STATISTICAL SIMULATION IN PYTHON

Advanced applications of simulation

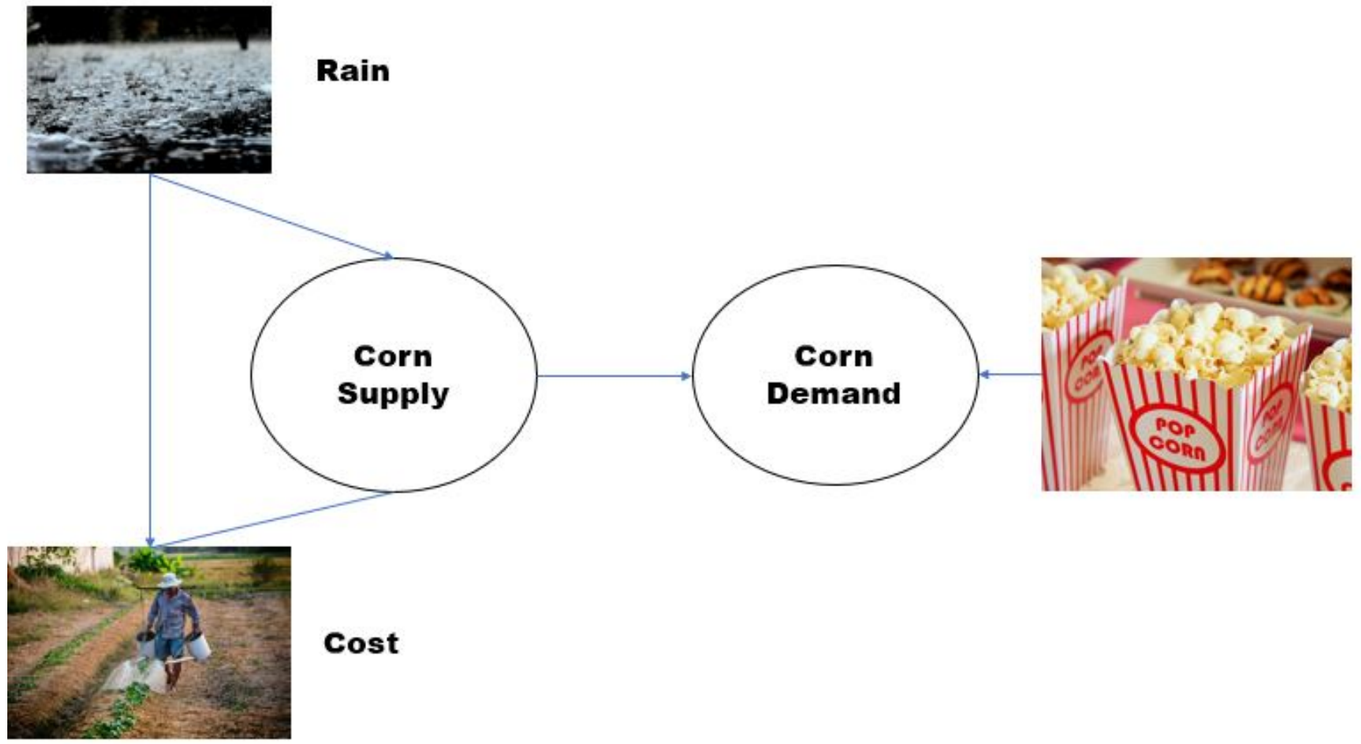
Overview

