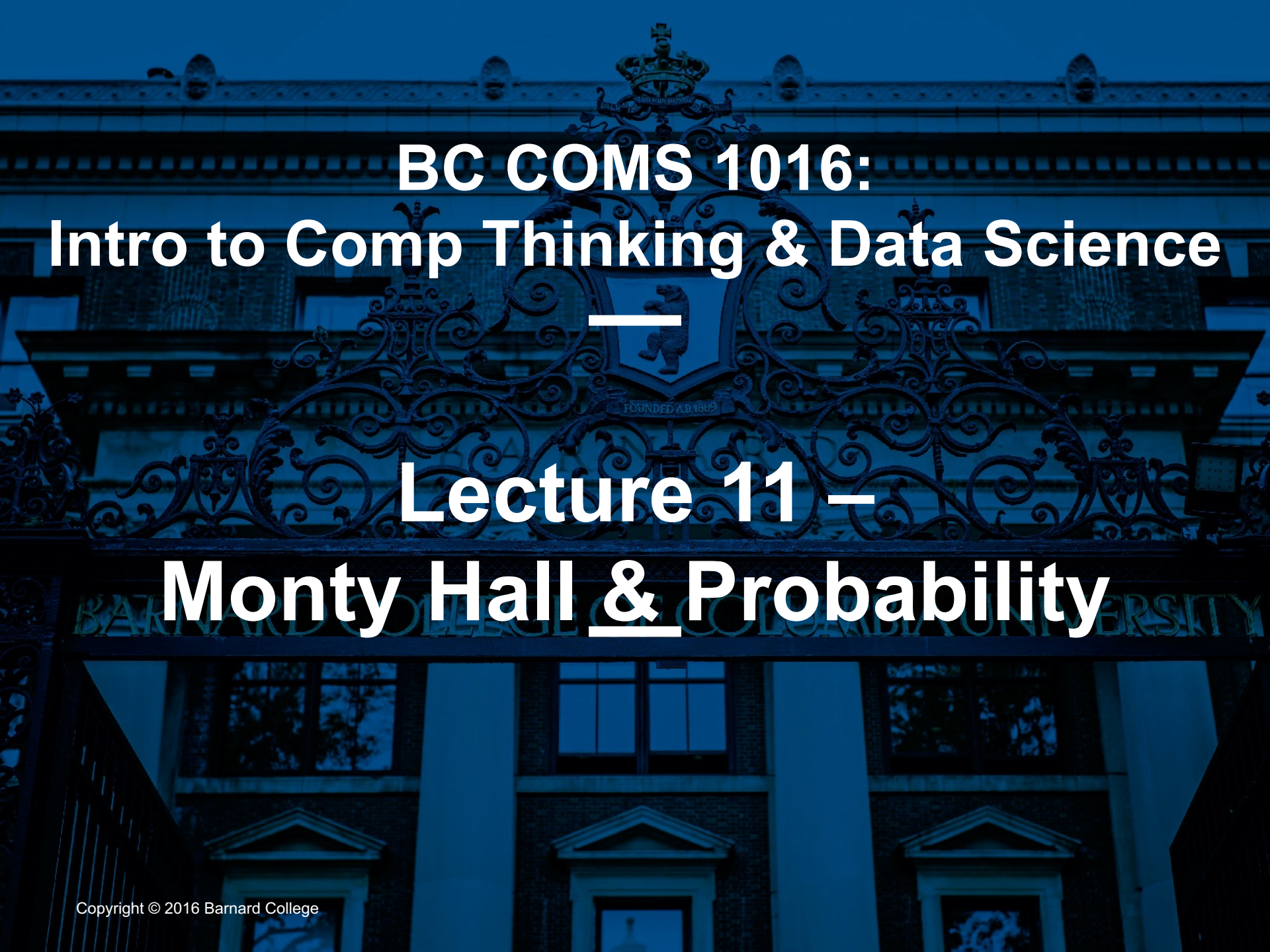

BC COMS 1016:
Intro to Comp Thinking & Data Science

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Lecture 11 –
Monty Hall & Probability

Announcements

- HW04 - Applying Functions and Iteration
  - Due Tuesday (03/01)
- Lab 04 - Lab 4 – Simulations
  - Due Monday (02/28)
- Checkpoint/Project 1:
  - Paired assignment that covers the previous section of the course material
  - Due Thursday (03/03)
  - Recommended to complete first 8 questions by today/tomorrow
  - If you want a partner, stay after class

Control Statements

Control Statements

These statements *control* the sequence of computations that are performed

- The keywords if and for begin control statements
- The purpose of if is to define functions that choose different behavior based on their arguments
- The purpose of for is to perform a computation for every element in a list or array

- for name in sequence:
  BODY where we use the value in the name

Experimentation & Simulation

Experimentation

- Why do we want to run experiments?
  - Test a hypothesis
- What could a hypothesis be in our previous (coin flipping) experiment?
  - Is a coin loaded, i.e. not fair
  - ….

