true in a particular set of spaces and times (all objects attract each other according to an inverse square law) is true everywhere, all the time.
- Probablism: A statement is scientific only if it can be shown to be probable (and therefore one scientific theory is "better" than another if it is more probable)
- Because the universe is large, most probabilities are small.

Conventionalism

- The idea that a scientific theory is a convention or a means people agree to in order to make certain calculations.
- Ptolemaic crystal spheres provide an accurate predictive framework.
- Clumsy conventions (Ptolemy) are replaced by simpler ones (Copernicus)
- Is quantum mechanics a form of conventionalism?

Falsification

- A statement is scientific if an experiment can be stated that could falsify it.
- Suppose a statement requires a measurement made by an instrument to be falsified.
  - There needs to be a theory of how the instrument works and what it measures (conventionalism).
  - If the instrument provides a reason to throw out the statement, then there needs to be a analysis of whether there are potential disturbing factors (ceteris paribus).
- At any given time, every theory has numerous "anomalies" that are considered either the result of "disturbing factors" or things to be cleared up later.

Research Programmes

- A research programme is a series of "progressive" theories; a theory is progressive (over the last) when:
  - it leads to new predictions
  - none of its bold predictions are falsified
  - it is not "patched" by ad hoc statements, but instead retains its hard core and adjusts its protective belt

Bruno Latour

- Scientific "fact" is determined by a jury (Boyle)
- Science is constructed in a laboratory

Explore; Discover; Understand

- Exploration: "some combination of premeditated searching and undisciplined, perhaps only partly conscious, rambling." Defocused attention; flat associative hierarchies.

  Exploration is assertive action in the face of uncertain assumptions, often involving false starts, missteps, and surprises.

- Discovery: "a reckless encounter with the unexpected." Focus; concentration; persistence.

  "If we persist [in exploration], we discover."

—Maps of the Imagination

Explore; Discover; Understand

- Understand: Only after discovery can the work be properly structured, can the selection and organization of the significant moments of time take place.

  "If we attempt to map the world of a story before we explore it, we are likely either to (a) prematurely limit our exploration, so as to reduce the amount of material we need to consider, or (b) explore at length but, recognizing the impossibility of taking note of everything, and having no sound basis for choosing what to include, arbitrarily omit entire realms of information. The opportunities are overwhelming."

  —Maps of the Imagination

Art

ARTISTIC CREATION is a voyage into the unknown. In our own eyes, we are off the map. The excitement of potential discovery is accompanied by anxiety, despair, caution, perhaps, perhaps boldness, and, always, the risk of failure. Failure can take the form of our becoming hopelessly lost, or pointlessly lost, or not finding what we came for (though that last is sometimes happily accompanied by the discovery of something we didn't anticipate, couldn't even imagine before we found it). We strike out for what we believe to be uncharted waters, only to find ourselves sailing in someone else's bathtub. Those are the days it seems there is nothing new to discover but the limitations of our own experience and understanding.

—Maps of the Imagination

Art

Some of the oldest stories we know, including creation myths, were attempts to make sense of the world. Those early storytellers invented answers to the mysteries all around them. Why does the rain come? Why does it stop? If a child is created by two adults, from where did the first two adults originate? What is the earth like beyond what we have seen, and beyond what the people we know have seen? What lies beyond the stars?

—Maps of the Imagination

Art

Having "the technique"—the means, or ability, to get from here to there—is always, and has always been, the issue. The need to find methods of expression led to speech, to drawing, to maps ("Here's how you get there"), and to writing. The artist is always developing and refining the techniques he uses to convey his vision, his discoveries. This ongoing development often involves the guide himself being guided; and so we have a long tradition of artists referring to divine intervention, the muses, great artists of the past, and teachers. Odysseus's long journey home, assisted by trustworthy characters, bedeviled by others, mirrors a writer's frustration and exhilaration. Every artist is in conversation with his or her own practice, peers, and predecessors.

—Maps of the Imagination

Art

"Sometimes it's very tempting to be satisfied with what's easy, particularly if people tell you it's good.... What's essential is to work without any preconception whatever, without knowing in advance what the picture is going to look like.... It is very, very important to avoid all preconception, to try to see only what exists ... to translate one's sensation."

—James Lord agreed to pose for Alberto Giacometti for one afternoon, for a sketch. The sketch became a painting, and the session went on for eighteen days.

Art

Writing offers the Scylla and Charybdis of Authority and Humility. It requires us to assume authority over our creations, to assert our knowledge and talent; yet it also requires humility, a recognition that there is always more to learn. Danger looms at either extreme. While it may be good for the soul, living in a constant state of humility can lead to a refusal to take responsibility for the work or to pursue fully one's ambitions. Constantly asserting authority can lead to being far too sure of oneself, to the detriment of true discovery. Our task is not to avoid the two entirely, but to steer between them, making the most of the currents they create.

—Maps of the Imagination

Robust Yet Fragile Systems

Through design and evolution, HOT [Highly Optimized Tolerance] *systems achieve rare structured states which are robust to perturbations they were designed to handle, yet fragile to unexpected perturbations and design flaws. As the sophistication of these systems is increased, engineers encounter a series of tradeoffs between greater productivity or throughput and the possibility of catastrophic failure. Such robustness tradeoffs are central properties of the complex systems which arise in biology and engineering.*

—"Highly Optimized Tolerance: Robustness and Design in Complex Systems,"
J. M. Carlson & John Doyle

Science?

Then the scientist-homeostat could be seen as open-endedly searching through spaces of the material performativity of its environment, which itself open-endedly and unpredictably unfolds, with the final stable state of the four-homeostat assemblage appearing as the emergent joint product of open-ended trial and error through states of both the scientist and the environment.

—"CYBERNETICS AND THE MANGLE: ASHBY, BEER AND PASK," Andrew Pickering