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

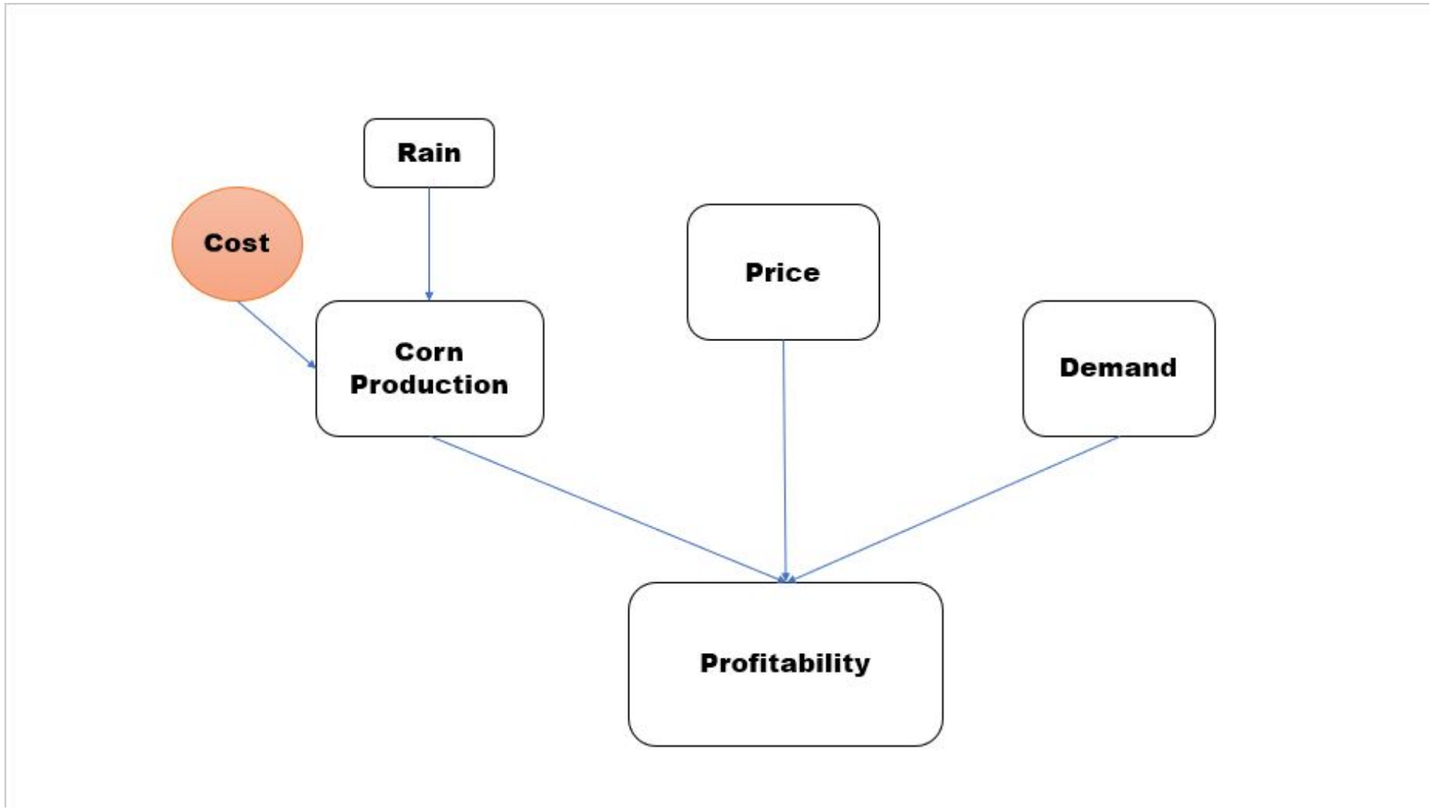
Simulation for business planning

CORN FARM

