

305 Lecture 10.1 - Learning from Evidence

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Plan

- Today we're going to talk a bit about how to learn from uncertain data.
- We've talked a bit about the mathematics of how to update in clear cases.
- Today we're going to talk about less clear cases.
- And to do that, it helps to start with a story.

Associated Reading

- This is a build up to part 3 of Odds and Ends, but this particular story isn't in the book.
- It's too good a story to leave out though.

Abraham Wald



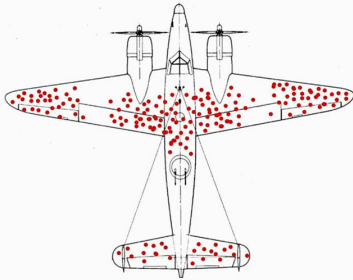
We're going to do a bit of math,
but we'll start with a point made
by someone who was a
mathematician (and a good one)
that doesn't require any math.

Abraham Wald

Surviving Gunfire

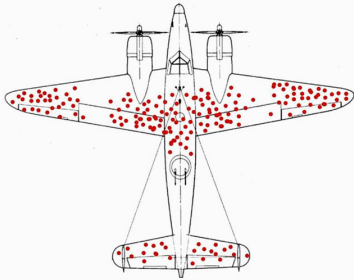
- The backstory is that during WWII the Allies were losing a lot of planes to German artillery.
- They were thinking about how to add armor to the planes in order to defend them better.
- So they investigated the planes that had come back to see where they were getting most bullet holes, and planned to add extra armor to those parts.

The Evidence



Bulletholes

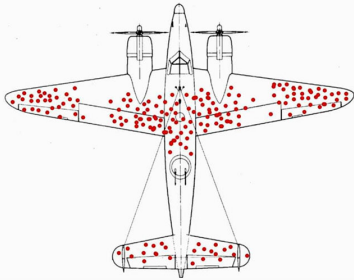
Here's a representation of where they found holes in the planes.



Bulletholes

Where should they add the armor?

Wald's Answer



Bulletholes

You should put the extra armor where the holes aren't.

Hypothesis One - The Original Airforce View

- The planes coming back are our best sample of the planes in the field.
- The bullet holes in them are asymmetrically distributed.
- So that's evidence that certain parts of the planes are more likely to get hit.
- And that's where we should add extra protection.

Hypothesis Two - Wald's View

- Bullet holes are almost surely randomly distributed.
- The planes coming back are not a random sample of the planes in the air.
- They do not include all of the planes that crashed.
- The best explanation of the asymmetry is that the 'missing' bullet holes are for the planes that crashed.
- And the best explanation in turn for that is that those are the places where bullet holes are fatal to the plane.

Who Was Right

- We nowadays think Wald was.
- Artillery, especially artillery of that era, is really a random process.
- Moreover, the places with no holes - the engines and the cockpit - are just where you'd expect fatal injuries to occur.
- So the thing to do was to protect those areas, and try to turn fatal injuries into non-fatal ones.

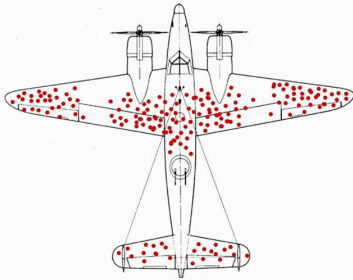
Big Lesson

When you see that p is true, there are two different possible lessons to learn.

1. p is true.
2. I'm seeing that p is true.

Very often, the second is the right lesson to draw.

Example



Bulletholes

- A plane comes back with a bullethole in its left wing.
- That tells us that this plane got shot in the left wing.
- It also tells us, from the fact that we can see that this plane got shot in the left wing, that this damage is non-fatal.

Big Picture

- We want to learn from our evidence.
- But sometimes that requires thinking about why we got just this evidence.
- And to do that it helps to have a theory about how to think about how evidence bears on uncertainty.

For Next Time

We'll talk about an error in thinking probabilistically that some people make - the gambler's fallacy.