



STATISTICAL SIMULATION IN PYTHON

Advanced applications of simulation



Overview

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

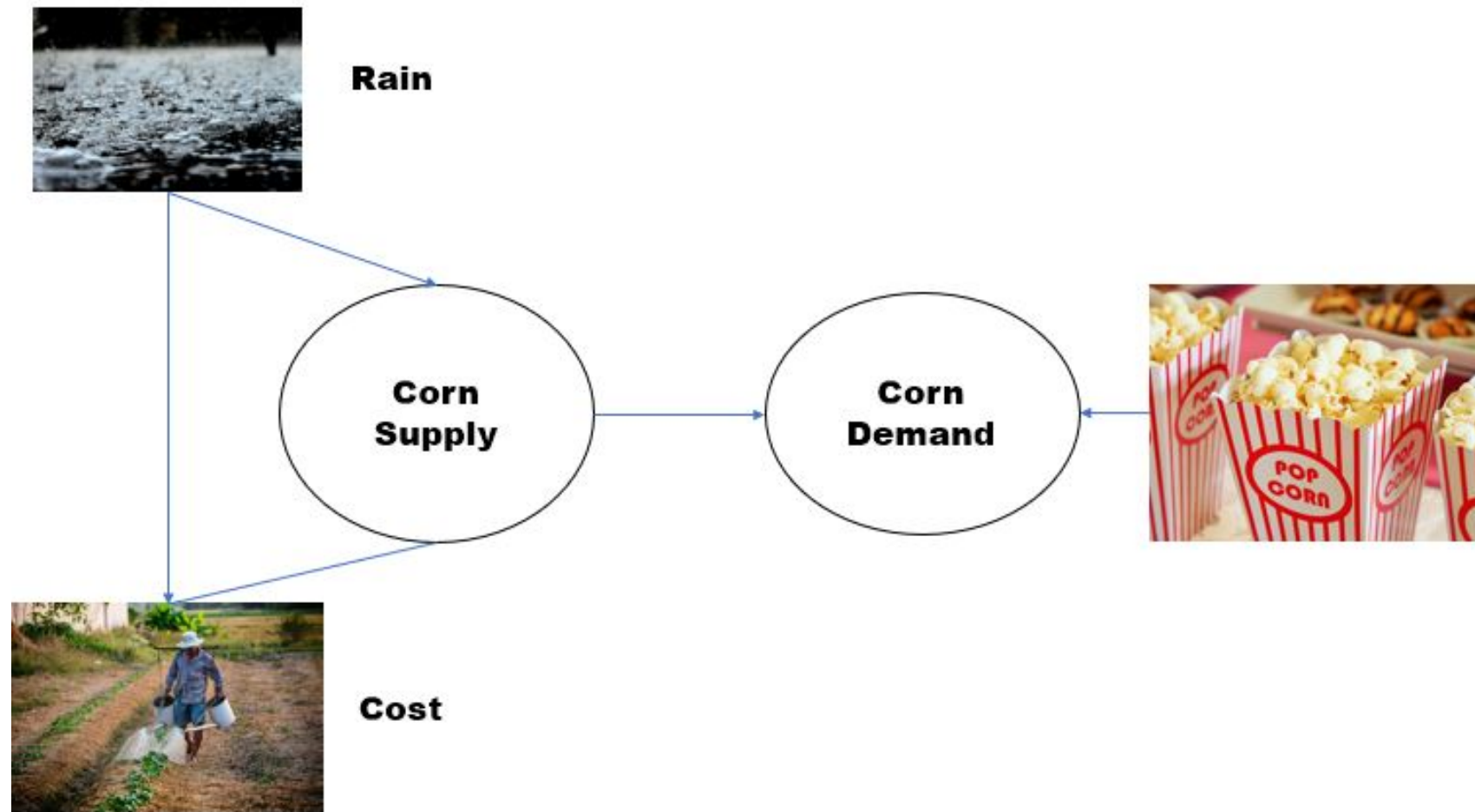
