

A discussion on the paper “Strong inference” by Platt

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A quarrel on Biophysics

"The problems of how enzymes are induced, of how proteins are synthesized, of how antibodies are formed, are closer to solution than is generally believed. If you do stupid experiments, and finish one a year, it can take 50 years. But if you stop for a little while and think how proteins can possibly be synthesized, there are only about 5 different ways, not 50! And it will take only a few experiments to distinguish these."

Leo Szilard



"I was not quarreling with third-rate scientists; I was quarreling with first-rate scientists."

"Well, there are two kinds of biologists, those who are looking to see if there is one thing that can be understood, and those who keep saying it is very complicated and that nothing can be understood. . . . You must study the simplest system you think has the properties you are interested in."

"It is essentially the old question: How small and elegant an experiment can you perform?"

Opponent A

"No two cells give the same properties. Biology is the science of heterogeneous systems."

Opponent B

"You know there are scientists; and there are people in science who are just working with these oversimplified model systems-DNA chains and in vitro systems-who are not doing science at all. We need their auxiliary work: they build apparatus, they make minor studies, but they are not scientists."

"What does Szilard expect me to do shoot myself?"

The core of Leo Szilard's point of view

Think before do experiments

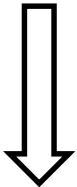
Simplified model system

“Hardly a month goes by without a stunning success in molecular biology being reported in the Proceedings of the National Academy of Sciences.”

-----Alvin Weinberg (1964)

Background

Scientists tend to keep up a polite fiction that all science is equal.
Actually, some fields of science are moving forward faster than others.



