

Unsure Calculator

100 / 4~6|

7	8	9	/	⌫
4	5	6	x	~
1	2	3	-	
0	.		+	=

Write a formula and hit Enter,
or press =.

Calculate with numbers you're not sure about

Hi, I'm Filip, and I'd like to introduce to you an early version of an uncertainty calculator.

Statistics are scary, but they don't need to be. If you allow me to simplify, the field of statistics is just saying: *I'm not certain about these numbers, but I would still like to reason about them.* Turns out we're unsure about a lot in our lives, but we can't just throw our arms in the air and say, *well, I'm not a statistician.*

Filip's imperfect uncertainty notation

The idea is simple: apart from regular numbers (like 4 , 3.14 or 43942), you can also input *ranges* (like 4~6 , 3.1~3.2 or 40000~45000). The character

between the two extremes of the *range* is a tilde ($\sim$), a little wave symbol. You can find it on most keyboards, but for convenience, I also included it in the keypad above.

The *range* notation says the following to the calculator: *I am not sure about the exact number here, but I am 95% sure it's somewhere in this range.*

That's it. I thought long and hard about this, and I got to the conclusion that simplicity is key. Yes, we could have notations for different probability distributions, for different confidence levels, for truncations, for covariance, and so on. But that would also make it harder to understand. My assumption is that, if you're already cozy enough with things like confidence levels, you'll want to use something more sophisticated anyway. Here, we're interested in unlocking the power of statistics to a broad audience.

Reading the notation is easy: when you see $10\sim 15$, you say: "ten to fifteen".

Statistics for the rest of us

People short-circuit when they encounter uncertainty. *"Well, this is not certain, but that other thing also isn't, so it doesn't matter."*

It often does!

"Well, I don't know this number exactly, so I'll just pick the first number that seems plausible and calculate with that."

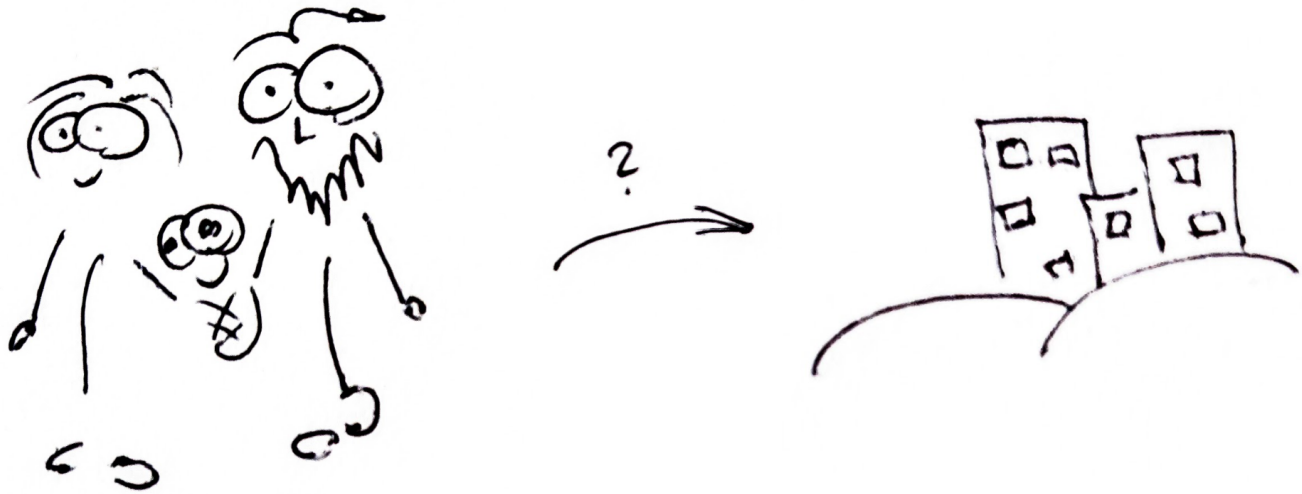
Please don't! Our brains like the simplicity of single numbers, simple answers, but it's a trap. See below.

A practical example

This example is inspired by a true story.

It is the year 2015 and our family has a dilemma. I get a chance to apply for a job in a different part of the world. My wife and I agree it would be pretty sweet to try living

somewhere else for a few years, and we welcome the learning opportunity. On the other hand, we also have a new mortgage for our small flat in the city, and a one year old baby.



I would like to at least know if it's a good move, financially. Will we be losing money? If so, how quickly?

The problem is, nothing is certain. The company won't tell us the salary until *after* we go through most of the steps. I ask friends and random people on the internet about the cost of living in the area, but I get wildly different numbers. Even the tax rate isn't a simple percentage, but "depends".

At first, I go with a simple spreadsheet calculation. I pick a reasonably conservative number for each variable and do the math. \$1,500 salary, 40% tax rate, \$650 rent, \$150 food, \$30 baby stuff, \$20 transportation.

$$1500 * 0.6 - 650 - 150 - 30 - 20 = 50$$

It looks like we'll be making +\$50 each month, assuming we don't spend on anything extra. On one hand, that's cool: we're not considering the move to get rich. On the other hand, it's a little scary. What if I wasn't conservative enough with some of the numbers, and we realize too late that we're bankrupting our family?

