

Attendance, Warmup

Attendance link at
ignite.byu.edu/cbe400/lectures

Show that you can
make any postage
of 8¢ or more, using
only 3¢ cent and 5¢
stamps



Show and Tell

Jonathan
Josh
McKay

Next week: Emily, Sara, Kaylee

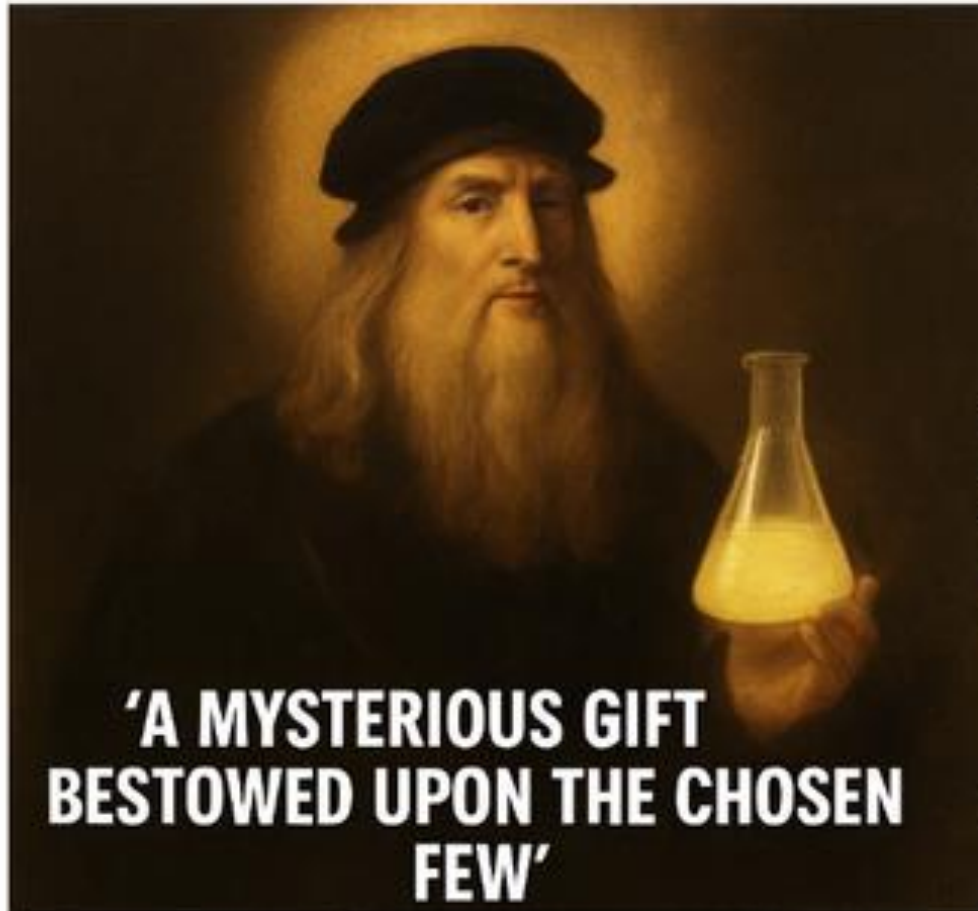


Other Fields

- "Anyone can look for fashion in a boutique or history in a museum. The creative explorer looks for history in a hardware store and fashion in an airport"
- examples given from ideas from outside fields
 - (warship camo from Picasso)
- "Make a practice to keep on the lookout for novel and interesting ideas that others have used successfully. Your idea has to be original only in its adaptation to the problem you are working on" Edison

Douglas

**HOW WE USED TO
THINK CREATIVITY WORKED –**



**HOW IT ACTUALLY
WORKS –**

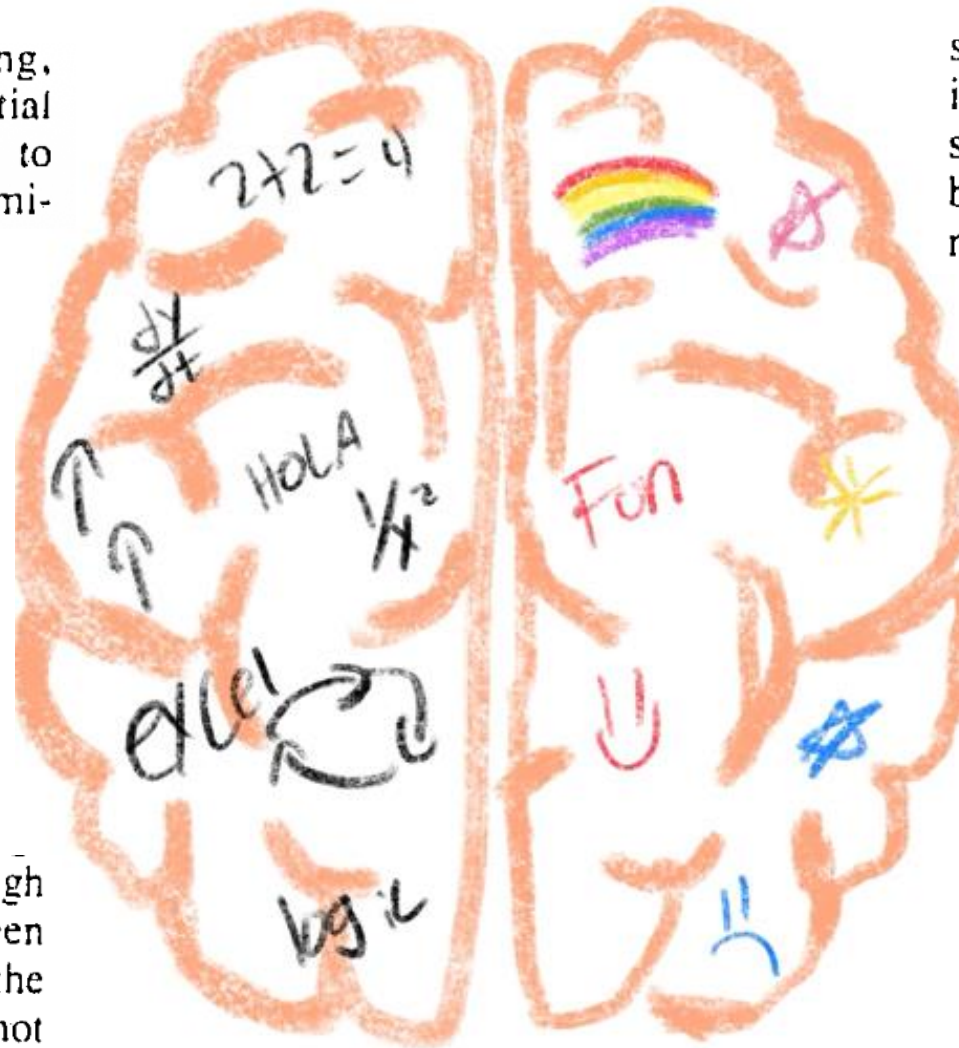


Inspiration is for amateurs



Brain

gent abilities. Speech, logic, reading, mathematical analysis and sequential memory (convergent abilities) appear to be controlled by the brain's left hemi-



nizing faces (divergent abilities). A high degree of cooperation takes place between the two hemispheres, however, and the overall control of brain function is still not well understood.

