Physical Probability 1
Compatibility with Determinism; Frequency Theory

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Introduction

- "Physical probability" is the non-logical sense that the word "probability" has in ordinary language (see Confirmation 2).
- These lectures will discuss how to explicate this concept.
- Abbreviation: "pp" for physical probability.

Other terms for pp

- *Objective probability* (Howson and Urbach, Gillies)
  - Since inductive probability is also objective, this is poor terminology.
- *Chance* (Levi, Lewis, Mellor, Skyrms)
  - In ordinary language, "chance" is interchangeable with "probability," so this uses "chance" in a special sense.
  - These authors don't distinguish explicandum from explicatum, so their "chance" is not clearly what I mean by "pp."

Compatibility with determinism

Example

Ordinary language statement:

The probability of heads on a toss of this coin is 1/2.

This relates three things:

- An **experiment**: Tossing this coin.
- An **outcome**: This coin landing heads.
- A **number**: 1/2.

General form of pp statements

The pp of experiment X having outcome O is r (a number).

Abbreviation: $pp_X(O) = r$.

Types versus tokens

- An *experiment token* is a particular event at a particular place and time; it is unrepeatable. E.g., Maher's tossing of a quarter at 1:04pm on November 9, 2006.
- An *experiment type* is a kind of event, e.g., tossing this coin. There can be many tokens of the same type.
- Similarly for outcomes: We can distinguish *tokens* and *types* of outcomes.
- A pp statement relates *types* of experiments and outcomes, not tokens. E.g.,
  - $X =$ tossing this coin (a type)
  - $O =$ this coin landing heads (a type)
  - $r = 1/2$.

One token belongs to many types

A particular (token) coin toss belongs to the following types:

- X: Toss of this coin.
- X': Toss of this coin, starting with the coin in such-and-such a position, with such-and-such a force applied at such-and-such a point, etc.

If $O =$ heads, then $pp_X(O) = 1/2$ but $pp_{X'}(O) = 0$ or 1.

In general: pp is different for different X, even though the different X may share some tokens.

Determinism and pp

- Determinism is the view that the state of the world at one time, together with the laws of nature, completely determine the state of the world at all later times.
- Many philosophers say that if determinism is true, then all pp's are 0 or 1 (Laplace, Lewis, Giere, Mellor).
- But the concept of pp isn't like that.
  - We attribute intermediate pp's in games of chance, while believing that the underlying processes are deterministic.
  - Scientific theories in statistical mechanics, genetics, and social sciences postulate non-extreme pp's in situations where the underlying laws are believed to be deterministic.
- How this is possible:
  - pp relates experiment and outcome *types*, not tokens.
  - Determinism only implies that if X were sufficiently specific, then $pp_X(O)$ would be 0 or 1.
  - But X need not be this specific, and hence there can be more than one possible outcome of X.

Frequency theory

Background

- Let n = the number of observed occurrences (tokens) of X.
- Let m = the number of these occurrences that give O.
- In many cases, when X is repeated, the occurrences of O are random, but m/n eventually settles down near some value (e.g., $1/2$ for tossing a normal coin hundreds of times).

Statement of the theory (my formulation; based on Mises 1957)

Define a function $f_X(O)$ as follows:

> $f_X(O) = r$ iff, in an infinite sequence of repetitions of X, O would occur randomly but m/n would approach r as a limit.

The theory proposes $f_X(O)$ as an explicatum for $pp_X(O)$.

Criticism of the frequency theory

Consider a simple example, e.g., X is tossing a particular coin and O is the coin landing heads. We can suppose $pp_X(O) = 1/2$. But:

1. O may occur or not on each trial of X, so the occurrences of O need not be random. Hence it is not true that O would occur randomly.
2. Similarly, it is not true that m/n would approach a limit; it need not.
3. Similarly, if it did approach a limit, there is no value that the limit would be; it could be any number from 0 to 1.

For all these reasons, $f_X(O)$ does not exist. Therefore, f is not similar enough to pp to be able to be used in place of pp, and hence is a poor explicatum.

Questions

1. What is an experiment token? What is an experiment type? Give an example of each.
2. What is determinism? Is it possible for pp's to have values other than 0 or 1 if determinism is true? Explain.
3. Suppose $f_X(O)$ is defined as follows:

   > $f_X(O) = r$ iff, in an infinite sequence of repetitions of X, O would occur randomly but m/n would approach r as a limit.

   Is $f_X(O)$ a good explicatum for $pp_X(O)$? Why, or why not?

References

- Isaac Levi, "Chance," *Philosophical Topics 18* 2 (Fall 1990), 117–149. Reconciles pp with determinism in essentially the same way I have done (though with different terminology).
- David Lewis, "A Subjectivist's Guide to Objective Chance," reprinted with postscripts in Lewis's *Philosophical Papers* vol. 2, Oxford U.P. 1986. Takes pp to be relative to the whole prior history of the world, rather than to types of experiments, and hence asserts that pp is incompatible with determinism.
- Richard von Mises, *Probability, Statistics and Truth*, 2nd English edition, George Allen & Unwin 1957. Dover reprint. A classic and readable presentation of the frequency theory.