Reasons

a. the tractability of the subject

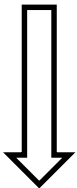
b. the quality of researchers

c. the size of research contracts

Important but
inadequate

The primary
factor

d. Lack of the particular method
of doing scientific research



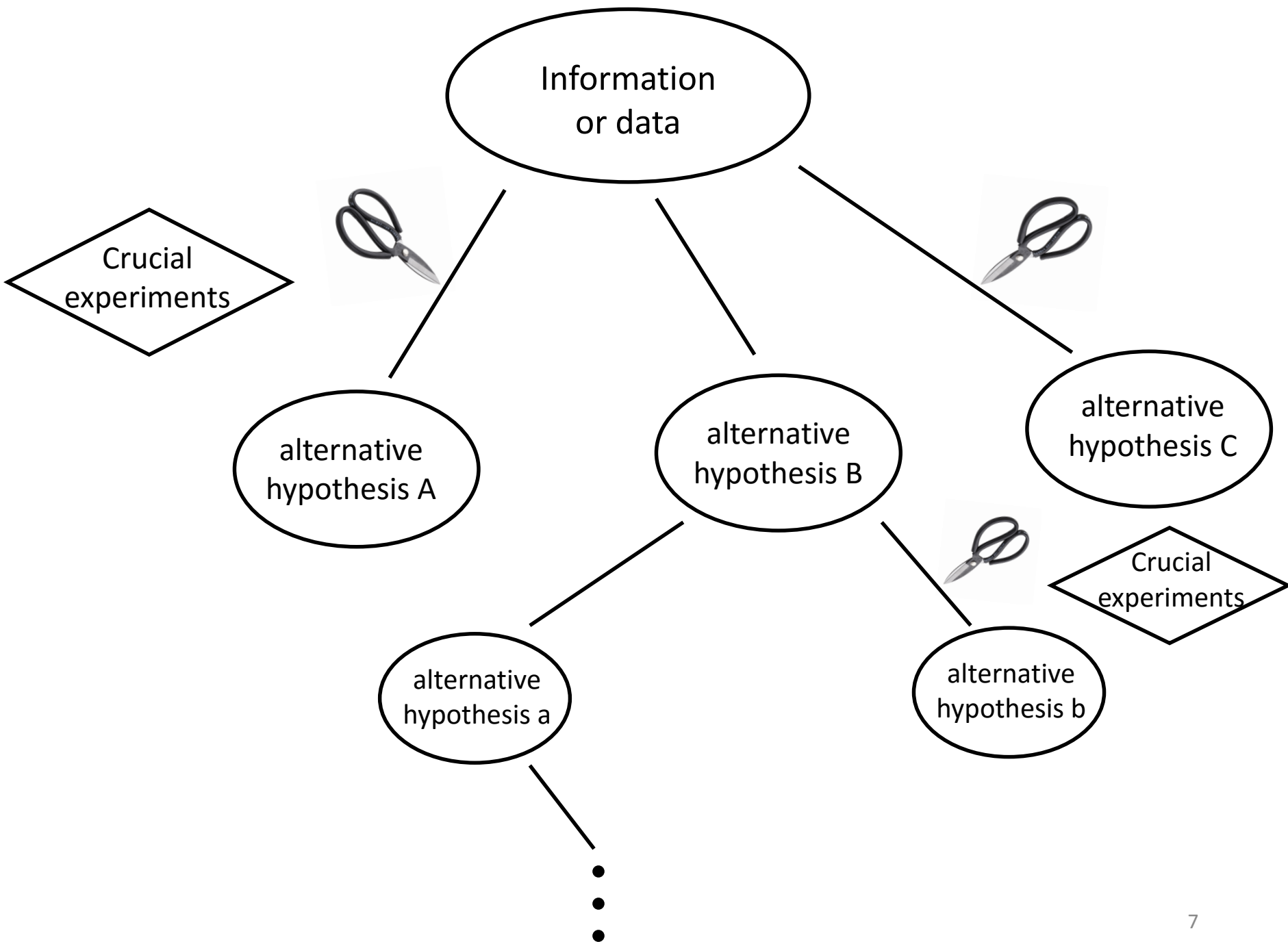
Solution

an accumulative method of inductive inference:

Strong inference

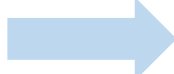
The main steps of Strong Inference

- 1) Devising **alternative hypotheses**;
- 2) Devising a **crucial experiment** (or several of them), with alternative possible outcomes, each of which will, as nearly as possible, **exclude** one or more of the hypotheses;
- 3) Carrying out the experiment so as to get a clean result;
- 4) Recycling the procedure, making subhypotheses or sequential hypotheses to refine the possibilities that remain; and so on.

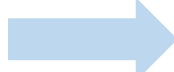


*Note
of SI*

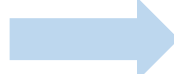
It is no faster method for exploring the unknown

 **Importance**

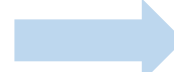
Any conclusion that is not an exclusion is insecure and must be rechecked

 **Integrity**

Induction inference VS Detection inference

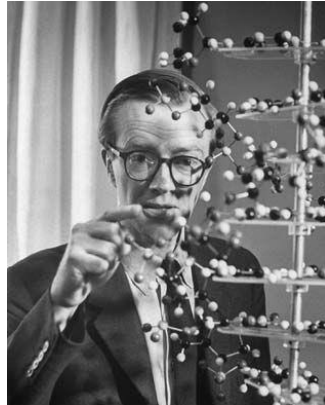
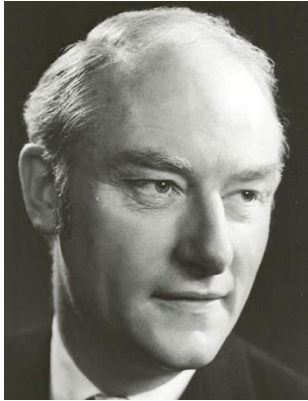
 **Creativity**

Scientists do busywork and forget the method of science

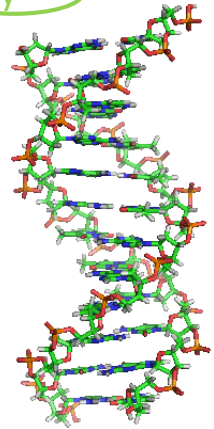
 **Insistence**

Application in Molecular Biology

Vast informational detail
and complexity



James Watson and Francis Crick
proposed that the DNA molecule is a
long two stranded helical molecule.



Year	Scientists	Alternative hypotheses	Crucial experiments	Results
1958	Matthew Meselson and Franklin Stahl	Do the two strands of the helix stay together when a cell divides?	Isotope-density-labeling technique	They are separated.
1959	Alexander Rich	Does the DNA helix always have two strands?	Change the ionic concentration	No, three strands exist.
1959	Seymour Benzer	Is the “genetic map” a one-dimensional map, or does it have two- dimensional loops or branches?	Hundreds of fine microgenetic experiments on bacteria	Only the mathematical matrix for the one- dimensional case

Application in High-Energy Physics

Step 1



C. N. Yang and T. D. Lee put forward the question that the fundamental particles conserve mirror-symmetry or “parity” in certain reactions, or do they not?

