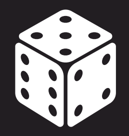
Experiment **Outcomes** **Sample Space** **Event**

Dice 

What are the outcomes? $\{1\}, \{2\}, \{3\}, \{4\}, \{5\}, \{6\}$

What is the sample space?

"Sample space is the collection of all outcomes" $S = \{1, 2, 3, 4, 5, 6\}$

What is an event? "An event is a subset of a sample space"

Eg: Suppose we bet that the dice outcome is an odd number

$A = \{1, 3, 5\}$ Here, A is an example of an event

Eg: Suppose we bet that the dice outcome less than or equal to 4

$B = \{1, 2, 3, 4\}$ Here, B is an example of an event

Eg: $C = \{1, 3, 5, 7\}$ Is this an event? No!

$\{7\}$ does not belong to sample space

Experiment **Outcomes** **Sample Space** **Event**

Coin Toss

What are the outcomes? $\{H\}, \{T\}$

What is the sample space?

"Sample space is the collection of all outcomes" $S = \{H, T\}$

Examples of events:

$$A = \{H\} \qquad B = \{H, T\} \qquad C = \{\,\} \qquad D = \{T\}$$

All four above are events Even the empty set is considered event!!!

Experiment Outcomes Sample Space Event

Two Coin Tosses

What are the outcomes? $\{HH\}$, $\{HT\}$, $\{TH\}$, $\{TT\}$

What is the sample space? $S = \{HH, HT, TH, TT\}$

Examples of events:

$A = \{HH, HT, TH\}$ "Atleast one heads"

$B = \{HH, TT\}$ "Both tosses are the same"

A and B above are events

Experiment | Outcomes | Sample Space | Event

Coin followed by dice

What is the sample space?

$$S = \left\{ \begin{matrix} (H,\ 1),\ (H,\ 2),\ (H,\ 3),\ (H,\ 4),\ (H,\ 5),\ (H,\ 6) \\ (T,\ 1),\ (T,\ 2),\ (T,\ 3),\ (T,\ 4),\ (T,\ 5),\ (T,\ 6) \end{matrix} \right\}$$

Examples of events:

"Coin is heads"

$$A = \{(H,\ 1),\ (H,\ 2),\ (H,\ 3),\ (H,\ 4),\ (H,\ 5),\ (H,\ 6)\}$$

"Dice is 3"

$$B = \{(H,\ 3),\ (T,\ 3)\}$$

Set Operations

Intersection **Union** **Complement**

Dice

$S = \{1, 2, 3, 4, 5, 6\}$

$A = \{1, 3, 5\}$

$B = \{1, 5, 6\}$

$A \cap B = \{1, 5\} = B \cap A$ Outcomes that are in both A and B

$A \cup B = \{1, 3, 5, 6\} = B \cup A$ Outcomes that are in A or B

$A^c = \{2, 4, 6\}$ "A complement"

Outcomes that are in S but not in A

$B^c = \{2, 3, 4\}$ "B complement"

Outcomes that are in S but not in B

Probability   Coin Toss

$$S = \{H, T\}$$

$$P(H) = \frac{1}{2}$$

$$P(T) = \frac{1}{2}$$

Probability Dice

$S = \{1, 2, 3, 4, 5, 6\}$

$A = \{2, 4, 6\}$ $\quad P(A) = \frac{3}{6}$ $\quad A^c = \{1, 3, 5\}$ $\quad P(A^c) = \frac{3}{6} = 1 - \frac{3}{6}$

$B = \{1, 2\}$ $\quad P(B) = \frac{2}{6}$ $\quad B^c = \{3, 4, 5, 6\}$ $\quad P(B^c) = \frac{4}{6} = 1 - \frac{2}{6}$

$P(A \cap B) = P(\{2\}) = \frac{1}{6}$

$P(A \cup B) = P(\{1, 2, 4, 6\}) = \frac{4}{6}$

Why can't we say $P(A \cup B) = P(A) + P(B)$?

$\{2\}$ is common in both A and B

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$C = \{1, 3, 5\}$

$A \cap C = \{\}$ $\quad$ A and C are "Mutually exclusive" or "Disjoint"

$P(A \cap C) = 0$

Recap

Sample space

"Collection of all outcomes"

Event

"Any subset of the sample space"

