

The story of Jon Snow...



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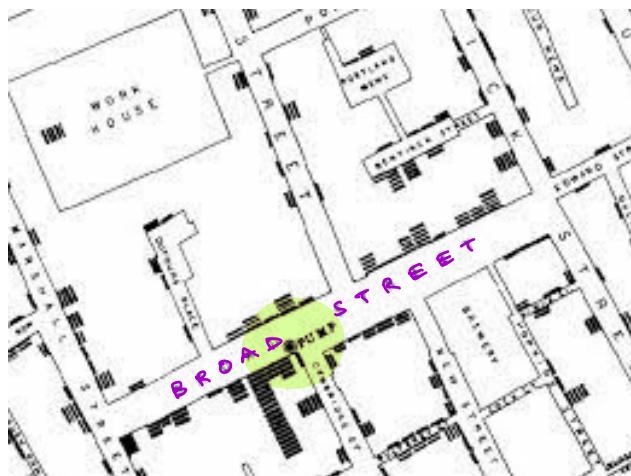
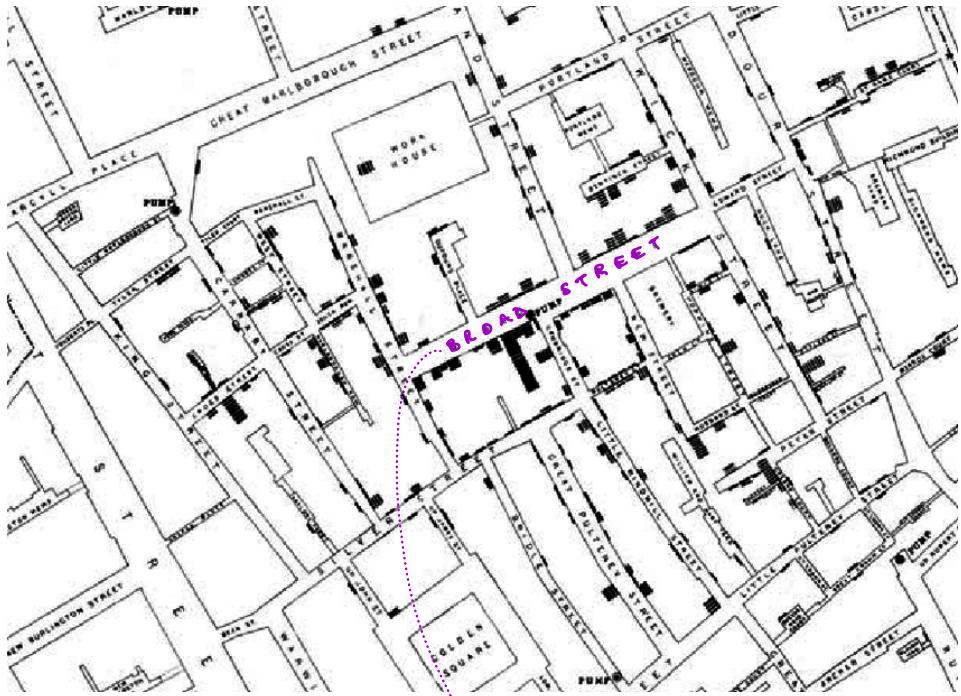
not really !

Jon Snow (1813 - 1858)



✓

1854 Cholera Outbreak (London)



Moral of the story : Visualization matters !

Review of Elementary Logic

* Given two statements A and B ,

Name	Schema
Statement	$A \Rightarrow B$
Converse	$B \Rightarrow A$
Contrapositive	$\neg B \Rightarrow \neg A$
Inverse	$\neg A \Rightarrow \neg B$

* Linguistic conventions

A only if B

$$A \Rightarrow B$$

A if B

$$B \Rightarrow A$$

A if and only if B
iff

$$A \Leftrightarrow B$$

B is necessary for A

B is sufficient for A

B is necessary and
sufficient for A .

$$\boxed{(A \Rightarrow B)} \equiv \boxed{(\neg B \Rightarrow \neg A)}$$

Modes of Reasoning

- * Deduction ↴ used primarily in mathematics
- * Induction ↴
- * Abduction ↴

primary mode of reasoning
in science, engineering, etc.

Deduction is also used in
science / engineering once we
have a mathematical model!

Deduction

- * Primary mode of reasoning in axiomatic systems.
- * Given a bunch of axioms (that are assumed to be true)
deduce logical consequences of these axioms to
establish the truth of other statements.

How do we know
this?

* Example MODUS PONENS

If $C \Rightarrow E$ is true
and C is true
then E has to be true

no room for
doubt / uncertainty

* Deduction is the strongest form of reasoning !

Example :

C : m is prime and $m > 2$.

E : m is odd

$C \Rightarrow E$ is true.

Choosing $m = 17$, we see that

C is true

$\Rightarrow E$ is true : 17 is odd

In practice, the contrapositive is more useful here :

18 is even & $18 > 2 \Rightarrow 18$ is not prime.

Induction

- * Induction is characterized by **extrapolation** from empirical observations.