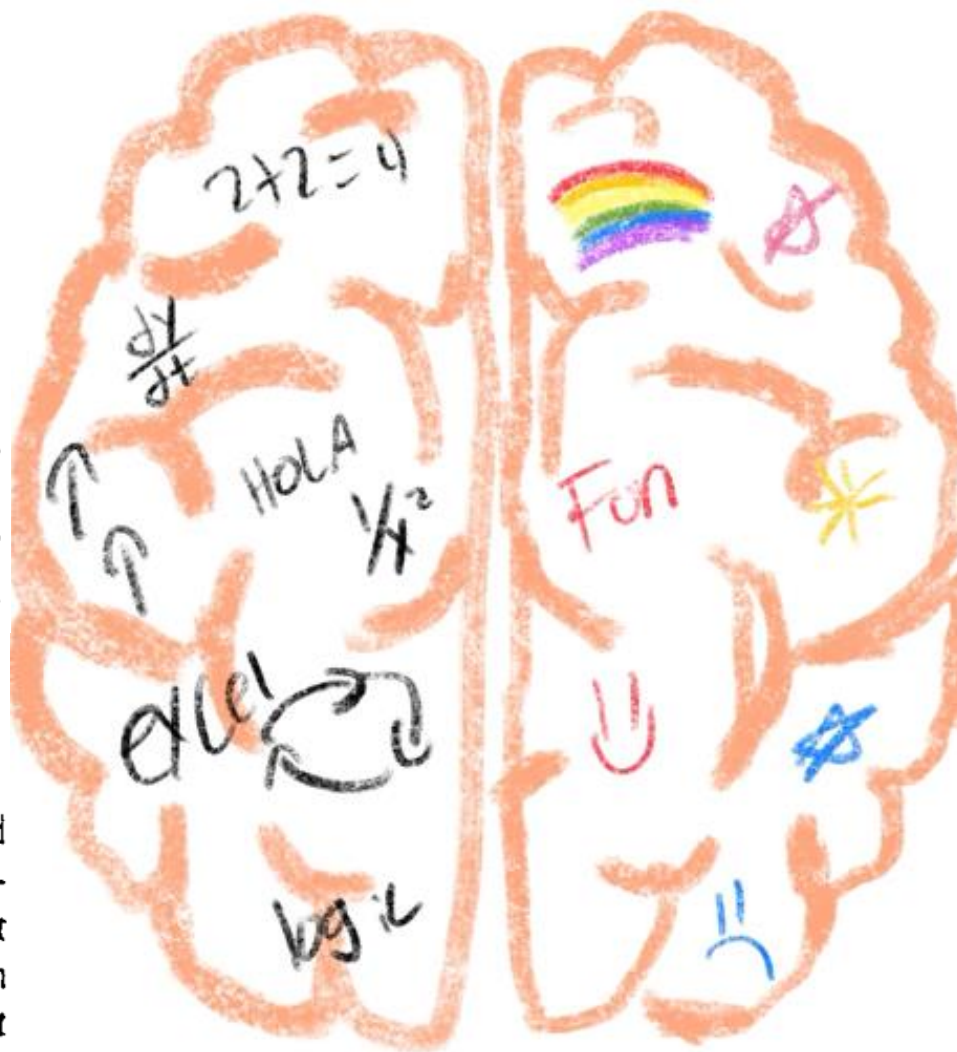
sphere. The right hemisphere seems to be involved in recognizing spatial relationships, in carrying out holistic and symbolic thought processes, and in recognizing faces (divergent abilities). A high

frightening—questions: Are IQ tests failing to identify students whose divergent thinking abilities or other qualities gave them a high potential for success? And do the new “creativity tests” reveal that traditional education is doing little to develop creative abilities, and might even be suppressing them? The results of two decades research now indicate that, with some qualifications, the answer to both questions is. Yes. The implications of

Brain

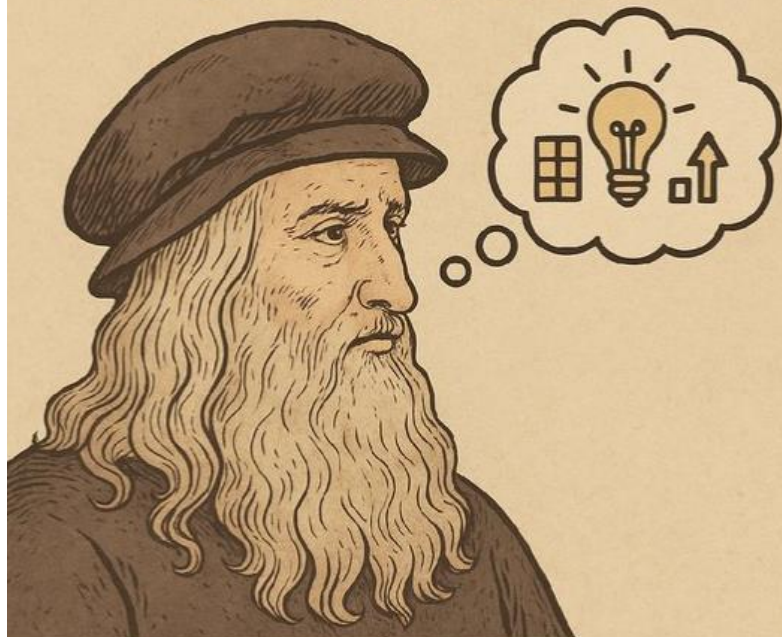
University of Utah psychologist Calvin W. Taylor, working with some collaborators that included a medical college dean, devised a set of 77 measures for on-the-job performance of physicians. They then correlated each of these to the doctors' grades during college, during the first two years of medical school, and during the last two years of medical school. They found that grades showed no significant relationship to performance for 97 percent of the correlations, and for the remaining three percent, the majority of correlations were *negative*. Concluded the

grades. The discovery hardly surprised him, for he pointed out that "the relationship of undergraduate college grade-point average to success as a scientist has been shown by many investigations to be at best low."

