

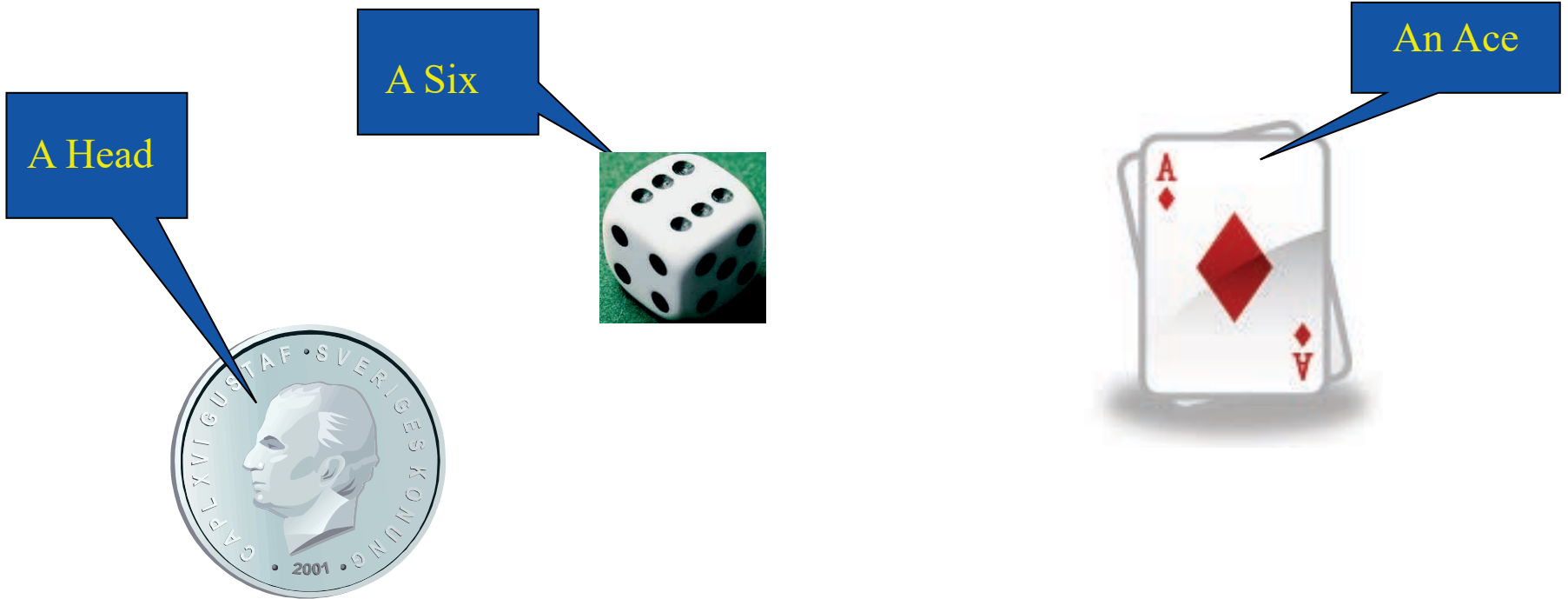
Section 2.1 Basic Ideas

- ▶ An **experiment** is an act or process of observation that leads to a single outcome that cannot be predicted with certainty
- ▶ Examples:
 - rolling a die
 - tossing a coin
 - drawing a card



Sample point

- ▶ A **sample point** is the most basic outcome of an experiment.



Sample space

- ▶ A **sample space** Ω of an experiment is the collection of all sample points
- ▶ Examples:
 - ▶ For rolling a fair die, the sample space is $\{1, 2, 3, 4, 5, 6\}$.
 - ▶ For a coin toss, the sample space is $\{\text{heads}, \text{tails}\}$.
 - ▶ For weighing a cereal box, the sample space is $(0, \infty)$, a more reasonable sample space is $(12, 20)$ for a 16 oz. box.

Event

- ▶ A subset of a sample space is called an **event**.
- ▶ For any sample space, the empty set $\emptyset$ is an event, as is the entire sample space.
- ▶ A given event is said to have occurred if the outcome of the experiment is one of the outcomes in the event.
- ▶ For example
 - ▶ if a die comes up 2, the events $\{2, 4, 6\}$ and $\{1, 2, 3\}$ have both occurred, along with every other event that contains the outcome “2.”



Example

An electrical engineer has on hand two boxes of resistors, with four resistors in each box. The resistors in the first box are labeled 10 ohms, but in fact their resistances are 9, 10, 11, and 12 ohms. The resistors in the second box are labeled 20 ohms, but in fact their resistances are 18, 19, 20, and 21 ohms. The engineer chooses one resistor from each box and determines the resistance of each.