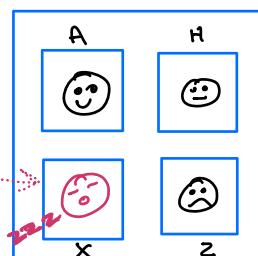
Does not have the logical certainty of deduction!

- * A special kind of induction is **generalizing** from the particular to the general.

Example:

Due to a glitch in MS teams, the video of students turned on momentarily during the lecture on five different occasions.

Student Mr. X was found to be happily napping on all 5 occasions.



Induction: Mr. X naps in all the lectures!

Abduction

* If we observe an effect E , what cause C best
explains E ?

* Abduction is also called Inference to the Best Explanation (IBE) for this reason.

* A typical scenario:

- Whenever condition C is present, the effect E is observed.
- E is observed.
- C is likely to be the cause of E .

how likely exactly?

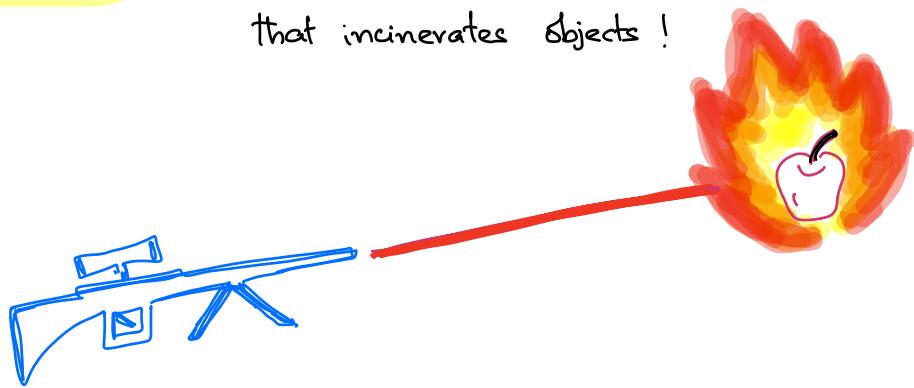
do you smell PROBABILITY theory?

* IBE is the most common kind of reasoning
in science, engineering, data analysis,

We observe epicycles in the night sky. What causes it?

Pop Quiz 1

- * Your physicist friend develops a laser gun that incinerates objects!



after doing a lot of experiments

- * She notices [↑] that

Laser gun incinerates object **IF** object has carbon

- * You are fascinated by this. You pick up a "random" object from your bag and give it to her.



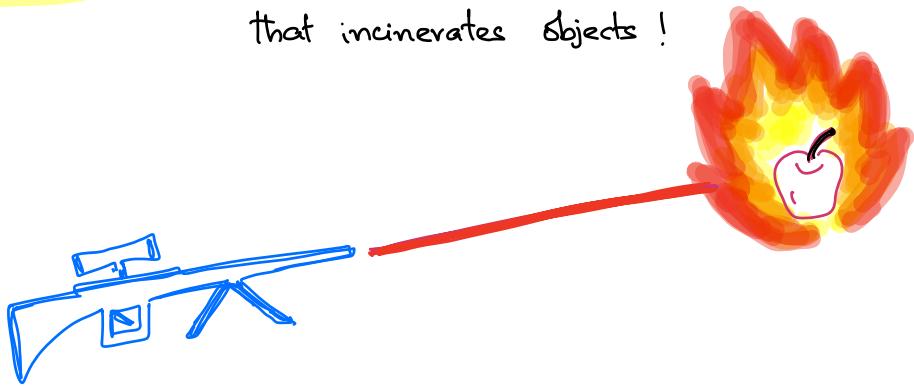
- * Your friend points her laser gun on your object and it burns down. Your friend concludes that your object has carbon in it.

Her argument is

- A. Deductive
- B. Inductive
- C. Abductive
- D. Absurd

Pop Quiz 2

- * Your physicist friend develops a laser gun that incinerates objects!



after doing a lot of experiments

- * She notices [↑] that

Laser gun incinerates object **ONLY IF** object has carbon

- * You are fascinated by this. You pick up a "random" object from your bag and give it to her.

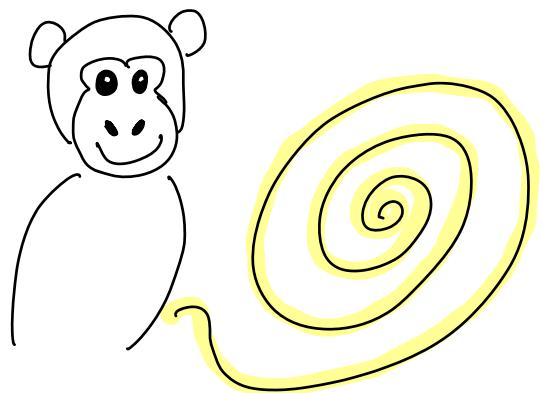


- * Your friend points her laser gun on your object and it burns down. Your friend concludes that your object has carbon in it.

Her argument is

- A. Deductive
- B. Inductive
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- D. Absurd

A tale of tails



... to be continued!