444 Lecture 26

Network Epistemology

Brian Weatherson

4/13/23

Day Plan

Density Functions

Potted History

Sullivan et al

Networks

Wisdom of Crowds

Methods

PDF

Probability density functions are ways of expressing probabilities over continuous values.

- Example: Probability that we will get precipitation in such-and-such interval over the next 12 months.

- For any given number, probability that precipitation is exactly that is zero.

- But probability that we get between 30 and 36 inches of precipitation is an interesting number.

Example
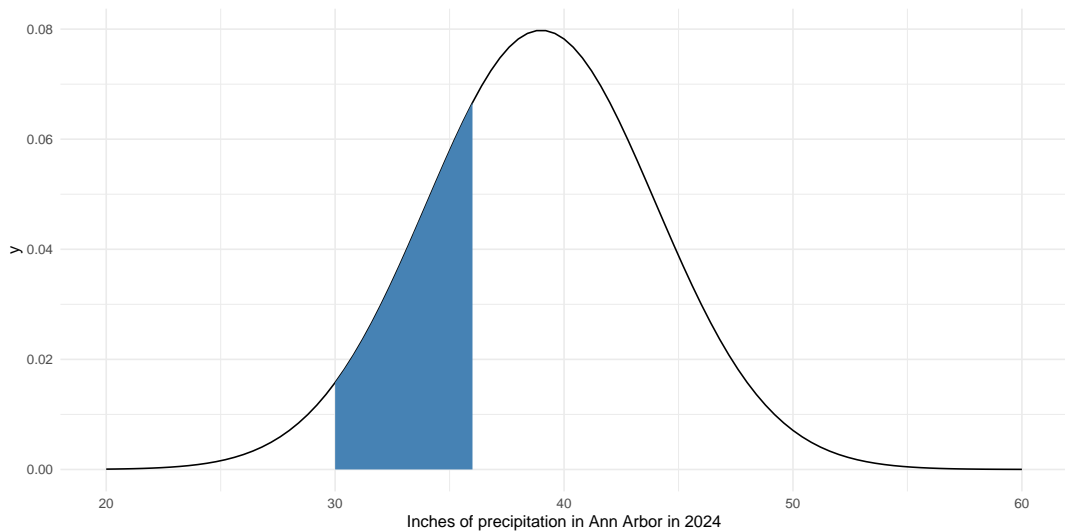
Question

What is the arithmetic mean of two PDFS?

- Answer: Just take the arithmetic mean of the value at each point.

Question

What is the geometric mean of two PDFS?

- Possible answer: Take the geometric means of the value at each point and renormalise.

- Does that preserve the cool features of discrete geometric means? Not sure – hard question.

How PDFs get used

- Step 1: Come up with the 'shape' of the density function, either by armchair reasoning or background knowledge.

- Step 2: Observe the target phenomena to set the parameter values.

Normal Distribution

A common answer to step 1 is that the 'shape' should be the normal distribution. (Not going to go over what that is - it's in early stats classes.)

- Two parameters.

- First is mean - which is obvious.

- Second is standard deviation, which is *very roughly* half the distance between the mean and values that would be *weird*.

Cauchy distribution

Inches of precipitation in Ann Arbor in 2024
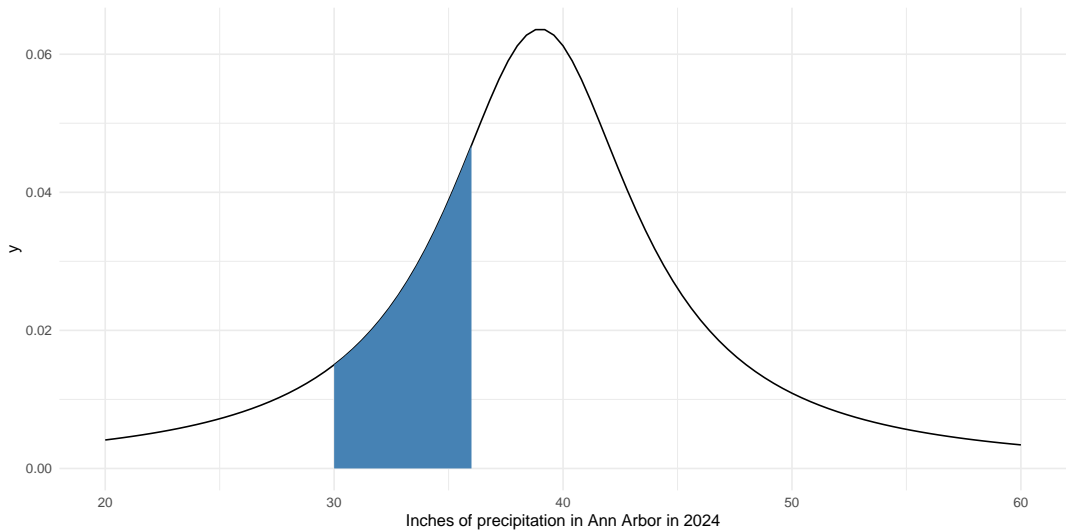
Larger Tails
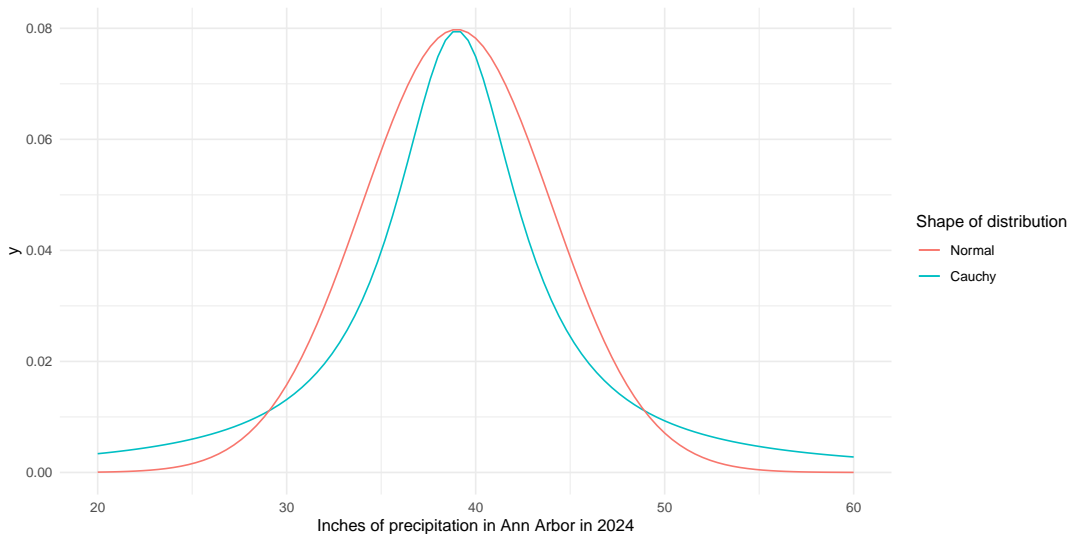
Problems