How to run an experiment/test a hypothesis

- Step 1: Choose a measurement/statistic to study
  - Textbook lingo: what to simulate
- Step 2: Figure out how to compute the measurement
  - Textbook lingo: figure out how to simulate the statistic
- Step 3: Choose how many times to simulate the statistics
  - Textbook lingo: Number of Repetitions
- Step 4: Do it!
  - Textbook lingo: simulate multiple values

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func for np.append()

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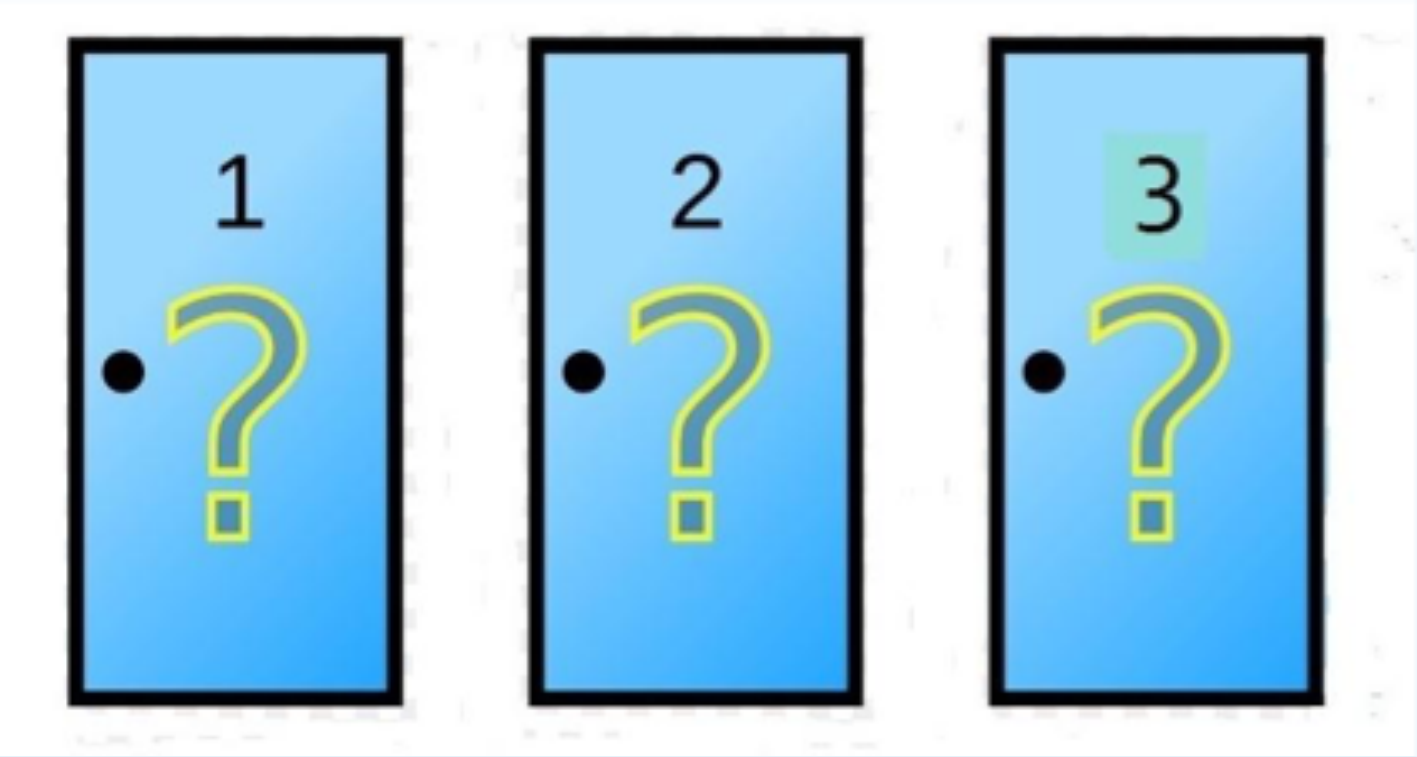
How to Simulate multiple values

- Collection array
  - empty array to store the simulated values/statistic
  - make_array()
- Create a “repetitions sequence”:
  - A sequence as long as the number of iterations. For n repitions, use the sequence np.arange(n)
- Create a for loop. For each element:
  - Simulate *one* value by using the function you wrote in Step 2.
  - Augment the collection array with this simulated value.