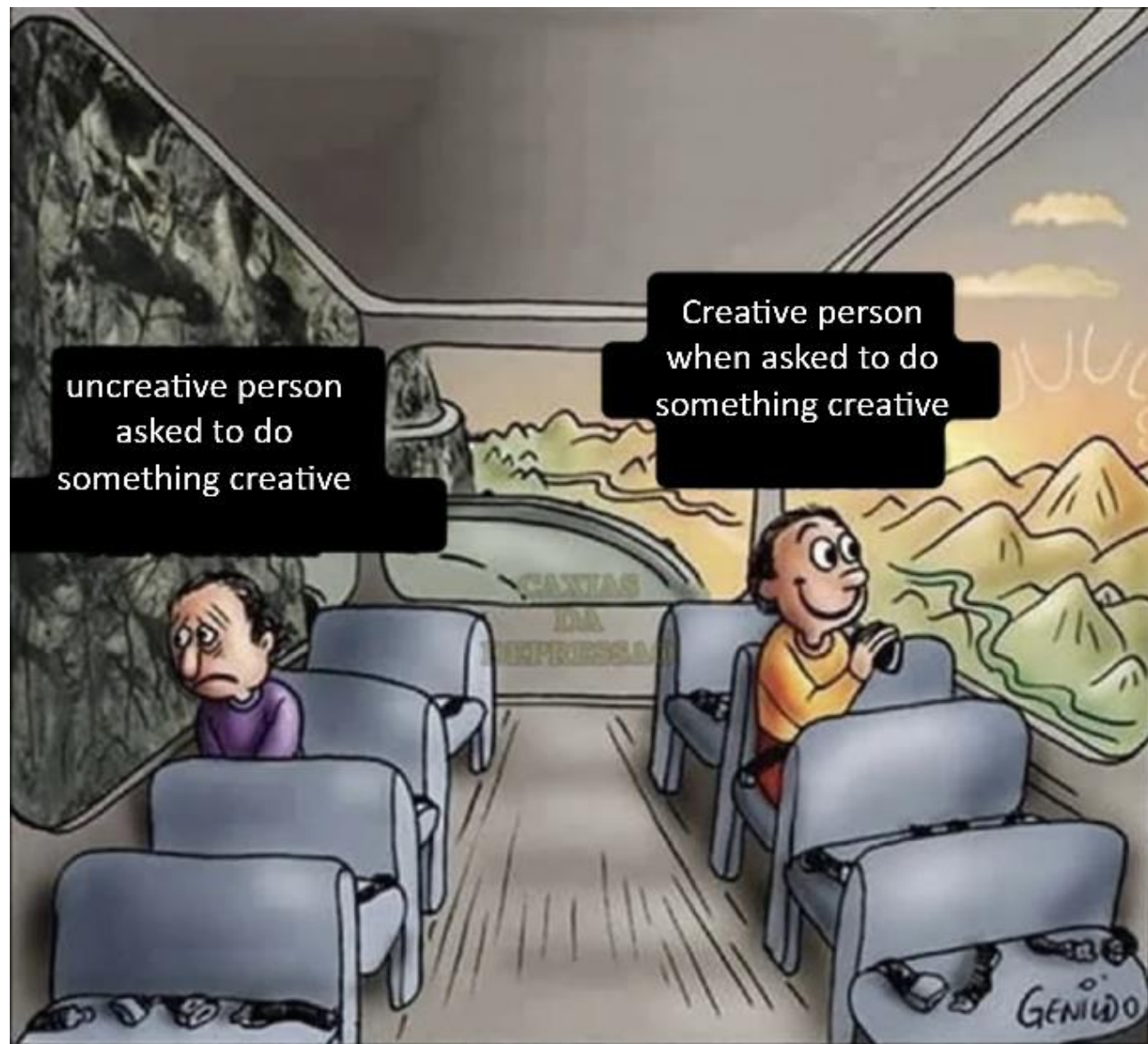


entity. British psychologist Liam Hudson sees life as "continual and unresolved tension between the forces of self-expression and those of control." This tension, he says, "governs, in very considerable detail, the nature of creative work." The American psychiatrist and author Rollo May goes one step further: "We express our being by creating," he says. "Creativity is a necessary sequel to being." Since being implies risk, he says, creativity requires courage. The creative person is thus one who dares to encounter blank reality and seek to bring it form.

THE MYTH OF GENIUS



IS CRUMBLING



uncreative person
asked to do
something creative

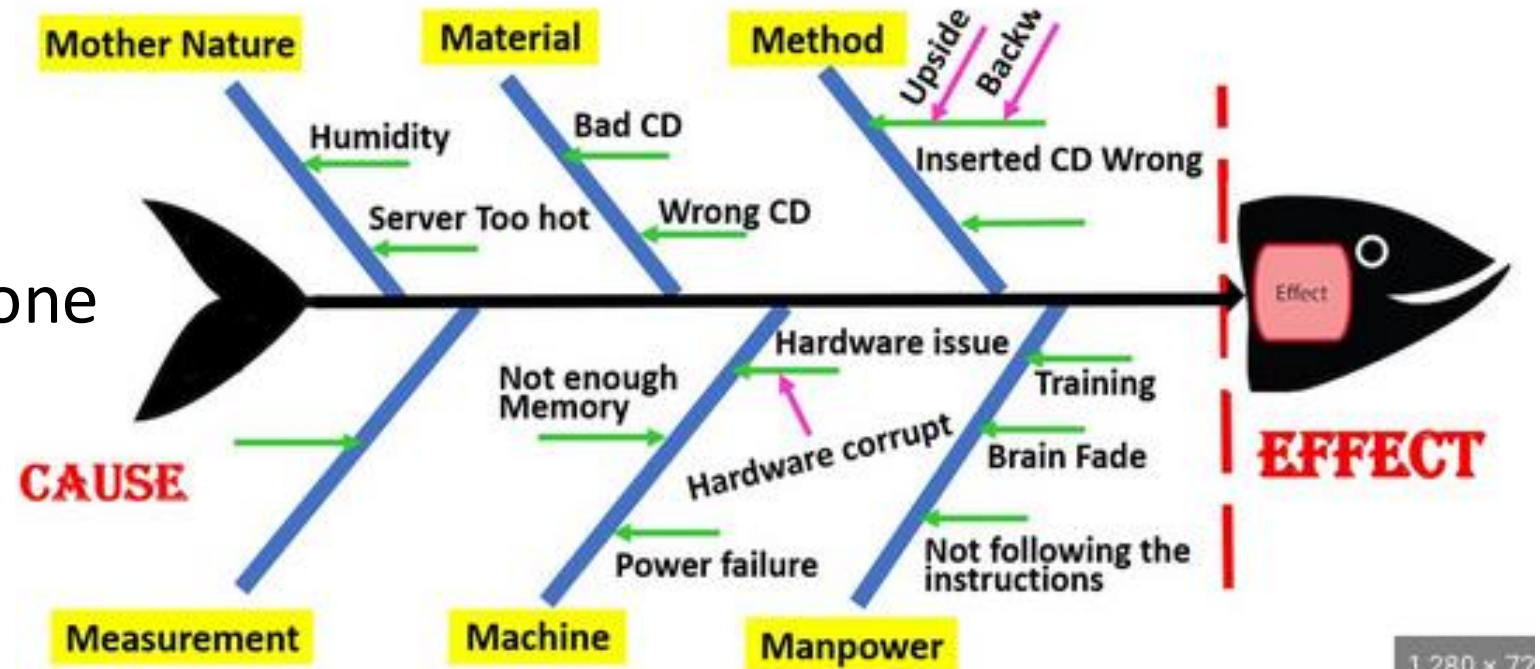
Creative person
when asked to do
something creative

Risk Taking

- 6.12.** Identify a small, medium, and large risk you should take in the not-too-distant future. Describe your fear of failure for each risk. Apply each of the items in the table on overcoming the fear of failure.
- 6.17.** Think of a situation where you took a risk. Describe the fears that you had to overcome to be able to take the risk. What were the negative consequences that you had to consider might occur as a result of your decision to proceed? How would you have dealt with those consequences if the risk had not been successful?

