Inductive arguments, inductive fallacies and related biases

Fino PhD Lectures 2019 –Genoa

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Plan of the seminar

1 Induction – Tuesday March 12

- 1 Inductive arguments
- 2 Induction and Probability
- 3 Inductive Fallacies
- 4 Biases

2 Probability & Causal reasoning Tuesday, March 19

Arguments

Deductive vs Inductive

Non ampliative – (containment)

All the information or factual content in the conclusion was already contained, at least implicitly, in the premises

Truth transmission –

If all the premises are true, the conclusion *must* be true

Monotonic

Given a valid deductive argument, we may add as many premises as we wish without destroying its validity (its conclusion)

Ampliative –

The conclusion contains information not present, even implicitly, in the premises

Support –

If all the premises are true, the conclusion is probably true but not necessarily true

Non monotonic –

The degree of support of the conclusion by the premises can be increased or decreased by additional evidence in the form of additional premises

Containment vs Ampliativity

The conclusion contains information not present, even implicitly, in the premises

Deductive :

Every mammal has a heart
All whales are mammals
∴ Every whale has a hearth

Inductive :

Every whale that has been observed has a heart
∴ Every whale has a hearth

Deductive:

The first premises says that all mammals have hearts, and that includes all whales (2.premise).
The conclusion is contained in the premises –

The conclusion explicitly reformulates information already given

Inductive:

the premise refers only to whales which have been observed up to the present, while the conclusion refers to whales which have not yet been observed.

The conclusion makes a statement which goes beyond the information given in the premise.

Transmission of truth vs Degree of support

If a deductive argument its valid, the premises support the conclusion completely: the conclusion cannot be false.

Therefore, a deductive argument is completely conclusive or completely inconclusive.

Deductive arguments are valid or not valid,

In an inductive argument the premises support a conclusion *to a certain degree* (inductive probability)

.

Inductive arguments admit *degree of strength*, depending on the amount of support given by the premises to the conclusion

Inductive arguments are more o less strong

Trade off – expansion of content vs. necessity

Monotonicity vs....

An argument is monotonic *if and only if* the addition of a new premise will never require the elimination of a previously established conclusion.

Deductive arguments are monotonic

Eg.

All the airplanes on the airstrip will take off in hour

Airplan XYZ is on an airstrip

∴Airplan XYZ will take off in an hour

…

Added premise Airplain XYZ is a boeing (is Alitalia, is Lufthansa…)

The added premise does not change the conclusion

…. Non monotonicity

Inductive arguments are not monotonic

Most Italians drink wine

∴ [probably] The next Italian coming into this room drinks wine

…Added premise

The next Italian coming into this room is 4 years old

Different conclusion:

[probably] she will not drink wine

[Note: This inductive argument is not “from particular to universal”]

TEST: Inductive or deductive?

a) In Genoa, 30% of electors will not vote; therefore, in Turin 30% of electors will not vote.

b) Killer whales are mammals, live in the sea and are dangerous; dolphins are mammals and live in the sea; therefore, dolphins are dangerous.

c) 'Rain' and 'not rain' are exhaustive and mutually exclusive states of affair

d) wrt a given scenario; the probability of 'Rain' in that scenario is .70; therefore, the probability of 'Not rain' is .30.

e) The probability that an Italian loves pizza is .80; Half of Italian pizza lovers love "Quattrostagioni"; therefore,the probability that an Italian loves "Quattrostagioni" is .40.

2

Induction and probability (short remark)

Caveat

not all inferences about probabilities are inductive, not all inductive inferences mention probability

Probability Calculus : principles for obtaining new probability values from old ones by means of operations

[it can be framed in a deductive way as a mathematical theory (Kolmogorov's axioms)]

Assigning initial probabilities: Probability calculus depends on methodological (inductive) considerations and on our interpretation of probability

Interpretations of probability

Two main different ways of interpret probability statements:

1. as reports about 'objective' probabilities
   (= measures of real tendencies of occurrences od certain outcomes, reflect observed empirical frequencies: the probability that an human embryo will be male is slightly over .5; …

2. As reports about 'subjective' probabilities
   (measures of the degree of belief in a certain proposition)

3

Inductive fallacies

Hasty generalization (or over- generalization- secundum quid)

An unwaranted induction is drawn on the basis of a few particular observations.