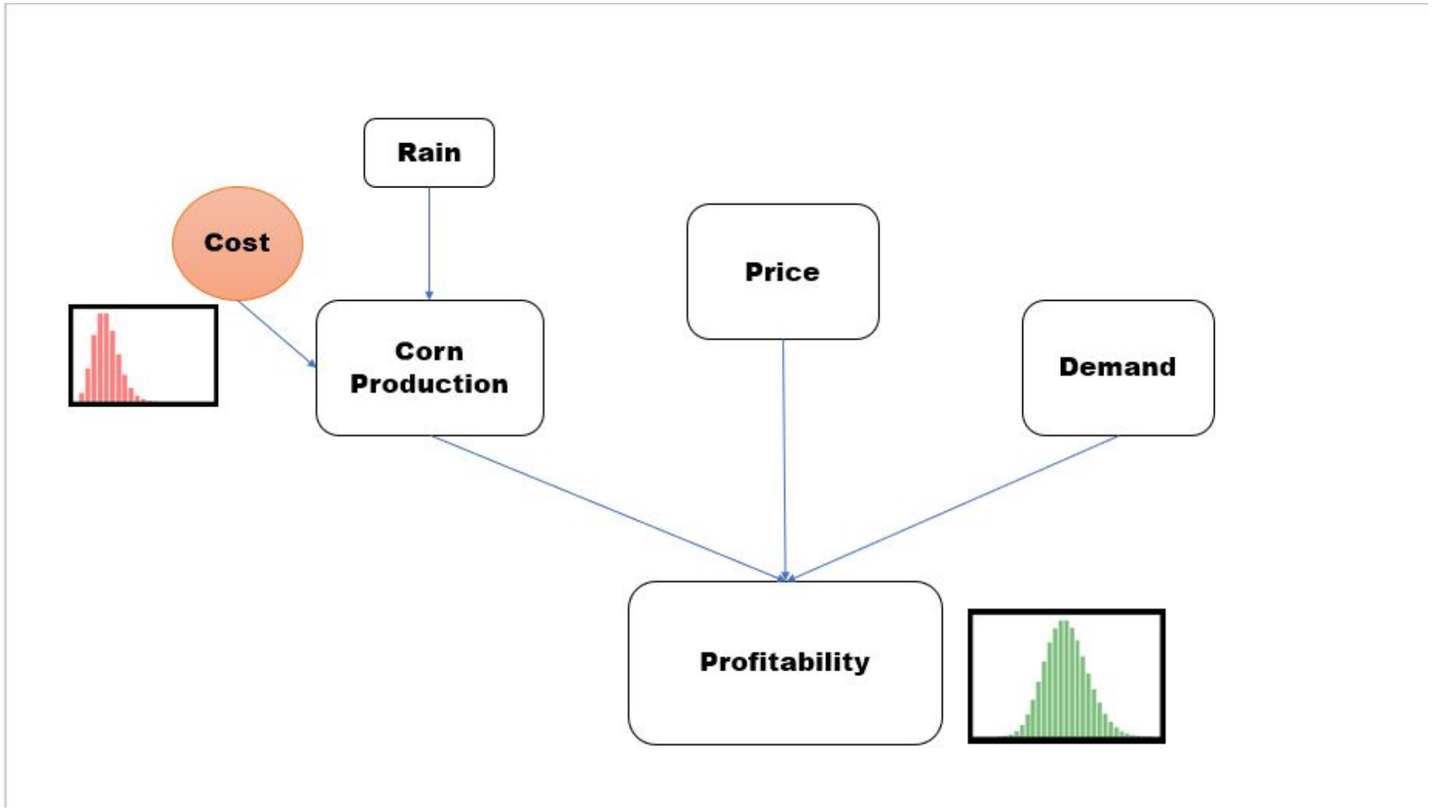
Corn farm



Business profitability



Business profitability



STATISTICAL SIMULATION IN PYTHON

Let's practice!