Generation Techniques

- Brainstorming
- Vertical Thinking
- Horizontal Thinking
- Organizing ideas: fishbone
- Futuring
- Cross-fertilization
- Analogy
- Incubate
- TRIZ (Theory of inventive problem solving)



Free Association, Brainstorming

- Triggering of ideas in others
- Ask “what if?” questions
- Reserve judgement until later
 - Nothing kills a brainstorming session faster than negative comments

Comments That Reduce Brainstorming to Braindrizzling

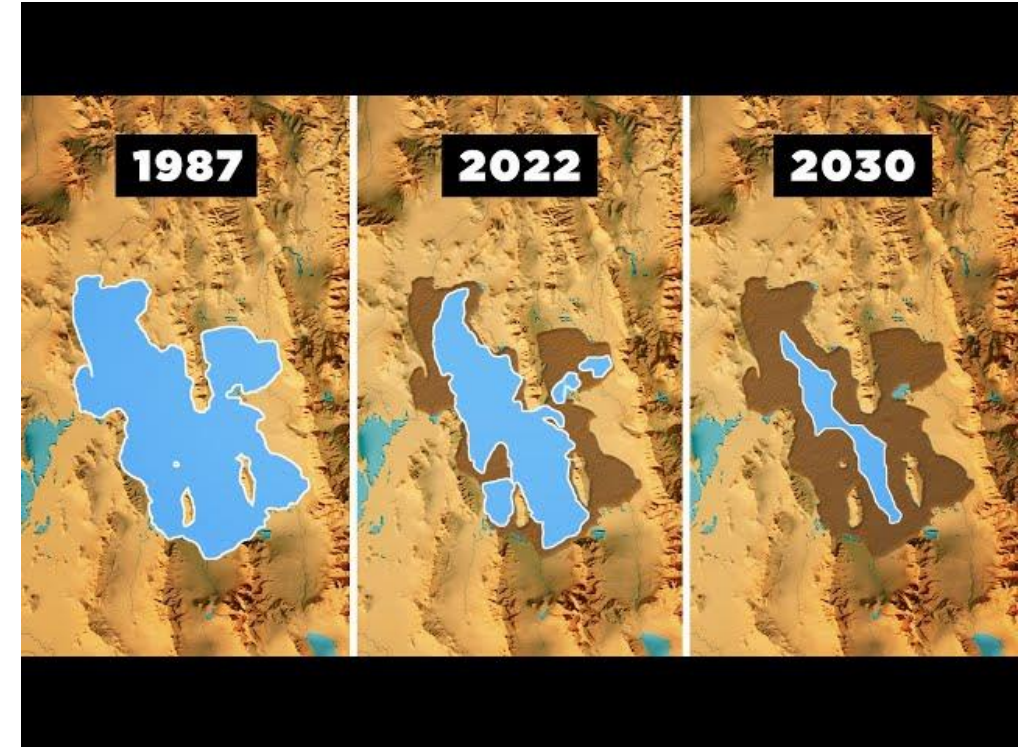
- | | |
|---------------------------------------|--------------------------------|
| • That won't work. | • That's too expensive. |
| • It's against our policy. | • That's too much hassle. |
| • It's not our job. | • That's not practical. |
| • We haven't done it that way before. | • That's too radical. |
| • We don't have enough time. | • We can't solve this problem. |



Free Association, Brainstorming

- Explore everywhere for new ideas
- Anything goes
- Fast, wild, crazy, not logical or realistic
- You find a magic red screwdriver ...
- You woke up this morning and gravity was broken ...
- You can fire-bend, so ...

Restore the Great Salt Lake



Vertical Thinking

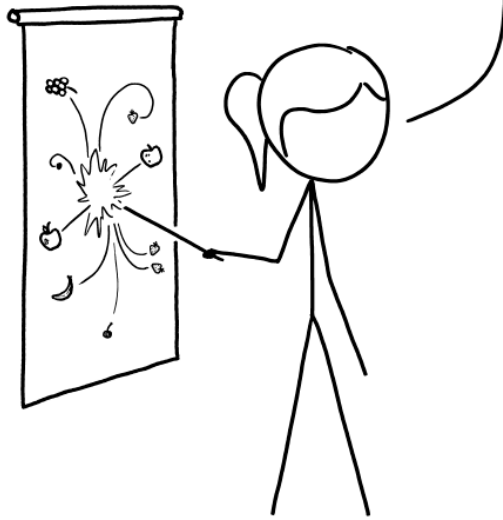
Build on Existing Ideas

- Substitute
- Combine
- Remove
- Eliminate
- Emphasize
- Rearrange
- Reverse
- Adapt
- Magnify
- Minimize
- Parody
- What if ...

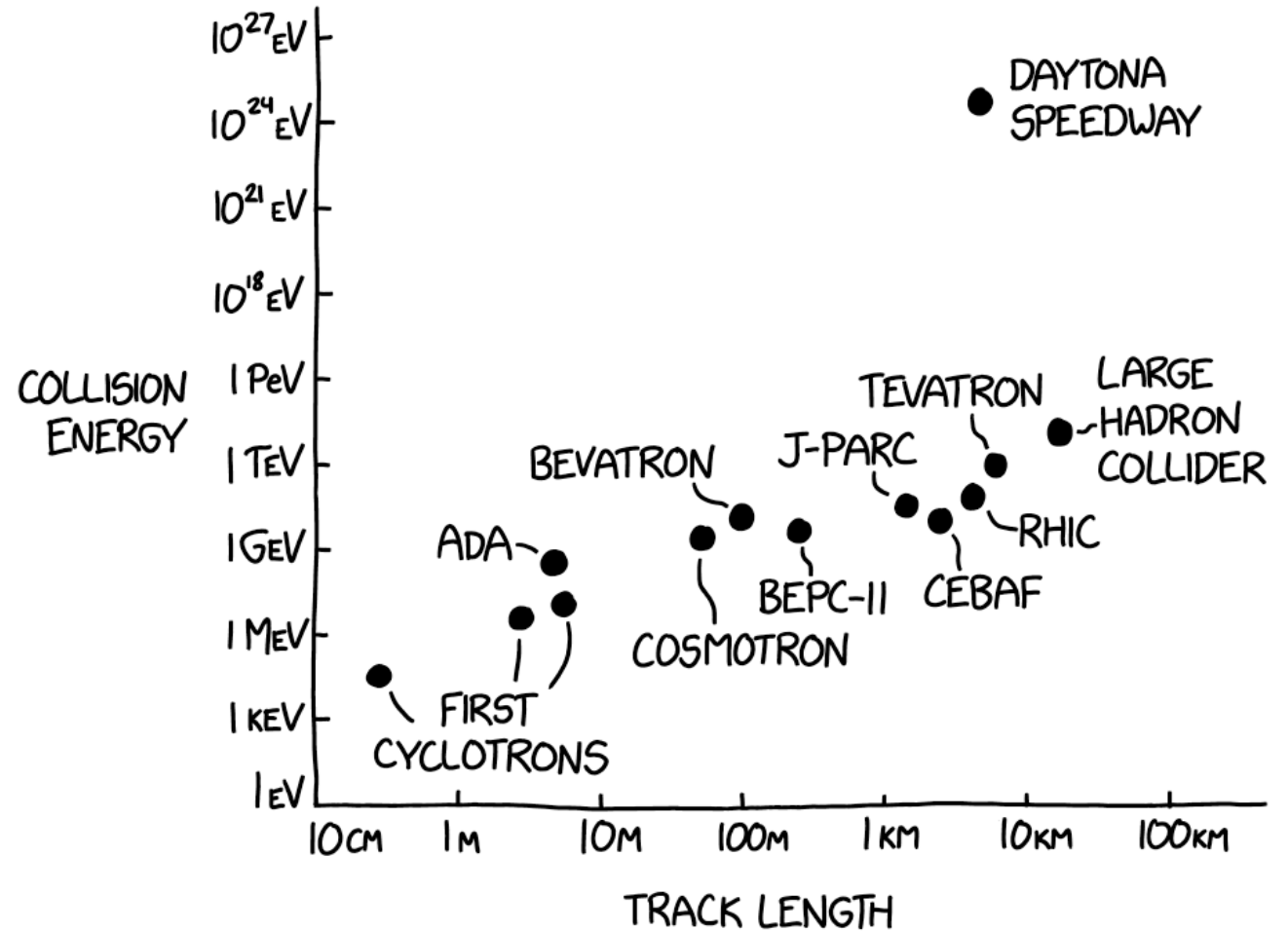
WHEN TWO APPLES COLLIDE, THEY CAN BRIEFLY FORM EXOTIC NEW FRUIT. PINEAPPLES WITH APPLE SKIN. POMEGRANATES FULL OF GRAPES. WATERMELON-SIZED PEACHES.

