Advanced applications of simulation

STATISTICAL SIMULATION IN PYTHON

Tushar Shanker
Data Scientist

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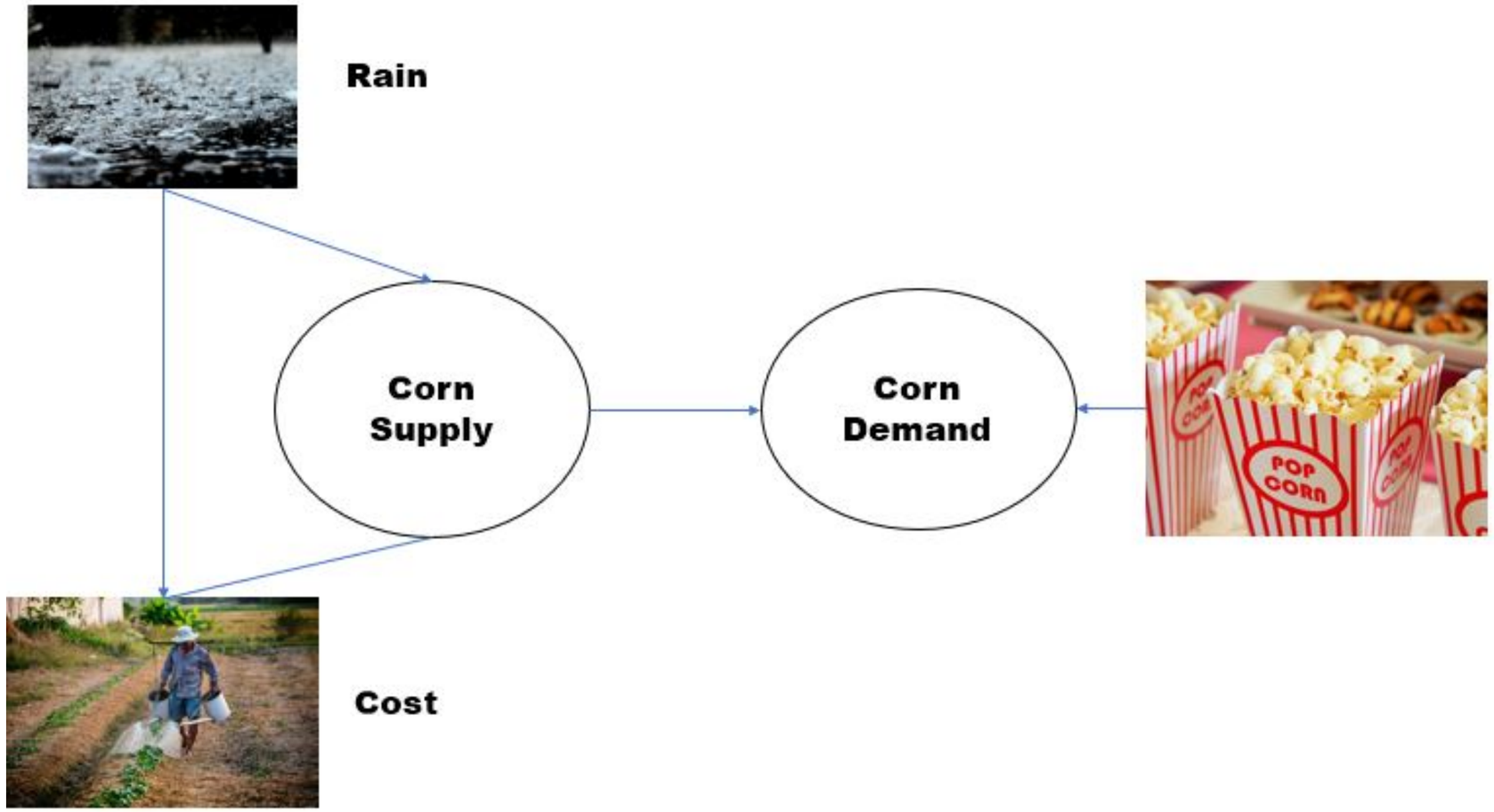
Overview

- Simulation for Business Planning
- Monte Carlo Integration
- Simulation for Power Analysis
- Portfolio Simulation