STATISTICAL SIMULATION IN PYTHON

Monte Carlo integration

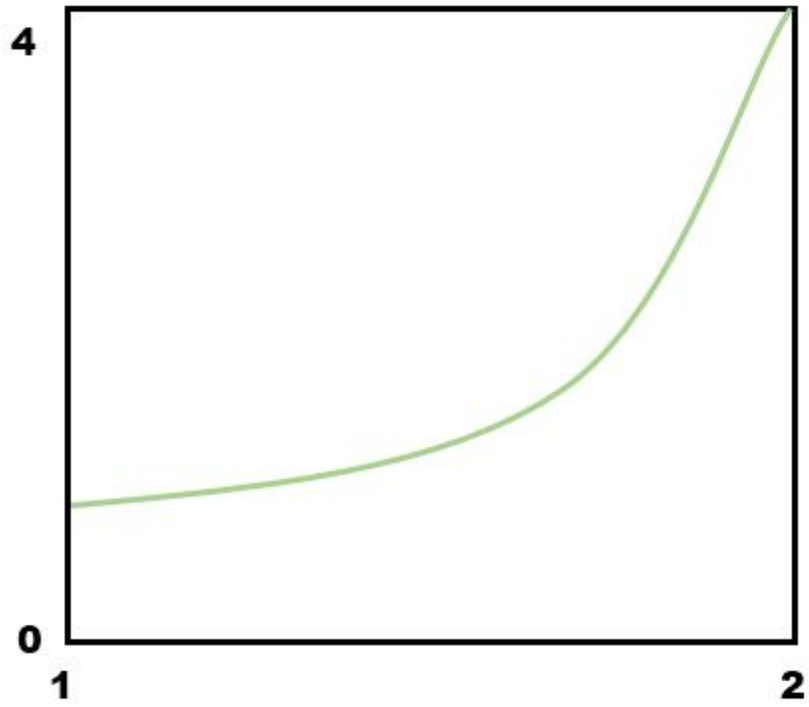
Definite integration

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

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

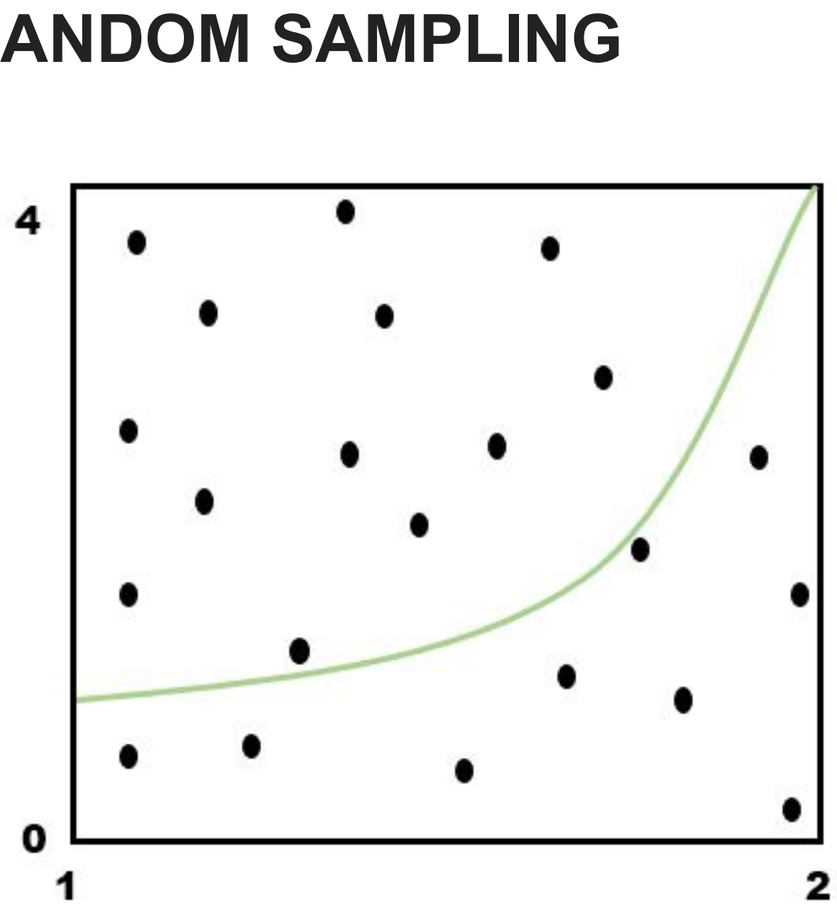
- **Calculate overall area.**
- Randomly sample points in the area.
- Multiply the fraction of the points below the curve by overall area.

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.