THESE NORMALLY DECAY INTO A SHOWER OF FRUIT SALAD, BUT BY STUDYING THE DEBRIS, WE CAN LEARN WHAT WAS PRODUCED.

THEN, THE HUNT IS ON FOR A STABLE FORM.



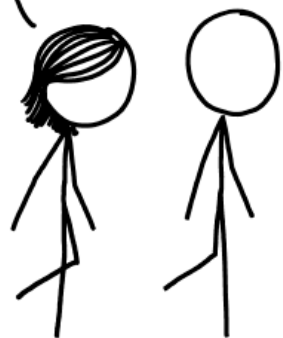
HOW NEW TYPES OF FRUIT ARE DEVELOPED



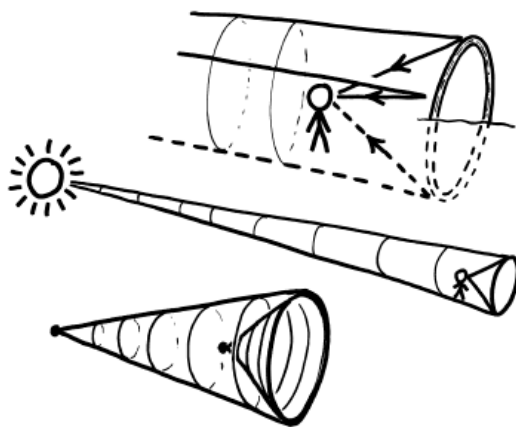
THERE'S A POT OF GOLD AT
THE END OF THE RAINBOW.

RAINBOWS ARE
CIRCLES. THEY
HAVE NO END.

NOT QUITE!



A RAINBOW IS LIGHT LEAVING
THE SUN, BOUNCING OFF THE
CLOUDS, AND CONVERGING ON
YOUR EYE. IT'S AN INSIDE-
OUT TWO-ENDED CONE.



ONE END OF
THAT CONE IS
YOUR RETINA.

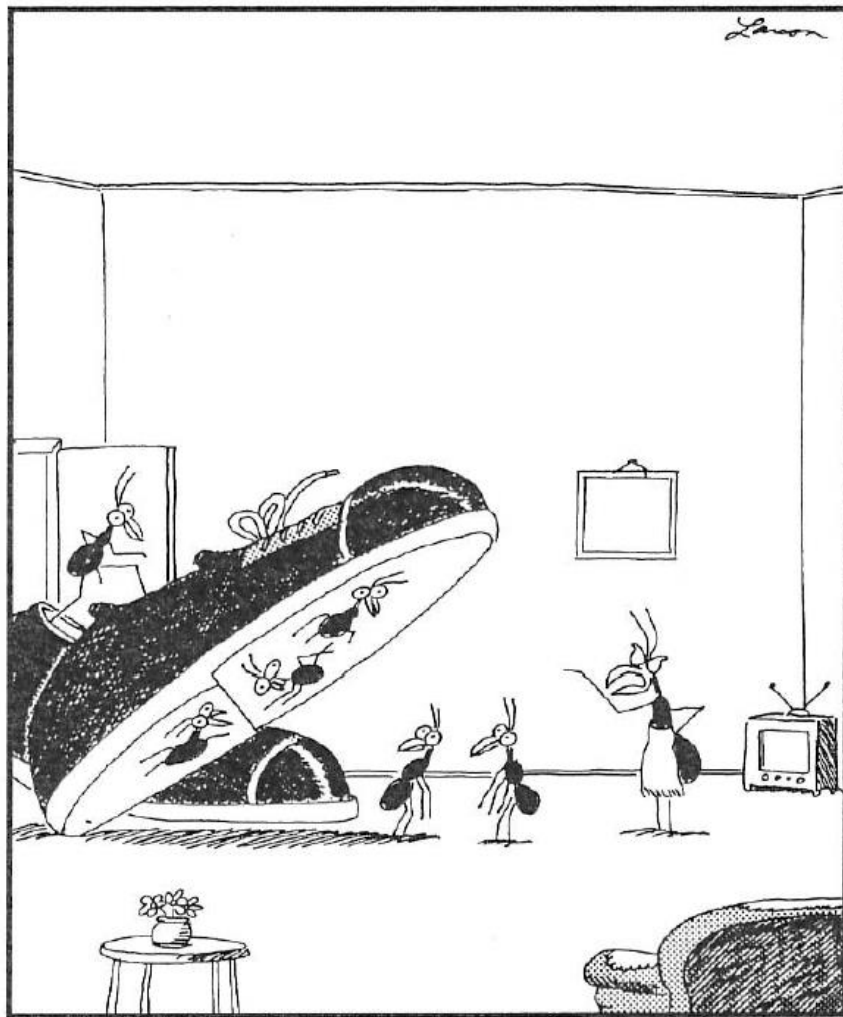


THE OTHER END IS THE SUN—WHICH
CONTAINS QUINTILLIONS OF TONS OF
GOLD. THERE'S MORE GOLD IN THE
SUN THAN WATER IN THE OCEANS.