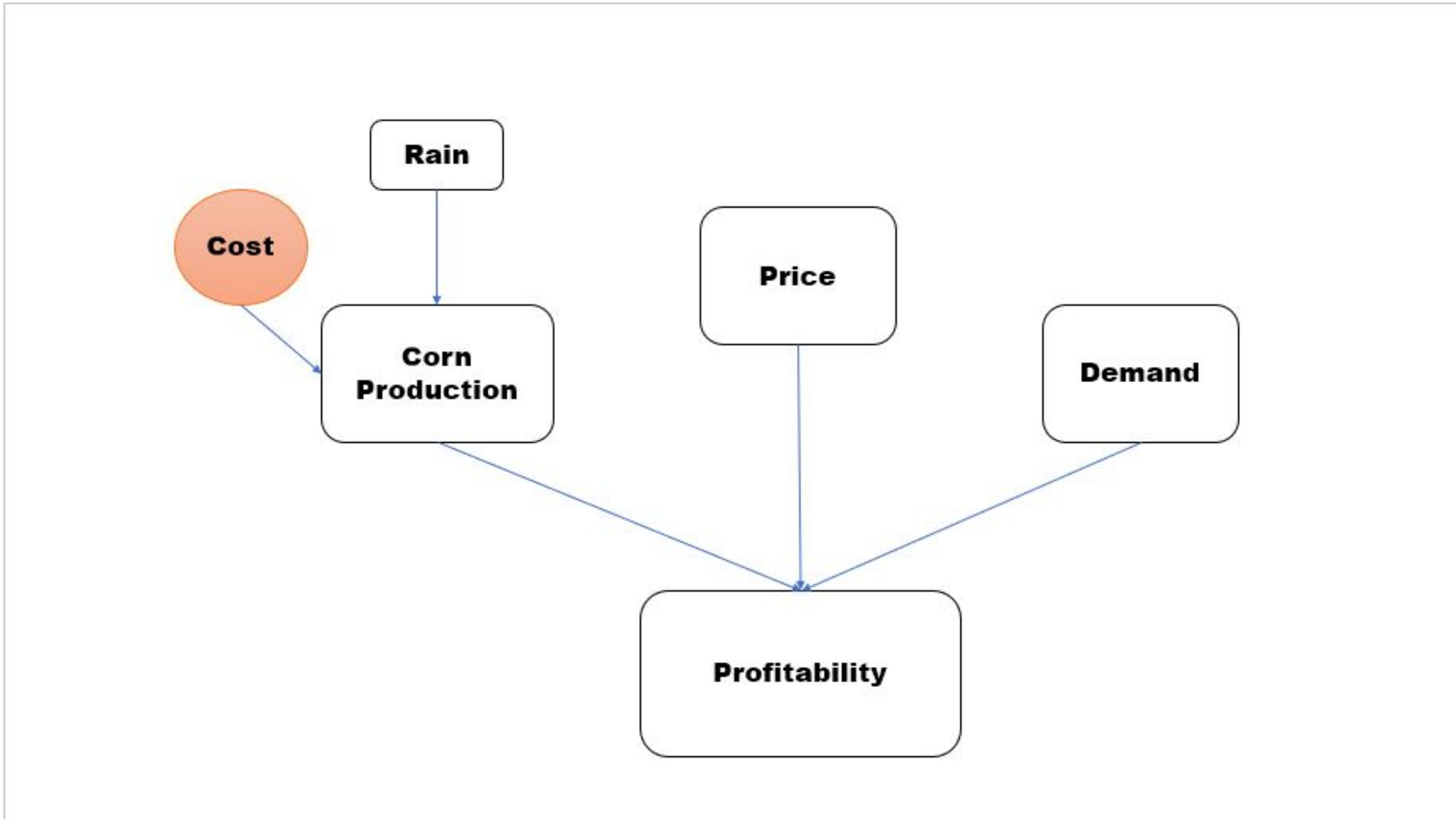
Simulation for business planning

Corn Farm

