Bayesianism

Preliminary Remarks

- Last time: Qualitative Confirmation

- Is there a quantitative way to revise our beliefs in light of evidence?

- This week: Bayesianism

Bayes Theorem

- Bayes Theorem: $P_{new}(H) = P(H/E) = P(E/H) \times P(H) / P(E)$

  P (H/E) – posterior probability (we can call this ‘P_{new} (H)’)

  P (E/H) – likelihood of evidence

  P (H) – prior probability of hypothesis

  P (E) – expectedness of evidence or prior prob. of evidence

- Orthodox (i.e. subjective) Bayesians take all probabilities as subjective degrees of belief.
- The subjective interpretation allows us to plug in our degrees of belief as values on the right hand side of the equation.
- Bayes theorem provides a rule for correctly updating our beliefs.

Bayesianism

- Bayesianism is a confirmation theory whose central tool is Bayes theorem.

- The Relevance Criterion of Confirmation:
  - E confirms H if and only if $P(H/E) > P(H)$
  - E disconfirms H if and only if $P(H/E) < P(H)$

- Bayesianism has prima facie appeal in that it provides a quantitative account of confirmation based on the probability calculus.

Bayesianism (2)

- Advantages:

  (1) Entailment: When H entails E, E confirms H.

  Suppose that H entails E, and that $1 > P(H) > 0$ and $1 > P(E) > 0$.

  From H entails E we know that $(E/H) = 1$. $P(H/E)$ is thus reduced to $P(H)/P(E)$. That means that $P(E) \geq P(H)$, otherwise $P(H/E) > 1$ something that is disallowed by our axioms.

  - If $P(E) = P(H)$ then $P(H/E) = 1$. Since $P(H) < 1$, E confirms H.

  - If $P(E) > P(H)$ then $P(H/E) > P(H)$, i.e. E confirms H.

  <u>THUS</u>: Provided the above conditions hold, any consequence of H confirms H.

  <u>Upshot</u>: Being able to deal with cases of entailment means that it can deal with explanations given in the H-D model.

Bayesianism (3)

(2) Surprising Evidence

Unexpected evidence is meant to give greater confirmation to theories. Given that P(E) is alone in the denominator: The lower the probability of the evidence > The more surprising the evidence/prediction > The higher the confirmation.

<u>Example</u>: 19th century optics. Poisson discovered that Fresnel’s wave theory of light predicts a white spot in the middle of the shadow of an opaque disk when in the path of a narrow beam of light. This was completely unexpected. When Arago experimentally confirmed this prediction, the wave theory quickly received widespread acceptability.

<u>Upshot</u>: It accounts for Popper’s demand for risky predictions. Of two deductive consequences of a hypothesis, the more improbable one confirms it more strongly because: $p(H|E_1) = p(H) / p(E_1) > p(H) / p(E_2) = p(H|E_2)$

where $p(E_1) < p(E_2)$.

According to Popper, scientists must make risky predictions to test their theory. (NB: Popper didn’t believe in confirmation but only in corroboration).

Bayesianism (4)

(3) Raven paradox

The paradox does not say how strongly the observation of a non-black non-raven thing confirms the original hypothesis. Bayesianism allows us to assign very low confirmation values to non-black non-ravens (vs. black ravens).

One argument goes like this: Since (our background knowledge about the world tells us that) there are many more non-black non-ravens in the world than black ravens, the expectedness of 'x is not black & x is not a raven' is much greater than the expectedness of 'x is a raven & x is black'. But, the higher the expectedness, i.e. P(E), the less the confirmation.

<u>Upshot</u>: The paradox is dissolved since black ravens confirm the hypothesis 'All ravens are black' much more than non-black non-raven things.

Objections to Bayesianism

(1) The problem of choosing priors

To get results we must plug in *subjective* values for the prior probability of the hypothesis and the expectedness and likelihood of the evidence.

Reply: As the data accumulates the choice of priors loses significance. Washing out / swamping of the priors.

(2) Simplicity:

Suppose H_2 is a deoccamised version of H_1. Since the two entail the same evidence, their likelihoods are the same. So, Bayesians cannot appeal to likelihoods to explain the 'economic difference' between these theories.

Reply: Assign different prior probabilities

Problem: To identify that a theory has 'extra wheels' is only judged relative to a body of evidence.

Objections to Bayesianism (2)

(3) Zero priors:

The posterior probability $P(H/E)$ will always equal zero if either: (i) the prior probability $P(H)=0$ or (ii) the likelihood $P(E/H)=0$. Indeed, Popper held that the probability of a universal law with infinite instances is zero.

Reply: Never assign zero probabilities to theories!

(4) The Problem of Old Evidence:

To support their theories, scientists often appeal to facts that are already known. But, if evidence is ‘old’ then $P(E) = 1$ and also $P(E/H) = 1$. So, E cannot confirm H contrary to what we seem to think happens in science.

Reply 1: Bite the bullet, i.e. old evidence cannot confirm.

Problem: This goes contrary to our intuitions.

Objections to Bayesianism (3)

(4) The Problem of Old Evidence - continued:

Reply 2: Deny that P(E) = 1. We can assign a value to P(E) in a counterfactual way, i.e. If E were not know yet, then P(E) = ...

Problem: There is no satisfactory way to calculate P(E).

Rejoinder: Howson (1991) – Subjective Bayesianism *allows* for different individuals to calculate P(E) differently.

Reply 3: Garber (1983), Niiniluoto (1983), Jeffrey (1983) – Adopt a new criterion for confirmation to replace the standard relevance criterion. For example,

E confirms T if and only if P(T/T *explains* E) > P (T).

Problem: Howson (1991) – Historical counterexamples, e.g. Newton's theory and Kepler's laws.

Food for Thought

- Can we get an objective theory of confirmation off the ground?

Reading

- Glymour, C. (1980) ‘Why I am not a Bayesian’, in Curd and Cover, pp. 584-606.