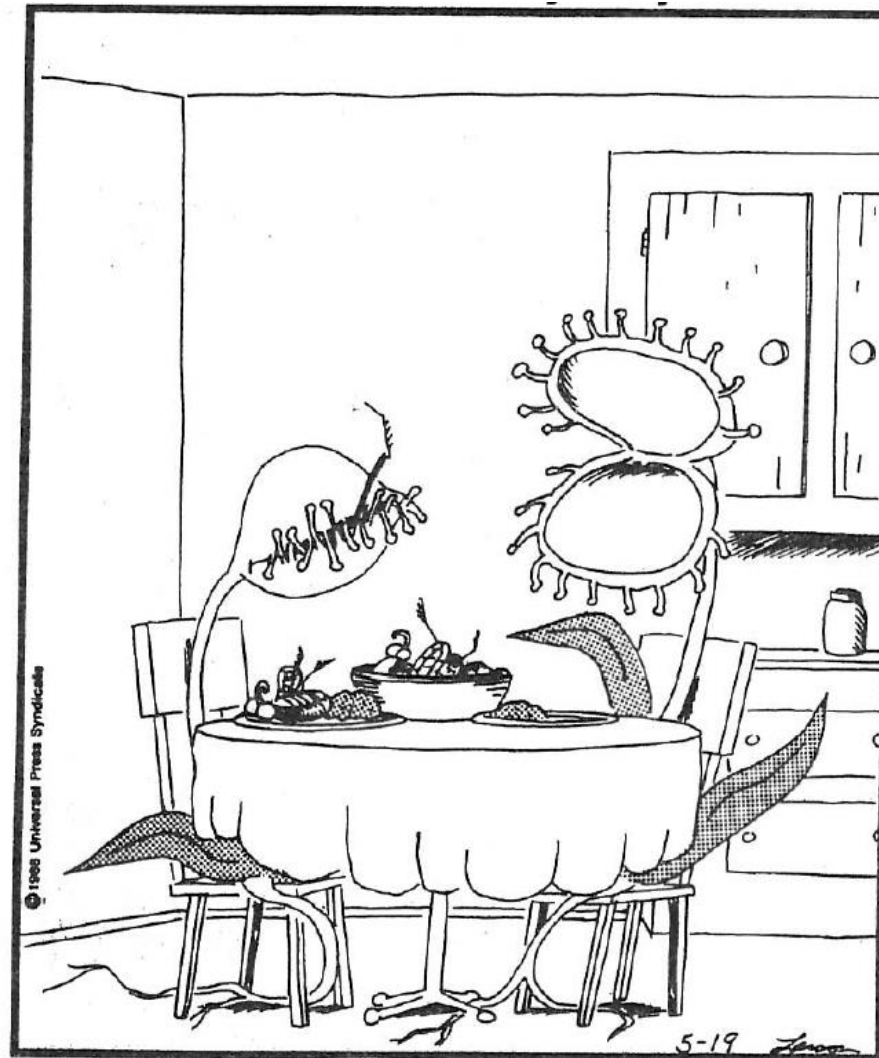
SO THERE IS A POT OF GOLD!
WHAT ABOUT LEPRECHAUNS?

ALL INCINERATED AS THE
SUN FORMED. VERY SAD.

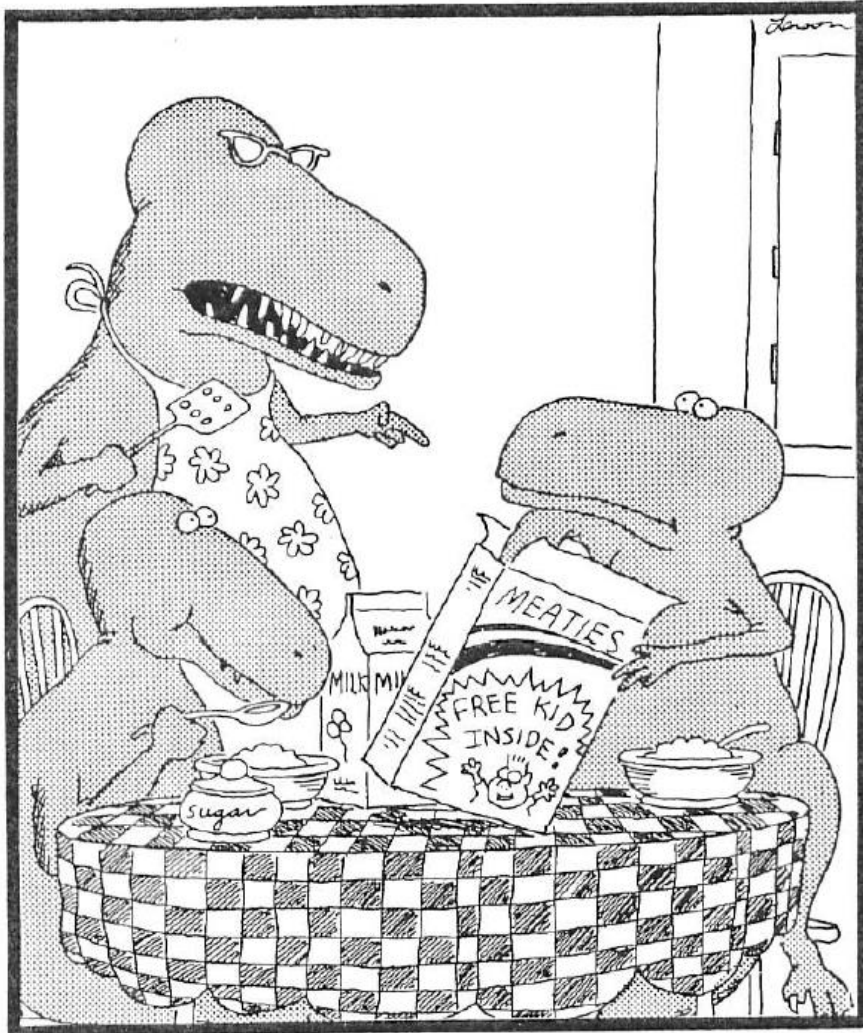




"Ernie! Look what you're doing—
take those shoes off!"

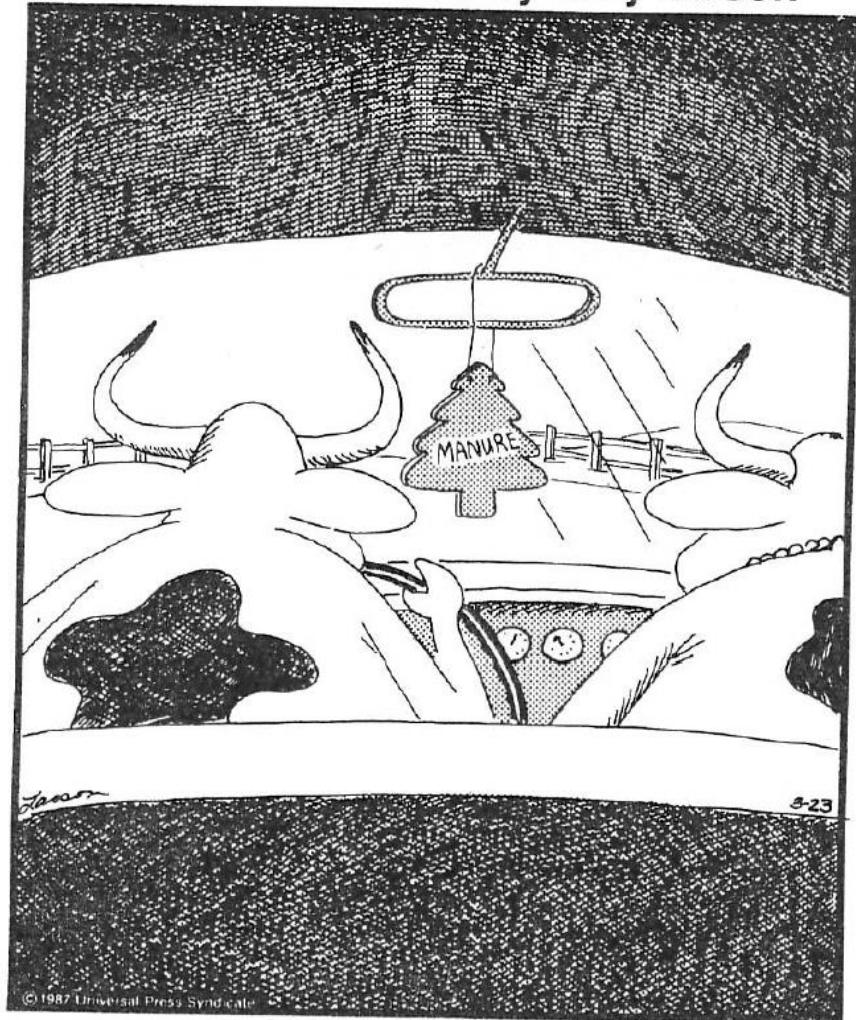


"No more flies, Arnold, until you've
eaten some of your fertilizer."