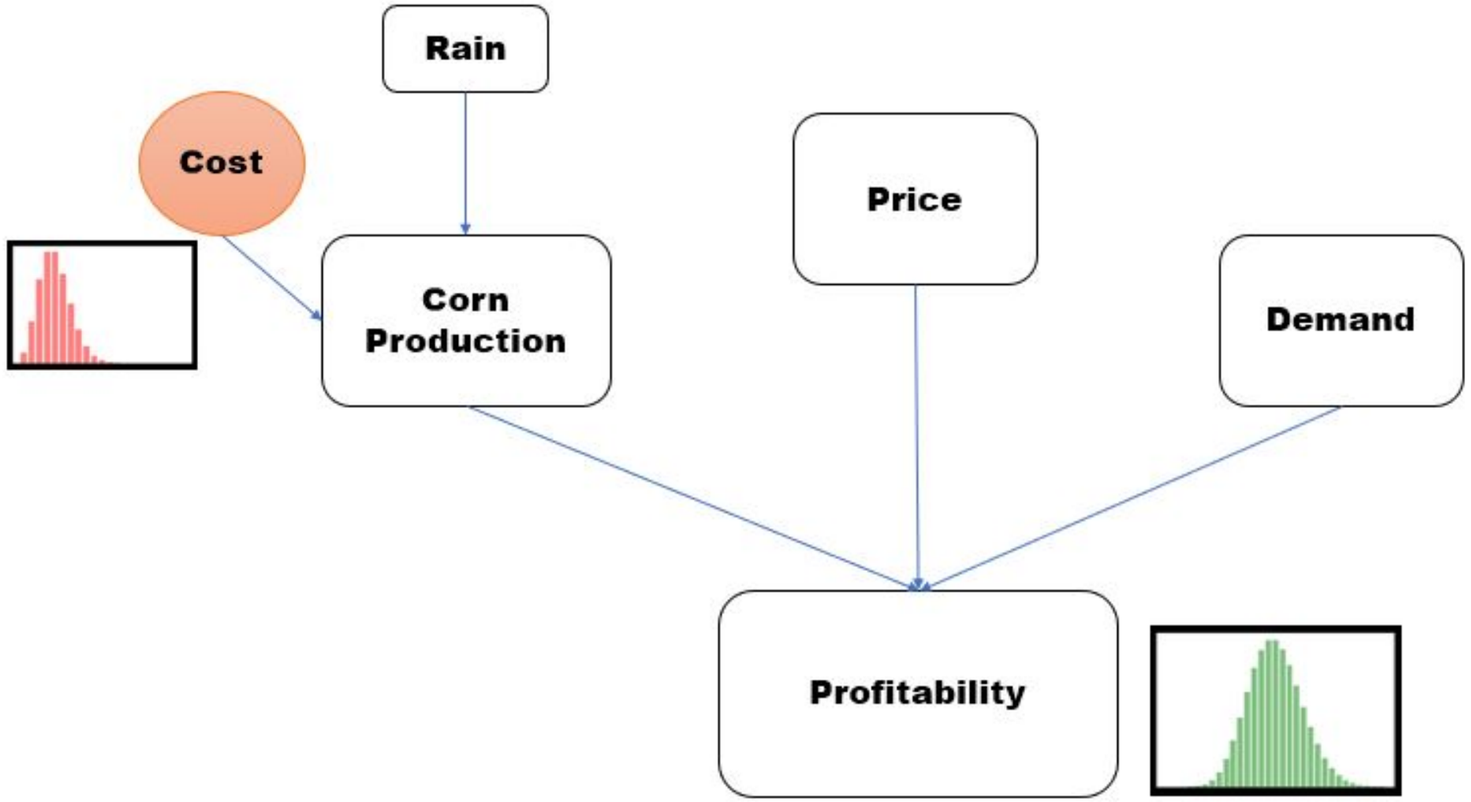
Corn farm



Business profitability



Business profitability



Let's practice!

