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Generate a comprehensive lecture scribe for Lecture 3 based solely on the attached material. This scribe is intended as reference material for a closed notes exam. For every definition, theorem, derivation, and worked example, you must reason through the logic step-by-step within the text. Make the logical dependencies between concepts explicit so a student can reconstruct the proofs independently. Do not include any information, examples, analogies, or intuition not explicitly present in the provided PDF. Include all formal notation, assumptions, and mathematical conditions exactly as they appear in the source. Maintain a formal, academic tone and start the response immediately with the scribe content, do not include personal AI comments or greetings. Do not include any information, examples, analogies, or intuition not explicitly present in the provided PDF. Include all formal notation, assumptions, and mathematical conditions exactly as they appear in the source. If the lecture presents a conceptual flow rather than mathematical proofs, reason through the logical dependencies of those concepts to make the structure explicit for a student. Maintain a formal, academic tone and start the response immediately with the scribe content, do not include personal AI comments or greetings.

CSE400 – Fundamentals of Probability in Computing

Lecture 3: Introduction to Probability Theory

Instructor: Dhaval Patel, PhD

Date: January 13, 2026

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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 situated after initial course orientation content and before advanced probabilistic modeling and algorithmic applications. Its role is to formally introduce probability theory as the foundational mathematical framework that will be used throughout the course.

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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. 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 before any formal definitions, establishing the necessity of probability as a prerequisite tool rather than an abstract mathematical subject.

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3. Engineering and Computing Applications of Probability

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

The applications listed are:

- **Speech Recognition**
- **System Radar Systems**
- **Communication Networks**

Dependency Explanation:

1. Each listed system must process 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 serve as motivating contexts, not as worked examples or case studies. No additional interpretation beyond what is listed is introduced.

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4. Conceptual Flow of the Lecture

The lecture follows a **conceptual flow** rather than immediate mathematical formalism.

Flow Structure:

1. **Course framing**
   Establishes where probability 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.

This logical sequencing ensures students understand *why* probability theory is studied before engaging with definitions, axioms, or derivations in subsequent lectures.

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5. Academic and Instructional Structure

The lecture is delivered as part of an **active learning framework**, supported by:

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

While these elements are administrative, they establish the instructional environment in which probability theory will be learned and assessed. No probabilistic definitions or theorems are formally introduced in this lecture.

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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.
- The lecture functions as a **conceptual and motivational introduction**.

This lecture therefore serves as a *logical prerequisite* to subsequent lectures where probability theory will be formalized mathematically.

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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 later lectures.

End of Lecture 3 Scribe