STATISTICAL SIMULATION IN PYTHON

Probability Basics

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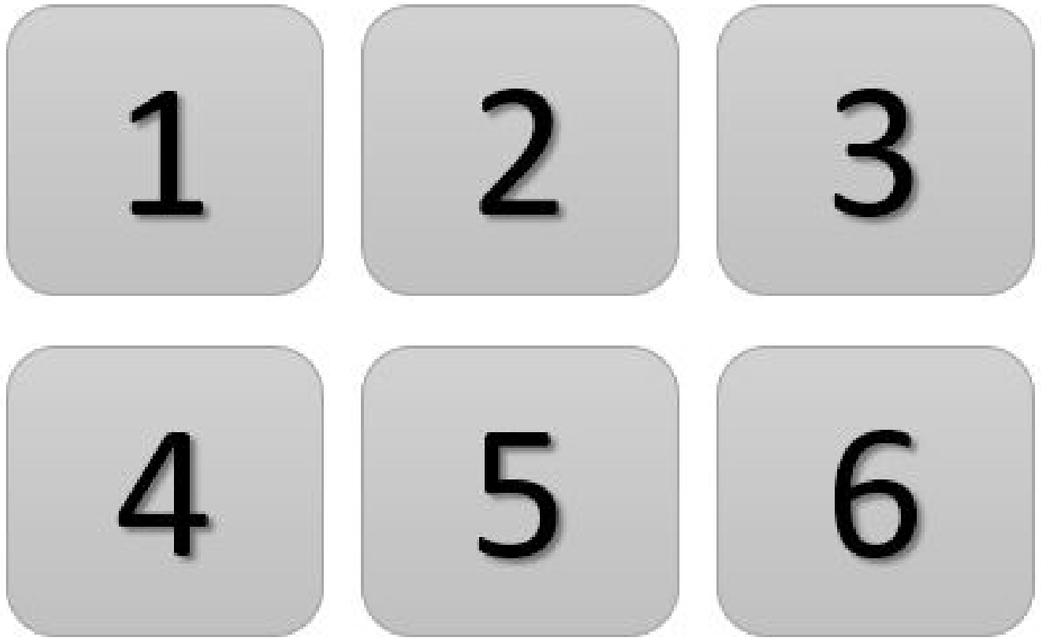
Data Scientist