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Monte Carlo integration

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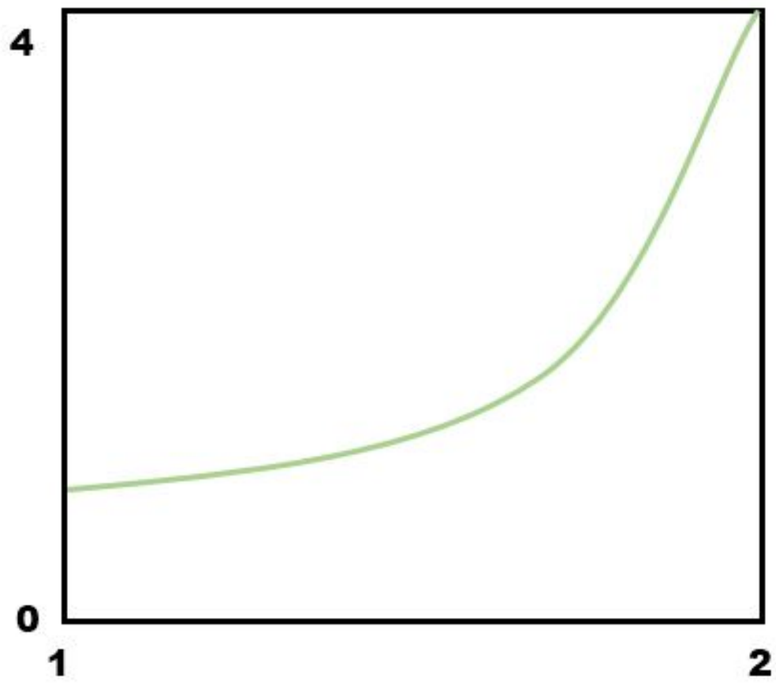
Definite integration

$$\int_1^2 x^2 dx = \frac{x^3}{3}|_1^2 = \frac{7}{3} \approx 2.3333$$

Monte Carlo integration

- Calculate overall area.
- Randomly sample points in the area.
- Multiply the fraction of the points below the curve by overall area.

- $f(x) = x^2$



Monte Carlo integration

- **Calculate overall area.**
- Randomly sample points in the area.
- Multiply the fraction of the points below the curve by overall area.

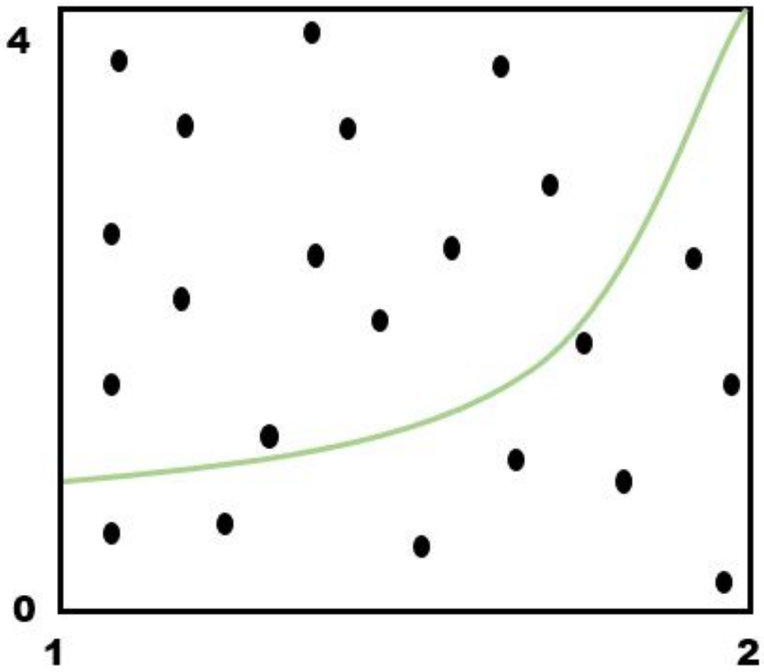
Calculate Overall Area

- $\int_1^2 x^2 dx$
- $x_{min} = 1, x_{max} = 2$
- $\min(0, f_{min}(x)) = 0, f_{max}(x) = 4$
- $\text{Overall Area} = 4$

Monte Carlo integration

- Calculate overall area.
- **Randomly sample points in the area.**
- Multiply the fraction of the points below the curve by overall area.