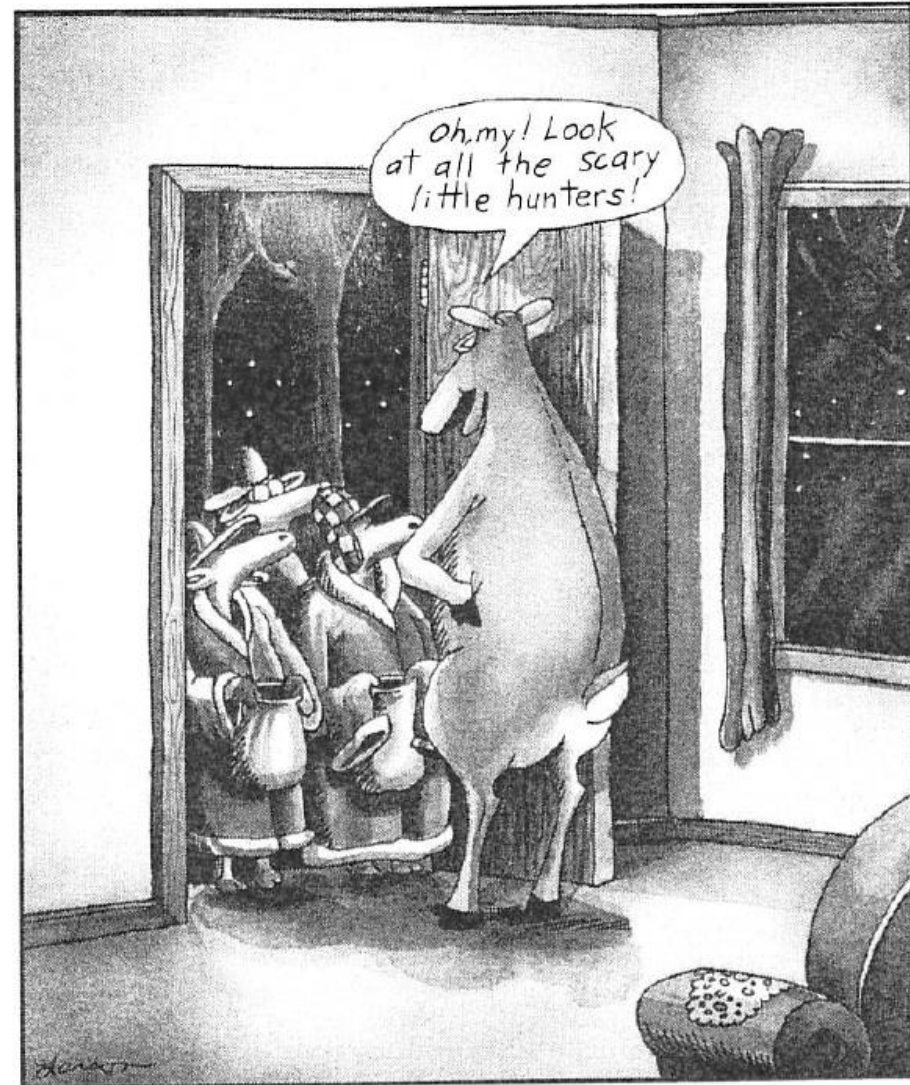
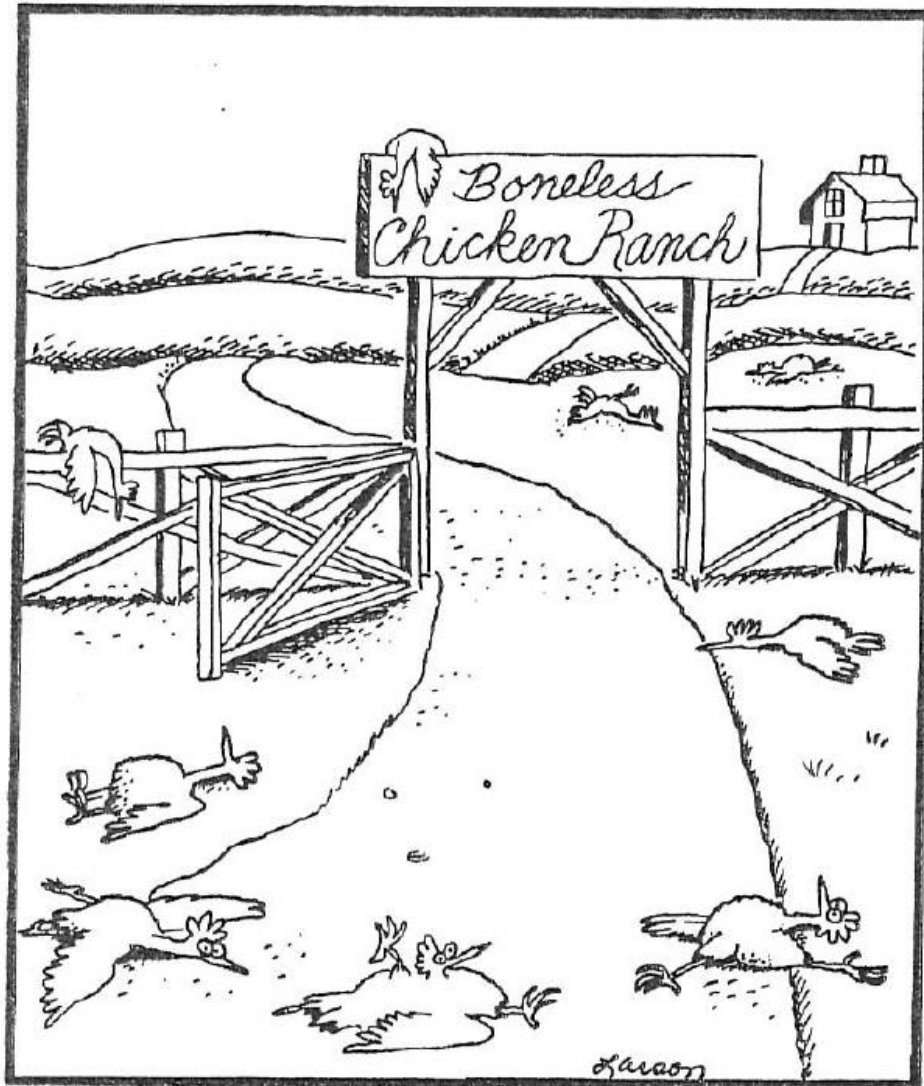


"Randy! Just sit down, eat your cereal,
and look for that thing later!"

