

# Basic Probability Definitions: Joint Probabilities

Video companion

## 1 Introduction

### Definition

*joint probability*—probability that two separate events with separate probability distributions are both true

$P(A \text{ and } B)$  is written  $P(A, B)$ , and read “the joint probability of  $A$  and  $B$ ” or “the probability that  $A$  is true and  $B$  is true.”

## 2 Order of joint probabilities

For probability distributions  $X$  and  $Y$ :

$$X = \{x_1, x_2, x_3, \dots, x_n\}$$

$$Y = \{y_1, y_2, y_3, \dots, y_n\}$$

Ordering does not matter in joint probabilities, for either the probability distributions or the individual events.

$$P(X, Y) = P(Y, X)$$

$$P(x_1, y_1) = P(y_1, x_1)$$

## 3 Independence

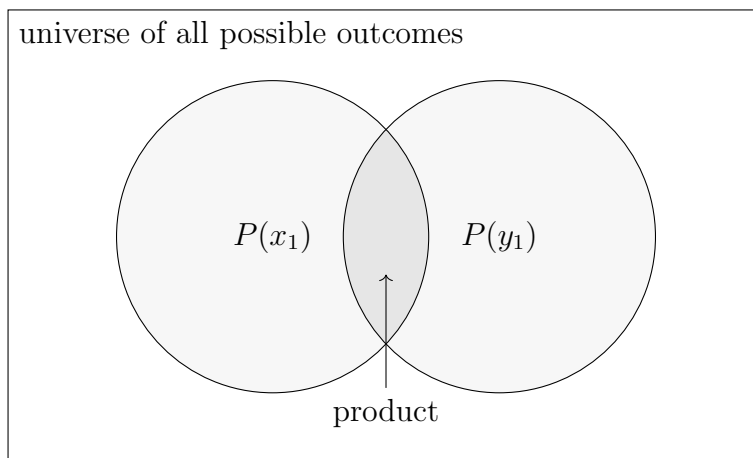
### Definition

*independence*—knowing the outcome of one event does not change the probability of the other

The probability of two independent events:

$$\underbrace{P(x_1, y_1)}_{\text{“joint distribution”}} = \underbrace{P(x_1)P(y_1)}_{\text{“product distribution”}}$$

Venn diagrams—show the intersection and union of sets



## 4 OR probability

Probability that either of two events occurs:

$$P(x_1 \text{ or } y_1) = P(x_1) + P(y_1) - P(x_1, y_1)$$

Venn diagram:

