CS70 Continuous Probability

Kelvin Lee

UC Berkeley

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Discrete Math and Probability Theory

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Overview



- 2 Cumulative Distribution Function
- 3 Continuous Joint Distribution
- Expectation and Variance
- 5 Uniform Distribution
- 6 Exponential Distribution

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Remark: f(x) is not probability of anything and does not have to be bounded by 1! One example is $U[0, \frac{1}{2}]$ where f(x) = 2 > 1. f(x) actually represents the density, or **probability per unit length** vicinity of x!

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$$f(x)=\frac{dF(x)}{dx}.$$

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$$\mathbb{P}(a \leq X \leq b, c \leq Y \leq d) = \int_{c}^{d} \int_{a}^{b} f(x, y) dx dy.$$

We connect the joint density f(x, y) with probabilities by looking at a very small square $[x, x + dx] \times [y, y + dy]$ close to (x, y); then we have

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We interpret f(x, y) as the **probability per unit area** in the vicinity of (x, y).

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The variance of a continuous random variable X with PDF f is

$$\operatorname{Var}(X) = \mathbb{E}[X^2] - \mathbb{E}[X]^2 = \int_{-\infty}^{\infty} x^2 f(x) dx - \left(\int_{-\infty}^{\infty} x f(x) dx\right)^2.$$

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Uniform Random Variable

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Uniform Random Variable

• $X \sim U[a, b]$.

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$$\mathbb{E}[X] = \int_a^b x \cdot \frac{1}{b-a} dx = \frac{a+b}{2}.$$

• Variance:

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$$\operatorname{Var}(X) = \mathbb{E}[X^2] - \mathbb{E}[X]^2$$

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$$f(x)=\frac{1}{b-a}.$$

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$$\mathbb{E}[X] = \int_a^b x \cdot \frac{1}{b-a} dx = \frac{a+b}{2}.$$

• Variance:

$$Var(X) = \mathbb{E}[X^2] - \mathbb{E}[X]^2$$
$$= \int_a^b x^2 \cdot \frac{1}{b-a} dx - \int_a^b x \cdot \frac{1}{b-a} dx$$
$$= \frac{(b-a)^2}{12}.$$

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• $X \sim \text{Exp}(\lambda)$.

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Problem Time!