Sample Space

Sample Space S: Set of all possible outcomes



Probability

Sample Space S: Set of all possible outcomes

Probability $P(A)$: Likelihood of event A

- $0 \leq P(A) \leq 1$
- $P(S) = 1$ *eg.* $P(H) + P(T) = 1$

Probability

Sample Space S: Set of all possible outcomes

Probability $P(A)$: Likelihood of event A

- $0 \leq P(A) \leq 1$
- $P(S) = 1$ *eg.* $P(H) + P(T) = 1$

Mutually Exclusive Events

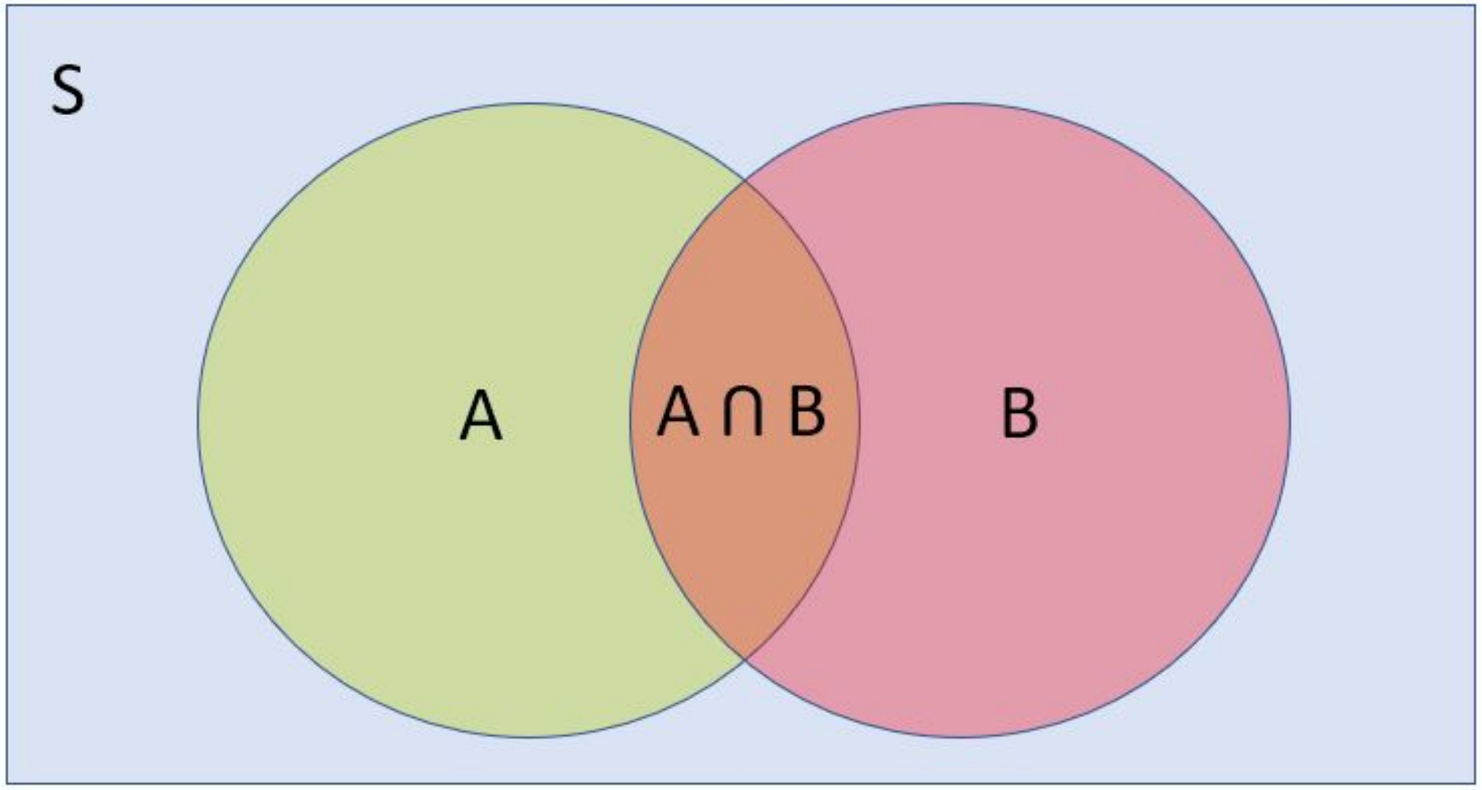
Sample Space S: Set of all possible outcomes

Probability $P(A)$: Likelihood of event A

- $0 \leq P(A) \leq 1$
- $P(S) = 1$
  - $P(H) + P(T) = 1$
- For mutually exclusive events A and B:
  - $P(A \cap B) = 0$
  - $P(A \cup B) = P(A) + P(B)$

Probability

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$



Using Simulation for Probability Estimation

Steps for Estimating Probability:

1. Construct sample space or population.
2. Determine how to simulate one outcome.
3. Determine rule for success.
4. Sample repeatedly and count successes.
5. Calculate frequency of successes as an estimate of probability.

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Let's practice!