The Far Side by Gary Larson



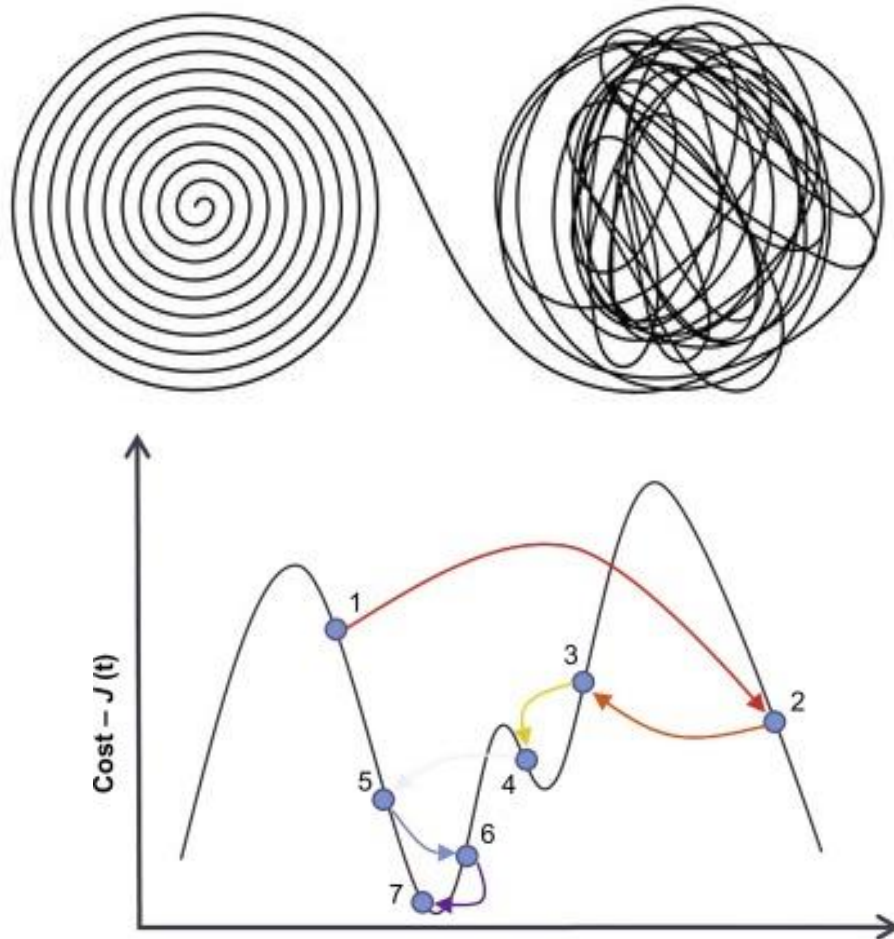
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Deer Halloweens

Horizontal/Lateral Thinking

Add a little chaos...



Optimization by Simulated Annealing

S. Kirkpatrick, C. D. Gelatt, Jr., M. P. Vecchi

In this article we briefly review the central constructs in combinatorial optimization and in statistical mechanics and then develop the similarities between the two fields. We show how the Metropolis algorithm for approximate numerical simulation of the behavior of a many-body system at a finite temperature provides a natural tool for bringing the techniques of statistical mechanics to bear on optimization.

We have applied this point of view to a number of problems arising in optimal design of computers. Applications to partitioning, component placement, and wiring of electronic systems are described in this article. In each context, we introduce the problem and discuss the improvements available from optimization.

Of classic optimization problems, the traveling salesman problem has received the most intensive study. To test the power of simulated annealing, we used the algorithm on traveling salesman problems with as many as several thousand cities. This work is described in a final section, followed by our conclusions.

Combinatorial Optimization

The subject of combinatorial optimization (*1*) consists of a set of problems that are central to the disciplines of computer science and engineering. Research in this area aims at developing efficient techniques for finding minimum or maximum values of a function of very many independent variables (*2*). This function, usually called the cost function or objective function, represents a quantitative mea-

sure of the "goodness" of some complex system. The cost function depends on the detailed configuration of the many parts of that system. We are most familiar with optimization problems occurring in the physical design of computers, so examples used below are drawn from

Summary. There is a deep and useful connection between statistical mechanics (the behavior of systems with many degrees of freedom in thermal equilibrium at a finite temperature) and multivariate or combinatorial optimization (finding the minimum of a given function depending on many parameters). A detailed analogy with annealing in solids provides a framework for optimization of the properties of very large and complex systems. This connection to statistical mechanics exposes new information and provides an unfamiliar perspective on traditional optimization problems and methods.

that context. The number of variables involved may range up into the tens of thousands.

The classic example, because it is so simply stated, of a combinatorial optimization problem is the traveling salesman problem. Given a list of N cities and a means of calculating the cost of traveling between any two cities, one must plan the salesman's route, which will pass through each city once and return finally to the starting point, minimizing the total cost. Problems with this flavor arise in all areas of scheduling and design. Two subsidiary problems are of general interest: predicting the expected cost of the salesman's optimal route, averaged over some class of typical arrangements of cities, and estimating or obtaining bounds for the computing effort necessary to determine that route.

All exact methods known for determining an optimal route require a computing effort that increases exponentially

with N , so that in practice exact solutions can be attempted only on problems involving a few hundred cities or less. The traveling salesman belongs to the large class of NP-complete (nondeterministic polynomial time complete) problems, which has received extensive study in the past 10 years (*3*). No method for exact solution with a computing effort bounded by a power of N has been found for any of these problems, but if such a solution were found, it could be mapped into a procedure for solving all members of the class. It is not known what features of the individual problems in the NP-complete class are the cause of their difficulty.

Since the NP-complete class of problems contains many situations of practical interest, heuristic methods have been developed with computational require-

ments proportional to small powers of N . Heuristics are rather problem-specific: there is no guarantee that a heuristic procedure for finding near-optimal solutions for one NP-complete problem will be effective for another.

There are two basic strategies for heuristics: "divide-and-conquer" and iterative improvement. In the first, one divides the problem into subproblems of manageable size, then solves the subproblems. The solutions to the subproblems must then be patched back together. For this method to produce very good solutions, the subproblems must be naturally disjoint, and the division made must be an appropriate one, so that errors made in patching do not offset the gains

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Sleep

How Sleep Helps the Brain Learn

The learning process has three main stages: acquisition (gathering information), consolidation (storing it), and recall (retrieving it). Sleep heavily impacts all three:  Harvard Sleep Medicine +1

- **Before learning:** Sleeping primes the brain and helps you pay attention, focus, and stay alert the next day.
- **After learning:** Deep and REM (rapid eye movement) sleep stages replay and strengthen neural connections, turning temporary experiences into permanent memories.
- **Problem solving:** Sleep helps the brain find patterns, extract rules, and boost creative problem-solving skills.  McCormick Teaching E... +4

DC 88:124 ...retire to thy bed early, that ye may not be weary; arise early, that your bodies and your minds may be invigorated.

3 Nephi 17:2-3

2 I ^aperceive that ye are weak, that ye cannot ^bunderstand all my words which I am commanded of the Father to speak unto you at this time.

3 Therefore, go ye unto your homes, and ^aponder upon the things which I have said, and ask of the Father, in my name, that ye may understand, and ^bprepare your minds for the ^cmorrow, and I come unto you again.