I mean, it's good to know that *one potential result* is +\$50 per month. But what about the other possible results?

There's a piece of monologue in a Czech theatrical comedy that I'm quite fond of, and it goes something like this: "According to our carbon dating analysis, this letter was

written on January 21, 1842, plus-minus two thousand years.”



Unsure Calculator to the rescue!

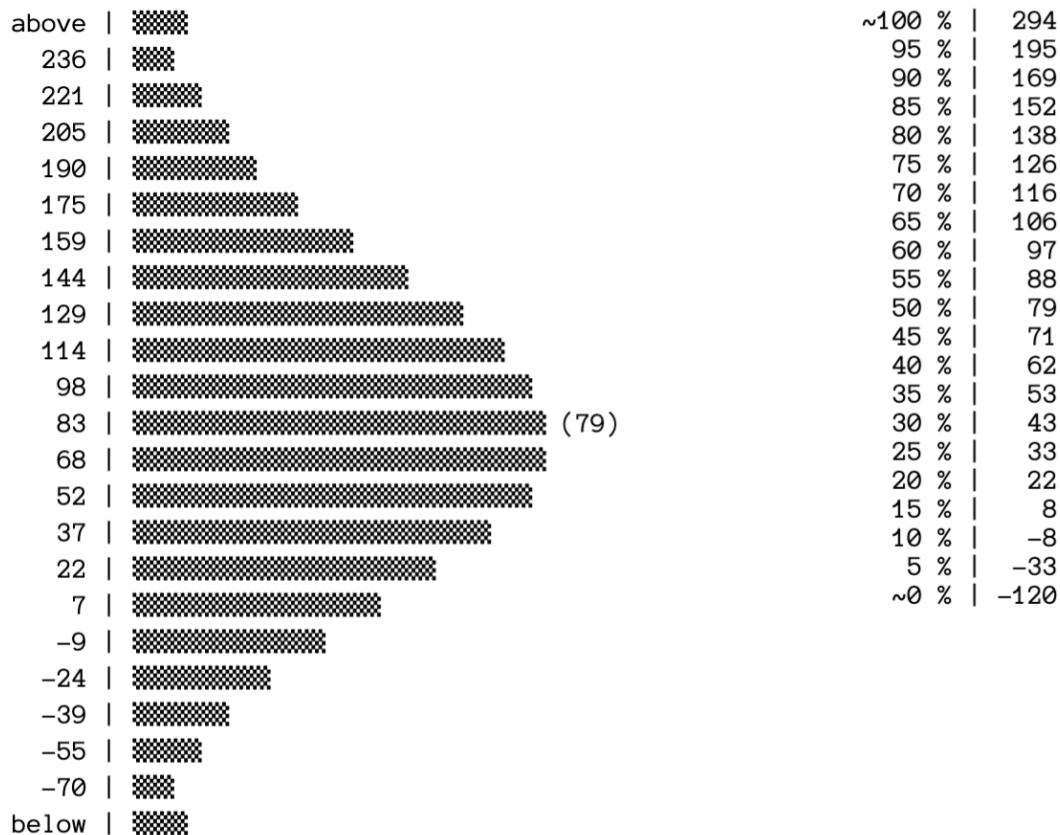
It seems we have quite a few values in our little formula that are actually *ranges*. I'm not sure about the exact value, but I *am* pretty sure about the general range into which each value will fall.

Let's redo the calculation with ranges:

$$1400 \sim 1700 * 0.55 \sim 0.65 - 600 \sim 700 - 100 \sim 200 - 30 - 20 = -60 \sim 220$$

Now, I am 95% sure the real value of each item falls into the range. That means I am also 95% sure the real balance will fall into the -\$60 to +\$220 range. This is much more helpful than the one number before. For one thing, I now know that we could very well be losing money.

I also have the probability distribution and the percentiles.

Histogram ([hide](#))Percentiles ([hide](#))

The percentiles tell me that there's a 10% chance that our monthly balance will be -\$8 or worse. (Because I see -\$8 as the 10th percentile, which means that 10% of the outcomes will be lower than -\$8. Conversely, 90% of the outcomes will be higher than -\$8.) Now, our family can make a better informed decision. Are we willing to risk the 10% chance that we'll be losing money by this move? What about the 5% risk that we'll be losing \$33 or more per month?

The answer to that will depend on the family and the situation. Without a kid and a mortgage, I was way more likely to take risks than I am today. On the other hand, if we didn't have backup plans, I'd be a lot more wary of the 10% chance.

In the end, we did it. And, in our case, it happened to pay back. The end.

A sci-fi example

This tool is meant for practical, everyday calculations. One example of such a use is in the previous section. But I can't pass by the opportunity to make an example that

involves ... aliens.

There is a famous formula in astrophysics called the Drake equation. It is an estimate of the number of civilizations in our galaxy with which communication might be possible.