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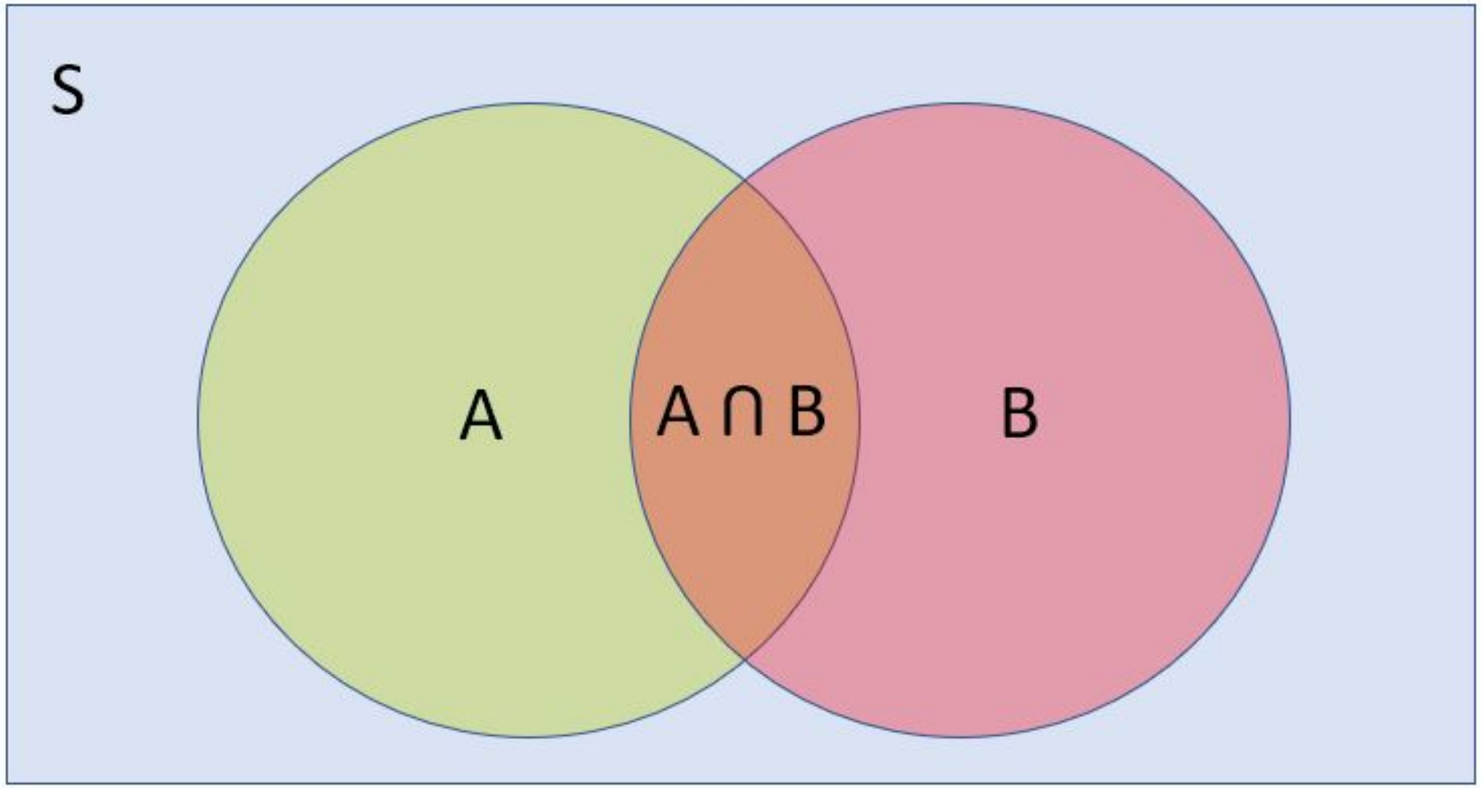
More Probability Concepts

Conditional Probability

- Conditional Probability
  - $P(A|B) = \frac{P(A \cap B)}{P(B)}$



Conditional Probability

- Conditional Probability
  - $P(A|B) = \frac{P(A \cap B)}{P(B)}$
  - $P(B|A) = \frac{P(B \cap A)}{P(A)}$
  - $P(A \cap B) = P(B \cap A)$

