Probability and Random Variables (ECE313/ECE317)

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Introduction

What is this class about?

- ▶ "Probability": A language of describing uncertainties.
- ▶ "Random variables": The application of probability to quantitative measurements.
- ▶ Application of this field in real word problems.

Probability

▶ What is "Probability":

- Probability is a branch of mathematics relating the numerical illustration of how likely an event can occur.

- The likelihood of any event to occur is a number between 0 and 1.

  • 0 indicates the impossibility of the event to occur.

  • 1 indicates the certainty of the event to occur.

Application of probability

▶ **Probability** is widely used in all sectors in daily life like: sports, weather reports, disabilities, statistics, and many.

- Some of the applications of probability are predicting the outcome (or the result) when you:

- Forecast the weather
- Flipping a coin.
- Choosing a card from the deck.
- Throwing a dice.
- Winning a game.
- Winning a lottery in many millions.

Examples

- Tossing a coin:

- The outcomes will be either a **Head** or a **Tail** $\{H, T\}$.

- Tossing two coins at the same time?

- The result can be a combination of Head and Tail

$$\{(H, H), (H, T), (T, T), (T, H)\}.$$

- The correct answer can not be obtained in advance,

$\rightarrow$ only we can predict the possibility of a result $\Rightarrow$ This prediction is known as Probability.

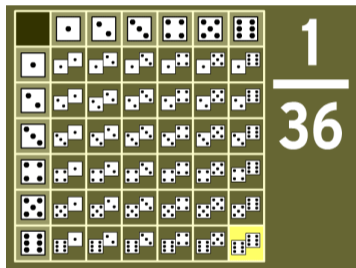**What is the probability to get (H,T)?**

Head　**Tail**
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Examples

• When two dices are rolled simultaneously:
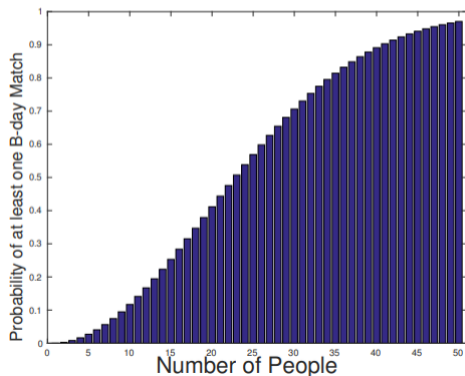The outcomes will be given as below

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

Examples

• The Birthday problem:

- Are there at least two people in this course whose birthdays happen on the same day ?

- What would you think the probability is, for a group of n people to have at least one matching birthday?

$$\mathbb{P}(n) \approx 1 - \frac{365.364.\dots.(365-n+1)}{365^n}$$

Examples

• The disease problem:
- A patient undergoes a routine medical screening and tests positive for a disease that affects 5% of the population.
- If the patient has the disease, the screening test is always positive.
- If the patient doesn't have the disease the test is negative in 90% of cases and positive for the remaining 10%.

If a patient tests positive, what is the probability that she/he

has the disease?

• In Games:
Blackjack, poker, gambling, all sports, board games, video games use probability to know **how likely a team or a person has chances to win.**

Examples

- **Weather Forecasting:**

- Before planning for an outing or a picnic, we always check the weather forecast. Suppose it says that there is a 70% chance that rain may occur. Do you ever wonder from where this 70% come from?

- Meteorologists use a specific tool and technique to predict the weather forecast: They look at all the other historical database of the days, which have similar characteristics of temperature, humidity, and pressure, etc. And determine that on 70 out of 100 similar days in the past, it had rained.

Goals of the course

After attending this class you will know

- ▶ The fundamental notions of probability theory.
- ▶ The most common uni-variate probability distributions.
- ▶ The most common multivariate probability distributions.
- ▶ Basic methods to estimate quantities from data.
- ▶ Some basic statistical tests (if time allows).