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Guesstimation: The Art of Getting About the Right Answer

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Guesstimation:
The Art of Getting *About* the Right Answer

Estimating the answer to problems we encounter every day in the world around us is a extremely useful skill. We will talk about trick and tip to estimate thing like how many people are airborne over the US at any given time or how much more efficient an automobile is than a New York City bicycle rickshaw? Even cooler (at least for us geeks), we will use the same techniques to estimate the likelihood of finding life on another planet and the size of atoms.

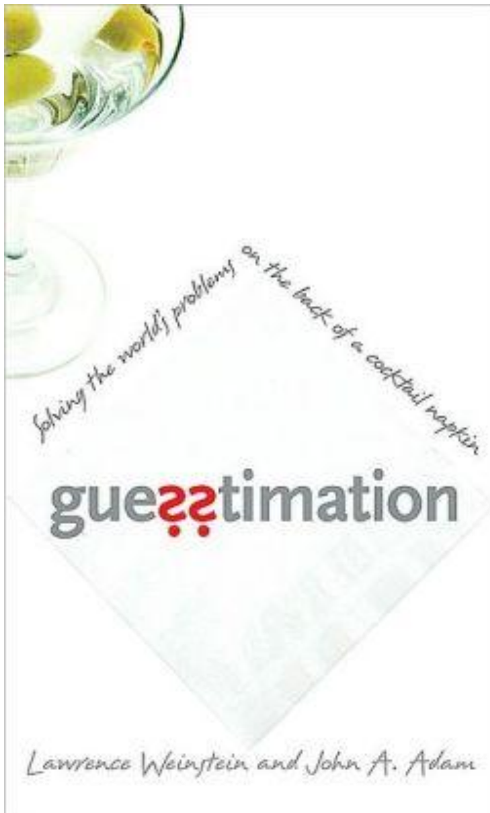
JR Dennison

October 9, 2014

How many jelly beans are there in this jar?

$$N_{jellybean} = \frac{Volume_{jar}}{Volume_{jellybean}} = \frac{\pi\cdot(10\cdot cm)^2\cdot(20\cdot cm)}{\pi\cdot(0.5\cdot cm)^2\cdot 2\cdot cm} = 4000$$

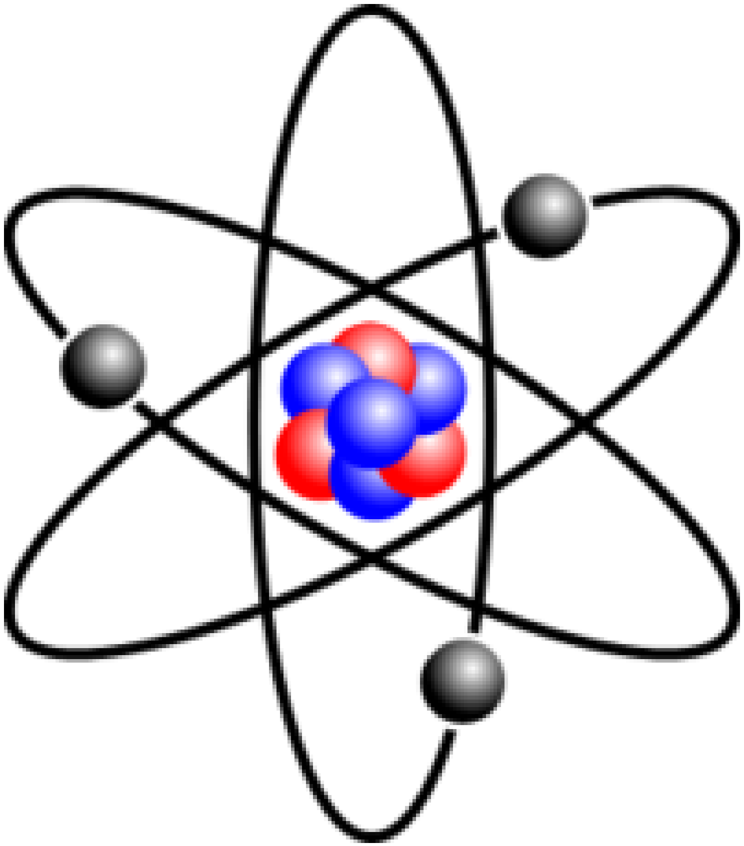
What is Guesstimation?



Guesstimation: Solving the World's Problems on the Back of a Cocktail Napkin by

[Lawrence Weinstein](), [John A. Adam]()

How big is an atom?



Seeing Atoms…

and putting them to work

or

Physics at the Atomic Scale

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Steps for Guesstimation

Step 1: Guess!!!

Often can guess to within a factor of 10. And often, that is good enough.

How well do you need to know the answer to make a decision?

- **too big?**
- **too small?**
- **just right? ➔ then more work is needed**

Steps for Guesstimation

<u>Step 2: Divide and concur</u>

Break problem in the smaller problems you can guess and answer each of these to within about a factor of ten.

For Maria: The central limit theorem says you get closer by making many smaller guesses, each with an equal chance of being too high or too low

<u>Often easier to guess an upper and lower bound</u>

- **same factor too high and too low**
- **easy for powers of ten (remember those pesky logarithms and slide rules?)**
- **Otherwise average coefficients and powers seperately**
- **Of the joys of scientific notation and the metric system!!!**

Powers of Ten: The Movie

Let’s Guesstimate!!!

A Few Examples

Let’s Guesstimate!!!

You Make Up a Question
(and an answer)

Final Guesstimation

The Drake Equation

How many others are there "out there"??

How many civilizations are there in our galaxy with which radio-communication might be possible?

The Drake equation is: $N = R_{*} \cdot f_p \cdot n_e \cdot f_{\ell} \cdot f_i \cdot f_c \cdot L$

where:

N = the number of civilizations in our galaxy with which radio-communication might be possible (i.e. which are on our current past light cone);

and

R_* = the average rate of star formation in our galaxy

f_p = the fraction of those stars that have planets

n_e = the average number of planets that can potentially support life per star that has planets

f_l = the fraction of planets that could support life that actually develop life at some point

f_i = the fraction of planets with life that actually go on to develop intelligent life (civilizations)

f_c = the fraction of civilizations that develop a technology that releases detectable signs of their existence into space

L = the length of time for which such civilizations release detectable signals into space[8]

There is considerable disagreement on the values of these parameters, but the 'educated guesses' used by Drake and his colleagues in 1961 were:[19][20]

- R_* = 1/year (1 star formed per year, on the average over the life of the galaxy; this was regarded as conservative)
- f_p = 0.2-0.5 (one fifth to one half of all stars formed will have planets)
- n_e = 1-5 (stars with planets will have between 1 and 5 planets capable of developing life)
- f_l = 1 (100% of these planets will develop life)
- f_i = 1 (100% of which will develop intelligent life)
- f_c = 0.1-0.2 (10-20% of which will be able to communicate)
- L = 1000-100,000,000 years (which will last somewhere between 1000 and 100,000,000 years)

Inserting the above minimum numbers into the equation gives a minimum N of 20. Inserting the maximum numbers gives a maximum of 50,000,000. Drake states that given the uncertainties, the original meeting concluded that $N \approx L$, and there were probably between 1000 and 100,000,000 civilizations in the Milky Way galaxy.