Bayes Rule

- Conditional Probability
  - $P(A|B) = \frac{P(A \cap B)}{P(B)}$
  - **Bayes' rule**: $P(A|B) = \frac{P(B|A)P(A)}{P(B)}$

Independent Events

- Independent Events
  - $P(A \cap B) = P(A)P(B)$
  - Conditional Probability: $P(A|B) = \frac{P(A \cap B)}{P(B)} = \frac{P(A)P(B)}{P(B)} = P(A)$

Solar Panels & Clean Vehicles

- Number of houses = 150

	Solar Panels	No Solar Panels	
Hybrid / EV	$^{30}/_{150}$	$^{50}/_{150}$	
No Hybrid / EV	$^{10}/_{150}$	$^{60}/_{150}$	
			150

Solar Panels & Clean Vehicles

$$P(\text{Solar}) = P(\text{Solar} \cap \text{Hybrid, EV}) + P(\text{Solar} \cap \text{No Hybrid, EV}) = \frac{30}{150} + \frac{10}{150} = \frac{40}{150}$$

	Solar Panels	No Solar Panels	
Hybrid / EV	$^{30}/_{150}$	$^{50}/_{150}$	$^{80}/_{150}$
No Hybrid / EV	$^{10}/_{150}$	$^{60}/_{150}$	$^{70}/_{150}$
	$^{40}/_{150}$	$^{110}/_{150}$	$^{150}/_{150}$

Solar Panels & Clean Vehicles

$$P(\text{Solar}|\text{Hybrid, EV}) = \frac{P(\text{Solar} \cap \text{Hybrid, EV})}{P(\text{Hybrid, EV})} = \frac{30}{80} = 0.375$$

	Solar Panels	No Solar Panels	
Hybrid / EV	$^{30}/_{150}$	$^{50}/_{150}$	$^{80}/_{150}$
No Hybrid / EV	$^{10}/_{150}$	$^{60}/_{150}$	$^{70}/_{150}$
	$^{40}/_{150}$	$^{110}/_{150}$	$^{150}/_{150}$

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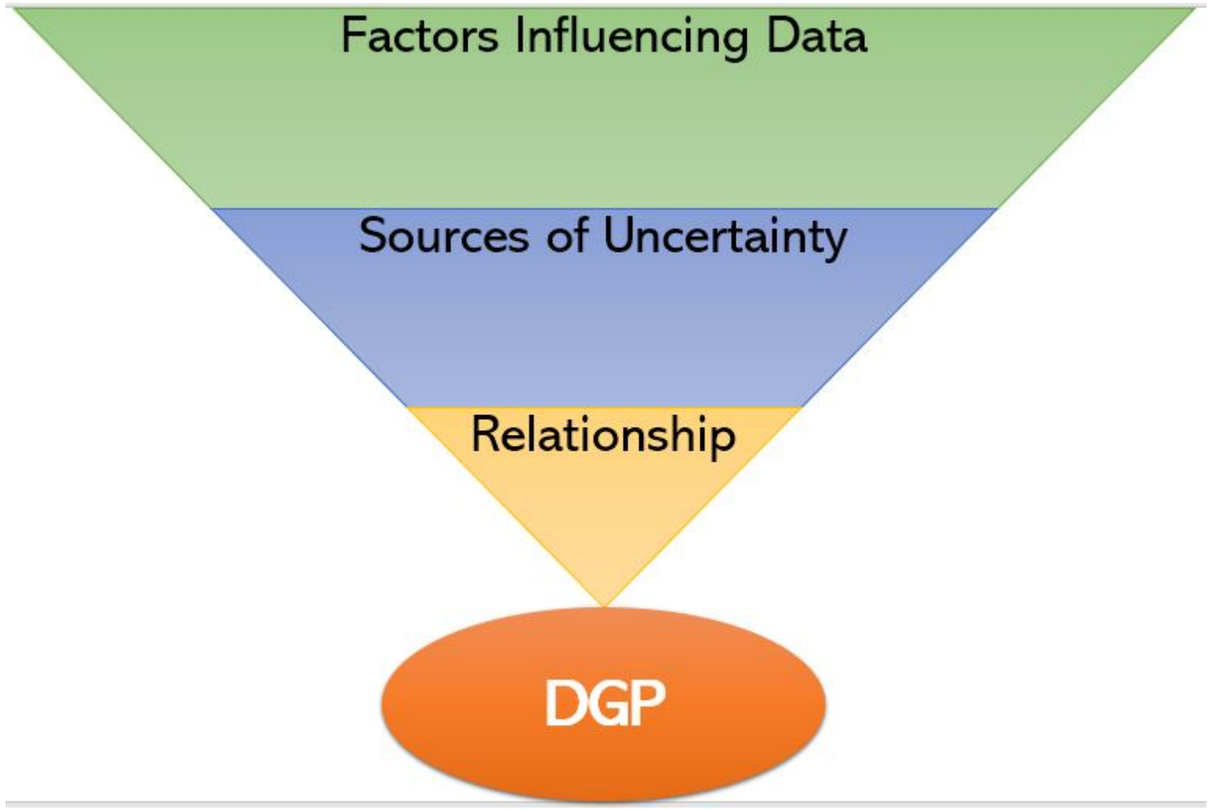
Data Generating Process