Step 2



Chien-Shiung Wu performed the experiment of beta decay of cobalt-60



R. L. Garwin, Leon Lederman and R. Weinrich modified an existing cyclotron experiment

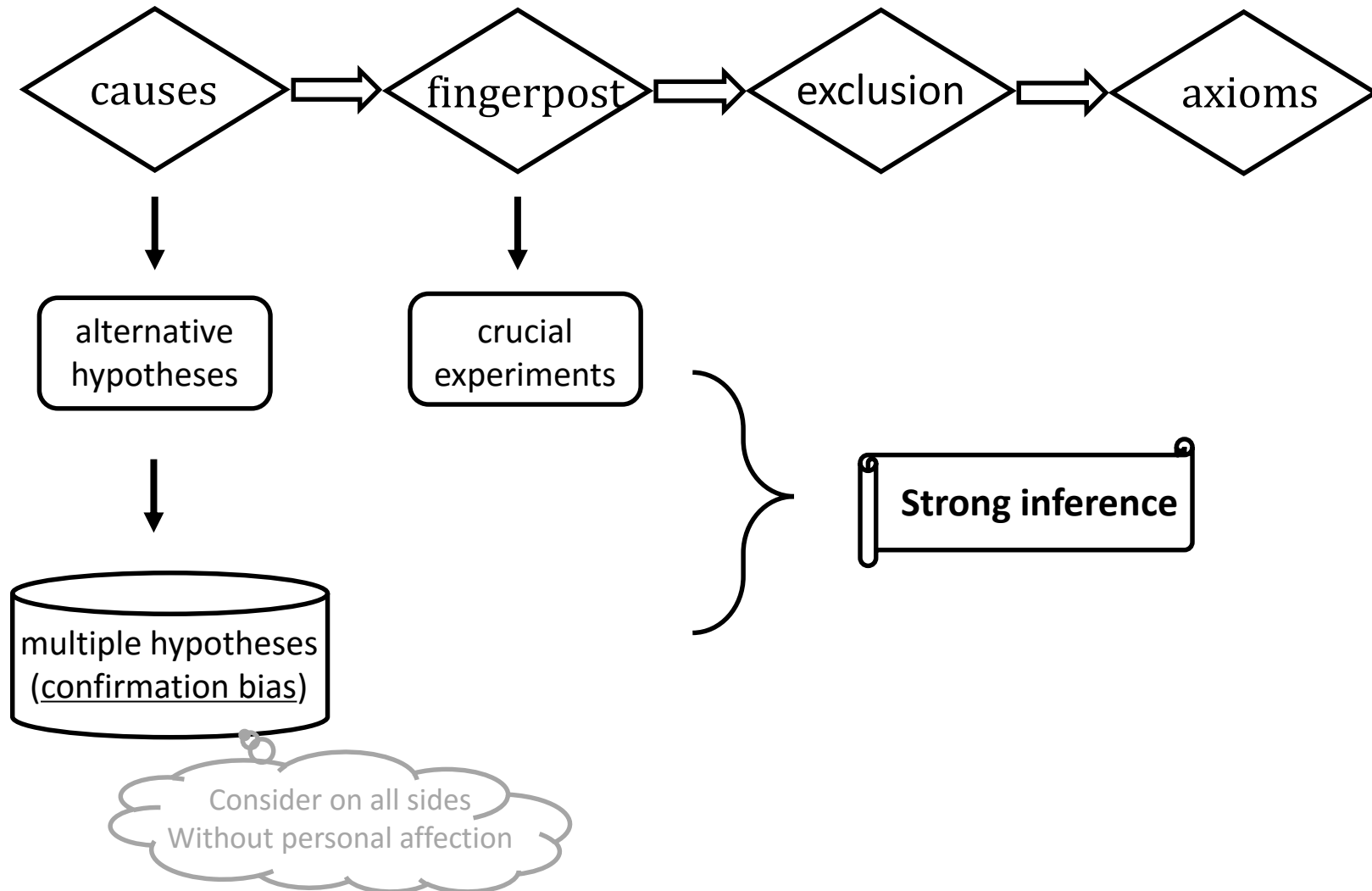
The first hypothesis was excluded and both experiments verified the parity violation