Monty Hall Problem

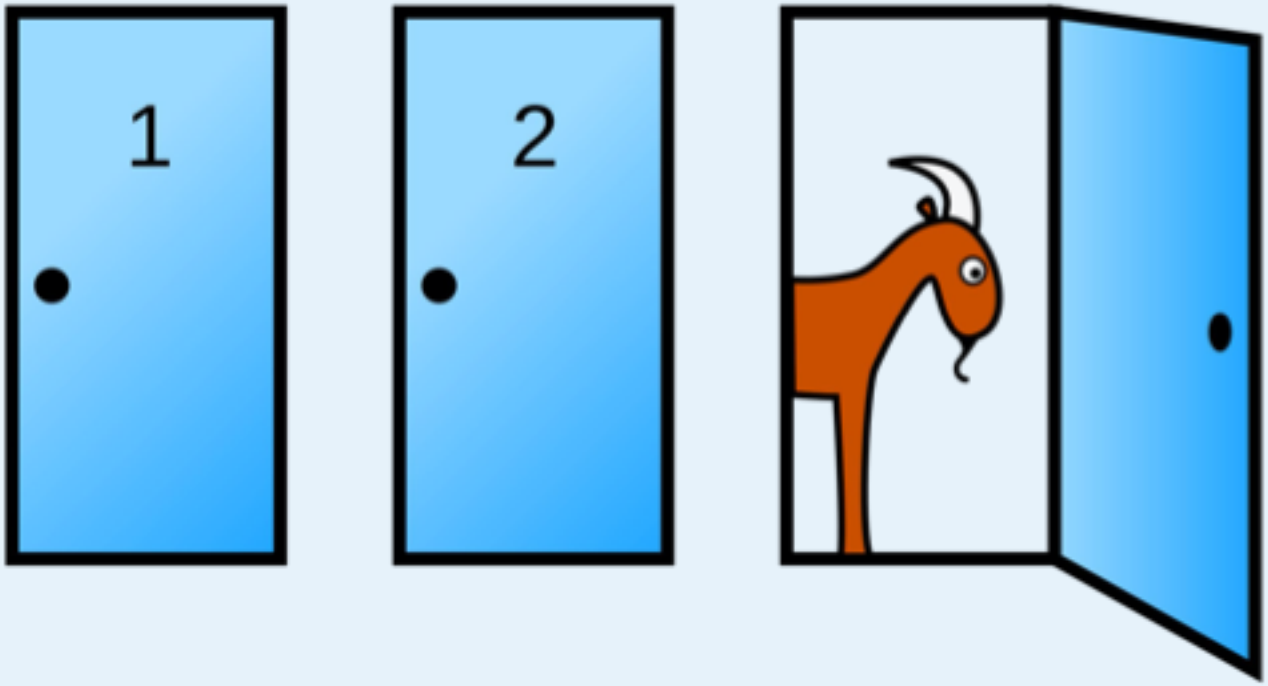
https://miro.medium.com/max/680/1*qZ9S-OE6Og3S5hxrOdni8g.jpeg