Sometimes the differences between shapes only show up in very rare cases.

- But those cases, like a pandemic, or a stock market crash, or a massive snow storm, are really practically important.

- If you see people talking about 'fat tails', that's what they mean.

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A Puzzle

Assume some people have non-probabilistic yes/no judgments on a bunch of propositions.

- Question: How do you get a group judgment?

Obvious Answer

Majority Rule.

- The group believes p iff a majority of members believe p.

Problem 1

What to do with ties.

- Maybe that's ok, just neither belief nor disbelief.

Problem 2

Leads to inconsistency.

- E.g., we each agree that precisely one team will win the playoffs, and the three of us disagree about which it is.

Practical Consequence

This matters a lot in jurisprudence.

- When do judges decide on a question point by point, and when all at once.

Philosophical History

Lots of detailed approaches, none of them particularly attractive.

- General thought (through 2000s), should just get people to state probabilities, those are easy to merge.

- Implicit thought: the merger is by arithmetic means.

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Methods and Conclusions

- The conclusions of the Sullivan et al paper aren't very surprising.

- The 'wisdom of crowds' isn't very wise on politically charged matters, even when you measure it very carefully.

- But the methods are really interesting, and point to very interesting kinds of research.

- This includes both conceptual and empirical research.

Methods

- Look at networks not just individuals.

- Focus on the asymmetric links in these networks.

- Use computer science tools to both analyse and investigate these networks.

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A Brief History of Western Epistemology

- Dawn-of-time to 1990s: Epistemology is primarily about sense perception and inference.

- 1990s-2010s: Testimony is really important too.

- 2020s: And testimony isn't just a one-one relationship; it happens in networks.

I'm stressing *western* here because the relationship between testimony and other forms of knowledge is a very big deal in plenty of other philosophical traditions.

Simple Testimony

- One speaker; one hearer.

- Two big questions.

- First, what prior knowledge does hearer have to have to get knowledge from speaker?

- Second, is there is something special about being spoken to, as opposed to overhearing?

Network Testimony

- Breaks down the recipient/eavesdropper distinction.

- Is the TV news anchor talking to *you*?

Network Testimony

- Cross-topic connections can start to matter.

- Is who you trust on vaccines related to what they say on climate change?

Network Testimony

- If the network is a huge part of your contact with the world, what happens when the network 'chooses' to prioritise some information over others.

Some Empirical/Philosophical Questions

- Are networks with strong centers better or worse at getting/distributing/filtering information than networks with weak centers?

- What makes someone become central to a network?

- What happens when people use views on one topic to choose a network to trust on other topics?

Day Plan

Condorcet

Marquis de Condorcet (1743-1794)

Jury Theorem

If you have a large bunch of people who make a judgment on a question, then the majority answer will almost certainly be right given the following constraints:

1. Each has a success probability greater than 0.5.

2. Each makes their judgment independently.

Jury Theorem

- The first constraint doesn't always hold in real world cases.

- The second never does.

- Some work on how much it can be weakened, but it's a challenge to get much out of it.

Real World Data

There are some impressive cases where this works though, especially on things that are not politically charged.

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Real World Case

Sullivan et al use a real world case: Twitter posts about vaccines.

- Upside: Gotta say something about the actual world eventually.

- Downside: So much noise

Asymmetric Networks

This adds a surprising amount to the computational complexity.

- But it does make for more realistic models.

PageRank

- As you might know, PageRank was initially developed to power the Google search engine.

- But it's a very general mathematical construction, that can be used in any case where there are inbound and outbound links.

- And it makes sense in any case that the existence of those links indicates (sort of) trust.

PageRank

- Most statistical programs these days have an implementation of PageRank built in to them.

- The math behind it isn't very sophisticated, but because of the iterative nature of it, actually doing the calculations can be time-consuming.

- But again, that's been optimised a lot in readily available software.

Sentiment Analysis

- They use something called latent Dirichlet allocation to do this.

- I could talk all day about this if you want (quite literally – I wrote a book using this tool).

- It's a weird tool for this purpose.

Sentiment Analysis circa 2023

- GPT rules everything.

- This is a remarkably good use case for it.

- It's less good than expert analysis, but better than non-expert analysis.

- And in studies I've seen, it's much closer to experts than non-experts.