Step 3

The development of Strong inference



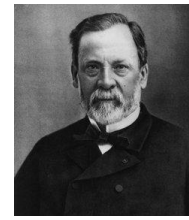
Francis Bacon



T. C. Chamberlin



Roentgen
and X-ray



Pasteur
and biology

How to improve
effectiveness of
scientific methods

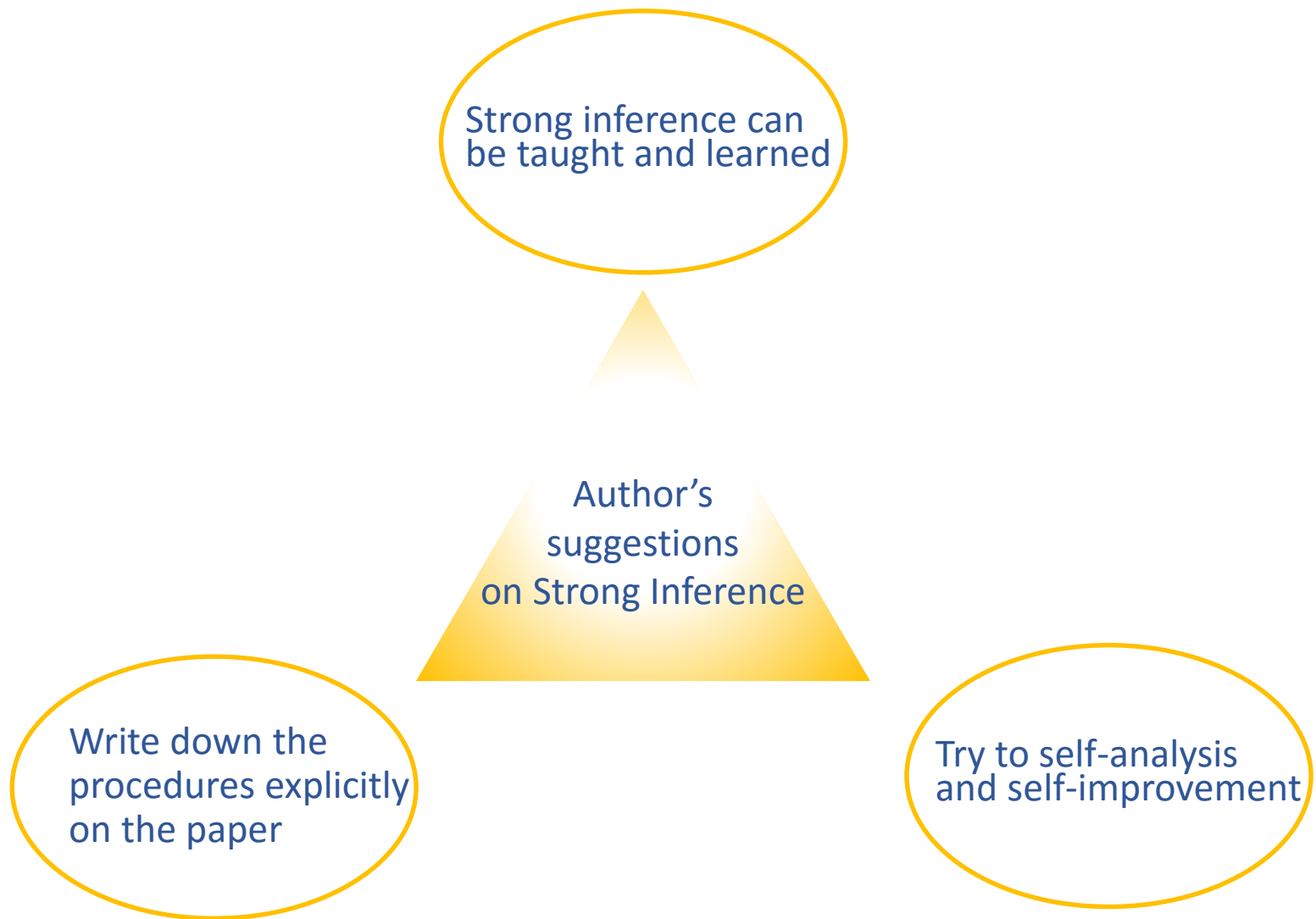
A few months or weeks of
analytical inductive inference
before the exploration

Be a problem-oriented man,
instead of method-oriented
man

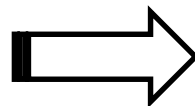
Refuse to have blind faith in
quantitative analysis



Calculation to
Five decimal places or by Using rules of thumb
Catch phenomena
in a mathematical box or in a logical box.



Simple model system
(Strong inference)



high-information and
complex problem

The weaknesses of the Strong Inference

- 1) Whether all problems addressed by the scientist are well defined?
- 2) Pay attention to the Quine-Duhem problem;
- 3) Author assumed that research is conducted in a top-down fashion, which ignored serendipitous observations;
- 4) Without a explicit criteria about when to stop Recycling the procedure.

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(Source: O'Donohue 2001)

Attempt it and Improve it!