

# Lecture 11 Transformation



L11\_S2\_A.pdf  
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Lecture Scribe Writing Guidelines.pdf  
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you are a student in udergrad university of computer science major. follow these lecture scribe guidelines strictly follow zero shot prompting style and write the lecture scribe for L11 pdf

## CSE 400: Fundamentals of Probability in Computing

### Lecture 11: Transformation of Random Variables

**Instructor:** Dhaval Patel, PhD

**Date:** February 10, 2026

**Course:** CSE400

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## 1. Overview and Learning Objectives

This lecture focuses on:

### 1. Transformation of Random Variables

Learning techniques to determine the distribution of a transformed random variable.

### 2. Function of Two Random Variables

Studying joint transformations and deriving the resulting distributions.

### 3. Illustrative Example

Detailed derivation for the specific case:

$$Z = X + Y$$

The objective is to develop systematic methods to compute the distribution of new random variables defined as functions of existing ones.

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## 2. Transformation of a Random Variable

Let  $X$  be a random variable with a known distribution.

Suppose we define a new random variable:

$$Y = g(X)$$

where  $g(\cdot)$  is a function.

The problem addressed in this lecture is:

Given the distribution of  $X$ , determine the distribution of  $Y$ .

The transformation technique allows us to derive the probability distribution of  $Y$  from that of  $X$ .

This requires:

- A clear definition of the transformation function
  - Identification of the support of the transformed variable
  - Careful handling of probability mapping from  $X$  to  $Y$
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### 3. Function of Two Random Variables

Let  $X$  and  $Y$  be two random variables with a known joint distribution.

Define a new random variable:

$$Z = h(X, Y)$$

The goal is to determine the distribution of  $Z$ .

This involves:

- Using the joint distribution of  $X$  and  $Y$
- Identifying the region of integration corresponding to the transformation
- Expressing probabilities in terms of the derived variable

The lecture emphasizes joint transformations and derived distributions in the two-variable setting.

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### 4. Illustrative Example: $Z = X + Y$

Consider two random variables  $X$  and  $Y$ .

Define:

$$Z = X + Y$$

The task is to derive the distribution of  $Z$ .

#### 4.1 Problem Structure

To determine the distribution of  $Z$ , we analyze:

$$P(Z \leq z)$$

Since:

$$Z = X + Y$$

We rewrite the event:

$$Z \leq z \Leftrightarrow X + Y \leq z$$

This converts the problem into evaluating probability over a region defined by:

$$X + Y \leq z$$

Thus, the derivation requires:

- Using the joint distribution of  $X$  and  $Y$
- Integrating (or summing, depending on the case) over the region where

$$x + y \leq z$$

#### 4.2 Logical Steps in the Derivation

1. Express the cumulative distribution function (CDF) of  $Z$ :

$$F_Z(z) = P(Z \leq z)$$

2. Substitute the definition of  $Z$ :

$$F_Z(z) = P(X + Y \leq z)$$

3. Rewrite this probability in terms of the joint distribution of  $X$  and  $Y$ .
4. Evaluate the probability by integrating (continuous case) or summing (discrete case) over the appropriate region.

This procedure produces the distribution of the sum of two random variables.

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## 5. Conceptual Structure of the Lecture

The lecture builds the following progression:

1. Start with transformation of a single random variable.
2. Extend the idea to functions involving two random variables.
3. Apply the method concretely to the sum  $Z = X + Y$ .

The example illustrates how derived distributions are computed from known joint distributions.

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## 6. Key Takeaways

- A transformed random variable requires careful mapping from the original distribution.
- For two random variables, joint distributions are essential for deriving new distributions.
- The distribution of  $Z = X + Y$  is obtained by evaluating

$$P(X + Y \leq z)$$

over the appropriate region.

- The derivation relies strictly on the structure of the joint probability distribution.
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This completes the lecture scribe for Lecture 11: *Transformation of Random Variables*.

Generate a lecture scribe intended to serve as exam-oriented reference material for CSE 400: Fundamentals of Probability in Computing.

Use ONLY the provided context, which consists of the lecture slides in the attached PDF (Lecture 11, Section 2). Do not use any external knowledge or introduce material that is not present in the provided lecture content.

The scribe must faithfully reconstruct what was taught in the lecture. Include:

- All definitions and notation exactly as presented

- Assumptions and conditions stated in the lecture
- Statements of results, theorems, or propositions if present
- Proofs or derivations step by step, only if they appear in the lecture
- Worked examples with all intermediate steps, only if they appear in the lecture

Do NOT introduce new examples, alternative explanations, additional intuition, or simplified interpretations. Do NOT add content for clarity beyond what is explicitly in the lecture.

Organize the scribe in a clear, structured manner with appropriate section headings so that it can be reliably used for exam revision. Prioritize correctness, completeness, and strict faithfulness to the lecture material. please give me the text in copy pastable manner without compromising the content.

CSE 400 – Fundamentals of Probability in Computing

Lecture 11: Transformation of Random Variables

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February 10, 2026

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### 1. Outline

### 2. Transformation of Random Variables

Learning of transformation techniques for random variables.

### 3. Function of Two Random Variables

Joint transformations and derived distributions.

### 4. Illustrative Example

Detailed derivation for the case:  $Z = X + Y$

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## 2. Transformation of Random Variables

The lecture introduces the concept of transforming a random variable into another random variable through a functional relationship.

If  $X$  is a random variable, and a function is applied to  $X$ , then the resulting quantity is also a random variable.

This section focuses on learning transformation techniques for random variables.

The objective is to determine the distribution of a transformed random variable when the original random variable and its distribution are known.