Monty Hall Problem

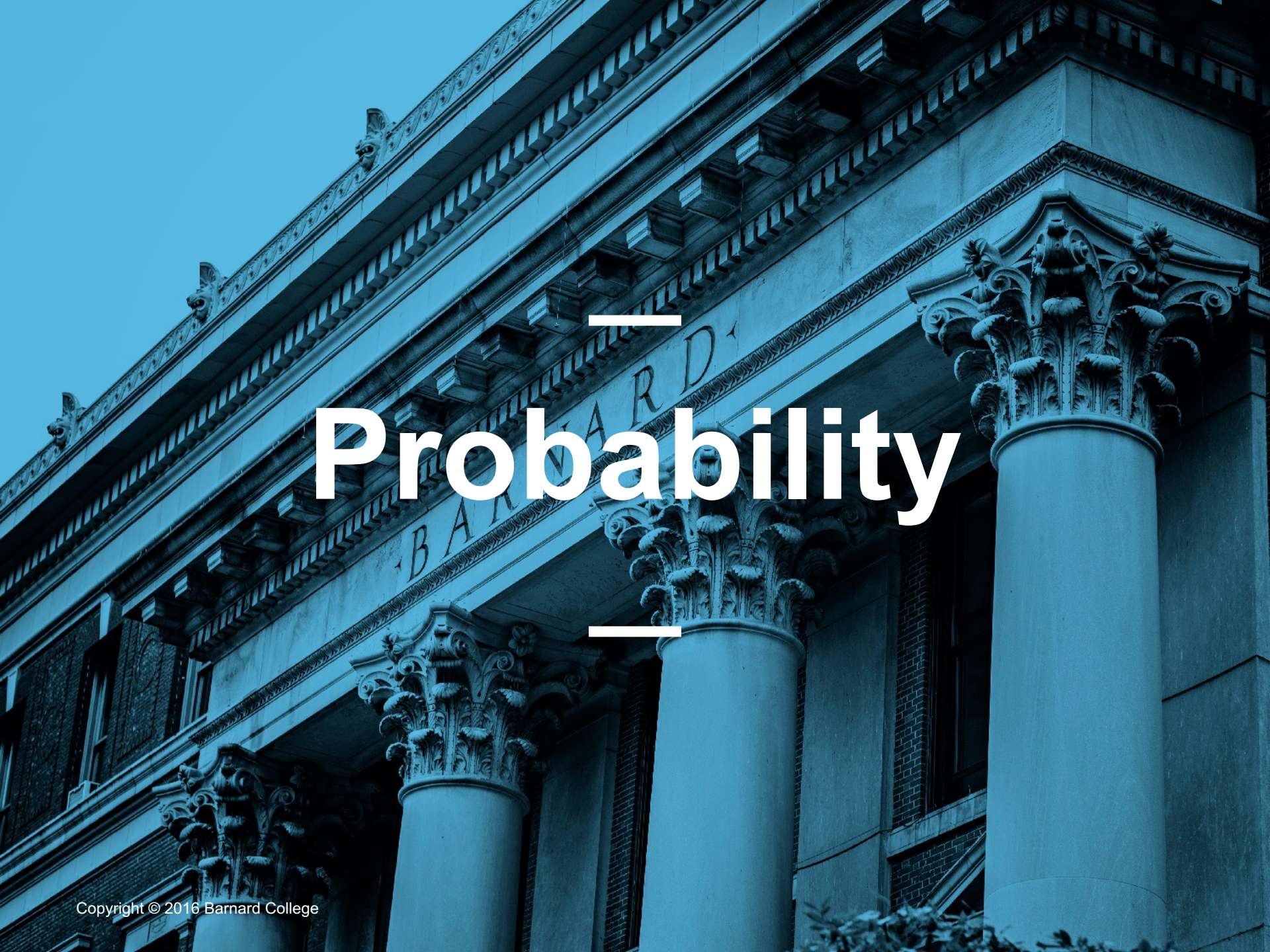


https://probabilityandstats.files.wordpress.com/2017/05/monty-hall-pic-1.jpg

Monty Hall Problem



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



Probability

Basics

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

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

Equally Likely Outcomes

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

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

A Question

- I have 3 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?

Approach 1: Enumerate all outcomes

- What is the chance that I get the Queen followed by the King?
    1. Queen, King
    2. Queen, Ace
    3. Ace, King
    4. Ace, Queen
    5. King, Queen
    6. King, Ace

Approach 1: Enumerate all outcomes

- What is the chance that I get the Queen followed by the King?
  1. Queen, King
  2. Queen, Ace
  3. Ace, King
  4. Ace, Queen
  5. King, Queen
  6. King, Ace

Approach 1: Enumerate all outcomes

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

1. Queen, King
2. Queen, Ace
3. Ace, King
4. Ace, Queen
5. King, Queen
6. King, Ace

- Answer: 1/ 6

Approach 2: Probabilities of the sequences

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

- What's the probability I first draw Queen and what's the probability I then draw King

Approach 2: Probabilities of the sequences

- Step 1:
  - Draw Queen from {Ace, King, Queen}
  - What's the probability of drawing Queen? **1/3**
- Step 2:
  - Draw King from {King, Ace}
  - What's the probability of drawing King? **1/2**
- Combining them:
  - What's 1/2 of 1/3? **1/6**

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

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

Complement: At Least One Head

- What the probability that I flip coins and I get at least one head?
- In 3 tosses:
  - Any outcome *except* TTT (tails, tails, tails)
  - 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%