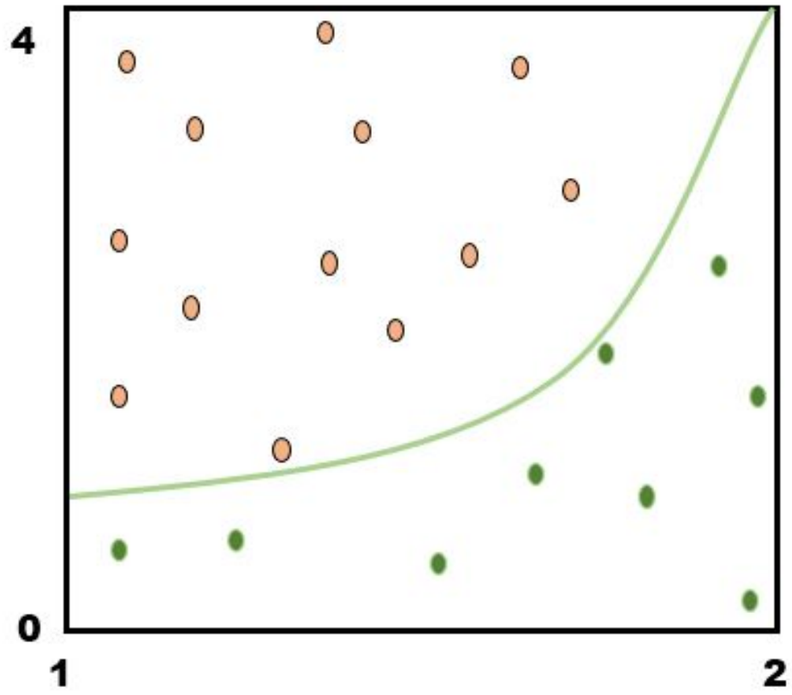
Monte Carlo integration

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

FRACTION OF AREA

$$\text{Overall Area} \times \text{fraction of points under curve} = 2.303$$

- $\text{Actual Answer} = 2.333$



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STATISTICAL SIMULATION IN PYTHON