Random Sampling

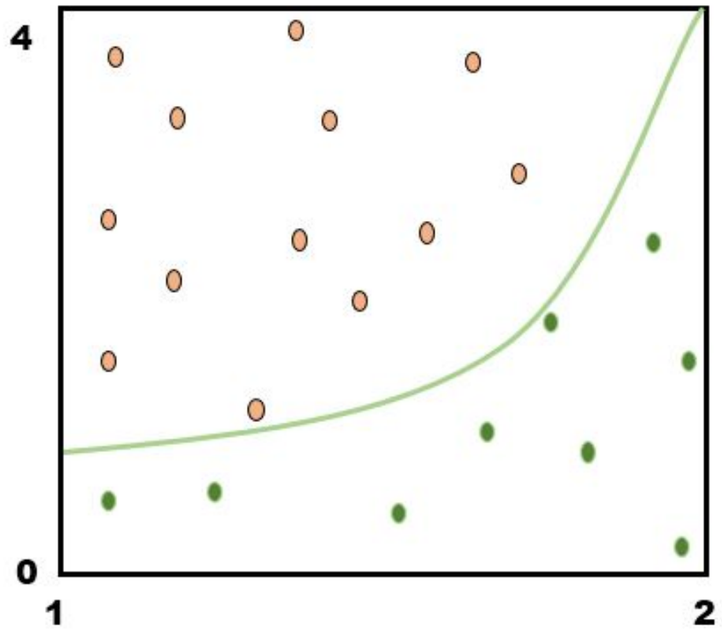


Monte Carlo integration

- Calculate overall area.
- Randomly sample points in the area.
- **Multiply the fraction of the points below the curve by overall area.**

Fraction of Area

- $\text{Overall Area} \times \text{fraction} = 2.303$
- $\text{Actual Answer} = 2.333$



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Simulation for power analysis

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What is power?

- **What Is Power? - Statistics Teacher**
- $\text{power} = P(\text{rejecting Null} | \text{true alternative})$
- Probability of detecting an effect if it exists.
- Depends on sample size, α and effect size.
- Typically 80% power recommended for $\alpha = 0.05$.