For example, if we listen to radio signals from the stars, should we expect hundreds of civilizations trying to reach each other in our galaxy? Or is it more like thousands? Or zero? Is it realistic to expect we're alone here?

The Drake equation is actually very simple: it's just a multiplication of 7 numbers:

The original formula (written in 1961 by one Frank Drake) and its values went like this: in our galaxy, there is one star formed per year (R_*), of which one fifth (f_p) have about 3 planets (n_e), of which 100% (f_l) will eventually develop life, of which 100% (f_i) will eventually become intelligent, of which 10% (f_c) will be able to communicate, and will last 1 million years (L).

If you put all these numbers together, you'll get to the number 60,000. There should be 60 thousand civilization at any one time, trying to communicate with each other across the galaxy. Where are they?

As you might expect, there's been a lot of discussion about this equation since 1961. The estimated values for each of the parameters vary wildly between astrophysicists.

So, let's get the latest estimates, and put them into *ranges*. This gives us the following:

$1.5 \sim 3 \times 0.9 \sim 1.0 \times 0.1 \sim 0.4 \times 0.1 \sim 1.0 \times 0.1 \sim 1.0 \times 0.1 \sim 0.2 \times 304 \sim 10000$

If we put it into the Unsure Calculator, we get this:

So, we can expect anywhere between 0 and 450 civilizations. And the probability skews to the lower end (the histogram is wider towards the bottom).

Note: If you're curious why there is a negative number (-5) in the histogram, that's just an inevitable downside of the simplicity of the Unsure Calculator. Without

further knowledge, the calculator cannot know that a negative number is impossible (in other words, you can't have -5 civilizations, for example).

Other use cases

Here are some ideas of how to use this calculator and its notation.

- Estimate viability of a business idea, with uncertain size of the market, uncertain market share, uncertain monthly sales per person, and uncertain operational costs. For example: $50000 \sim 80000 \times 0.10 \sim 0.20 \times 5 \sim 10 - 20000 \sim 50000$
- Estimate future income with uncertain money per month, length of a gig, and tax rate. For example: $1000 \sim 1500 \times 10 \sim 12 \times (30 \sim 50 / 100)$
- Estimate time saved by a dishwasher (or any other piece of technology) given uncertain number of times used per week, uncertain time saving per use, uncertain lifetime and uncertain installation costs. For example: $(3 \sim 5 * 5 \sim 10 * 51 * 7 \sim 15) / 60 - 10 \sim 15$
- Estimate total return of an investment account. Both the interest rate and length of investing is unsure. For example: $5000 \times (-2 \sim 5 / 100) \times 5 \sim 10$
- Estimate the probability of dying in a pandemic, given an uncertain morbidity rate (how many people get sick) and mortality rate (how many infected people die). For example: $(10 \sim 30 / 100) * (0.1 \sim 1.0 / 100) * 100$
- Estimate the height of a skyscraper, given an uncertain distance from its base, and an uncertain angle in which we see the top of it. For example: $100 \times \tan(70 \sim 80)$
- Estimate return on investment of a marketing campaign, given an uncertain number of views, uncertain click through rate, uncertain conversion rate, and uncertain spend. For example: $1000000 \times (2 \sim 3 / 100) \times (3 \sim 5 / 100) \times (10 \sim 15)$

Available functions

In the keypad above, you will only find $+$, $-$, $\times$ and $/$. But the calculator supports more than that, even in this early stage. You can calculate 2^3^4 (two to three, to the power of four), $\text{sqrt}(10^{12})$ (square root of ten to twelve) or $\sin(90^{95})$ (sine of ninety to ninety five degrees).

Limitations

This is a one man show. You should expect breakages. The formula parser is brittle and gives unhelpful error messages.

The computation is quite slow. In order to stay as flexible as possible, I'm using the Monte Carlo method. Which means the calculator is running about 250K AST-based computations for every calculation you put forth.

The UI is ugly, to say the least.

The only way to share formulas is to manually construct a URL. For example, sending someone to `https://filiph.github.io/unsure/#f=20~30` will auto-compute 20^{30} for them.

Range is always a normal distribution, with the lower number being two standard deviations below the mean, and the upper number two standard deviations above. Nothing fancier is possible, in terms of input probability distributions.

And of course, this is not a statistician's tool. Use the Unsure Calculator for back-of-a-napkin calculations. For anything more involved, use one of the free or paid statistical tools, a full programming environment, or hire a statistician.

I hope some people will find this tool useful, despite the limitations and despite its spartan design.

P.S.: If you want to help improve this tool, or if you want to get the command-line version, go to github.com/filiph/unsure.

P.P.S. (**update 2025**): I've been using this notation and tool for the past 5 years, and it's now an indispensable part of my workflow when starting any new project. A more recent "notebook" version of the app can be found [here](#) — that one is less beginner-friendly, but more helpful for "power users" (N=1). If you're interested in this project, you can [follow me](#) or subscribe to [my mailing list](#) (check "software development" as the topic you're interested in).