Simulation for power analysis

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

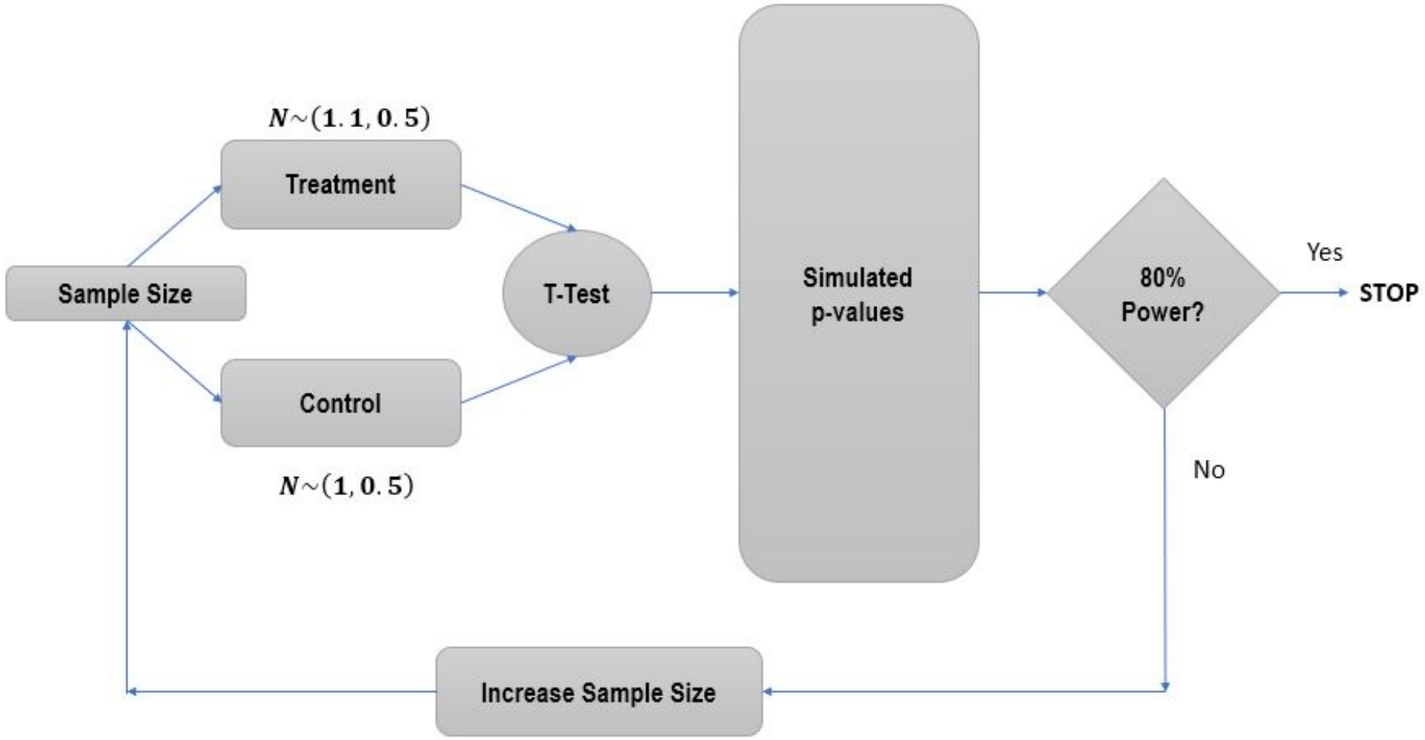
Effect Size: 10%

Power: 80%

Sig Level: 0.05

Sample Size: ?

Simulation for power analysis



STATISTICAL SIMULATION IN PYTHON

Let's practice!