News media website

Treatment:
Faster Loading Time

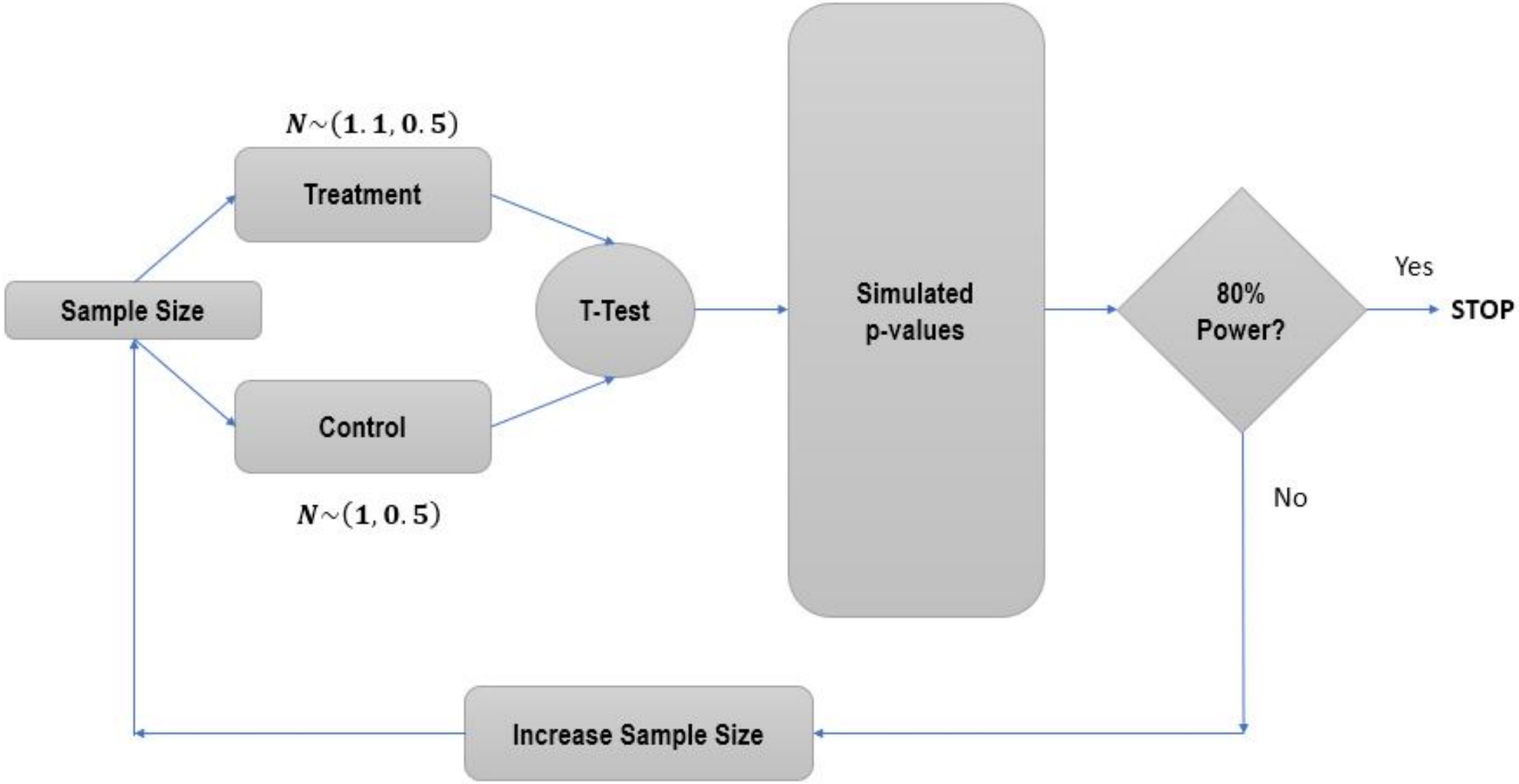
Effect Size: 10%

Power: 80%

Sig Level: 0.05

Sample Size: ?