Example cont.

Let A be the event that the first resistor has a resistance greater than 10, let B be the event that the second resistor has resistance less than 19, and let C be the event that the sum of the resistances is equal to 28.

1. Find the sample space for this experiment.

$$S = \{(9,18), (9,19), (9,20), \dots, (12,20), (12,21)\}$$

2. Specify the subsets corresponding to the events A , B , and C .

$$A = \{(11,18), (11,19), (11,20), \dots, (12,20), (12,21)\}$$

$$B = \{(9,18), (10,18), (11,18), (12,18)\}$$

$$C = \{(9,19), (10,18)\}$$

Example: Draw a single card from the deck

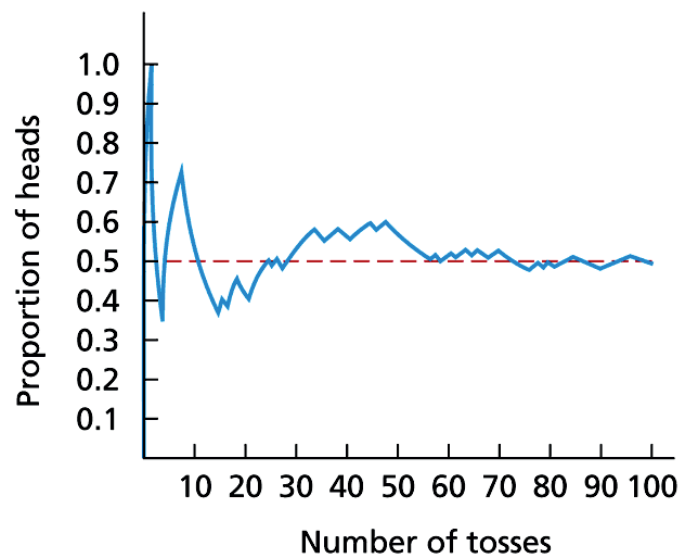
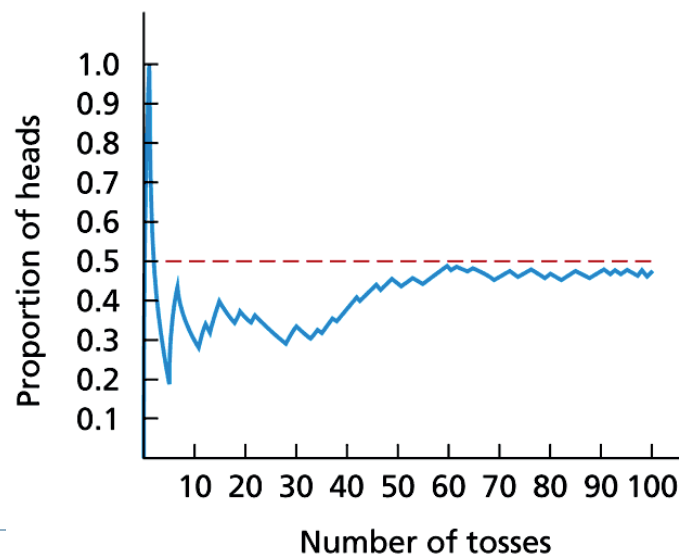
- ▶ The sample space is a 52-element set, as each individual card is a possible outcome
- ▶ An event: any subset of the sample space
 - ▶ "A card" (52 elements)
 - ▶ "A King" (4 elements)
 - ▶ "The 5 of Hearts" (1 element)
 - ▶ "A Face card" - JQK (12 elements)
 - ▶ "Red and black at the same time" (0 element)
- ▶ A sample space of N possible outcomes yields 2^N possible events.



spades (♠), hearts (♥),
diamonds (♦), clubs (♣)

Probability

- ▶ Probability of an event A is the proportion of times that the event A would occur in the long run, if the experiment were to be repeated over and over again.
- ▶ If a fair coin is tossed, probability of each side equals 0.5.
- ▶ If you toss a coin 1 million times, the proportion of heads is anticipated to be very close to $1/2$.



