Probability

What – How to Calculate?

Prof. Dr. Mostafa Elhosseini

https://youtube.com/drmelhosseini

Probability

- Each event in a sample space has a probability of occurring.
- Intuitively, the probability is a quantitative measure of how likely the event is to occur
- Probability is simply how likely something is to happen

Given any experiment and any event A:

- The expression **P(A)** denotes the **probability that the event A occurs**.
- P(A) is the **proportion of times that event A would occur in the long run**, if the experiment were to be **repeated over and over again**.

Probability – How to estimate?

- Repeat the experiment many times and determine the proportion of times that the event occurs
- Probabilities can be determined through knowledge of the physical nature of an experiment
- Once the probabilities of some events have been found through scientific knowledge or experience, the probabilities of other events can be computed mathematically
  - printed circuit board
  - steel pins
- In practice, **scientists and engineers estimate** the probabilities of some events on the basis of **scientific understanding and experience** and then use **mathematical rules to compute estimates** of the probabilities of other events

Axioms of Probability

Let S be a sample space. Then P(S) = 1.

- The outcome of an experiment is always in the sample space. This is obvious, because by definition the sample space contains all the possible outcomes of the experiment

Axioms of Probability

For any event A, $0 \leq P(A) \leq 1$.

- The second axiom says that the long-run frequency of any event is always between 0 and 100%.

Axioms of Probability

- If **A and B are mutually exclusive** events, then **P(A ∪ B) = P(A) + P(B)**.
- More generally, if A1, A2, . . . are mutually exclusive events, then

$$P(A1 \cup A2 \cup \cdots) = P(A1) + P(A2) + \cdots .$$

- we previously discussed a process that manufactures steel pins, in which the probability that a **pin is too short is 0.02** and the probability that a **pin is too long is 0.03**.
- The third axiom says that the probability that the pin is either too short or too long is 0.02 + 0.03 = 0.05.

Note…

- For any event A,

$$\mathbf{P(A^c) = 1 - P(A)}$$

  - Probability that an event does not occur is equal to 1 minus the probability that it does occur
  - if there is a 40% chance of rain, there is a 60% chance that it does not rain
- Let **Ø** denote the **empty set**. Then **P(Ø) = 0**
  - It is impossible for an experiment to have no outcome

Example

- You randomly draw a marble from a bag of marbles that contains 8 blue marbles, 5 green marbles, and 8 red marbles. What is P(draw a blue or red marble)?

Tips

- The probability of an event can only be between 0 and 1 and can also be written as a percentage.
- The probability of event A is often written as P(A)
- If **P(A) > P(B)**, then event A has a higher chance of occurring than event B.
- If **P(A) = P(B)** then events A and B are equally likely to occur.

References

- Understanding Boxplots https://towardsdatascience.com/understanding-boxplots-5e2df7bcbd51
- What does a box plot tell you? https://www.simplypsychology.org/boxplots.html
- Statistics for Engineers and Scientists, Fourth Edition, William Navidi Colorado School of Mines
- Khan Academy

https://www.khanacademy.org/math/cc-sixth-grade-math/cc-6th-data-statistics/cc-6th-box-whisker-plots/v/constructing-a-box-and-whisker-plot