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## Math for Machine Learning

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# Probability and Statistics - Week 1



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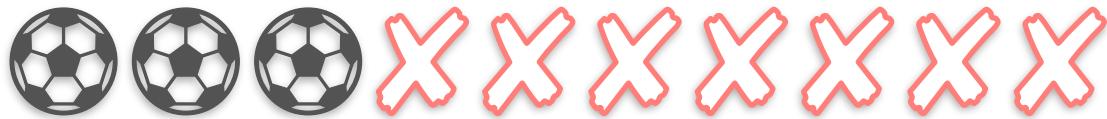
## Introduction to probability

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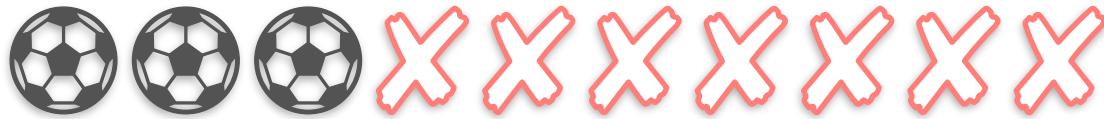
# What is Probability?

# Introduction to Probability

# Introduction to Probability

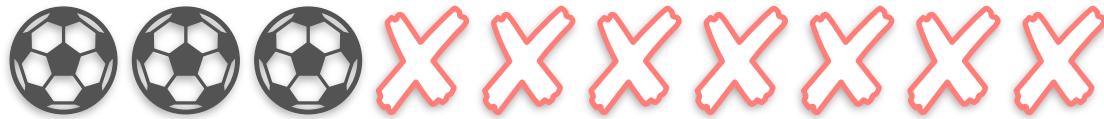


# Introduction to Probability



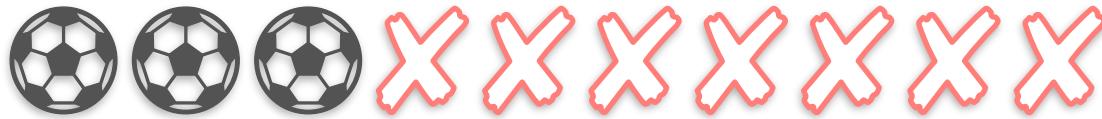
Find the probability that a child picked at random plays soccer.

# Introduction to Probability



Find the probability that a child picked at random plays soccer.

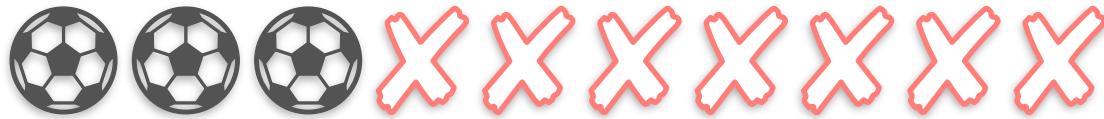
# Introduction to Probability



Find the probability that a child picked at random plays soccer.

**The probability that a child picked at random plays soccer.**

# Introduction to Probability

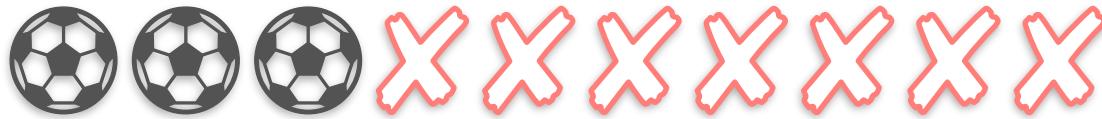


Find the probability that a child picked at random plays soccer.

**The probability that a child picked at random plays soccer.**

$$P(\text{soccer})$$

# Introduction to Probability



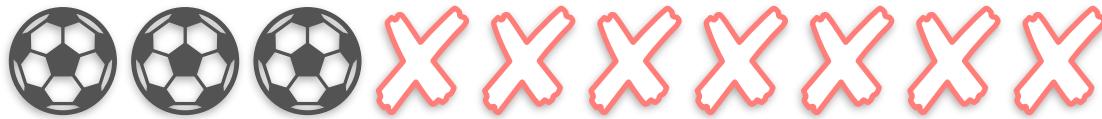
Find the probability that a child picked at random plays soccer.

**The probability that a child picked at random plays soccer.**

$$P(\text{soccer})$$

A teal curved arrow points from the text "The probability that a child picked at random plays soccer." down to the mathematical expression  $P(\text{soccer})$ .

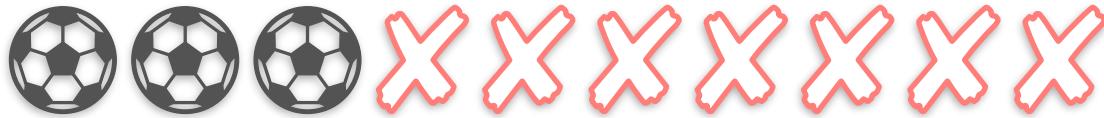
# Introduction to Probability



Find the probability that a child picked at random plays soccer.

$$P(\text{soccer})$$

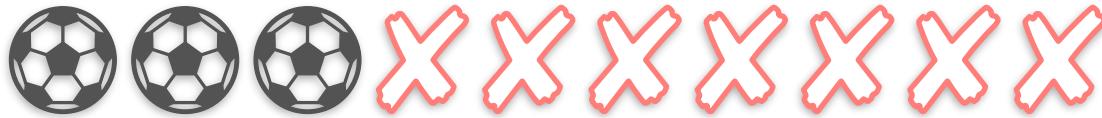
# Introduction to Probability



Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}}$$

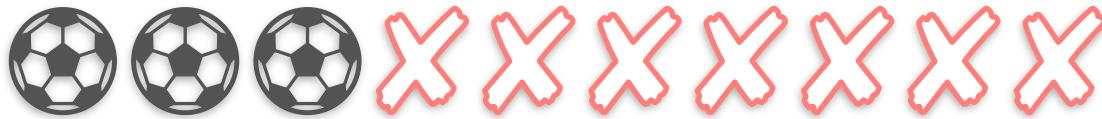
# Introduction to Probability



Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \underline{\hspace{2cm}}$$

# Introduction to Probability

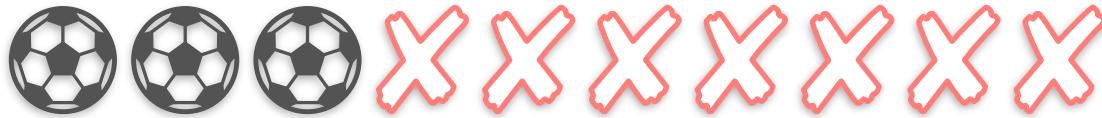


Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{3}{10}$$



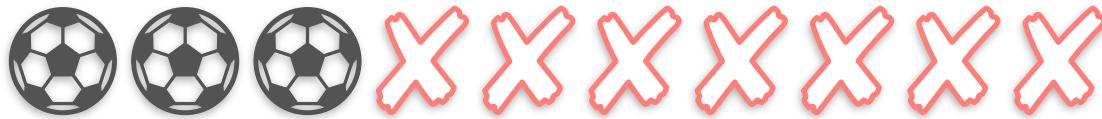
# Introduction to Probability



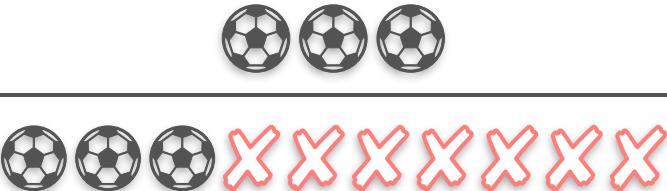
Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{\text{soccer balls}}{\text{total items}}$$
The equation shows the probability of picking a soccer ball from the set. The numerator is labeled "soccer balls" and the denominator is labeled "total items". The fraction is equivalent to the ratio of soccer balls to the total number of items in the sequence.

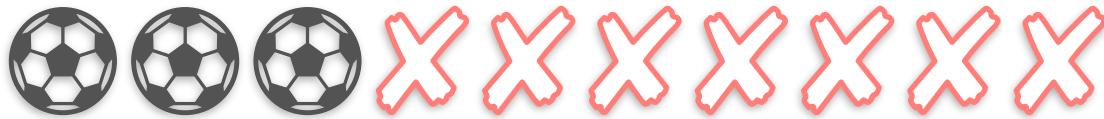
# Introduction to Probability



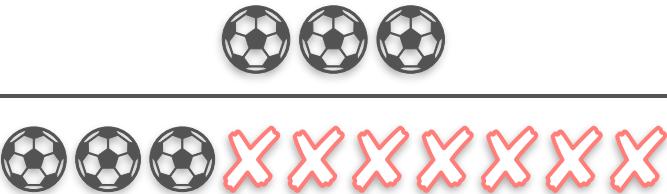
Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{3}{10}$$
The fraction is displayed with a horizontal line separating the numerator from the denominator. The numerator is represented by three solid black soccer balls. The denominator is represented by a sequence of ten items: three solid black soccer balls followed by seven red 'X' marks.

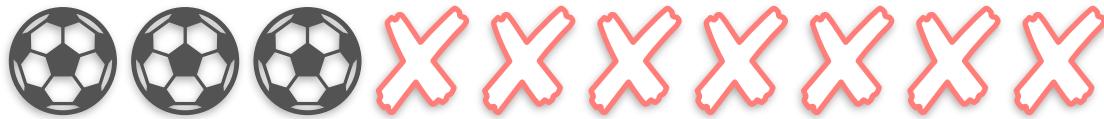
# Introduction to Probability



Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{3}{10} = 0.3$$
A mathematical equation illustrating the calculation of probability. The fraction  $\frac{\text{soccer}}{\text{total}}$  is shown with a horizontal line separating the numerator from the denominator. Above the numerator, there are three black soccer ball icons. Above the denominator, there is a sequence of three black soccer ball icons followed by seven red 'X' marks. To the right of the fraction, the fraction  $\frac{3}{10}$  is shown, followed by an equals sign and the decimal value 0.3.

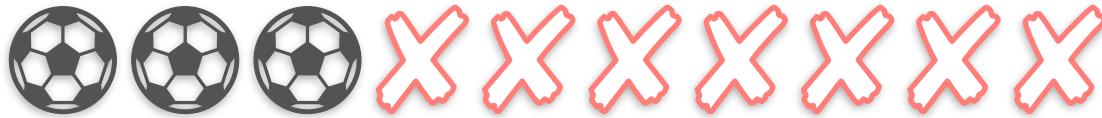
# Introduction to Probability



Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{3}{10} = 0.3$$
The equation shows the probability of picking a soccer ball (soccer) over the total number of items (total). The numerator is represented by a teal box containing the first three items from the sequence above. The denominator is represented by a teal box containing the first three items from the sequence below. Both sequences consist of three soccer balls followed by seven red 'X' marks.

# Introduction to Probability



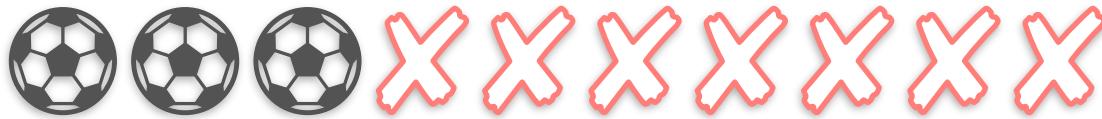
Find the probability that a child picked at random plays soccer.

Event

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{\text{Number of soccer balls}}{\text{Total number of items}} = \frac{3}{10} = 0.3$$

The equation shows the probability of picking a soccer ball (Event) from a total of 10 items. The numerator is the count of soccer balls (3), and the denominator is the total number of items (10). The result is 0.3. The word "Event" is written above the first three items, which are highlighted with a teal border. Below the fraction, the full sequence of 10 items is shown again, with the first three being soccer balls and the next seven being 'X' marks.

# Introduction to Probability

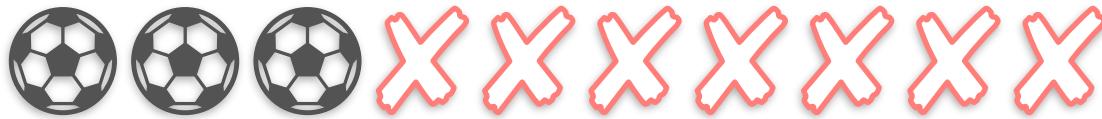


Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{\text{Event}}{\text{Total}} = \frac{3}{10} = 0.3$$

The diagram illustrates the calculation of probability. A teal box labeled "Event" highlights the first three items in the sequence: three solid black soccer balls. An arrow points from the word "Event" to this highlighted group. Below the sequence, the total number of items is indicated as 10, represented by a horizontal line with tick marks under the sequence, and the label "Total".

# Introduction to Probability

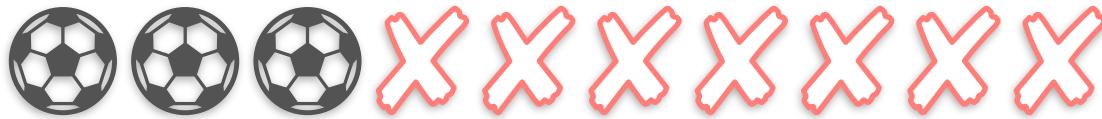


Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{\text{Event}}{\text{Total Sample Space}} = \frac{3}{10} = 0.3$$

The diagram illustrates the calculation of probability. A teal box labeled "Event" contains the three soccer ball icons. Another teal box labeled "Total Sample Space" contains all ten items (three soccer balls and seven 'X' marks). An arrow points from the word "Event" to the top of the "Event" box.

# Introduction to Probability

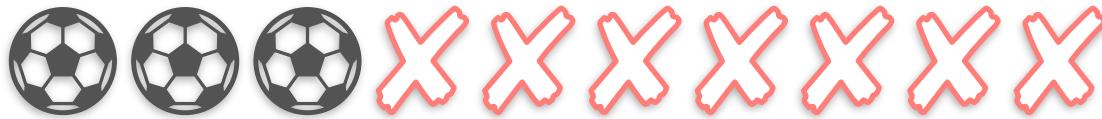


Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{\text{Event}}{\text{Sample space}} = \frac{3}{10} = 0.3$$

The equation illustrates the probability calculation. The numerator, labeled "Event", is represented by a teal-outlined box containing three soccer balls. The denominator, labeled "Sample space", is represented by a larger teal-outlined box containing all ten items from the sequence above. An arrow points from the word "Event" to the box of soccer balls.

# Introduction to Probability



Find the probability that a child picked at random plays soccer.

$$P(\text{soccer}) = \frac{\text{soccer}}{\text{total}} = \frac{\text{Event}}{\text{Sample space}} = \frac{3}{10} = 0.3$$

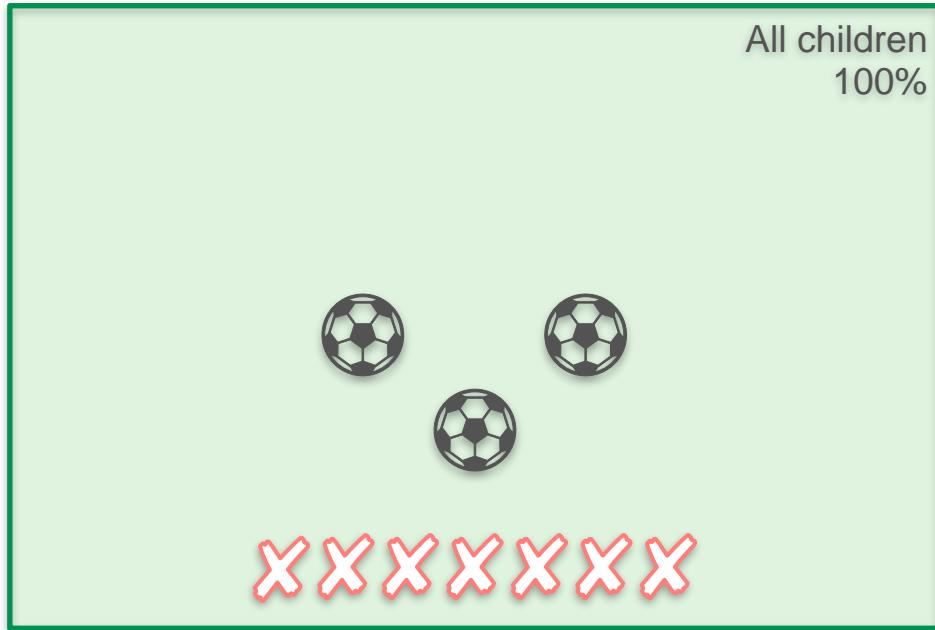
The diagram illustrates the calculation of probability. A teal box labeled "Event" encloses the three soccer balls. A larger teal box labeled "Sample space" encloses all ten items (three soccer balls and seven 'X' marks). Arrows point from the labels to their respective boxes.

# Introduction to Probability: Venn Diagram

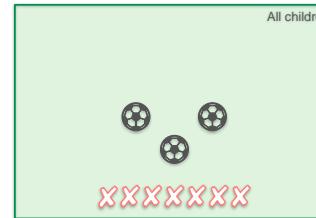


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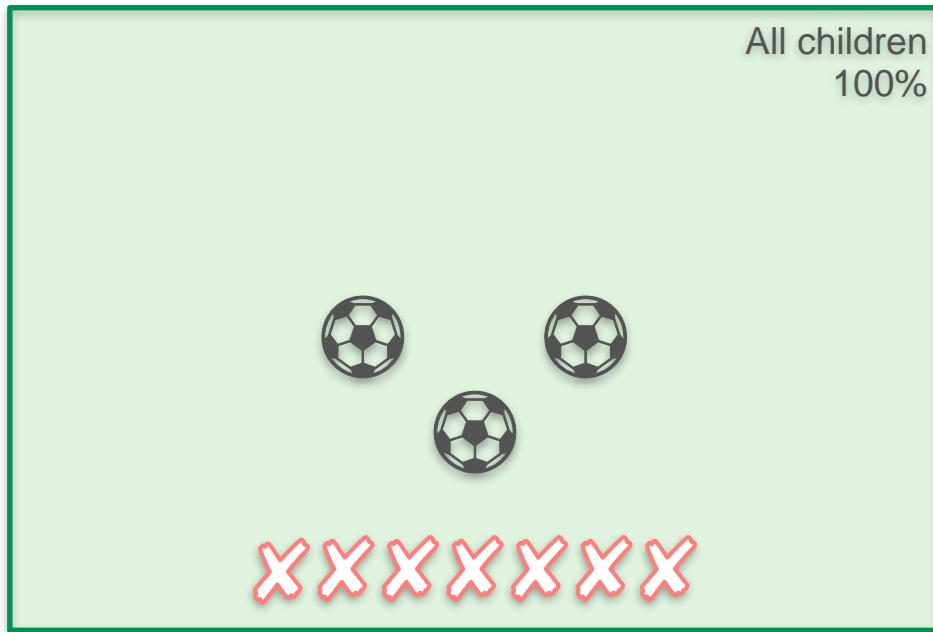
# Introduction to Probability: Venn Diagram



# Introduction to Probability: Venn Diagram

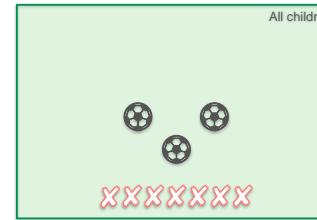
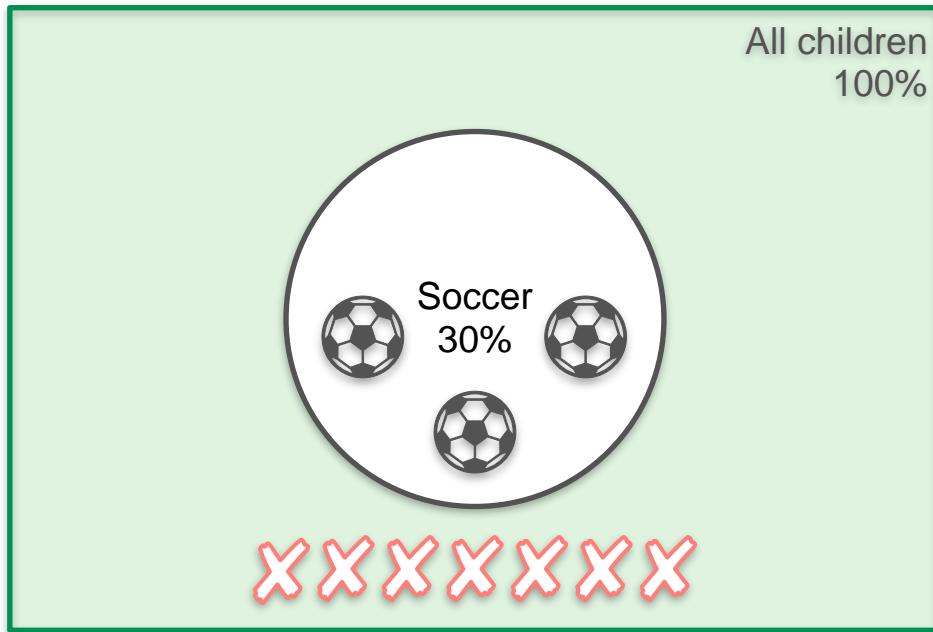


# Introduction to Probability: Venn Diagram



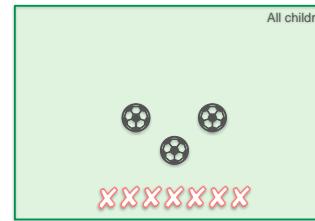
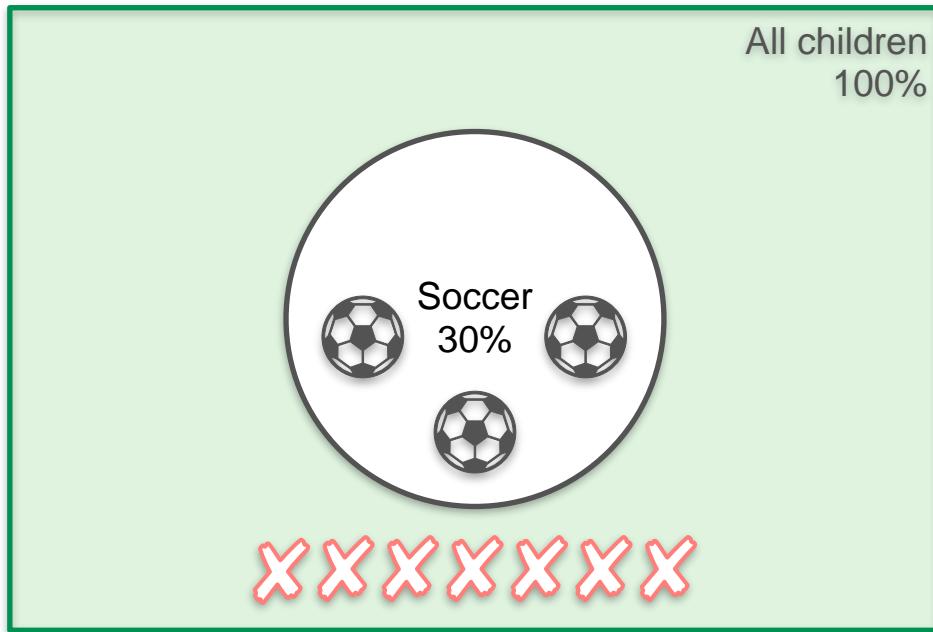
Sample Space

# Introduction to Probability: Venn Diagram



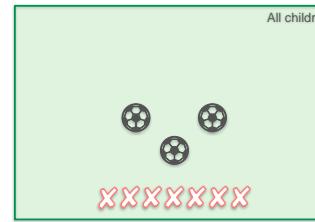
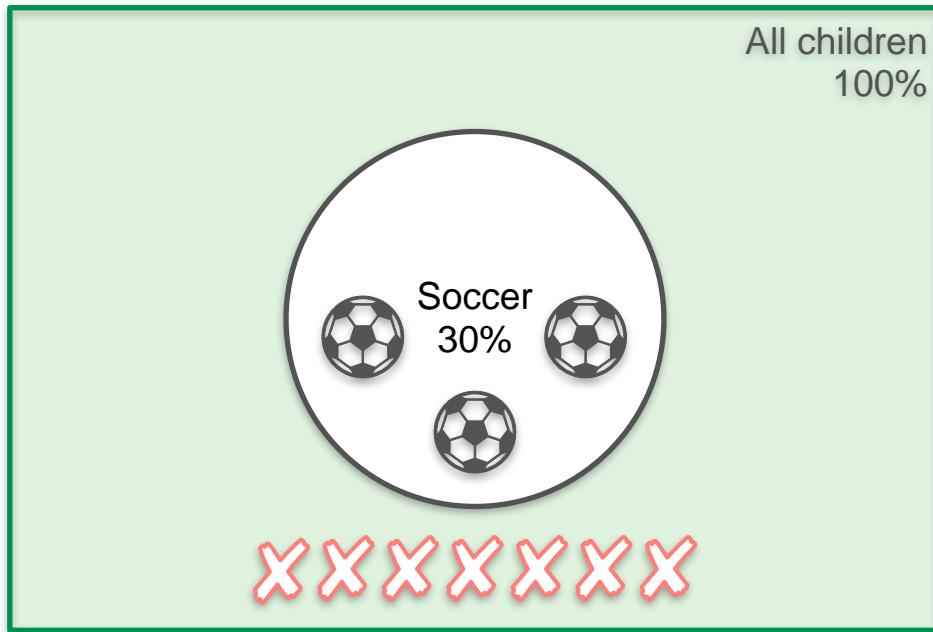
Sample Space

# Introduction to Probability: Venn Diagram

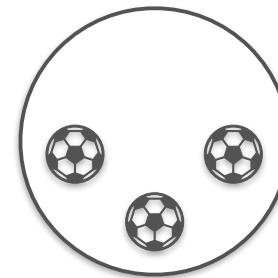


Sample Space

# Introduction to Probability: Venn Diagram



Sample Space



Event

# Introduction to Probability: Coin Example 1



# Introduction to Probability: Coin Example 1



# Introduction to Probability: Coin Example 1



**Experiment**

# Introduction to Probability: Coin Example 1



## Experiment

Probability of landing on heads

# Introduction to Probability: Coin Example 1



## Experiment

Probability of landing on heads

$$P(\text{heads})$$

# Introduction to Probability: Coin Example 1

# Introduction to Probability: Coin Example 1



# Introduction to Probability: Coin Example 1



50%

# Introduction to Probability: Coin Example 1



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# Introduction to Probability: Coin Example 1



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$$P(\text{heads}) = \underline{\hspace{2cm}}$$

# Introduction to Probability: Coin Example 1



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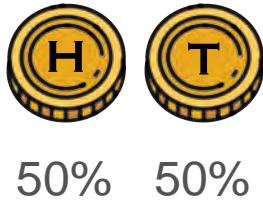
$$P(\text{heads}) = \frac{\text{ }}{\text{ }}$$

# Introduction to Probability: Coin Example 1



$$P(\text{heads}) = \frac{\text{Number of heads}}{\text{Total number of outcomes}}$$
A fraction is shown to calculate the probability of getting heads. The numerator is a single gold coin with 'H' (heads) facing up. The denominator consists of three gold coins arranged horizontally: the top one has 'H' (heads), the bottom-left has 'H' (heads), and the bottom-right has 'T' (tails).

# Introduction to Probability: Coin Example 1



$$P(\text{heads}) = \frac{\begin{array}{c} \text{H} \\ \text{---} \\ \text{H} \end{array}}{\begin{array}{c} \text{H} \\ \text{---} \\ \text{H} \quad \text{T} \end{array}} = \frac{1}{2} = 0.5$$

# Introduction to Probability: Coin Example 2



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# Introduction to Probability: Coin Example 2



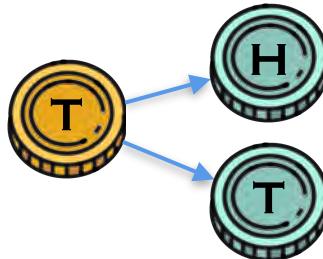
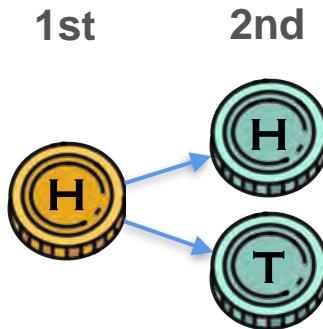
1st



# Introduction to Probability: Coin Example 2



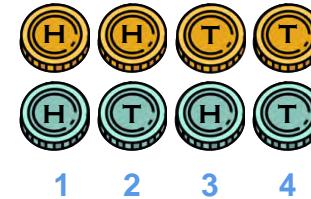
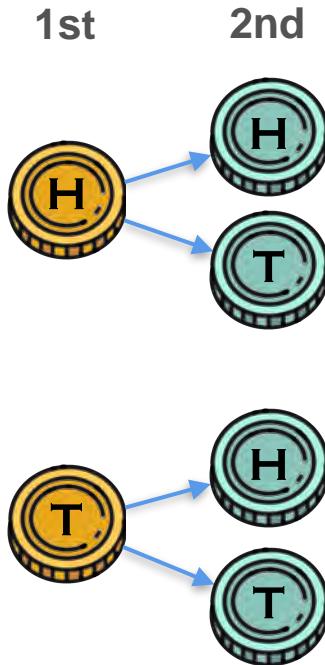
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# Introduction to Probability: Coin Example 2



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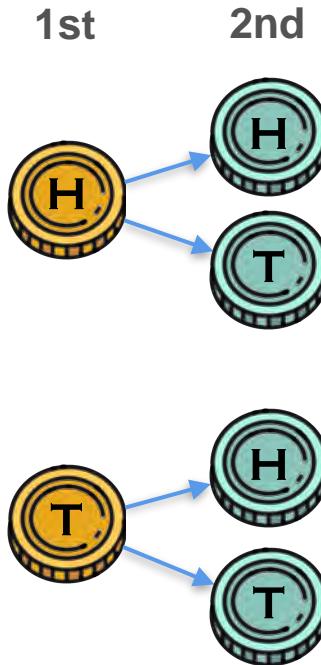


# Introduction to Probability: Coin Example 2



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What is the probability of landing on heads twice?



# Introduction to Probability: Coin Example 2



50% 50%



# Introduction to Probability: Coin Example 2



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$$P(HH) = \underline{\hspace{2cm}}$$



# Introduction to Probability: Coin Example 2



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$$P(HH) = \underline{\hspace{2cm}}$$



# Introduction to Probability: Coin Example 2



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$$P(HH) = \underline{\hspace{2cm}}$$

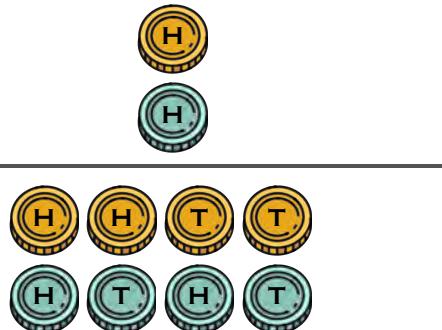


# Introduction to Probability: Coin Example 2



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$$P(HH) = \frac{\text{Number of HH outcomes}}{\text{Total number of outcomes}}$$


The equation shows the probability of getting two heads (HH) as a fraction. The numerator is the count of outcomes where both coins are heads (HH), represented by two coins stacked vertically, one yellow with 'H' and one teal with 'H'. The denominator is the total number of possible outcomes, represented by a stack of four rows of two coins each, totaling 16 coins. The first two rows show all heads (HH), and the last two rows show all tails (TT).

# Introduction to Probability: Coin Example 2



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$$P(HH) = \frac{\text{Number of HH outcomes}}{\text{Total number of outcomes}} = \frac{1}{4} = 0.25$$

The equation shows the probability of getting two heads (HH) in a sequence of two coin flips. The numerator represents the number of outcomes where both coins show heads (HH), which is 1. The denominator represents the total number of possible outcomes (HT, TH, TT, HH), which is 4. This results in a probability of 0.25 or 1/4.

A 2x4 grid of eight coins representing all possible outcomes of two coin flips. The top row contains four coins: the first two are yellow with 'H', the third is teal with 'T', and the fourth is yellow with 'T'. The bottom row contains four coins: the first is teal with 'H', the second is teal with 'T', the third is yellow with 'H', and the fourth is teal with 'T'.

# Introduction to Probability: Coin Example 3



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# Introduction to Probability: Coin Example 3



1st

50% 50%

# Introduction to Probability: Coin Example 3



50%    50%

1st



# Introduction to Probability: Coin Example 3



1st

2nd



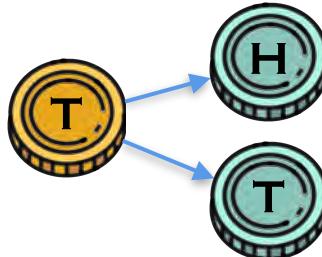
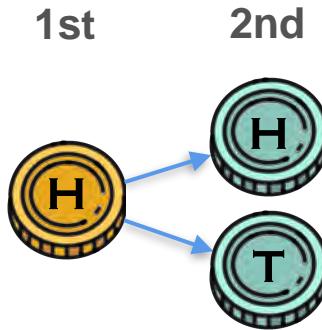
# Introduction to Probability: Coin Example 3



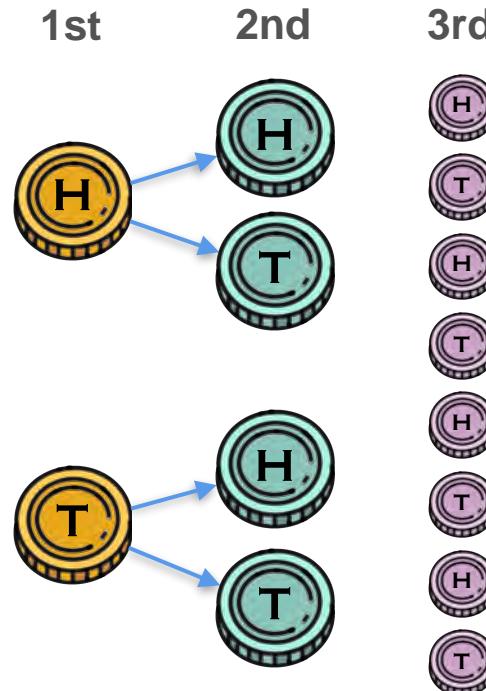
# Introduction to Probability: Coin Example 3



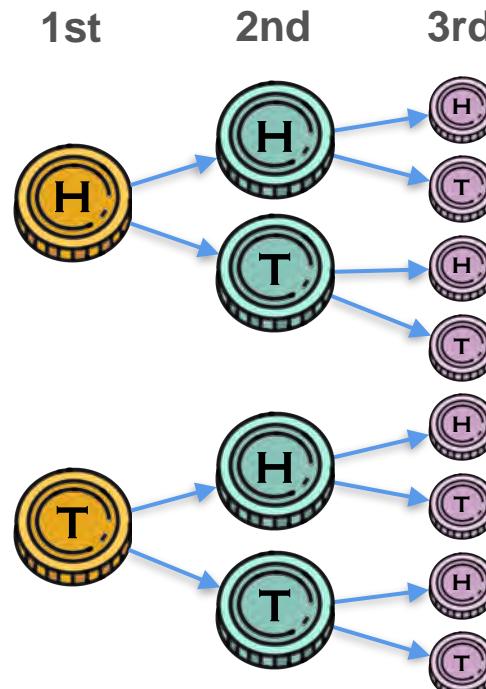
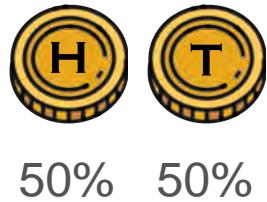
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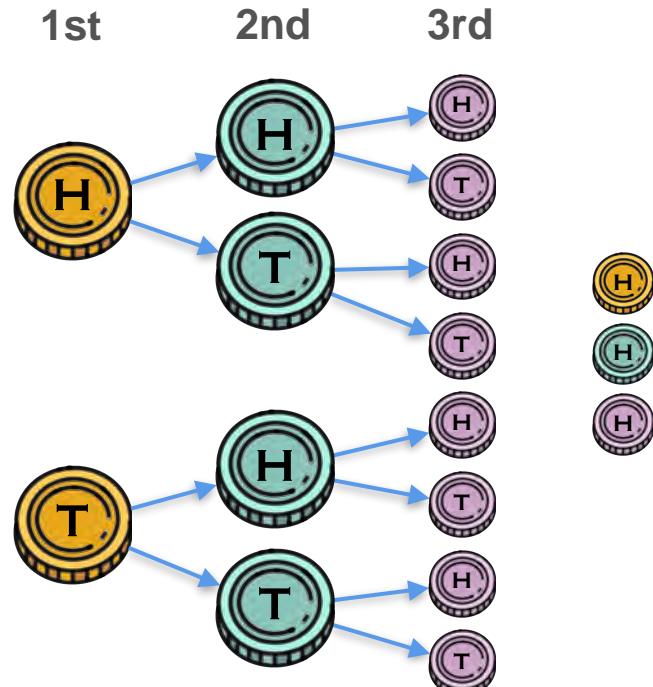
# Introduction to Probability: Coin Example 3



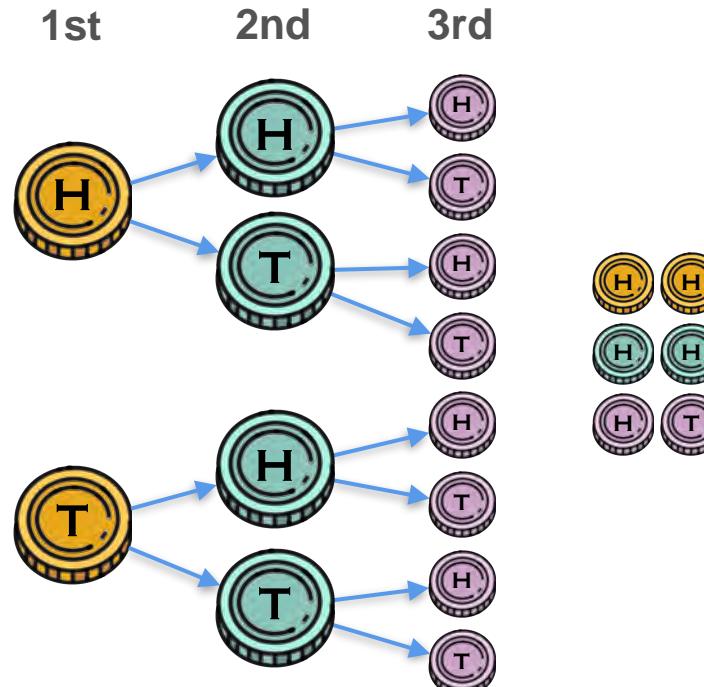
# Introduction to Probability: Coin Example 3



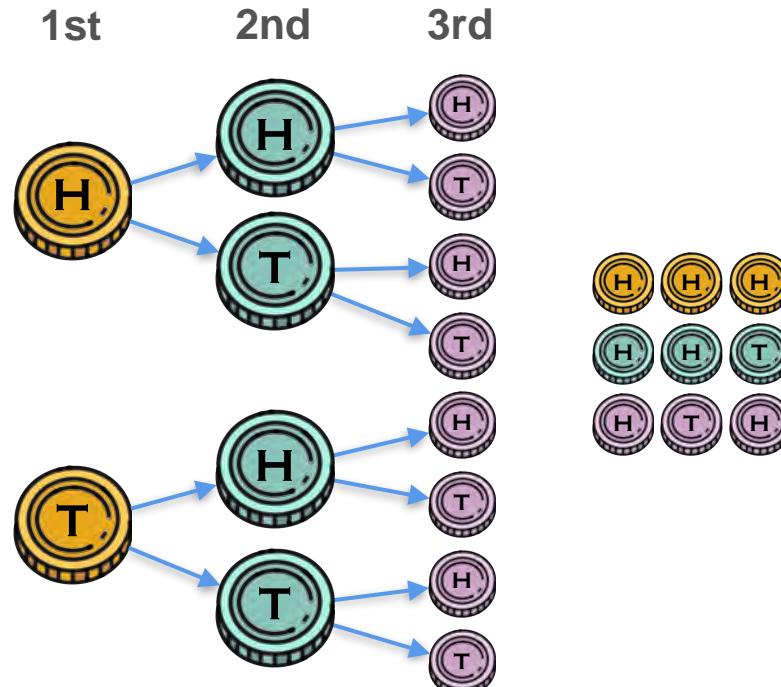
# Introduction to Probability: Coin Example 3



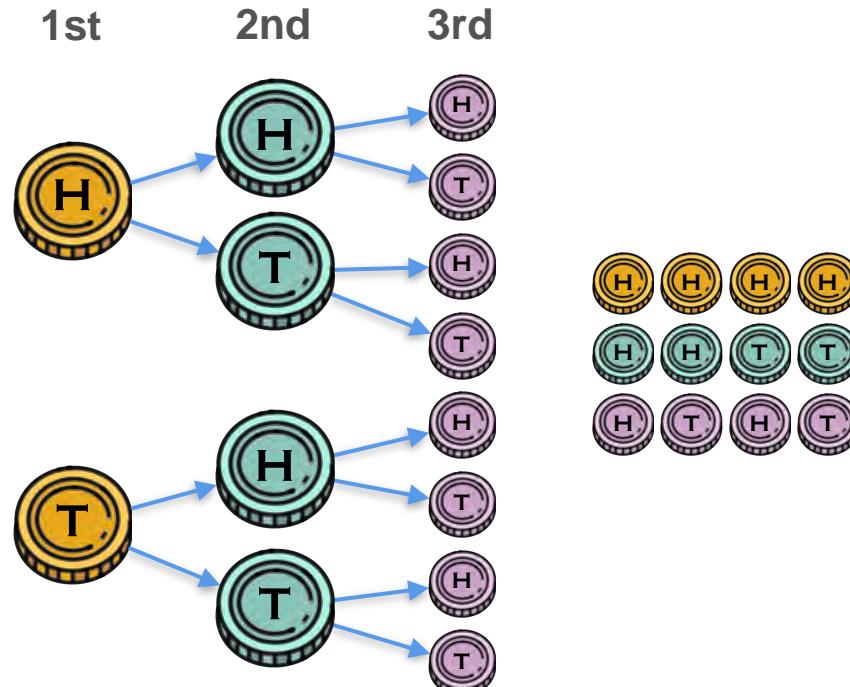
# Introduction to Probability: Coin Example 3



# Introduction to Probability: Coin Example 3



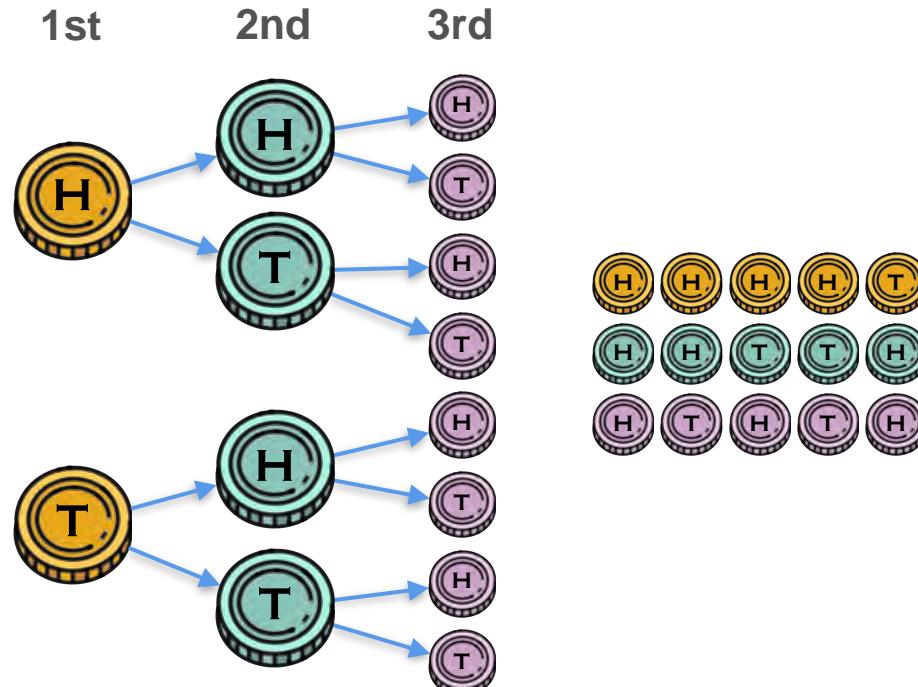
# Introduction to Probability: Coin Example 3



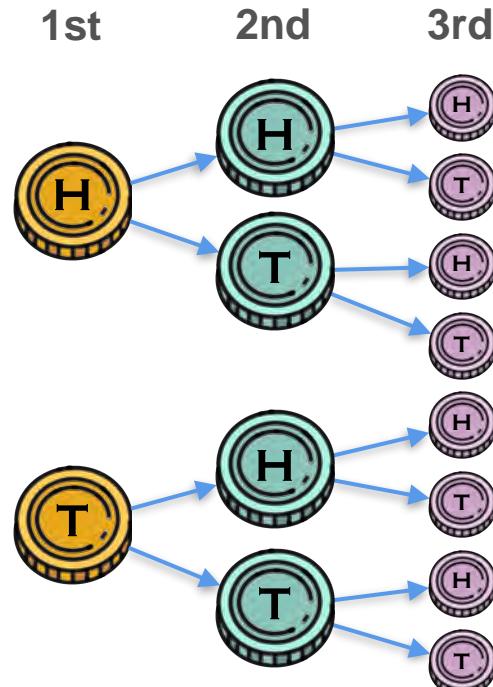
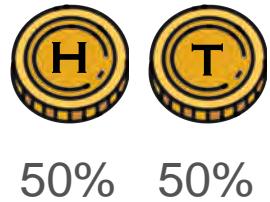
# Introduction to Probability: Coin Example 3



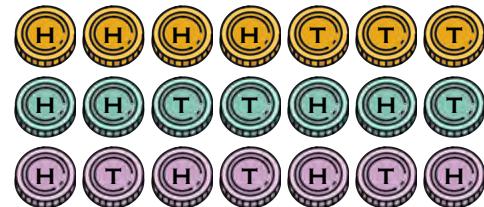
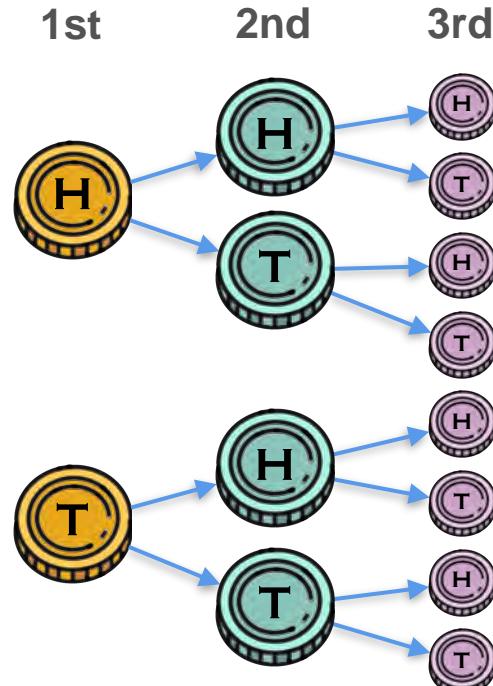
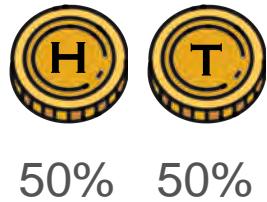
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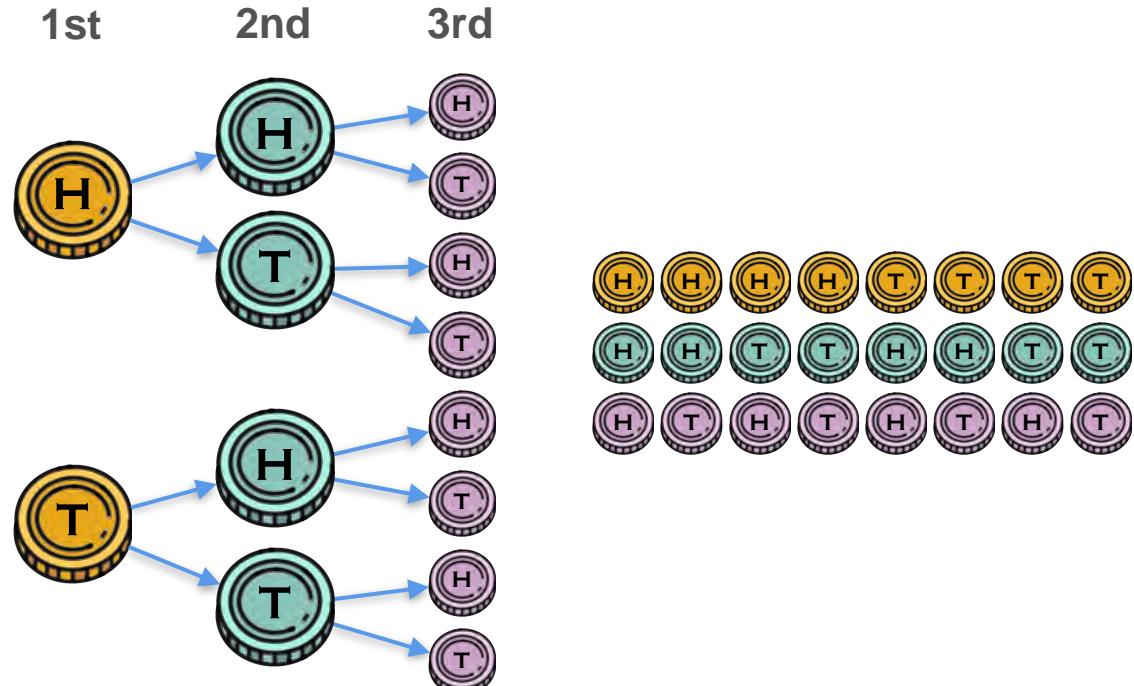
# Introduction to Probability: Coin Example 3



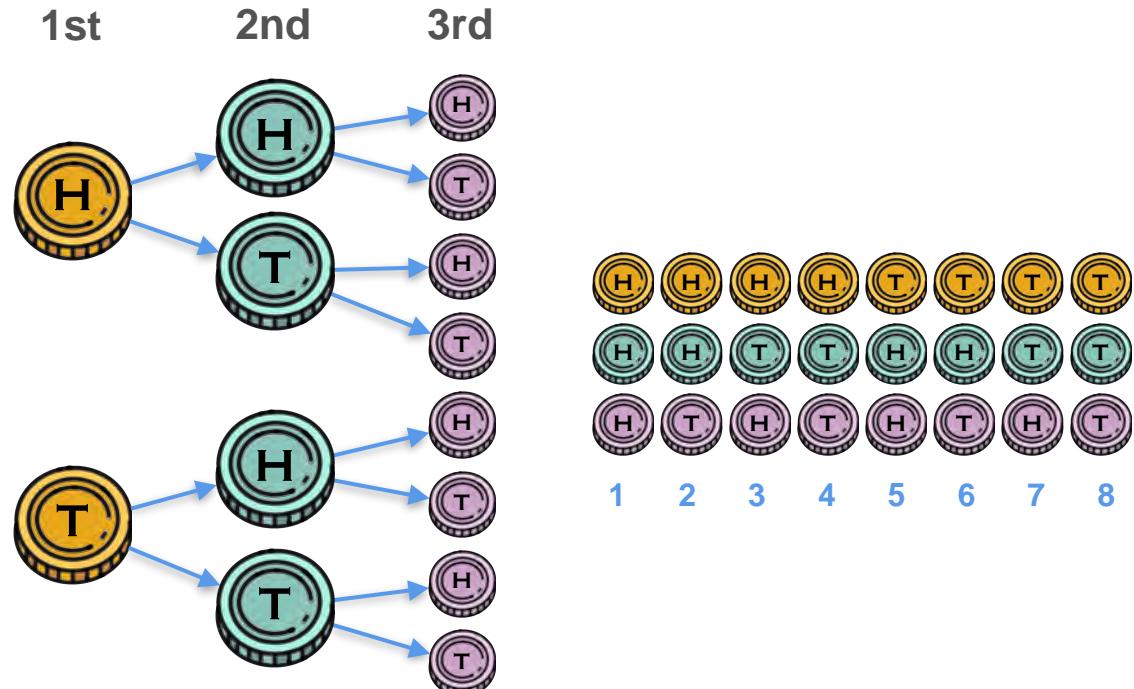
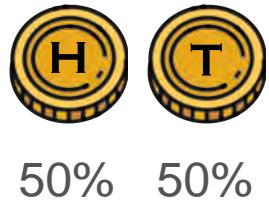
# Introduction to Probability: Coin Example 3



# Introduction to Probability: Coin Example 3



# Introduction to Probability: Coin Example 3

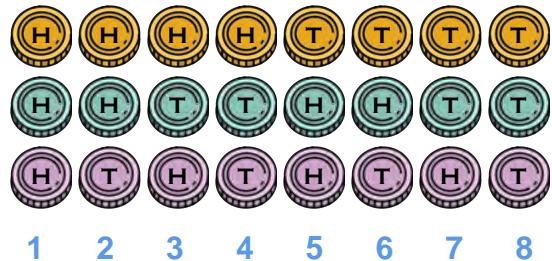
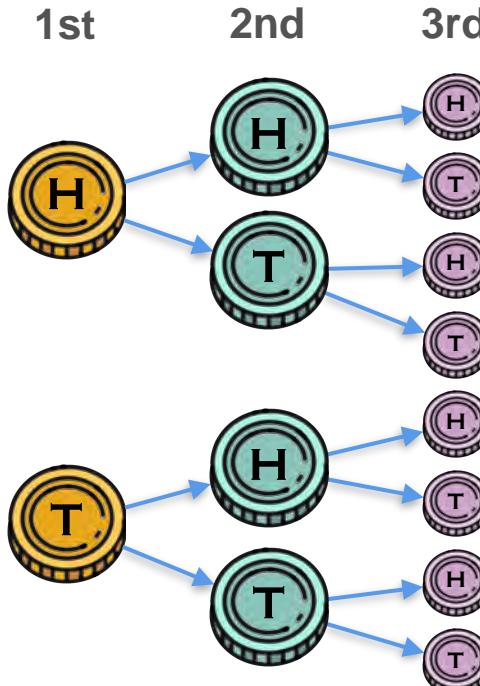


# Introduction to Probability: Coin Example 3



50% 50%

What is the probability of landing on heads 3 times?



# Introduction to Probability: Coin Example 3



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# Introduction to Probability: Coin Example 3



50% 50%

$$\mathbf{P}(HHH) = \underline{\hspace{2cm}}$$

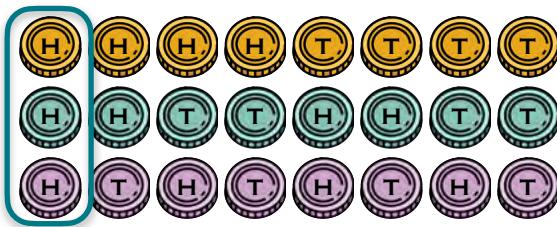


# Introduction to Probability: Coin Example 3



50% 50%

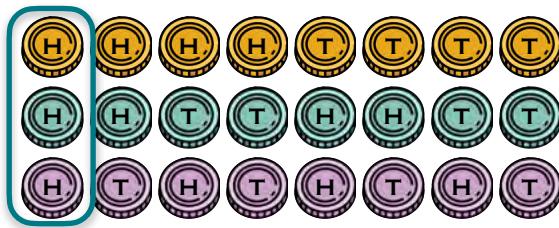
$$\mathbf{P}(HHH) = \underline{\hspace{2cm}}$$



# Introduction to Probability: Coin Example 3



50% 50%



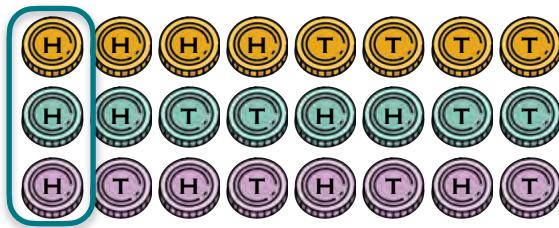
$$\mathbf{P}(HHH) = \underline{\hspace{2cm}}$$



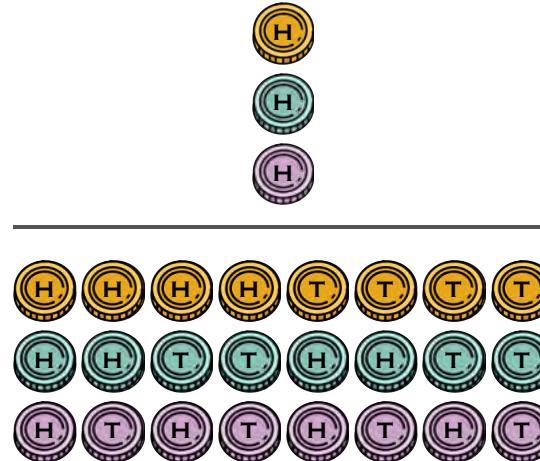
# Introduction to Probability: Coin Example 3



50% 50%



$$P(HHH) = \frac{\text{Number of favorable outcomes}}{\text{Total number of outcomes}}$$



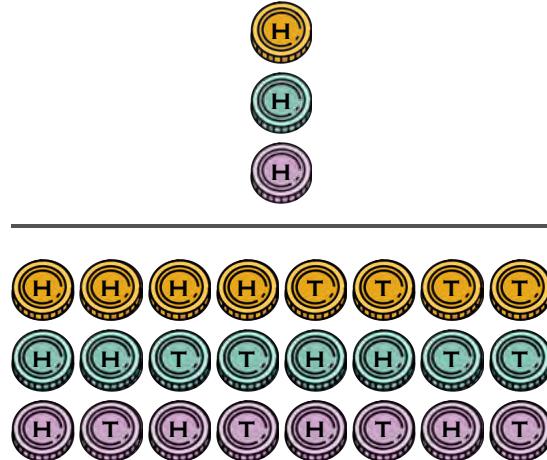
# Introduction to Probability: Coin Example 3



50% 50%



$$P(HHH) = \frac{\text{Number of favorable outcomes}}{\text{Total number of outcomes}}$$



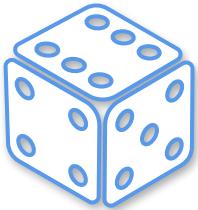
$$= \frac{1}{8} = 0.125$$

# Introduction to Probability: Dice Example 1

# Introduction to Probability: Dice Example 1

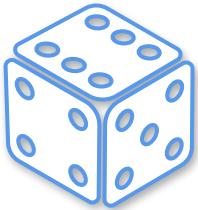


# Introduction to Probability: Dice Example 1



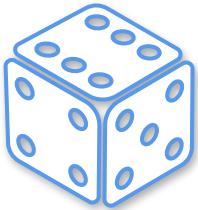
What is the probability of obtaining 6?

# Introduction to Probability: Dice Example 1



What is the probability of obtaining 6?

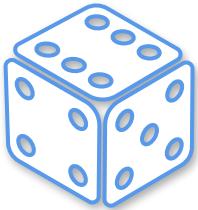
# Introduction to Probability: Dice Example 1



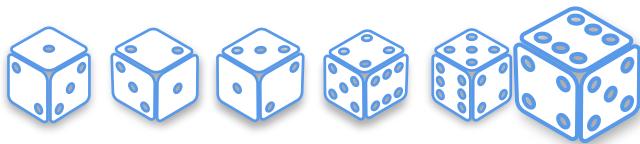
What is the probability of obtaining 6?



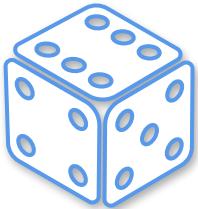
# Introduction to Probability: Dice Example 1



What is the probability of obtaining 6?



# Introduction to Probability: Dice Example 1

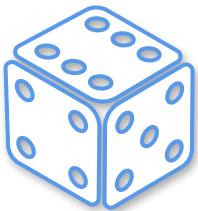


What is the probability of obtaining 6?

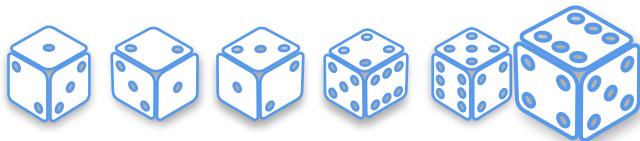


$$P(6) = \underline{\hspace{2cm}}$$

# Introduction to Probability: Dice Example 1



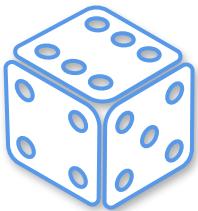
What is the probability of obtaining 6?



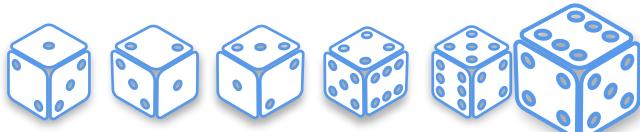
$$P(6) = \underline{\hspace{2cm}}$$



# Introduction to Probability: Dice Example 1

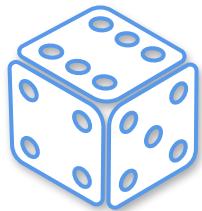


What is the probability of obtaining 6?



$$P(6) = \frac{1}{6}$$

# Introduction to Probability: Dice Example 1



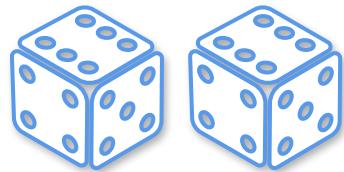
What is the probability of obtaining 6?

$$P(6) = \frac{1}{6}$$

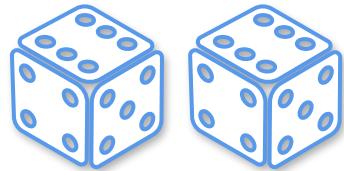
The equation illustrates the probability of rolling a 6 on a single die. The numerator is represented by a single die showing a 6, and the denominator is represented by a row of six dice, one for each possible outcome (1 through 6).

# Introduction to Probability: Dice Example 2

# Introduction to Probability: Dice Example 2

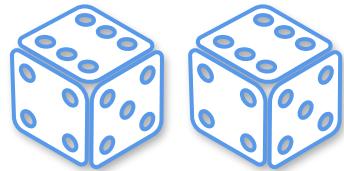


# Introduction to Probability: Dice Example 2



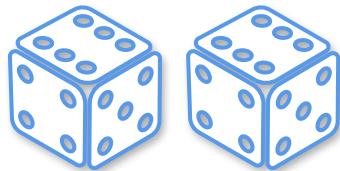
What is the probability of obtaining 6,6?

# Introduction to Probability: Dice Example 2



What is the probability of obtaining 6,6?

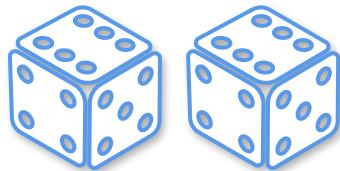
# Introduction to Probability: Dice Example 2



What is the probability of obtaining 6,6?



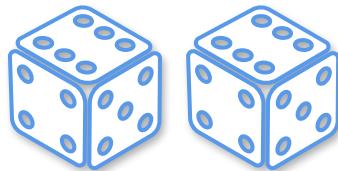
# Introduction to Probability: Dice Example 2



What is the probability of obtaining 6,6?

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6

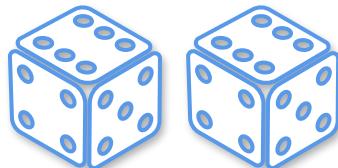
# Introduction to Probability: Dice Example 2



What is the probability of obtaining 6,6?

	1,1	1,2	1,3	1,4	1,5	1,6
1,1						
1,2						
1,3						
1,4						
1,5						
1,6						
2,1						
2,2						
2,3						
2,4						
2,5						
2,6						
3,1						
3,2						
3,3						
3,4						
3,5						
3,6						
4,1						
4,2						
4,3						
4,4						
4,5						
4,6						
5,1						
5,2						
5,3						
5,4						
5,5						
5,6						
6,1						
6,2						
6,3						
6,4						
6,5						
6,6						

# Introduction to Probability: Dice Example 2

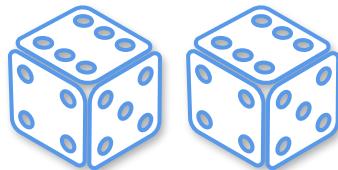


What is the probability of obtaining 6,6?

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6
6,1						

$$P(6,6) = \underline{\hspace{10em}}$$

# Introduction to Probability: Dice Example 2

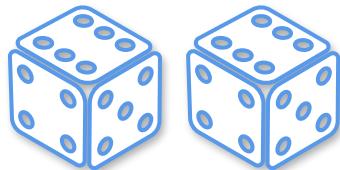


What is the probability of obtaining 6,6?

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6
6,1						

$$P(6,6) = \frac{1}{36}$$

# Introduction to Probability: Dice Example 2



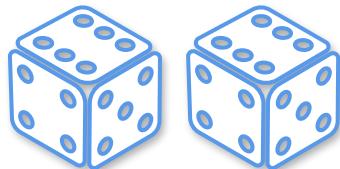
What is the probability of obtaining 6,6?

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6
6,1						

$$P(6,6) = \frac{1}{36}$$

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

# Introduction to Probability: Dice Example 2



What is the probability of obtaining 6,6?

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

$$P(6,6) = \frac{1}{36} = \frac{1}{36}$$

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6



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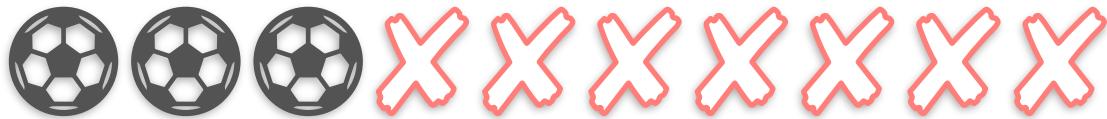
## Introduction to probability

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## Complement of Probability

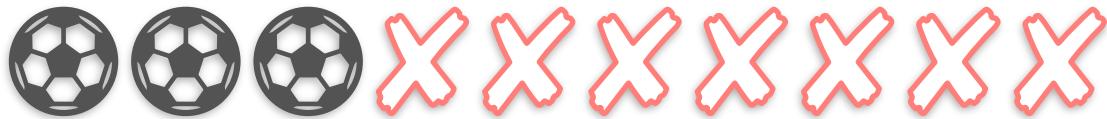
# Complement of Probability

# Complement of Probability



30%

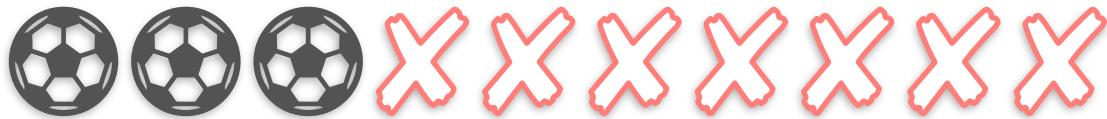
# Complement of Probability



30%

What is the probability of a child NOT playing soccer?

