MA-250 Probability and Statistics

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Lecture 10

Probability

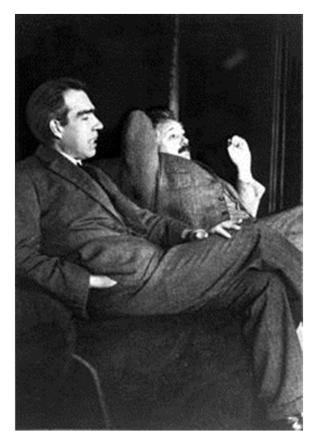
- One of the most important branches of Mathematics.
- Many problems can be reformulated in terms of a probabilistic framework.
- Can be rather unintuitive.
- Has its own language and terminology.
- Motivation: Chance error!
 - Real world always has chance errors. How do we get the best predictions in presence of such uncertainty.

Outline

- Quantifying Probabilities
- Simple Sample Spaces
- Probabilities via Counting Elements
- Probabilities via Measuring Sizes

God does not play dice with the Universe

- Niels Bohr and Albert Einstein were two of the greatest Physicists.
- Bohr argued that real phenomenon can only be understood via uncertainty.
- Einstein rejected it saying: "I am convinced that He [God] does not throw dice."



Niels Bohr with Albert Einstein (1925)

Quantifying Probabilities

- Experiments can be of 2 types
 - Deterministic (we can accurately predict outcome)
 - Random (we cannot accurately predict outcome)
- Prediction is the hallmark of science.
- It is what separates humans from animals.
- Probability theory plays a fundamental role in prediction when the experiment is random.

Three key concepts

- 1. Sample Space
- 2. Events
- 3. Probabilities of events

The next few slides will introduce some terminology that is <u>crucial</u> for understanding Probability. So pay attention!

Terminology

- Outcome of the random experiment is denoted by the symbol ω .
- Sample space the set of all possible outcomes is denoted by the set *S*.
 - For coin toss, $S=\{H,T\}$.
 - − For a roll of the die, S={1,2,3,4,5,6}.
 - Select a number between 0 and 1, S=[0,1].

Terminology

- Event a statement concerning the elements of the sample space
 - Even number on the die, S=[1,2,3,4,5,6] and A=[2,4,6].
- An event is always an element of the sample space. (WHY?)
- Outcomes ω that agree with the statement form the event.
- Probability deals with assigning numbers to events.

Terminology

- Set Theory
 - Union
 - Intersection
 - Complement