

# MAT434: Theory of Mathematical Statistics

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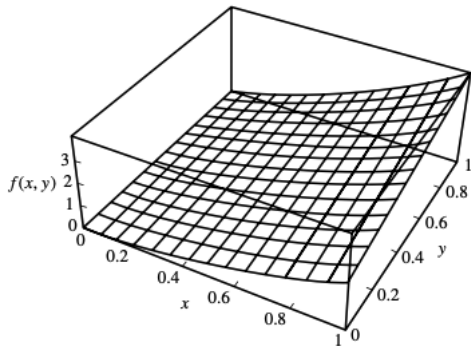
# Continuous Random Variables

## Example A

Consider the bivariate density function

$$f(x, y) = \frac{12}{7}(x^2 + xy), \quad 0 \leq x \leq 1, \quad 0 \leq y \leq 1.$$

Calculate  $P(X > Y)$ .



# Continuous Random Variables

The **marginal cdf** of  $X$ , of  $F_X$ , is

$$\begin{aligned} F_X(x) &= P(X \leq x) \\ &= \lim_{y \rightarrow \infty} F(x, y) \\ &= \int_{-\infty}^x \int_{-\infty}^{\infty} f(u, y) \, dy \, du \end{aligned}$$

The marginal density of  $X$  is

$$f_X(x) = F'_X(x) = \int_{-\infty}^{\infty} f(x, y) \, dy$$

## Example B

Consider the bivariate density function

$$f(x, y) = \frac{12}{7}(x^2 + xy), \quad 0 \leq x \leq 1, \quad 0 \leq y \leq 1.$$

Find the marginal density of  $X$ .

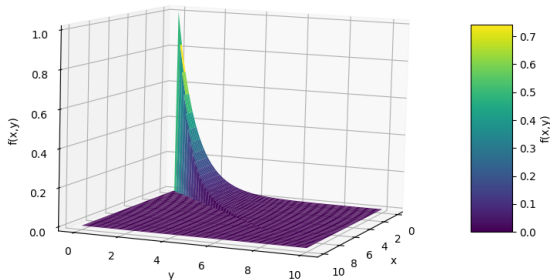
## Example D

Consider the following joint density:

$$f(x, y) = \begin{cases} \lambda^2 e^{-\lambda y}, & 0 \leq x \leq y, \lambda > 0 \\ 0, & \text{elsewhere} \end{cases}$$

Find the marginal densities.

Joint Density  $f(x, y)$



# Continuous Random Variables

- ▶ In some applications, it is useful to analyze distributions that are uniform over some region space.
- ▶ For example, in the plane, the random point  $(X, Y)$  is uniform over a region  $R$ , if for any  $A \subset R$ ,

$$P((X, Y) \in A) = \frac{|A|}{|R|}$$

## Example E

A point is chosen randomly in a disk of radius 1. Since the area of the disk is  $\pi$ ,

$$f(x, y) = \begin{cases} \frac{1}{\pi} & \text{if } x^2 + y^2 \leq 1 \\ 0, & \text{otherwise} \end{cases}$$

Find  $F_R(r)$ ,  $f_R(r)$ ,  $f_X(x)$  and  $f_Y(y)$ .



# Independent Random Variables

# Independent Random Variables

## Definition

Random variables  $X_1, X_2, X_3, \dots, X_n$  are said to be *independent* if their joint cdf factors into the product of their marginal cdf's:

$$F(x_1, x_2, \dots, x_n) = F_{X_1}(x_1)F_{X_2}(x_2) \dots F_{X_n}(x_n)$$

for all  $x_1, x_2, \dots, x_n$ .

This definition holds for both continuous and discrete random variables: