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Inductive arguments, inductive fallacies and related biases

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- Plan of the seminar
- 1 Induction
 - 1.1 Inductive arguments
 - 1.2 What 'probability' means? *A very short introduction*
 - 1.3 Inductive Fallacies
 - 1.4 Biases
- 2 Probability & Causal reasoning

1.1 Inductive arguments

- What are arguments?
- What are *inductive* arguments?
- What properties make them different from *deductive* arguments?

Deductive arguments

Non ampliative – 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

Inductive arguments

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

1. 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 explicitly reformulates information already given in the premises.

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.

2. Transmission of truth vs Degree of support

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

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

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

- Deductive arguments are valid or not valid, inductive arguments admit **degree of strength**, depending on the amount of support given by the premises to the conclusion

Trade off – expansion of content vs. necessity

3. Non monotonicity

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 airstrips 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.

Inductive arguments are not

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

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

Non monotonicity at work

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

Most Italians drink wine

Mario is italian

Therefore

Mario drinks wine [With high inductive probability: the argument is strong]

- Add the premise 'Mario is 4 years old':

Most Italians drink wine

Mario is italian

Mario is 4 years old

Therefore

Mario drinks wine

[Now the inductive probability of the conclusion is lower than before]

1.1 Inductive arguments

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

1.1 Inductive arguments

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 operation = mathematical theory (Kolmogorov's axioms) = deduction

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

1.2 What 'probability' means? A *very* short introduction

- **Interpretations of probability**
- Two main different ways of interpret probability statements:
 - 1. as reports about '*objective*' probabilities
 - (= measures of real tendencies of occurrences of certain outcomes, reflect observed empirical *frequencies*: the probability that a 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)

- **1.3 Inductive Fallacies**

1.3 Inductive Fallacies

Hasty generalization (or over-generalization- secundum quid)

An unwarranted 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 scientists are nerds.

Sub-species

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

Biased statistics – the generalization is based on a sample that does not represent 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

1.3 Inductive Fallacies

Accident (converted)

Unjustified generalization from exceptions

E.g.

Terminally ill people are allowed to use morphine;
therefore we should legalize it.

1.4 Biases

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

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

- **Properties of heuristics**

- Results 'good enough' (Simon: *satisficing*), but sometimes sub-optimal; the loss of optimality is compensated by time saving
- Can produce biases in judgment and decisions
- 'Spontaneous' character

Heuristics and biases

- How do people assess the probability of an uncertain event or the value of an uncertain quantity?
- «People rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simple judgemental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors».
- *Spontaneity* of biases: biases as cognitive illusions, analogous to optical illusions.

1.4 Biases

Heuristics

Representativeness

- What is the probability that A belongs to category B?
- Si valuta tale probabilità in base al grado in cui A è simile a un B.

Esempio

In un esperimento si descrivono a due gruppi di studenti le personalità di alcuni individui estratti a caso da un gruppo di ingegneri e di avvocati e si chiede loro di indicare loro la probabilità che la persona descritta sia un ingegnere.

Lawyer/Engineer Problem (K&T, 1973)

- 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.

•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?

- **Judgement process from**

Event/Property A is more representative than Event/Property B

to:

Event/Property A is more probable than Event/Property B

- The similarity of the particular case to the stereotype of a category influences how representative this category can be.

Representativeness

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

MFMFMF

FMFMMF

MFFMFM

- A.: They have the same probability, but the first sequence is less representative of a random sequence.

Availability

Our judgements relies on immediate examples;
immediateness of retrieval

linked to overestimations or underestimations

E.g.

- Frequency of words in which r is
the 1th letter
the 3° letter

- Are more frequent

Homicides
Suicides

- Are more frequent

Airplan accidents
Car accidents

Anchoring and adjustment

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

E.g.

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

Exercise

What are

Confirmation Bias

Bandwagon effect

Baader-Meinhof Effect ?

Are they inductive biases, and if they are, why?