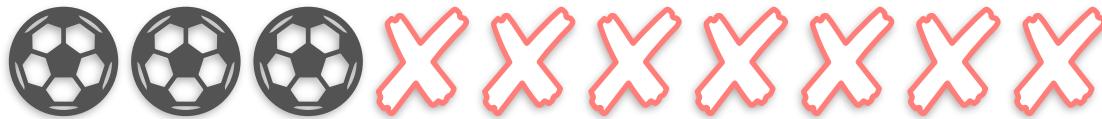
# Complement of Probability



30%

What is the probability of a child NOT playing soccer?

# Complement of Probability

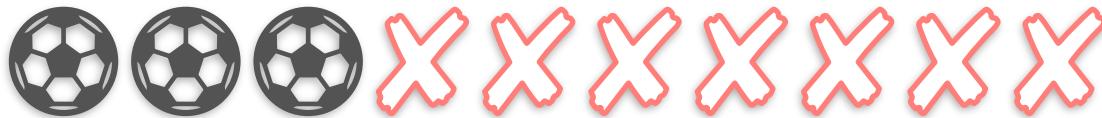


30%

What is the probability of a child NOT playing soccer?

$$P(\text{not soccer}) = \frac{\text{not soccer}}{\text{total}}$$

# Complement of Probability

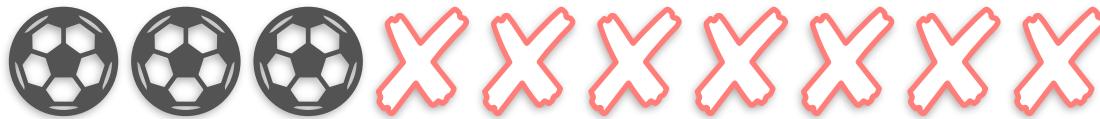


30%

What is the probability of a child NOT playing soccer?

$$P(\text{not soccer}) = \frac{\text{not soccer}}{\text{total}} = \underline{\hspace{2cm}}$$

# Complement of Probability

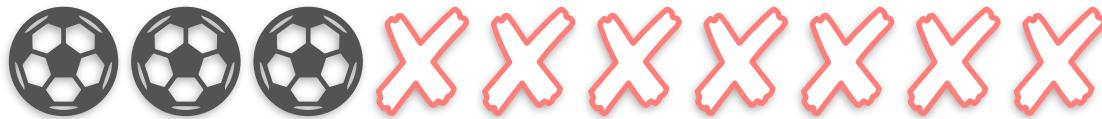


30%

What is the probability of a child NOT playing soccer?

$$P(\text{not soccer}) = \frac{\text{not soccer}}{\text{total}} = \frac{\text{XXXXXX}}{\text{XXXXXX}}$$

# Complement of Probability

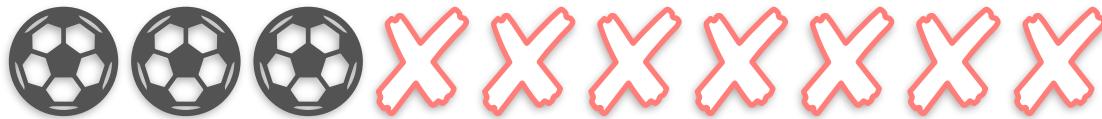


30%

What is the probability of a child NOT playing soccer?

$$P(\text{not soccer}) = \frac{\text{not soccer}}{\text{total}} = \frac{\text{XXXXXXX}}{\text{XXXXXXX}}$$

# Complement of Probability

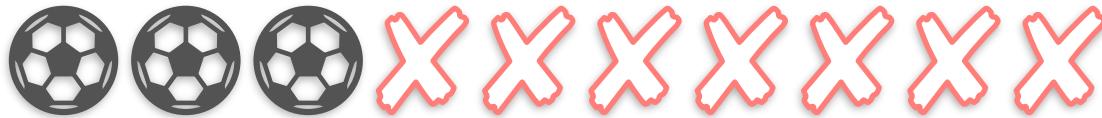


30%

What is the probability of a child NOT playing soccer?

$$P(\text{not soccer}) = \frac{\text{not soccer}}{\text{total}} = \frac{\text{XXXXXXX}}{\text{XXXXXXX}} = \frac{7}{10}$$

# Complement of Probability



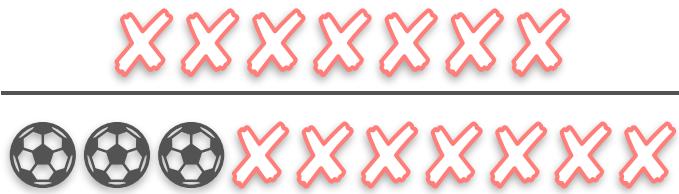
30%

What is the probability of a child NOT playing soccer?

$$P(\text{not soccer}) = \frac{\text{not soccer}}{\text{total}} = \frac{\text{XXXXXXX}}{\text{XXXXXXX}} = \frac{7}{10} = 0.7$$

# Complement of Probability

# Complement of Probability



$P(\text{not soccer})$

0.7

# Complement of Probability

XXXXXX

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●●●XXXX

$P(\text{not soccer})$

0.7

●●●

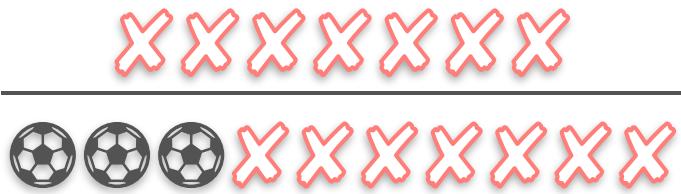
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●●●XXXX

$P(\text{soccer})$

0.3

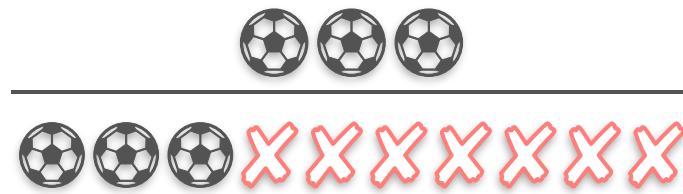
# Complement of Probability



$P(\text{not soccer})$

0.7

+

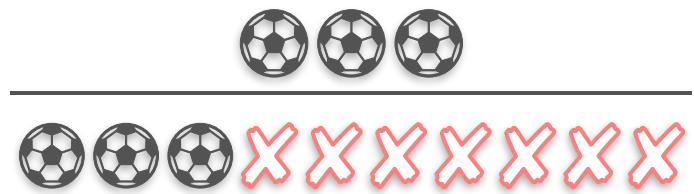
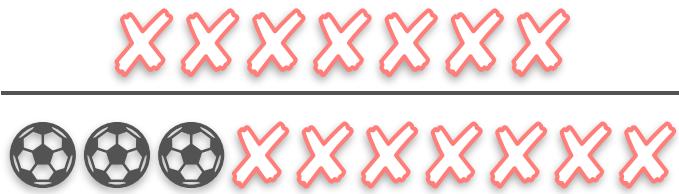


$P(\text{soccer})$

0.3

= 1

# Complement of Probability



$P(\text{not soccer})$

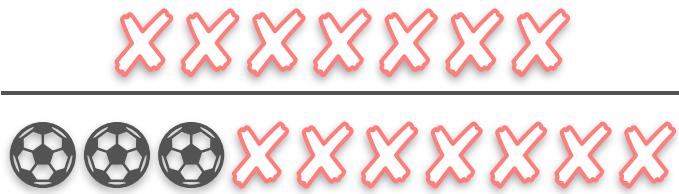
0.7

= 1

$P(\text{soccer})$

0.3

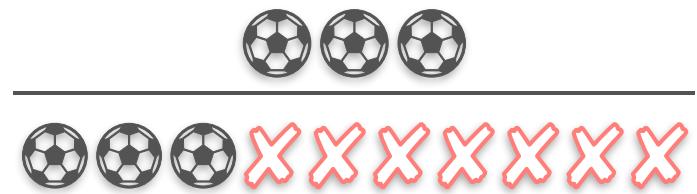
# Complement of Probability



$P(\text{not soccer})$

0.7

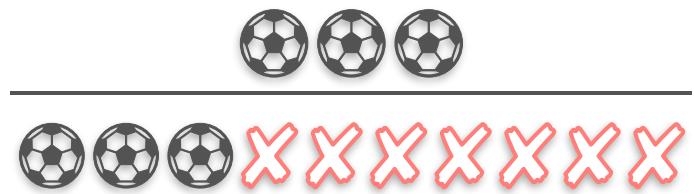
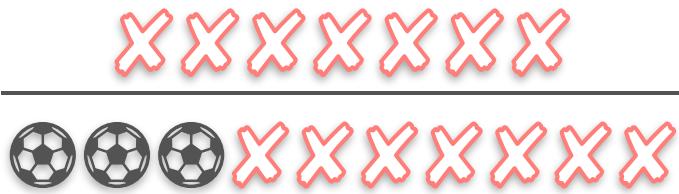
$$= 1 -$$



$P(\text{soccer})$

0.3

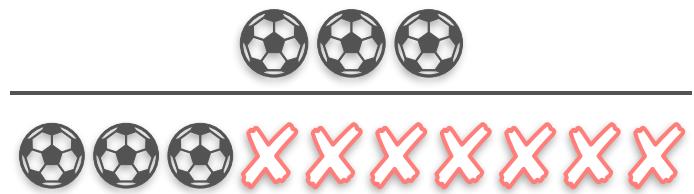
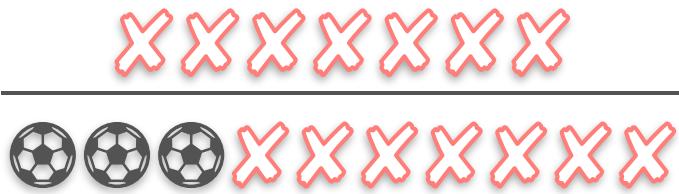
# Complement of Probability



$$P(\text{not soccer}) = 1 - P(\text{soccer})$$

$$0.7 = 1 - 0.3$$

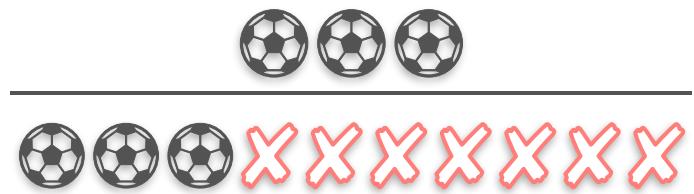
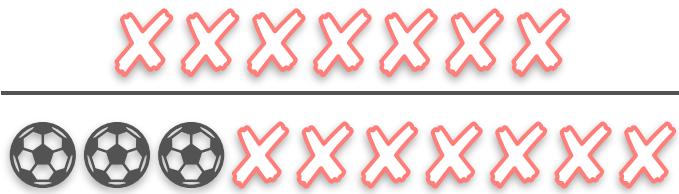
# Complement of Probability



$$P(\text{not soccer}) = 1 - P(\text{soccer})$$

$$0.7 = 1 - 0.3$$

# Complement of Probability



$$P(\text{not soccer}) = 1 - P(\text{soccer})$$

$$0.7 = 1 - 0.3$$

Complement Rule

# Complement of Probability

$$P(\text{not soccer}) = 1 - P(\text{soccer})$$

Complement Rule

# Complement of Probability

$$P(\text{not soccer}) = 1 - P(\text{soccer})$$

$$P(A') = 1 - P(A)$$

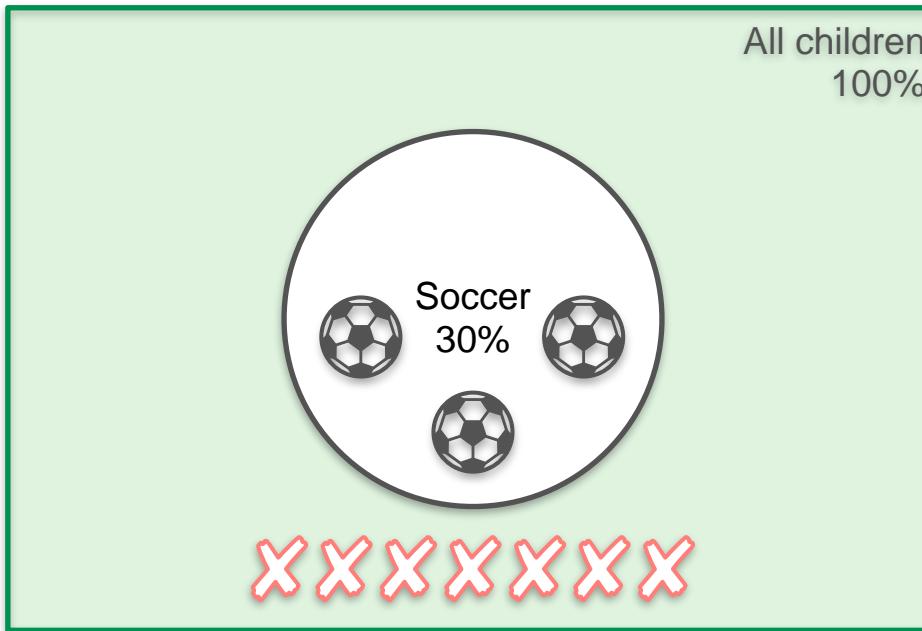
Complement Rule

# Complement of Probability: Venn Diagram

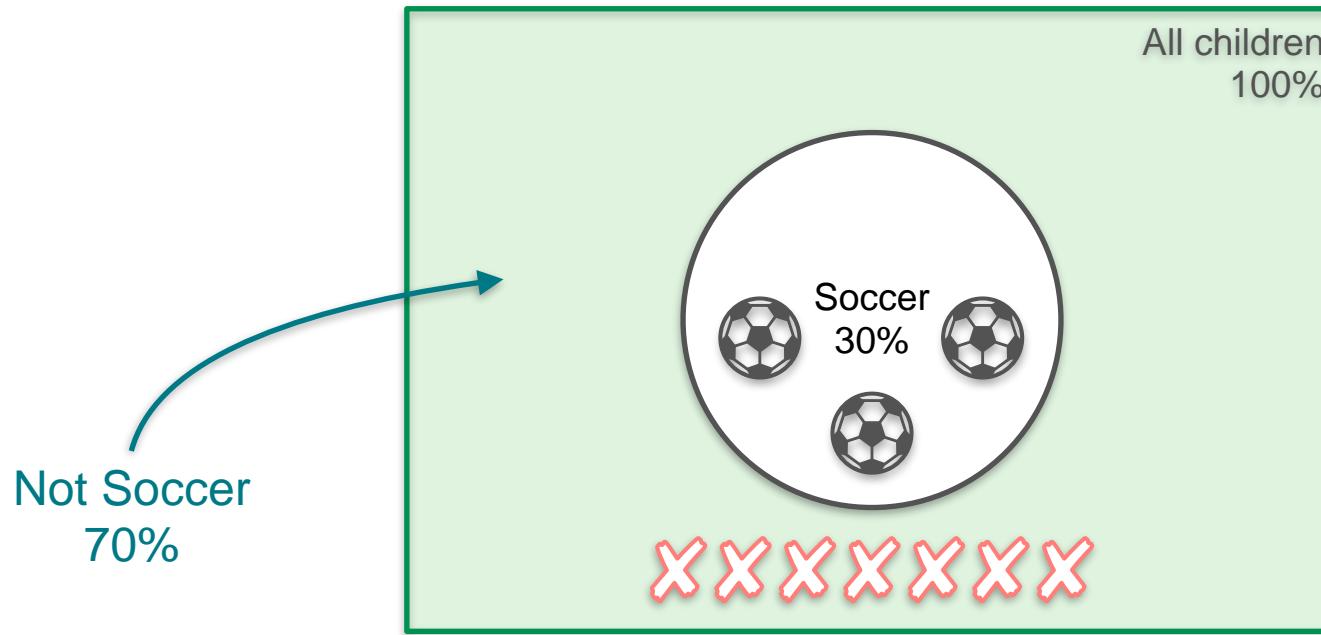
# Complement of Probability: Venn Diagram



# Complement of Probability: Venn Diagram



# Complement of Probability: Venn Diagram



# Complement of Probability: Coin Example 1



# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH)$$

# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) =$$

# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1$$

# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1 - P(HHH)$$

# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1 - P(HHH)$$

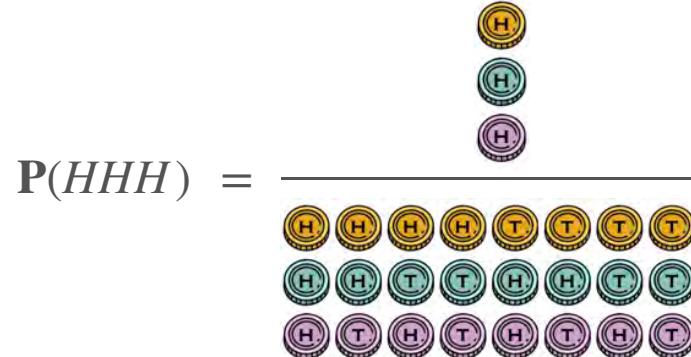
$$P(HHH) =$$

# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1 - P(HHH)$$

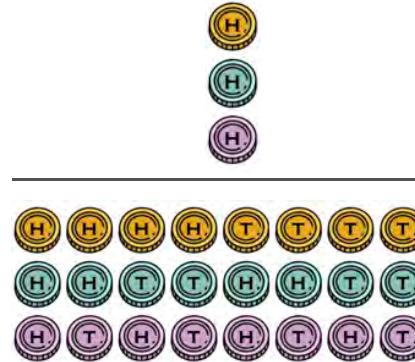


# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1 - P(HHH)$$



# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1 - P(HHH)$$

$$P(\text{not } HHH) = 1 - \frac{\text{_____}}{\text{_____}}$$

The denominator consists of three rows of 8 coins each, totaling 24 coins. The top row has all heads (H). The middle row has 7 heads (H) and 1 tail (T). The bottom row has 4 heads (H) and 4 tails (T).

# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1 - P(HHH)$$

$$P(\text{not } HHH) = 1 - \frac{1}{8}$$

# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1 - P(HHH)$$

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# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1 - P(HHH)$$

$$P(\text{not } HHH) = 1 - \frac{1}{8}$$

$$= \frac{7}{8}$$

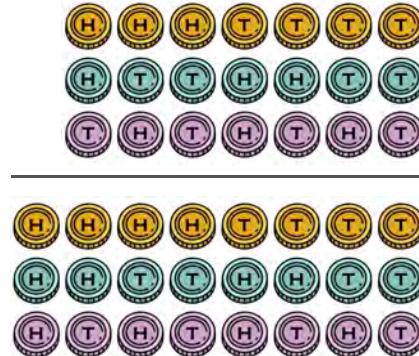
# Complement of Probability: Coin Example 1



What is the probability of not landing on heads 3 times?

$$P(\text{not } HHH) = 1 - P(HHH)$$

$$\begin{aligned} P(\text{not } HHH) &= 1 - \frac{1}{8} \\ &= \frac{7}{8} \end{aligned}$$



# Complement of Probability: Dice Example 1

# Complement of Probability: Dice Example 1



# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?

# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?

# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) =$$

# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) = \frac{\text{Number of outcomes not 6}}{\text{Total number of outcomes}}$$

The equation shows a fraction where the numerator is represented by six dice showing faces other than 6 (1, 2, 3, 4, or 5), and the denominator is represented by six dice showing faces from 1 to 6.

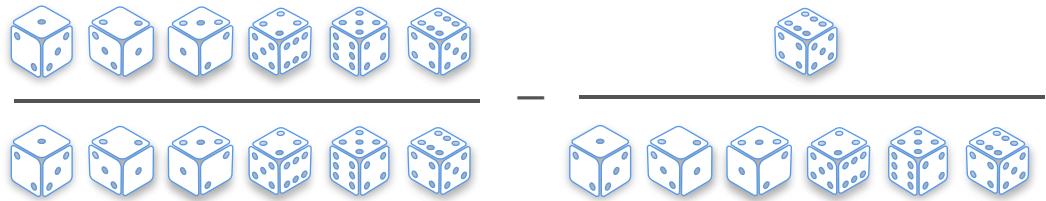
# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) =$$



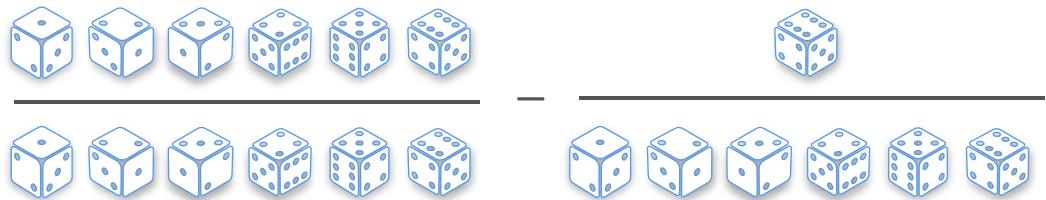
# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) =$$



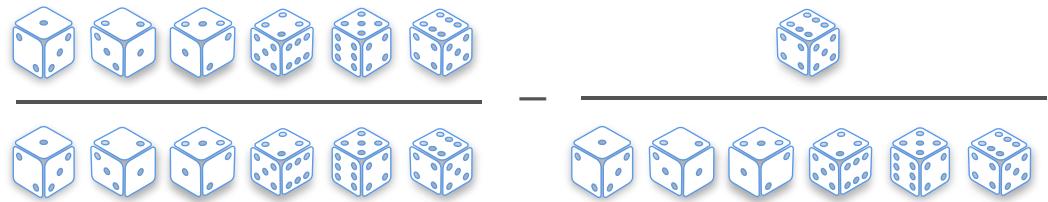
# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) =$$



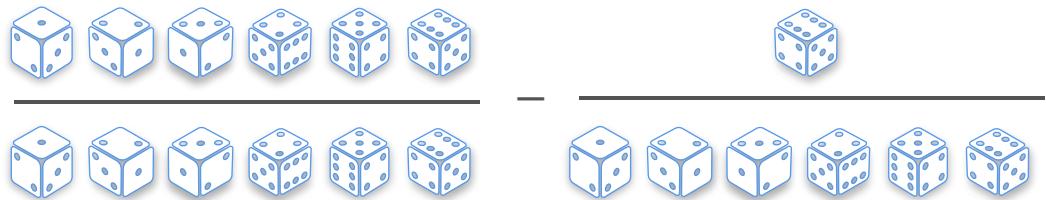
# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) =$$



$$= \frac{\text{Number of outcomes not 6}}{\text{Total number of outcomes}}$$

# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) =$$

$$\frac{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \\ \hline \end{array}}{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \end{array}} - \frac{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \\ \hline \end{array}}{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \end{array}}$$
$$= \frac{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \\ \hline \end{array}}{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \end{array}}$$

# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) =$$

$$\frac{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \\ \hline \end{array}}{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \end{array}} - \frac{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \\ \hline \end{array}}{\begin{array}{cccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \end{array}}$$
$$= \frac{\begin{array}{ccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \\ \hline \end{array}}{\begin{array}{ccccc} \text{dice} & \text{dice} & \text{dice} & \text{dice} & \text{dice} \end{array}}$$

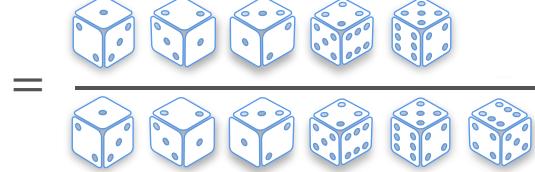
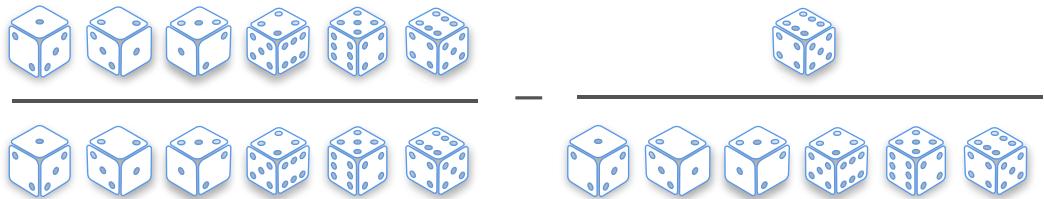
# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) =$$



=

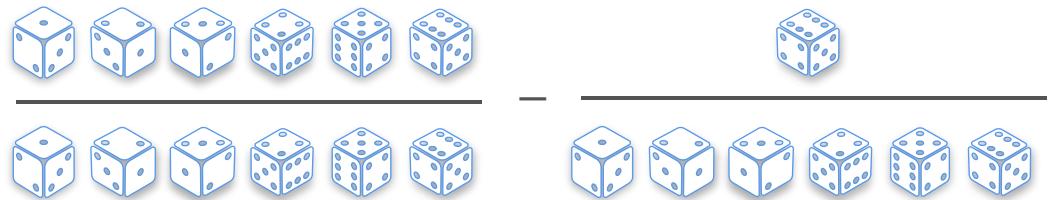
# Complement of Probability: Dice Example 1



What is the probability of obtaining anything other than 6?



$$P(\text{not } 6) =$$



$$= \frac{5}{6}$$



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# Introduction to probability

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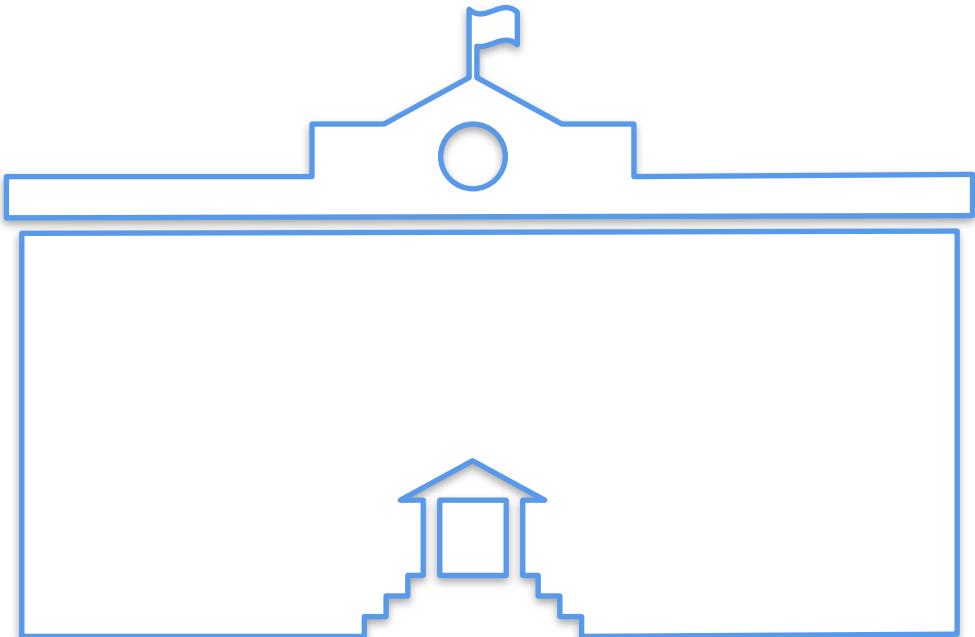
## Sum of Probabilities

# Sum of Probabilities: Quiz 1

# Sum of Probabilities: Quiz 1

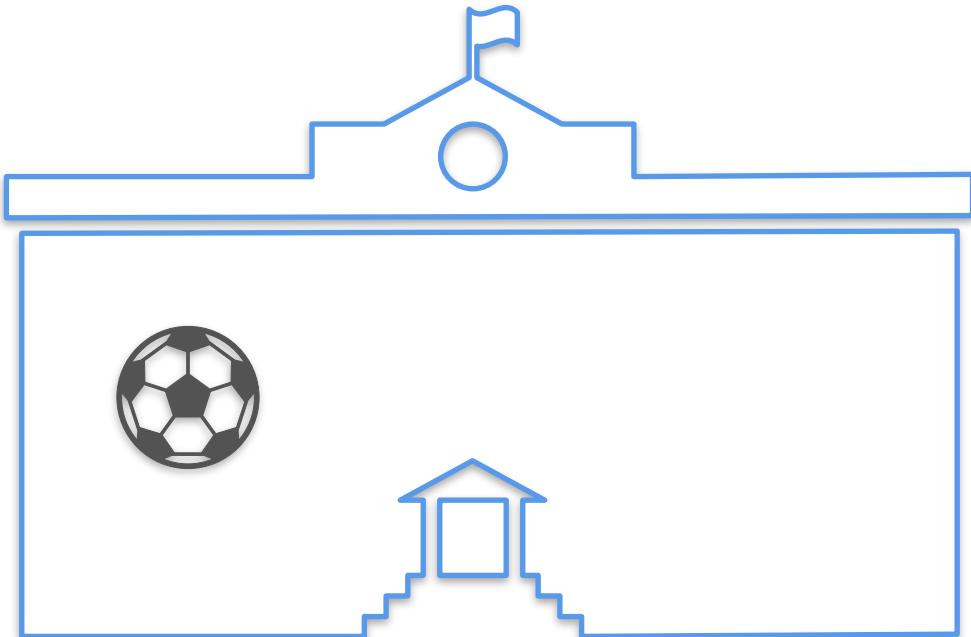
At a school, kids can only play one sport.

# Sum of Probabilities: Quiz 1



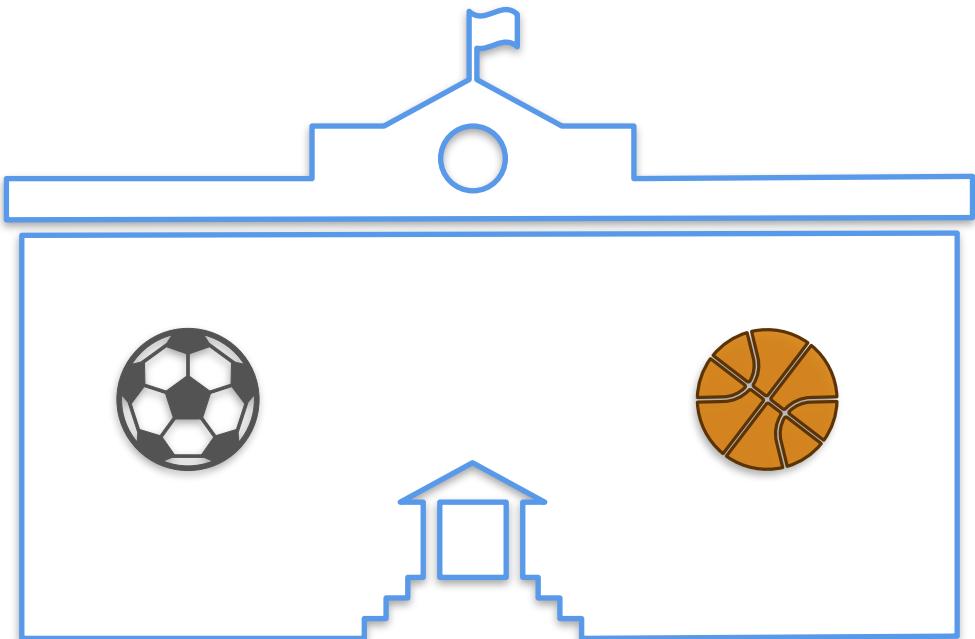
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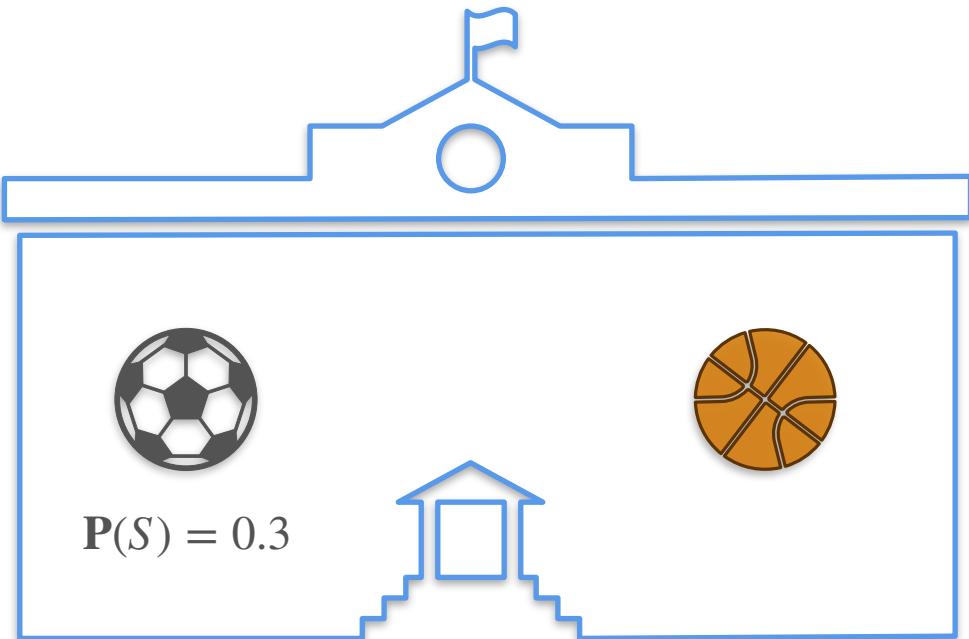
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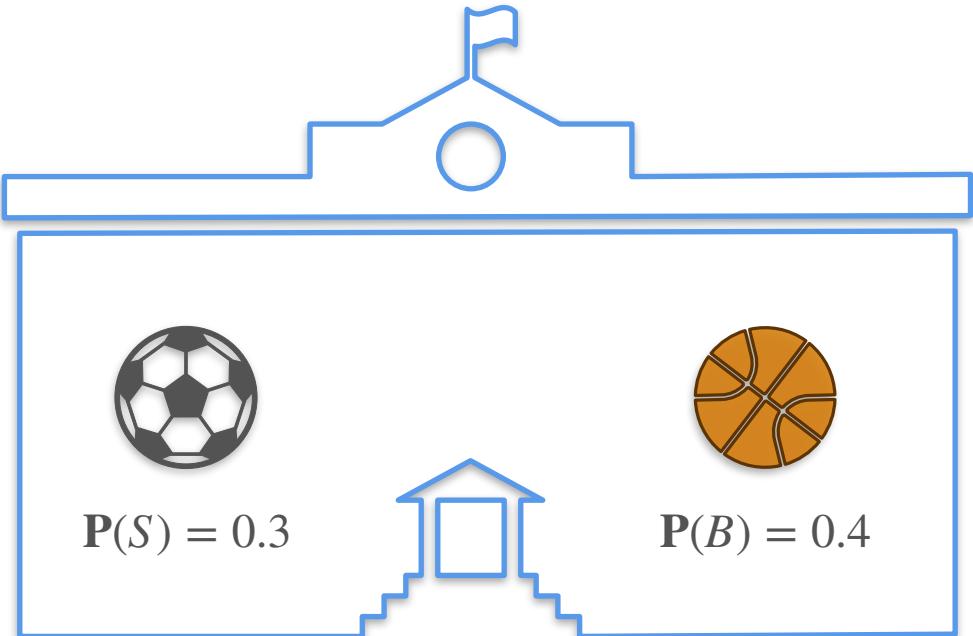
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# Sum of Probabilities: Quiz 1



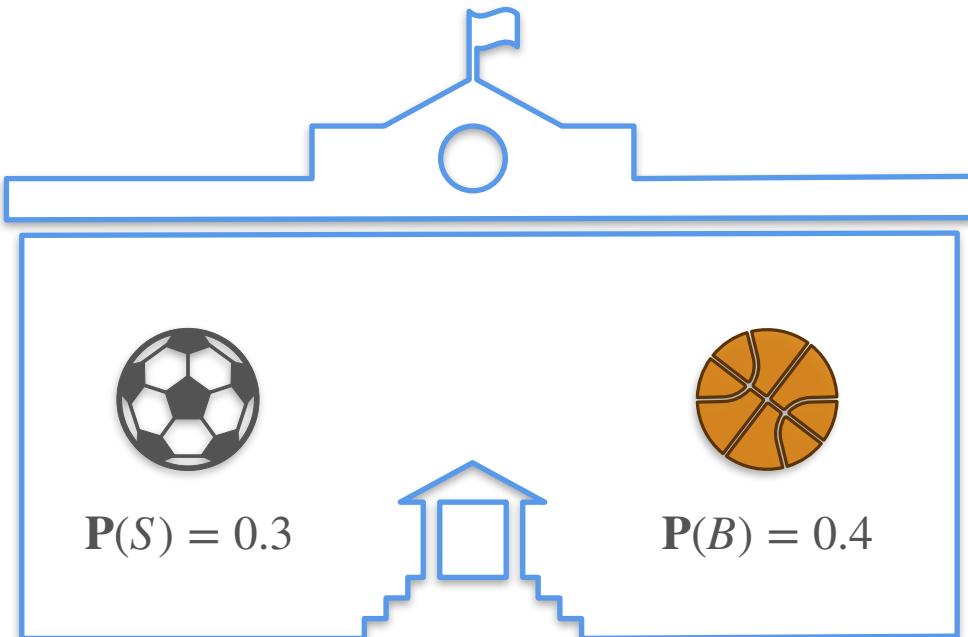
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# Sum of Probabilities: Quiz 1



At a school, kids can only play one sport.

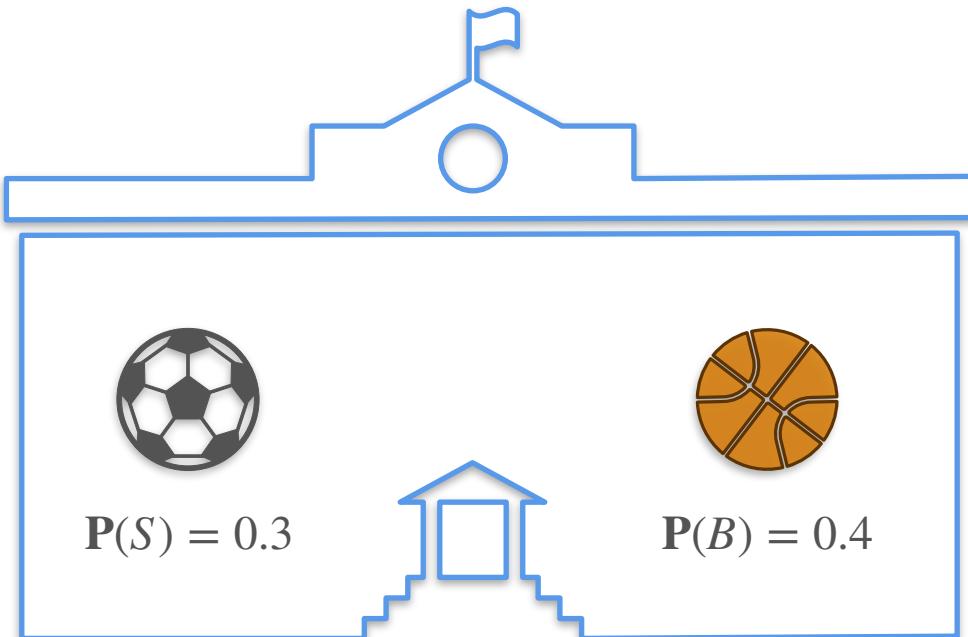
# Sum of Probabilities: Quiz 1



At a school, kids can only play one sport.

What is the probability that a kid plays soccer or basketball?

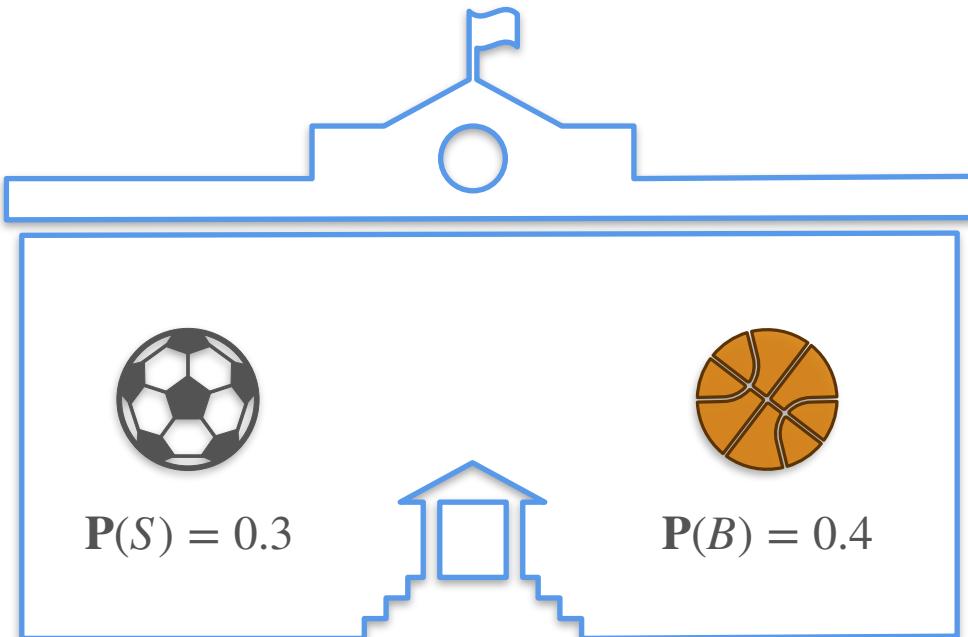
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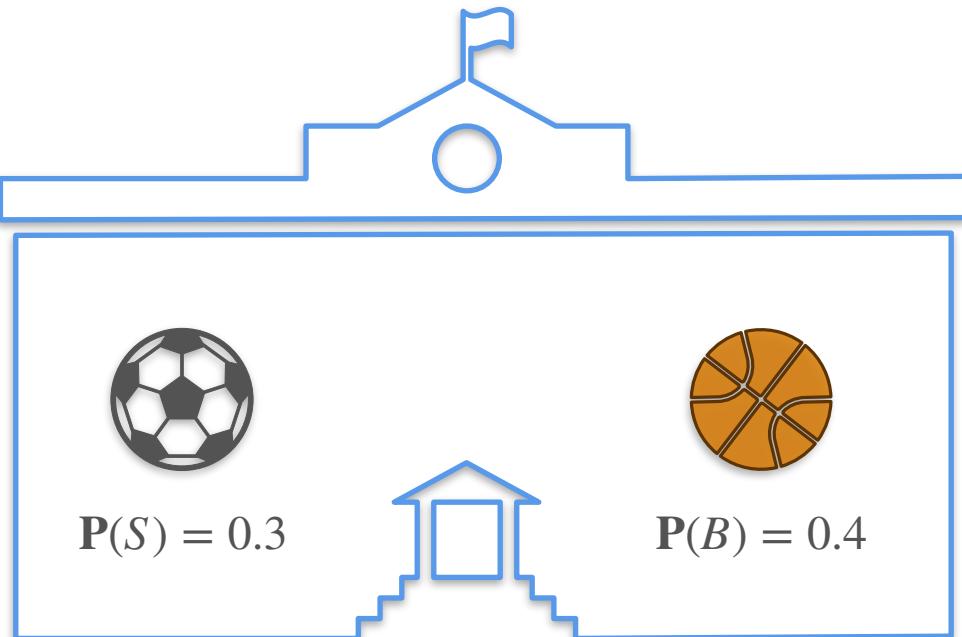
# Sum of Probabilities: Quiz 1



At a school, kids can only play one sport.

What is the probability that a kid plays soccer or basketball?

# Sum of Probabilities: Quiz 1



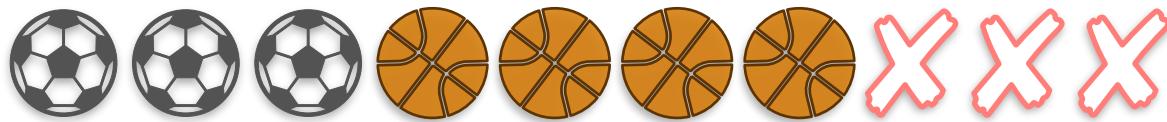
At a school, kids can only play one sport.

What is the probability that a kid plays soccer or basketball?

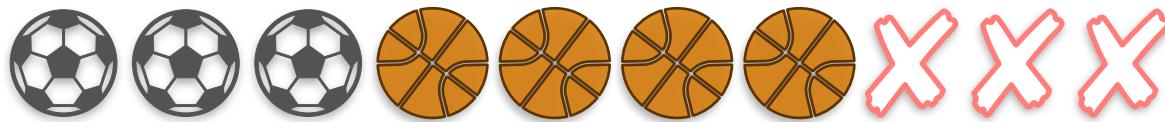
Hint: What if there were only 10 kids?

# Sum of Probabilities: Quiz 1 Solution

# Sum of Probabilities: Quiz 1 Solution

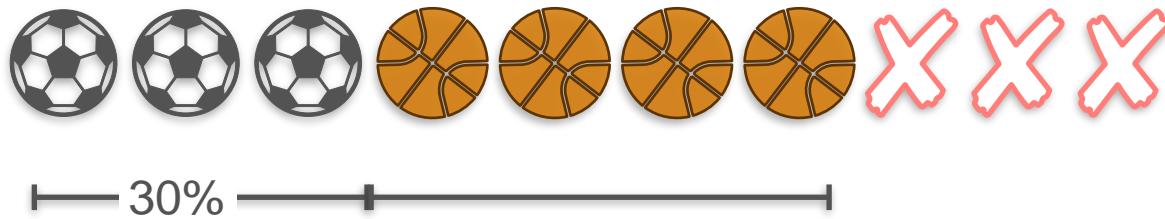


# Sum of Probabilities: Quiz 1 Solution

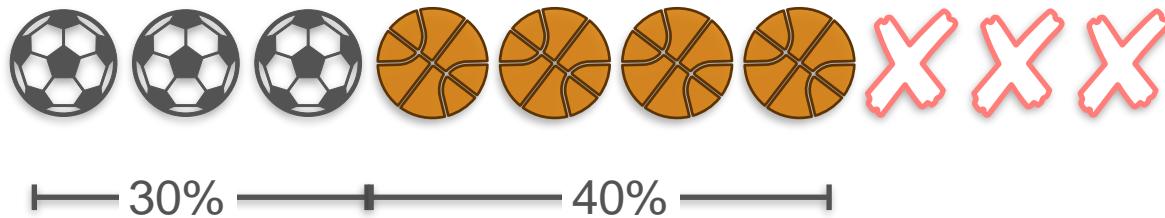


— 30% —

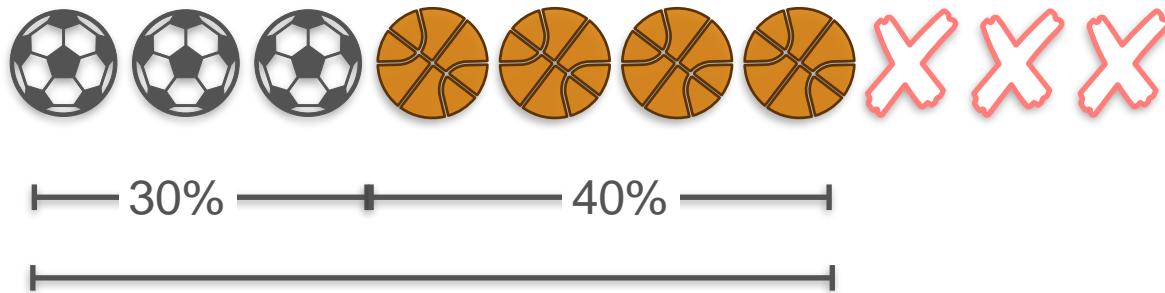
# Sum of Probabilities: Quiz 1 Solution



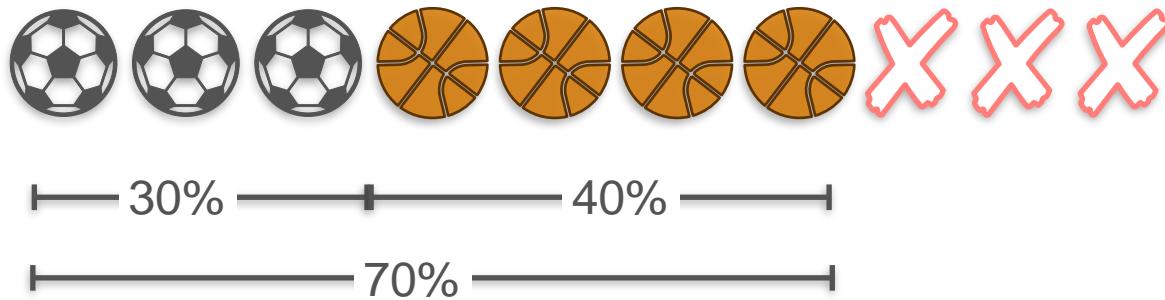
# Sum of Probabilities: Quiz 1 Solution



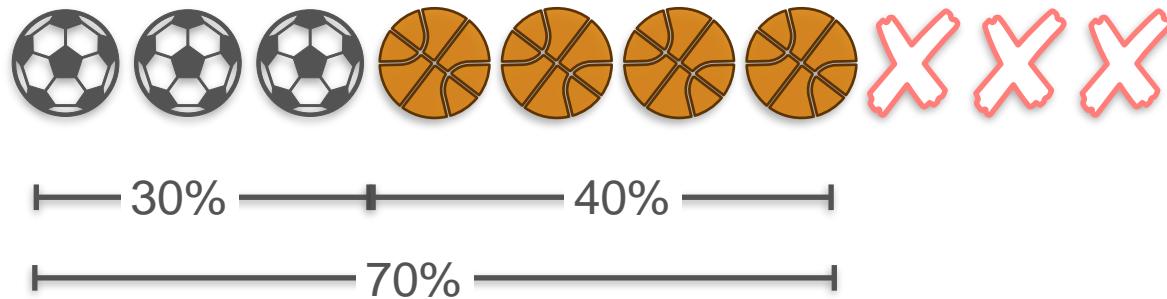
# Sum of Probabilities: Quiz 1 Solution



# Sum of Probabilities: Quiz 1 Solution

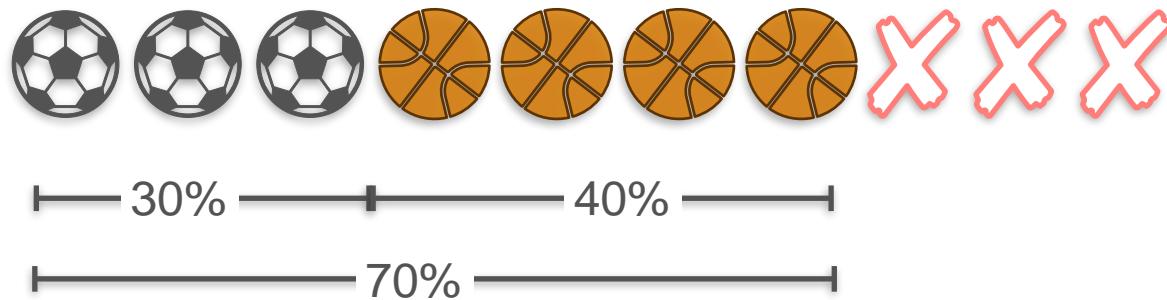


# Sum of Probabilities: Quiz 1 Solution



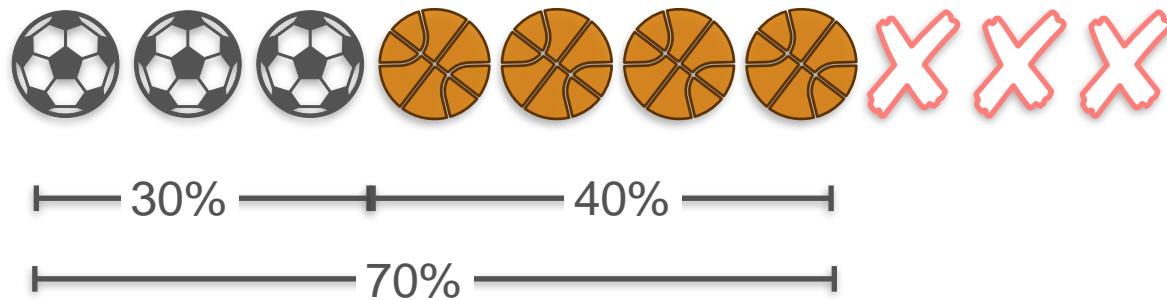
$$P(\text{soccer or basketball}) = \frac{\text{soccer or basketball}}{\text{total}}$$

# Sum of Probabilities: Quiz 1 Solution



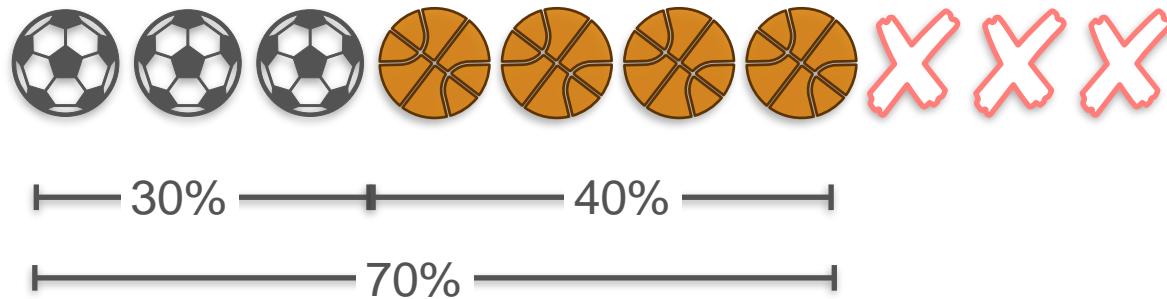
$$P(\text{soccer or basketball}) = \frac{\text{soccer or basketball}}{\text{total}} = \frac{3 + 4}{10}$$

# Sum of Probabilities: Quiz 1 Solution



$$P(\text{soccer or basketball}) = \frac{\text{soccer or basketball}}{\text{total}} = \frac{3 + 4}{10} = 0.7$$

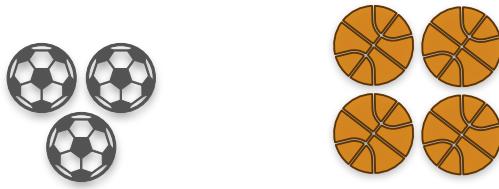
# Sum of Probabilities: Quiz 1 Solution



$$P(\text{soccer or basketball}) = \frac{\text{soccer or basketball}}{\text{total}} = \frac{3 + 4}{10} = 0.7$$

$$P(\text{soccer or basketball}) = P(\text{soccer}) + P(\text{basketball})$$

# Sum of Probabilities: Quiz 1 Solution



XXX

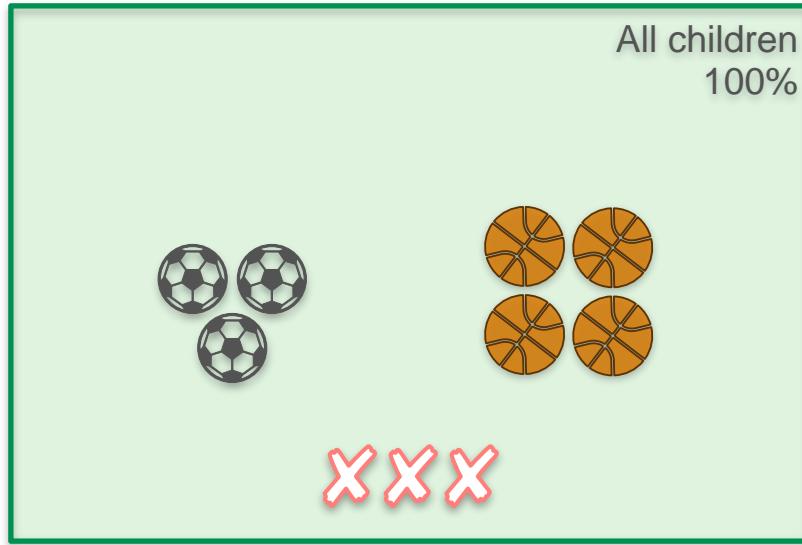
# Sum of Probabilities: Quiz 1 Solution



XXX

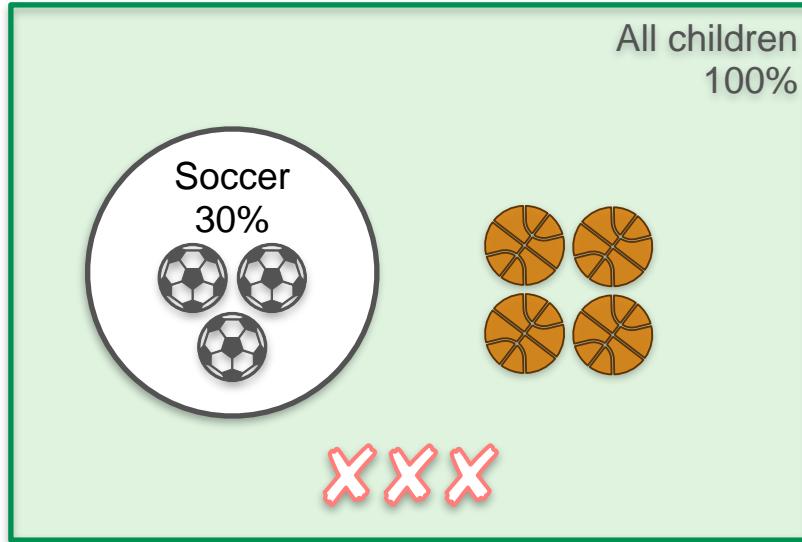
$$P(\text{soccer} \cup \text{basketball}) = P(\text{soccer}) + P(\text{basketball})$$

# Sum of Probabilities: Quiz 1 Solution



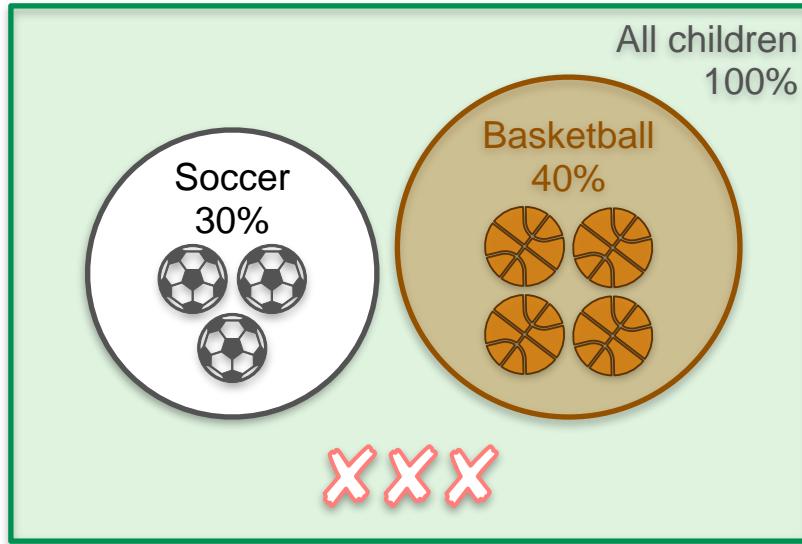
$$P(\text{soccer} \cup \text{basketball}) = P(\text{soccer}) + P(\text{basketball})$$

# Sum of Probabilities: Quiz 1 Solution



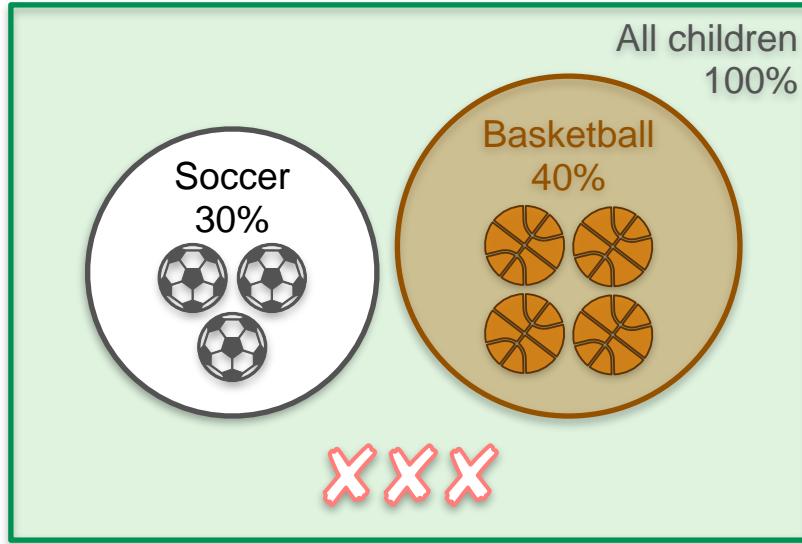
$$P(\text{soccer} \cup \text{basketball}) = P(\text{soccer}) + P(\text{basketball})$$

# Sum of Probabilities: Quiz 1 Solution



$$P(\text{soccer} \cup \text{basketball}) = P(\text{soccer}) + P(\text{basketball})$$

# Sum of Probabilities: Quiz 1 Solution



$$P(\text{soccer} \cup \text{basketball}) = P(\text{soccer}) + P(\text{basketball})$$

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

# Sum of Probabilities: Dice Example 1

# Sum of Probabilities: Dice Example 1



# Sum of Probabilities: Dice Example 1



What is the probability of obtaining  
an even number or a 5?

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining  
an even number or a 5?

# Sum of Probabilities: Dice Example 1

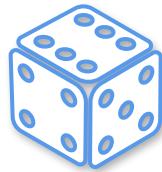


What is the probability of obtaining an even number or a 5?

A

B

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

A



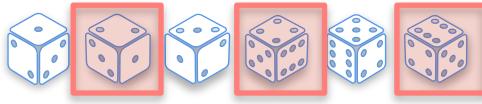
B

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

A



B

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

A



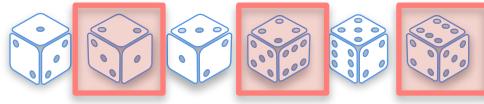
B

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

A



B



# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

A



B

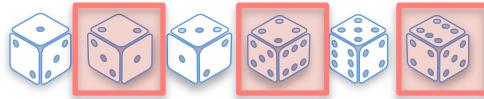


# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

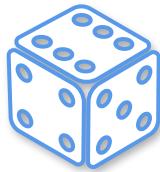
A



B



# Sum of Probabilities: Dice Example 1

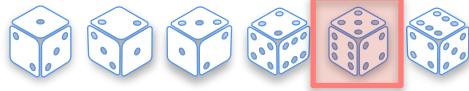


What is the probability of obtaining an even number or a 5?

A



B



+

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

A



B



+



# Sum of Probabilities: Dice Example 1

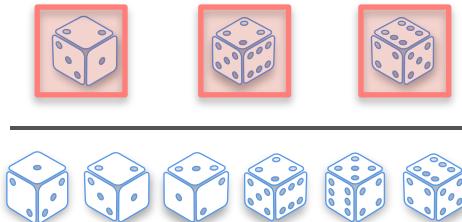
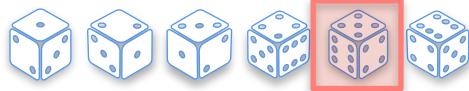


What is the probability of obtaining an even number or a 5?

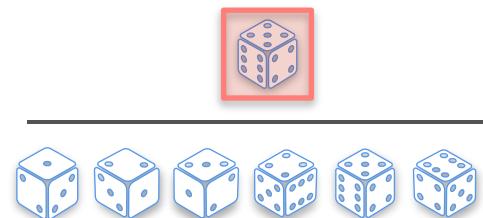
A



B



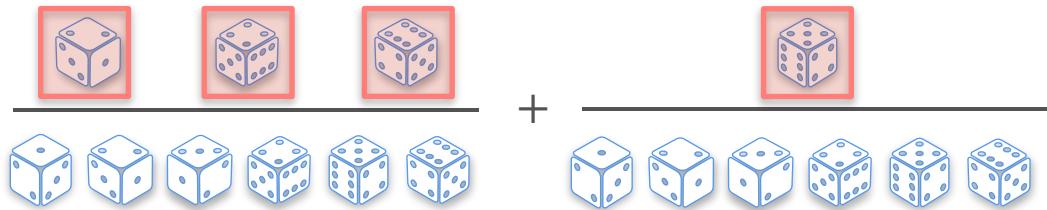
+



# Sum of Probabilities: Dice Example 1



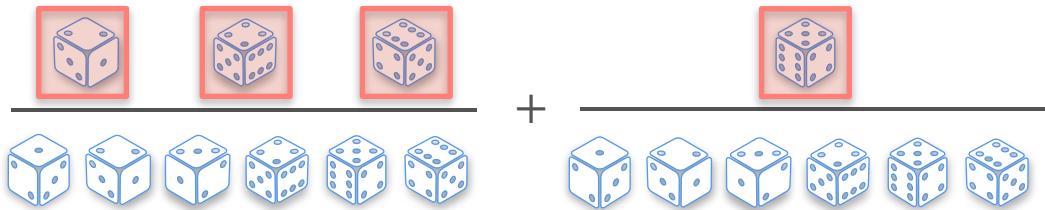
What is the probability of obtaining an even number or a 5?



# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

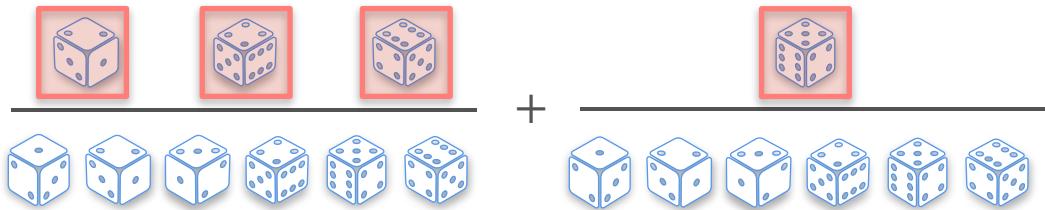


$$P(\text{even number or } 5) =$$

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

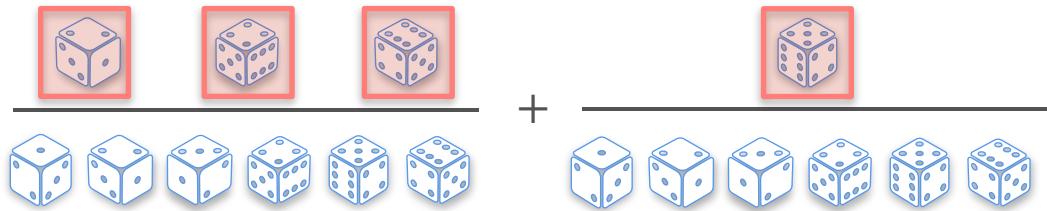


$$P(\text{even number or } 5) = P(\text{even number})$$

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

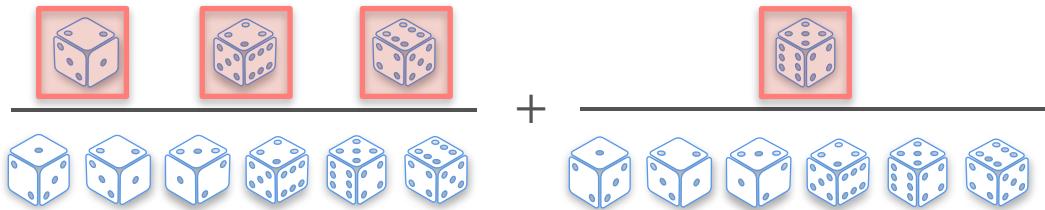


$$P(\text{even number or } 5) = P(\text{even number}) + P(5)$$

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

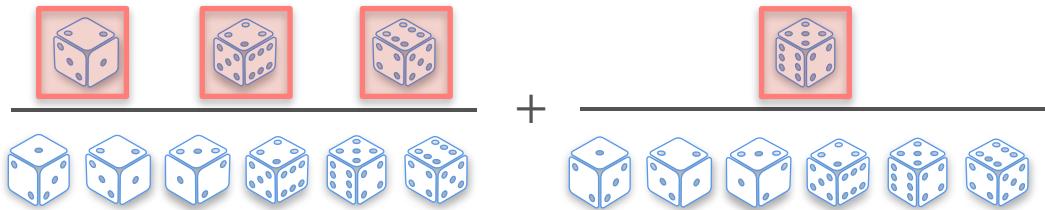


$$P(\text{even number or } 5) = P(\text{even number}) + P(5) = \frac{3}{6}$$

# Sum of Probabilities: Dice Example 1

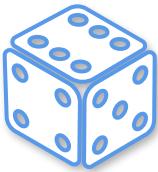


What is the probability of obtaining an even number or a 5?

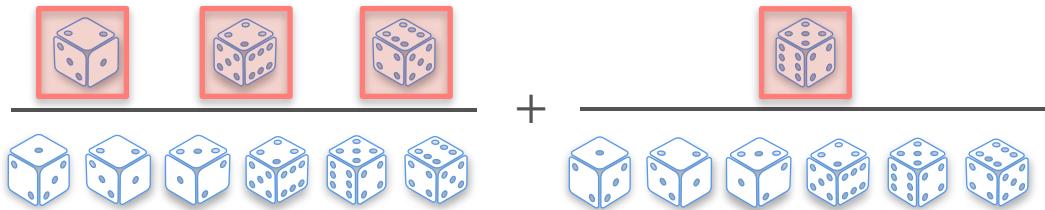


$$P(\text{even number or } 5) = P(\text{even number}) + P(5) = \frac{3}{6} + \frac{1}{6}$$

# Sum of Probabilities: Dice Example 1



What is the probability of obtaining an even number or a 5?

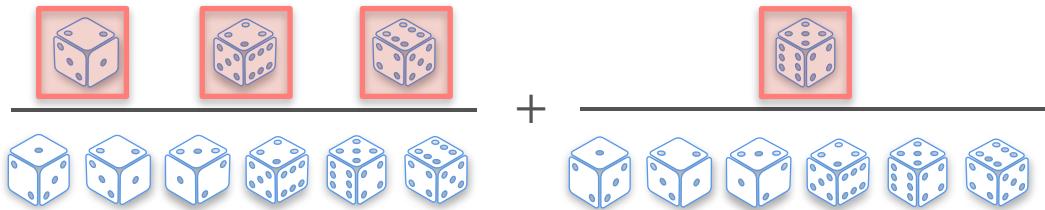


$$P(\text{even number or } 5) = P(\text{even number}) + P(5) = \frac{3}{6} + \frac{1}{6} = \frac{4}{6}$$

# Sum of Probabilities: Dice Example 1



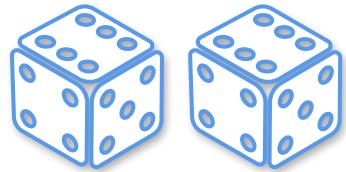
What is the probability of obtaining an even number or a 5?



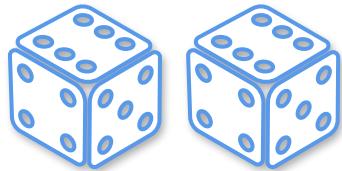
$$P(\text{even number or } 5) = P(\text{even number}) + P(5) = \frac{3}{6} + \frac{1}{6} = \frac{4}{6} = \frac{2}{3}$$

# Sum of Probabilities: Dice Example 2

# Sum of Probabilities: Dice Example 2



# Sum of Probabilities: Dice Example 2



What is the probability of obtaining a sum of 7 or a sum of 10?

# Sum of Probabilities: Dice Example 2

# Sum of Probabilities: Dice Example 2

*A*

*B*

# Sum of Probabilities: Dice Example 2

*A*

sum of 7

*B*

sum of 10

# Sum of Probabilities: Dice Example 2

A

sum of 7

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6

B

sum of 10

# Sum of Probabilities: Dice Example 2

A

sum of 7

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6

B

sum of 10

# Sum of Probabilities: Dice Example 2

A

sum of 7

1,1	1,2	1,3	1,4	1,5	1,6	
2,1	2,2	2,3	2,4	2,5	2,6	
3,1	3,2	3,3	3,4	3,5	3,6	
4,1	4,2	4,3	4,4	4,5	4,6	
5,1	5,2	5,3	5,4	5,5	5,6	
6,1	6,2	6,3	6,4	6,5	6,6	

B

sum of 10

1,1	1,2	1,3	1,4	1,5	1,6	
2,1	2,2	2,3	2,4	2,5	2,6	
3,1	3,2	3,3	3,4	3,5	3,6	
4,1	4,2	4,3	4,4	4,5	4,6	
5,1	5,2	5,3	5,4	5,5	5,6	
6,1	6,2	6,3	6,4	6,5	6,6	

# Sum of Probabilities: Dice Example 2

*A* or *B*

sum of 7 or sum of 10

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

P(sum of 7 or sum of 10)



# Sum of Probabilities: Dice Example 2

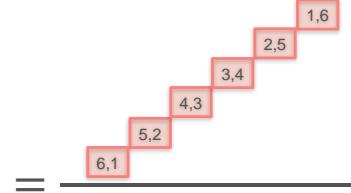
1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

P(sum of 7 or sum of 10) = \_\_\_\_\_

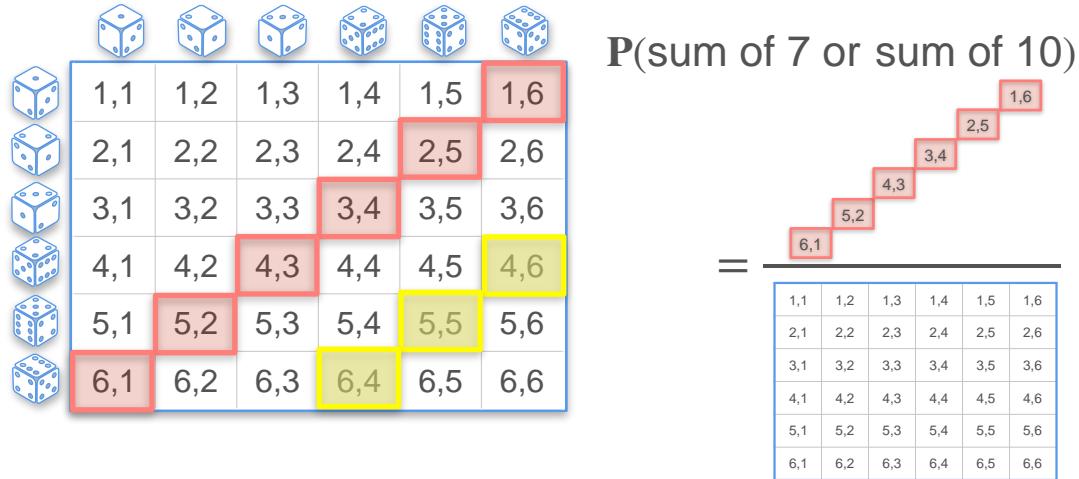
# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

P(sum of 7 or sum of 10)



# Sum of Probabilities: Dice Example 2



# Sum of Probabilities: Dice Example 2



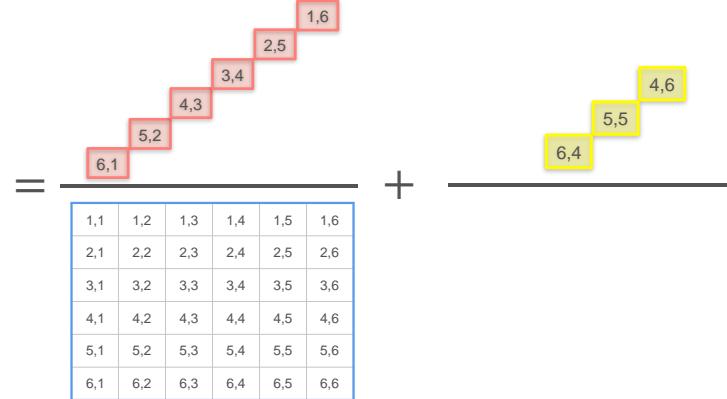
**P(sum of 7 or sum of 10)**

$$\begin{array}{c}
 = \quad - \quad + \quad - \\
 \boxed{6,1} \quad \boxed{5,2} \quad \boxed{4,3} \quad \boxed{3,4} \quad \boxed{2,5} \quad \boxed{1,6}
 \end{array}$$

# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

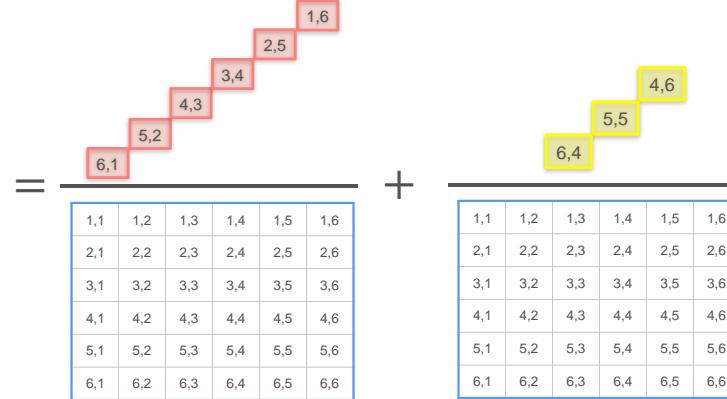
P(sum of 7 or sum of 10)



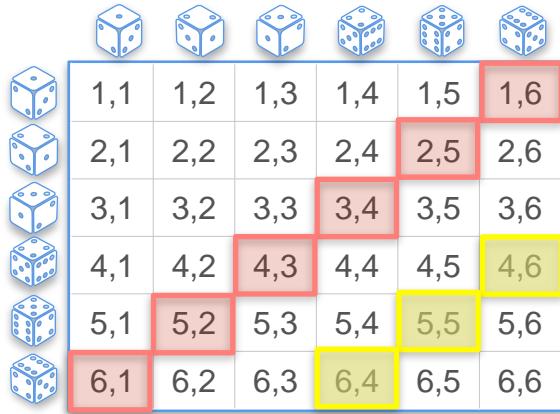
# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

P(sum of 7 or sum of 10)



# Sum of Probabilities: Dice Example 2



**P(sum of 7 or sum of 10)**

$$\begin{array}{c}
 \begin{array}{c}
 = \quad - \quad + \quad \\
 \begin{array}{cccccc}
 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\
 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\
 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\
 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\
 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\
 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6
 \end{array}
 \end{array}
 \end{array}
 \begin{array}{c}
 \begin{array}{c}
 \begin{array}{c}
 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\
 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\
 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\
 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\
 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\
 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6
 \end{array}
 \end{array}
 \end{array}
 \begin{array}{c}
 \begin{array}{c}
 6 \\
 = \frac{6}{36}
 \end{array}
 \end{array}$$

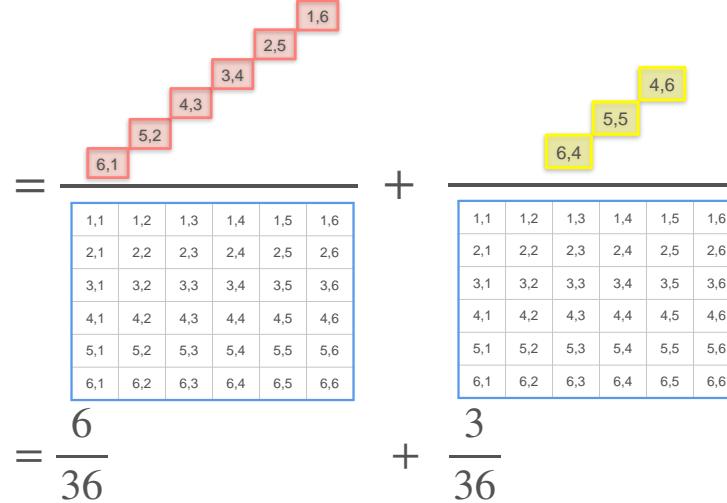
# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

P(sum of 7 or sum of 10)

$$\begin{aligned} &= \frac{\text{Number of outcomes for sum 7}}{\text{Total number of outcomes}} + \frac{\text{Number of outcomes for sum 10}}{\text{Total number of outcomes}} \\ &= \frac{6}{36} + \frac{3}{36} \end{aligned}$$

The diagram illustrates the calculation of the probability of rolling a sum of 7 or 10 with two dice. It shows a 6x6 grid of outcomes. Outcomes for a sum of 7 are highlighted in red boxes: (1,6), (2,5), (3,4), (4,3), (5,2), and (6,1). Outcomes for a sum of 10 are highlighted in yellow boxes: (4,6), (5,5), (6,4), and (6,5). The total number of outcomes is 36.



# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

P(sum of 7 or sum of 10)

$$\begin{aligned} &= \frac{\begin{array}{c} 1,1 \\ 2,1 \\ 3,1 \\ 4,1 \\ 5,1 \\ 6,1 \end{array}}{36} + \frac{\begin{array}{c} 1,6 \\ 2,5 \\ 3,4 \\ 4,3 \\ 5,2 \\ 6,1 \end{array}}{36} + \frac{\begin{array}{c} 4,6 \\ 5,5 \\ 6,4 \\ 7,3 \\ 8,2 \\ 9,1 \end{array}}{36} \\ &= \frac{6}{36} + \frac{3}{36} \\ &= \frac{9}{36} \end{aligned}$$

# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

P(sum of 7 or sum of 10)

$$\begin{aligned} &= \frac{\begin{array}{|c|c|c|c|c|c|c|}\hline 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 & \\ \hline 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 & \\ \hline 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 & \\ \hline 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 & \\ \hline 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 & \\ \hline 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 & \\ \hline \end{array}}{36} + \frac{\begin{array}{|c|c|c|c|c|c|c|}\hline 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 & \\ \hline 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 & \\ \hline 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 & \\ \hline 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 & \\ \hline 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 & \\ \hline 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 & \\ \hline \end{array}}{36} \\ &= \frac{6}{36} + \frac{3}{36} \\ &= \frac{9}{36} = \frac{1}{4} \end{aligned}$$

# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

P(sum of 7 or sum of 10)

$$\begin{aligned} &= \boxed{P(\text{sum of 7})} + \frac{\begin{array}{|c|c|c|c|c|c|c|}\hline 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 & \\ \hline 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 & \\ \hline 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 & \\ \hline 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 & \\ \hline 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 & \\ \hline 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 & \\ \hline \end{array}}{36} \\ &= \frac{6}{36} + \frac{3}{36} \\ &= \frac{9}{36} = \frac{1}{4} \end{aligned}$$

# Sum of Probabilities: Dice Example 2

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

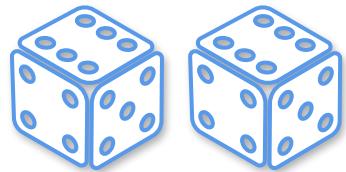
P(sum of 7 or sum of 10)

$$\begin{aligned} &= \boxed{P(\text{sum of 7})} + \boxed{P(\text{sum of 10})} \\ &= \frac{6}{36} + \frac{3}{36} \\ &= \frac{9}{36} = \frac{1}{4} \end{aligned}$$

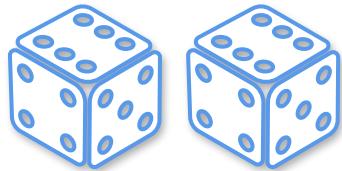
The diagram illustrates the calculation of the probability of rolling a sum of 7 or 10 with two six-sided dice. It shows a 6x6 grid of outcomes. Outcomes where the sum is 7 are highlighted in red boxes (e.g., (1,6), (2,5), (3,4), (4,3), (5,2), (6,1)). Outcomes where the sum is 10 are highlighted in yellow boxes (e.g., (4,6), (5,5), (6,4)). The total number of outcomes for a sum of 7 is 6, and for a sum of 10 is 3. The probability is the sum of these counts divided by the total number of outcomes (36).

# Sum of Probabilities: Dice Example 3

# Sum of Probabilities: Dice Example 3



# Sum of Probabilities: Dice Example 3



What is the probability of obtaining a difference of 2 or a difference of 1?

# Sum of Probabilities: Dice Example 3

# Sum of Probabilities: Dice Example 3

*A*

diff = 2

*B*

diff = 1

# Sum of Probabilities: Dice Example 3

A

diff = 2

	1,1	1,2	1,3	1,4	1,5	1,6
1,1						
1,2						
1,3						
1,4						
1,5						
1,6						
2,1	1,1	1,2	1,3	1,4	1,5	1,6
2,2	2,1	2,2	2,3	2,4	2,5	2,6
2,3	3,1	3,2	3,3	3,4	3,5	3,6
2,4	4,1	4,2	4,3	4,4	4,5	4,6
2,5	5,1	5,2	5,3	5,4	5,5	5,6
2,6	6,1	6,2	6,3	6,4	6,5	6,6

B

diff = 1

# Sum of Probabilities: Dice Example 3

A

diff = 2

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,1	6,2	6,3	6,4	6,5	6,6

B

diff = 1

# Sum of Probabilities: Dice Example 3

A

diff = 2

		dice					
		1,1	1,2	1,3	1,4	1,5	1,6
		2,1	2,2	2,3	2,4	2,5	2,6
		3,1	3,2	3,3	3,4	3,5	3,6
		4,1	4,2	4,3	4,4	4,5	4,6
		5,1	5,2	5,3	5,4	5,5	5,6
		6,1	6,2	6,3	6,4	6,5	6,6

B

diff = 1

		dice					
		1,1	1,2	1,3	1,4	1,5	1,6
		2,1	2,2	2,3	2,4	2,5	2,6
		3,1	3,2	3,3	3,4	3,5	3,6
		4,1	4,2	4,3	4,4	4,5	4,6
		5,1	5,2	5,3	5,4	5,5	5,6
		6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities: Dice Example 3

A

diff = 2

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	1,1	2,2	3,3	4,4	5,5	6,6
2,1	2,1	3,2	4,3	5,4	6,5	7,6
3,1	3,1	4,2	5,3	6,4	7,5	8,6
4,1	4,1	5,2	6,3	7,4	8,5	9,6
5,1	5,1	6,2	7,3	8,4	9,5	10,6
6,1	6,1	7,2	8,3	9,4	10,5	11,6

B

diff = 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	1,1	2,2	3,3	4,4	5,5	6,6
2,1	2,1	3,2	4,3	5,4	6,5	7,6
3,1	3,1	4,2	5,3	6,4	7,5	8,6
4,1	4,1	5,2	6,3	7,4	8,5	9,6
5,1	5,1	6,2	7,3	8,4	9,5	10,6
6,1	6,1	7,2	8,3	9,4	10,5	11,6

# Sum of Probabilities: Dice Example 3

A

diff = 2

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	1,1	2,2	3,3	4,4	5,5	6,6
2,1	2,1	3,2	4,3	5,4	6,5	7,6
3,1	3,1	4,2	5,3	6,4	7,5	8,6
4,1	4,1	5,2	6,3	7,4	8,5	9,6
5,1	5,1	6,2	7,3	8,4	9,5	10,6
6,1	6,1	7,2	8,3	9,4	10,5	11,6

B

diff = 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	1,1	2,2	3,3	4,4	5,5	6,6
2,1	2,1	3,2	4,3	5,4	6,5	7,6
3,1	3,1	4,2	5,3	6,4	7,5	8,6
4,1	4,1	5,2	6,3	7,4	8,5	9,6
5,1	5,1	6,2	7,3	8,4	9,5	10,6
6,1	6,1	7,2	8,3	9,4	10,5	11,6

# Sum of Probabilities: Dice Example 3

*A* or *B*

diff = 2 or diff = 1

	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
	6,1	6,2	6,3	6,4	6,5	6,6

Dice icons are placed along the top row and left column of the grid.

# Sum of Probabilities: Dice Example 3

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities: Dice Example 3

					
1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

# Sum of Probabilities: Dice Example 3

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

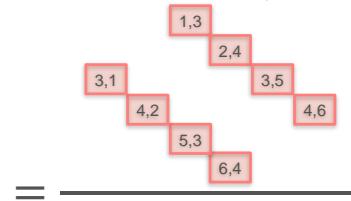
$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

= \_\_\_\_\_

# Sum of Probabilities: Dice Example 3

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

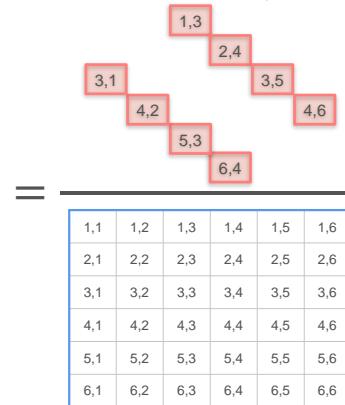
$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$



# Sum of Probabilities: Dice Example 3

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$



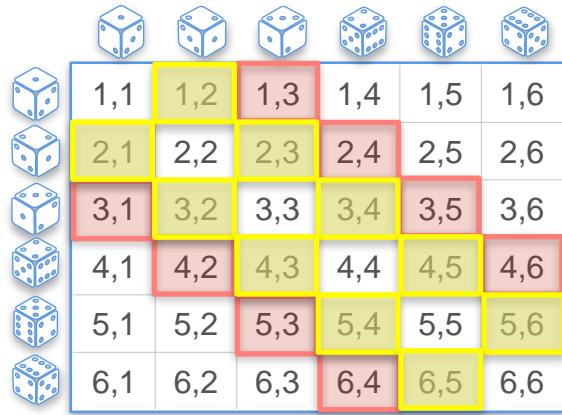
# Sum of Probabilities: Dice Example 3

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

$$= \boxed{\begin{array}{ccccccc} & & 1,3 & & 2,4 & & \\ & & 3,1 & 4,2 & & 5,3 & \\ & & & & 6,4 & & \\ & & 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ & & 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ & & 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ & & 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ & & 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ & & 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} + \boxed{\begin{array}{ccccccc} & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \end{array}}$$

# Sum of Probabilities: Dice Example 3



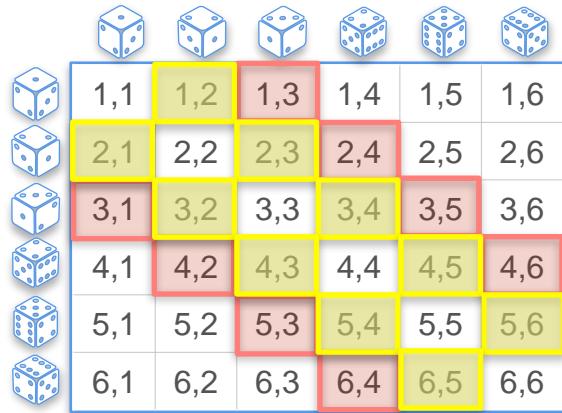
$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

$$= \begin{array}{c} \text{Outcomes where } \text{diff} = 2: \\ (1,3), (2,4), (3,5), (4,2), (5,1), (6,1) \end{array} + \begin{array}{c} \text{Outcomes where } \text{diff} = 1: \\ (1,2), (2,1), (2,3), (3,2), (3,4), (4,3), (5,2), (5,3), (6,4) \end{array}$$

Table of all 36 outcomes:

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities: Dice Example 3

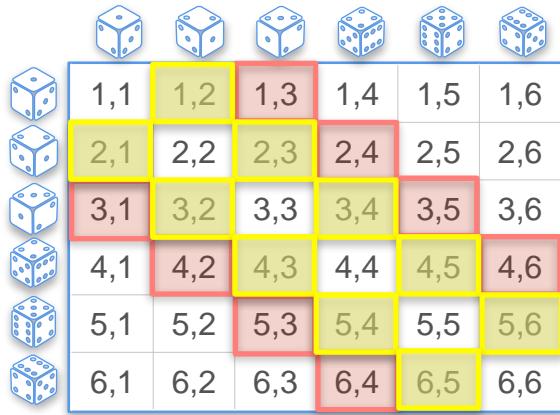


$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

$$= \frac{\begin{array}{c} 1,3 \\ 2,4 \\ 3,5 \\ 4,6 \\ 5,3 \\ 6,4 \end{array}}{36} + \frac{\begin{array}{c} 1,2 \\ 2,3 \\ 3,4 \\ 4,5 \\ 5,6 \\ 6,5 \end{array}}{36}$$

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities: Dice Example 3

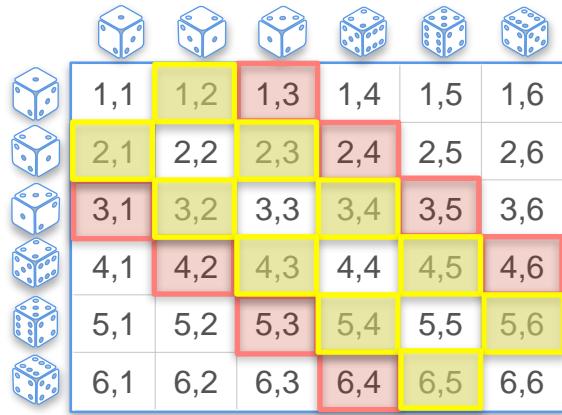


$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

$$= \frac{\begin{array}{c} 1,3 \\ 2,4 \\ 3,5 \\ 4,6 \\ 5,3 \\ 6,4 \end{array}}{36} + \frac{\begin{array}{c} 1,2 \\ 2,3 \\ 3,4 \\ 4,5 \\ 5,6 \\ 6,5 \end{array}}{36} = \frac{8}{36}$$

The equation shows the sum of probabilities for two events. The first event, represented by a red box, includes outcomes where the difference is 2: (1,3), (2,4), (3,5), (4,6), (5,3), and (6,4). The second event, represented by a yellow box, includes outcomes where the difference is 1: (1,2), (2,3), (3,4), (4,5), (5,6), and (6,5). Both boxes are divided by 36, representing the total number of outcomes for two dice rolls.

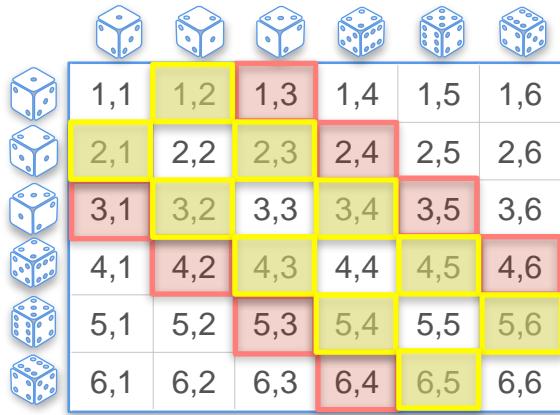
# Sum of Probabilities: Dice Example 3



$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

$$= \frac{\begin{array}{c} 1,3 \\ 2,4 \\ 3,5 \\ 4,6 \\ 5,3 \\ 6,4 \end{array}}{\begin{array}{cccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} + \frac{\begin{array}{c} 1,2 \\ 2,1 \\ 3,2 \\ 4,3 \\ 5,4 \\ 6,5 \end{array}}{\begin{array}{cccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}}$$
$$= \frac{8}{36} + \frac{10}{36}$$

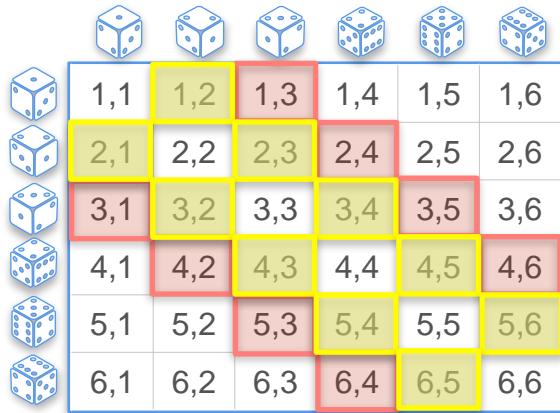
# Sum of Probabilities: Dice Example 3



$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

$$\begin{aligned} &= \frac{\begin{array}{c} 1,3 \\ 2,4 \\ 3,5 \\ 4,6 \\ 5,3 \\ 6,4 \end{array}}{\begin{array}{cccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} + \frac{\begin{array}{c} 1,2 \\ 2,1 \\ 3,2 \\ 4,3 \\ 5,4 \\ 6,5 \end{array}}{\begin{array}{cccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} \\ &= \frac{8}{36} + \frac{10}{36} \\ &= \frac{18}{36} \end{aligned}$$

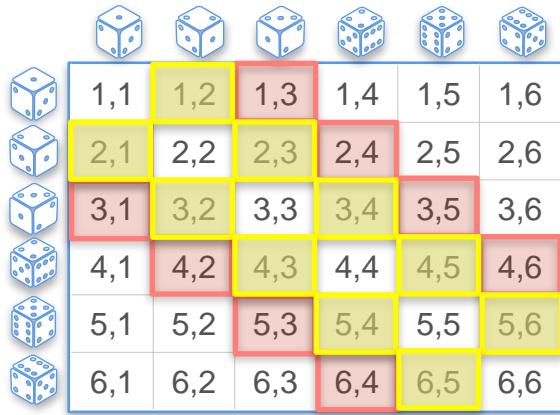
# Sum of Probabilities: Dice Example 3



$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

$$\begin{aligned} &= P(\text{diff} = 2) + \\ &\quad \begin{array}{c} \text{---} \\ \begin{matrix} 1,2 \\ 2,1 \\ 2,3 \\ 3,2 \\ 3,4 \\ 4,3 \\ 4,5 \\ 5,4 \\ 5,6 \\ 6,5 \end{matrix} \end{array} \\ &= \frac{8}{36} + \frac{10}{36} \\ &= \frac{18}{36} \end{aligned}$$

# Sum of Probabilities: Dice Example 3



$P(\text{diff} = 2 \text{ or } \text{diff} = 1)$

$$= P(\text{diff} = 2) + P(\text{diff} = 1)$$

$= \frac{8}{36} + \frac{10}{36}$   
 $= \frac{18}{36}$

The first diagram shows outcomes where the difference is 2: (1,3), (2,4), (3,5), (4,6), (2,1), (3,2), (4,3), (5,4), (1,2), (3,1), (4,2), (5,3), (6,4). These are highlighted in red boxes.

The second diagram shows outcomes where the difference is 1: (1,2), (2,3), (3,4), (4,5), (5,6), (1,1), (2,2), (3,3), (4,4), (5,5), (6,6). These are highlighted in yellow boxes.

2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

1,2	2,3	3,4	4,5	5,6	6,7
2,1	3,2	4,3	5,4	6,5	7,6
3,1	4,2	5,3	6,4	7,5	8,6
4,1	5,2	6,3	7,4	8,5	9,6
5,1	6,2	7,3	8,4	9,5	10,6
6,1	7,2	8,3	9,4	10,5	11,6



DeepLearning.AI

# Introduction to probability

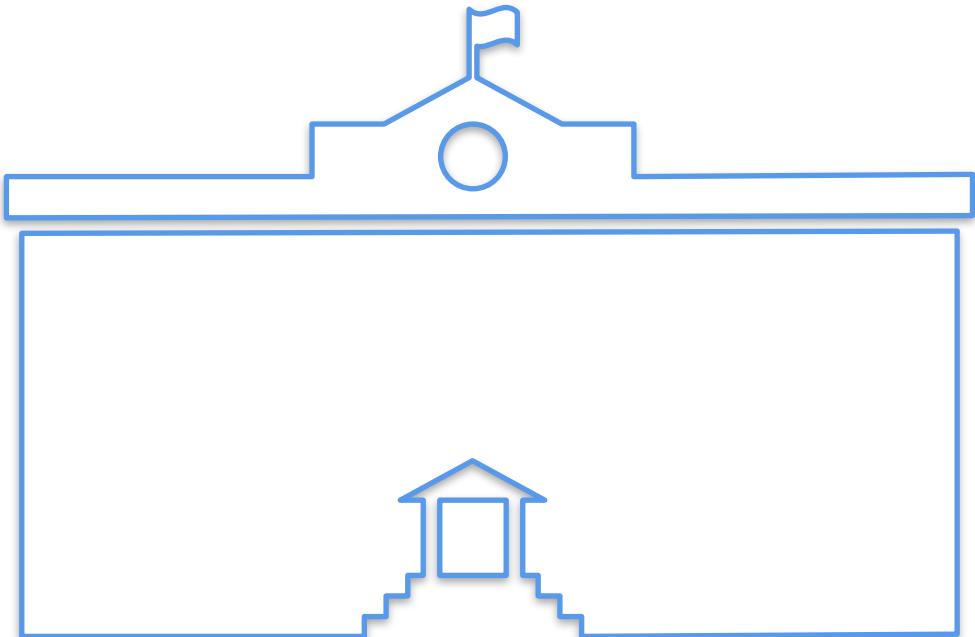
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**Sum of Probabilities  
(Joint Events)**

# Sum of Probabilities (Joint Events): Quiz 1

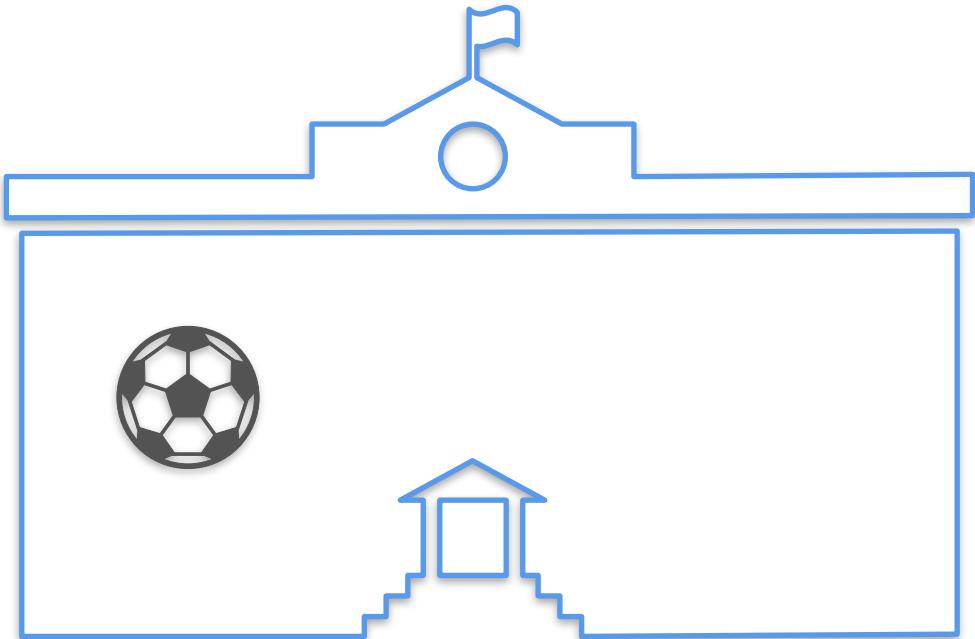
At a school, kids can play as many sports as they want.

# Sum of Probabilities (Joint Events): Quiz 1



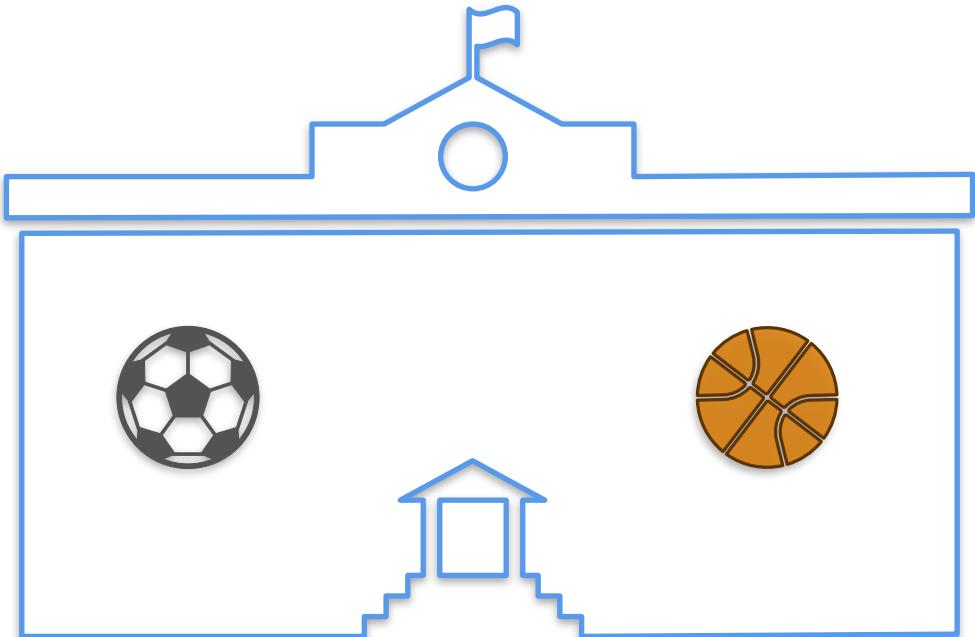
At a school, kids can play as many sports as they want.

# Sum of Probabilities (Joint Events): Quiz 1



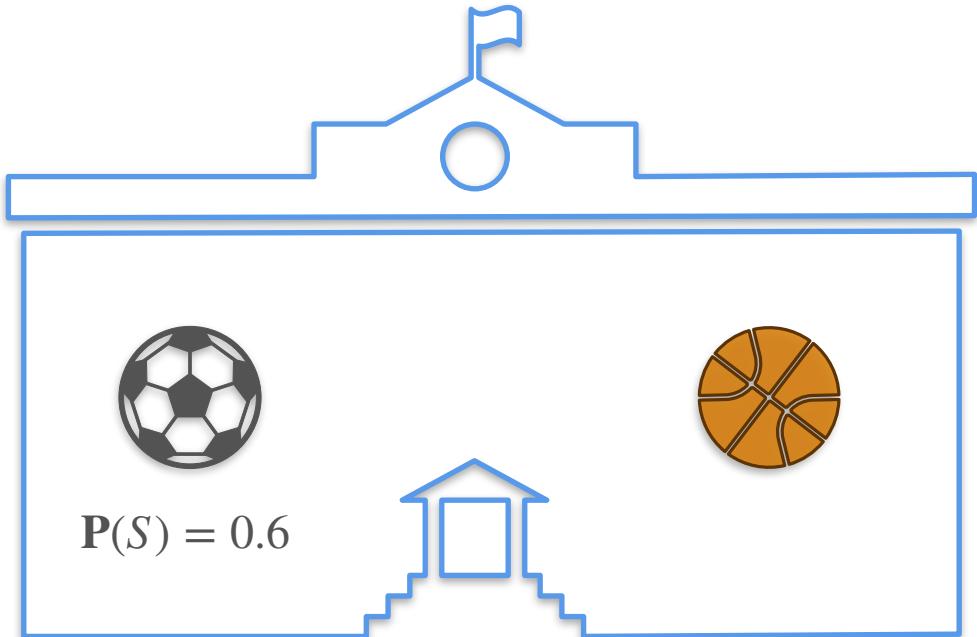
At a school, kids can play as many sports as they want.

# Sum of Probabilities (Joint Events): Quiz 1



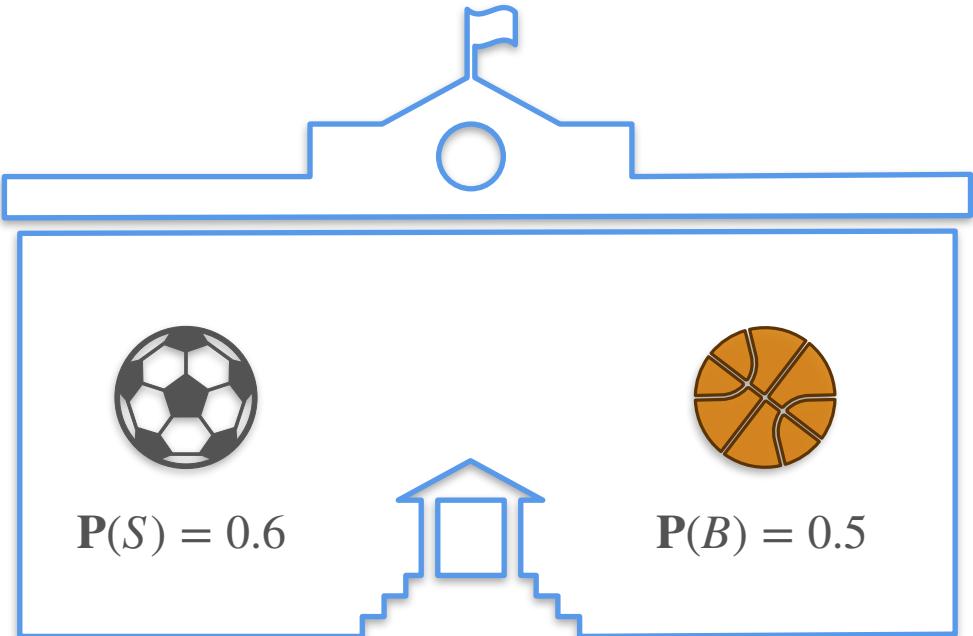
At a school, kids can play as many sports as they want.

# Sum of Probabilities (Joint Events): Quiz 1



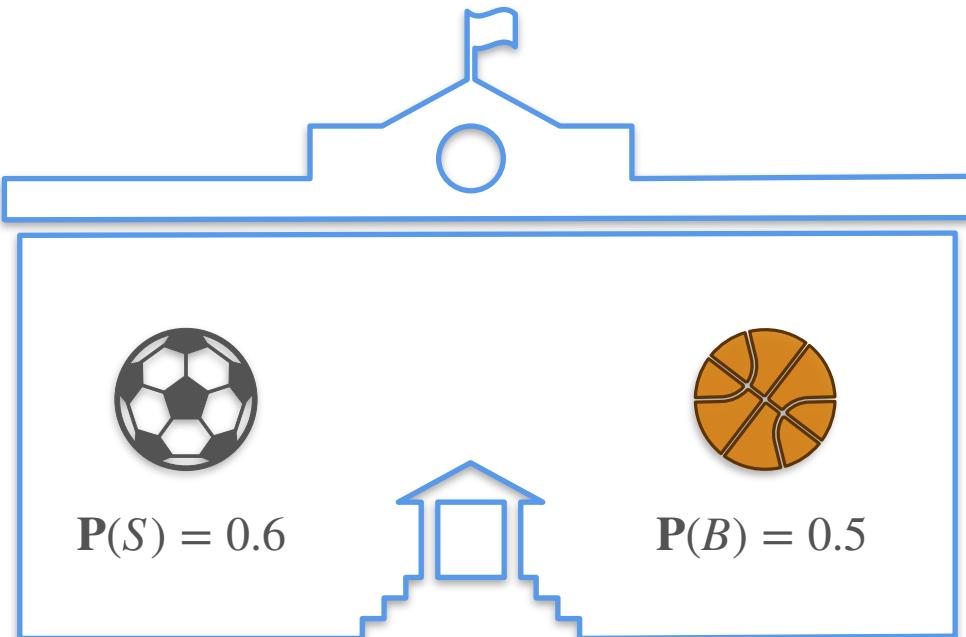
At a school, kids can play as many sports as they want.

# Sum of Probabilities (Joint Events): Quiz 1



At a school, kids can play as many sports as they want.

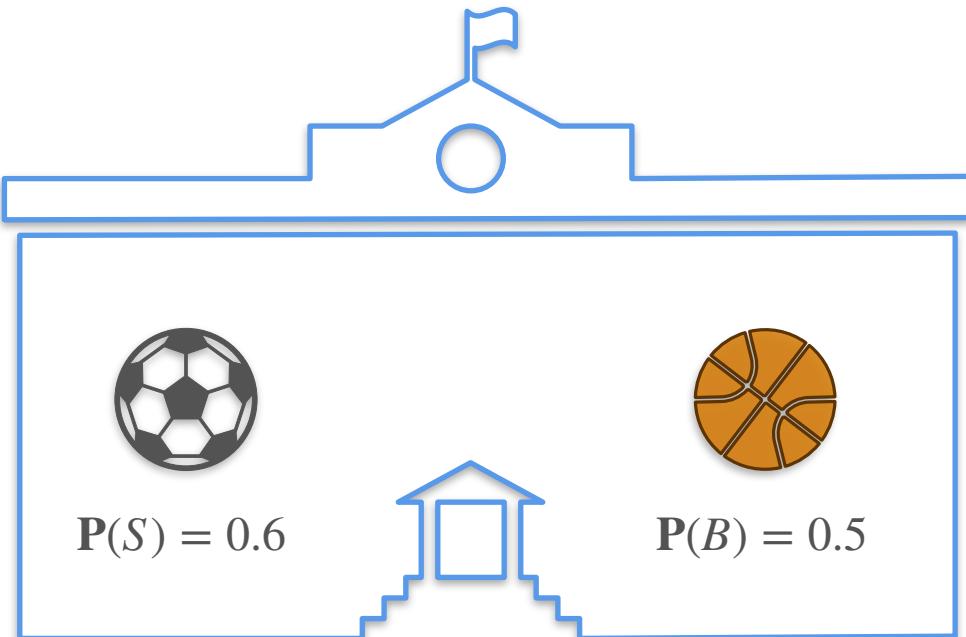
# Sum of Probabilities (Joint Events): Quiz 1



At a school, kids can play as many sports as they want.

What is the probability that a kid plays soccer or basketball?

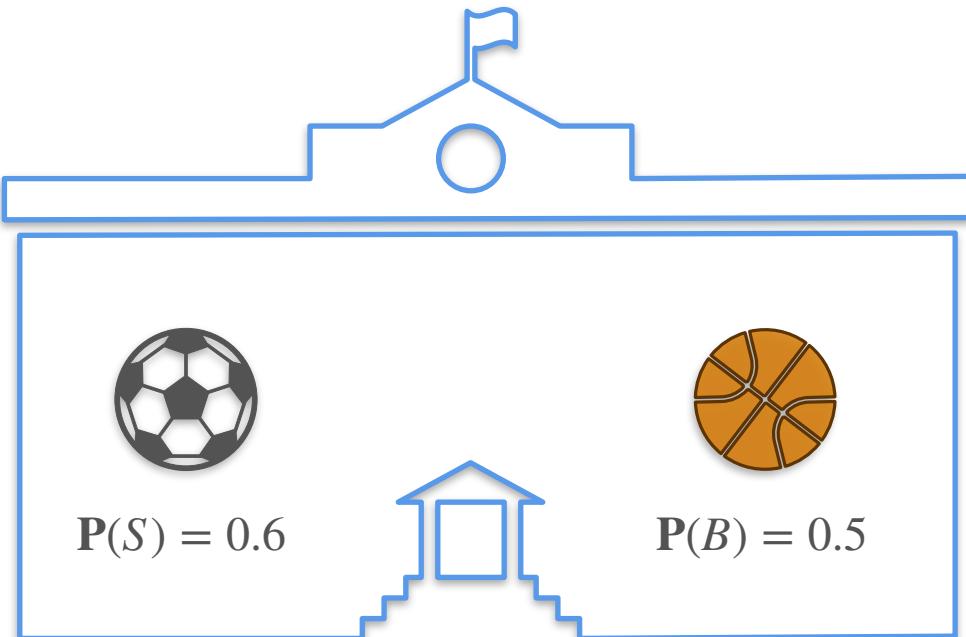
# Sum of Probabilities (Joint Events): Quiz 1



At a school, kids can play as many sports as they want.

What is the probability that a kid plays soccer or basketball?

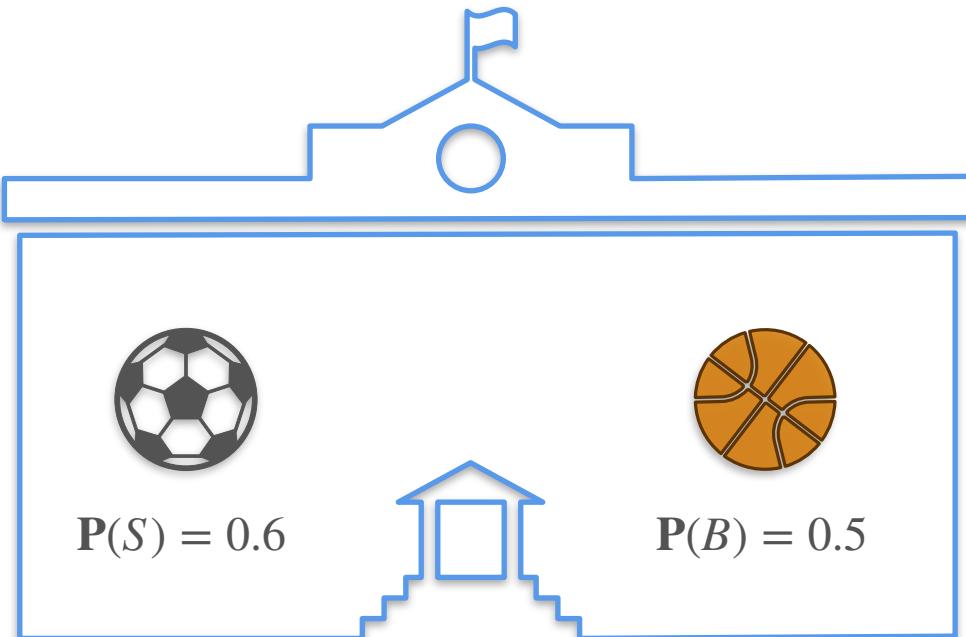
# Sum of Probabilities (Joint Events): Quiz 1



At a school, kids can play as many sports as they want.

What is the probability that a kid plays soccer or basketball?

# Sum of Probabilities (Joint Events): Quiz 1



At a school, kids can play as many sports as they want.

What is the probability that a kid plays soccer or basketball?

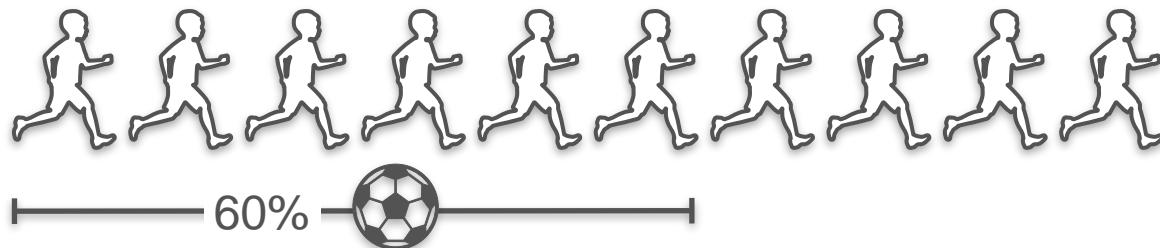
Hint: What if there were only 10 kids?

# Sum of Probabilities (Joint Events): Quiz 1 Solution

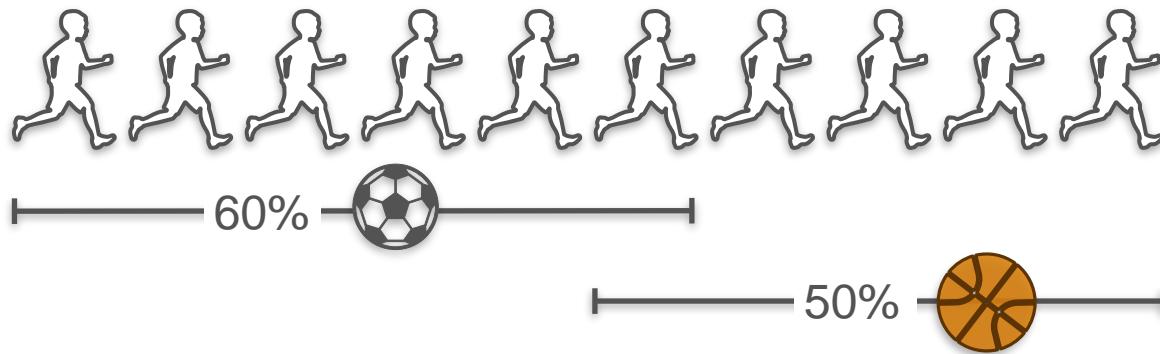
# Sum of Probabilities (Joint Events): Quiz 1 Solution



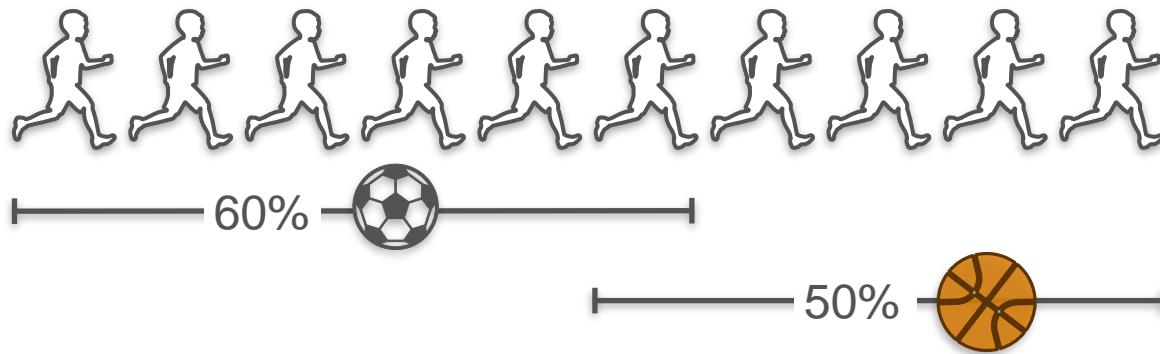
# Sum of Probabilities (Joint Events): Quiz 1 Solution



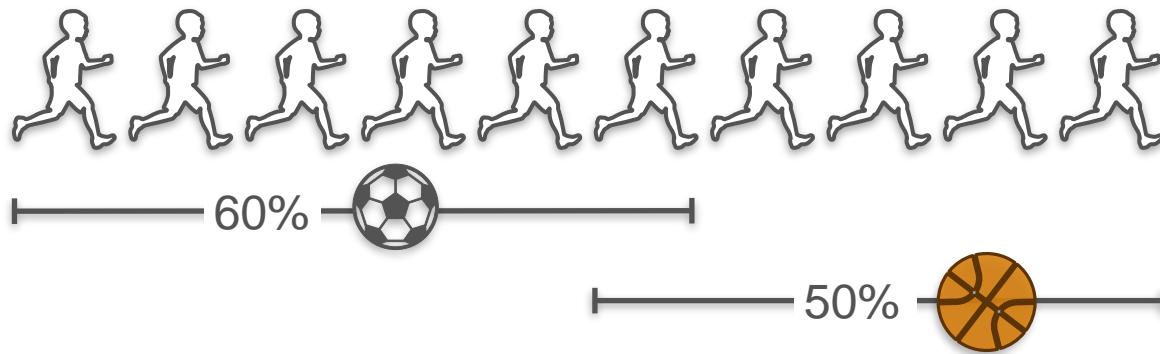
# Sum of Probabilities (Joint Events): Quiz 1 Solution



# Sum of Probabilities (Joint Events): Quiz 1 Solution

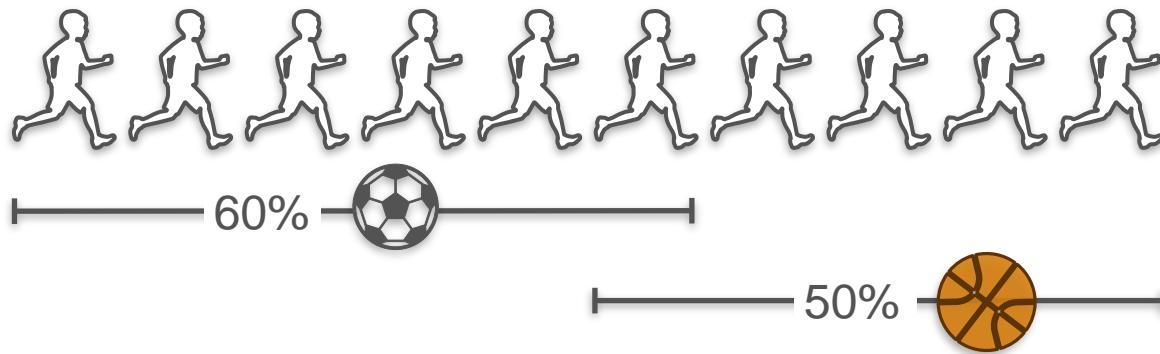


# Sum of Probabilities (Joint Events): Quiz 1 Solution



$$P(\text{soccer} \cup \text{basketball}) = ?$$

# Sum of Probabilities (Joint Events): Quiz 1 Solution



$$P(\text{soccer} \cup \text{basketball}) = ?$$

We don't know how many children play multiple sports

# Sum of Probabilities (Joint Events): Quiz 1 Solution

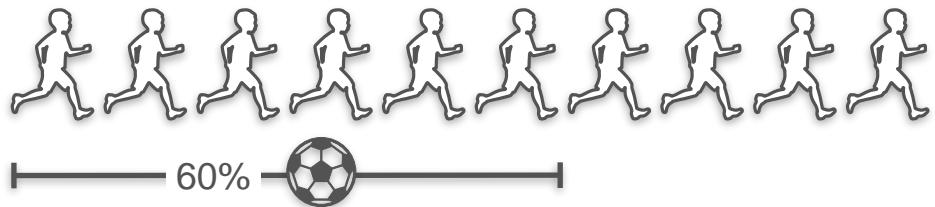
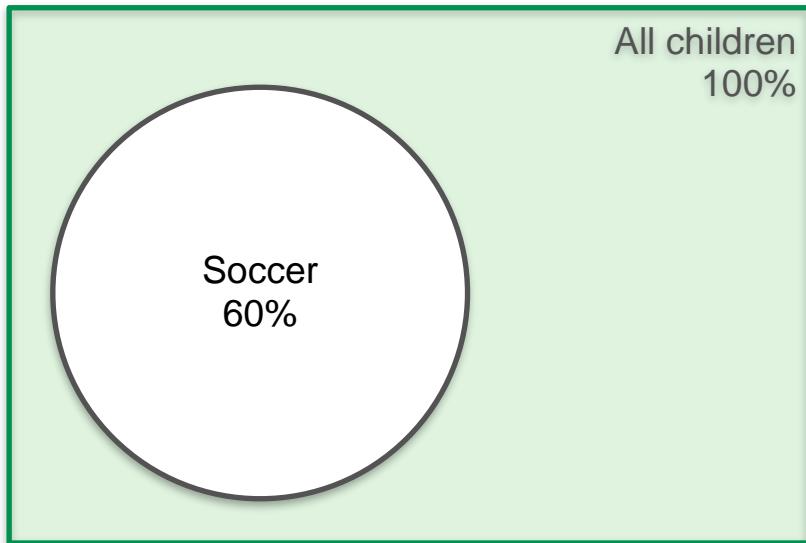


# Sum of Probabilities (Joint Events): Quiz 1 Solution

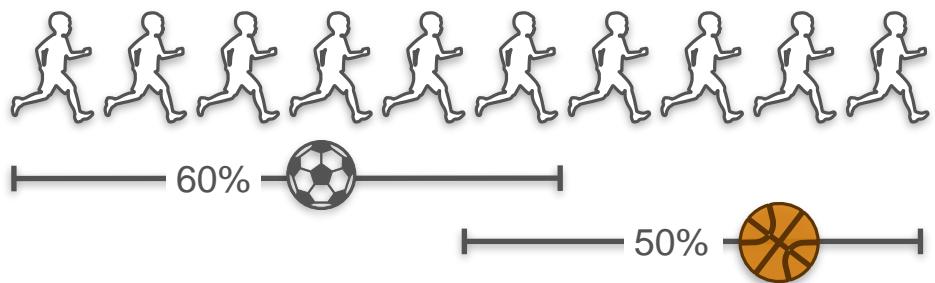
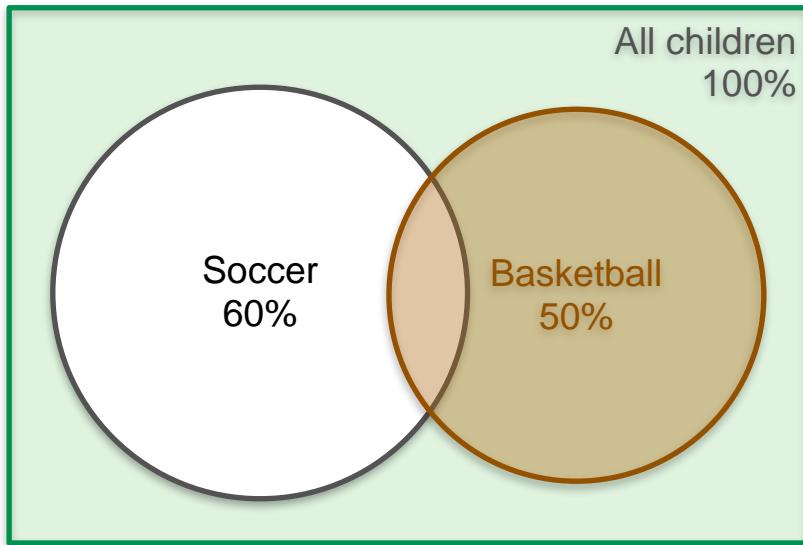
All children  
100%



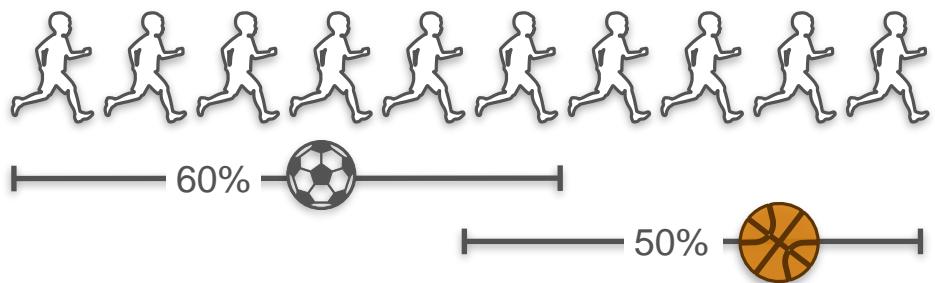
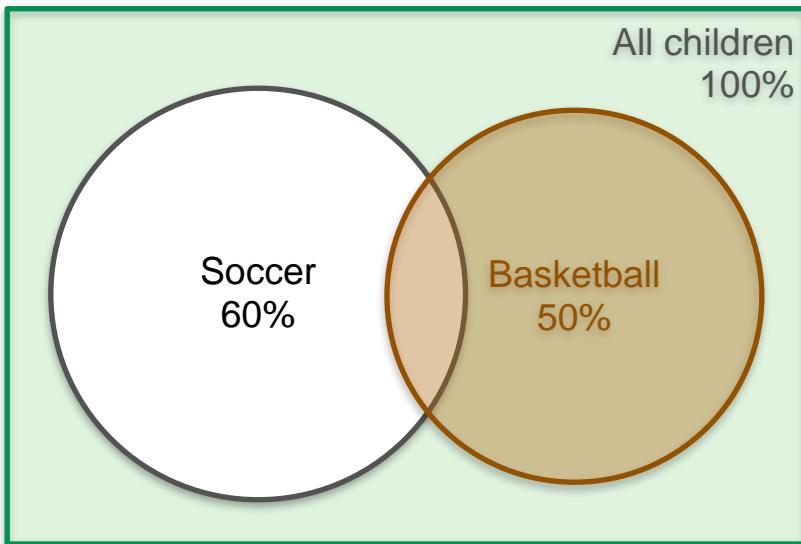
# Sum of Probabilities (Joint Events): Quiz 1 Solution



# Sum of Probabilities (Joint Events): Quiz 1 Solution

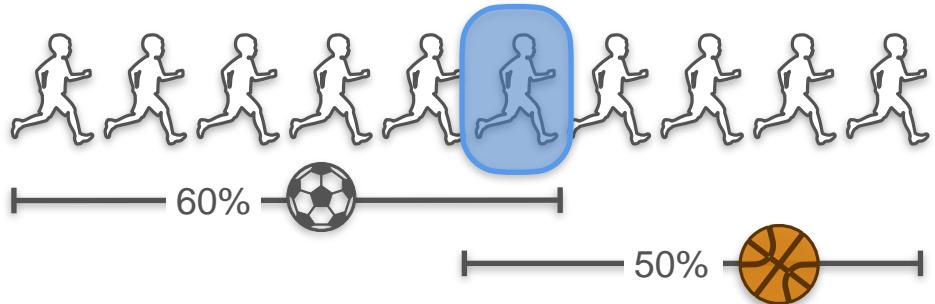
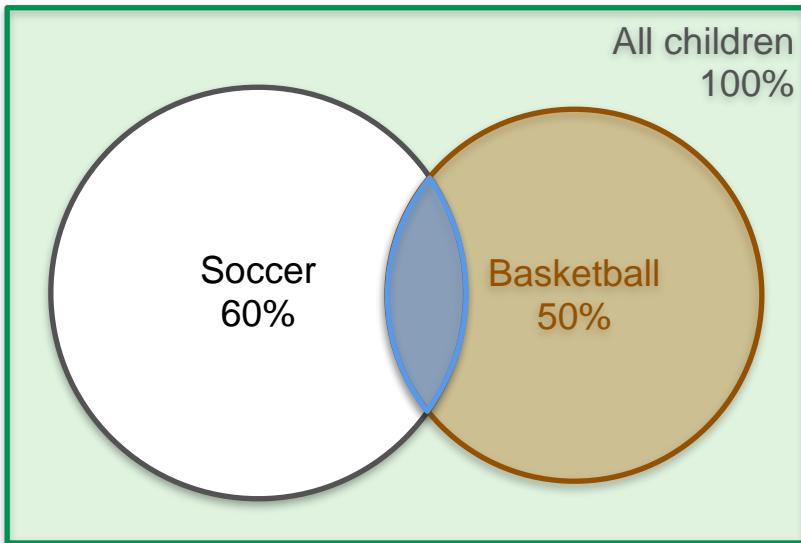


# Sum of Probabilities (Joint Events): Quiz 1 Solution



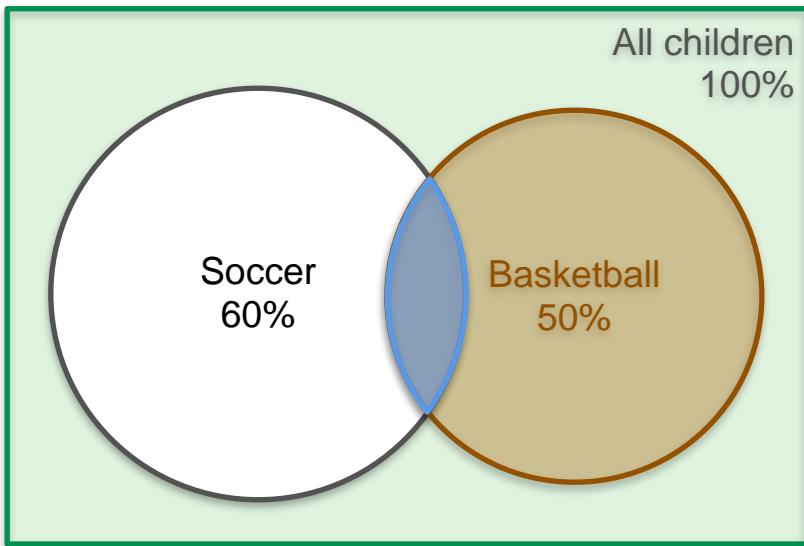
$$P(S \cup B) = P(S) + P(B)$$

# Sum of Probabilities (Joint Events): Quiz 1 Solution

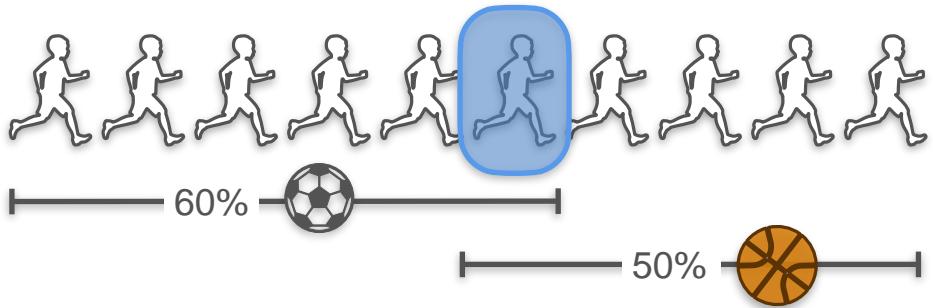


$$P(S \cup B) = P(S) + P(B)$$

# Sum of Probabilities (Joint Events): Quiz 1 Solution

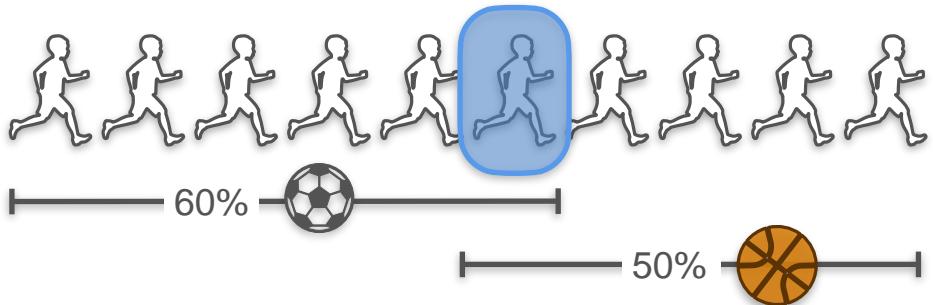
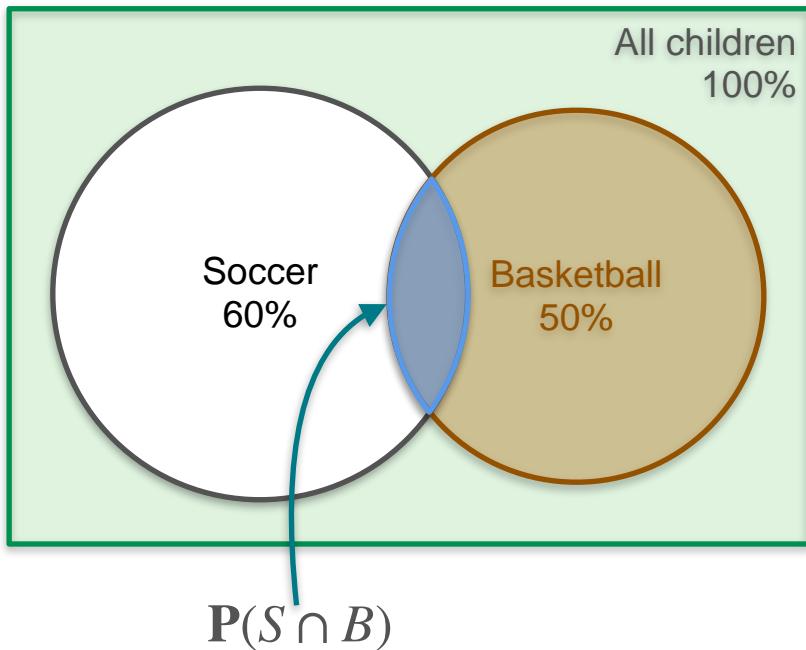


$$\mathbf{P}(S \cap B)$$



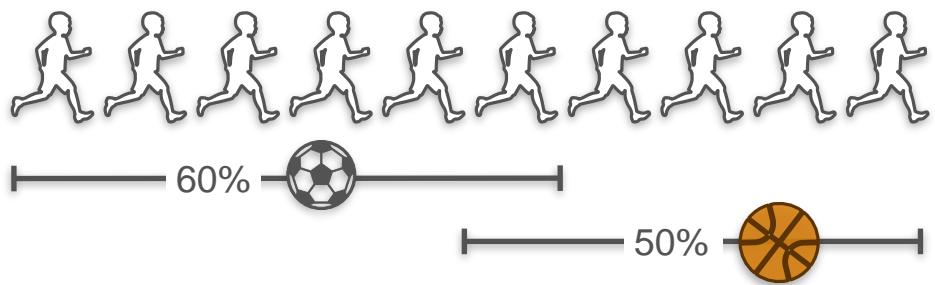
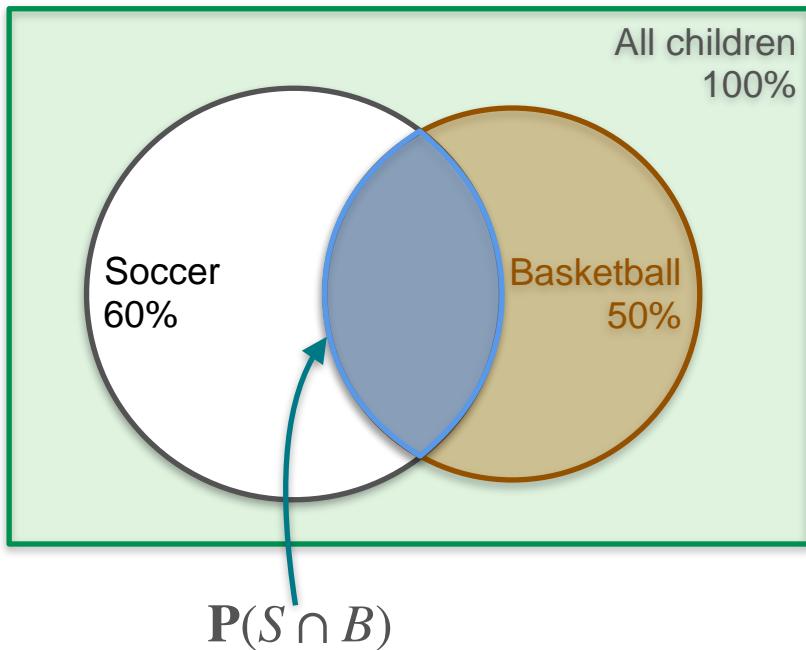
$$\mathbf{P}(S \cup B) = \mathbf{P}(S) + \mathbf{P}(B)$$

# Sum of Probabilities (Joint Events): Quiz 1 Solution



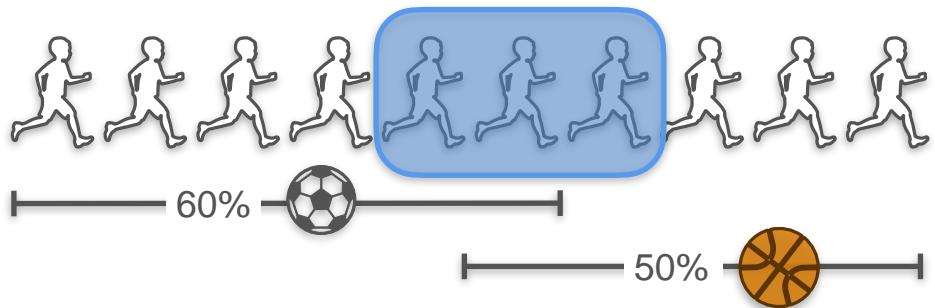
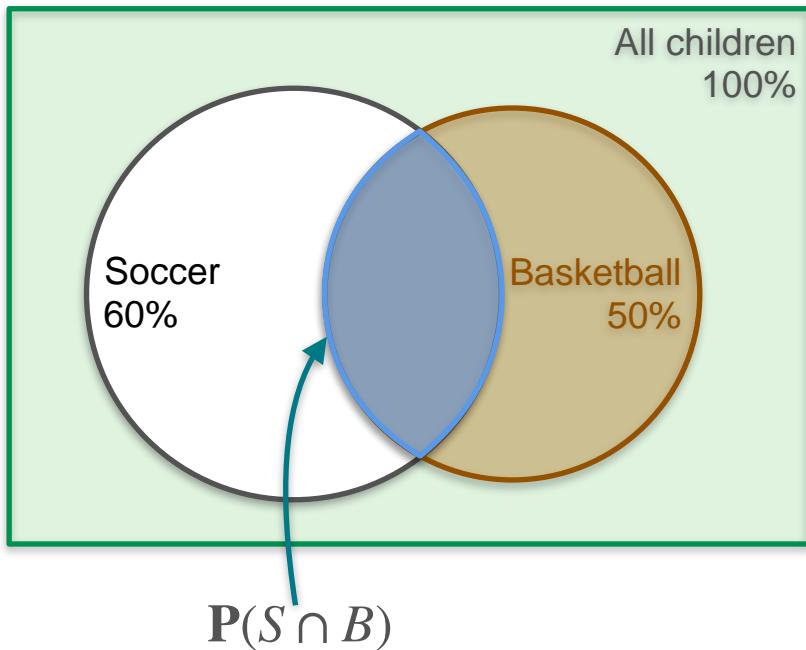
$$P(S \cup B) = P(S) + P(B)$$

# Sum of Probabilities (Joint Events): Quiz 1 Solution



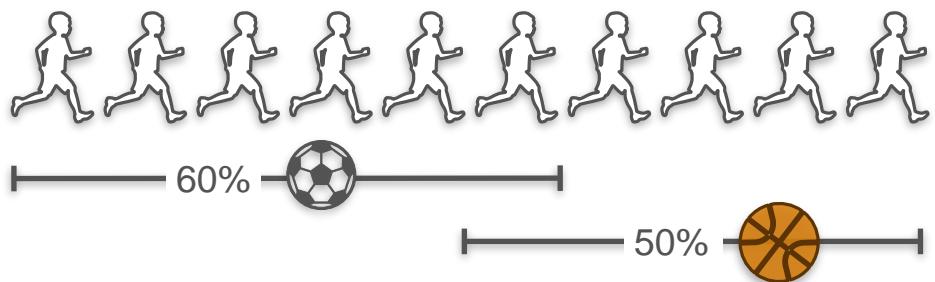
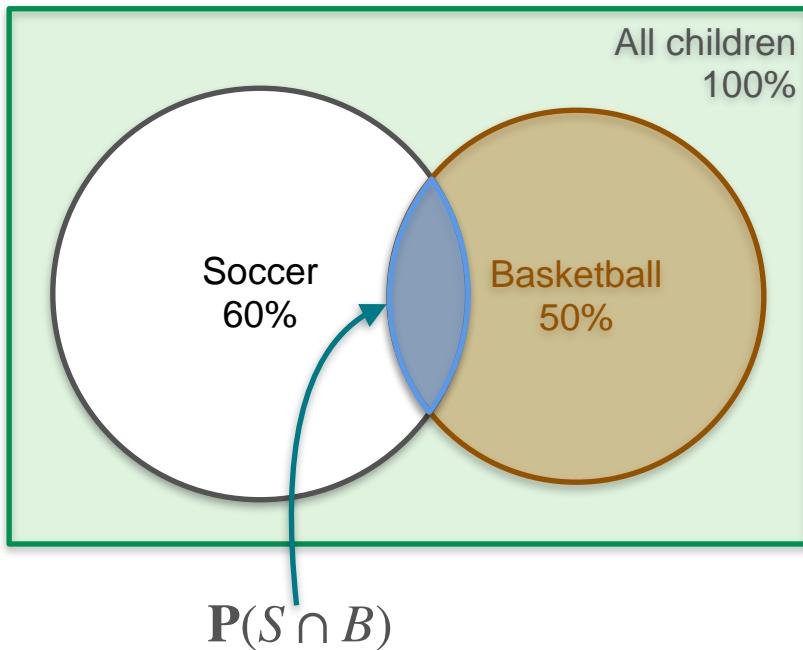
$$P(S \cup B) = P(S) + P(B)$$

# Sum of Probabilities (Joint Events): Quiz 1 Solution



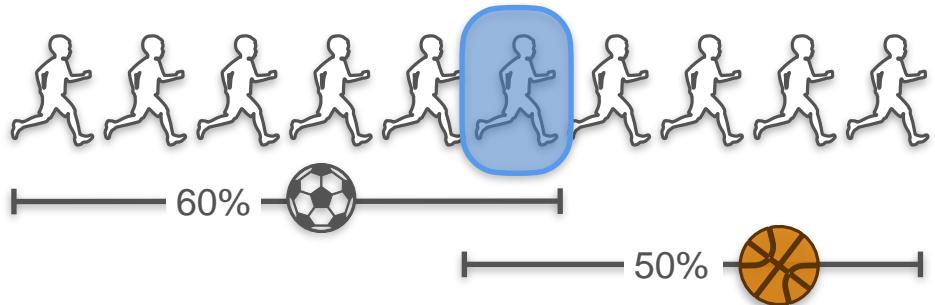
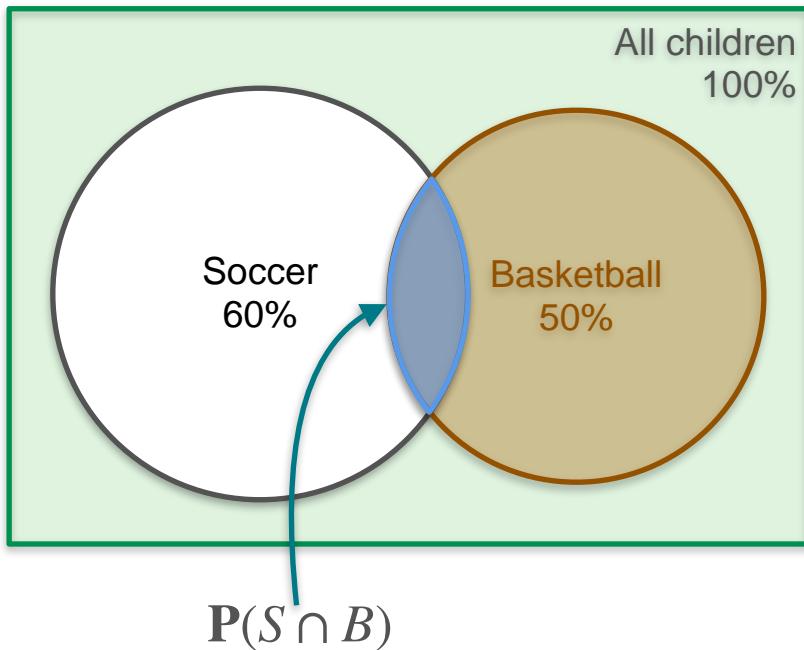
$$P(S \cup B) = P(S) + P(B)$$

# Sum of Probabilities (Joint Events): Quiz 1 Solution



$$P(S \cup B) = P(S) + P(B)$$

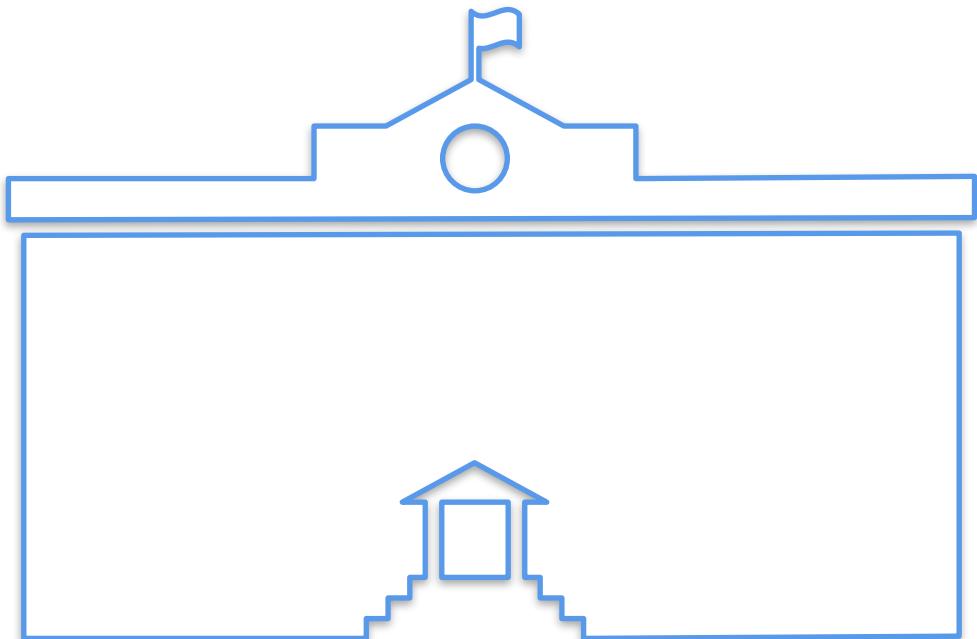
# Sum of Probabilities (Joint Events): Quiz 1 Solution



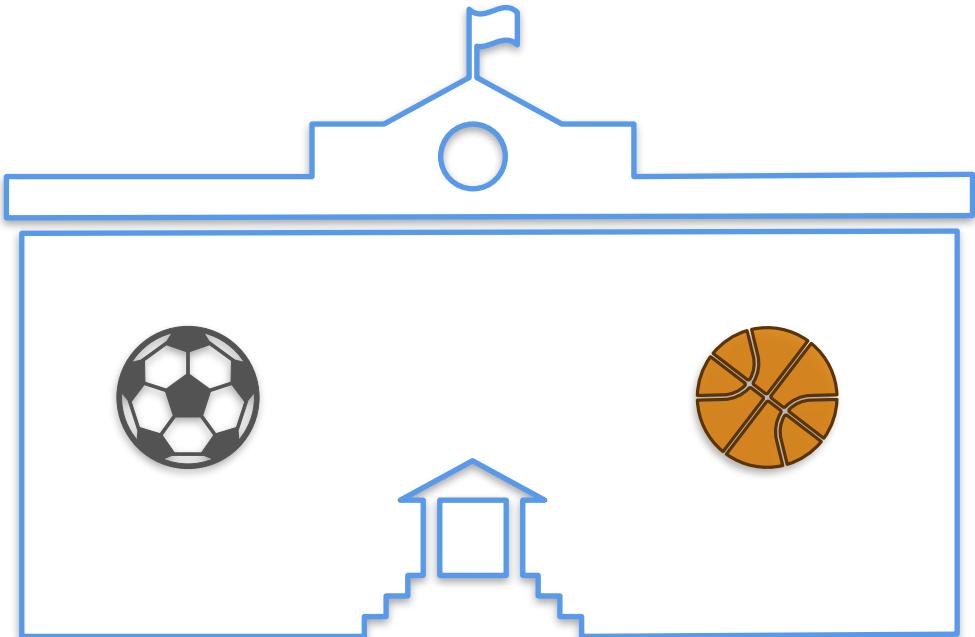
$$P(S \cup B) = P(S) + P(B)$$

# Sum of Probabilities (Joint Events): Quiz 2

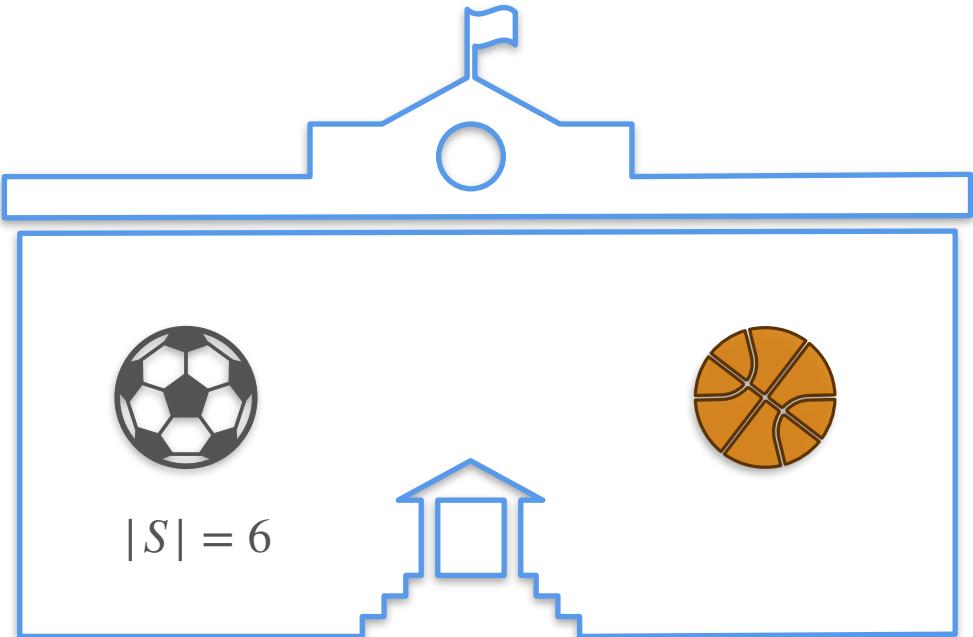
# Sum of Probabilities (Joint Events): Quiz 2



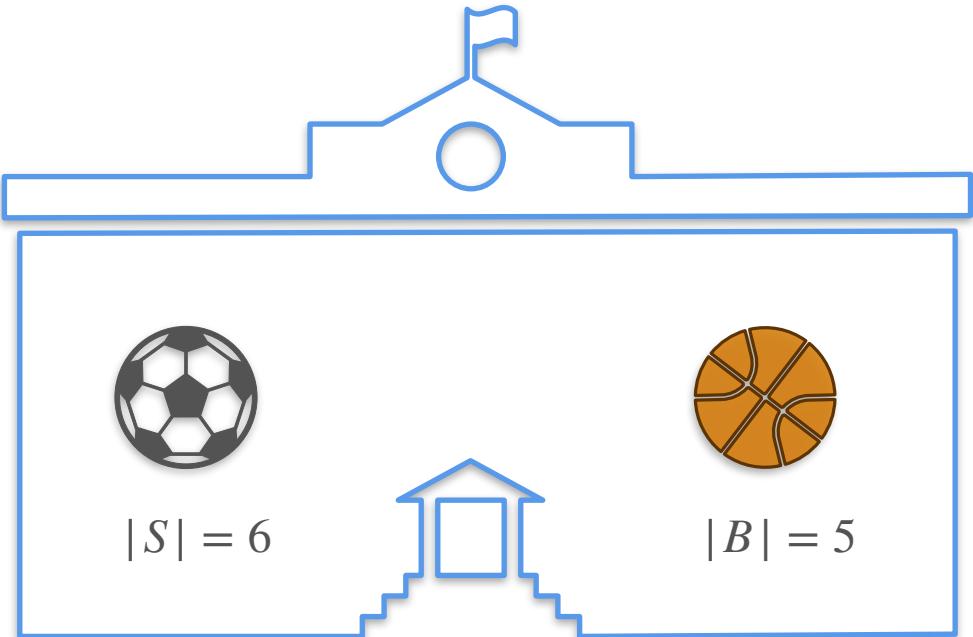
# Sum of Probabilities (Joint Events): Quiz 2



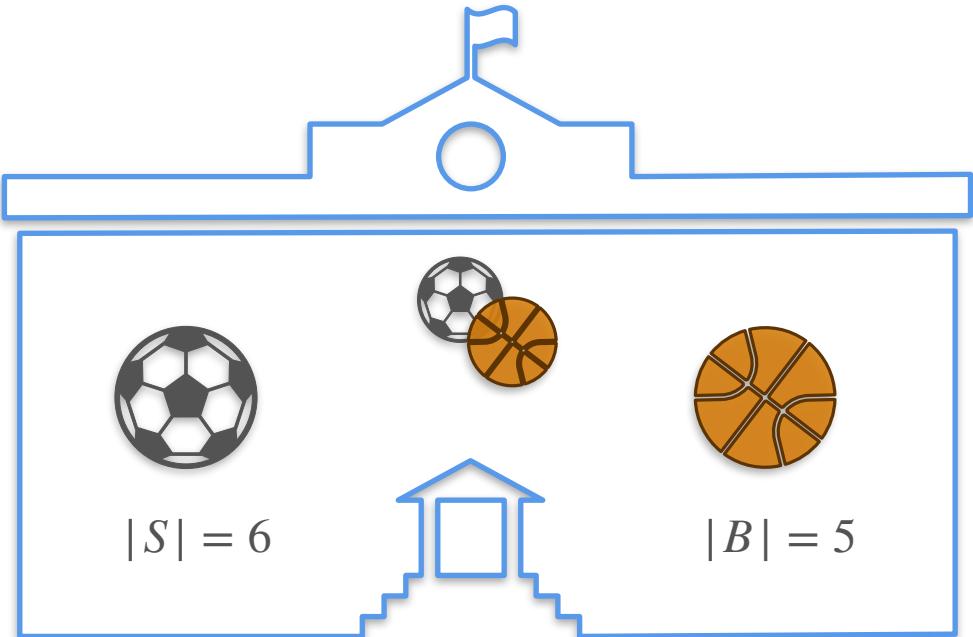
# Sum of Probabilities (Joint Events): Quiz 2



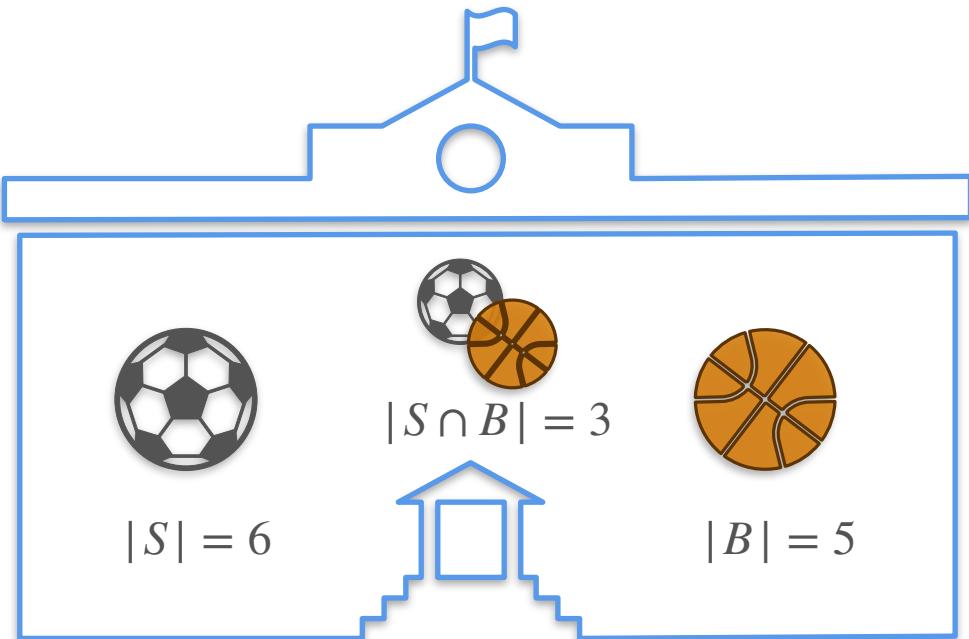
# Sum of Probabilities (Joint Events): Quiz 2



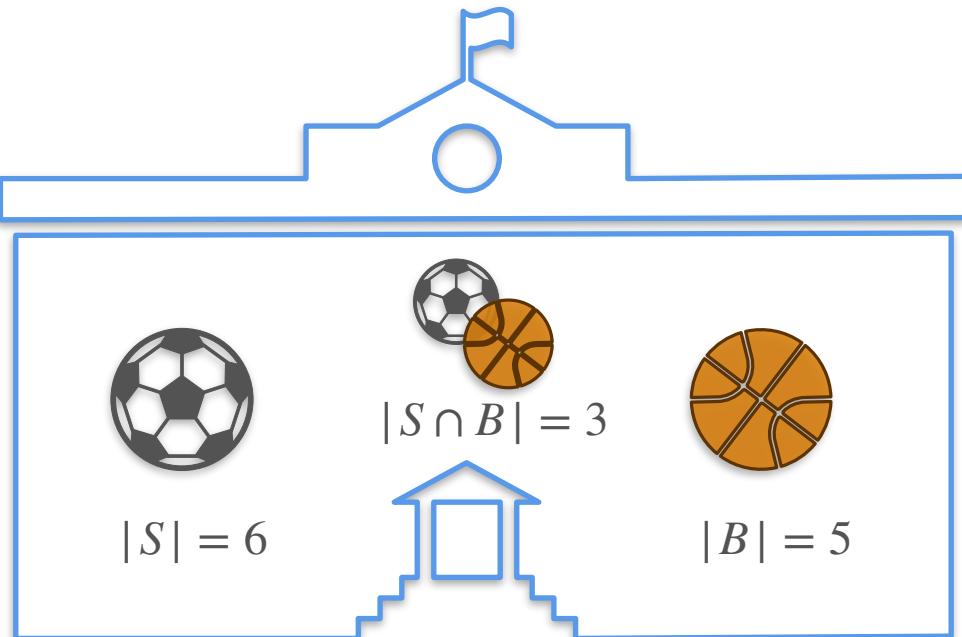
# Sum of Probabilities (Joint Events): Quiz 2



# Sum of Probabilities (Joint Events): Quiz 2

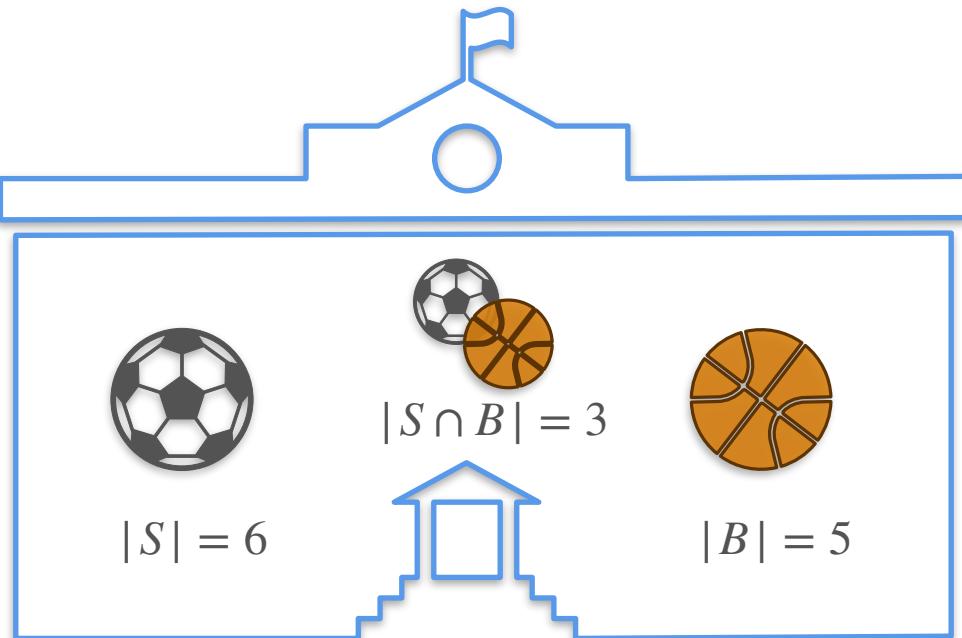


# Sum of Probabilities (Joint Events): Quiz 2



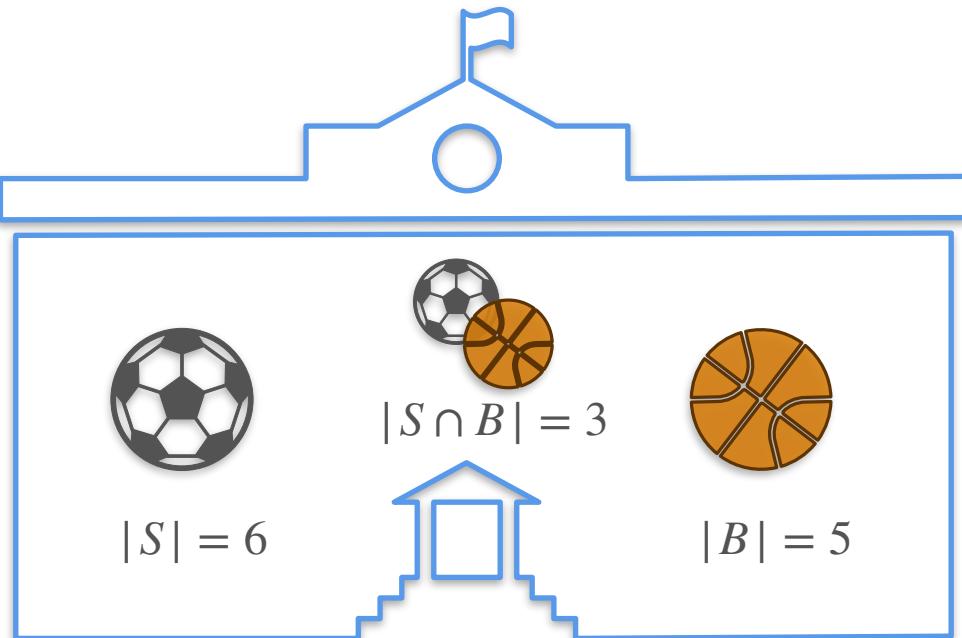
How many kids play soccer or basketball?

# Sum of Probabilities (Joint Events): Quiz 2



How many kids play soccer or basketball?

# Sum of Probabilities (Joint Events): Quiz 2



How many kids play soccer or basketball?

Hint: What if there were only 10 kids?

# Sum of Probabilities (Joint Events): Quiz 2 Solution

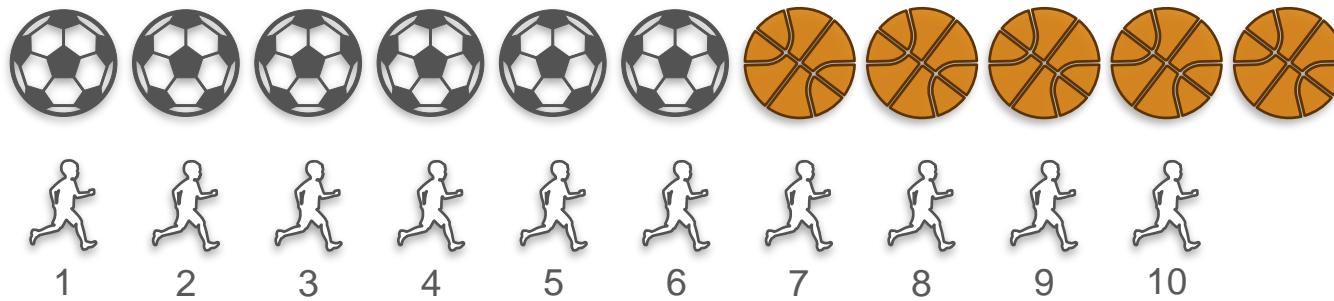
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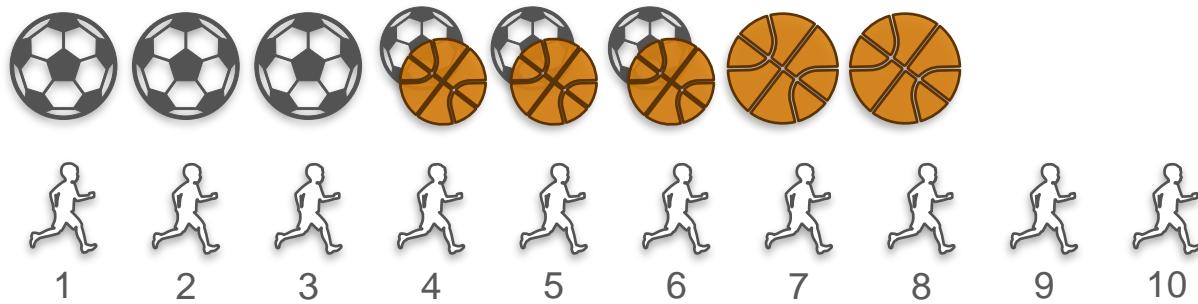
# Sum of Probabilities (Joint Events): Quiz 2 Solution



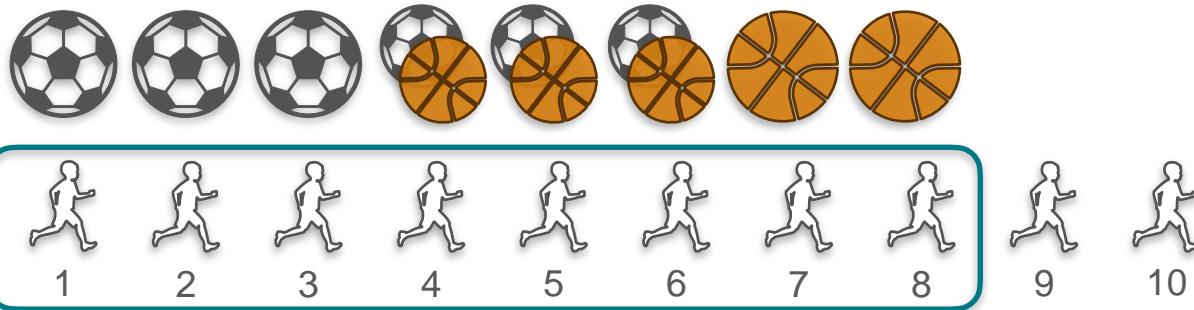
# Sum of Probabilities (Joint Events): Quiz 2 Solution



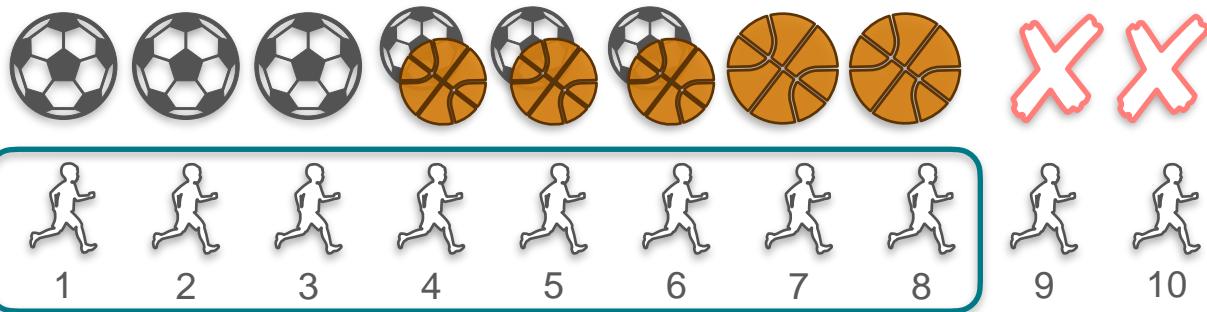
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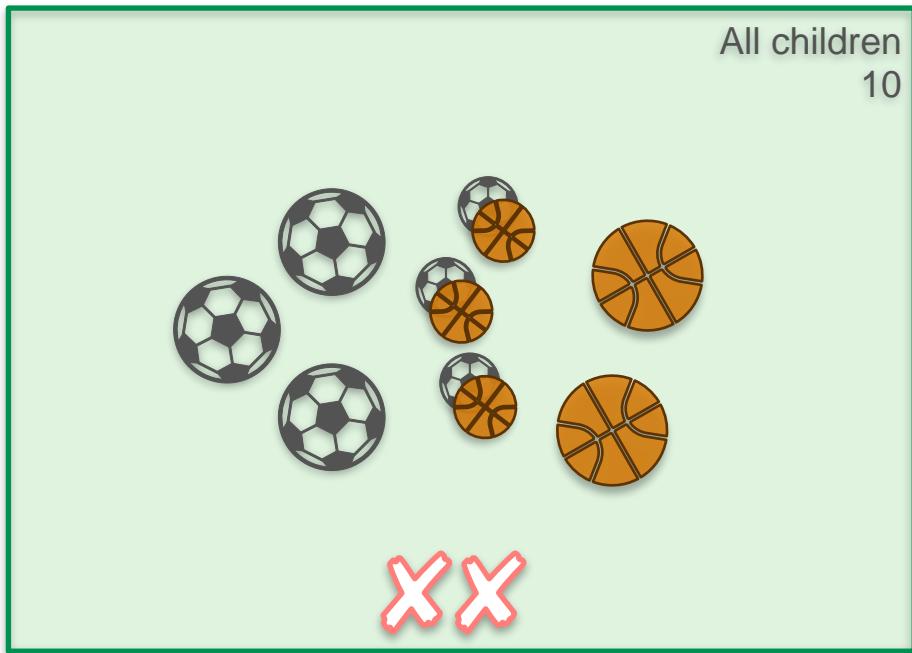


# Sum of Probabilities (Joint Events): Venn Diagram

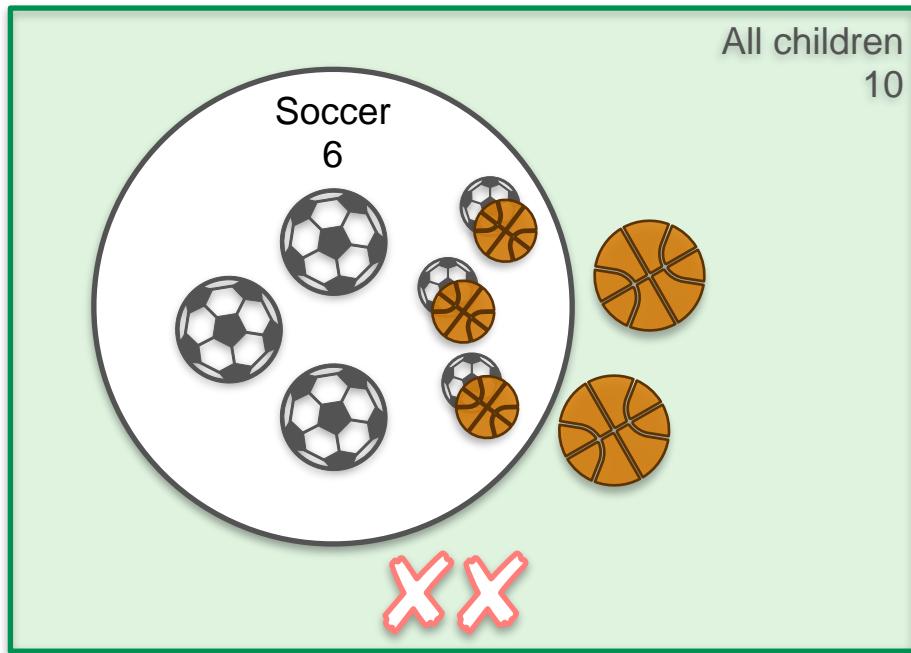


XX

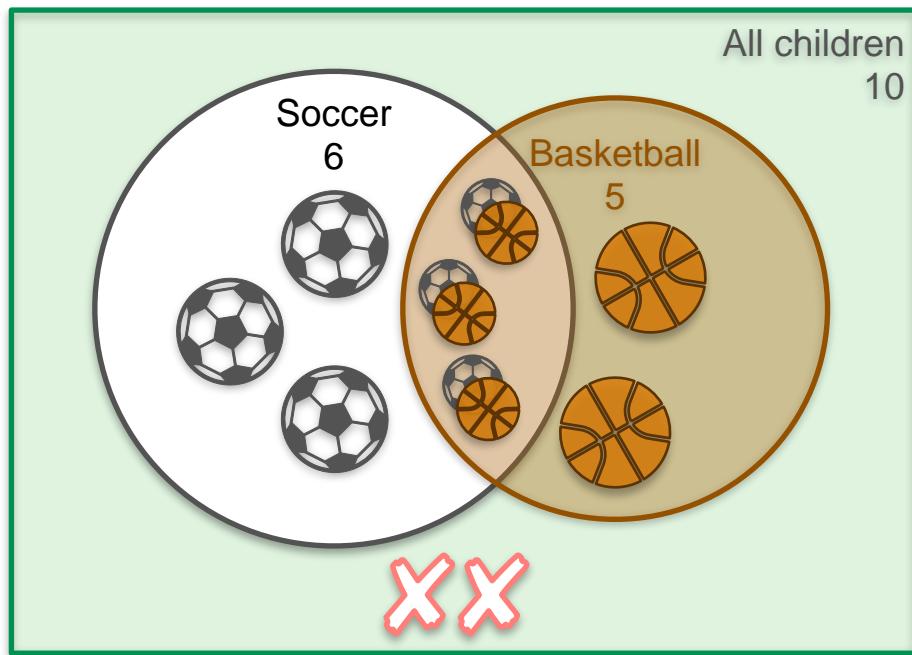
# Sum of Probabilities (Joint Events): Venn Diagram



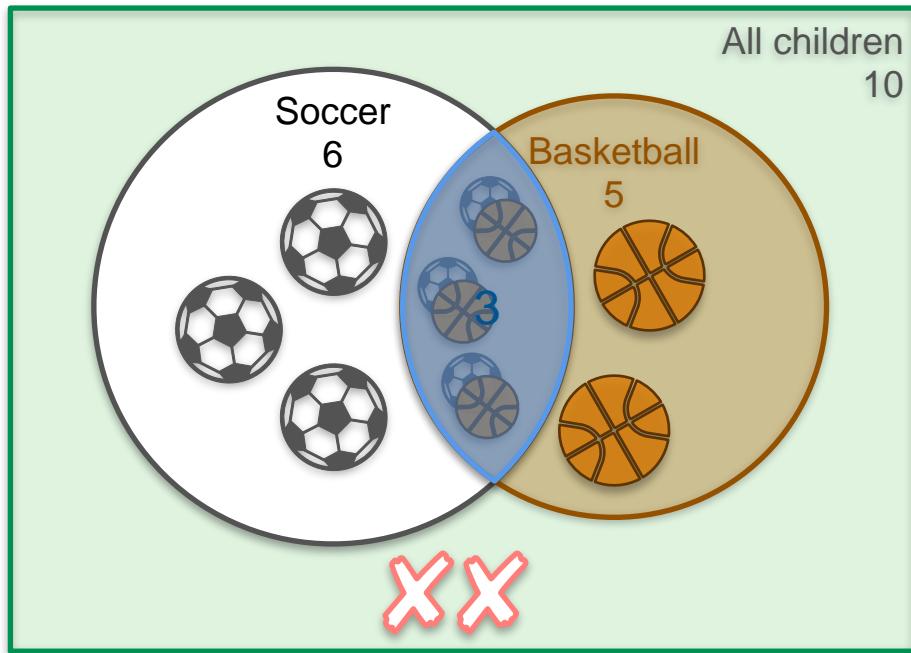
# Sum of Probabilities (Joint Events): Venn Diagram



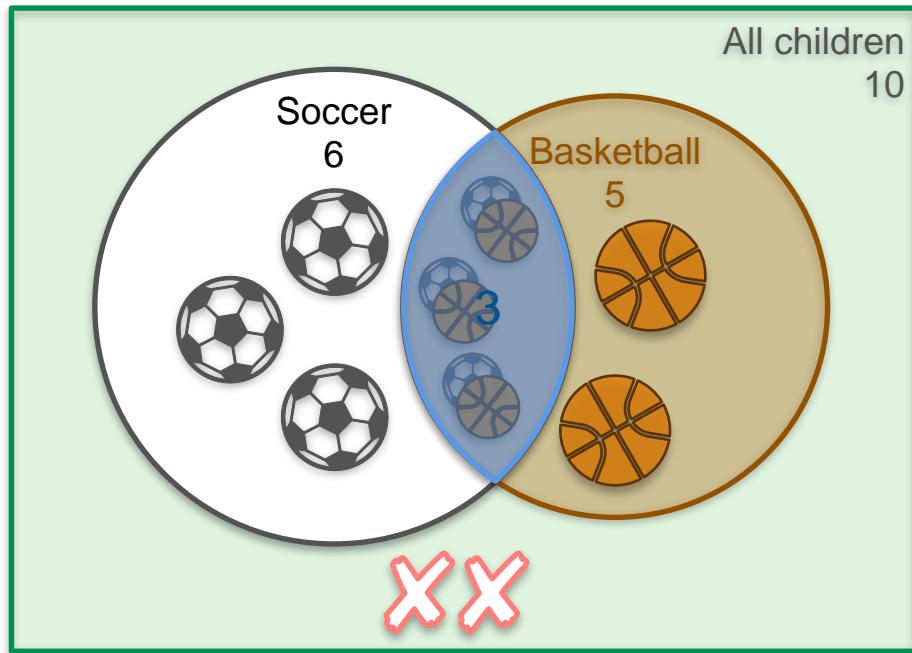
# Sum of Probabilities (Joint Events): Venn Diagram



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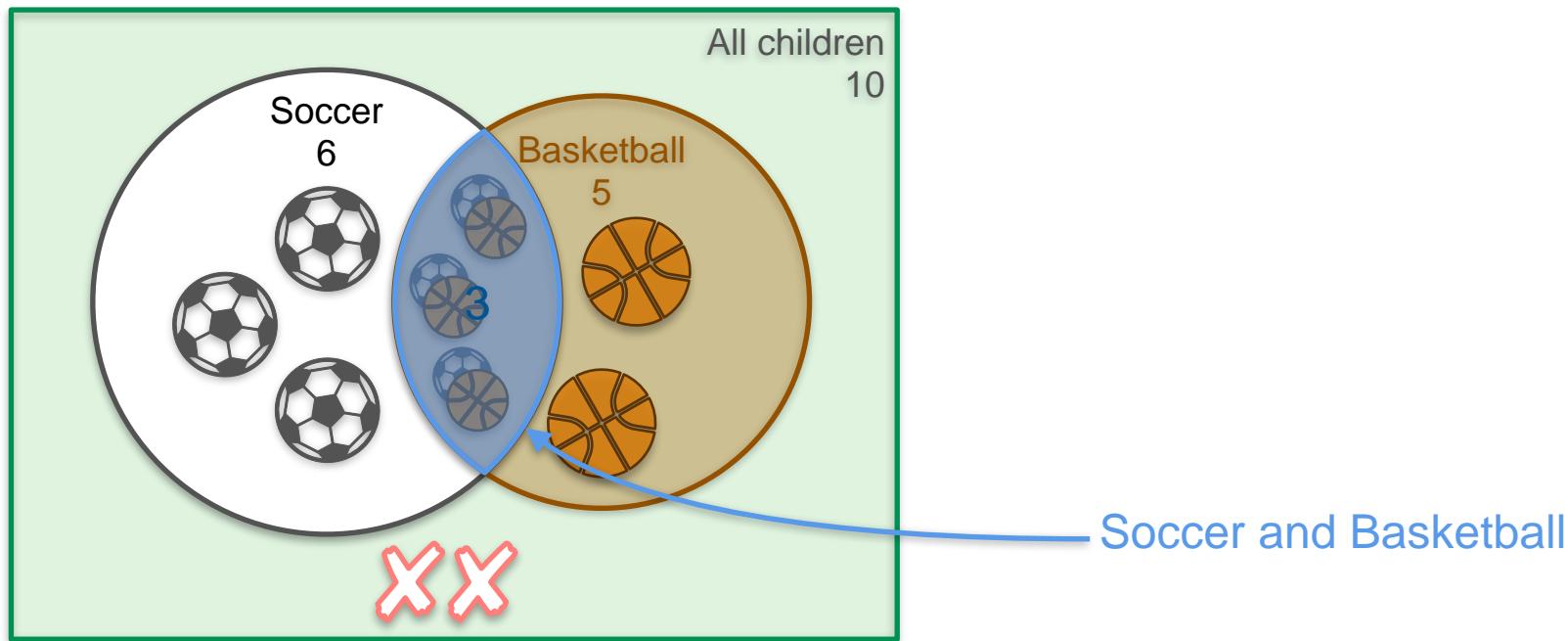


# Sum of Probabilities (Joint Events): Venn Diagram

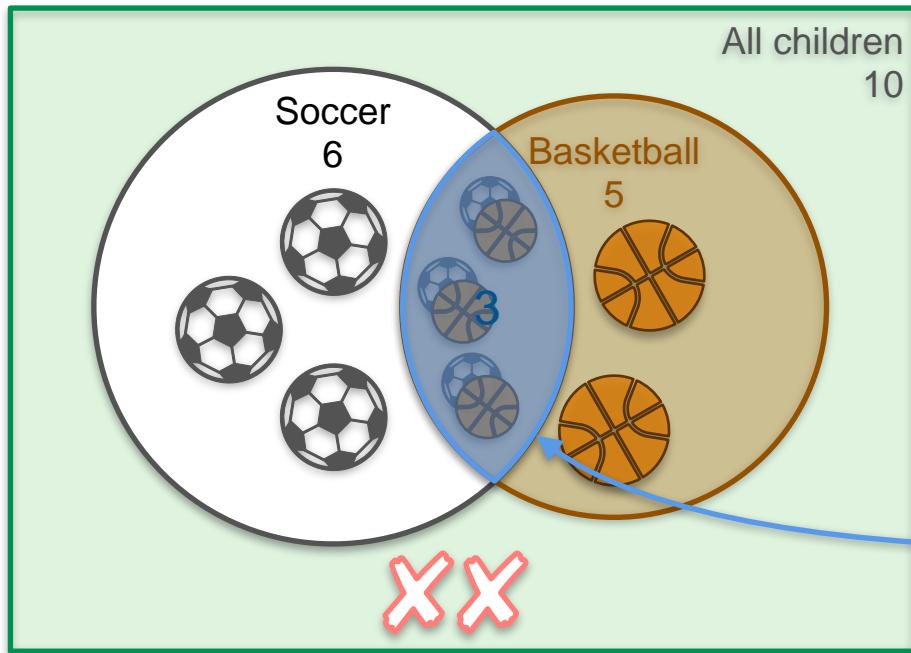


Soccer and Basketball

# Sum of Probabilities (Joint Events): Venn Diagram



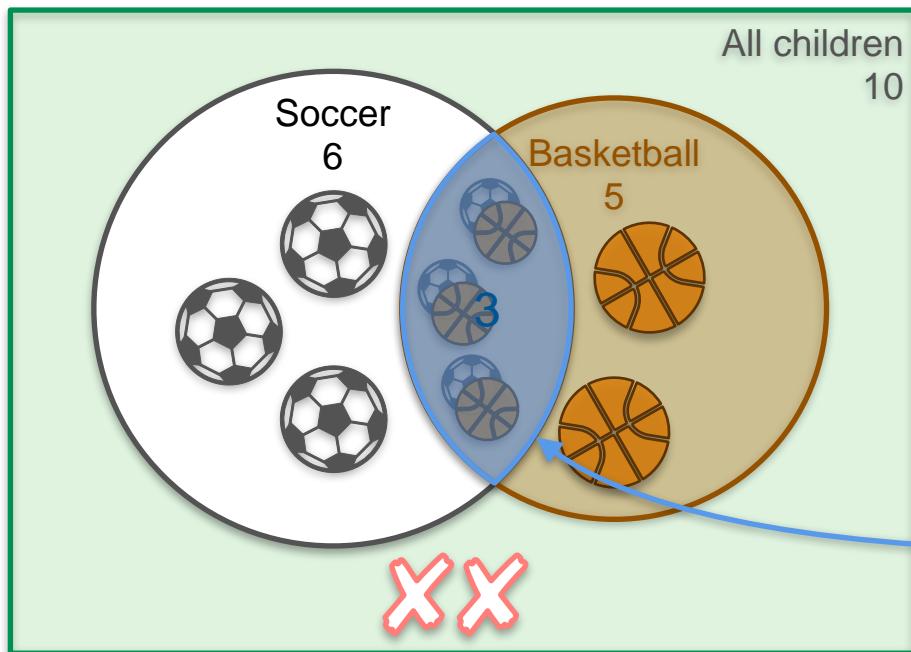
# Sum of Probabilities (Joint Events): Venn Diagram



$$|S \cup B| =$$

Soccer and Basketball

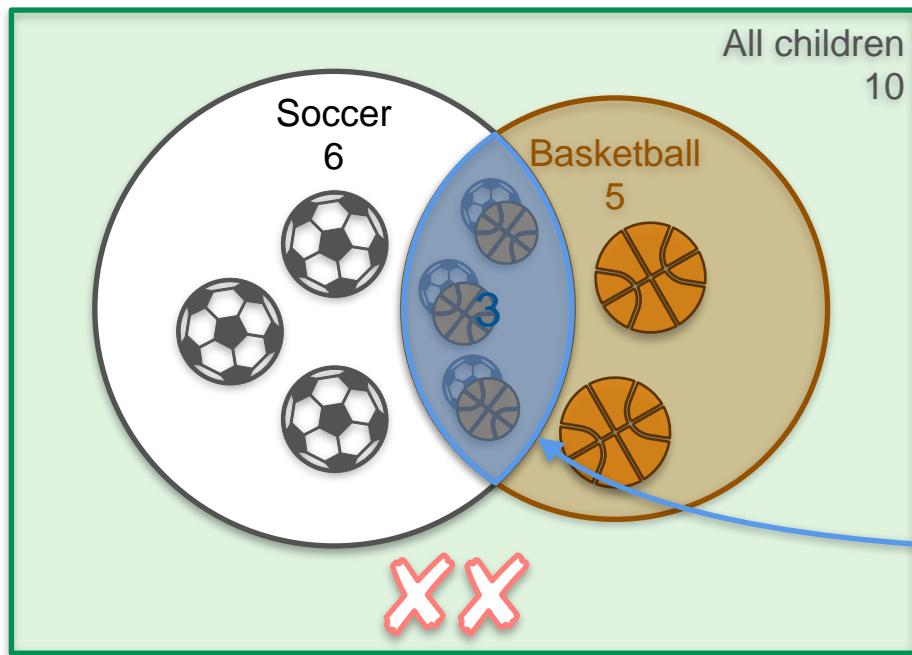
# Sum of Probabilities (Joint Events): Venn Diagram



$$|S \cup B| = |S|$$

Soccer and Basketball

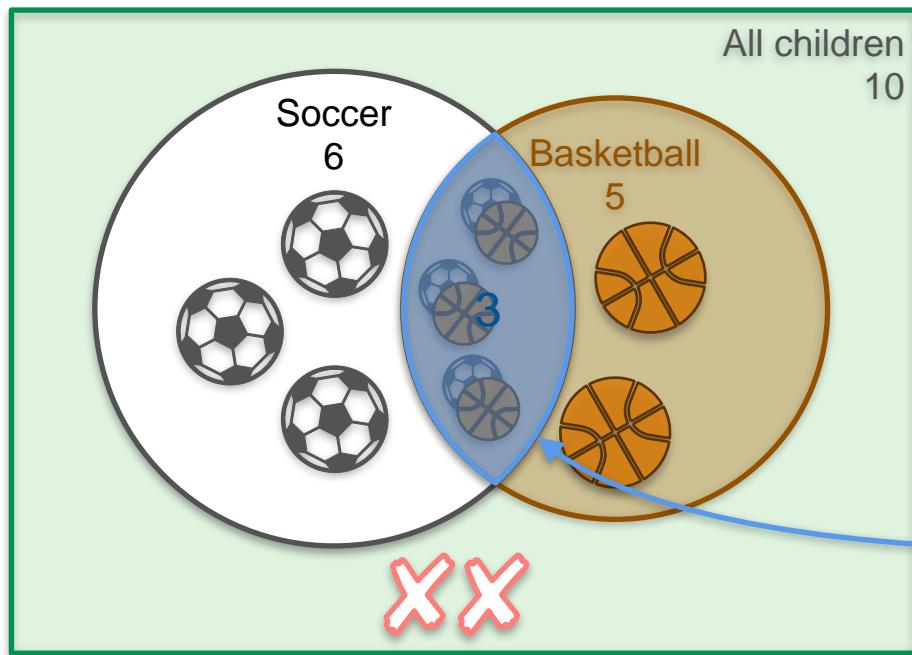
# Sum of Probabilities (Joint Events): Venn Diagram



$$|S \cup B| = |S|$$

Soccer and Basketball

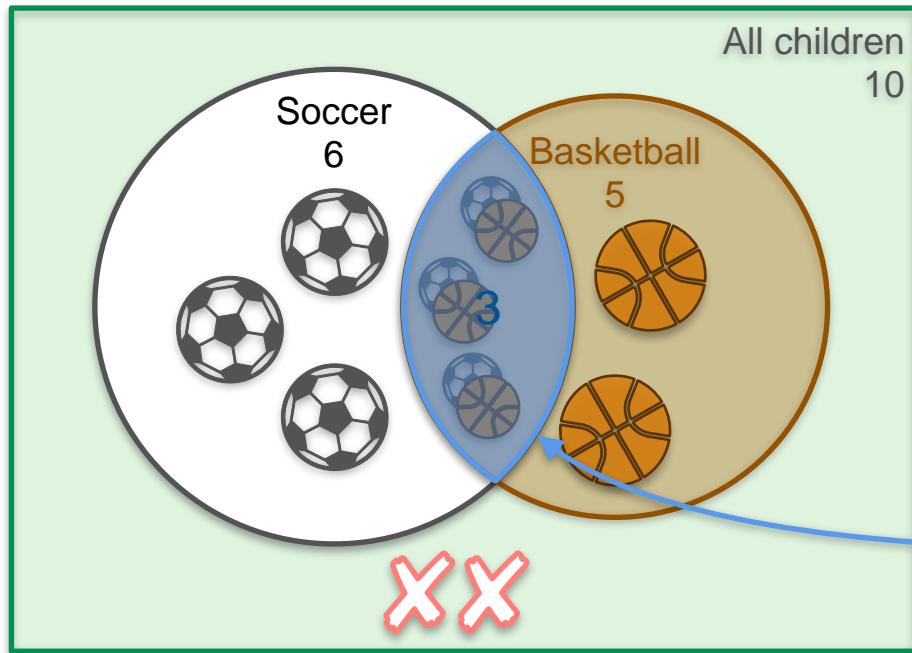
# Sum of Probabilities (Joint Events): Venn Diagram



$$|S \cup B| = |S| + |B|$$

Soccer and Basketball

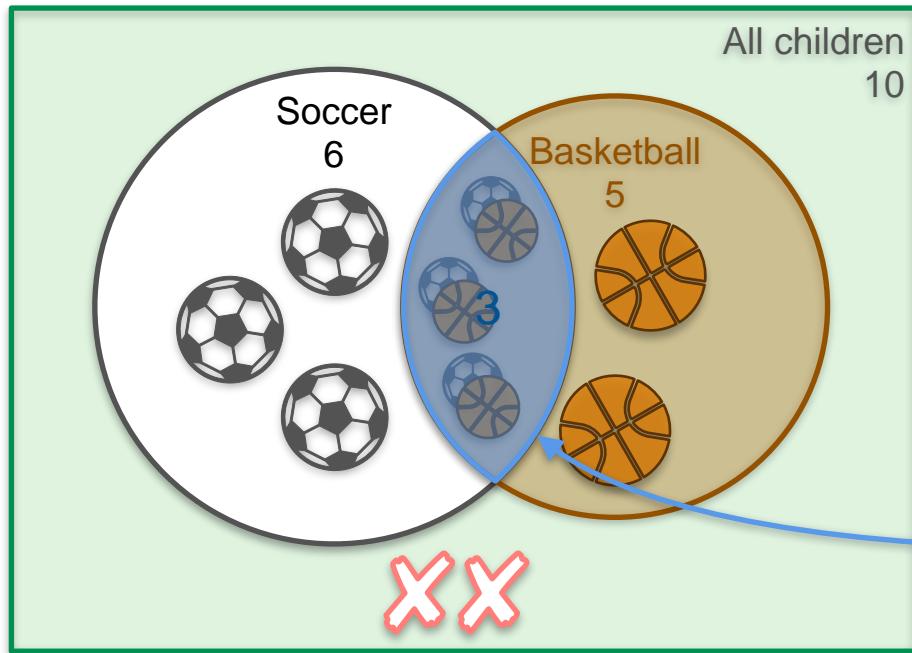
# Sum of Probabilities (Joint Events): Venn Diagram



$$|S \cup B| = |S| + |B|$$

Soccer and Basketball

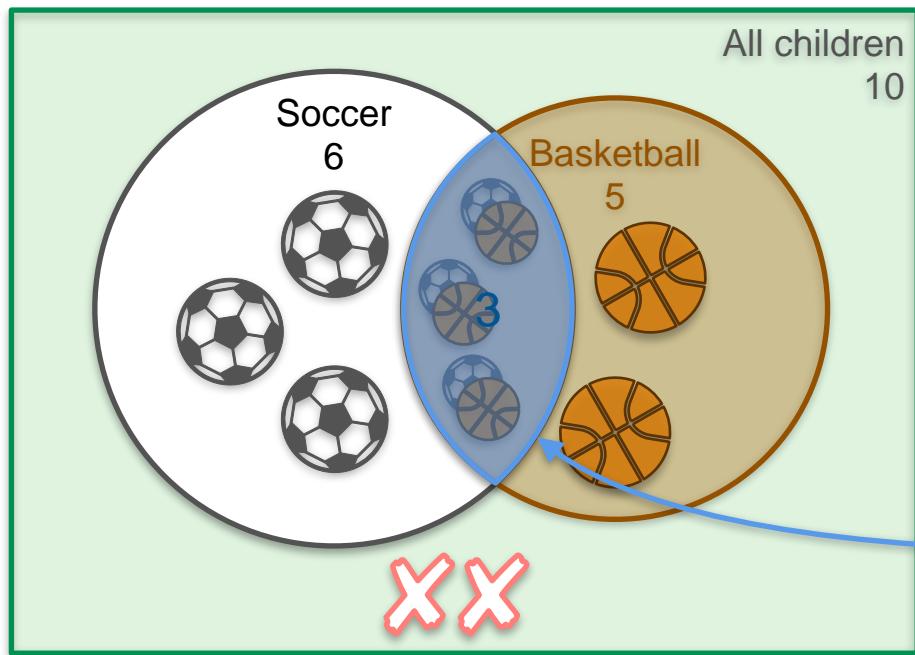
# Sum of Probabilities (Joint Events): Venn Diagram



$$|S \cup B| = |S| + |B| - |S \cap B|$$

Soccer and Basketball

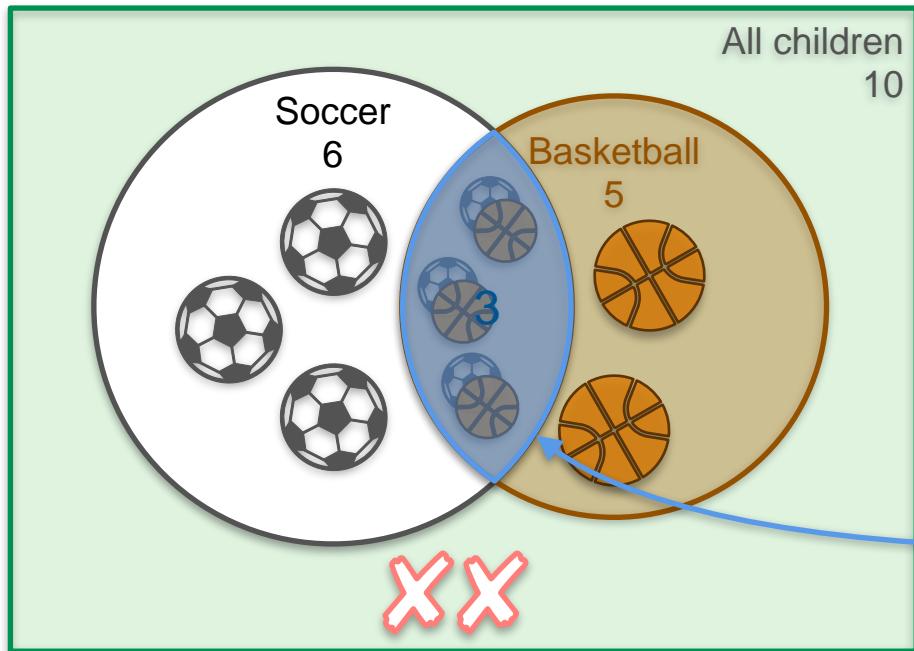
# Sum of Probabilities (Joint Events): Venn Diagram



$$|S \cup B| = |S| + |B| - |S \cap B|$$

Soccer and Basketball

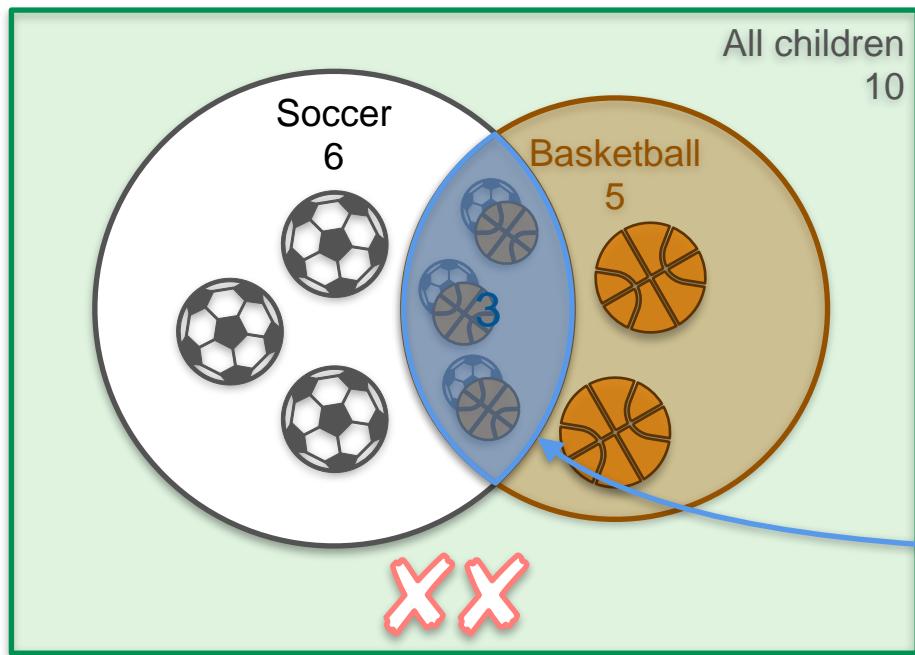
# Sum of Probabilities (Joint Events): Venn Diagram



$$|S \cup B| = |S| + |B| - |S \cap B| \\ =$$

Soccer and Basketball

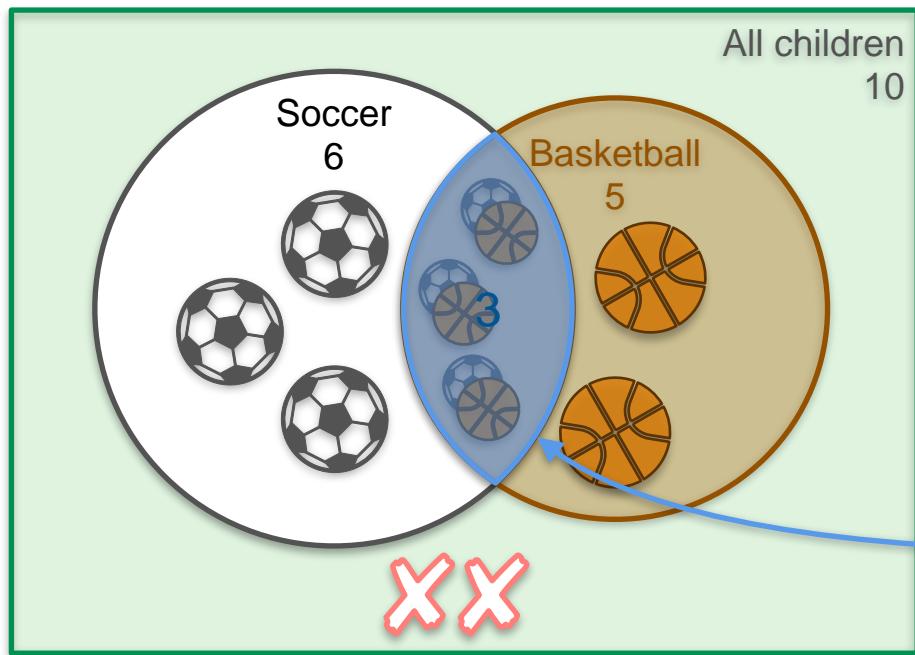
# Sum of Probabilities (Joint Events): Venn Diagram



$$\begin{aligned}|S \cup B| &= |S| + |B| - |S \cap B| \\&= 6 + 5 - 3\end{aligned}$$

