MATH1401

Fall 2021

Lecture 14

Probability and Simulations

Class Checklist

- **Lab 5 – Due Date** : Friday 10/22 – 9 PM
  - Graded Questions : 1.1-1.5, 2.1-2.3, 3.1-3.3
- **Quiz 11** – Tuesday: 10/19 – Covers Chapter 9.3
- **Quiz 12** – Thursday: 10/21 – Covers Chapter 10

Lecture 14 Checklist

- **Understand the Monty Hall Problem**

- **Find Probabilities**
  - An event that does not happen - Complements
  - When two events both must happen - Intersection
  - When an event can happen in two ways - Addition
  - When at least one event must happen - Or

Control Statements

Control Statements: if

These statements *control* the sequence of computations that are performed in a program

- The purpose of `if` is to define functions that choose different behavior based on their arguments

if <conditional>:
<if body>

if x>y:
print(‘oka’)

Control Statements: For

These statements *control* the sequence of computations that are performed in a program

- The purpose of **`for`** is to perform a computation for every element in a list or array

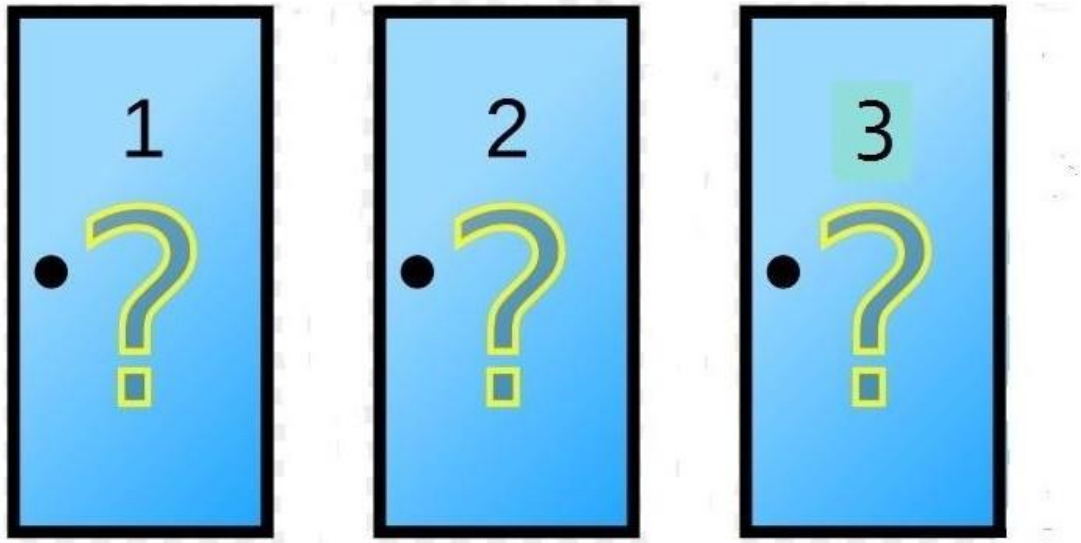
For i in array:
<for body>

for i in np.arrange(1,10):
print(i)

(Demo)

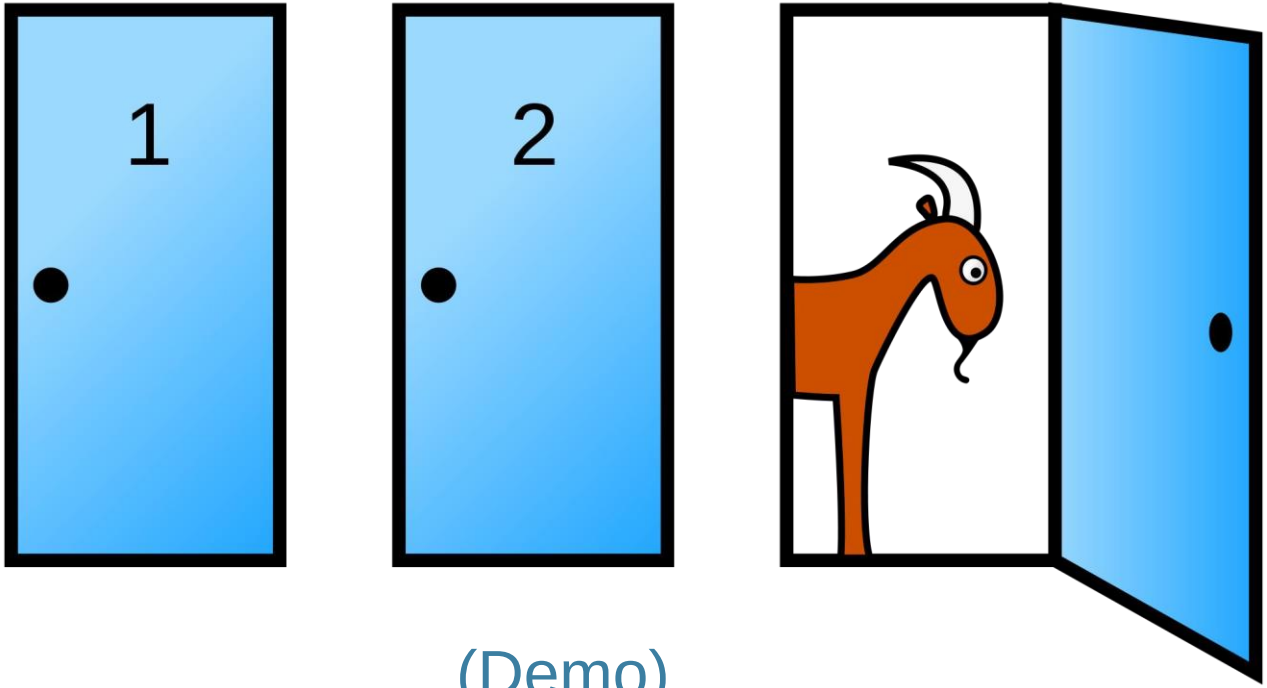
The Monty Hall Problem

Monty Hall Problem



https://probabilityandstats.files.wordpress.com/2017/05/monty-hall-pic-1.jpg

The Final Choice



https://en.wikipedia.org/wiki/Monty_Hall_problem

(Demo)

Probability

Basics

- **Lowest value**: 0
  - Chance of event that is impossible
- **Highest value**: 1 (or 100%)
  - Chance of event that is certain

- **Complement**: If an event has chance 70%, then the chance that it doesn’t happen is
  - 100% - 70% = 30%
  - 1 - 0.7 = 0.3

Equally Likely Outcomes

Assuming all outcomes are equally likely, the chance of an event A is:

$$P(A) = \frac{\text{number of outcomes that make } A \text{ happen}}{\text{total number of outcomes}}$$

Multiplication Rule

Chance that two events *A* and *B* both happen

= P(*A* happens) x P(*B* happens given that *A* has happened)

- The answer is *less than or equal to* each of the two chances being multiplied
- The more conditions you have to satisfy, the less likely you are to satisfy them all

A Question

- I have three cards: **ace of hearts**, **king of diamonds**, and **queen of spades**.
- I shuffle them and draw two cards *at random without replacement.*

- What is the chance that I get the Queen followed by the King?

(Demo)

Addition Rule

If event *A* can happen in *exactly one* of two ways, then

$$P(A) = P(\text{first way}) + P(\text{second way})$$

- The answer is *greater than or equal to* the chance of each individual way

Another Question

- I have three cards: **ace of hearts**, **king of diamonds**, and **queen of spades**.
- I shuffle them and draw two cards *at random without replacement.*

- What is the chance that one of the cards I draw is a King and the other is Queen?

(Demo)

Complement: At Least One Head

- In 3 tosses:
  - Any outcome *except* TTT
  - P(TTT) = (1/2) x (1/2) x (1/2) = 1/8
  - P(at least one head) = 1 - P(TTT) = 1 - (1/8) = 87.5%

- In 10 tosses:
  - 1 - (1/2)**10 ≅ 99.9%

(Demo)