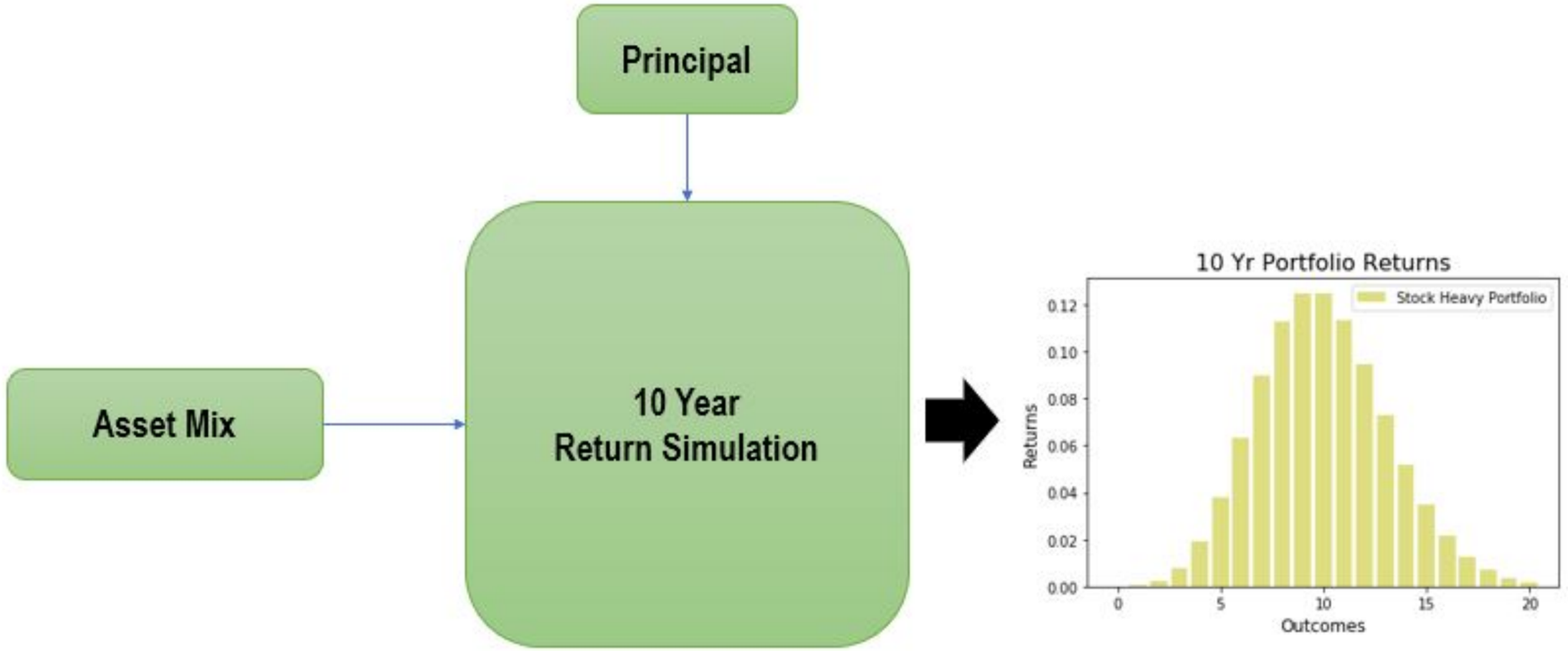
STATISTICAL SIMULATION IN PYTHON

Applications in Finance

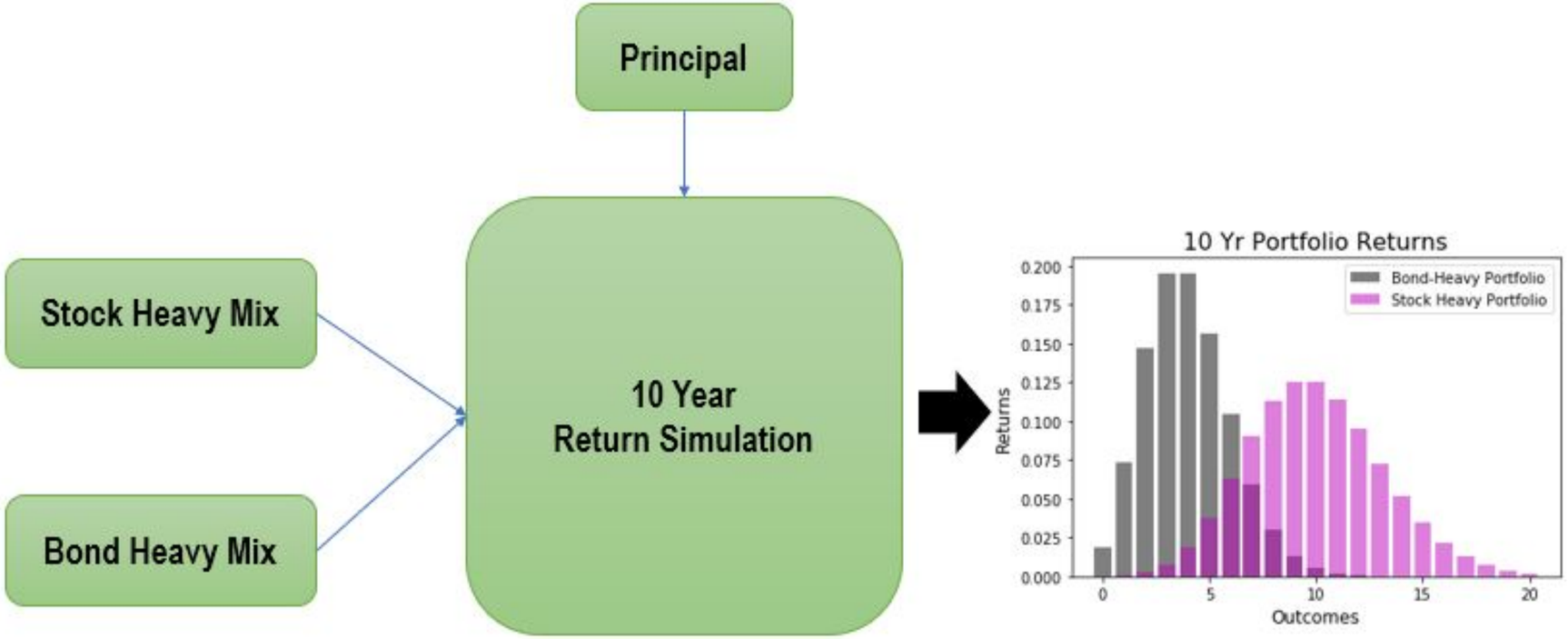
Applications in Finance

- **Option & Instrument Pricing**
- **Project Finance**
- **Portfolio Evaluation**

Portfolio Simulation



Portfolio Simulation



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STATISTICAL SIMULATION IN PYTHON

Wrap up

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**

STATISTICAL SIMULATION IN PYTHON

Thank You & Good Luck!