Soccer and Basketball

# Sum of Probabilities (Joint Events): Venn Diagram

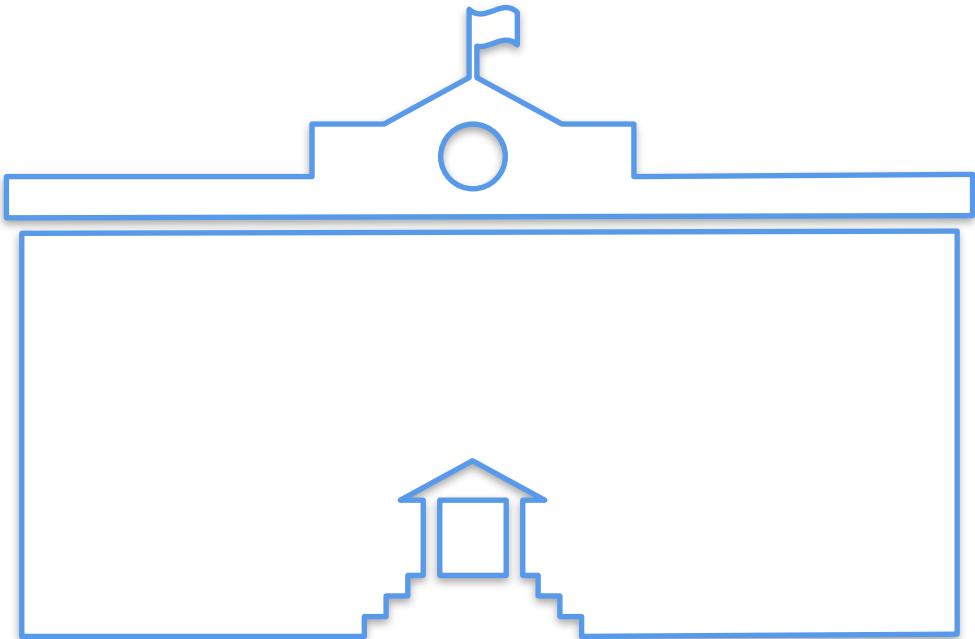


$$\begin{aligned}|S \cup B| &= |S| + |B| - |S \cap B| \\&= 6 + 5 - 3 \\&= 8\end{aligned}$$

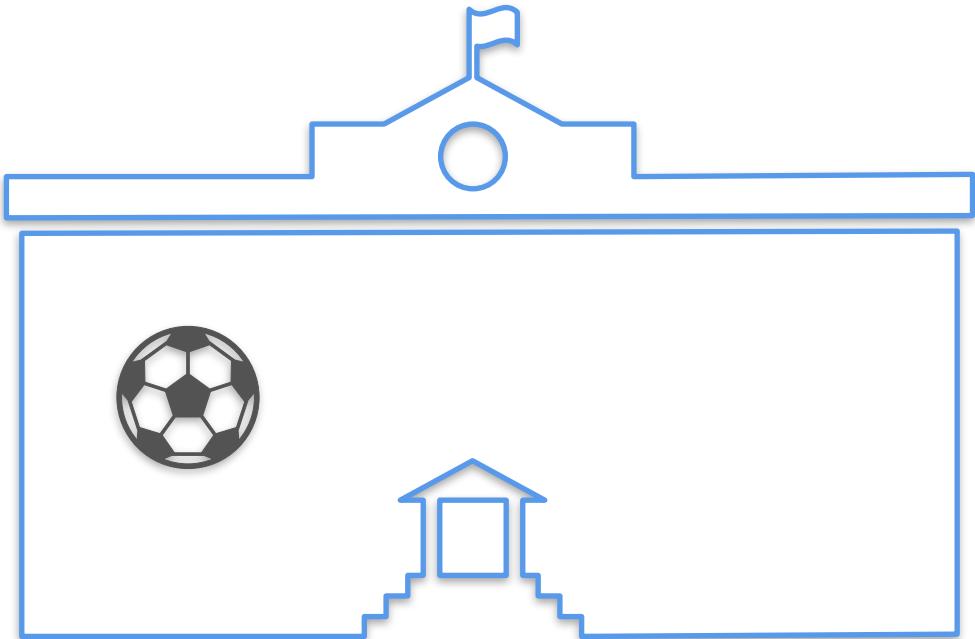
Soccer and Basketball

# Sum of Probabilities (Joint Events): Quiz 3

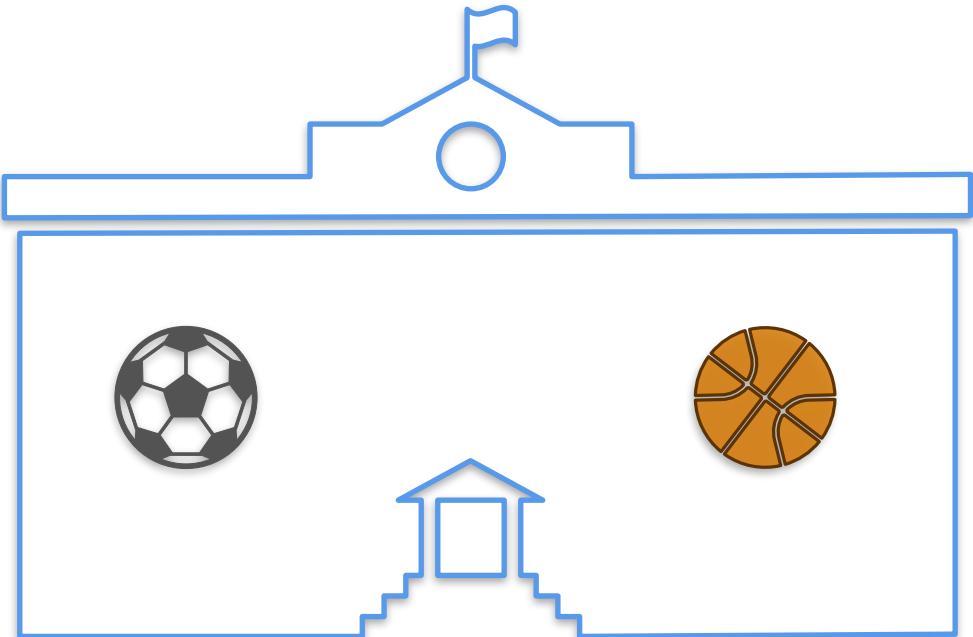
# Sum of Probabilities (Joint Events): Quiz 3



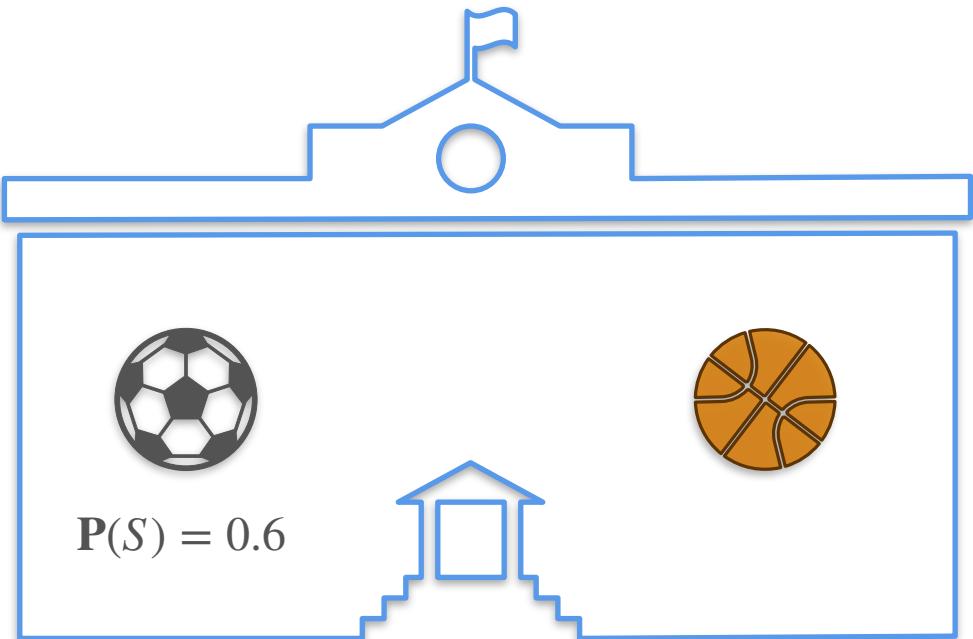
# Sum of Probabilities (Joint Events): Quiz 3



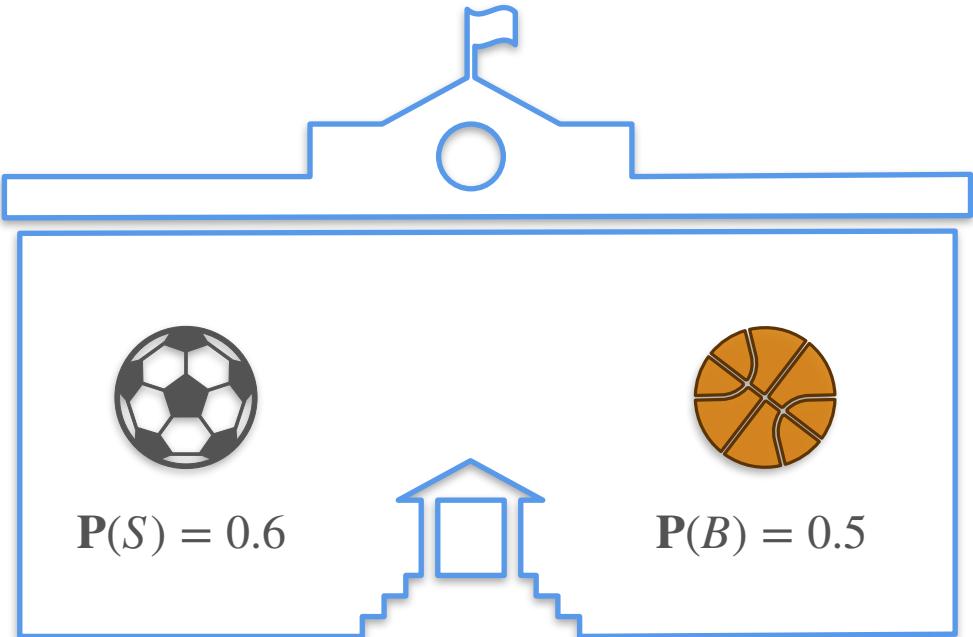
# Sum of Probabilities (Joint Events): Quiz 3



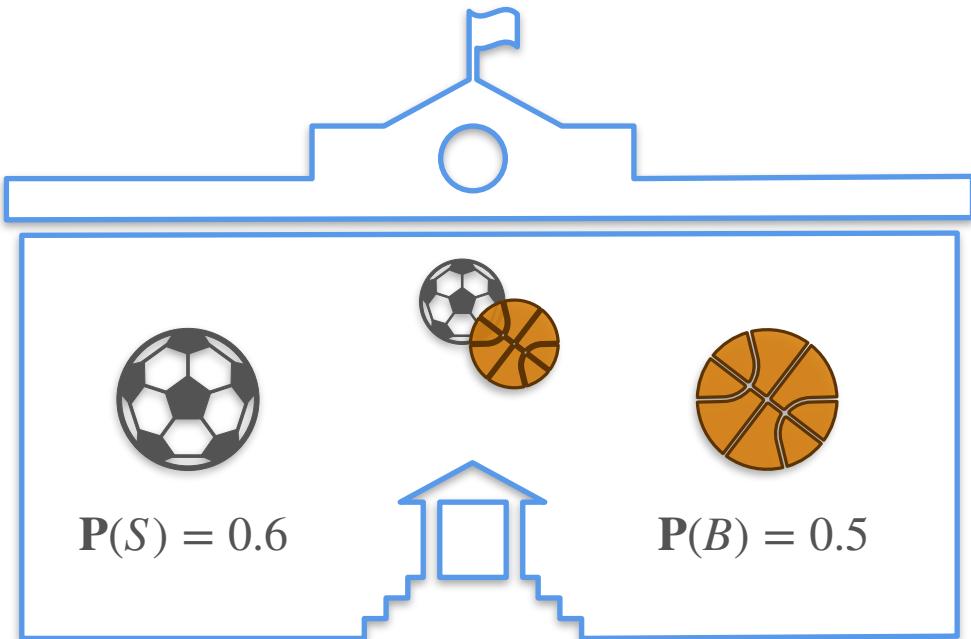
# Sum of Probabilities (Joint Events): Quiz 3



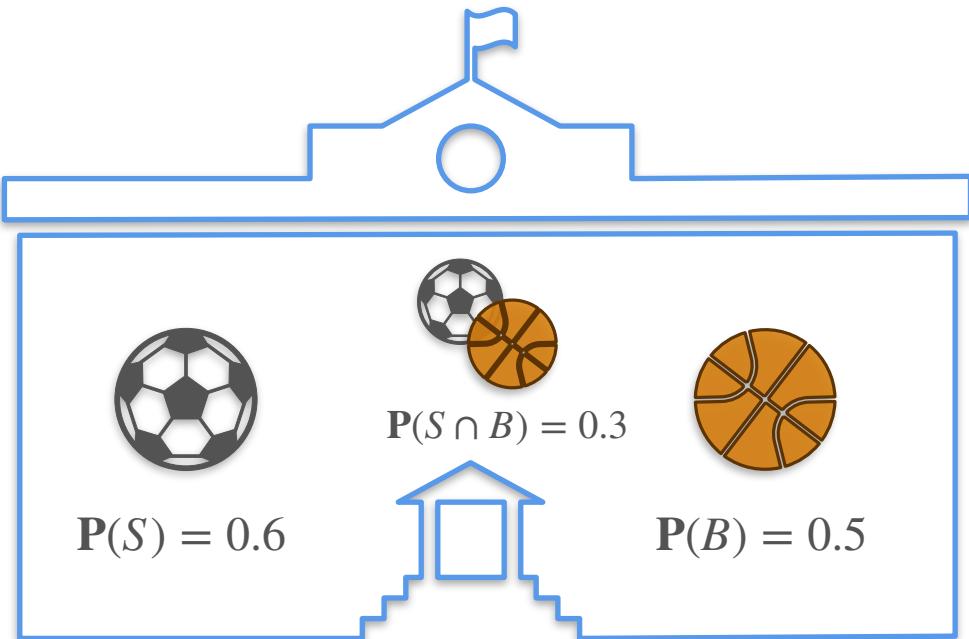
# Sum of Probabilities (Joint Events): Quiz 3



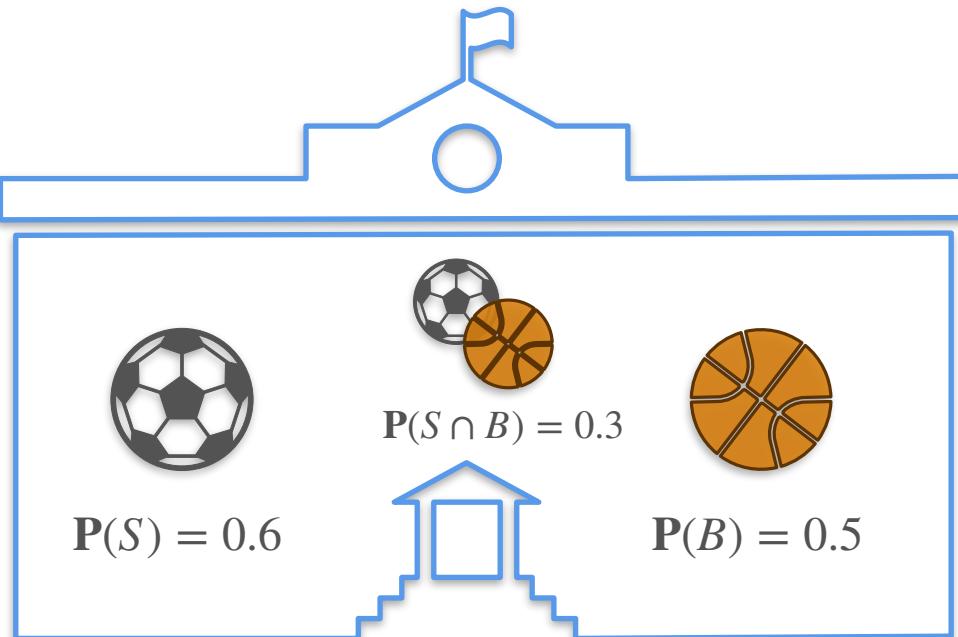
# Sum of Probabilities (Joint Events): Quiz 3



# Sum of Probabilities (Joint Events): Quiz 3



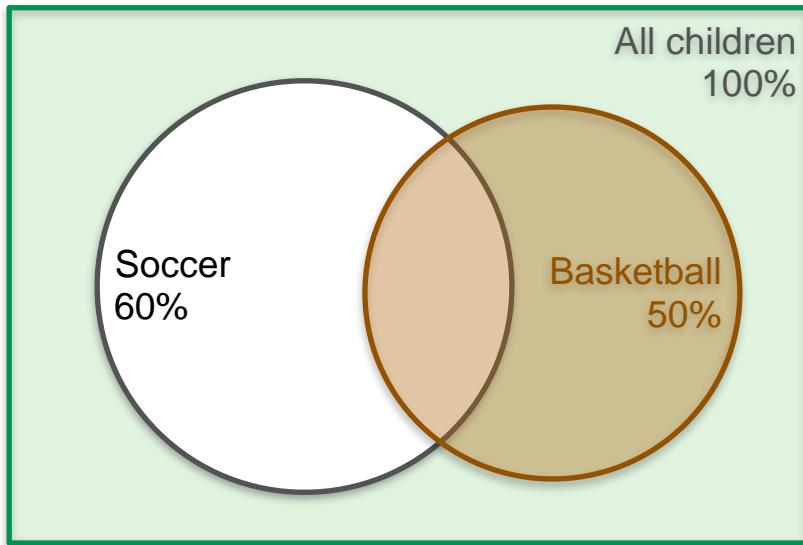
# Sum of Probabilities (Joint Events): Quiz 3



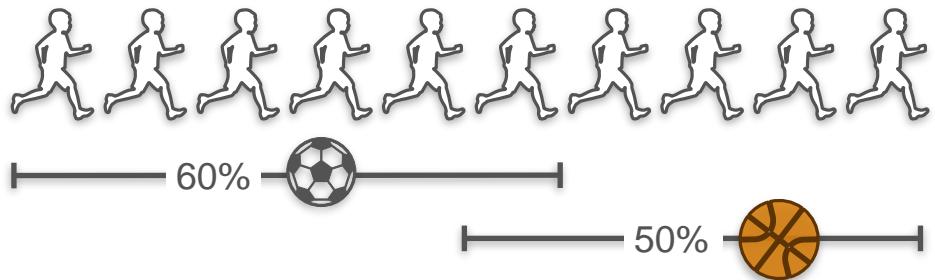
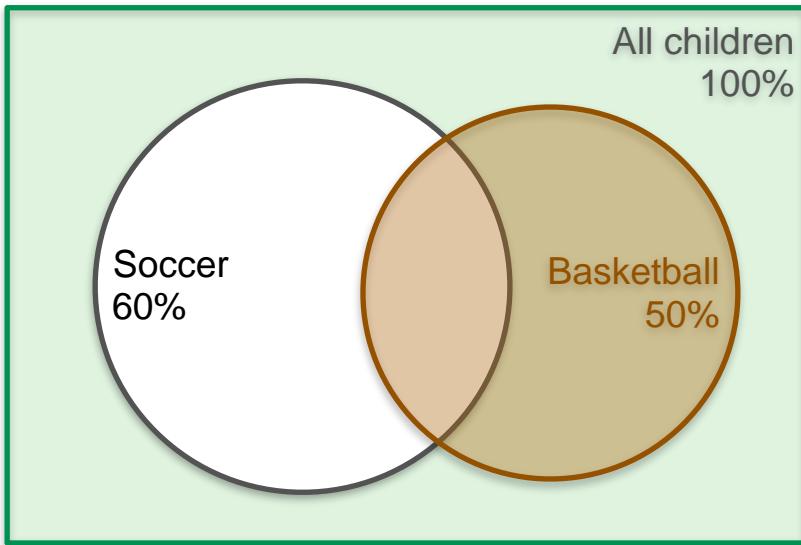
What is the probability that a child plays soccer or basketball?

# Sum of Probabilities (Joint Events): Quiz 3 Solution

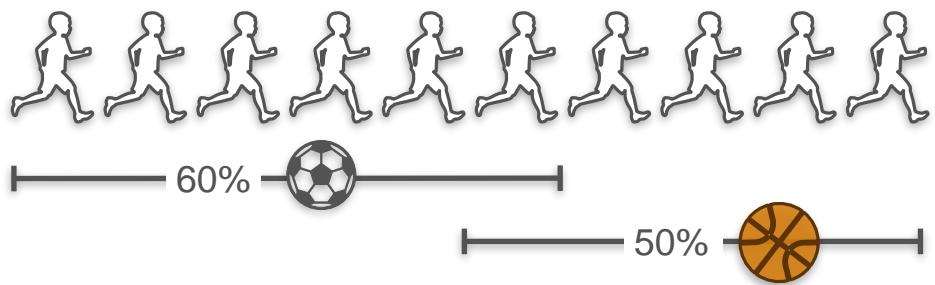
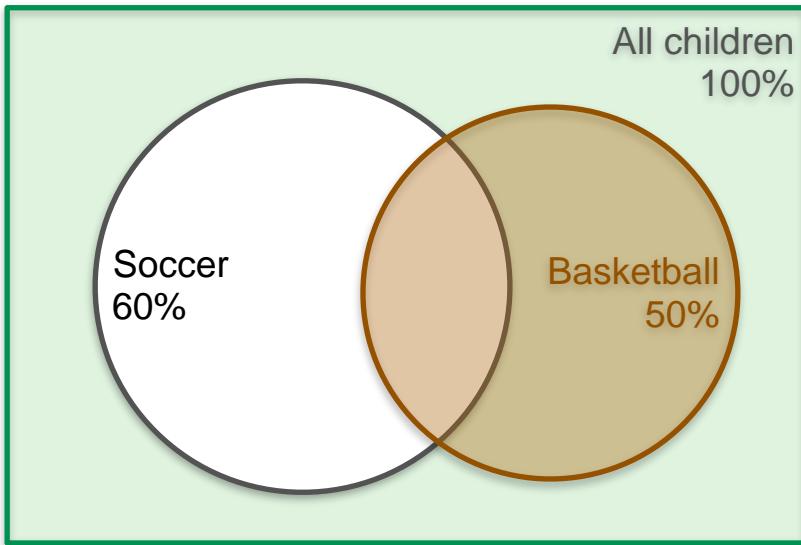
# Sum of Probabilities (Joint Events): Quiz 3 Solution



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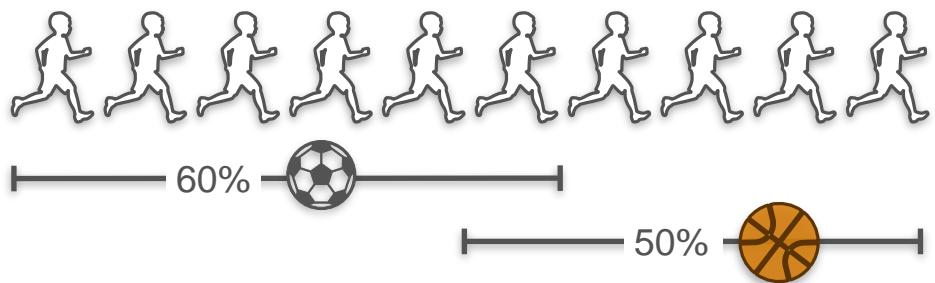
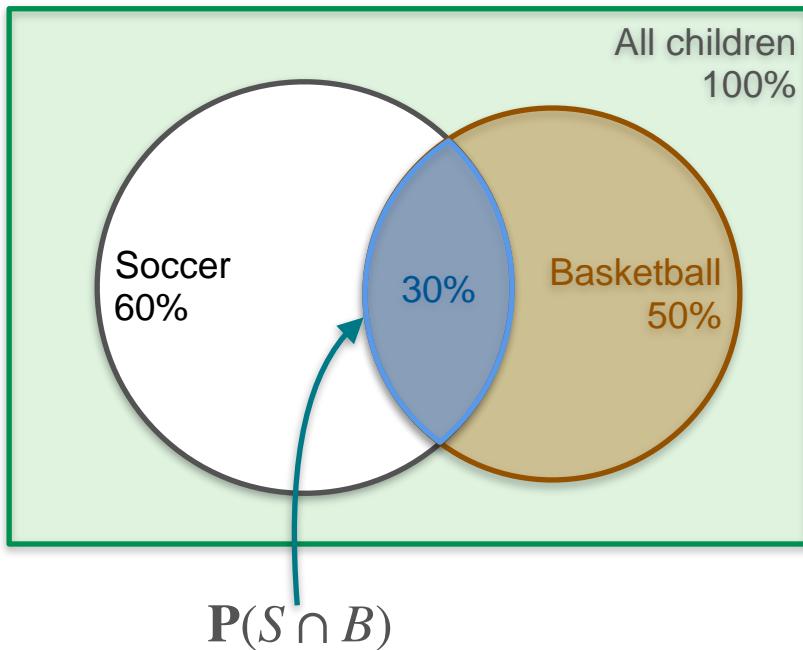


# Sum of Probabilities (Joint Events): Quiz 3 Solution



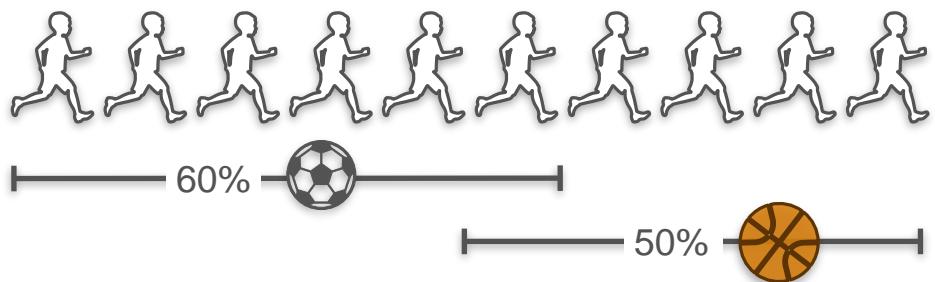
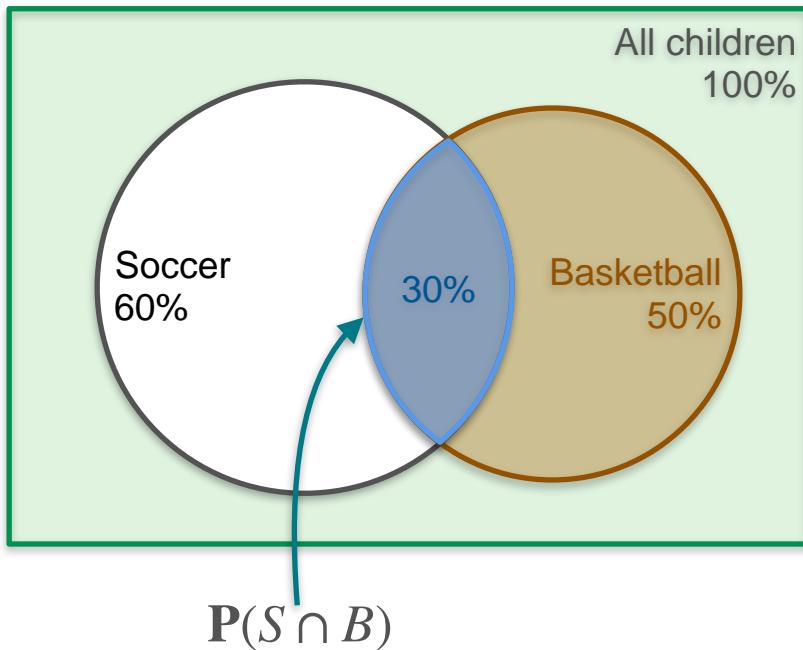
$$P(S \cup B) = P(S) + P(B)$$

# Sum of Probabilities (Joint Events): Quiz 3 Solution



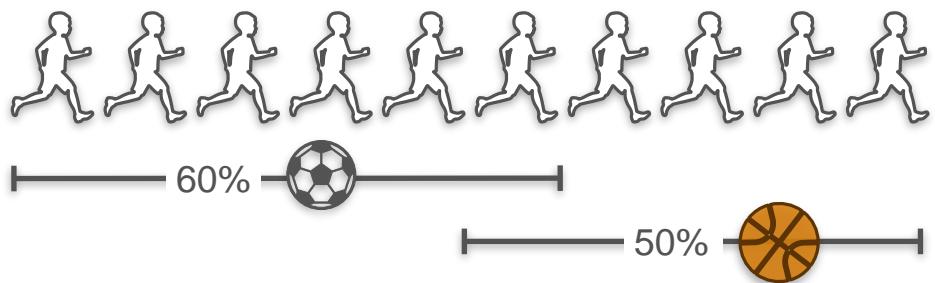
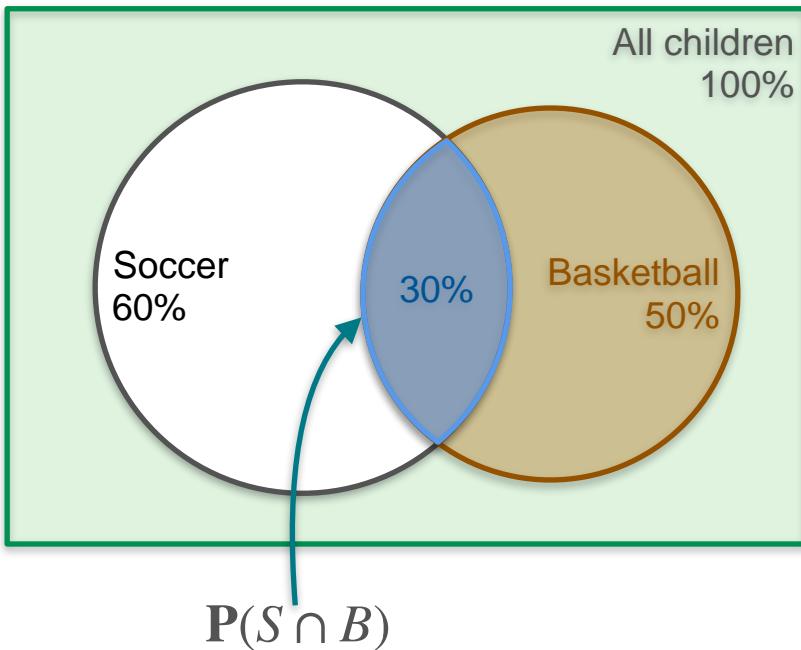
$$\mathbf{P}(S \cup B) = \mathbf{P}(S) + \mathbf{P}(B)$$

# Sum of Probabilities (Joint Events): Quiz 3 Solution



$$\mathbf{P}(S \cup B) = \mathbf{P}(S) + \mathbf{P}(B) - \mathbf{P}(S \cap B)$$

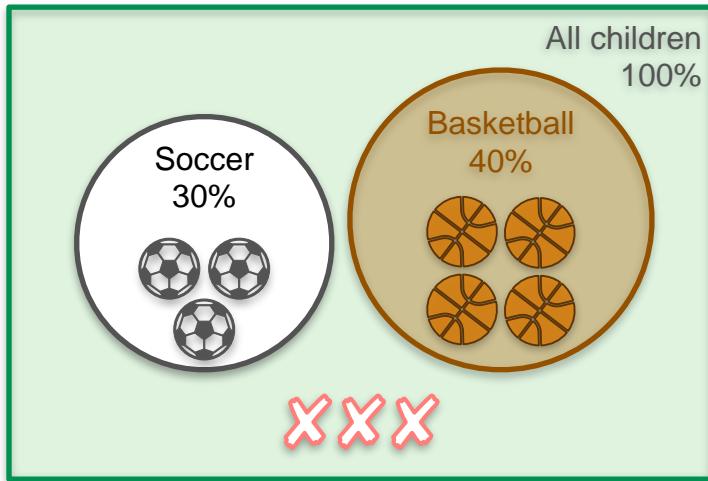
# Sum of Probabilities (Joint Events): Quiz 3 Solution



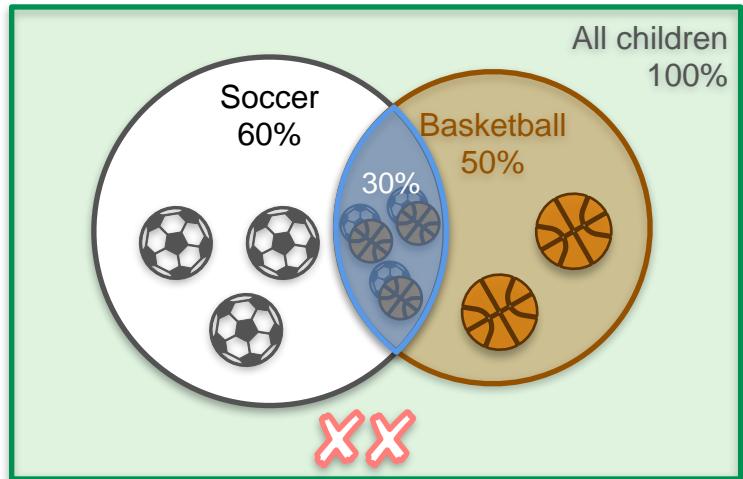
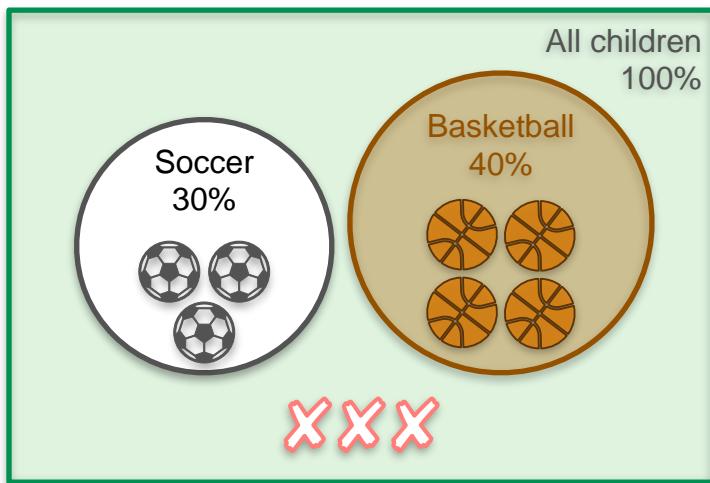
$$\begin{aligned} P(S \cup B) &= P(S) + P(B) - P(S \cap B) \\ &= 0.6 + 0.5 - 0.3 \\ &= 0.8 \end{aligned}$$

# Disjoint Events Vs Joint Events

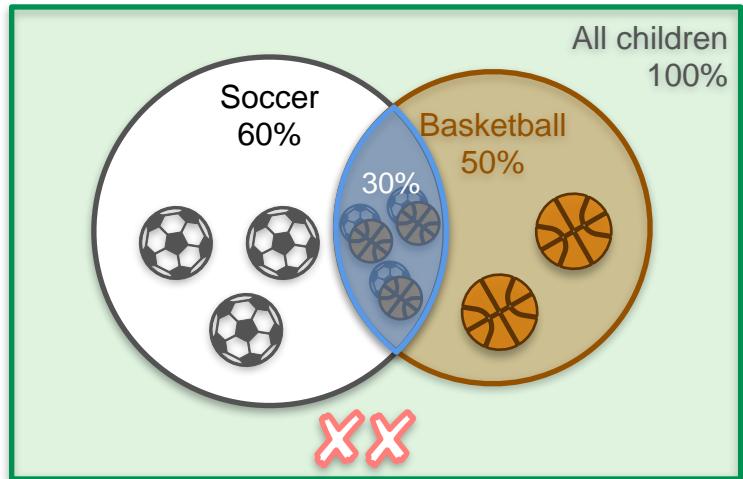
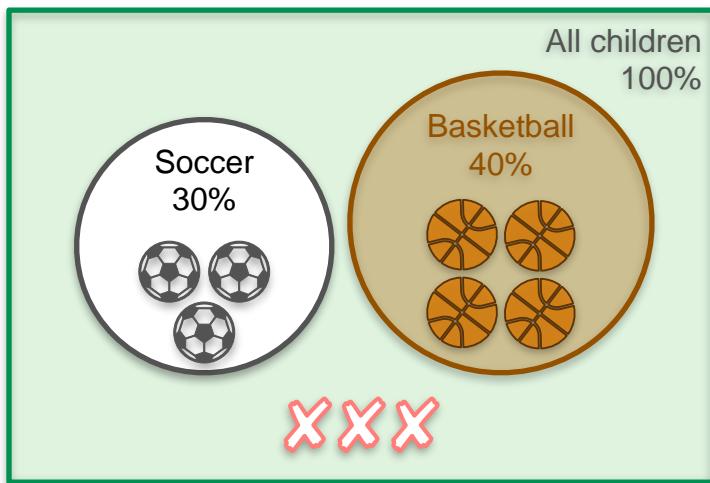
# Disjoint Events Vs Joint Events



# Disjoint Events Vs Joint Events

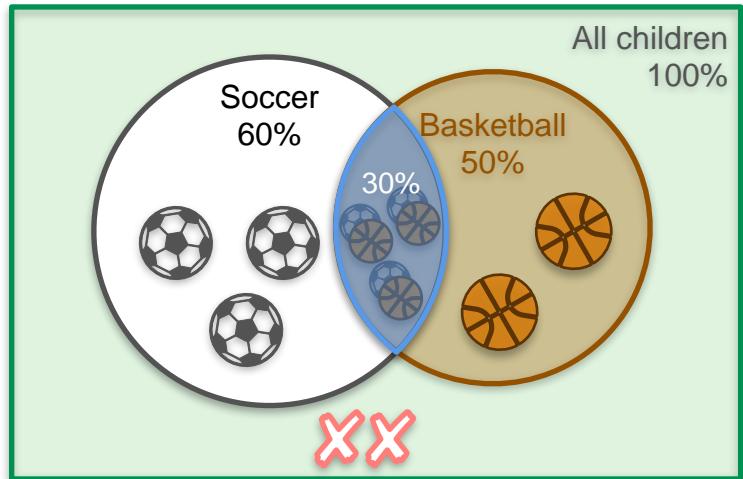
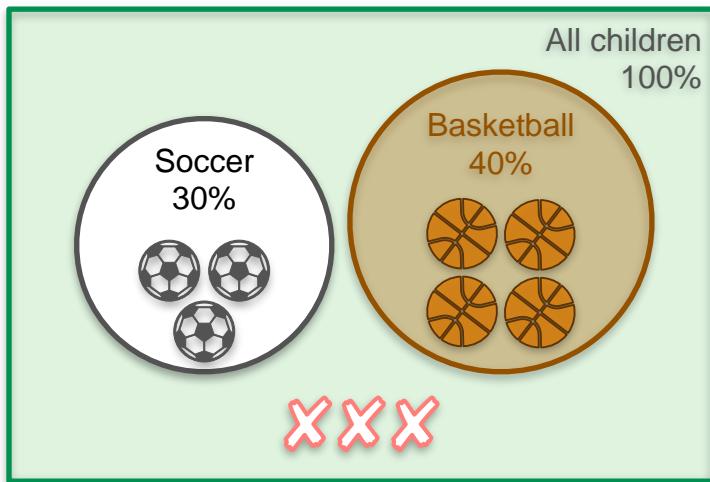


# Disjoint Events Vs Joint Events



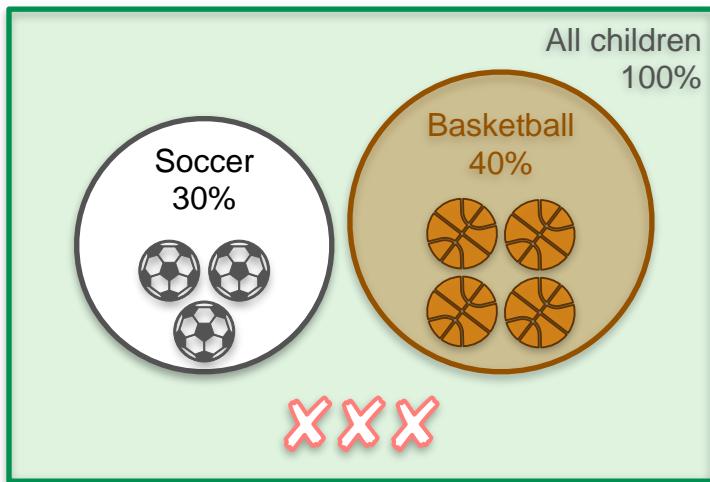
# Disjoint Events Vs Joint Events

Disjoint

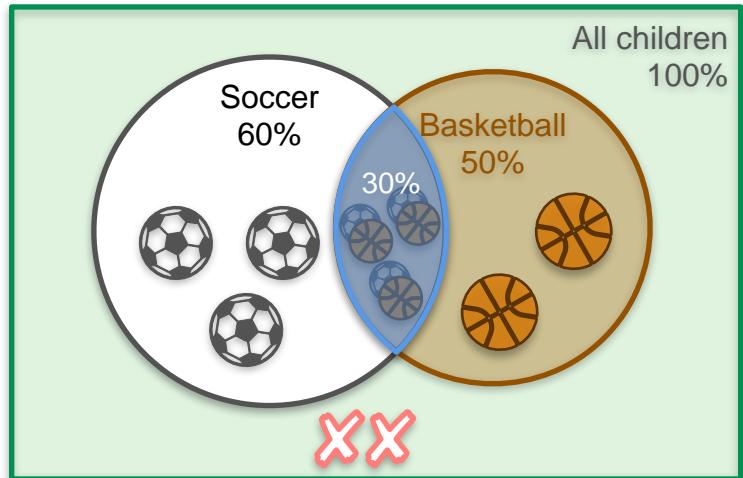


# Disjoint Events Vs Joint Events

Disjoint

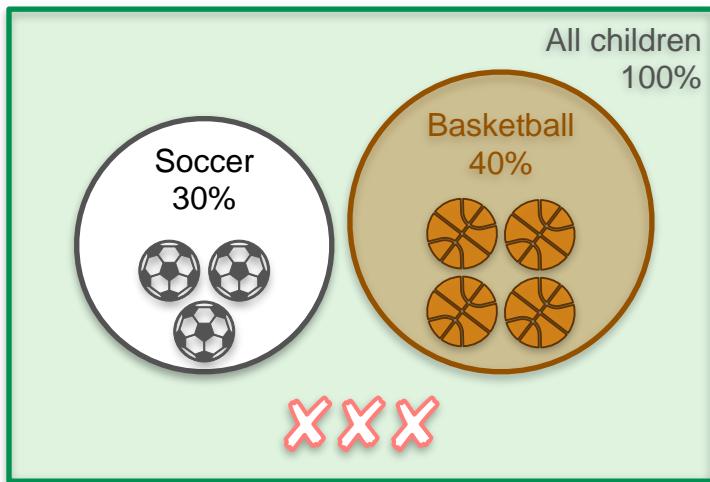


Mutually exclusive



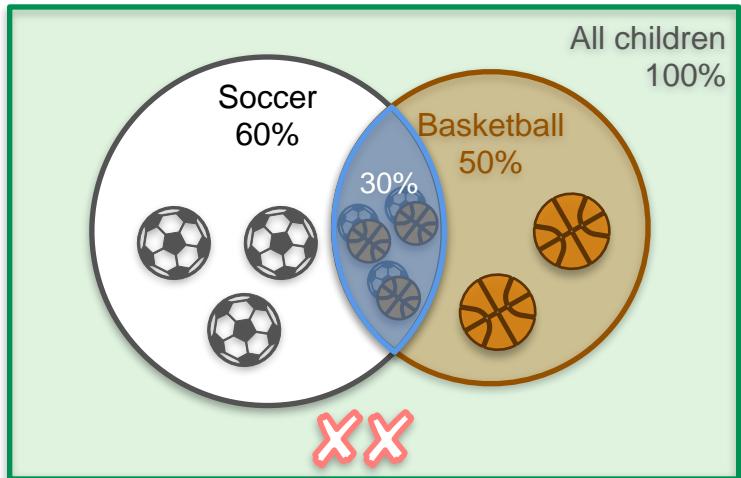
# Disjoint Events Vs Joint Events

Disjoint



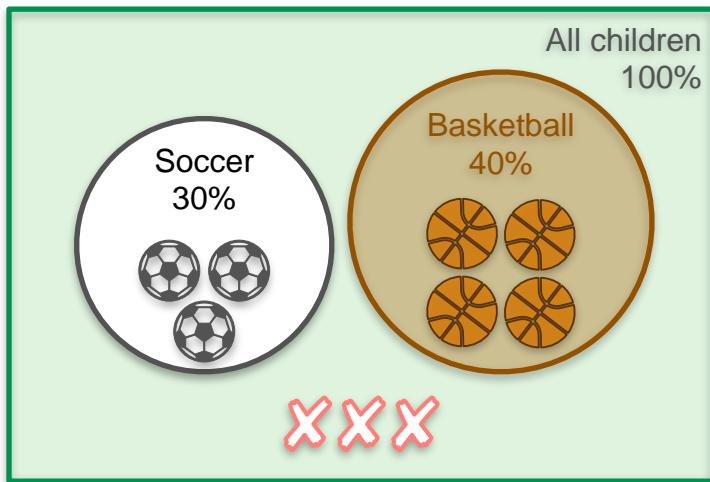
Mutually exclusive

$$P(S \cup B) = P(S) + P(B)$$



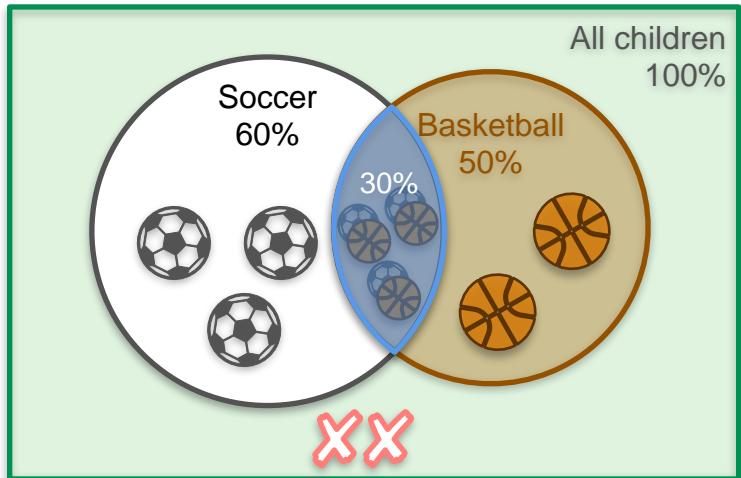
# Disjoint Events Vs Joint Events

Disjoint



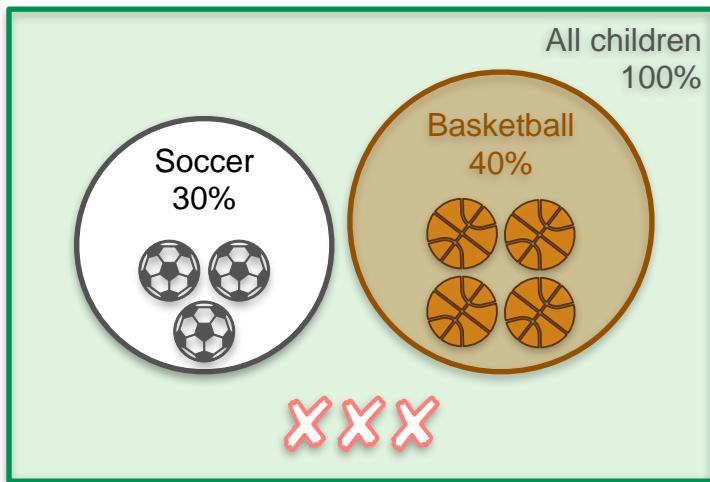
Mutually exclusive

$$P(S \cup B) = P(S) + P(B)$$



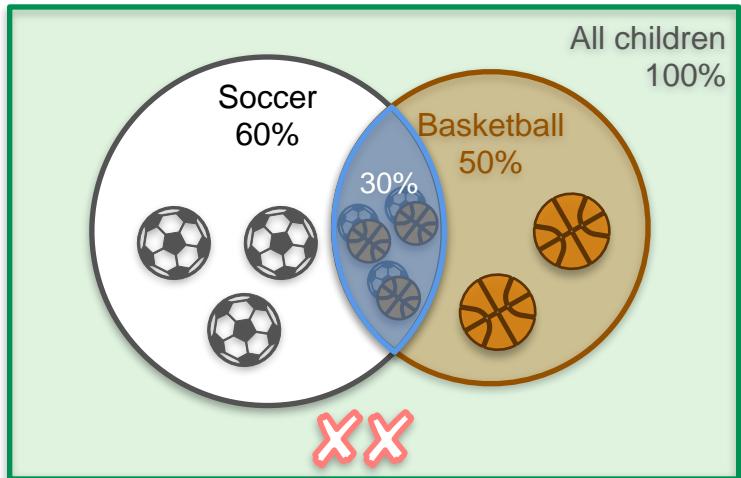
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Disjoint



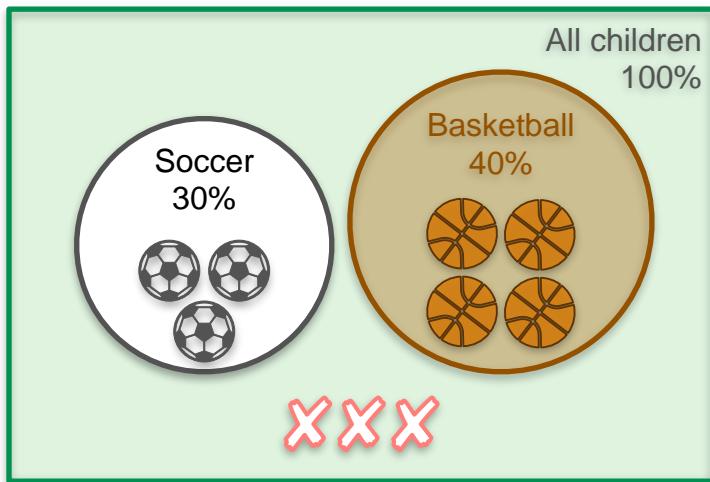
Mutually exclusive

$$P(S \cup B) = P(S) + P(B)$$

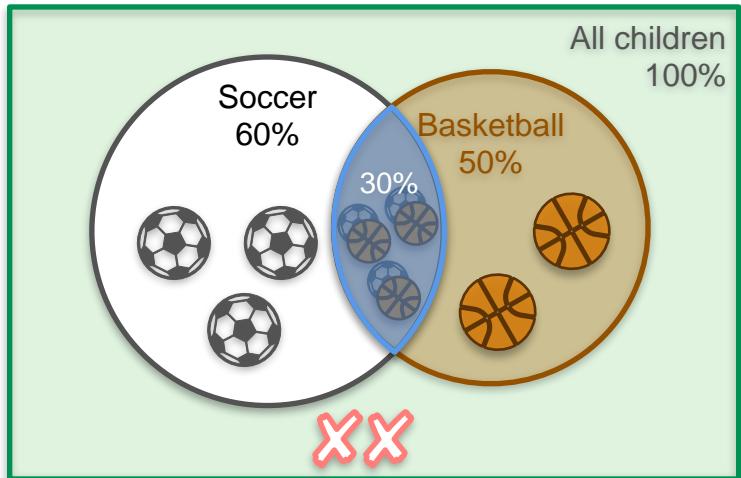


# Disjoint Events Vs Joint Events

Disjoint



Joint

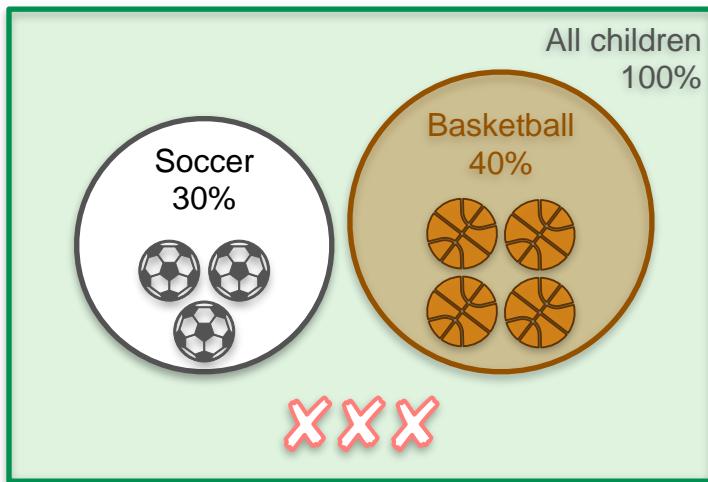


Mutually exclusive

$$P(S \cup B) = P(S) + P(B)$$

# Disjoint Events Vs Joint Events

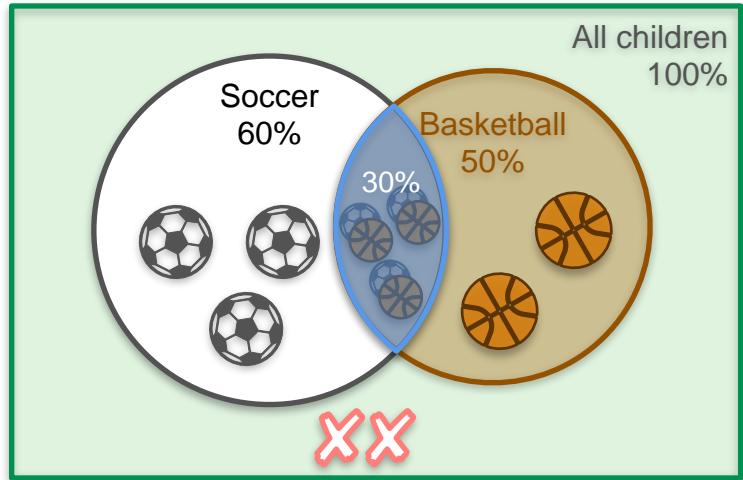
Disjoint



Mutually exclusive

$$P(S \cup B) = P(S) + P(B)$$

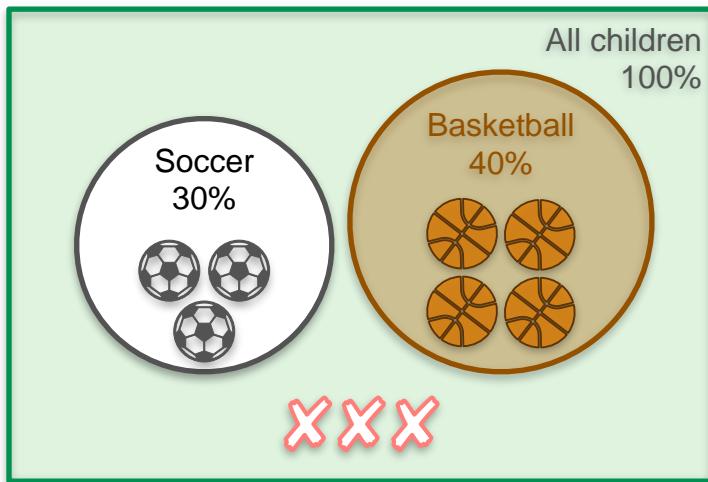
Joint



Non-mutually exclusive

# Disjoint Events Vs Joint Events

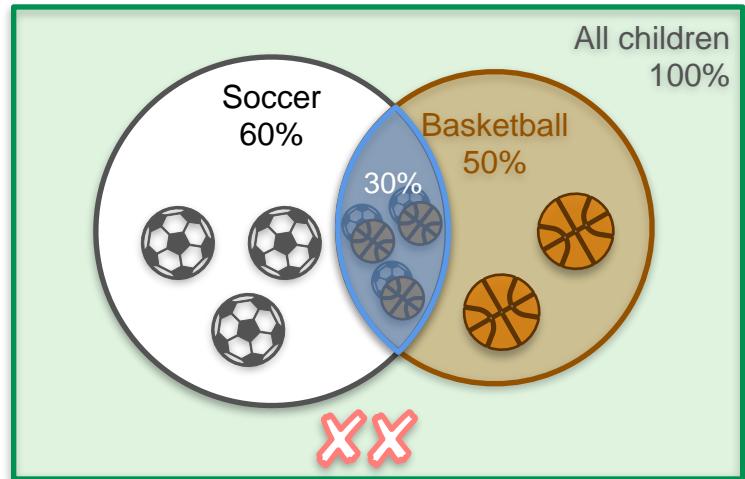
Disjoint



Mutually exclusive

$$P(S \cup B) = P(S) + P(B)$$

Joint

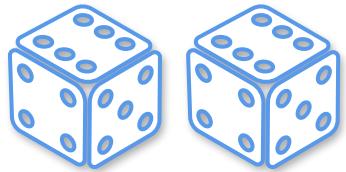


Non-mutually exclusive

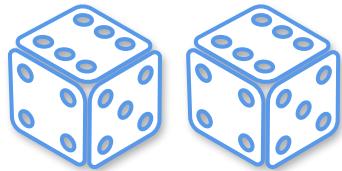
$$P(S \cup B) = P(S) + P(B) - P(S \cap B)$$

# Sum of Probabilities (Joint Events): Dice Example 1

# Sum of Probabilities (Joint Events): Dice Example 1



# Sum of Probabilities (Joint Events): Dice Example 1



What is the probability of obtaining a sum of 7 or a difference of 1?

