CSE400 – Fundamentals of Probability in Computing

Lecture 3: Introduction to Probability Theory

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1 Lecture Context and Position in the Course

This lecture is part of **CSE400: Fundamentals of Probability in Computing** and is explicitly titled **"Lecture 3: Introduction to Probability Theory."** The lecture is positioned after the initial course orientation content and before the introduction of advanced probabilistic modeling and algorithmic applications.

The primary role of this lecture is to introduce probability theory as the foundational mathematical framework that will be used throughout the remainder of the course.

2 Purpose and Motivation of Learning Probability

The lecture emphasizes why probability theory is necessary in computing and engineering disciplines.

Logical Structure

1. Computing systems frequently operate under **uncertainty**.
2. This uncertainty arises due to incomplete information, randomness, noise, or variability.
3. Probability theory provides a formal mathematical language to:
    - Represent uncertainty,
    - Quantify likelihoods,
    - Support rational decision-making.

This motivation is presented prior to any formal definitions, establishing probability theory as a prerequisite analytical tool rather than an abstract mathematical subject.

3 Engineering and Computing Applications of Probability

The lecture explicitly lists engineering applications to ground probability theory in real-world computational systems.

Applications Listed

- Speech Recognition
- System Radar Systems
- Communication Networks

Dependency Explanation

1. Each listed system processes uncertain or noisy inputs.
2. Deterministic models are insufficient due to variability in signals and environments.
3. Probability theory enables:
    - Modeling randomness,
    - Estimating unknown parameters,
    - Making statistically justified decisions.

These applications are presented solely as motivating contexts and not as worked examples or case studies.

4 Conceptual Flow of the Lecture

The lecture follows a conceptual progression rather than immediate mathematical formalism.

Flow Structure

1. **Course Framing:** Establishes where probability theory fits within the overall course objectives.
2. **Motivational Reasoning:** Explains why probability is required in computing and engineering contexts.
3. **Application Grounding:** Lists domains where probability theory is essential.

This ordering is deliberate:

- Motivation precedes formalism.
- Applications precede abstraction.
- Conceptual understanding precedes mathematical rigor.

5 Academic and Instructional Structure

The lecture is delivered within an active learning framework supported by:

- In-class discussions,
- Online participation via Campuswire,
- Continuous feedback mechanisms.

These elements define the instructional environment in which probability theory will be learned and assessed.

6 Scope and Limitations of Lecture 3

Based strictly on the provided material:

- No formal definitions (e.g., probability space, random variable) are introduced.
- No axioms, theorems, or proofs are presented.
- No mathematical derivations or worked examples appear.

This lecture functions solely as a conceptual and motivational introduction.

7 Logical Dependency Summary

- Probability theory is required because computing systems operate under uncertainty.
- Engineering systems exemplify this uncertainty.
- Understanding the necessity of probability precedes learning its formal mathematical structure.
- Lecture 3 establishes this necessity and prepares students for formal probability theory in subsequent lectures.

End of Lecture 3 Scribe