



Week 4: Introduction to Probability

## **Unit 4: Examples of Bayes' Theorem in Practice**

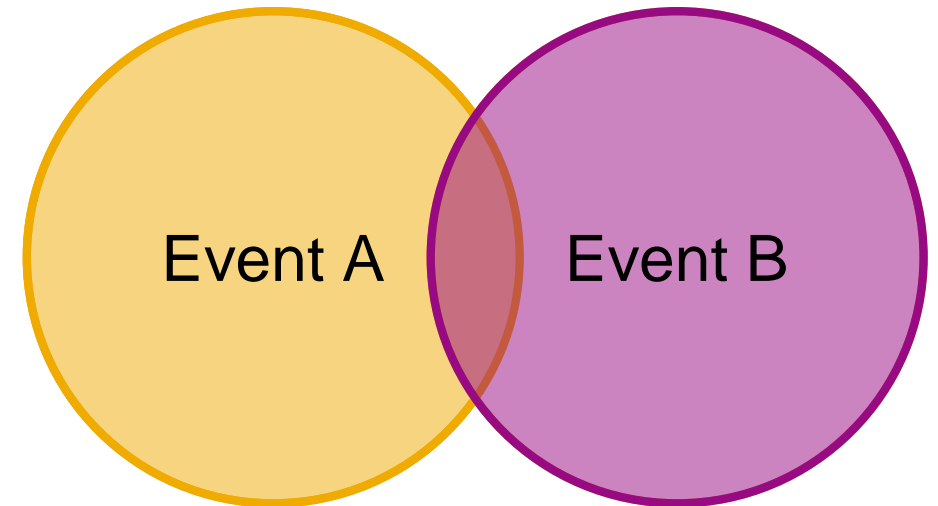
## Examples of Bayes' Theorem in Practice

### Reminder

- Let's remind ourselves of the formula:

$$P(A|B) = \frac{P(B|A) P(A)}{P(B)}$$

- That is ... **what is the likelihood of event A given the evidence we have of B.**



### Example 1 – Watching the weather!

- You look out of the window and see clouds everywhere. How do you calculate the likelihood that this will turn into rain later?

That is  **$P(R|C)$**

- You know from old weather data that rainy days start off cloudy 70% of the time:

That is  **$P(C|R) = 0.7$**

- This is the simple probability of the day having started cloudy earlier, given rain later in the day.

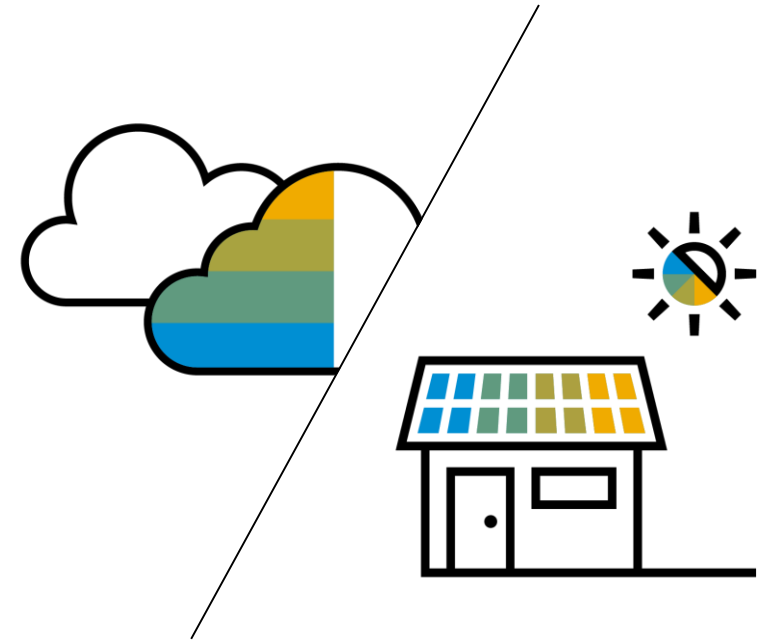
- Yet, 50% of days start off cloudy:

That is  **$P(C) = 0.5$**

- This month (June) normally only has a few cloudy days (3 days in the month, i.e. 10%):

That is  **$P(R) = 0.1$**

- What is the likelihood of rain?



## Example 1 – Watching the weather!

$$P(A|B) = \frac{P(B|A) P(A)}{P(B)}$$

$$P(\text{Rain}|\text{Cloud}) = \frac{P(\text{Cloud}|\text{Rain}) P(\text{Rain})}{P(\text{Cloud})}$$

- We know:

$$P(\text{Cloud}|\text{Rain}) = 0.7$$

$$P(\text{Rain}) = 0.1 \text{ (likelihood for June)}$$

$$P(\text{Cloud}) = 0.5$$

- Therefore, using Bayes' theorem, the probability of getting rain if it's cloudy in June is ...

$$P(\text{Rain}|\text{Cloud}) = \frac{0.7 \times 0.1}{0.5} = 0.14 \text{ or } 14\%$$



## Examples of Bayes' Theorem in Practice

### Summary

- Calculating probabilities is very useful, but it is important to be able to factor in information that will relate to and affect the probability.
- Bayes' theorem allows you to evaluate the likelihood of an event based on the occurrence of a prior event.
- This was illustrated with two very simple examples. However, Bayes' theorem can be used in much more interesting and complex ways, such as calculating the likelihood of false positives on a health screening test.



# Thank you.

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