E.g. I have known eight computer scientists and they were all typical nerds; therefore, all computer scients are nerds.

Appeal to coincidence Slothful induction) refusal to admit a probability when evidence suggest it:

"It is a coincidence I had 15 accidents in the last two monts, not my inability to drive my new Station Wagon!"

Insufficient statistics: the sample is too small to allow meaningful generalizations to the entire population.

Biased statistics (unrepresentative sample): the generalization is based on a sample that does not represents the population as a whole.

(E.g. A poll on what Americans think about gun control by interviewing the participants to a National Rifle Association Meeting)

Remedies Sampling theory; randomization

Accident (converted)

Unjustified generalization from exceptions

E.g. Terminally ill people are allowed to use morphine;

therefore

we should legalize it.

4. HEURISTICS AND BIAS

heuristics

Uncertainty - normally we reason with uncertainty:

– Limited information

– Limited computational capacities

[H. Saimon *Bounded Rationality*]

Heuristics – strategies for problem solving in a way that is compatible with the complexity of the task and the limits of our capacity of information storage and processing

[Tversky and Kahneman (1974)
Judgement under uncertainty: heuristics & biases]

Properties of heuristics

(1) Representativeness (2) Availability (3) Anchoring

Pros

– Results 'good enough' (Simon: satisficing), but sometimes subobtimal;
– The loss of optimality is compensated by time saving

Cons

– 'Spontaneous' character of cognitive illusions (like optical illusions)
– Can produce biases in judgment and decisions

Question 1 – births in hospital

Which of the three following sequences of births in a hospital is *the less probable*? (M= male, F= Female)

(1) – MFMFMF

(2) – FMFMMF

(3) – MFFMFM

They have *the same* probability! but the first sequence is *less representative* of a random sequence.

Question 2 Linda

Linda is 31 years old, single, outspoken, and very bright. She has a major in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations. Which of the two is more probable?

(1) Linda is a bank teller.

(2) Linda is a bank teller and is active in the feminist movement.

Kolmogorov law of conjunction

$$\Pr(X\&Y|Z) < \Pr(X|Z)$$

the probability of two events occurring in conjunction is always less than or equal to the probability of either one occurring alone.

Lawyer/Engeneer case (K-T)

Description of Jack.: Jack is a 45-year-old man. He is married and has four children. He is generally conservative, careful, and ambitious. He shows no interest in political and social issues.

He is taken at random among a group of x Lawyers and y Engeneers.

Is he a Lawyer or an Engeneer?

•30:70 Condition: High Base Rate for Engineer

If Jack's description were drawn at random from a set of **30 lawyers** and **70 engineers**, what would be the probability that Jack is one of the engineers?

•70:30 Condition: Low Base Rate for Engineer

If Jack's description were drawn at random from a set of **70 lawyers** and **30 engineers**, what would be the probability that Jack is one of the engineers?

Representativeness

Probability of "engineer" was rated to be the same in the low and high base rate conditions (insensitivity to Base Rate, a.k.a Base Rate Neglect).

Why people ignore base rates? (And in general probability?)

Confusion in our judgment processes between
(1) Event/Property A is *more representative* than Event/Property B
and
(2) Event/Property A is *more probable* than Event/Property B

The *similarity* of the particular case to the stereotype of a category
(random sequence, typical feminist…)
influences how representative this category can be, and be mistaken with probs..

Questions

Are more dangerous

– Airplans

– Cars

(*car accidents are so numerous that bypass any danger to go by plane*)

Are more frequent words in which k is

– the 1th letter

– the 3° letter

(k as third letter is three times more frequent thant first letter)

Are more frequent

– Homicides

– Suicides

(*the murder rate in US is 6 x100.000; suicide are 10.8 x 100.000 – every two murders there are three suicides)*

Availability

Our judgements relies on immediate examples;

– Immediateness of retrieval

(airplane crushes, terms with “K” as firse letter [key, kill, keep,kangoroo…] murders)

– linked to overestimations or underestimations

– Does Turkey have more or less than thirty million inhabitants?
– Please give an estimate of the number of inhabitants of Turkey.