# Sum of Probabilities (Joint Events): Dice Example 1

# Sum of Probabilities (Joint Events): Dice Example 1

sum = 7

diff = 1

# Sum of Probabilities (Joint Events): Dice Example 1

sum = 7

diff = 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1						
1,2						
1,3						
1,4						
1,5						
1,6						
2,1	2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities (Joint Events): Dice Example 1

sum = 7

diff = 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities (Joint Events): Dice Example 1

sum = 7

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6

diff = 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities (Joint Events): Dice Example 1

sum = 7

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6

diff = 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities (Joint Events): Dice Example 1

A

sum = 7

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6

B

diff = 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities (Joint Events): Dice Example 1

A or B

sum = 7 or diff = 1

1,1	1,2	1,3	1,4	1,5	1,6	
2,1	2,2	2,3	2,4	2,5	2,6	
3,1	3,2	3,3	3,4	3,5	3,6	
4,1	4,2	4,3	4,4	4,5	4,6	
5,1	5,2	5,3	5,4	5,5	5,6	
6,1	6,2	6,3	6,4	6,5	6,6	

# Sum of Probabilities (Joint Events): Dice Example 1

A or B

sum = 7 or diff = 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6

sum = 7 and diff = 1

# Sum of Probabilities (Joint Events): Dice Example 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6

# Sum of Probabilities (Joint Events): Dice Example 1

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

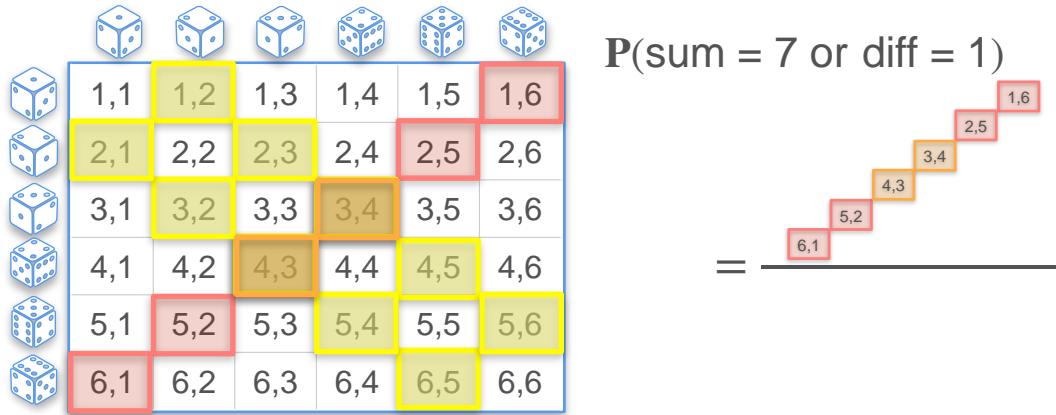
# Sum of Probabilities (Joint Events): Dice Example 1

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

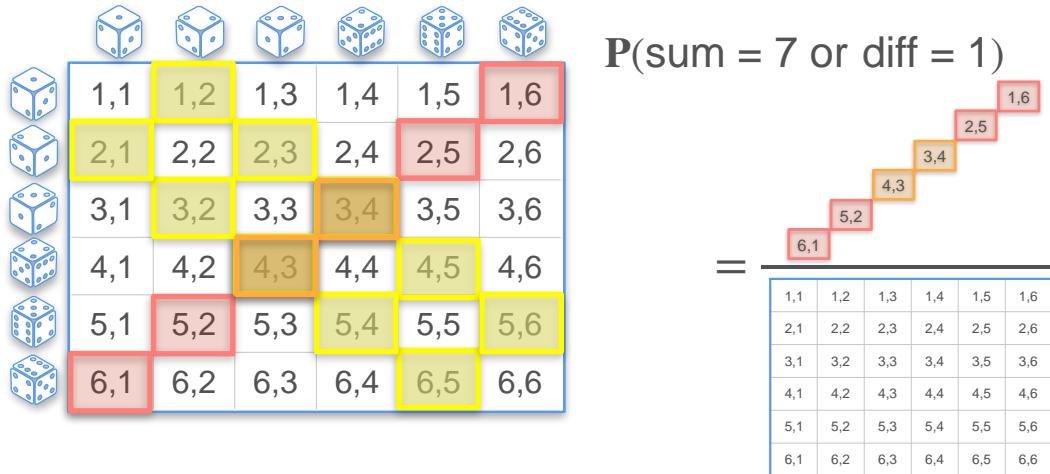
P(sum = 7 or diff = 1)

= \_\_\_\_\_

# Sum of Probabilities (Joint Events): Dice Example 1



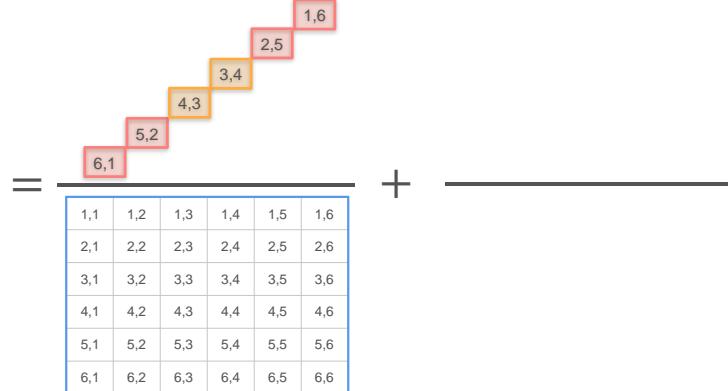
# Sum of Probabilities (Joint Events): Dice Example 1



## Sum of Probabilities (Joint Events): Dice Example 1

	1,1	1,2	1,3	1,4	1,5
	2,1	2,2	2,3	2,4	2,5
	3,1	3,2	3,3	3,4	3,5
	4,1	4,2	4,3	4,4	4,5
	5,1	5,2	5,3	5,4	5,5
	6,1	6,2	6,3	6,4	6,5
					6,6

$$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$$



# Sum of Probabilities (Joint Events): Dice Example 1

	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
	6,1	6,2	6,3	6,4	6,5	6,6

$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

$$= \frac{\begin{array}{ccccccc} & 1,2 & & & & & \\ & 2,1 & 2,3 & & & & \\ & 3,2 & 3,3 & 3,4 & & & \\ & 4,3 & 4,4 & 4,5 & 4,6 & & \\ & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 & \\ & 6,1 & & & & & \end{array}}{1,1 \quad 1,2 \quad 1,3 \quad 1,4 \quad 1,5 \quad 1,6} + \frac{\begin{array}{ccccccc} & 1,2 & & & & & \\ & 2,1 & & 2,3 & & & \\ & 3,2 & & 3,4 & & & \\ & 4,3 & & 4,5 & & & \\ & 5,4 & & 5,6 & & & \\ & 6,5 & & & & & \end{array}}{2,1 \quad 2,3 \quad 3,4 \quad 4,5 \quad 5,6}$$

# Sum of Probabilities (Joint Events): Dice Example 1

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

P(sum = 7 or diff = 1)

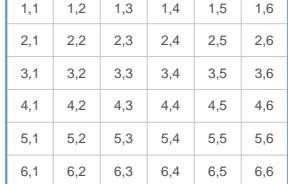
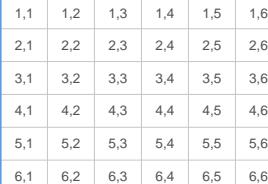
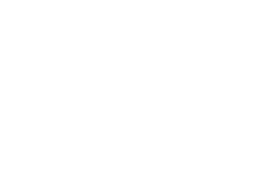
$$= \frac{\begin{array}{ccccccc} & 1,2 & & & & & \\ & 2,1 & 2,3 & & & & \\ & & & 3,4 & & & \\ & & & & 4,3 & & \\ & & & & & 5,2 & \\ & & & & & & 6,1 \end{array}}{1,1 \ 1,2 \ 1,3 \ 1,4 \ 1,5 \ 1,6} + \frac{\begin{array}{ccccccc} & 1,2 & & & & & \\ & 2,1 & 2,3 & & & & \\ & & & 3,4 & & & \\ & & & & 4,3 & & \\ & & & & & 5,4 & \\ & & & & & & 6,5 \end{array}}{1,1 \ 1,2 \ 1,3 \ 1,4 \ 1,5 \ 1,6}$$

# Sum of Probabilities (Joint Events): Dice Example 1

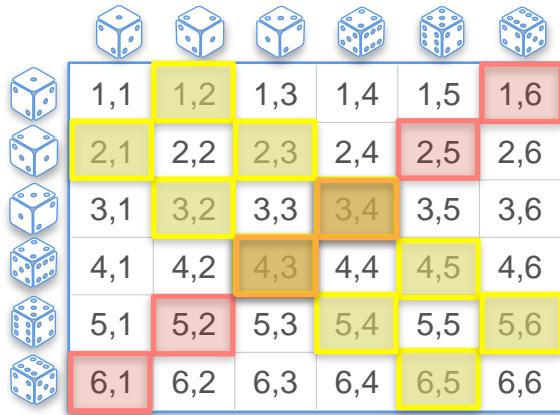
	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
	6,1	6,2	6,3	6,4	6,5	6,6

P(sum = 7 or diff = 1)

$$\begin{array}{c} \text{dice icons} \\ \begin{array}{|c|c|c|c|c|c|} \hline & 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ \hline 1,1 & & & & & & \\ \hline 2,1 & & & & & & \\ \hline 3,1 & & & & & & \\ \hline 4,1 & & & & & & \\ \hline 5,1 & & & & & & \\ \hline 6,1 & & & & & & \\ \hline \end{array} + \begin{array}{|c|c|c|c|c|c|} \hline & 1,2 & 2,1 & 2,3 & 3,2 & 3,4 & 4,3 \\ \hline 1,2 & & & & & & \\ \hline 2,1 & & & & & & \\ \hline 2,3 & & & & & & \\ \hline 3,2 & & & & & & \\ \hline 3,4 & & & & & & \\ \hline 4,3 & & & & & & \\ \hline 5,2 & & & & & & \\ \hline 6,1 & & & & & & \\ \hline \end{array} - \begin{array}{|c|c|c|c|c|c|} \hline & 1,3 & 2,2 & 3,1 & 4,2 & 5,1 & 6,0 \\ \hline 1,3 & & & & & & \\ \hline 2,2 & & & & & & \\ \hline 3,1 & & & & & & \\ \hline 4,2 & & & & & & \\ \hline 5,1 & & & & & & \\ \hline 6,0 & & & & & & \\ \hline \end{array} \end{array}$$

=  +  - 

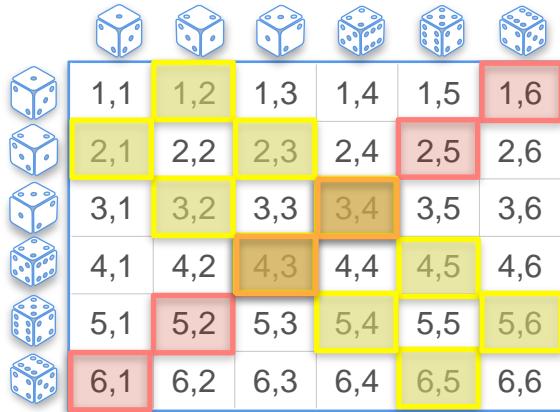
# Sum of Probabilities (Joint Events): Dice Example 1



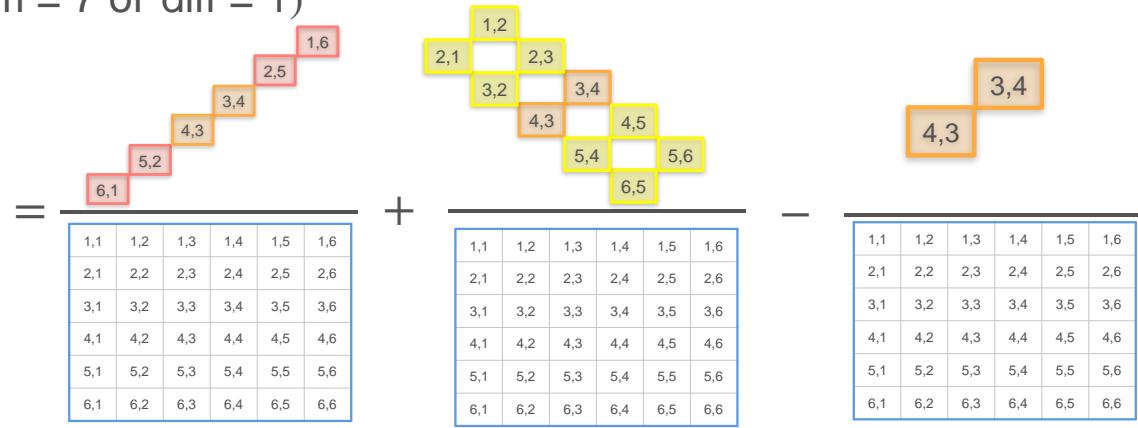
$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

$$= \frac{\begin{array}{c} 1,2 \\ 2,1 \\ 3,2 \\ 4,3 \\ 5,2 \\ 6,1 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} + \frac{\begin{array}{c} 1,2 \\ 2,3 \\ 3,4 \\ 4,5 \\ 5,6 \\ 6,5 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} - \frac{\begin{array}{c} 3,4 \\ 4,3 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}}$$

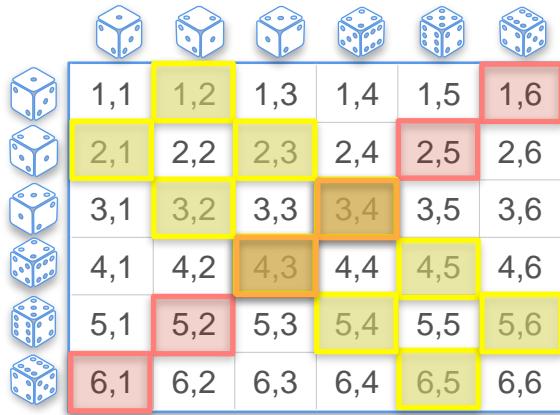
# Sum of Probabilities (Joint Events): Dice Example 1



$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$



# Sum of Probabilities (Joint Events): Dice Example 1

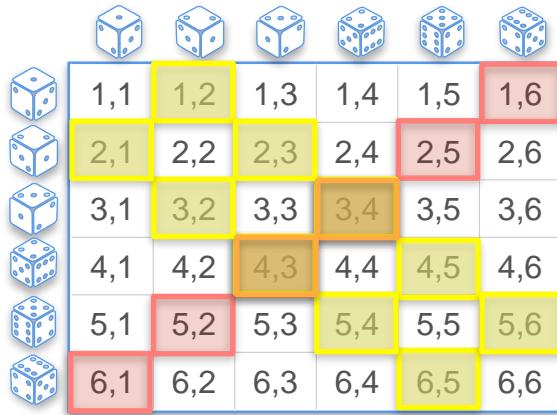


$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

$$\begin{aligned} &= \frac{\begin{array}{c} 1,2 \\ 2,1 \\ 3,2 \\ 4,3 \\ 5,2 \\ 6,1 \end{array}}{\begin{array}{cccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \end{array}} + \frac{\begin{array}{c} 1,2 \\ 2,3 \\ 3,4 \\ 4,3 \\ 5,4 \\ 6,5 \end{array}}{\begin{array}{cccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \end{array}} - \frac{\begin{array}{c} 3,4 \\ 4,3 \\ 5,3 \\ 6,3 \end{array}}{\begin{array}{cccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \end{array}} \\ &= \frac{6}{36} \end{aligned}$$

The diagram shows the sample space of two dice rolls as a 6x6 grid. It highlights the outcomes where the sum is 7 (red) or the absolute difference between the two dice is 1 (yellow). The outcomes are grouped into three sets: (1,2), (2,1), (3,2), (4,3), (5,2), (6,1) for the first term; (1,2), (2,3), (3,4), (4,3), (5,4), (6,5) for the second term; and (3,4), (4,3), (5,3), (6,3) for the third term. The final result is 6/36.

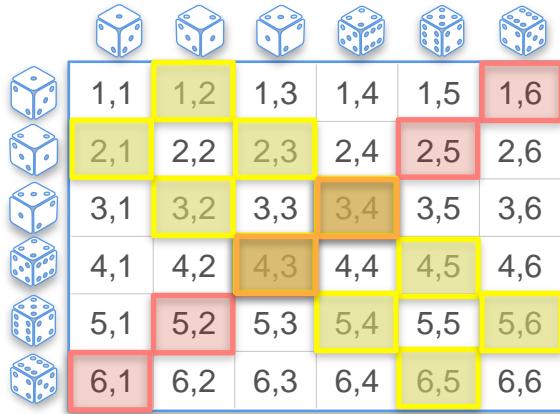
# Sum of Probabilities (Joint Events): Dice Example 1



$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

$$\begin{aligned} &= \frac{\begin{array}{c} 1,2 \\ 2,1 \\ 3,2 \\ 4,3 \\ 5,2 \\ 6,1 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} + \frac{\begin{array}{c} 1,2 \\ 2,1 \\ 2,3 \\ 3,2 \\ 3,4 \\ 4,3 \\ 4,5 \\ 5,4 \\ 5,6 \\ 6,5 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} - \frac{\begin{array}{c} 3,4 \\ 4,3 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} \\ &= \frac{6}{36} + \frac{10}{36} \end{aligned}$$

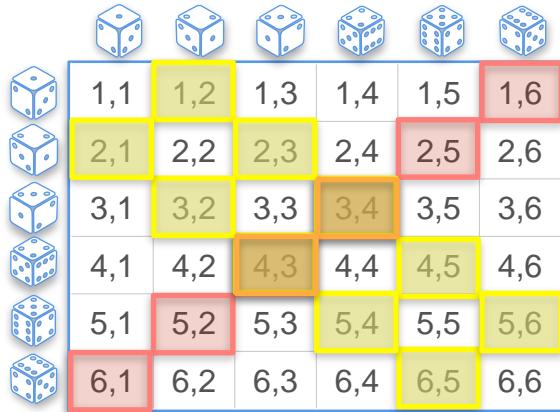
# Sum of Probabilities (Joint Events): Dice Example 1



$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

$$\begin{aligned} &= \frac{\begin{array}{c} 1,2 \\ 2,1 \\ 3,2 \\ 4,3 \\ 5,2 \\ 6,1 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} + \frac{\begin{array}{c} 1,2 \\ 2,3 \\ 3,4 \\ 4,5 \\ 5,6 \\ 6,5 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} - \frac{\begin{array}{c} 3,4 \\ 4,3 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} \\ &= \frac{6}{36} + \frac{10}{36} - \frac{2}{36} \end{aligned}$$

# Sum of Probabilities (Joint Events): Dice Example 1

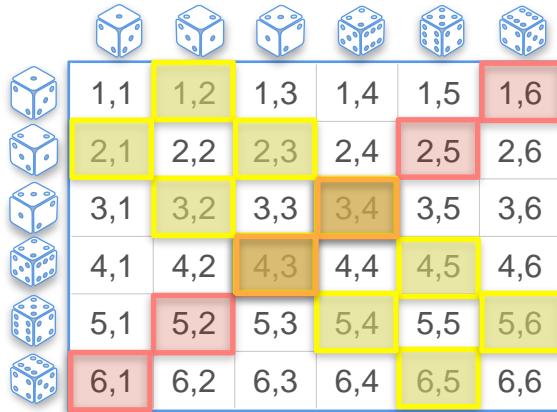


$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

$$\begin{aligned}
 &= \frac{\begin{array}{c} 1,2 \\ 2,1 \\ 3,2 \\ 4,3 \\ 5,2 \\ 6,1 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} + \frac{\begin{array}{c} 1,2 \\ 2,3 \\ 3,4 \\ 4,5 \\ 5,6 \\ 6,5 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}} - \frac{\begin{array}{c} 3,4 \\ 4,3 \end{array}}{\begin{array}{ccccccc} 1,1 & 1,2 & 1,3 & 1,4 & 1,5 & 1,6 \\ 2,1 & 2,2 & 2,3 & 2,4 & 2,5 & 2,6 \\ 3,1 & 3,2 & 3,3 & 3,4 & 3,5 & 3,6 \\ 4,1 & 4,2 & 4,3 & 4,4 & 4,5 & 4,6 \\ 5,1 & 5,2 & 5,3 & 5,4 & 5,5 & 5,6 \\ 6,1 & 6,2 & 6,3 & 6,4 & 6,5 & 6,6 \end{array}}
 \end{aligned}$$

$$\begin{aligned}
 &= \frac{6}{36} + \frac{10}{36} - \frac{2}{36} \\
 &= \frac{14}{36}
 \end{aligned}$$

# Sum of Probabilities (Joint Events): Dice Example 1



$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

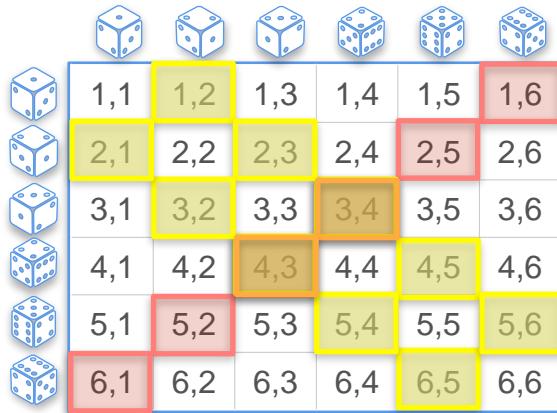
$$\begin{aligned}
 &= P(\text{sum} = 7) + - \\
 &\quad \frac{6}{36} + \frac{10}{36} - \frac{2}{36} \\
 &= \frac{14}{36}
 \end{aligned}$$

The diagram illustrates the calculation of the probability of sum = 7 or difference = 1. It shows three separate sets of outcomes highlighted with colored boxes:

- Yellow Box:** Outcomes where the sum is 7: (1,6), (2,5), (3,4), (4,3), (5,2), (6,1).
- Orange Box:** Outcomes where the difference is 1: (1,2), (2,1), (3,2), (4,1), (5,3), (6,2).
- Blue Box:** All other outcomes: (1,3), (2,4), (3,5), (4,6), (5,6).

The final result is  $\frac{14}{36}$ .

# Sum of Probabilities (Joint Events): Dice Example 1



$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

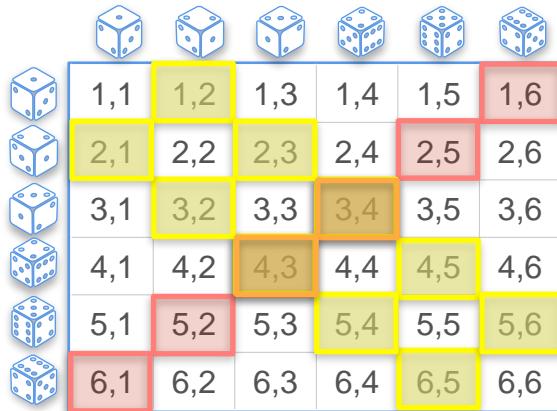
$$\begin{aligned}
 &= P(\text{sum} = 7) + P(\text{diff} = 1) - \\
 &\quad \frac{6}{36} + \frac{10}{36} - \frac{2}{36} \\
 &= \frac{14}{36}
 \end{aligned}$$

The diagram illustrates the calculation of the probability of joint events. It shows three separate sets of outcomes highlighted in yellow, red, and orange, representing the outcomes for which the sum is 7, the difference is 1, and both conditions are met respectively. These sets are then combined using the principle of inclusion-exclusion to find the total probability.

Legend for colored cells:

- Yellow: Sum = 7 (e.g., 1,6, 2,5, 3,4, 4,3, 5,2, 6,1)
- Red: Difference = 1 (e.g., 1,2, 2,1, 3,1, 4,1, 5,1, 6,2)
- Orange: Both conditions (e.g., 2,6, 3,6, 4,6, 5,6, 6,6)

# Sum of Probabilities (Joint Events): Dice Example 1



$P(\text{sum} = 7 \text{ or } \text{diff} = 1)$

$$\begin{aligned}
 &= P(\text{sum} = 7) + P(\text{diff} = 1) - P(\text{sum} = 7 \cap \text{diff} = 1) \\
 &= \frac{6}{36} + \frac{10}{36} - \frac{2}{36} \\
 &= \frac{14}{36}
 \end{aligned}$$

Diagram illustrating the Venn diagram for the joint events:

- Sum = 7:** Yellow-shaded cells (1,6), (2,5), (3,4), (4,3), (5,2), (6,1).
- Difference = 1:** Orange-shaded cells (1,2), (2,1), (3,2), (4,1), (5,3), (6,2), (1,5), (2,4), (3,3), (4,2), (5,1), (6,5).
- Intersection (Sum = 7 and Difference = 1):** Red-shaded cells (1,1), (2,2), (3,3), (4,4), (5,5), (6,6).

Below the Venn diagram, three smaller 6x6 grids show the individual sample spaces for each event:

- Sum = 7:** Contains only the yellow-shaded cells.
- Difference = 1:** Contains only the orange-shaded cells.
- Intersection:** Contains only the red-shaded cells.



DeepLearning.AI

# Introduction to probability

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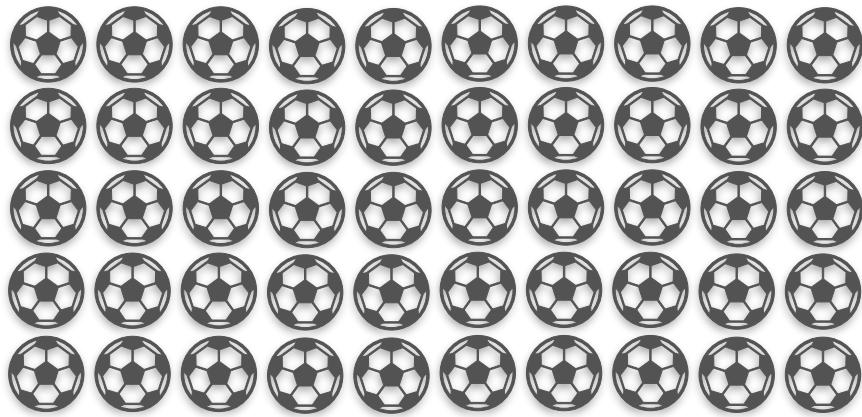
## Independence

# Independence: Quiz 1

# Independence: Quiz 1

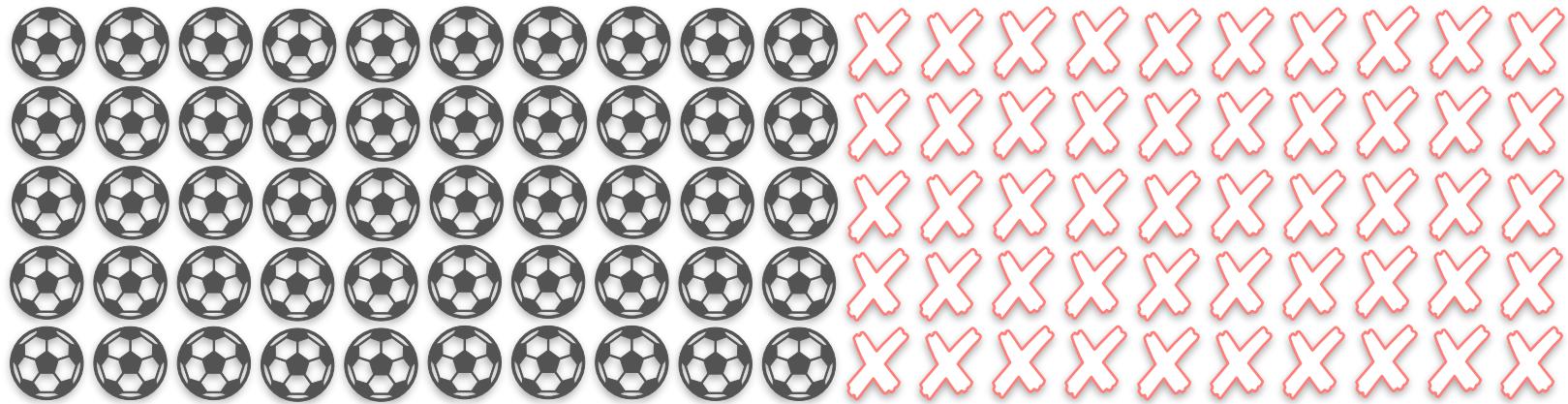
**100 kids**

# Independence: Quiz 1



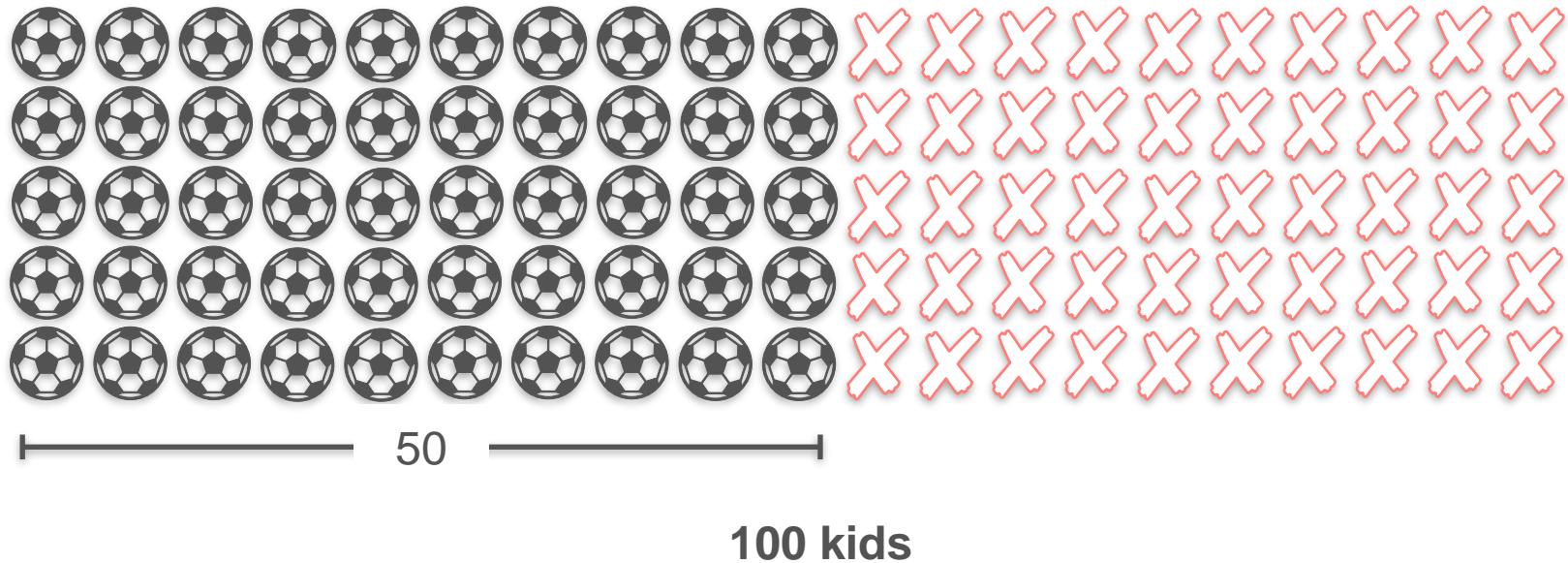
**100 kids**

# Independence: Quiz 1

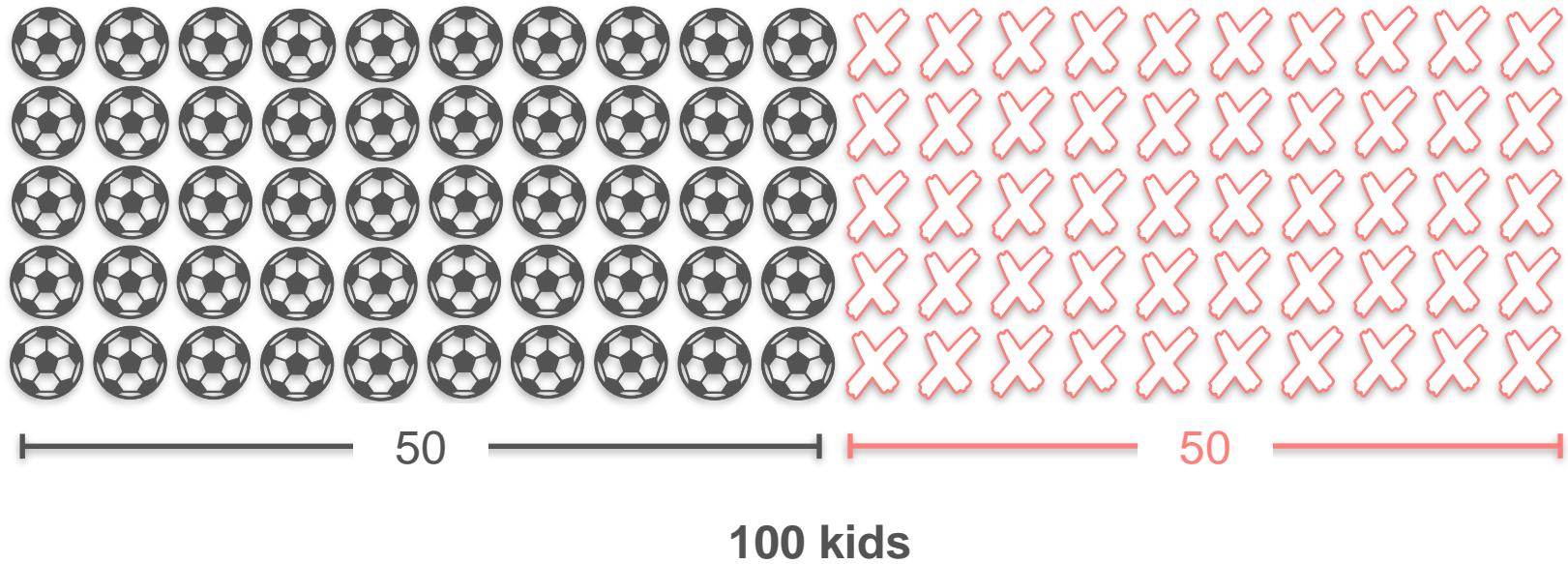


100 kids

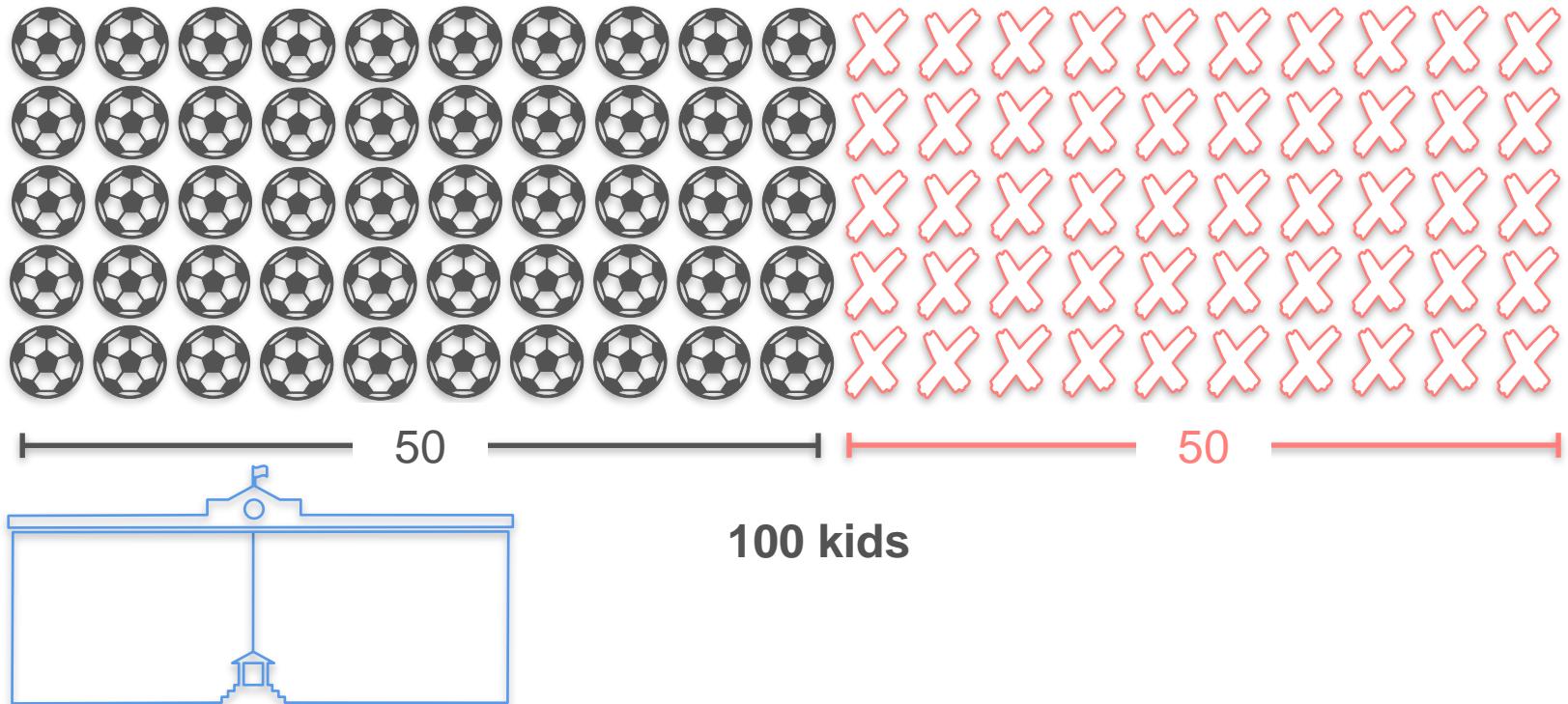
# Independence: Quiz 1



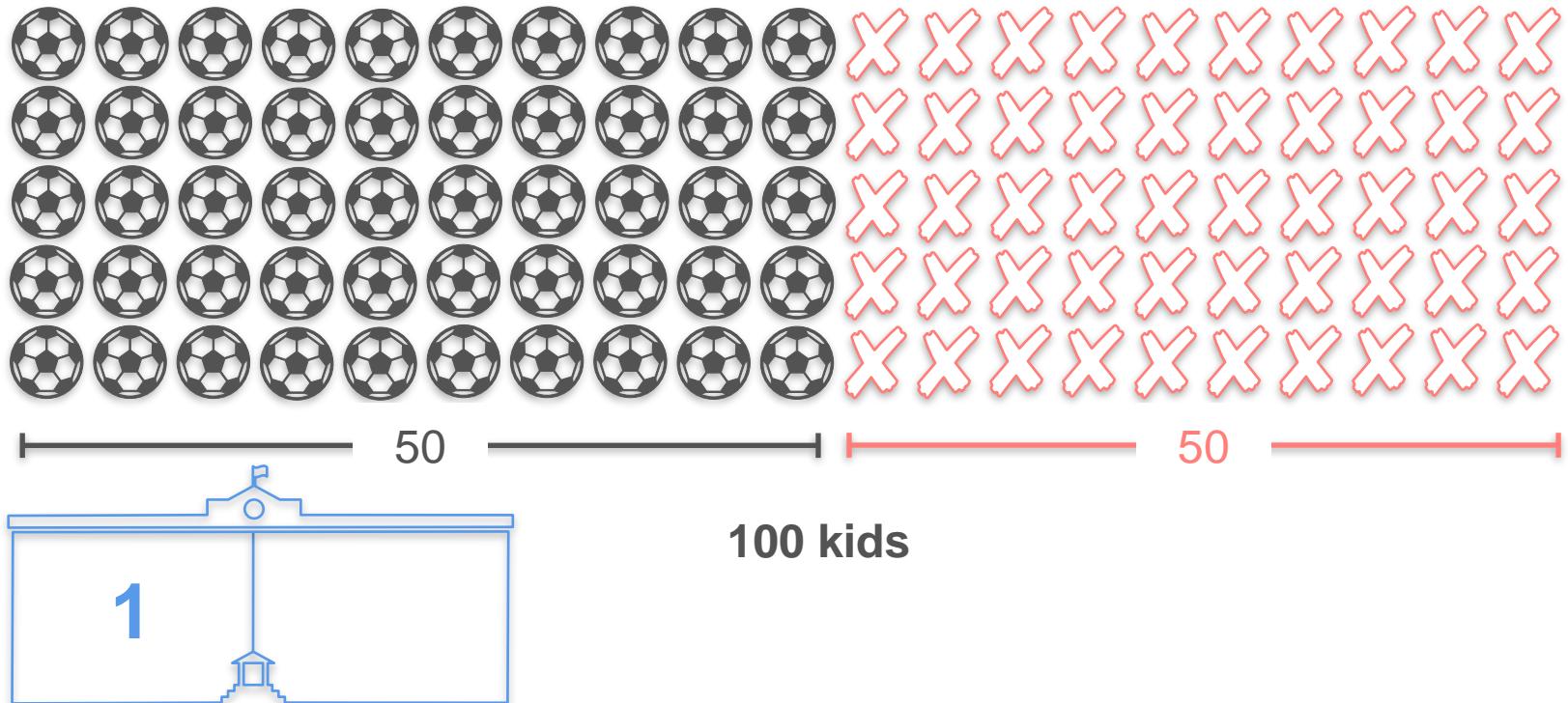
# Independence: Quiz 1



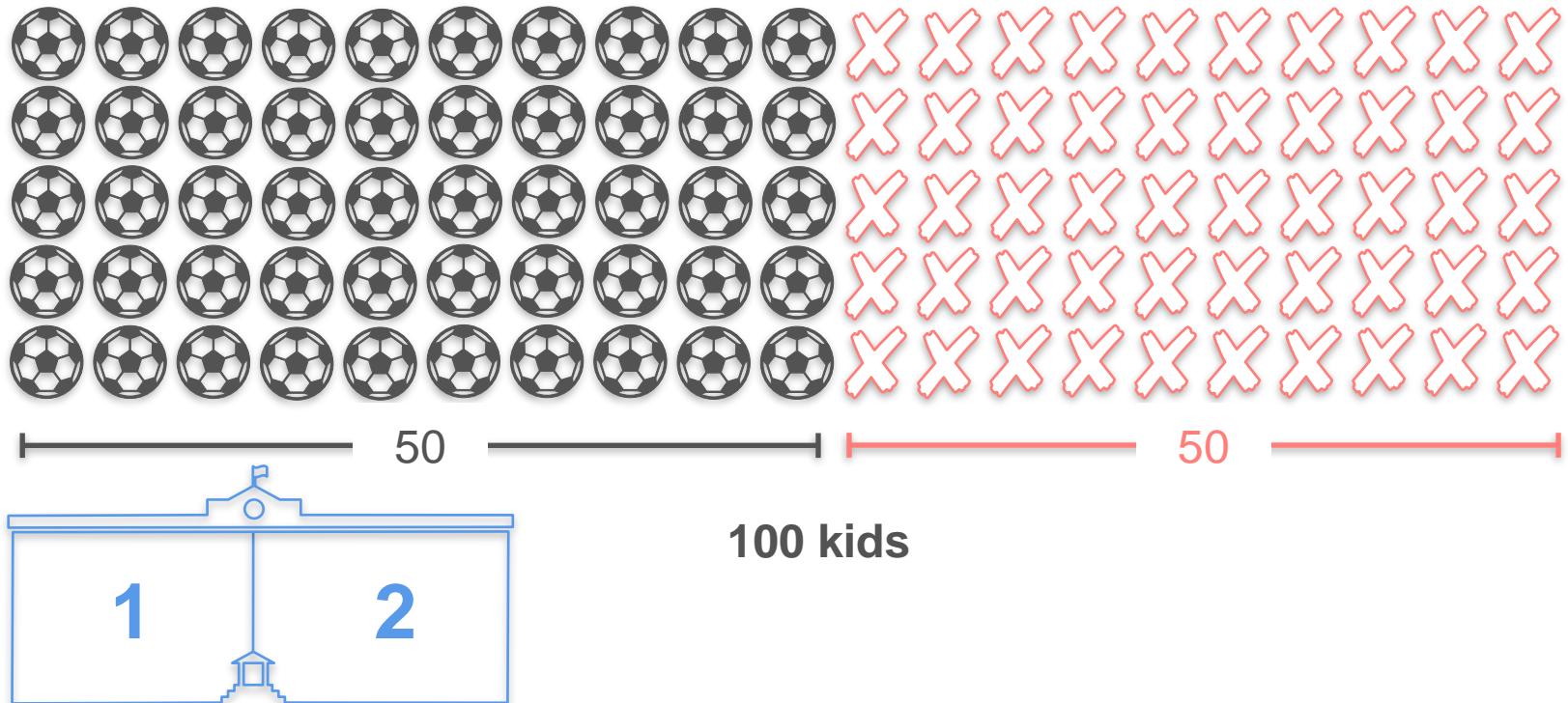
# Independence: Quiz 1



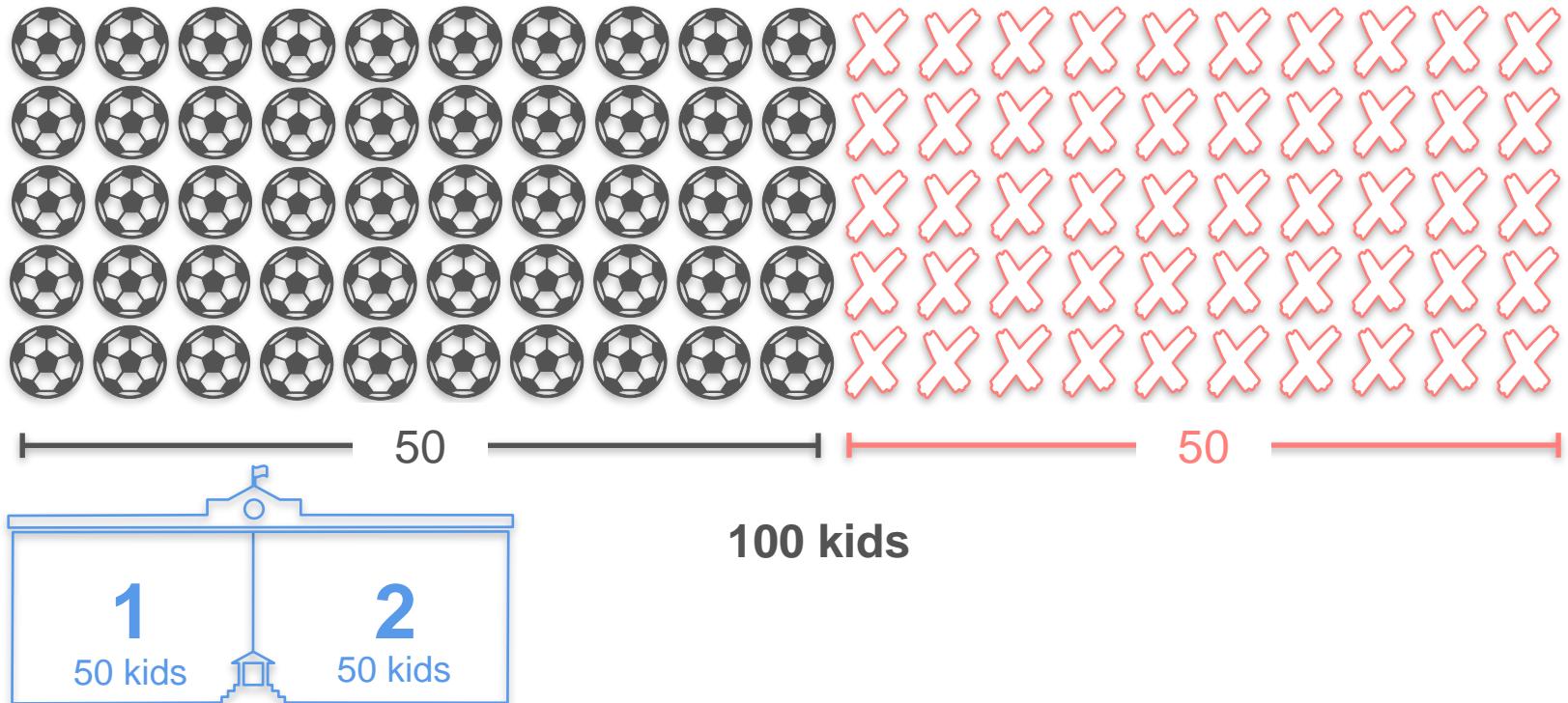
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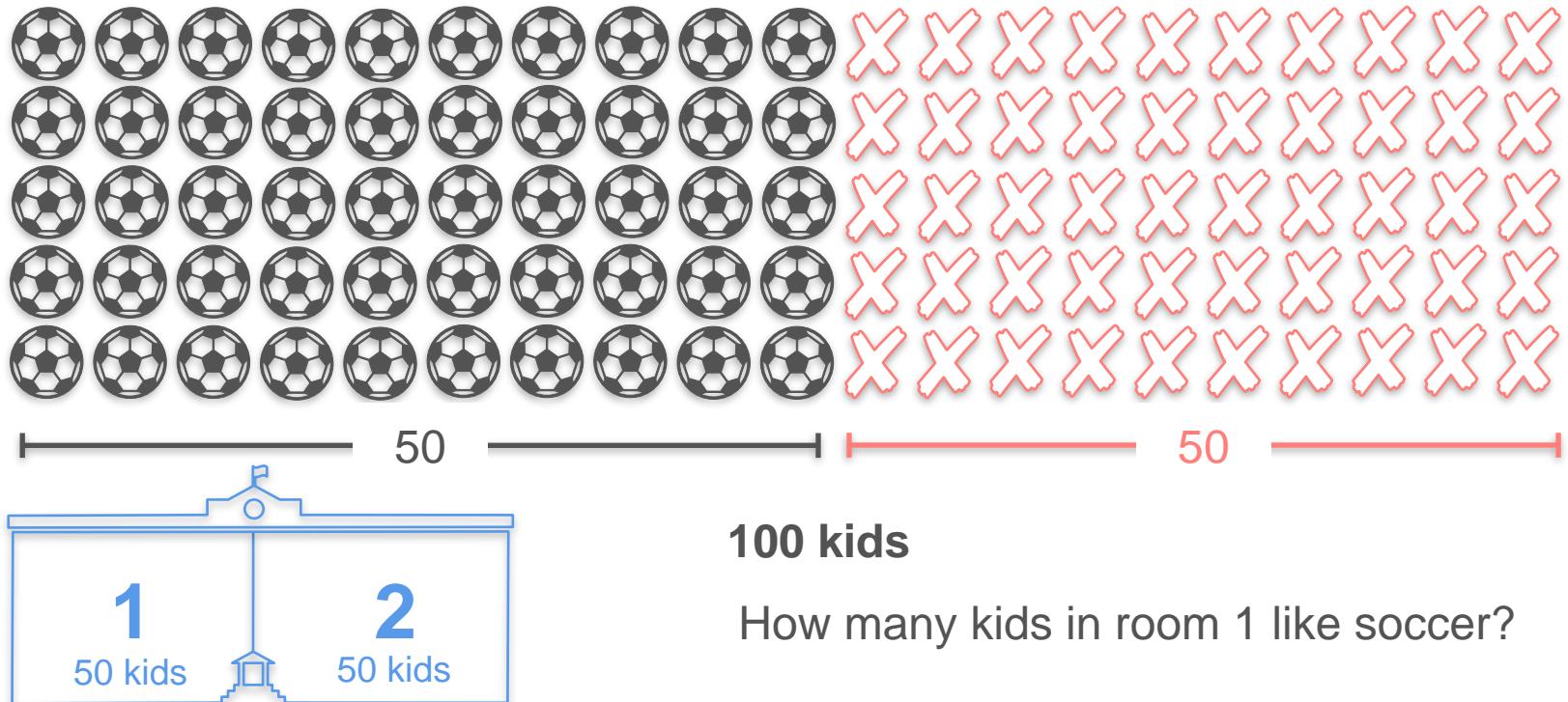
# Independence: Quiz 1