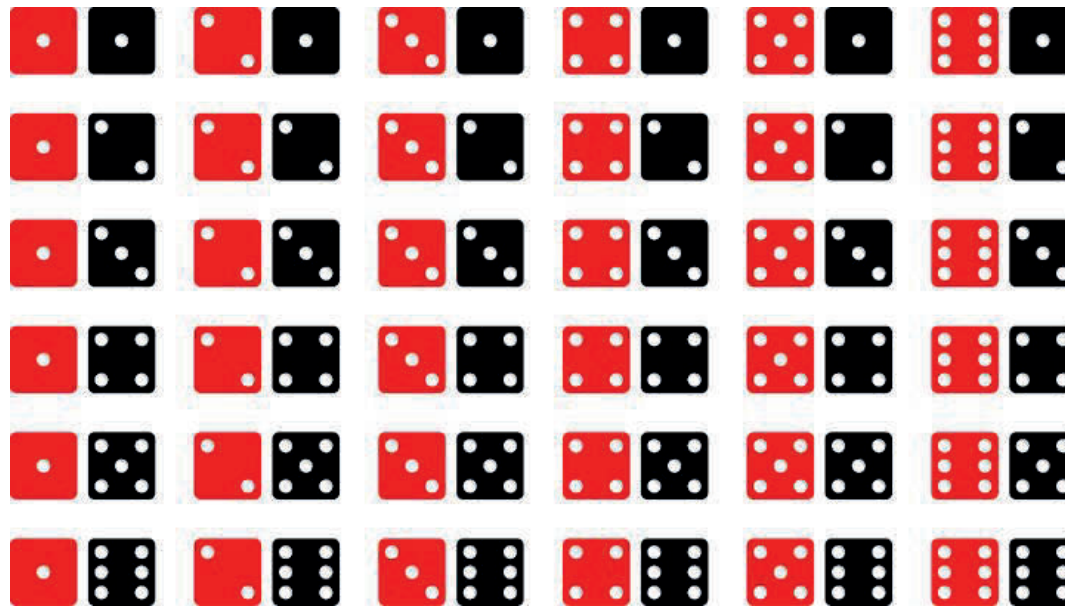
Probability of likely outcome

- ▶ Suppose an experiment has N possible outcomes, all equally likely
- ▶ An event that occur in f ways has probability f/N of occurring

$$\textit{Probability of an event} = \frac{f}{N}$$

Example: rolling 2 dice

- ▶ When two balanced dice are rolled, what is the probability that the sum of the dice is 11?



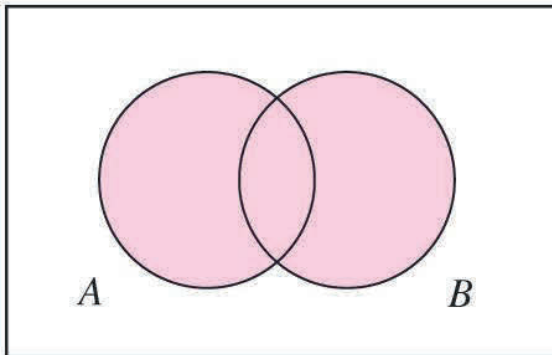
Answer

- ▶ When two balanced dice are rolled, 36 equally likely outcomes are possible
- ▶ The sum of the dice can be 11 in two ways.
- ▶ The probability that the sum is 11 is $f/N = 2/36 = 0.056$.

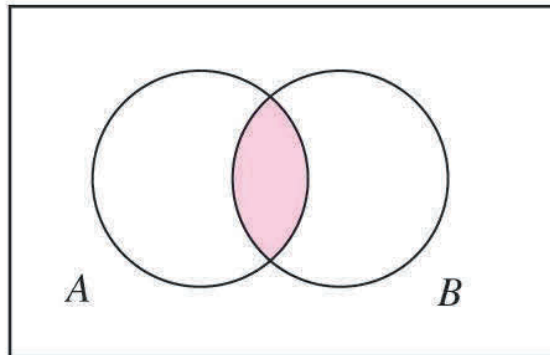
Combining events

- ▶ Union
- ▶ Intersection
- ▶ Complement

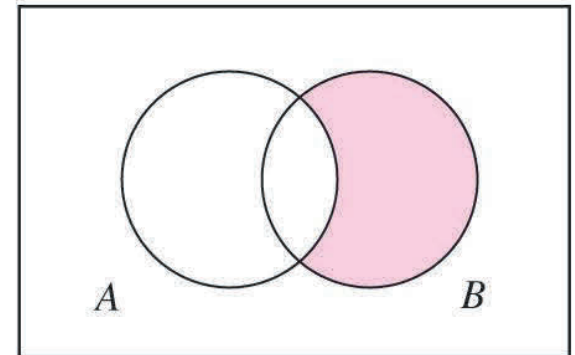
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(a)



(b)



(c)

Union

- ▶ The **union** of two events A and B (denoted $A \cup B$)
- ▶ The set of outcomes that belong to **either** A and to B .
- ▶ “ A or B ” occurs whenever either A or B (or both) occurs.

Let $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$.