Does Morocco have more or less than thirty million inhabitants?
– Please, give an estimate of hte number of inhabitants in Morocco

Does Iceland have more more or less than thirty million inhabitants?
– Please give an estimate of the number of inhabitants of Iceland

Turkey	Morocco	Iceland
80 ML	35 ML	340.000

Anchoring

Tendency to accept and rely on the first piece of information received (or the number mentioned) before answering.

Are Tversky and Kahnemann right?

An alternative explanation of Linda

(1) "John and Mary got married and had a baby"
(2) "John and Mary had a baby and got married."

A B	(1) A and B	(2) B and A
VV	V	V
VF	F	F
FV	F	F
FF	F	F

and = *and then*

(1a) Linda is a bank teller.

(2a) Linda is a bank teller a feminist

(1b) Linda is a bank teller (and NOT a feminist)

(2b) Linda is a bank teller and a feminist

(2a) Linda belongs to the set of (1a) – and P(1a) > P (1a)+ (2a)

(2b) Linda cannot belong to (1b) and, given the description, P(2b) > P(2a)

(1) **semantics** (strictly speaking)

pragmatics (loose talk)
interpreting the *implicit*

Have you had breakfast?
(1) "Yes" [you had breakfast yesterday or at least once in you life]
(2) "yes" [you have had breakfast this morning]

Do you know what time it is?
(1) "Yes, I do"
(2) Oh yes, it is more or less 11.30 a.m.

The intuitive answer in Linda case (that she is feminist is more probable) is grounded in a useful intellectual skill:

that of being able to determine the *implicit* in conversation:
what is relevant, or
what the speaker is attempting to convey
rather than what is semantically expressed

- Hilton, D. J. (1995). The social context of reasoning: Conversational inference and rational judgment. Psychological Bulletin, 118:248–271.
- Hertwig, R. and Gigerenzer, G. (1999). The 'Conjunction Fallacy' Revisited: How Intelligent Inferences Look Like Reasoning Errors. Journal of Behavioral Decision Making, 12:275–305.
- Sides, Ashley, Daniel Osherson, Nicolao Bonini, and Riccardo Viale. "On the reality of the conjunction fallacy." *Memory & Cognition* 30, no. 2 (2002): 191-198.

Exercises

To see how Americans will vote in the next election we polled a hundred people in Grenwich Village and in Brookling (New York). This poll shows almost conclusively that the Democratic Party will win the next elections.

Biased statistic-unrepresentative sample –there there is plenty of democrats

All swans are white and all crows are black

Hasty generalization – there are albino crows and black swans ☺

Nigerians are invading my town as cocaine dealers

Hasty generalizations, as if all nigerians are cocaine dealers

The drug has been fatal in 100 previous tests, but how do you know some unknown factor wasn't present causing the deaths? Maybe the drug is perfectly safe

Slothful induction (contrary of Hasty generalization)

We should give our papers in two months time. Therefore also X (who had an accident) has to give the paper in two months.

Accident

You permitted a delay in sending the paper to X (he was ill), then you have to allow me too to send my paper later

Accident (converse)

Lewis Carroll

Once master the machinery of Symbolic Logic, and you have a mental occupation always at hand, of absorbing interest, and one that will be of real use to you in any subject you may take up.

It will give you clearness of thought - the ability to see your way through a puzzle - the habit of arranging your ideas in an orderly and get-at-able form - and, more valuable than all, the power to detect fallacies, and to tear to pieces the flimsy illogical arguments, which you will so continually encounter in books, in newspapers, in speeches, and even in sermons, and which so easily delude those who have never taken the trouble to master this fascinating Art.

http://www.math.hawaii.edu/~hile/math100/logice.htm