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## 3. Function of Two Random Variables

The lecture extends the transformation concept to the case involving two random variables.

When two random variables are considered jointly, it is possible to define a new random variable as a function of both.

This section addresses:

- Joint transformations
- Derived distributions

The goal is to determine the distribution of a new random variable defined as a function of two given random variables.

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## 4. Illustrative Example

Case:  $Z = X + Y$

A detailed derivation is presented for the case where a new random variable  $Z$  is defined as:

$$Z = X + Y$$

This example demonstrates how to derive the distribution of  $Z$  when it is expressed as the sum of two random variables.

The derivation proceeds by expressing probabilities in terms of the joint behavior of  $X$  and  $Y$  and determining the resulting distribution of  $Z$ .

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## 5. Summary of Lecture 11

- Transformation techniques are used to obtain the distribution of a new random variable from an existing one.
  - Joint transformations extend this idea to functions of two random variables.
  - The example  $Z = X + Y$  illustrates how a derived distribution is obtained in practice.
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End of Lecture 11 Scribe

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does this content follow zero shot prompting style?

Yes — **the prompt you used follows Zero-Shot prompting style correctly**, based on the official Lecture Scribe Writing Guidelines.

Here is a strict evaluation against the Zero-Shot requirements:

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### ✓ 1. No Examples Provided in the Prompt

You did **not** include:

- Any sample scribe
- Any template
- Any partial derivation
- Any demonstration

This satisfies the Zero-Shot requirement of **task instructions only**.

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### ✓ 2. Purpose Clearly Stated

Your prompt explicitly states:

“Generate a lecture scribe intended to serve as exam-oriented reference material...”

This satisfies the requirement that the **exam-reference purpose must be clearly communicated**.

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### ✓ 3. Scope Constraints Clearly Defined

You explicitly constrained the model to:

- Use ONLY the provided context
- Not use external knowledge
- Not introduce new examples
- Not add alternative explanations
- Not simplify
- Not add additional intuition

This matches Section 6.2 and 6.3 requirements.

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### ✓ 4. Structural Expectations Included

You required:

- All definitions and notation
- Assumptions and conditions
- Statements of results
- Step-by-step proofs (only if present)
- Worked examples (only if present)
- Clear organization with headings

This satisfies the structural requirement.

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### ✓ 5. No CoT or Reasoning Instructions

You did **not**:

- Ask the model to “reason step by step”
- Request explicit reasoning chains
- Ask for explanation of thinking



So it does NOT mix with CoT style.

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## ✓ 6. No One-Shot Elements

You did **not** include:

- An example scribe
- A structural demonstration

So it does NOT mix with One-Shot style.

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## Final Verdict

Yes — your prompt strictly follows the **Zero-Shot prompting style** as defined in the guidelines.

However, one important note:

While your **prompt** follows Zero-Shot correctly, the **generated scribe output is incomplete** because the uploaded PDF slides contain very minimal visible content (mostly titles and outline slides). The output reflects exactly that minimal content.

If you submit this, it is compliant with Zero-Shot style — but its academic strength depends entirely on how much actual derivation content was present in the real slides.

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If you want, I can also evaluate whether the *scribe quality* aligns with grading expectations (separate from prompting style compliance).

integrate both of this answers and make the ans that is most efficient and best ans that contains very minimal visible content (mostly titles and outline slides). maintain academic strength with actual derivation content present in the real slides. But strictly follow the guidelines and zero shot prompting style

Below is the integrated and refined lecture scribe, written strictly in Zero-Shot style, faithful to the provided Lecture 11 (Section 2) slides. The slides contain primarily titles and structural statements; therefore, the reconstruction reflects only the explicitly visible lecture content without adding external derivations, formulas, or assumptions not present in the PDF.

The structure preserves academic tone and exam-reference utility while remaining strictly within the provided material.

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## 1. Lecture Overview

This lecture covers the following topics:

### 1. Transformation of Random Variables

Learning of transformation techniques for random variables.

### 2. Function of Two Random Variables

Joint transformations and derived distributions.

### 3. Illustrative Example

Detailed derivation for the case:

$$Z = X + Y$$

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## 2. Transformation of Random Variables

This section introduces transformation techniques for random variables.

Given a random variable, a transformation produces a new random variable defined through a function applied to the original variable.

The focus of this part of the lecture is:

- Understanding transformation techniques
- Learning how distributions change under transformation

No additional assumptions, formal definitions, or theorems are explicitly stated in the provided slides beyond the topic declaration.

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### 3. Function of Two Random Variables

This section extends the idea of transformation to functions involving two random variables.

The lecture addresses:

- Joint transformations
- Derived distributions

The objective is to determine the distribution of a new random variable defined as a function of two given random variables.

The slides present the topic structure without explicitly listing formal propositions, conditions, or assumptions.

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### 4. Illustrative Example

Case:

$$Z = X + Y$$

The lecture includes a detailed derivation for the case where a new random variable  $Z$  is defined as:

$$Z = X + Y$$

This example demonstrates the process of deriving the distribution of a function of two random variables.

The derivation corresponds specifically to the transformation involving the sum of two random variables.

No additional intermediate algebraic steps, formulas, or conditions are explicitly shown in the provided slides beyond the statement of the case.

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## 5. Structural Summary

Lecture 11 establishes:

- Transformation techniques for random variables.
- Extension of transformations to functions of two random variables.
- A focused illustrative derivation for the case  $Z = X + Y$ .

The lecture content, as presented in the slides, primarily outlines the conceptual structure and identifies the key transformation case studied.

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End of Lecture 11 Scribe

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