Simulation Steps

1. Define Possible Outcomes for Random Variables.
2. Assign Probabilities.
3. Define Relationships between Random Variables.

Data Generating Process



Cricket

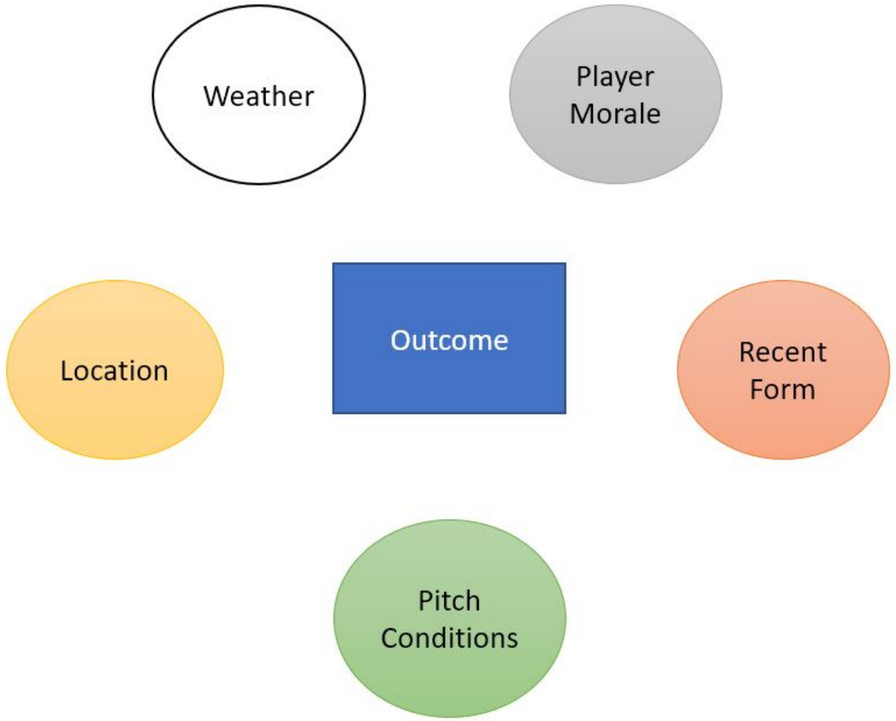
India

vs

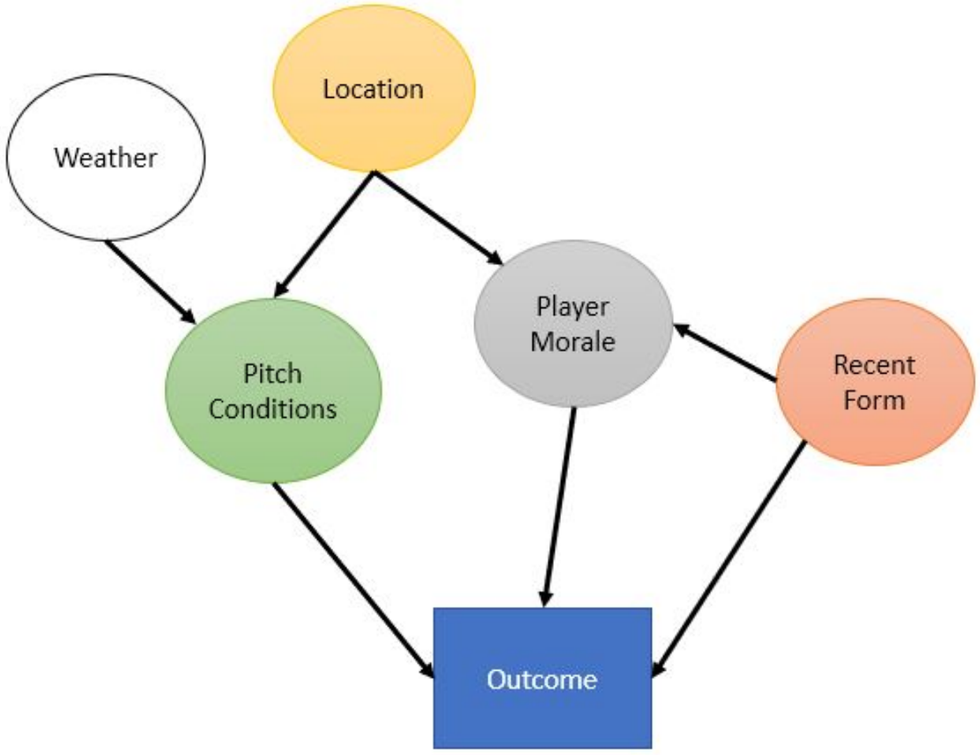