Probability of Union

$$P(A \cup B) = \quad P(A) + P(B) - P(A \cap B)$$

Probability of Complement

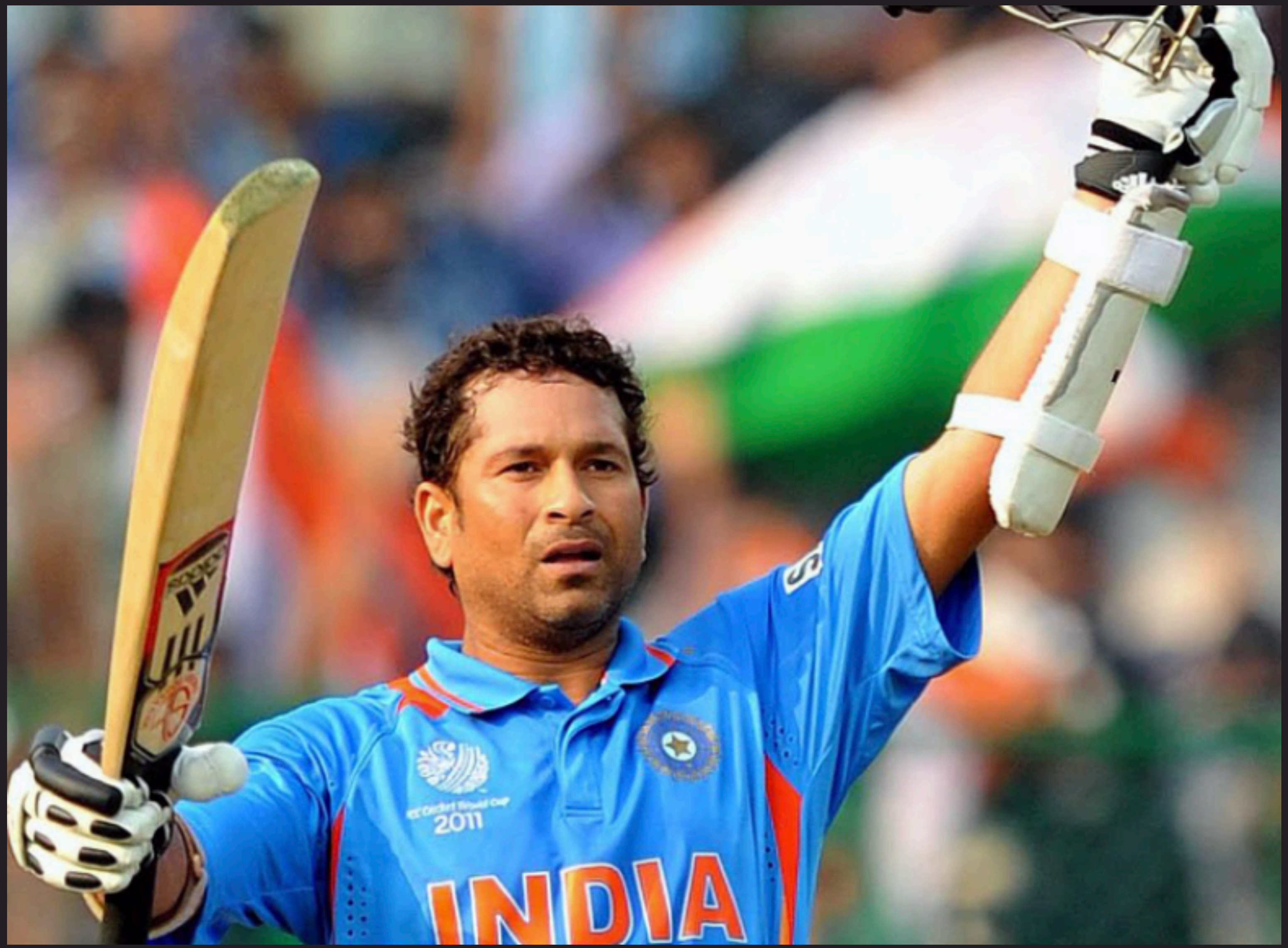
$$P(A^c) = 1 - P(A)$$

Mutually exclusive (Disjoint)

$$A \cap C = \{\}$$

$$P(A \cap C) = 0$$

Case Study: Sachin



Case Study: Sachin

Probability of winning

$$P[W] = \frac{184}{184 + 176} = 0.511$$

```
df_sachin["Won"].value_counts()
```

```
True     184
False    176
Name: Won, dtype: int64
```

Probability of century

$$P[C] = \frac{46}{46 + 314} = 0.127$$

```
df_sachin["century"].value_counts()
```

```
False    314
True      46
Name: century, dtype: int64
```

Probability of winning and century

$$P[W \cap C] = \frac{30}{360} = 0.083$$

```
pd.crosstab(
    index=df_sachin["century"],
    columns=df_sachin["won"],
    margins=True,
)
```

Won century	False	True	All
False	160	154	314
True	16	30	46
All	176	184	360

Case Study: Sachin

Probability of winning

$$P[W] = \frac{184}{184 + 176} = 0.511$$

Probability of century

$$P[C] = \frac{46}{46 + 314} = 0.127$$

Probability of winning and century

$$P[W \cap C] = \frac{30}{360} = 0.083$$