“Thinking outside of the box is difficult for some people. Keep trying.”
Creativity in the Sciences

Creative Ideas, Scientists, Processes, and Disciplines
Creative Ideas

- Two requirements
  - *Novelty*: an idea must be original
  - *Utility*: an idea must be useful

- Let *Novelty* and *Utility* be hypothetical variables ranging from 0-10

- Then *Creativity* = *Novelty* * Utility ranges between 0-100
Creative Scientists

- Productive Output
  - Lokta’s Law: $f(n) = c/n^2$
  - Price’s Law: $k^{1/2} \circ 50\%$
Creative Scientists

- Scientific Impact
  - Productivity 🕒 Citations
  - Citations 🕒 Recognition
Infinite originality

One-half class

Einstein

1st class

Dirac, Schrödinger, Heisenberg, etc.

2nd class

Other Nobel laureates

3rd class

N.A.S., F.R.S., and near Nobel-prize calibre etc.

4th class

National and international awards + prolific creativity

5th class

Local awards + prolific creativity

6th class

Over ten publications

7th class

2 to 10 papers

8th class

1 or no paper

Landau—Lotka logarithmic scale of research accomplishment.

Fig. 2 The Landau-Lotka diagram depicting the logarithmic scale on which the widely varying extremes of scientific accomplishment (counting both the quality and the quantity of scientific papers) may be represented.
8th class 1 or no paper
7th class - 2 to 10 papers
6th class  Over ten publications
5th class Local awards + prolific creativity
4th class - National and international awards + prolific creativity
3rd class - N.A.S., F.R.S., and near Nobel-prize calibre etc.
2nd class | Other Nobel laureates
1st class

Dirac, Schrödinger, Heisenberg, etc.
One-half class

Einstein
Creativity = 100
Creative Processes

- No one single “creative process” but rather a mix of methods that range from
  - “Strong” or “algorithmic” methods:
    - largely domain specific,
    - heavily expertise driven,
    - and have a high likelihood of providing useful solutions,
    - but are less likely to produce highly novel solutions
Creative Processes

- No one single “creative process” but rather a mix of methods that range from
  - “Strong” or “algorithmic” methods to
  - “Weak” or “heuristic” methods:
    - largely generic across domains,
    - highly contingent on personal traits related to creativity,
    - and have a low likelihood of providing useful solutions,
    - but are more likely to produce novel solutions
Creative Processes

- No one single “creative process” but rather a mix of methods that range from
  - “Strong” or “algorithmic” methods to
  - “Weak” or “heuristic” methods
- Hence, most creative thought requires an integration of these strong and weak methods
Creative Disciplines

- Similarly, creativity does not operate the same way in all scientific disciplines
- Instead, disciplines differ regarding:
  - the relative role of strong versus weak methods
  - the degree of conceptual precision and rigor
  - the magnitude of consensus
- In Kuhnian terms, the extent to which research in the domain is paradigmatic
- Hence, a hierarchy of the sciences …
Positive Indicators

- Peer evaluation consensus
- Citation concentration
- Early impact rate
- Citation immediacy
- Anticipation frequency
- Obsolescence rate
- Graph prominence
- Rated disciplinary hardness
Negative Indicators

- Consultation rate
- Theories-to-laws ratio
- Age at receipt of Nobel prize
- Lecture disfluency
- Confirmatory hypothesis tests
- Objectivity in the scientist rather than in the research process
Final Observations

- The disciplinary hierarchy can be extended to encompass the arts and humanities.
- Creators active in a given discipline will display dispositional traits and developmental experiences appropriate to that discipline.
- But the most creative persons in any discipline will tend to have traits and experiences more typical of creators active lower in the hierarchy!