England

source: Wikipedia

Cricket


Weather
Player Morale
Location
Outcome
Recent Form
Pitch Conditions

Cricket


Location
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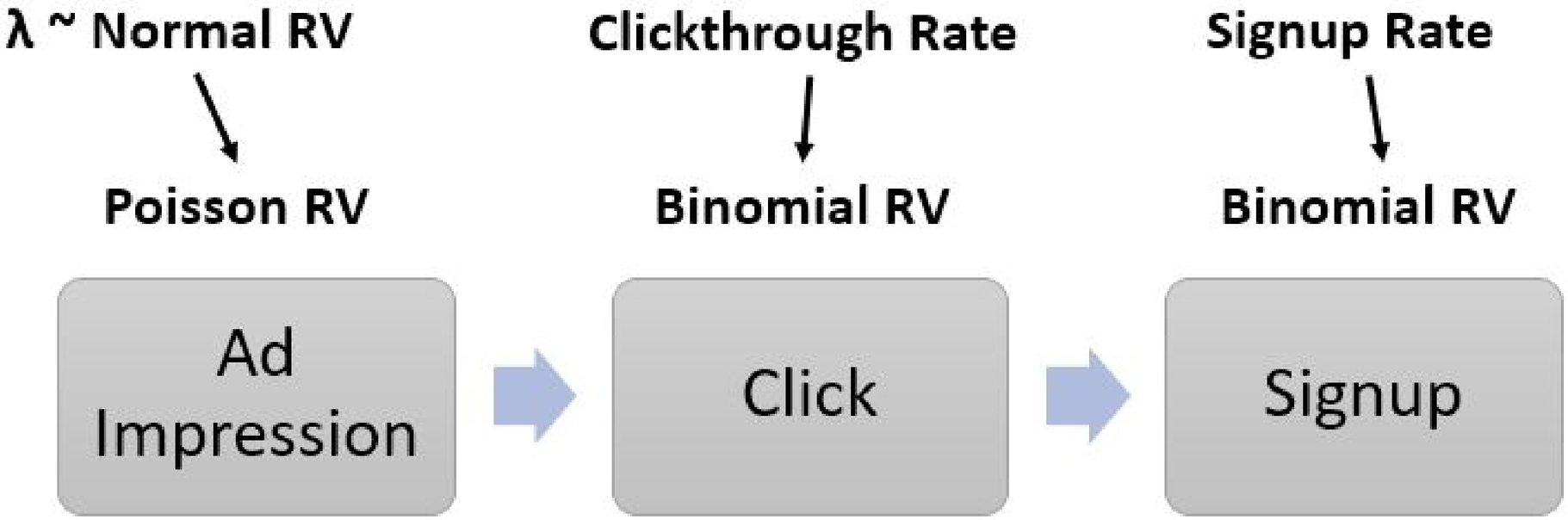
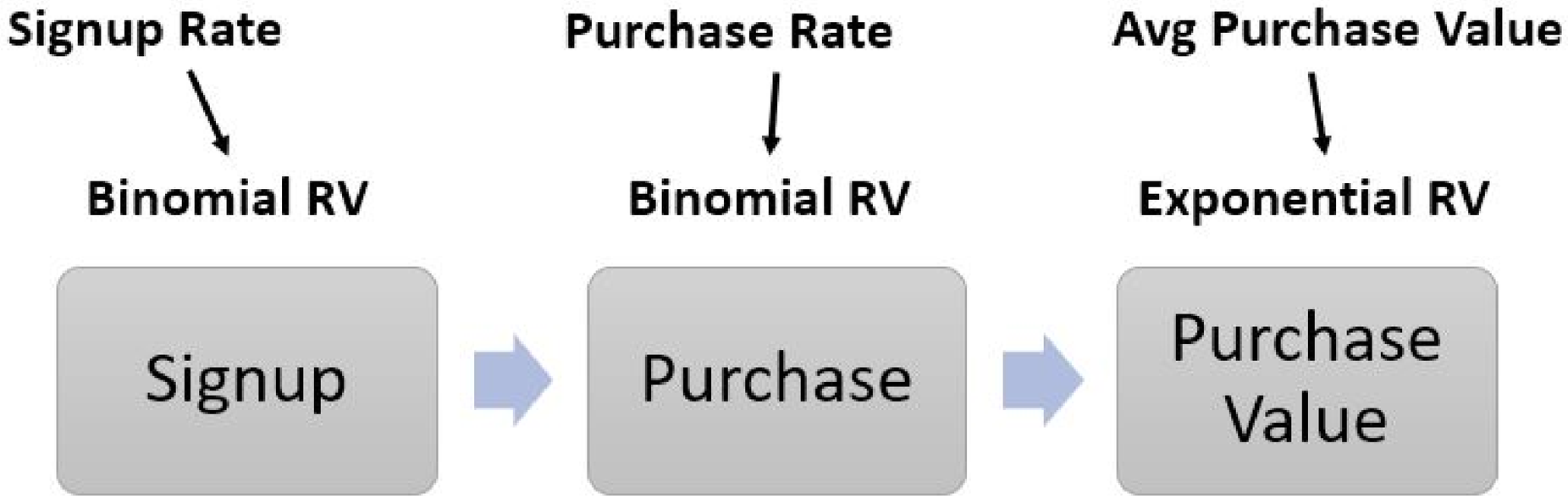
eCommerce Ad Simulation

eCommerce Funnel

Signup Flow


λ ~ Normal RV
Poisson RV
Clickthrough Rate
Binomial RV
Signup Rate
Binomial RV
Ad Impression
Click
Signup

Purchase Flow



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Let's practice!