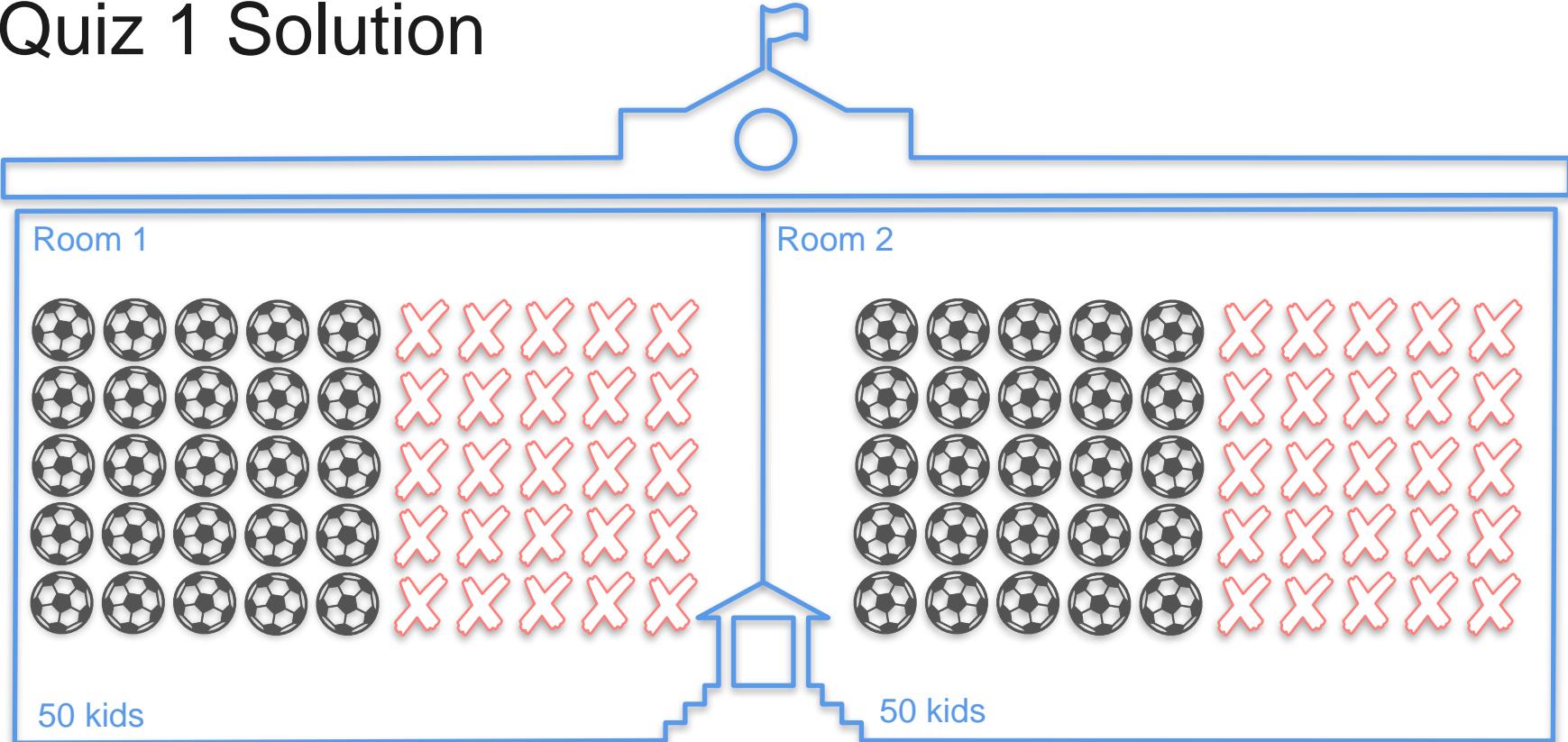
# Independence: Quiz 1



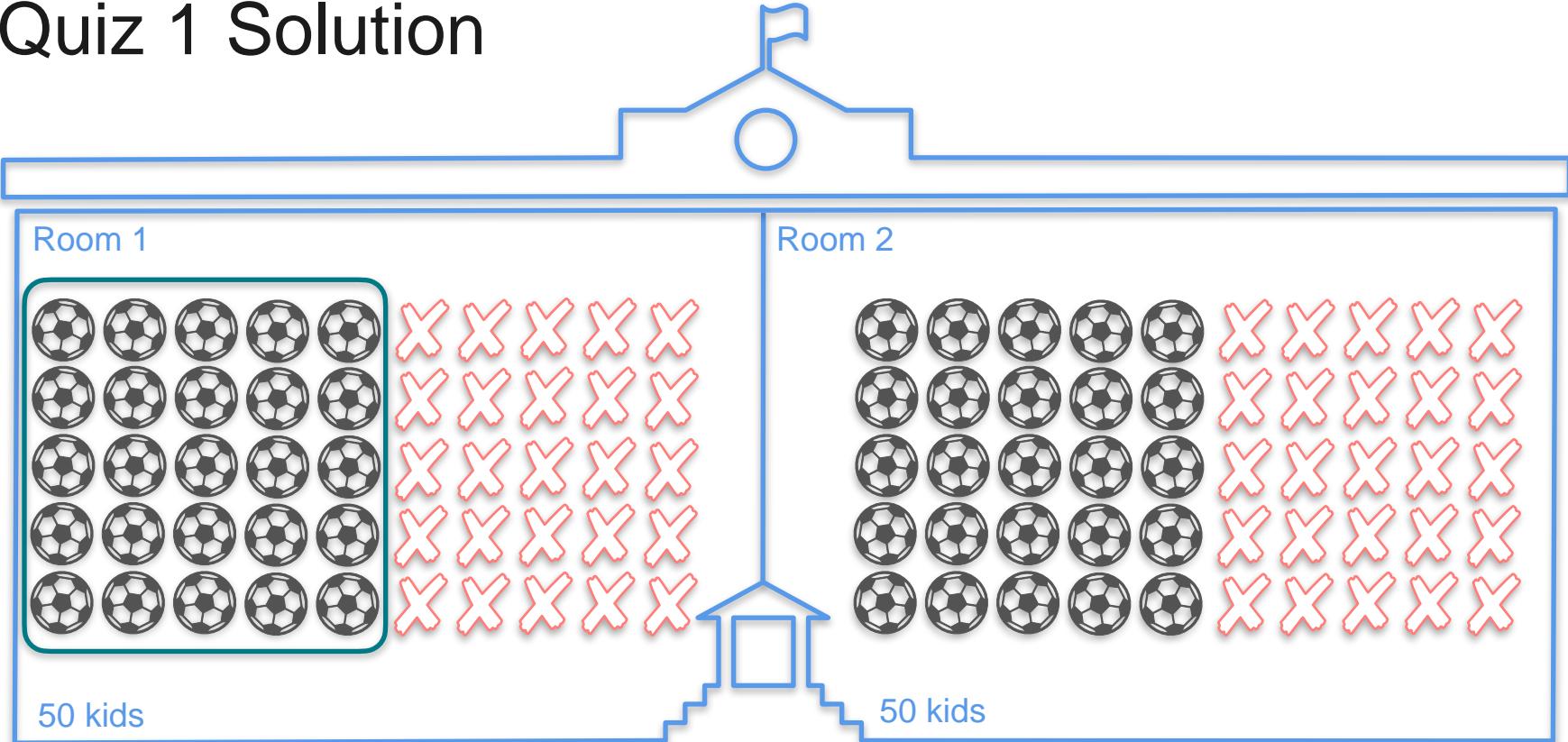
# Independence: Quiz 1



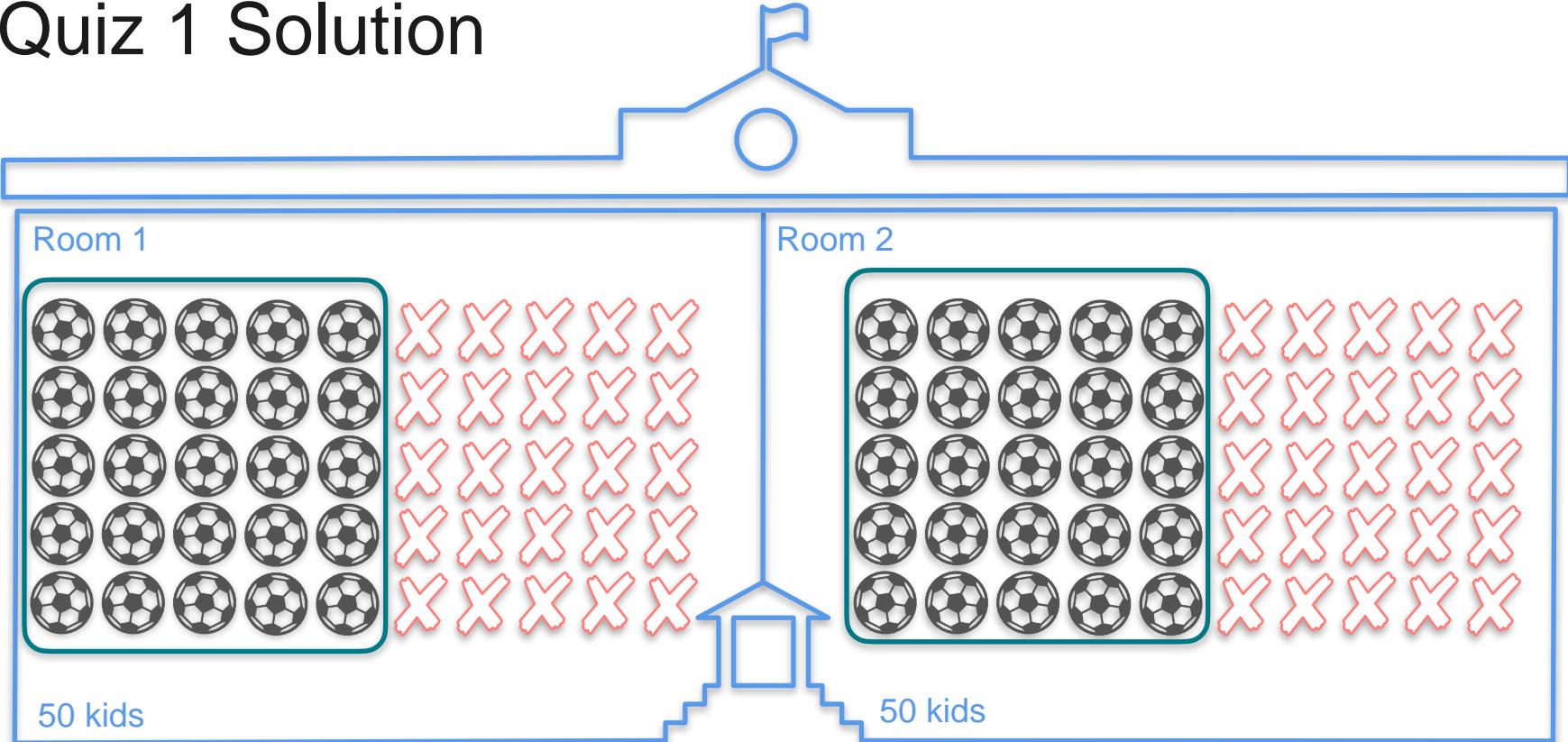
# Quiz 1 Solution



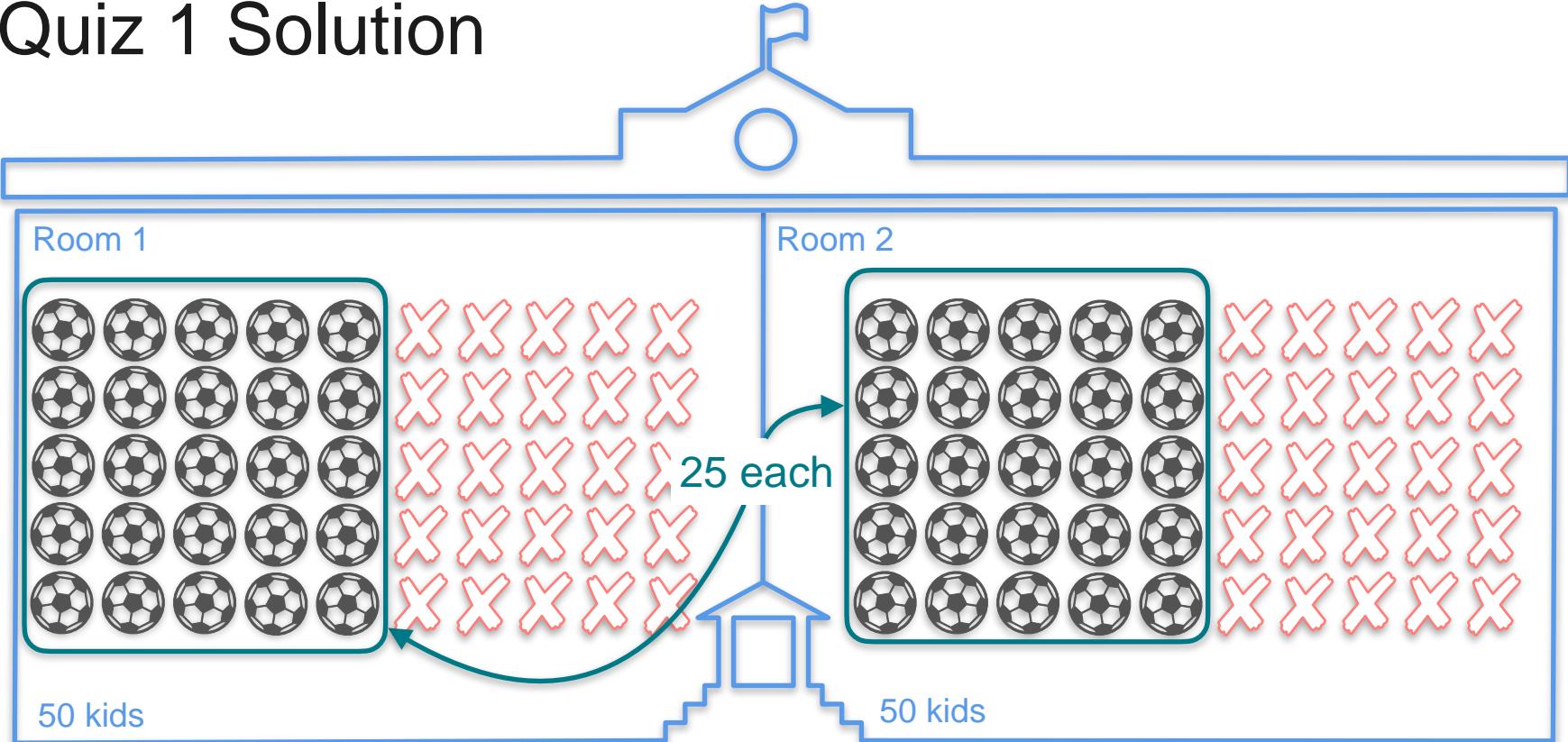
# Quiz 1 Solution



# Quiz 1 Solution

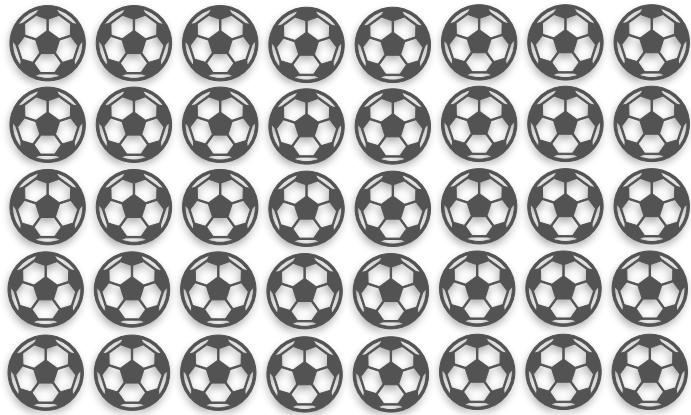


# Quiz 1 Solution

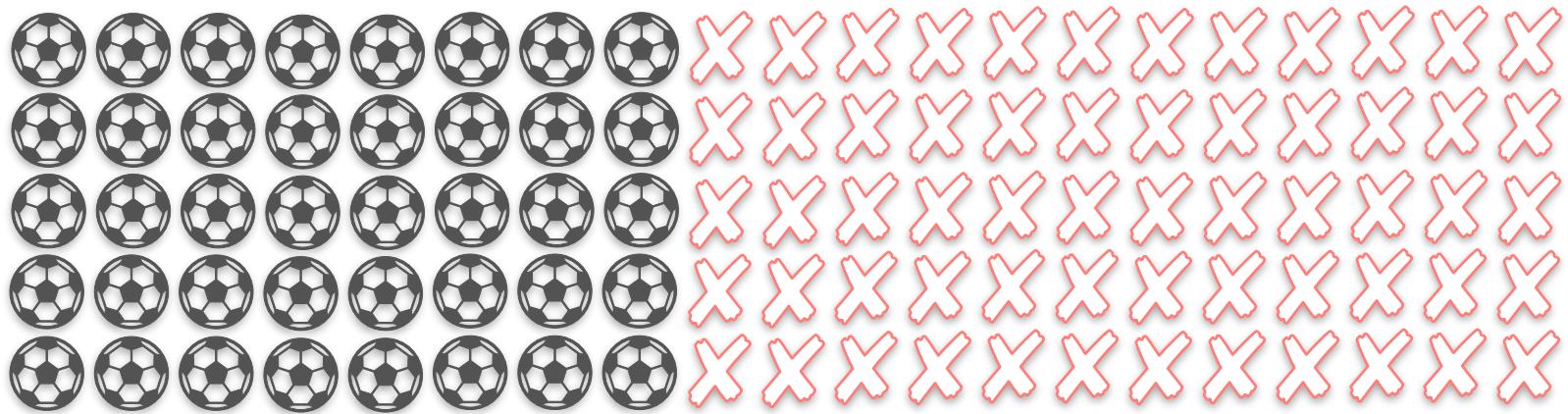


# Independence: Quiz 2

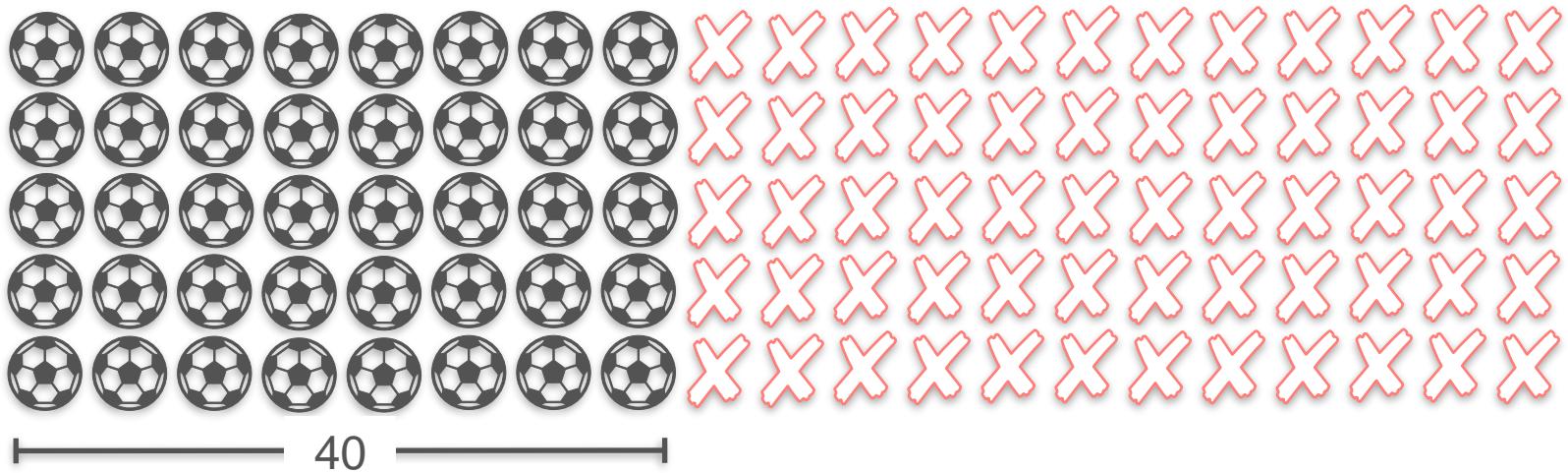
# Independence: Quiz 2



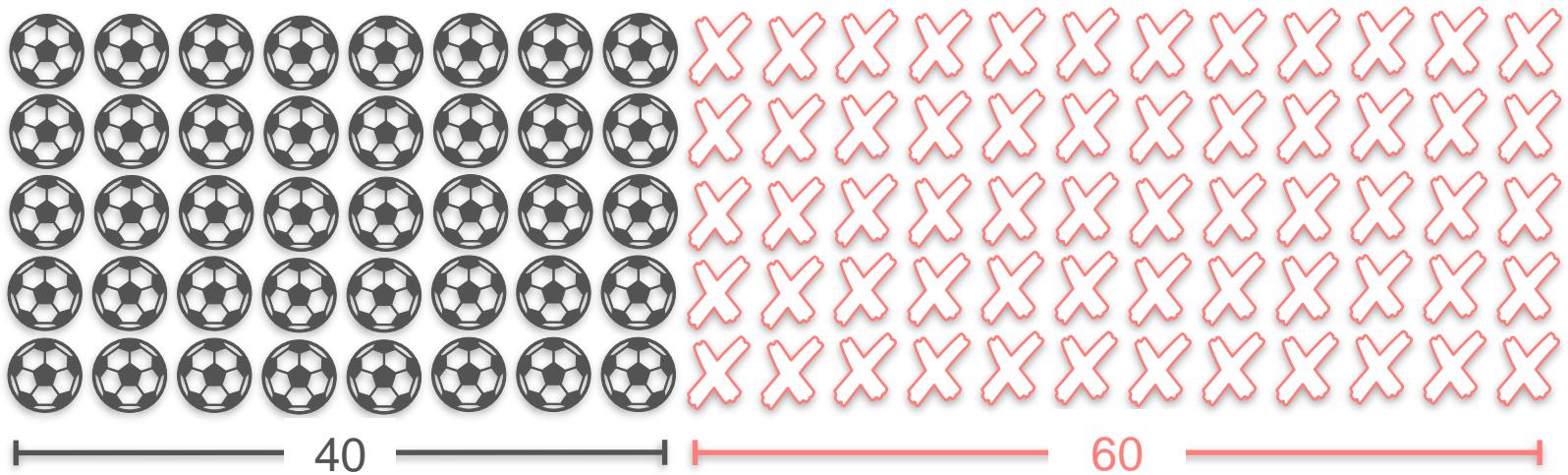
# Independence: Quiz 2



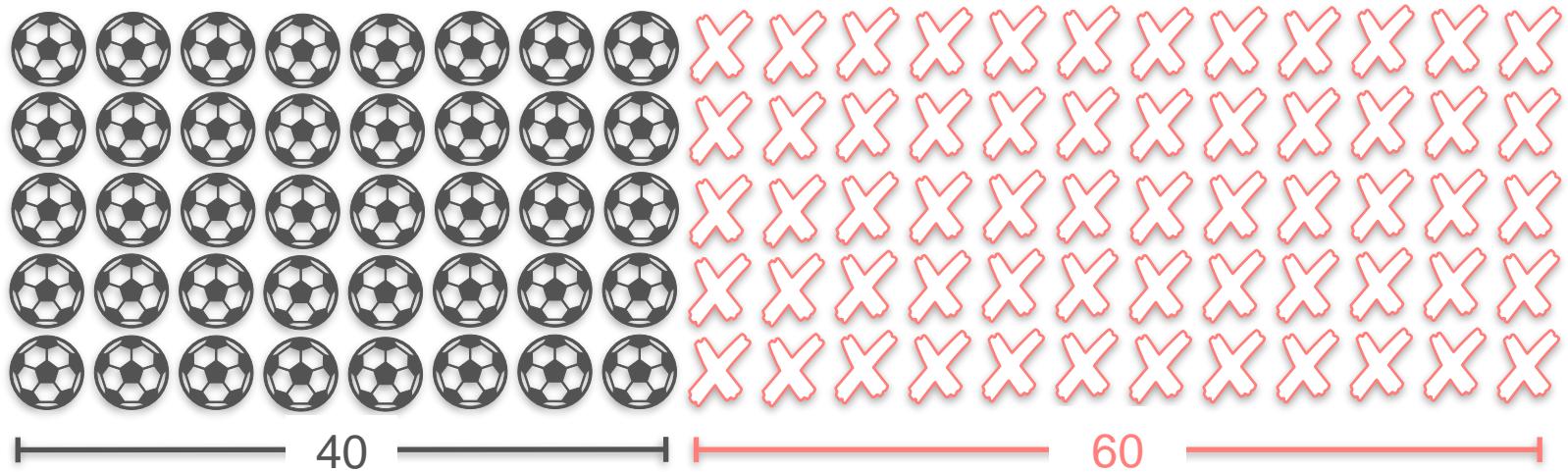
# Independence: Quiz 2



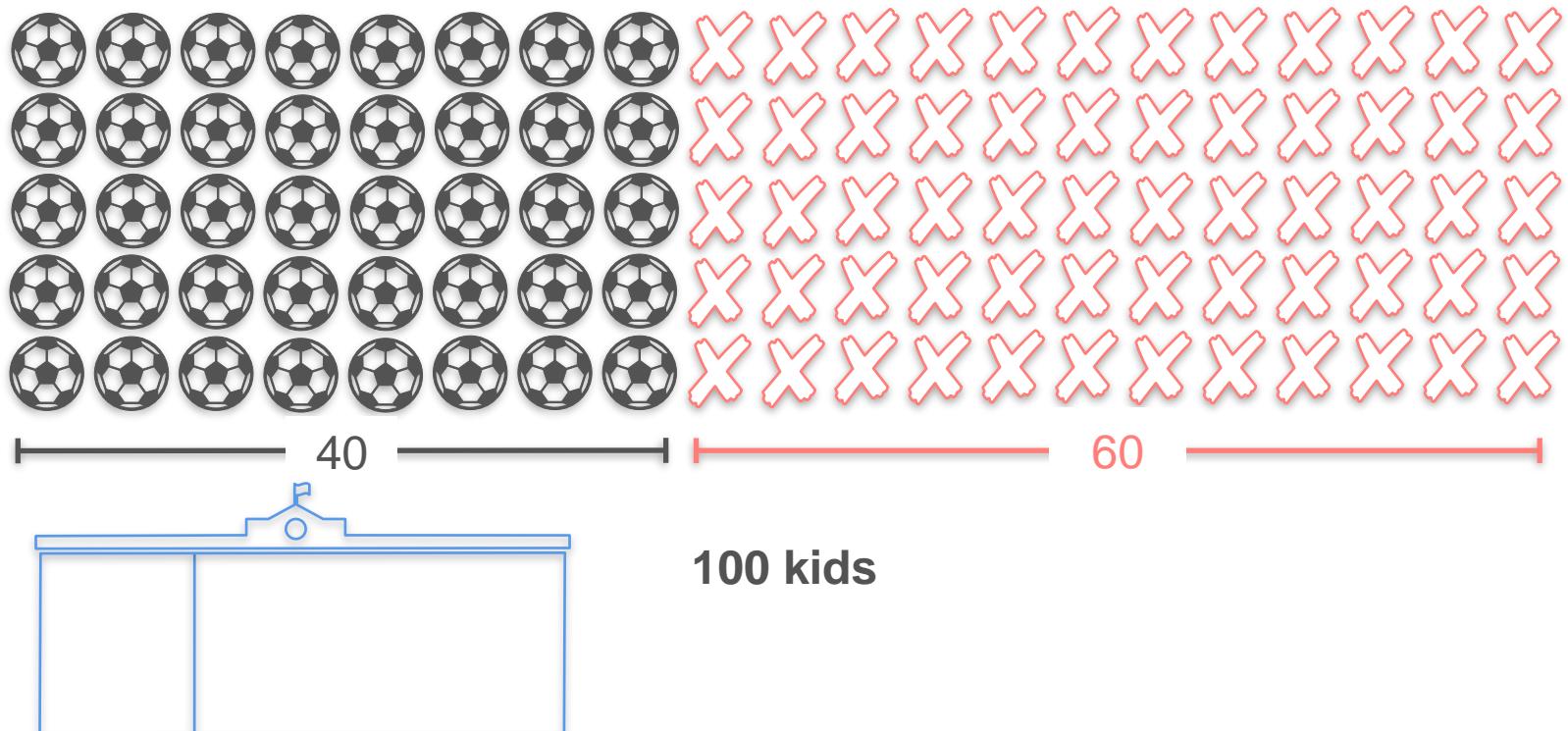
# Independence: Quiz 2



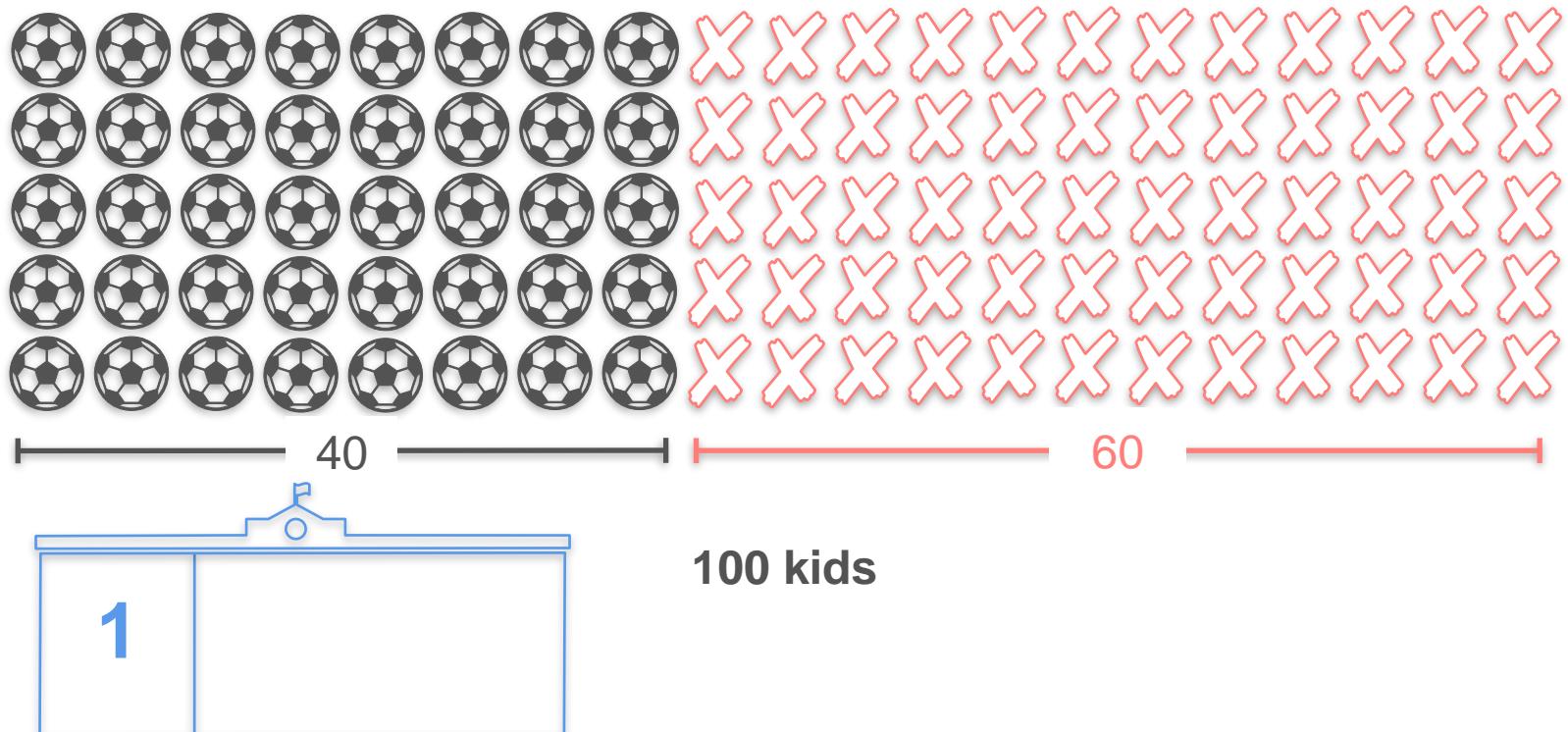
# Independence: Quiz 2



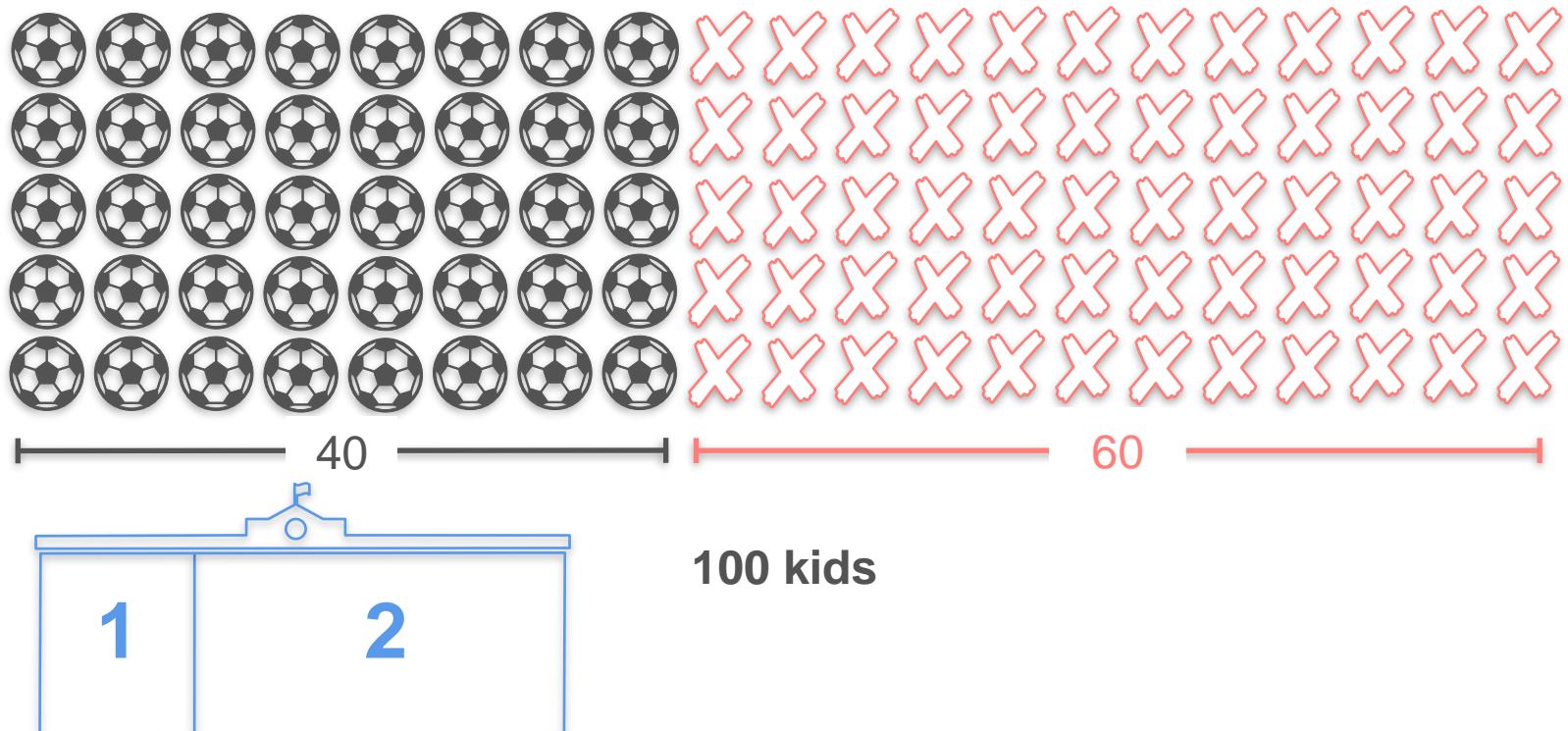
# Independence: Quiz 2



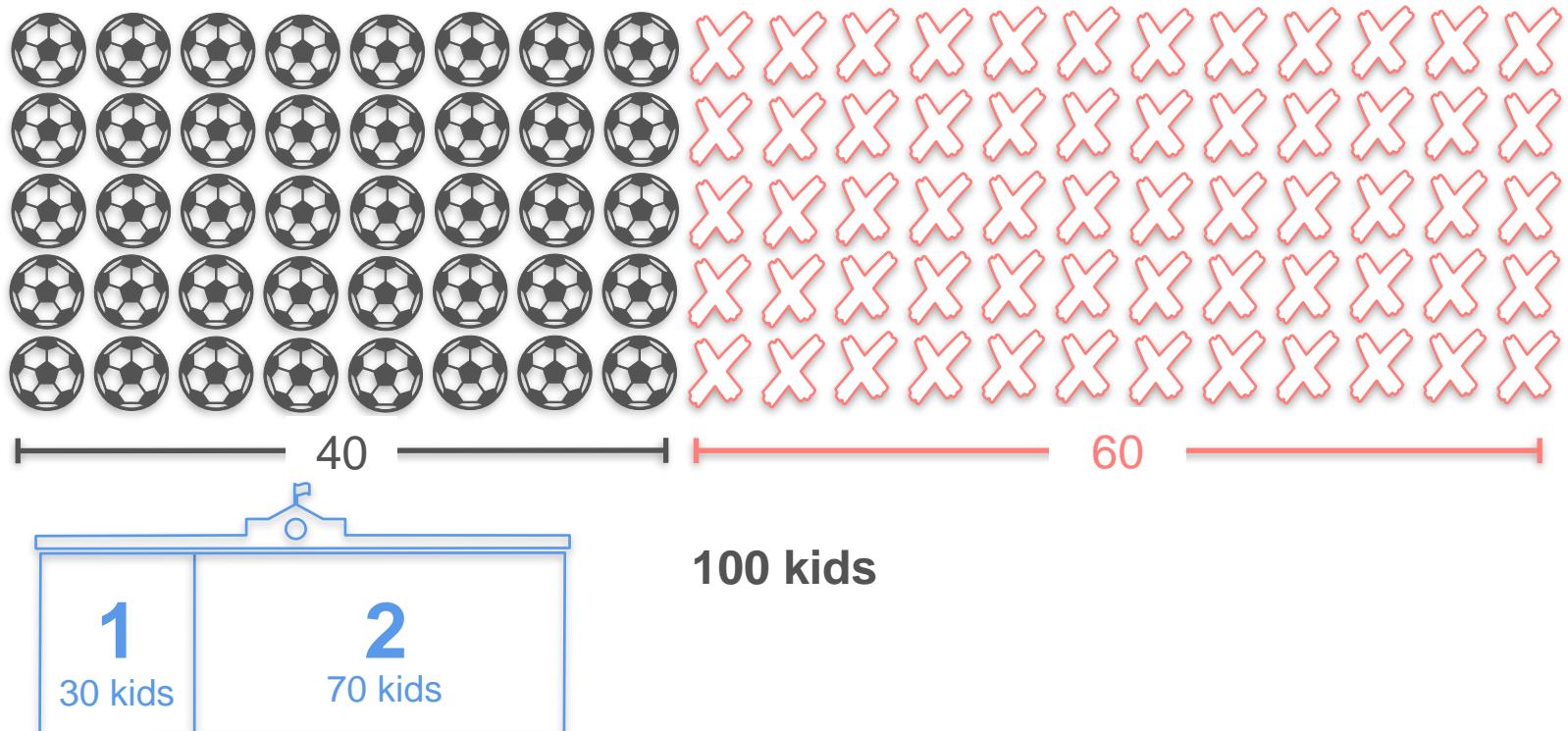
# Independence: Quiz 2



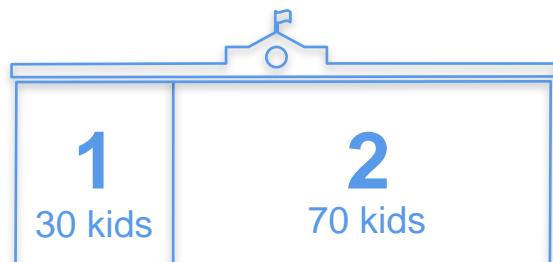
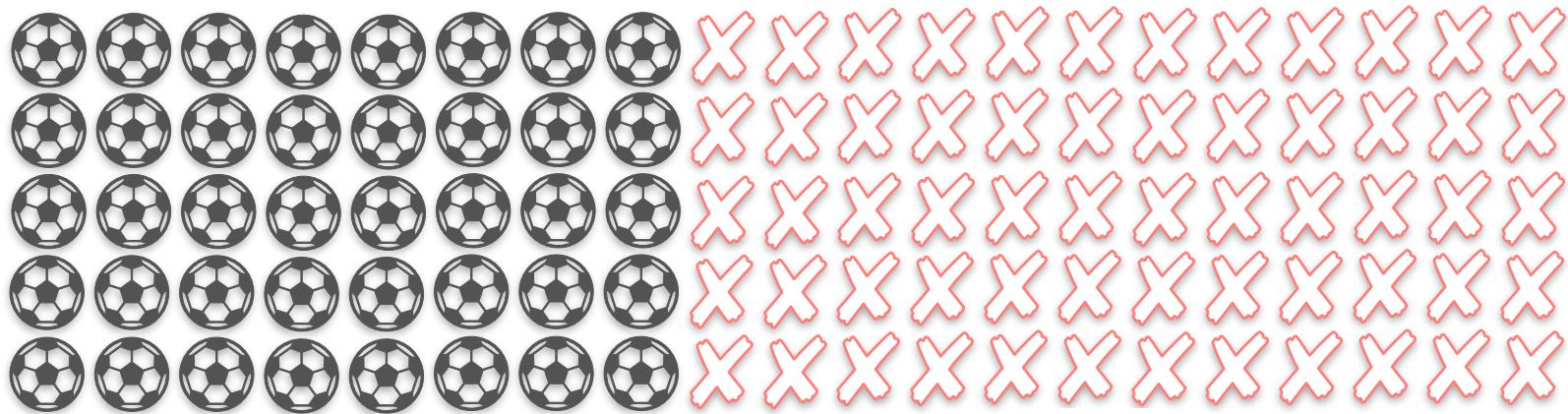
# Independence: Quiz 2



# Independence: Quiz 2



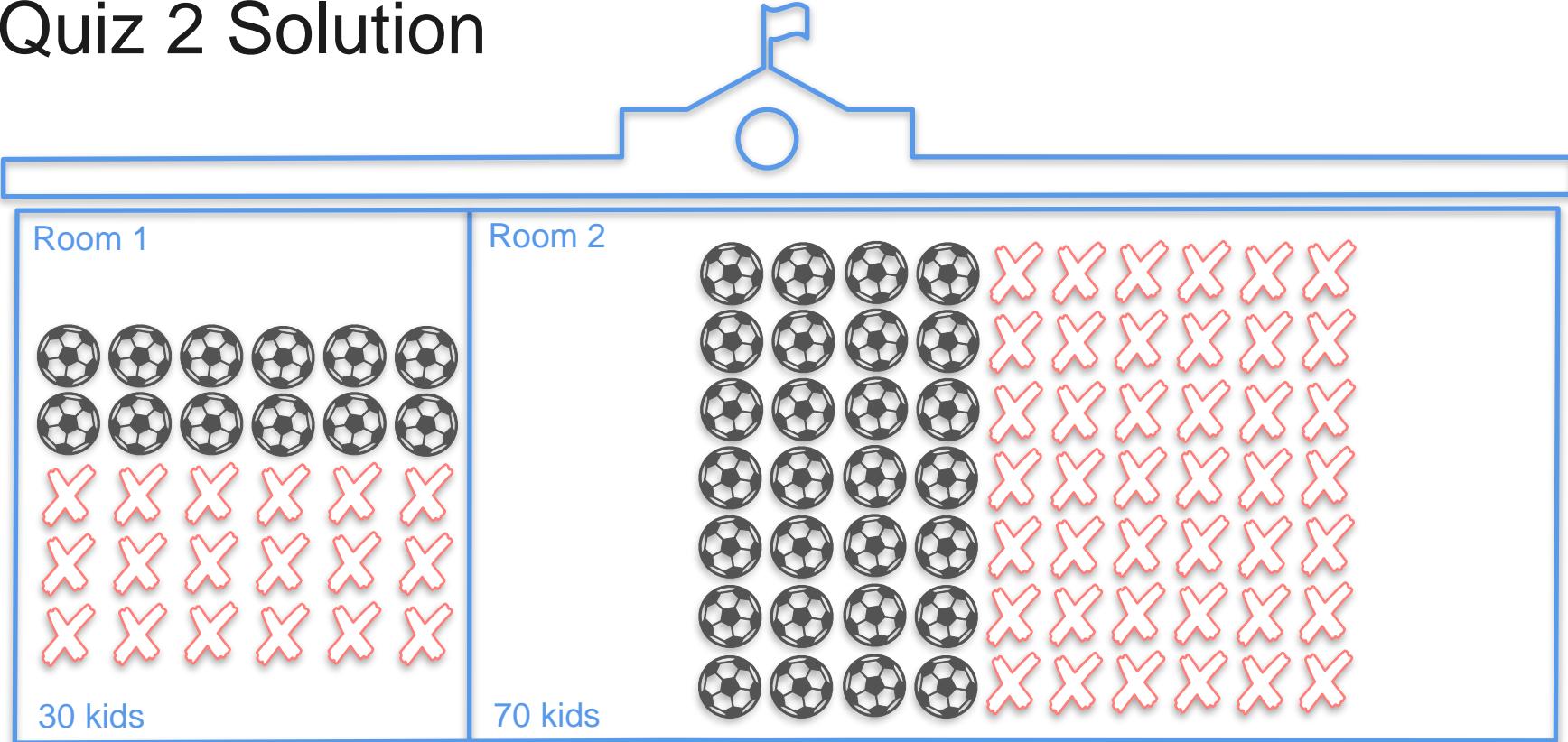
# Independence: Quiz 2



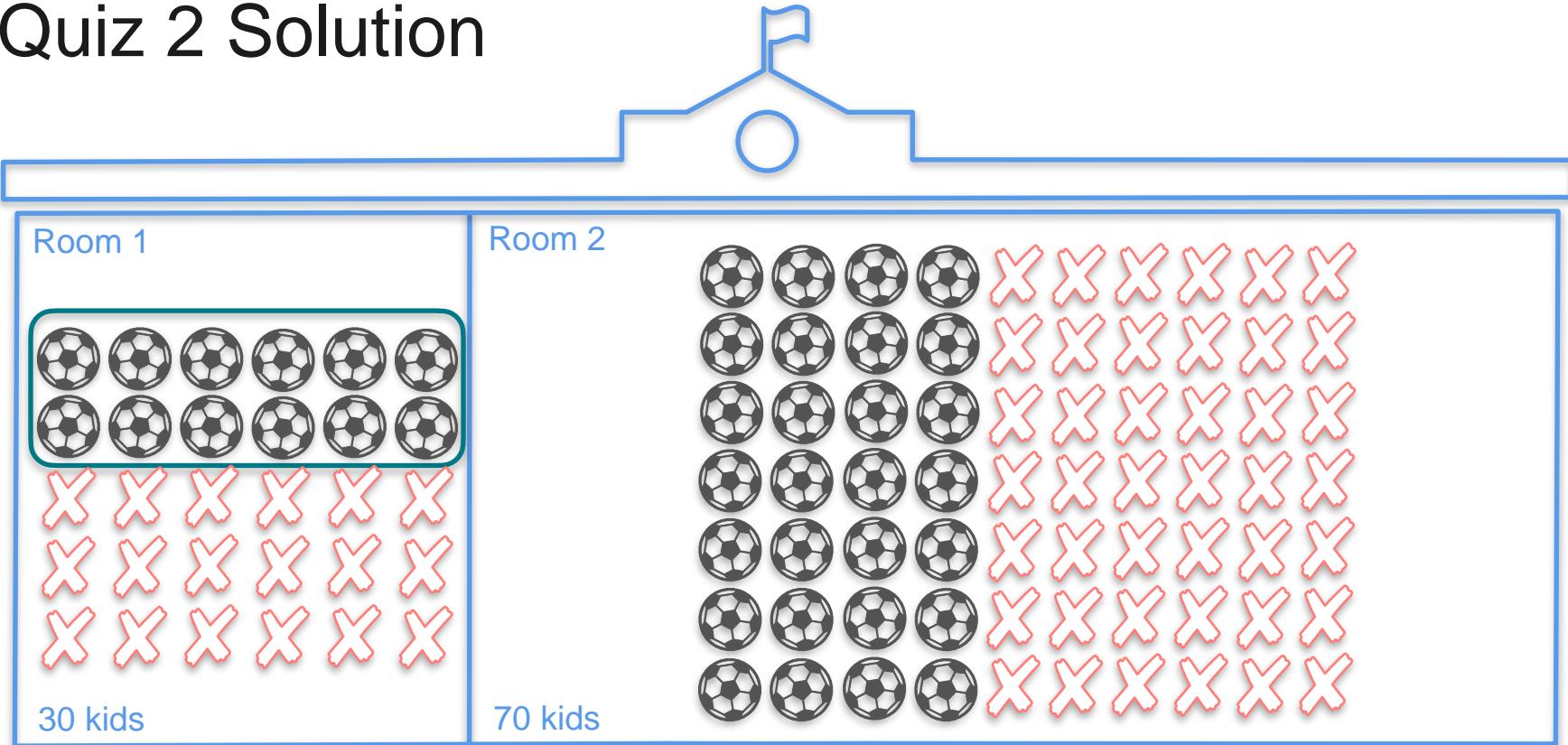
**100 kids**

How many kids in the smaller room like to play soccer?

