

# 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 crucial for understanding Probability. **So pay attention!**

# Terminology

- **Outcome** of the random experiment is denoted by the symbol  $\omega$ .
- **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  $\omega$  that agree with the statement form the event.
- **Probability** deals with assigning numbers to events.



# Terminology

- Set Theory
  - Union
  - Intersection
  - Complement