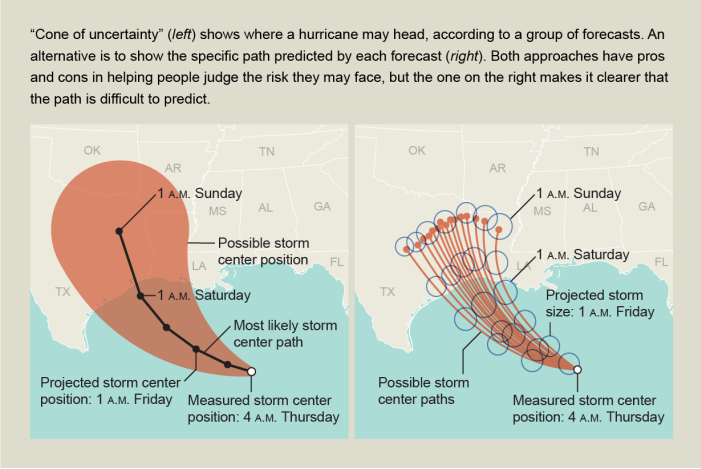
Uncertainty and Expected Value

#CMSC320 #probability_statistics #M1

Uncertainty

The idea behind **uncertainty** is that the outcome of events can be predicted but there is not garuntee that the predicted outcome will always occur, we always have some level of **uncertainty** in whether our predictions will be reflected by reality.



Definition

Uncertainty is a measure that relates to how a *predicted value may differ from the observed value*.

Purpose and Properties

Uncertainty can be used to assess the reliability of predictions

High Uncertainty

- Low Prediction Reliability
- High Outcome Variance

Low Uncertainty

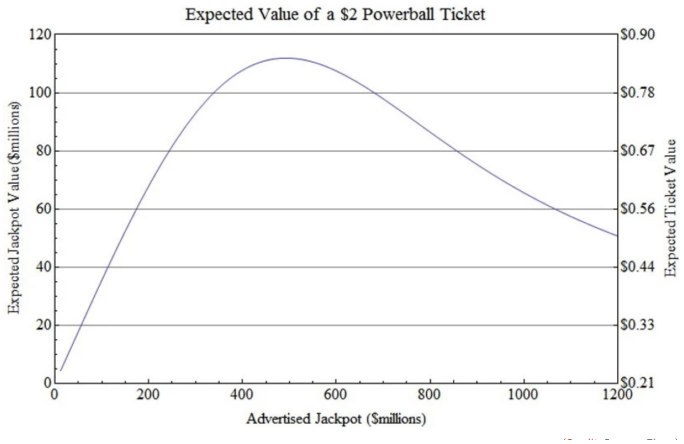
- High Prediction Reliability
- Low Outcome Variance

Examples of Uncertainty Measures

- Standard deviation
- IQR

Expected Value

Expected value is a central tendency measure (determines what is the average or typical value in a dataset). Expected value can help quantify risk and aid in decision making.



Graph of much value you expect to gain from betting on a $2 powerball ticket

Definition

Expected value is the *expected outcome* based on some *repeated trial* of a statistical experiment.

Formula

Expected value is the sum of all possible products of the value associated with a statistical outcome and its respective probability

$$E[X] = \sum x_i p(x_i)$$

Example

Suppose you are rolling a fair six-sided die, and you want to calculate the expected value of the roll. The possible outcomes are the numbers 1, 2, 3, 4, 5, and 6, each with equal probability of 1/6. What is the expected value in this scenario?

To calculate the expected value, you can use the above formula:

Expected Value = (Outcome 1 x Probability 1) + (Outcome 2 x Probability 2) + ... + (Outcome n x Probability n)

Expected Value = (1 × 1/6) + (2 × 1/6) + (3 × 1/6) + (4 × 1/6) + (5 × 1/6) + (6 x 1/6)

Expected Value = 3.5

Expected Value vs Mean

Expected Value	Mean
Expected value is the weighted average of all possible outcomes of a random variable, where the weights are the probabilities of each outcome	Mean is the arithmetic average of a set of numbers
Expected value considers all possible outcomes of a random variable	Mean only considers the values that actually occur in the data

Sources

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3. Soni, D. (2019, July 16). *What is expected value?* Medium. Retrieved March 19, 2023, from https://towardsdatascience.com/what-is-expected-value-4815bdbd84de