What is $A \cup B$?

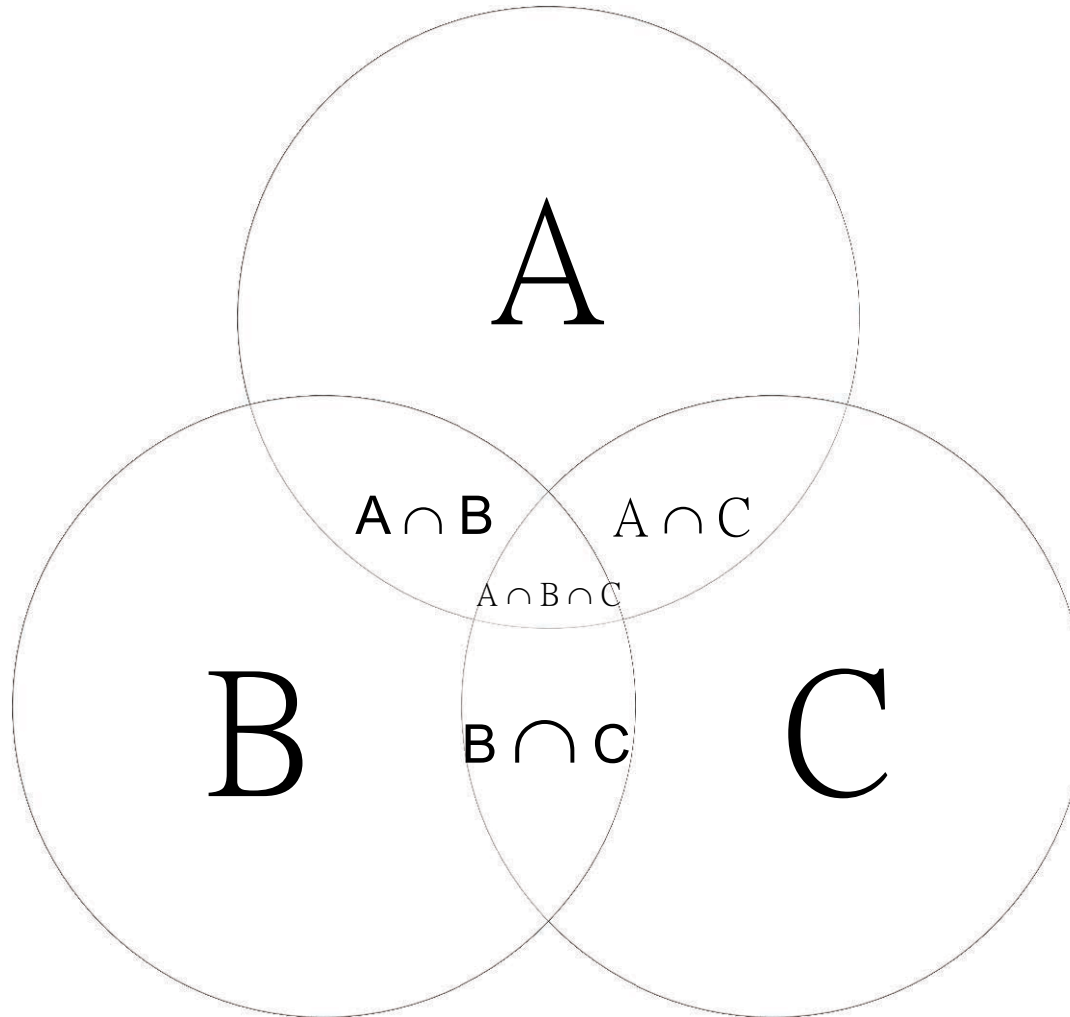
Intersection

- ▶ $A \cap B$ means “ A and B .”
- ▶ the set of outcomes that belong both to A and to B .

Let $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$.

What is $A \cap B$?

Union and intersection



Complement

- ▶ A^c or $\bar{A}$ denotes the **complement** of A
- ▶ The event “not A ” occurs whenever A does not occur

Consider rolling a fair six-sided die.

Let A be the event: “rolling a six” = $\{6\}$.

What is $\bar{A}$ = “not rolling a six”?

Mutually Exclusive Events

- ▶ Events A and B are **disjoint** (or **mutually exclusive**) if they cannot occur at the same time or if they have no outcomes in common
- ▶ More generally, a collection of events is said to be mutually exclusive if no two of them have any outcomes in common.
- ▶ That is, disjoint events do not overlap (their intersection is empty)

Let $\emptyset$ denote the empty set

$$A \cap B \cap C \cap \cdots = \emptyset$$

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