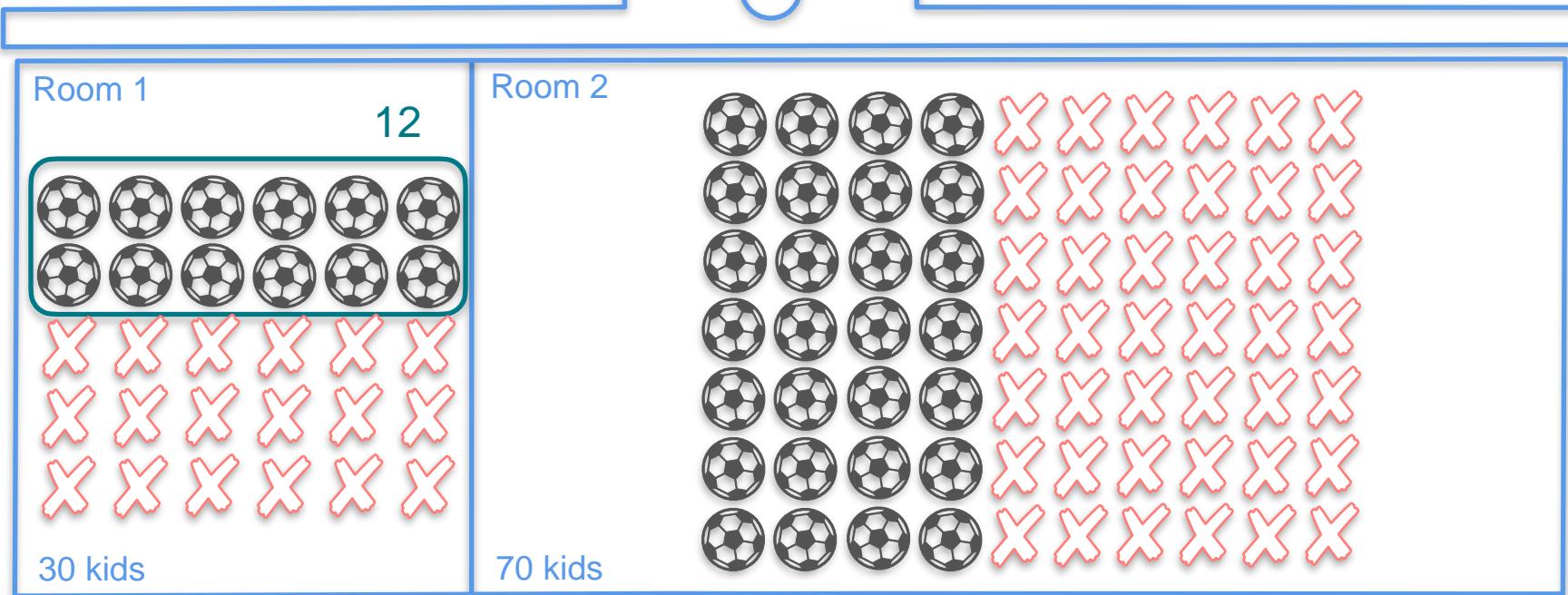
# Quiz 2 Solution



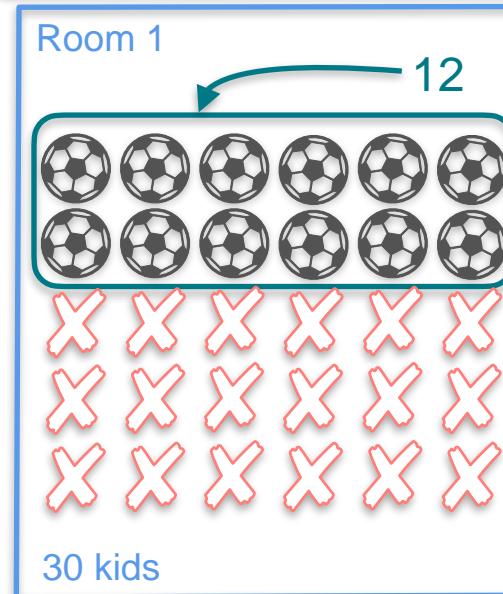
# Quiz 2 Solution



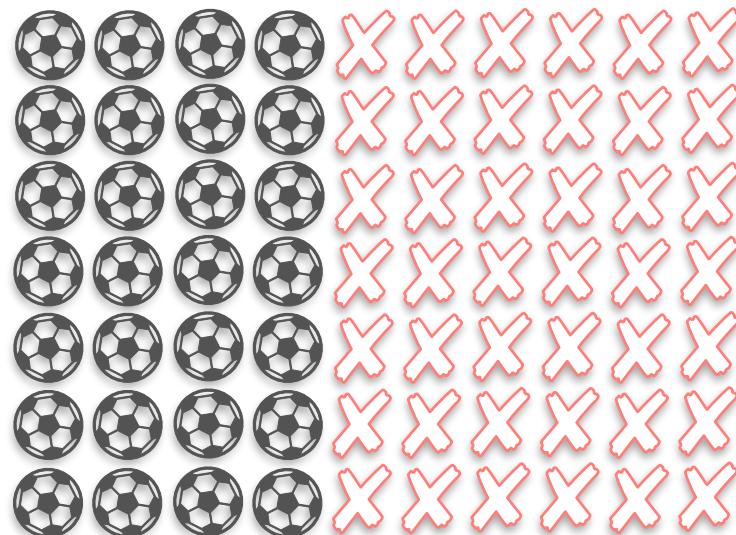
# Quiz 2 Solution



# Quiz 2 Solution

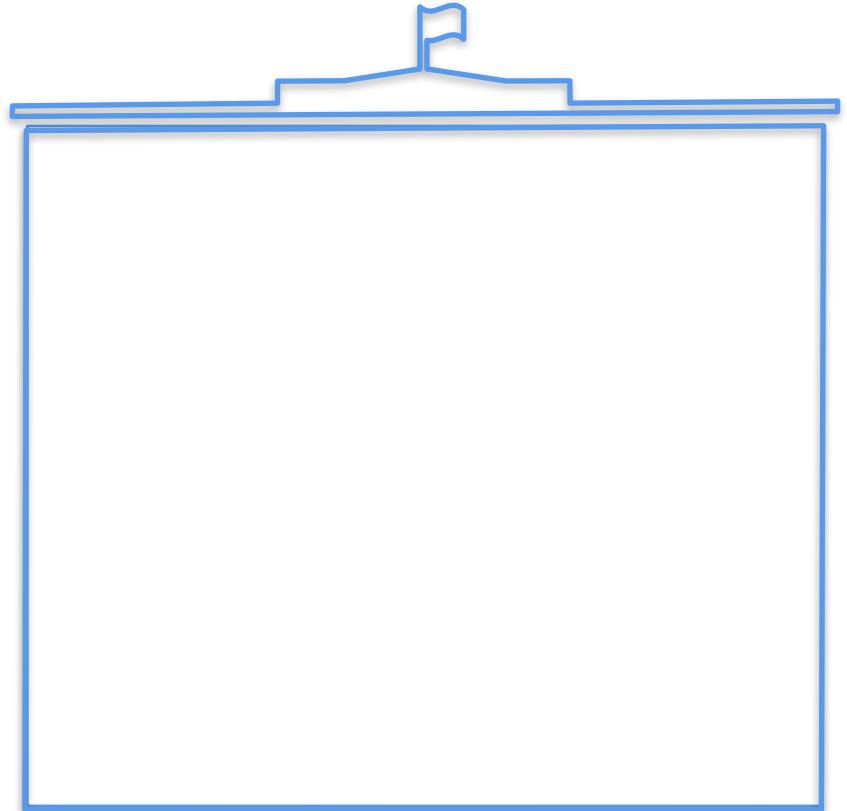


Room 2



# Independent Events

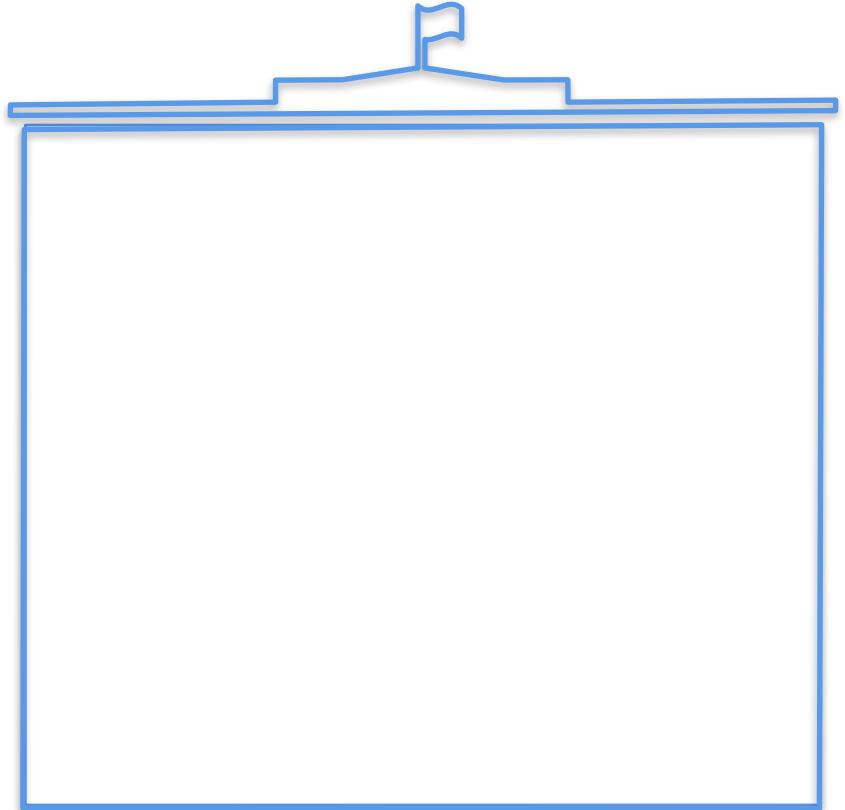
# Independent Events



# Independent Events



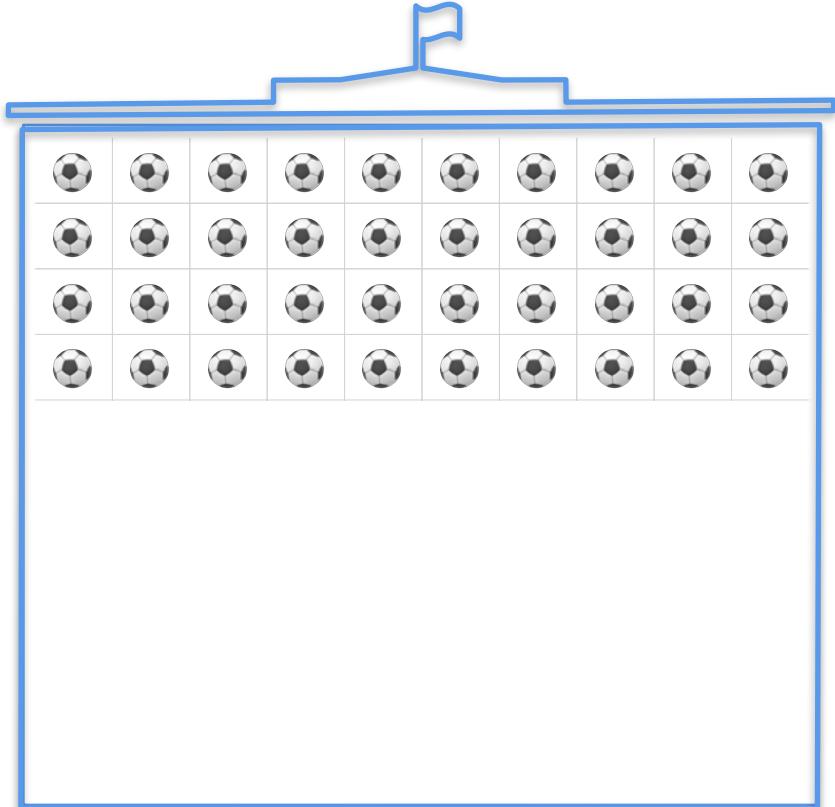
$$\mathbf{P}(S) = 0.4$$



# Independent Events



$$\mathbf{P}(S) = 0.4$$



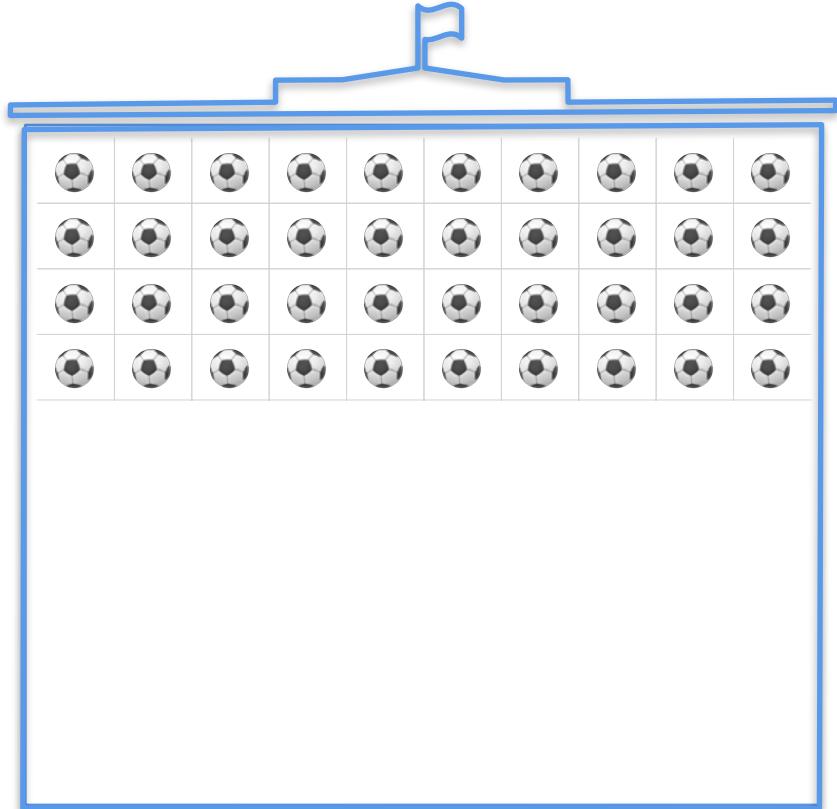
# Independent Events



$$P(S) = 0.4$$



$$P(\text{not } S) = 0.6$$



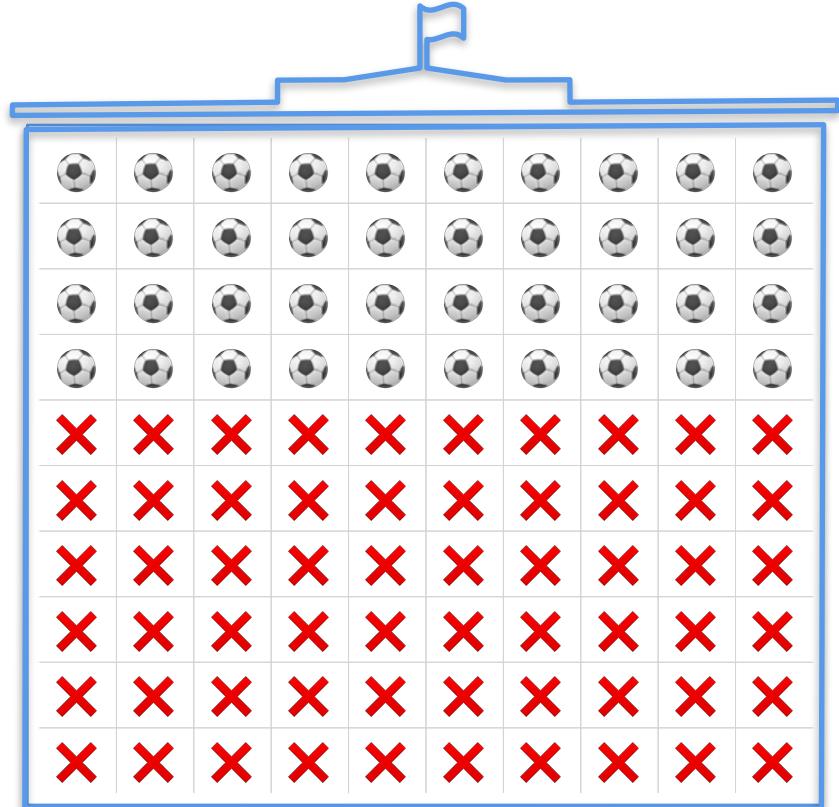
# Independent Events



$$P(S) = 0.4$$



$$P(\text{not } S) = 0.6$$



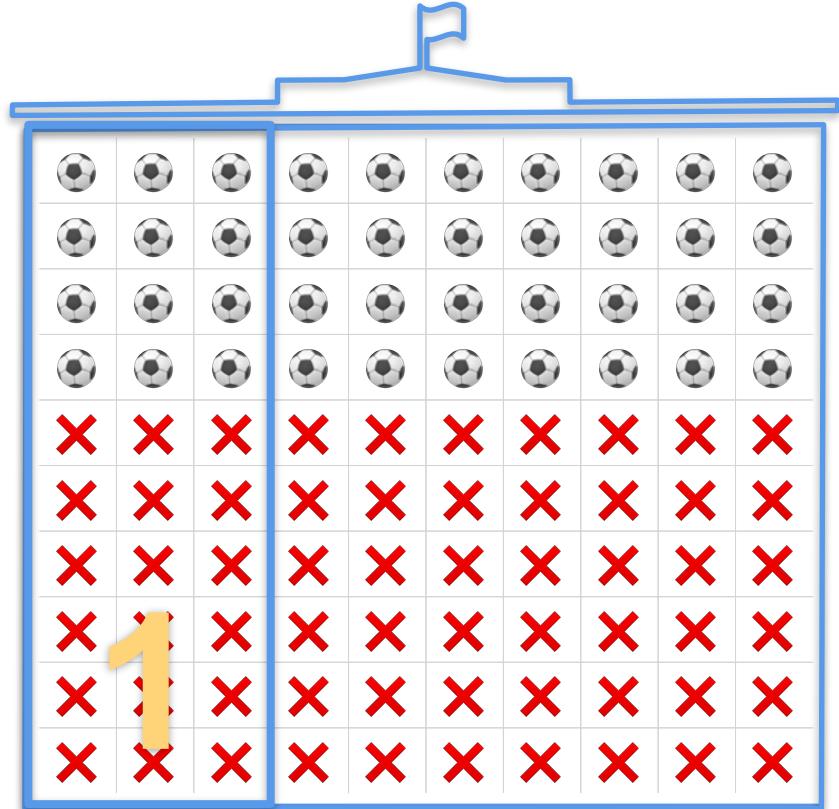
# Independent Events



$$P(S) = 0.4$$



$$P(\text{not } S) = 0.6$$



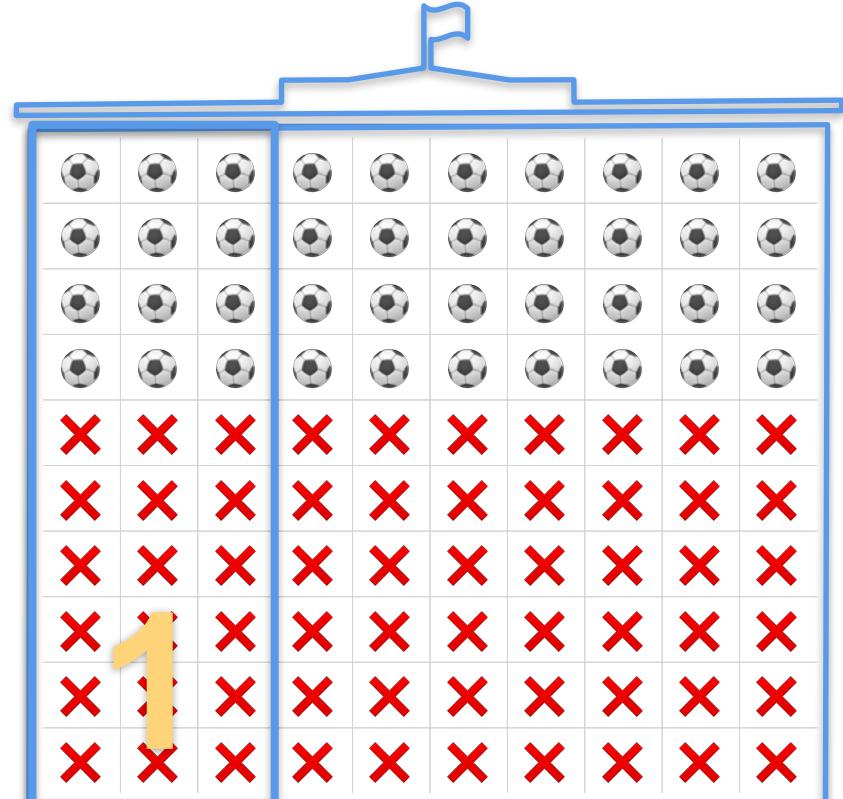
# Independent Events



$$P(S) = 0.4$$



$$P(\text{not } S) = 0.6$$



$$P(R_1) = 0.3$$

# Independent Events

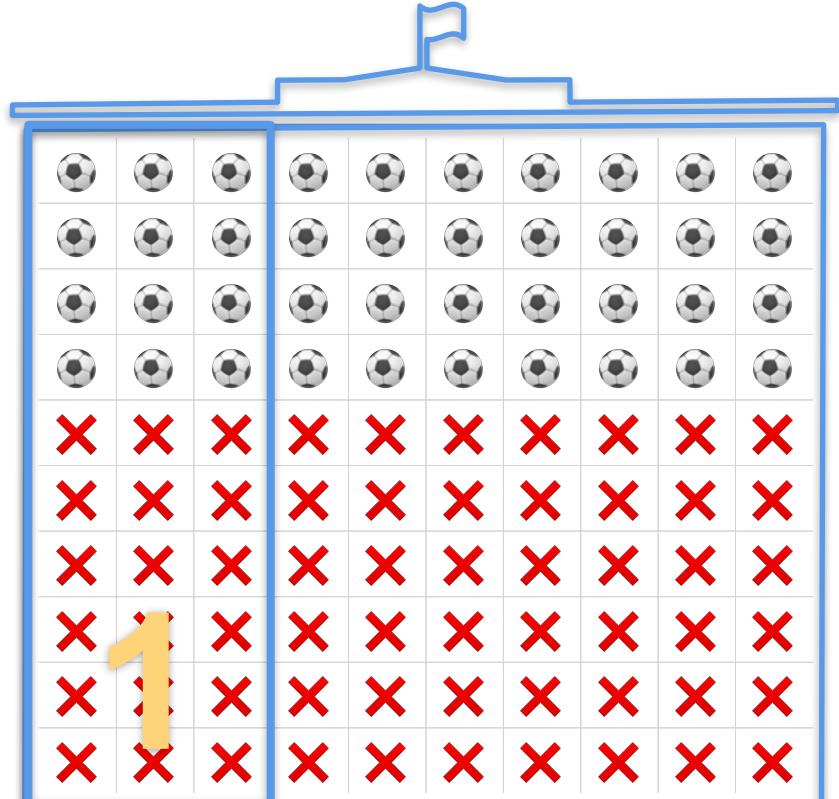
$P(\text{Soccer and Room 1})$



$$P(S) = 0.4$$



$$P(\text{not } S) = 0.6$$



$$P(R_1) = 0.3$$

# Independent Events

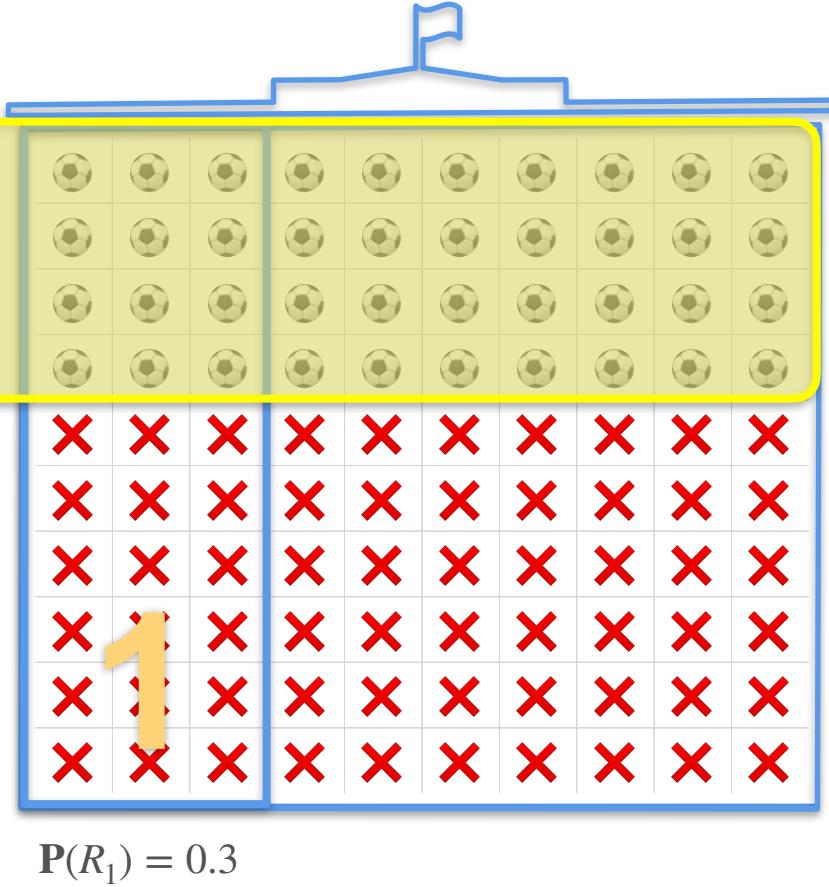
$P(\text{Soccer and Room 1})$



$$P(S) = 0.4$$



$$P(\text{not } S) = 0.6$$



# Independent Events

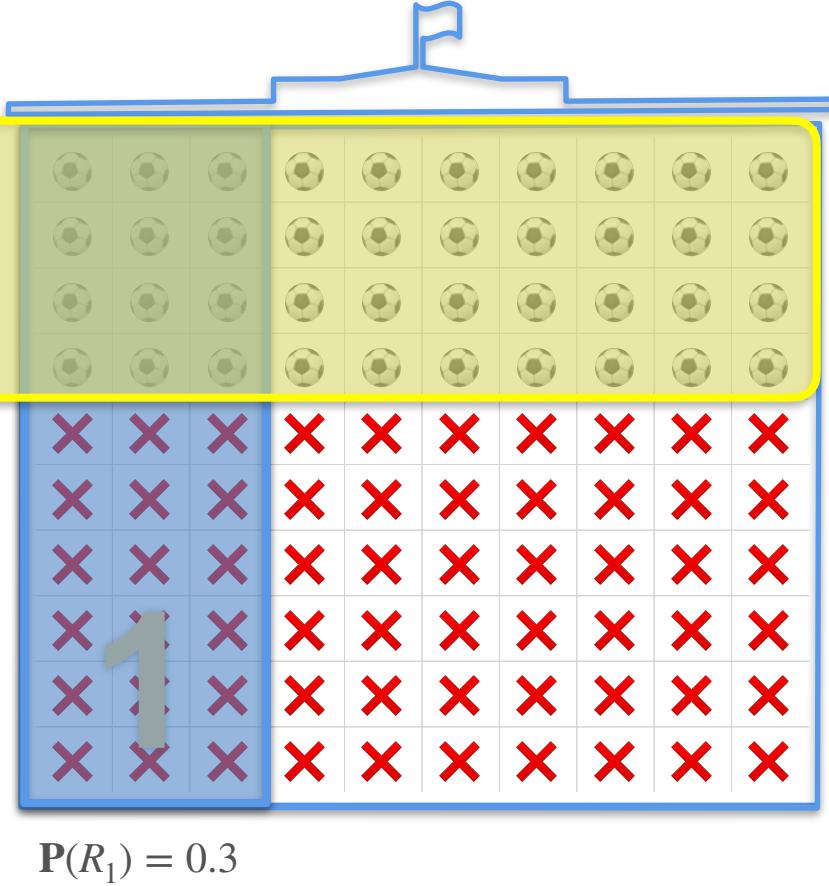
$P(\text{Soccer and Room 1})$



$$P(S) = 0.4$$



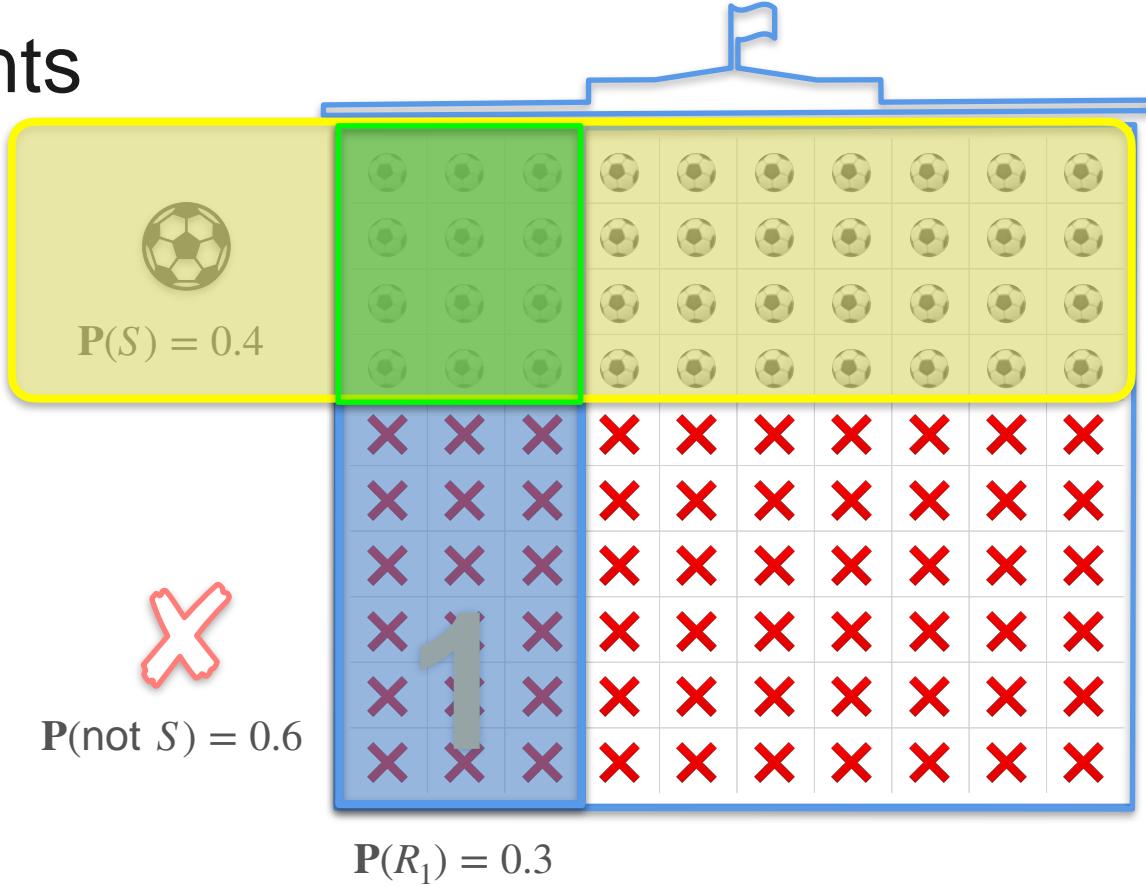
$$P(\text{not } S) = 0.6$$



$$P(R_1) = 0.3$$

# Independent Events

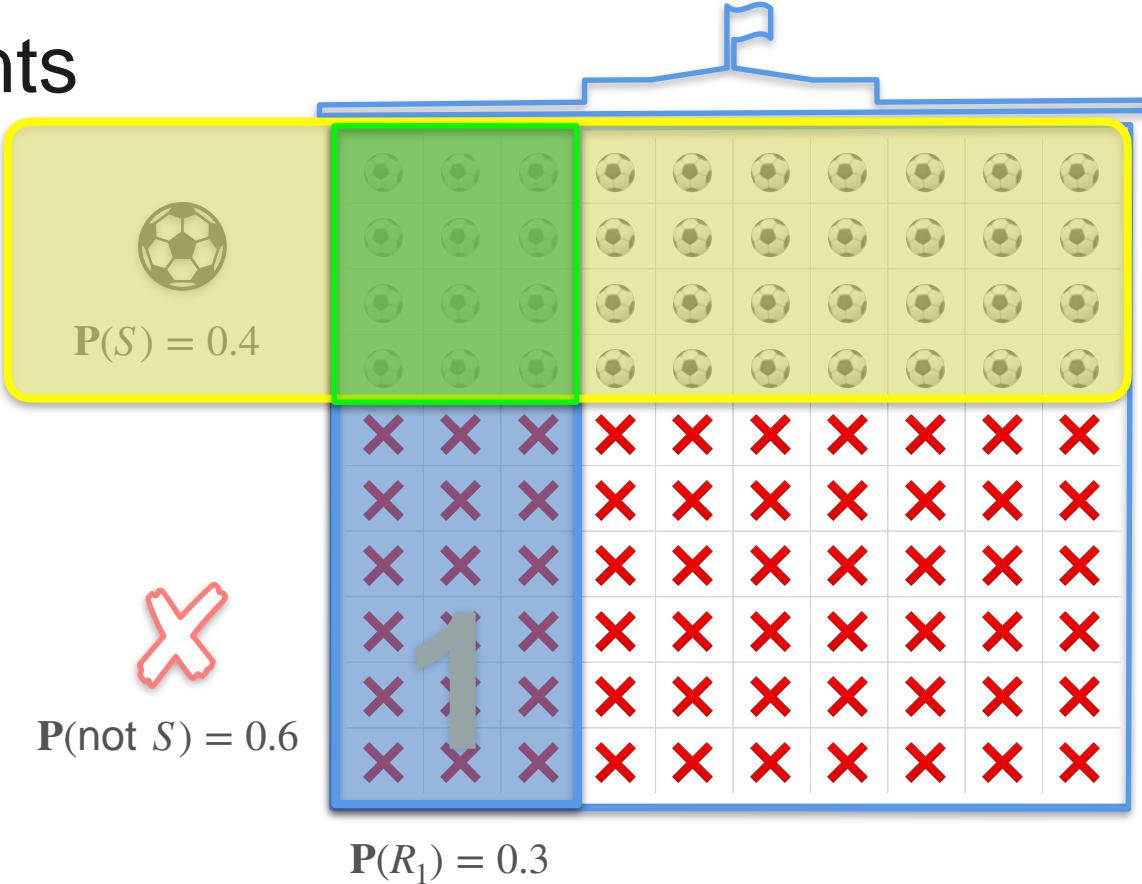
$P(\text{Soccer and Room 1})$



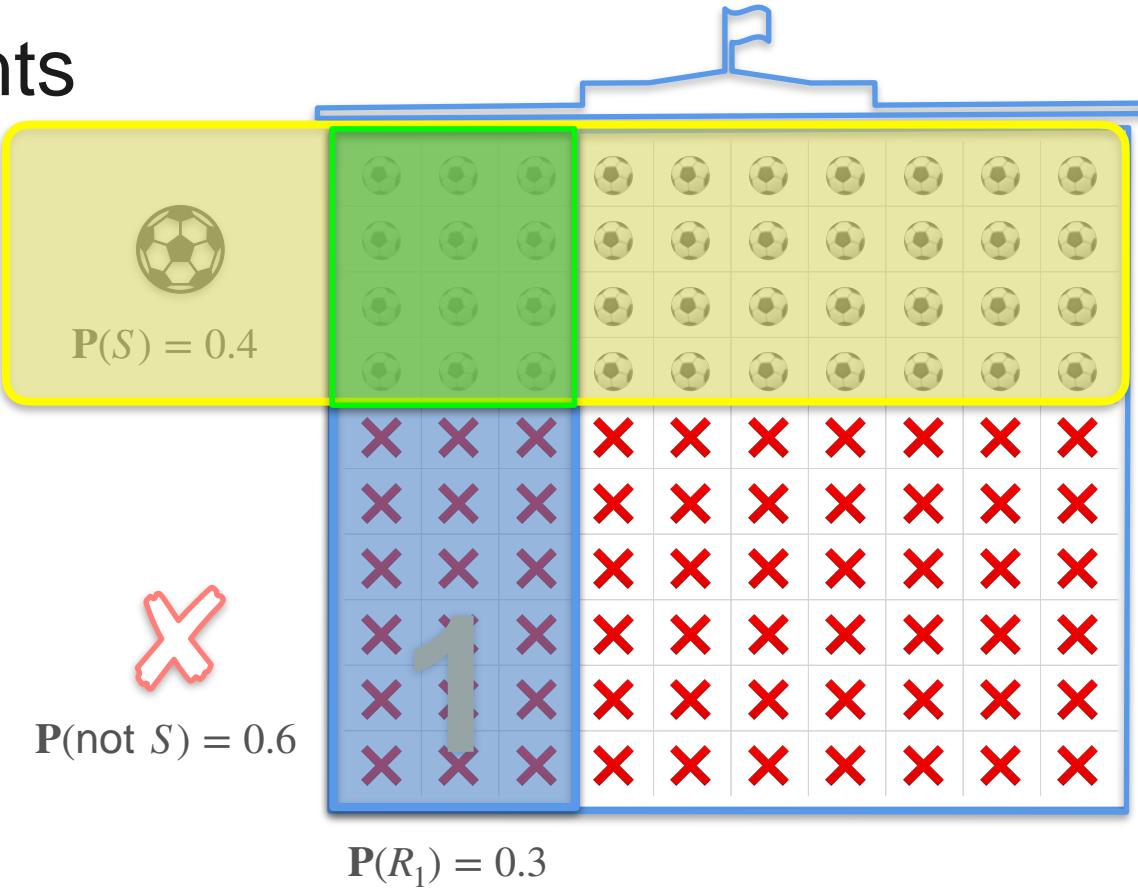
# Independent Events

$P(\text{Soccer and Room 1})$

$P(S \cap R_1) =$



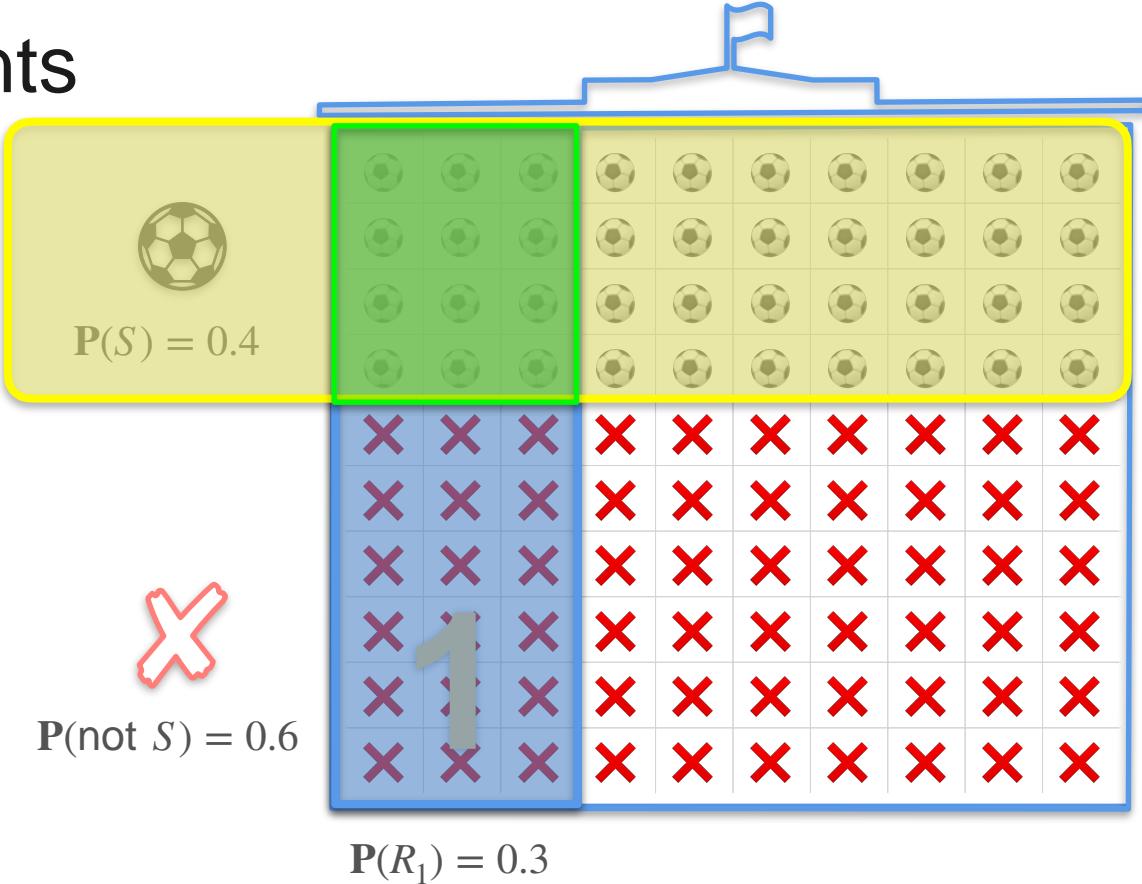
# Independent Events



# Independent Events

$P(\text{Soccer and Room 1})$

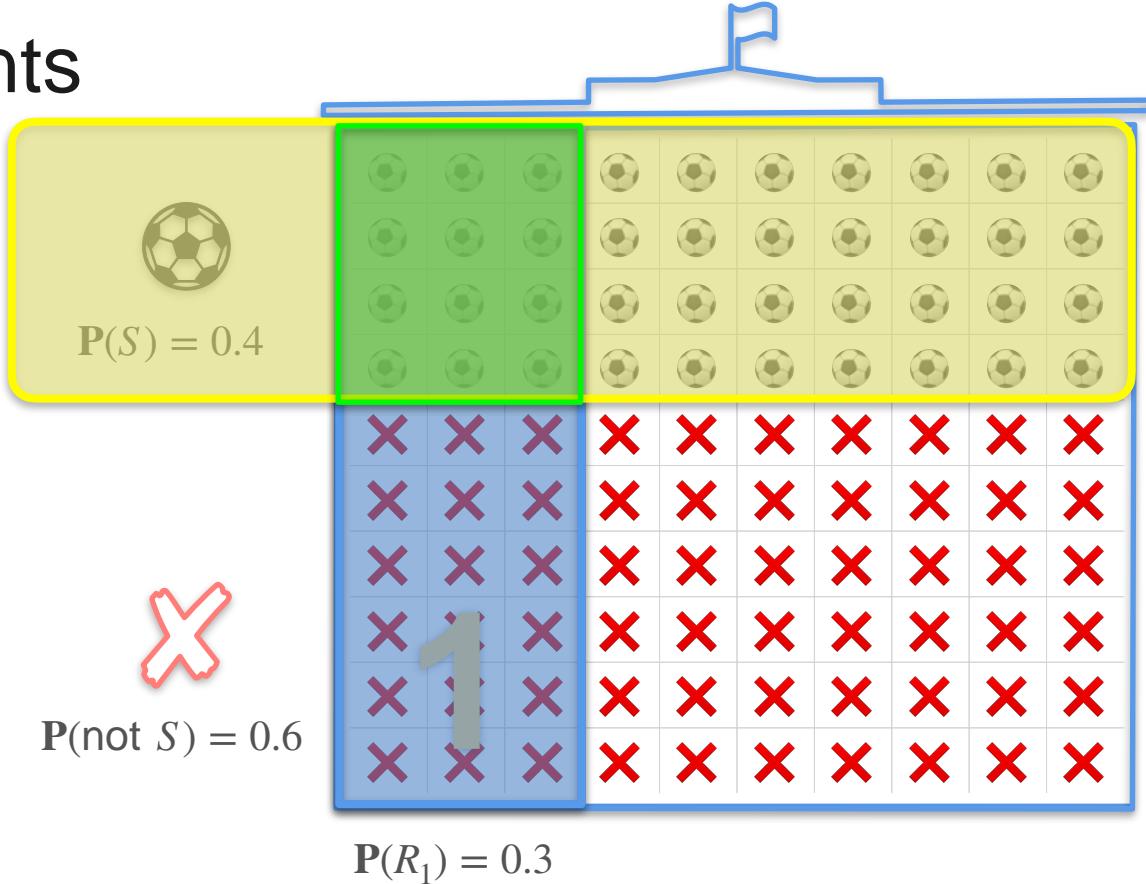
$$P(S \cap R_1) = P(S)$$



# Independent Events

$P(\text{Soccer and Room 1})$

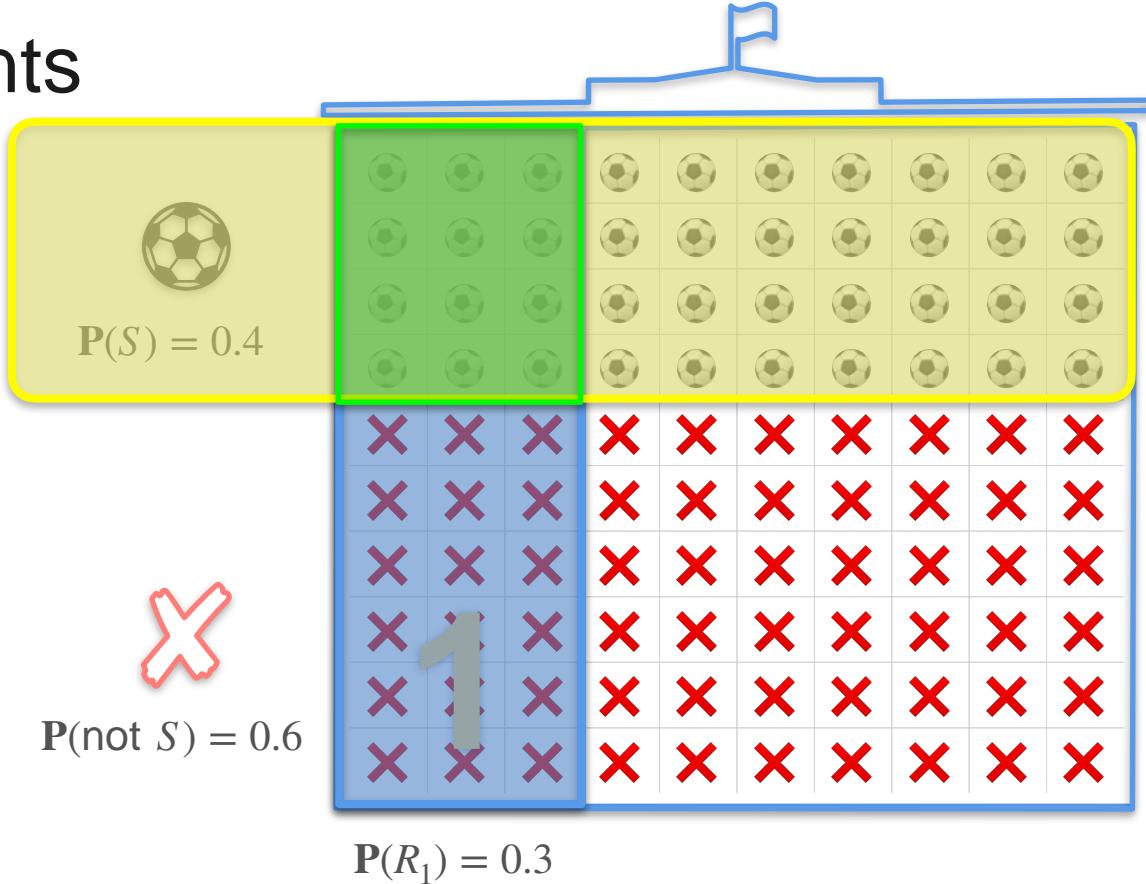
$P(S \cap R_1) = P(S) \bullet$



# Independent Events

$P(\text{Soccer and Room 1})$

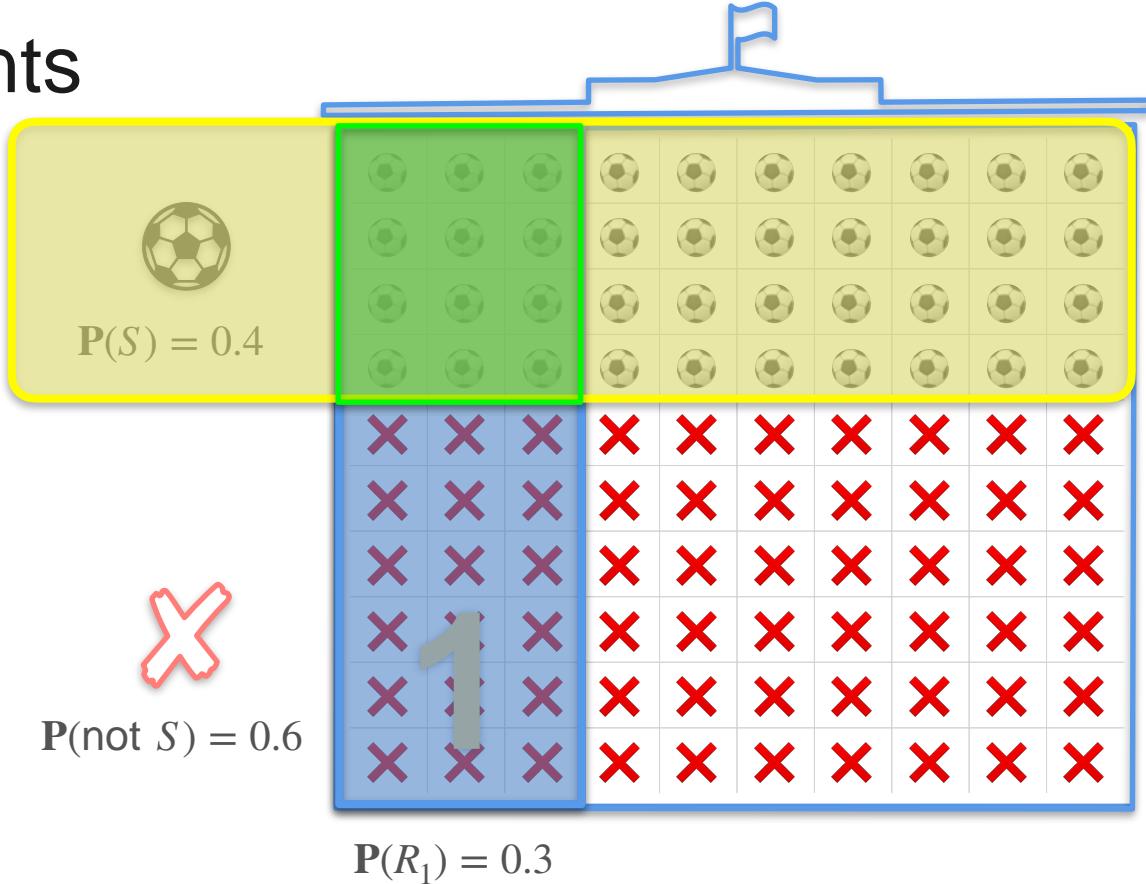
$$P(S \cap R_1) = P(S) \bullet P(R_1)$$



# Independent Events

$P(\text{Soccer and Room 1})$

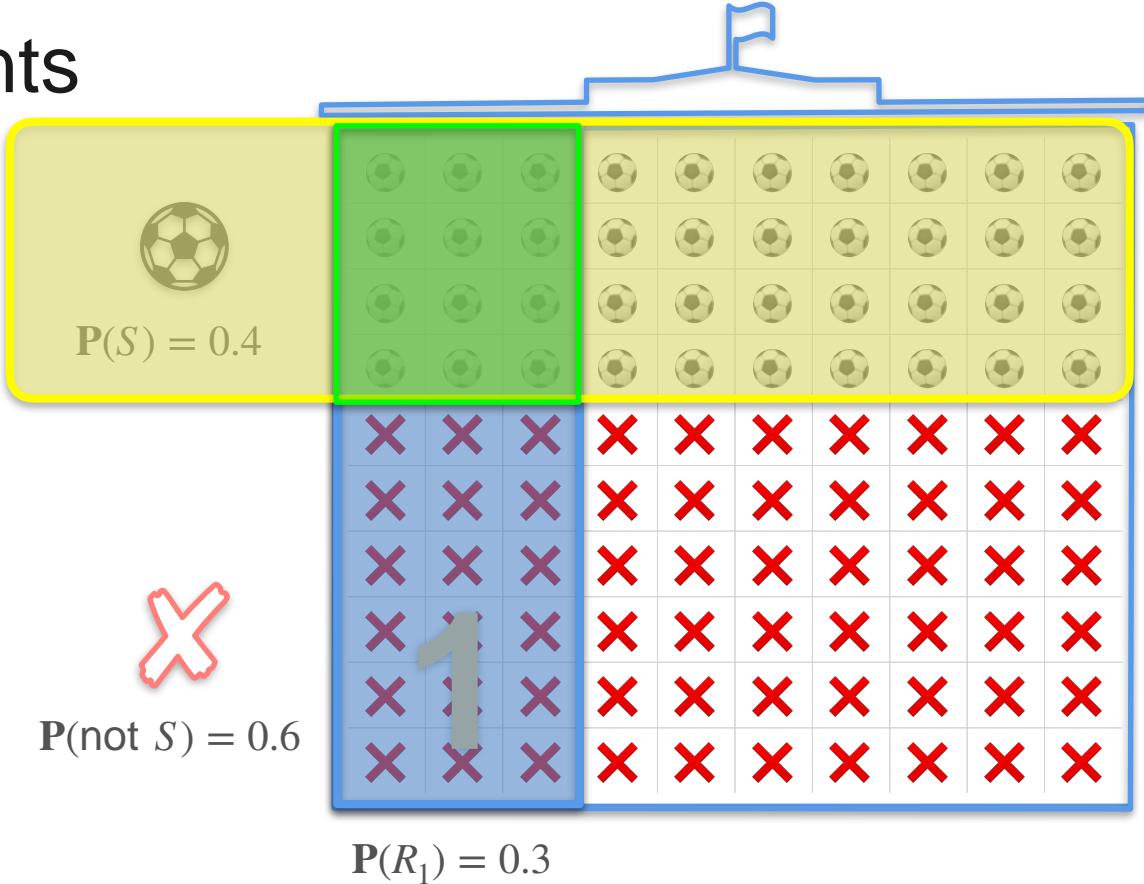
$$P(S \cap R_1) = P(S) \bullet P(R_1)$$



# Independent Events

$P(\text{Soccer and Room 1})$

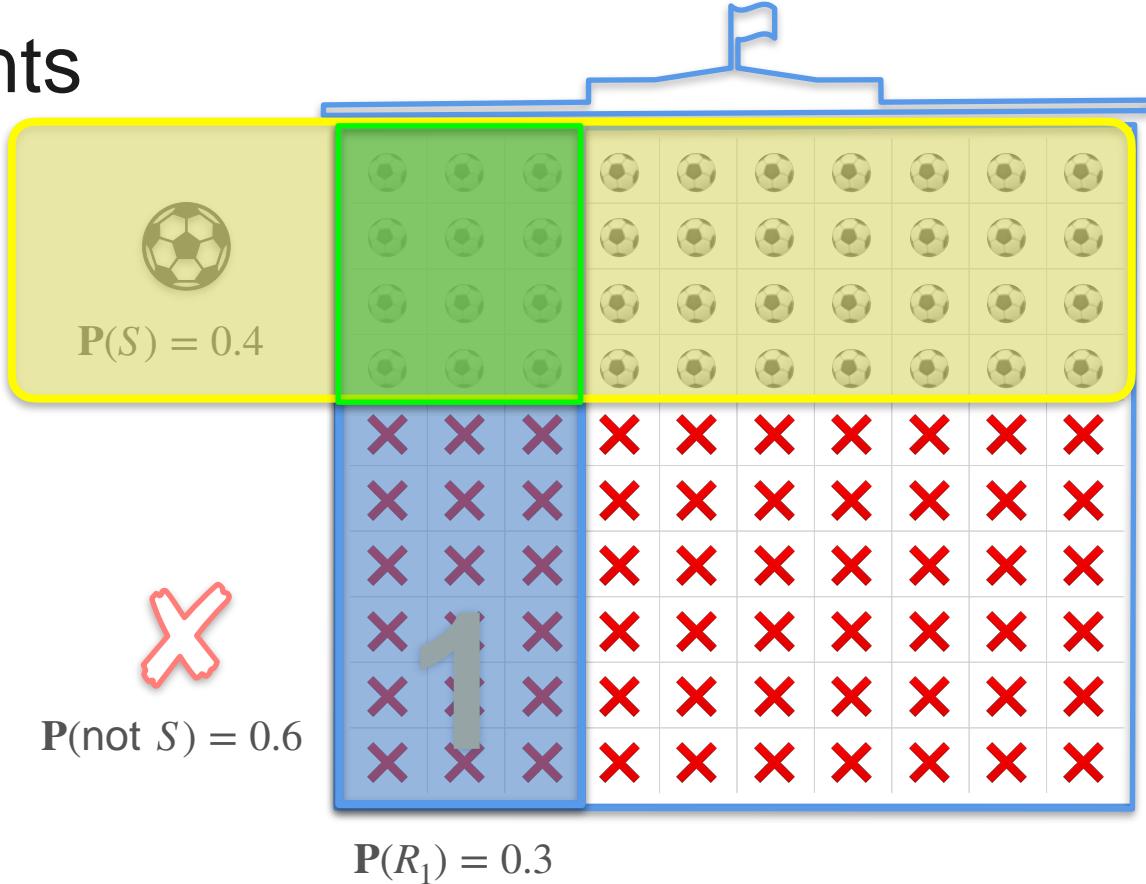
$$\begin{aligned} P(S \cap R_1) &= P(S) \bullet P(R_1) \\ &= 0.4 \end{aligned}$$



# Independent Events

$P(\text{Soccer and Room 1})$

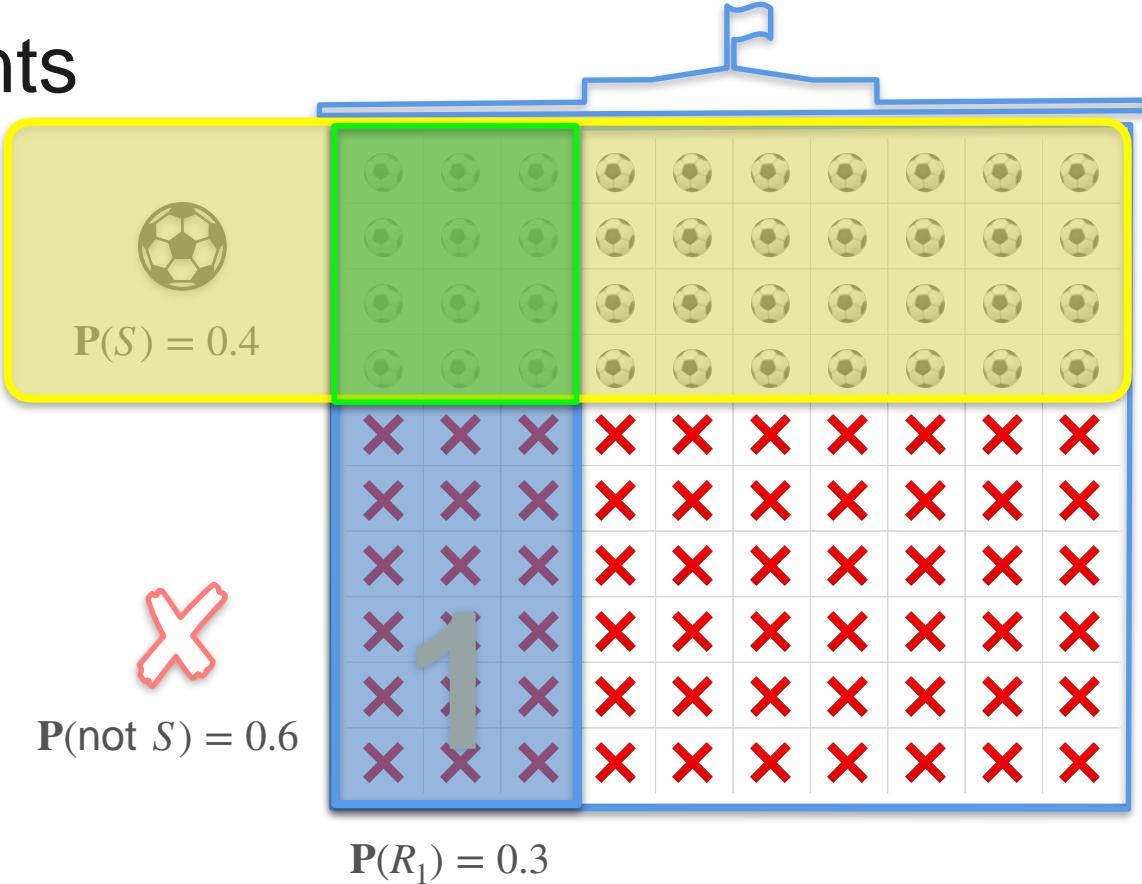
$$\begin{aligned} P(S \cap R_1) &= P(S) \bullet P(R_1) \\ &= 0.4 \bullet \end{aligned}$$



# Independent Events

$P(\text{Soccer and Room 1})$

$$\begin{aligned} P(S \cap R_1) &= P(S) \bullet P(R_1) \\ &= 0.4 \bullet 0.3 \end{aligned}$$



# Independent Events

$P(\text{Soccer and Room 1})$

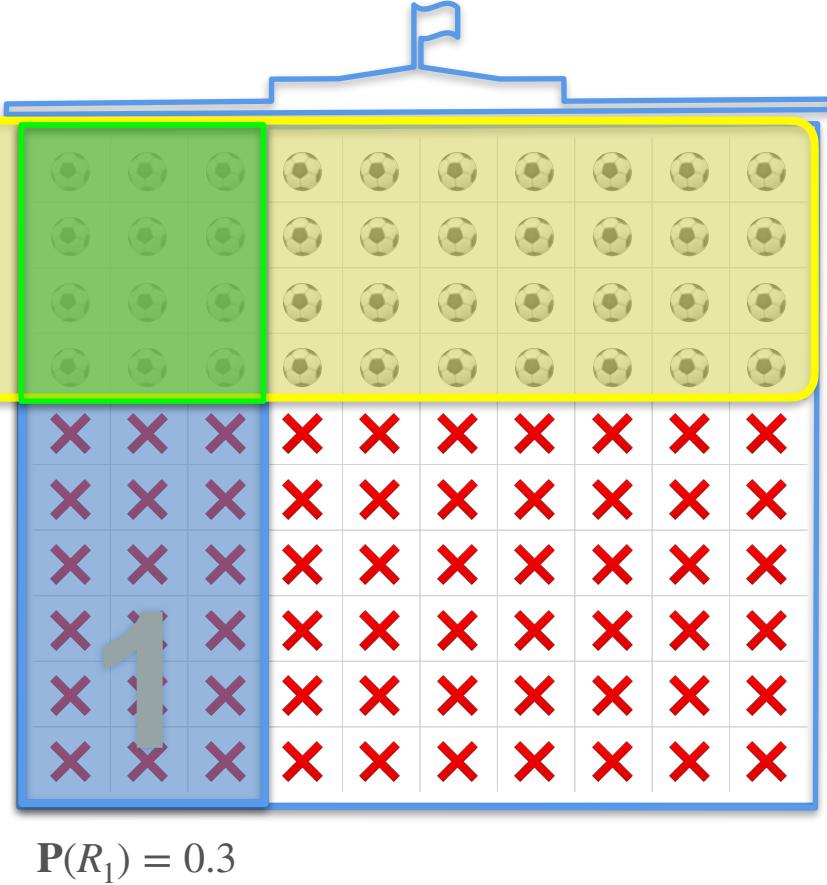
$$P(S \cap R_1) = P(S) \bullet P(R_1)$$

$$= 0.4 \bullet 0.3$$

$$= 0.12$$



$$P(\text{not } S) = 0.6$$



# Independent Events

$P(\text{Soccer and Room 1})$

$$P(S \cap R_1) = P(S) \bullet P(R_1)$$

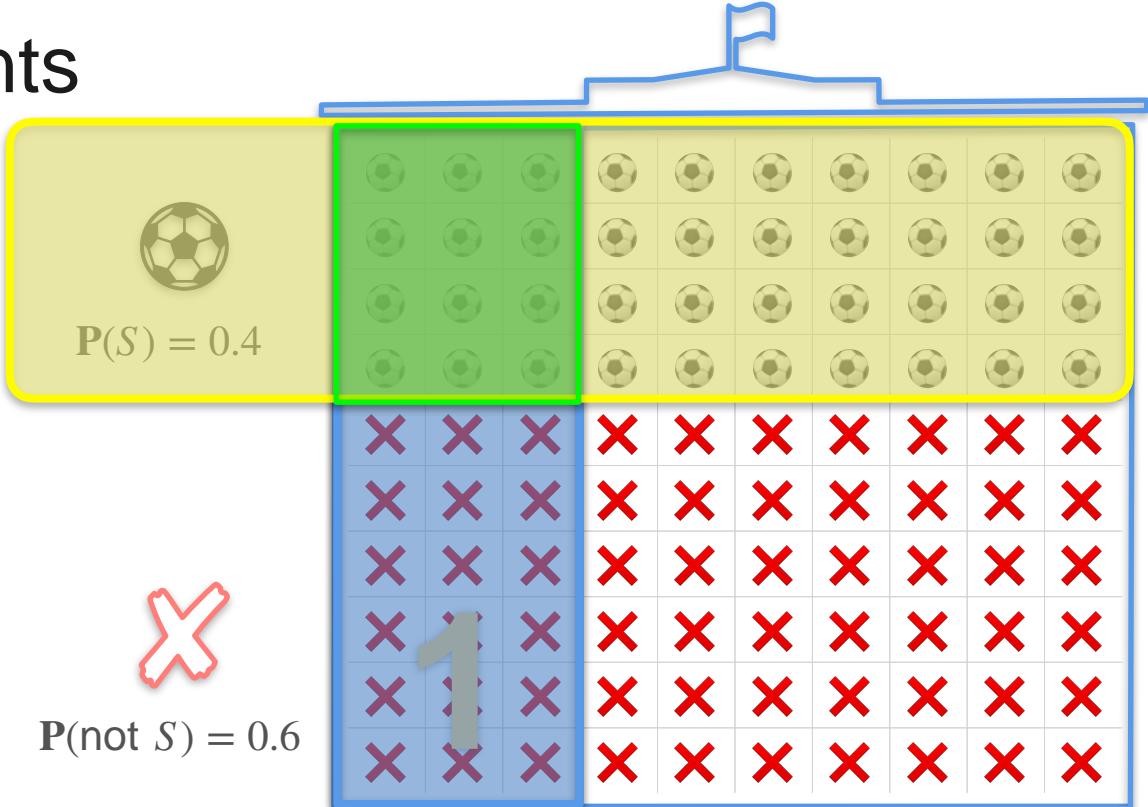
$$= 0.4 \bullet 0.3$$

$$= 0.12$$



$$P(\text{not } S) = 0.6$$

$$P(R_1) = 0.3$$



# Product Rule (for Independent Events)

# Product Rule (for Independent Events)

$$\mathbf{P}(A \cap B) = \mathbf{P}(A) \cdot \mathbf{P}(B)$$

# Independent Events: Coin Example 1



# Independent Events: Coin Example 1



50% 50%



# Independent Events: Coin Example 1



50% 50%

What is the probability of landing on heads five times?



# Independent Events: Coin Example 1



What is the probability of landing on heads five times?



# Independent Events: Coin Example 1



What is the probability of landing on heads five times?



# Independent Events: Coin Example 1



50% 50%

What is the probability of landing on heads five times?

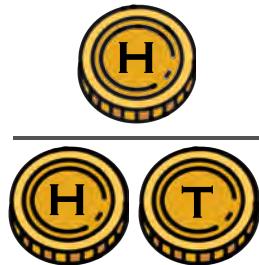


# Independent Events: Coin Example 1



50% 50%

What is the probability of landing on heads five times?



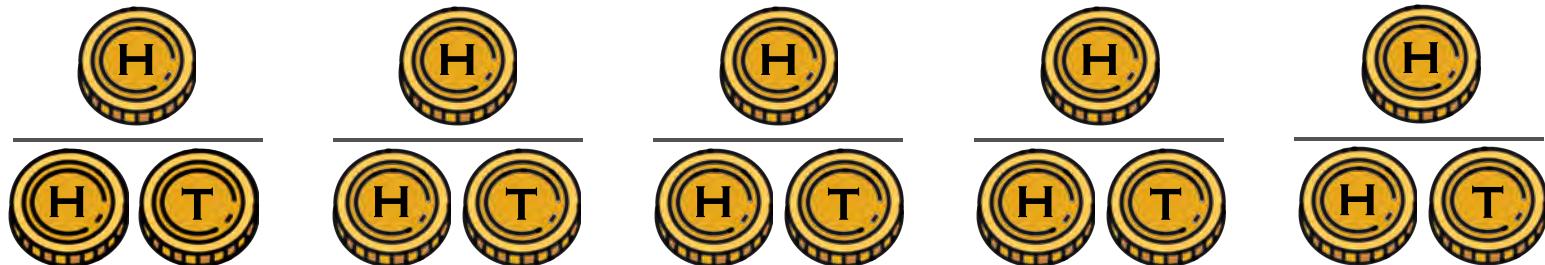
$$\frac{1}{2}$$

# Independent Events: Coin Example 1



50% 50%

What is the probability of landing on heads five times?



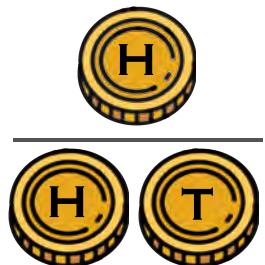
$$\frac{1}{2}$$

# Independent Events: Coin Example 1

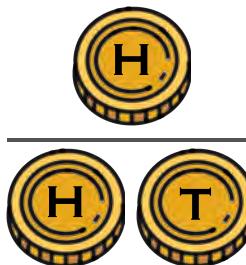


50% 50%

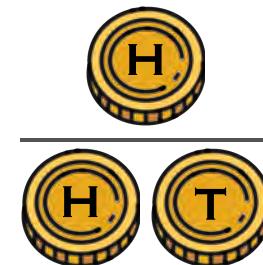
What is the probability of landing on heads five times?



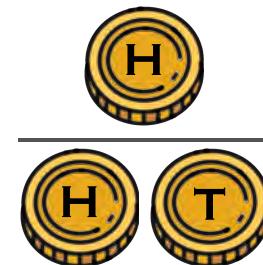
$$\frac{1}{2}$$



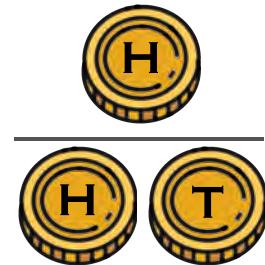
$$\frac{1}{2}$$



$$\frac{1}{2}$$



$$\frac{1}{2}$$



$$\frac{1}{2}$$

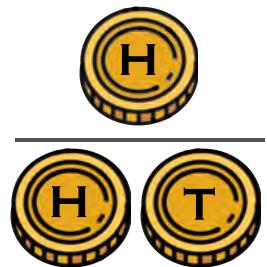
# Independent Events: Coin Example 1



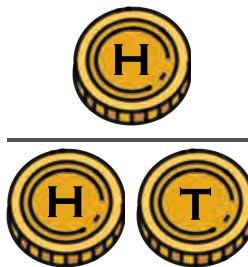
50% 50%

What is the probability of landing on heads five times?

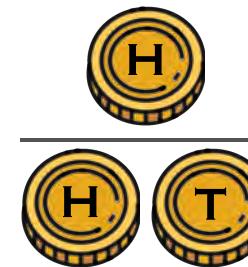
$$P(5 \text{ heads}) =$$



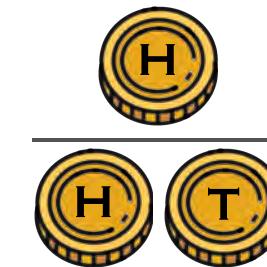
$$\frac{1}{2}$$



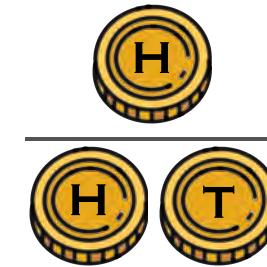
$$\frac{1}{2}$$



$$\frac{1}{2}$$



$$\frac{1}{2}$$



$$\frac{1}{2}$$

# Independent Events: Coin Example 1



50% 50%

What is the probability of landing on heads five times?

$$P(5 \text{ heads}) =$$

$$\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2}$$
The diagram illustrates the calculation of the probability of getting 5 heads in a row. It shows five sets of two coins each, separated by dots. The first set shows H and T. Subsequent sets show H and T, H and T, H and T, and H and T. Below each pair of coins is a fraction  $\frac{1}{2}$ , representing the probability of getting heads for that pair. The dots between the pairs indicate that the sequence continues for all five pairs.

# Independent Events: Coin Example 1



50% 50%

What is the probability of landing on heads five times?

$P(5 \text{ heads}) =$

$$\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2}$$

The equation shows the probability of getting 5 heads in a row. It consists of a fraction with 'P(5 heads)' as the numerator and a product of five terms as the denominator. Each term is  $\frac{1}{2}$ , representing the probability of getting heads on a single coin flip. The terms are separated by multiplication dots, indicating the sequence of independent events.

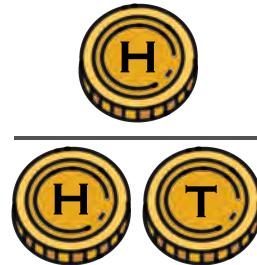
# Independent Events: Coin Example 2



50% 50%

What is the probability of landing on heads five times?

$$P(5 \text{ heads}) =$$



$$\frac{1}{2}$$

# Independent Events: Coin Example 2



50% 50%

What is the probability of landing on heads five times?

$$P(5 \text{ heads}) = \left( \frac{\text{Diagram of 5 heads}}{\text{Diagram of 5 heads and 5 tails}} \right)$$
A diagram illustrating the probability calculation. It shows a stack of five coins where all five coins are facing heads (H). Below this, there is a horizontal line, and below the line, there is another stack of five coins showing three heads (H) and two tails (T).

$$\frac{1}{2}$$

# Independent Events: Coin Example 2



50% 50%

What is the probability of landing 5n heads five times?

$$P(5 \text{ heads}) = \left( \frac{\text{Diagram of 5 coins showing all heads}}{\text{Diagram of 5 coins showing mixed heads and tails}} \right)$$
The equation shows the probability of getting 5 heads in 5 coin flips. The numerator is represented by a stack of 5 coins, all showing heads ('H'). The denominator is represented by a stack of 5 coins showing a mix of heads ('H') and tails ('T').

$$\frac{1}{2}$$

# Independent Events: Coin Example 2



50% 50%

What is the probability of landing on heads five times?

$$P(5 \text{ heads}) = \left( \frac{\text{Diagram of 5 heads}}{\text{Diagram of 1 head and 1 tail}} \right)^5$$

The fraction in the equation is visually represented by two rows of three gold coins each. The top row shows all three coins with 'H' (heads) facing up. The bottom row shows the first coin with 'H' facing up, the second coin with 'T' facing up, and the third coin with 'H' facing up.

$$\frac{1}{2}$$

# Independent Events: Coin Example 2



50% 50%

What is the probability of landing on heads five times?

$$P(5 \text{ heads}) = \left( \frac{\text{Diagram of 5 heads}}{\text{Diagram of 1 head and 1 tail}} \right)^5$$

The fraction in the equation compares two diagrams. The numerator is a stack of five coins, all showing heads (H). The denominator is a stack of two coins, one showing heads (H) and one showing tails (T).

$$\left( \frac{1}{2} \right)^5$$

# Independent Events: Coin Example 2



50% 50%

What is the probability of landing on heads five times?

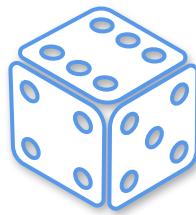
$$P(5 \text{ heads}) = \left( \frac{\text{Diagram of 5 heads}}{\text{Diagram of 2 heads and 3 tails}} \right)^5$$

The fraction in the equation compares two diagrams. The numerator is a stack of five coins, all showing heads ('H'). The denominator is a stack of three coins showing heads ('H') and two coins showing tails ('T').

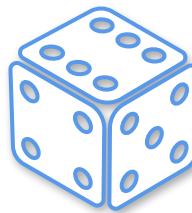
$$\left( \frac{1}{2} \right)^5 = \frac{1}{32}$$

# Independent Events: Dice Example 1

# Independent Events: Dice Example 1



# Independent Events: Dice Example 1



$$P(6) = \underline{\hspace{2cm}}$$

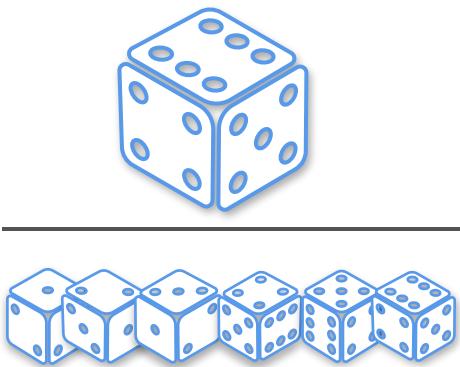
# Independent Events: Dice Example 1



$$P(6) = \underline{\hspace{2cm}}$$

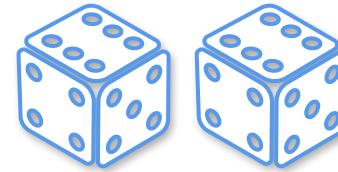


# Independent Events: Dice Example 1

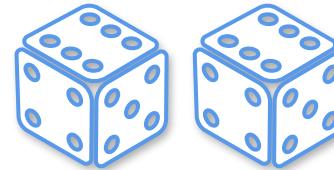
$$P(6) = \frac{1}{6}$$


# Independent Events: Dice Example 1

# Independent Events: Dice Example 1



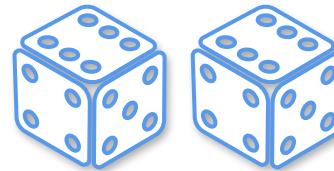
# Independent Events: Dice Example 1



2 dice

# Independent Events: Dice Example 1

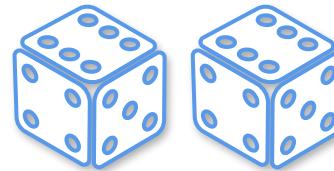
	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6



2 dice

# Independent Events: Dice Example 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6

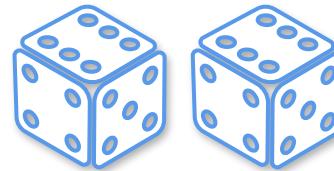


2 dice

$$P(6,6) = \underline{\hspace{2cm}}$$

# Independent Events: Dice Example 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6

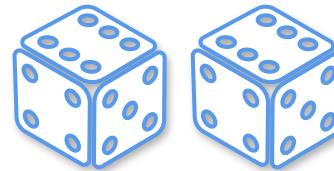


2 dice

$$P(6,6) = \underline{\hspace{2cm}}$$

# Independent Events: Dice Example 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6



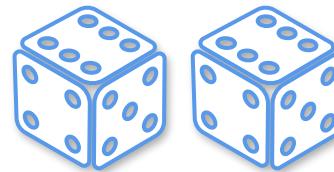
2 dice

6,6

$$P(6,6) = \underline{\hspace{2cm}}$$

# Independent Events: Dice Example 1

	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
	6,1	6,2	6,3	6,4	6,5	6,6



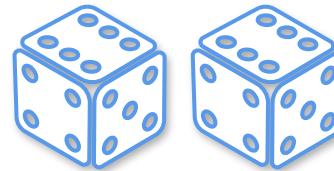
2 dice

$$P(6,6) = \frac{1}{36}$$

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

# Independent Events: Dice Example 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
2,1	3,1	3,2	3,3	3,4	3,5	3,6
3,1	4,1	4,2	4,3	4,4	4,5	4,6
4,1	5,1	5,2	5,3	5,4	5,5	5,6
5,1	6,1	6,2	6,3	6,4	6,5	6,6



2 dice

$$P(6,6) = \frac{1}{36}$$

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

# Independent Events: Dice Example 1

2 dice

						
	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
	6,1	6,2	6,3	6,4	6,5	6,6



# Independent Events: Dice Example 1

						
1,1	1,2	1,3	1,4	1,5	1,6	
2,1	2,2	2,3	2,4	2,5	2,6	
3,1	3,2	3,3	3,4	3,5	3,6	
4,1	4,2	4,3	4,4	4,5	4,6	
5,1	5,2	5,3	5,4	5,5	5,6	
6,1	6,2	6,3	6,4	6,5		

$$P(6,6) =$$



2 dice

# Independent Events: Dice Example 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6
$\frac{1}{6}$						

$$P(6,6) =$$



2 dice

# Independent Events: Dice Example 1

	1,1	1,2	1,3	1,4	1,5	1,6
1,1	2,1	2,2	2,3	2,4	2,5	2,6
1,2	3,1	3,2	3,3	3,4	3,5	3,6
1,3	4,1	4,2	4,3	4,4	4,5	4,6
1,4	5,1	5,2	5,3	5,4	5,5	5,6
1,5	6,1	6,2	6,3	6,4	6,5	6,6
1,6						

2 dice

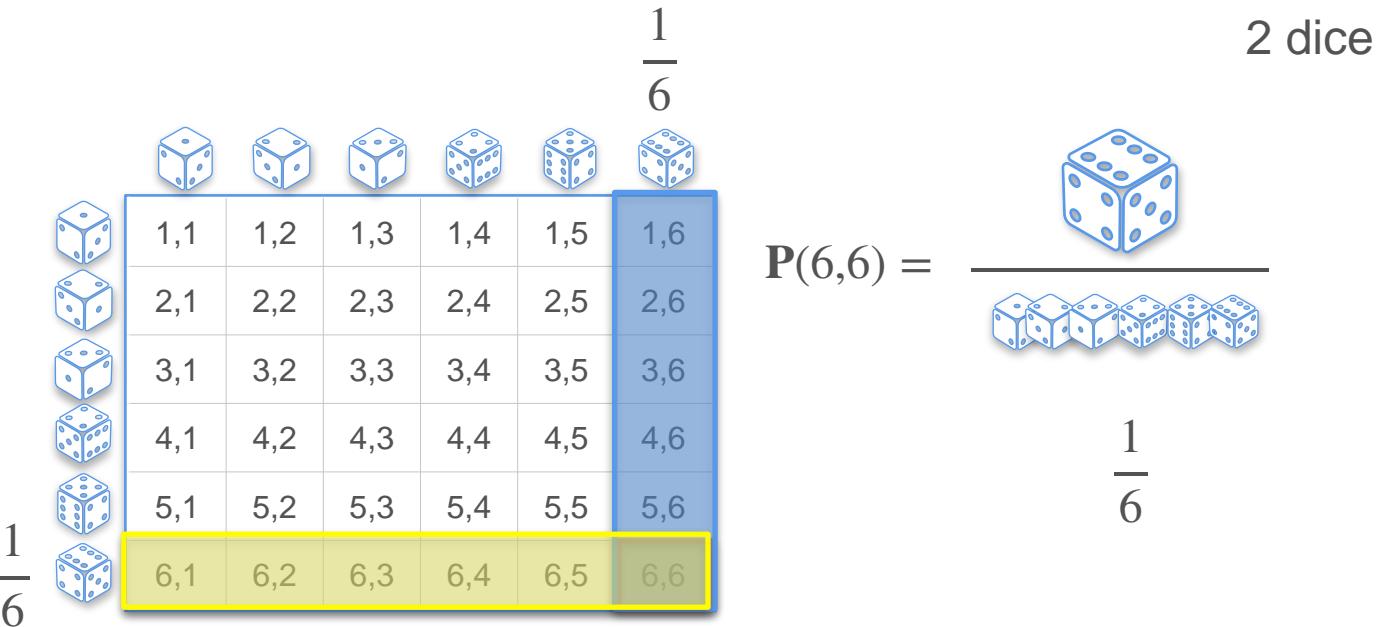
$$P(6,6) =$$



$$\frac{1}{6}$$

$$\frac{1}{6}$$

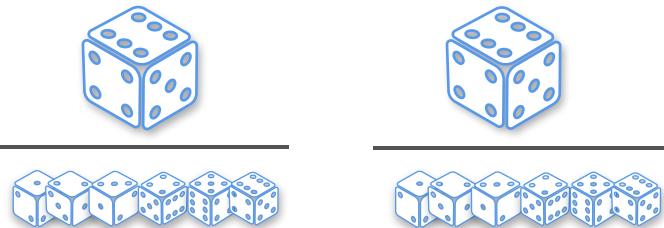
# Independent Events: Dice Example 1



# Independent Events: Dice Example 1

					$\frac{1}{6}$
					
1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
					
6,1	6,2	6,3	6,4	6,5	6,6

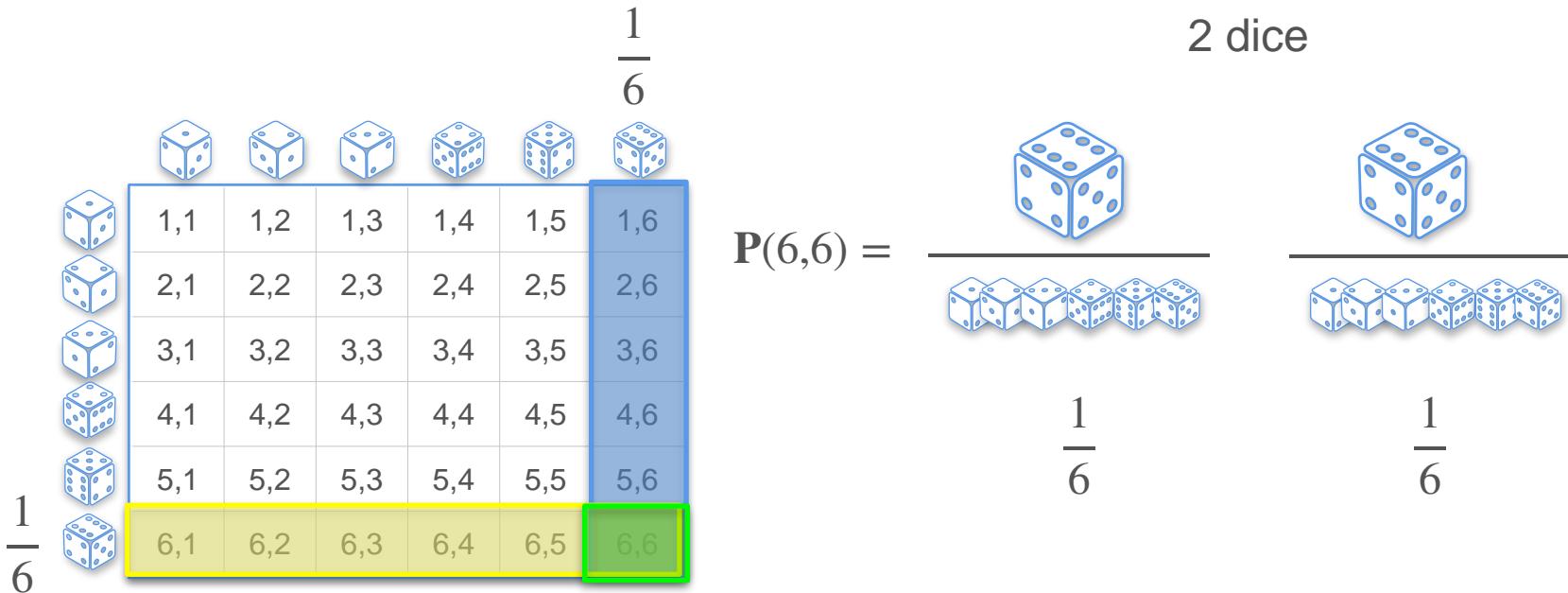
2 dice



$\frac{1}{6}$

1  
—  
6

# Independent Events: Dice Example 1



# Independent Events: Dice Example 1

						$\frac{1}{6}$
	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
$\frac{1}{6}$	6,1	6,2	6,3	6,4	6,5	6,6

2 dice

$$P(6,6) = \frac{\text{one outcome}}{\text{all outcomes}} = \frac{1}{6} \cdot \frac{1}{6} = \frac{1}{36}$$

# Independent Events: Dice Example 1

						$\frac{1}{6}$
	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
$\frac{1}{6}$	6,1	6,2	6,3	6,4	6,5	6,6

2 dice

$$P(6,6) = \frac{\text{one outcome}}{\text{all outcomes}} = \frac{1}{6} \cdot \frac{1}{6} = \left(\frac{1}{6}\right)$$

The diagram illustrates the probability calculation for rolling two dice. It shows a 6x6 grid of outcomes. The top row and left column are labeled with dice icons. The bottom-right cell, representing the outcome (6,6), is highlighted with a green border. Above the grid, the fraction  $\frac{1}{6}$  is shown twice, once vertically on the left and once horizontally above the grid. To the right of the grid, the expression  $P(6,6) =$  is followed by a fraction bar. Below the fraction bar, there are two sets of dice icons: one set for the numerator showing a single die with 6 faces, and one set for the denominator showing two dice. Each set is multiplied by a dot, indicating multiplication. Below each set of dice is the fraction  $\frac{1}{6}$ .

# Independent Events: Dice Example 1

						$\frac{1}{6}$
	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
$\frac{1}{6}$	6,1	6,2	6,3	6,4	6,5	6,6

2 dice

$$P(6,6) = \frac{\text{one outcome}}{\text{all outcomes}} = \frac{1}{6} \cdot \frac{1}{6} = \left(\frac{1}{6}\right)$$

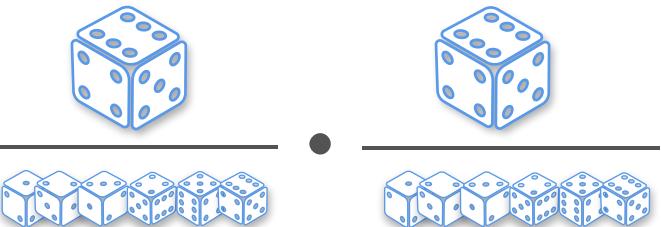
The diagram illustrates the probability calculation for rolling two dice. It shows a 6x6 grid of outcomes. The top row and left column are labeled with dice icons. The bottom-right cell, representing the outcome (6,6), is highlighted with a green border. Above the grid, the fraction  $\frac{1}{6}$  is shown twice, once vertically on the left and once horizontally at the top. To the right of the grid, the formula  $P(6,6) = \frac{\text{one outcome}}{\text{all outcomes}}$  is written. Below this, a dot product is shown:  $\frac{1}{6} \cdot \frac{1}{6}$ . The result is then simplified to  $\left(\frac{1}{6}\right)$ .

# Independent Events: Dice Example 1

						$\frac{1}{6}$
	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
$\frac{1}{6}$	6,1	6,2	6,3	6,4	6,5	6,6

2 dice

$$P(6,6) = \frac{\text{one outcome}}{\text{all outcomes}} = \frac{1}{6} \cdot \frac{1}{6} = \left(\frac{1}{6}\right)^2$$

$P(6,6)$  = 

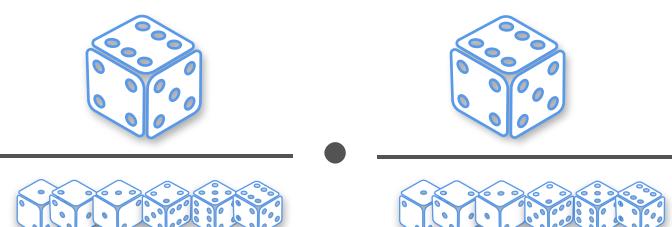
# Independent Events: Dice Example 1

						$\frac{1}{6}$
	1,1	1,2	1,3	1,4	1,5	1,6
	2,1	2,2	2,3	2,4	2,5	2,6
	3,1	3,2	3,3	3,4	3,5	3,6
	4,1	4,2	4,3	4,4	4,5	4,6
	5,1	5,2	5,3	5,4	5,5	5,6
$\frac{1}{6}$	6,1	6,2	6,3	6,4	6,5	6,6

2 dice

$$P(6,6) = \frac{\text{Number of favorable outcomes}}{\text{Total number of outcomes}} = \frac{1}{6} \cdot \frac{1}{6} = \left(\frac{1}{6}\right)^2 = \frac{1}{36}$$

$P(6,6) = \frac{1}{6} \cdot \frac{1}{6} = \left(\frac{1}{6}\right)^2 = \frac{1}{36}$



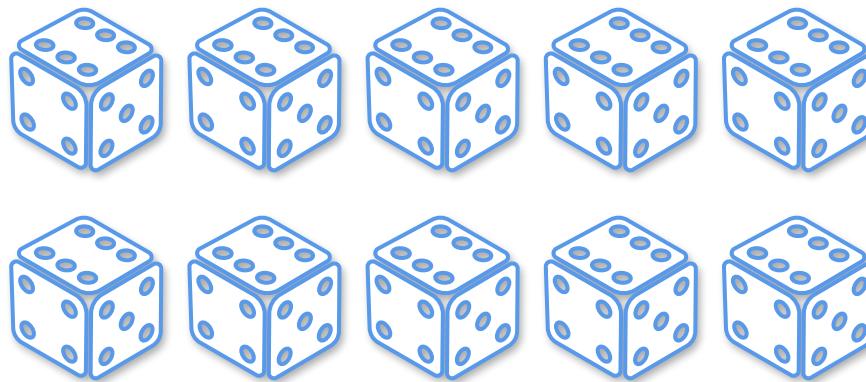
# Independent Events: Dice Example 2

# Independent Events: Dice Example 2

What is the probability of getting 10 sixes?

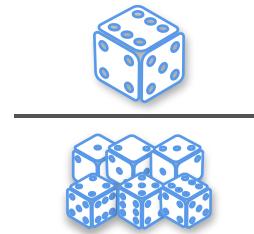
# Independent Events: Dice Example 2

What is the probability of getting 10 sixes?



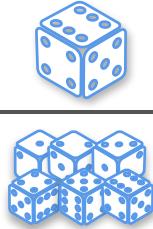
# Independent Events: Dice Example 2

What is the probability of getting 10 sixes?



# Independent Events: Dice Example 2

What is the probability of getting 10 sixes?

$$P(10 \text{ sixes}) = \frac{\text{one outcome}}{\text{all outcomes}}$$


# Independent Events: Dice Example 2

What is the probability of getting 10 sixes?

$$P(10 \text{ sixes}) = \left( \frac{\text{one die}}{\text{ten dice}} \right)$$

# Independent Events: Dice Example 2

What is the probability of getting 10 sixes?

$$P(10 \text{ sixes}) = \left( \frac{\text{one die showing 6}}{\text{ten dice showing 6}} \right)^{10}$$

# Independent Events: Dice Example 2

What is the probability of getting 10 sixes?

$$\begin{aligned} P(10 \text{ sixes}) &= \left( \frac{\text{one die showing 6}}{\text{ten dice showing 6}} \right)^{10} \\ &= \left( \frac{1}{6} \right)^{10} \end{aligned}$$



DeepLearning.AI

# Introduction to probability

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## Birthday problem

# 6. The Birthday Problem

- Quiz: You have a party with 30 friends. What do you think is more likely, that there are two with the same birthday, or not?
  - Answer: Same birthday
- Calculate the probability that two people have the same birthday. Show that it's very close to 1.
- Question: How many people do you think there should be for the probability that 2 have the same birthday is 50?
  - Answer: 23
  - Show calculation

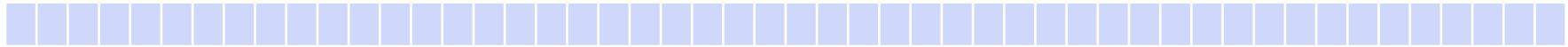
# Quiz

- You have 30 friends at a party. What do you think is more likely:
  - That there exist two people with the same birthday
  - That no two of them have the same birthday
- (Assume the year has 365 days, nobody has a birthday on Feb 29).

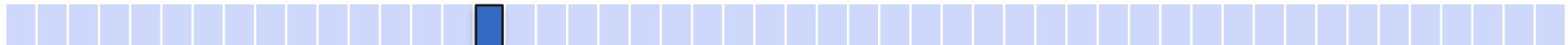
# Quiz

- Answer: It's more likely that 2 people have the same birthday.
- In fact, the probability of no two people having the same birthday is around 0.3.

# Probability That Everyone Has a Different Birthday



# Probability That Everyone Has a Different Birthday



$$\frac{365}{365}$$

# Probability That Everyone Has a Different Birthday



$$\frac{365}{365} \quad \frac{364}{365}$$

# Probability That Everyone Has a Different Birthday

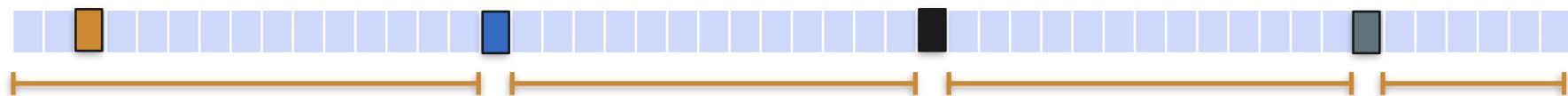


$$\frac{365}{365}$$

$$\frac{364}{365}$$

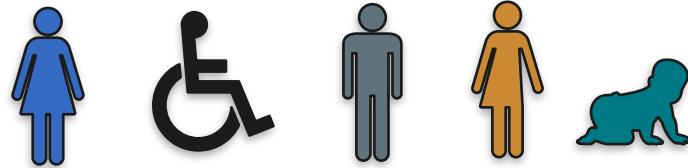
$$\frac{363}{365}$$

# Probability That Everyone Has a Different Birthday



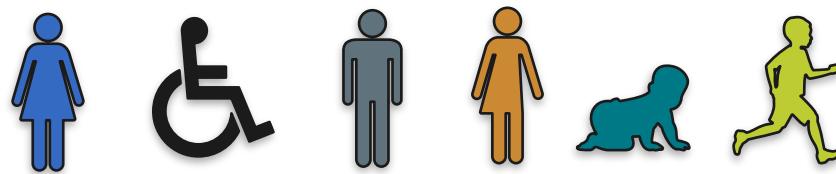
$$\frac{365}{365} \quad \frac{364}{365} \quad \frac{363}{365} \quad \frac{362}{365}$$

# Probability That Everyone Has a Different Birthday



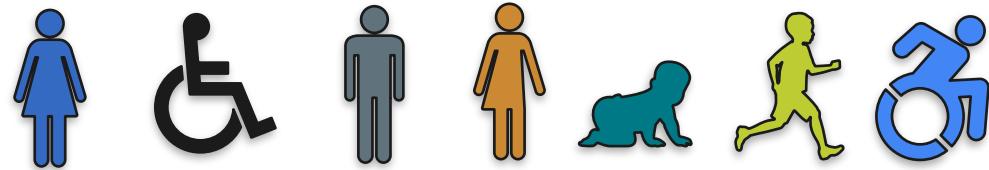
$$\frac{365}{365} \quad \frac{364}{365} \quad \frac{363}{365} \quad \frac{362}{365} \quad \frac{361}{365}$$

# Probability That Everyone Has a Different Birthday



$$\frac{365}{365} \quad \frac{364}{365} \quad \frac{363}{365} \quad \frac{362}{365} \quad \frac{361}{365} \quad \frac{360}{365}$$

# Probability That Everyone Has a Different Birthday



$$\frac{365}{365}$$

$$\frac{364}{365}$$

$$\frac{363}{365}$$

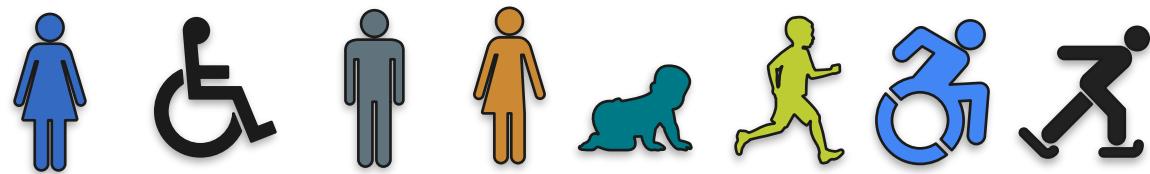
$$\frac{362}{365}$$

$$\frac{361}{365}$$

$$\frac{360}{365}$$

$$\frac{359}{365}$$

# Probability That Everyone Has a Different Birthday



$$\frac{365}{365}$$

$$\frac{364}{365}$$

$$\frac{363}{365}$$

$$\frac{362}{365}$$

$$\frac{361}{365}$$

$$\frac{360}{365}$$

$$\frac{359}{365}$$

$$\frac{358}{365}$$