

The German Tank Problem



Scenario

Imagine you are a soldier in World War II, and you have just captured a few German tanks. German tanks had serial numbers printed on them, which were sequentially numbered (numbered from 1 to whatever). Suppose the serial numbers are 76, 150, and 92. What would you estimate the total number of German tanks produced to be based off of this information?



First, the Obvious

- At least 150 tanks produced, seeing as how that is the greatest serial number out of the tanks you captured
- Probably not as many as a million tanks produced, or it would be very unlikely to capture a tank with such a low number.

So, a good estimate would probably be something greater than 150 but not too much greater.

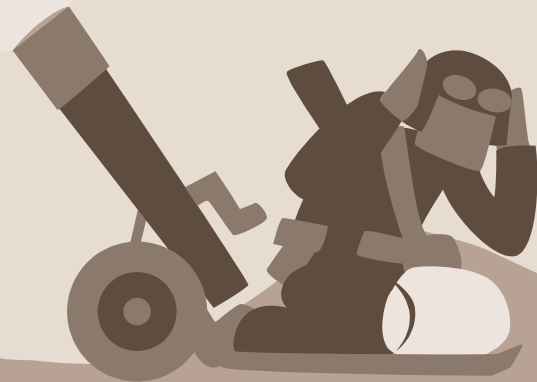


So how do you get a good estimate?

If you have multiple samples (multiple tanks), you can use Bayesian math to narrow down the range where the total number of tanks produced is probably at. Bayesian math is an approach that uses Bayes' Theorem:

$$P(A | B) = \frac{P(B | A) \cdot P(A)}{P(B)}$$

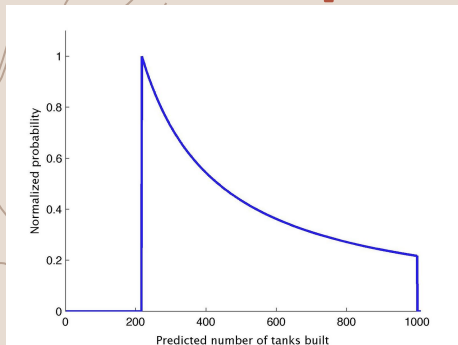
This allows you to create a probability distribution narrowing down the probable range for the amount of total tanks.



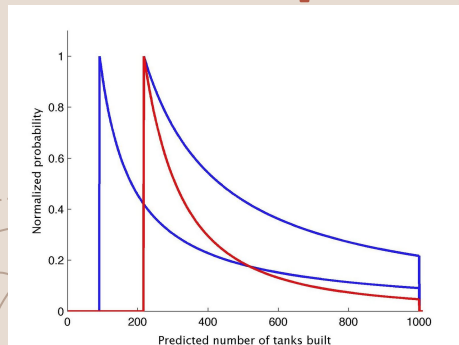
Probability Distributions

If M = guessed number of tanks produced, the probability of finding the specific tank you found out of all M tanks is simply $1/M$, at any given M .

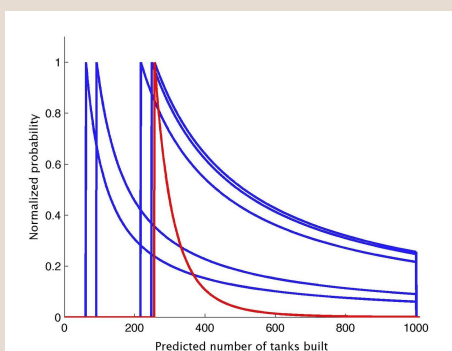
One Sample



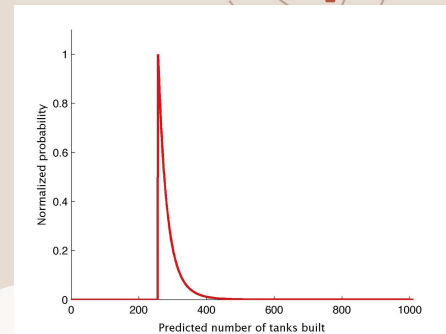
Two Samples



Five Samples

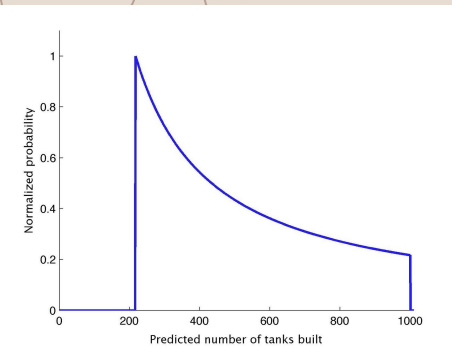


Ten Samples



But what if you only have one sample?

- If you only have one tank, then it's a lot harder and less likely for you to get a reasonable estimate for the total number of tanks produced
 - As seen on the graph, with only a single sample, there is a significantly larger range of plausible estimates
 - Your best bet might be to just double the serial number
 - It isn't very likely for the tank you captured to be in the first few tanks produced or the last few tanks produced
- So, it is most likely in the middle range, and doubling the serial number get you somewhere around the total number of tanks produced.



What if we applied the German tank problem to humans?

Set-up

Suppose we put all humans who have and will ever live in a line sorted by the year in which they were born, and then split them into three groups - the first 5%, the middle 90%, and the final 5%.

Doomsday Argument

We, in our current time, have a 90% chance of being in the middle 90% of all humans who will ever live. Given that there have been a total of 100 billion people who have lived so far, that should mean that there is a 95% chance that less than 2.2 trillion people will ever exist. Assuming that the human population plateaus at 9 billion, this suggests humans will probably go extinct in about 800 years, and not more than 16,000.



Wait, but that's stupid!

Yes, but no one can agree on why. People can't really come up with a good conclusive reason for which this probabilistic argument doesn't work, although there are many different approaches to refuting the argument.

Self-referencing Doomsday argument rebuttal

Some philosophers thinking about this topic have suggested that only people who have thought about the Doomsday argument belong in the reference class, or what the problem references off of to form its prediction, 'human'. If that is indeed chosen as the reference class, Carter, who had initially presented this argument to the Royal Society, defied his own prediction when he first described the argument. An attendant who listened to Carter's presentation could have argued:

Right now, only one person in the world understands the Doomsday argument, so by its own logic there is a 95% chance that it is a minor problem which will only ever interest twenty people, and I should ignore it.

If someone actually had argued this way, aside from being a stupid argument (if everyone ignored things that only a few people were interested in, all new discoveries would be ignored), they would have also created a paradox, or contradiction

Because they had made that claim against the Doomsday Argument, they obviously had also understood the argument, meaning that there would now be a 95% chance that 40-ish people would be concerned with it, contradicting their earlier claim.

Also, assuming that the philosophers' idea of choosing those who have contemplated the Doomsday Argument as the reference group is used, you can conclude that Carter had created a basis for his prediction by presenting his argument and getting the attendants to think about it.



Questions?