Simulation for power analysis



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Applications in Finance

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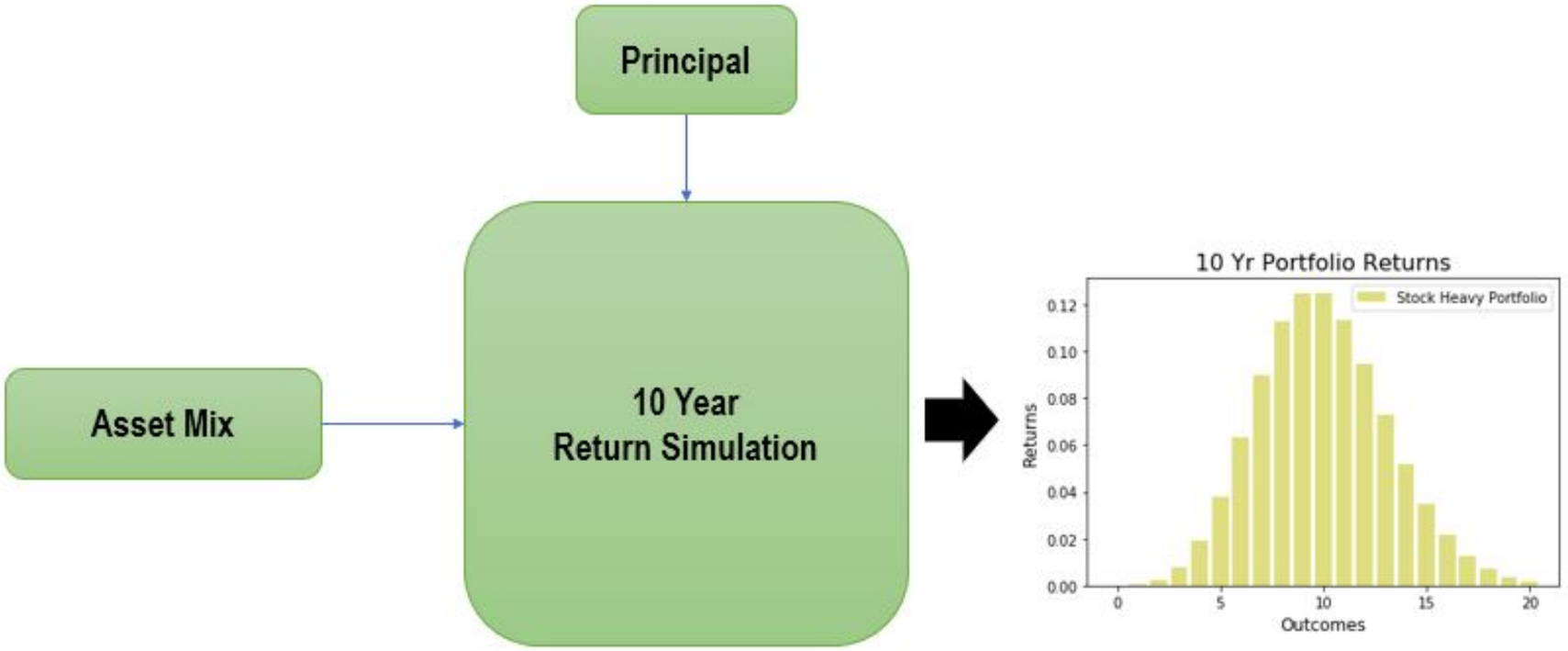
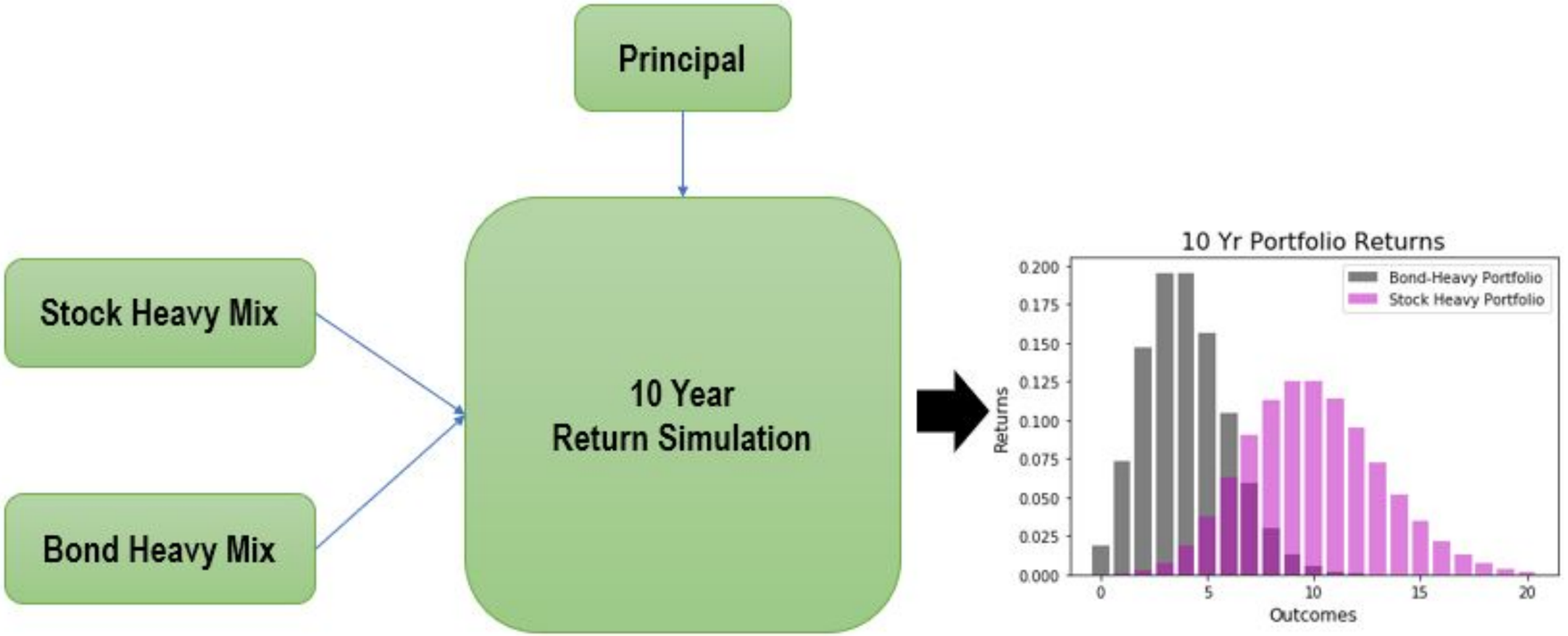
Applications in Finance

- Option & Instrument Pricing
- Project Finance
- Portfolio Evaluation

Portfolio Simulation



Portfolio Simulation



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Wrap up

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Simulation concepts covered

- Basics of Random Variables
- Simulation for Probability
- Data Generating Process
- Resampling Methods
- Monte Carlo Integration

Real-World applications designed

- eCommerce Ad Simulation
- Website Design for Donation
- Corn Production
- Portfolio Simulation

Thank You & Good Luck!

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