Simulation for business planning

CORN FARM



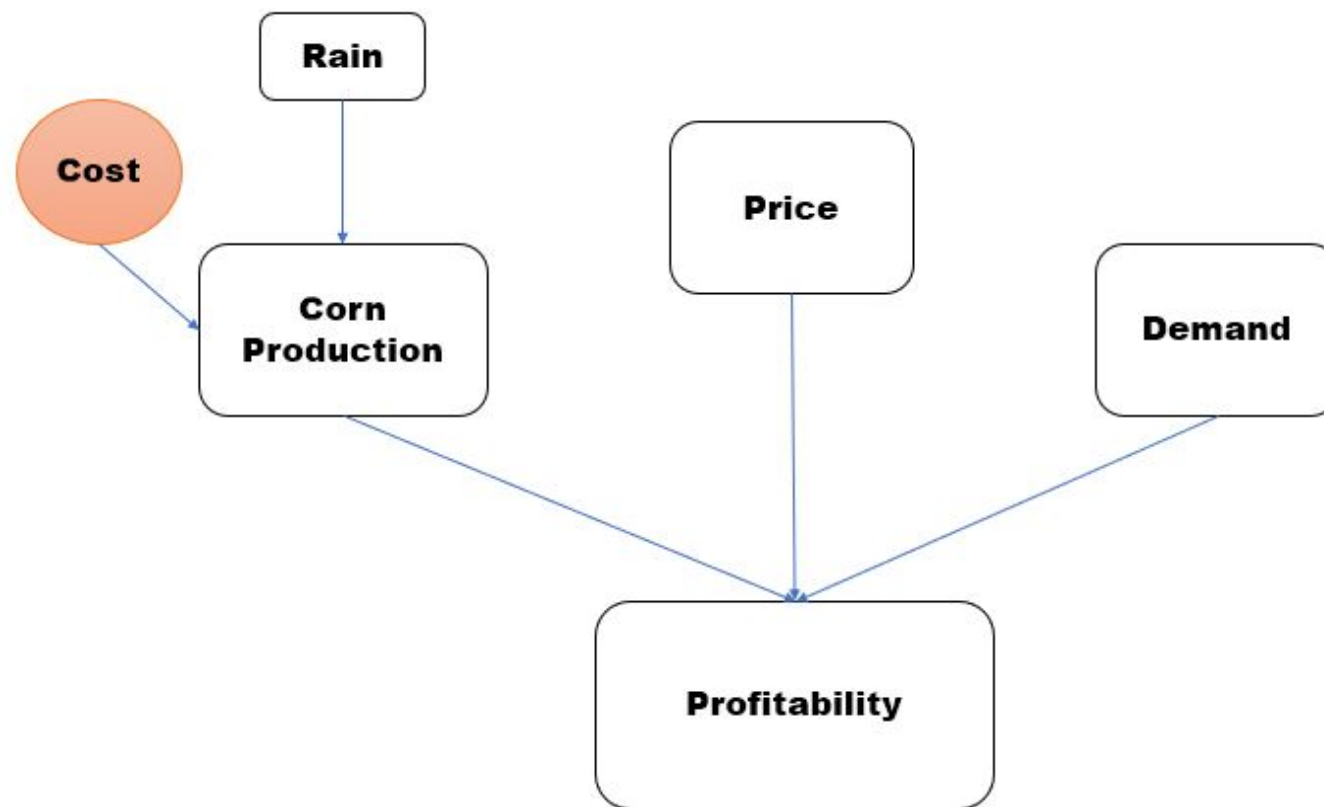


Corn farm



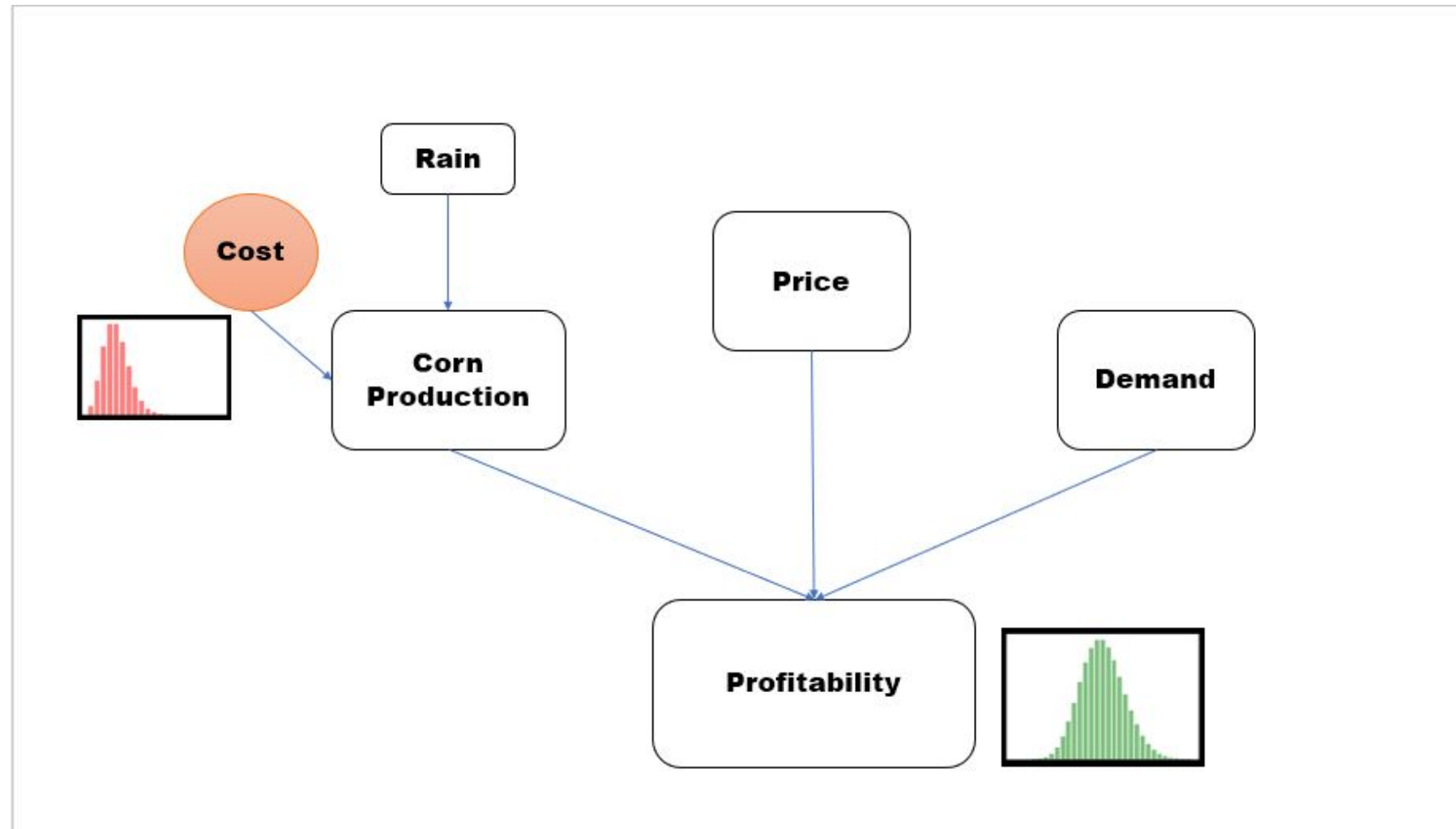


Business profitability





Business profitability





STATISTICAL SIMULATION IN PYTHON

Let's practice!



STATISTICAL SIMULATION IN PYTHON

Monte Carlo integration



Definite integration

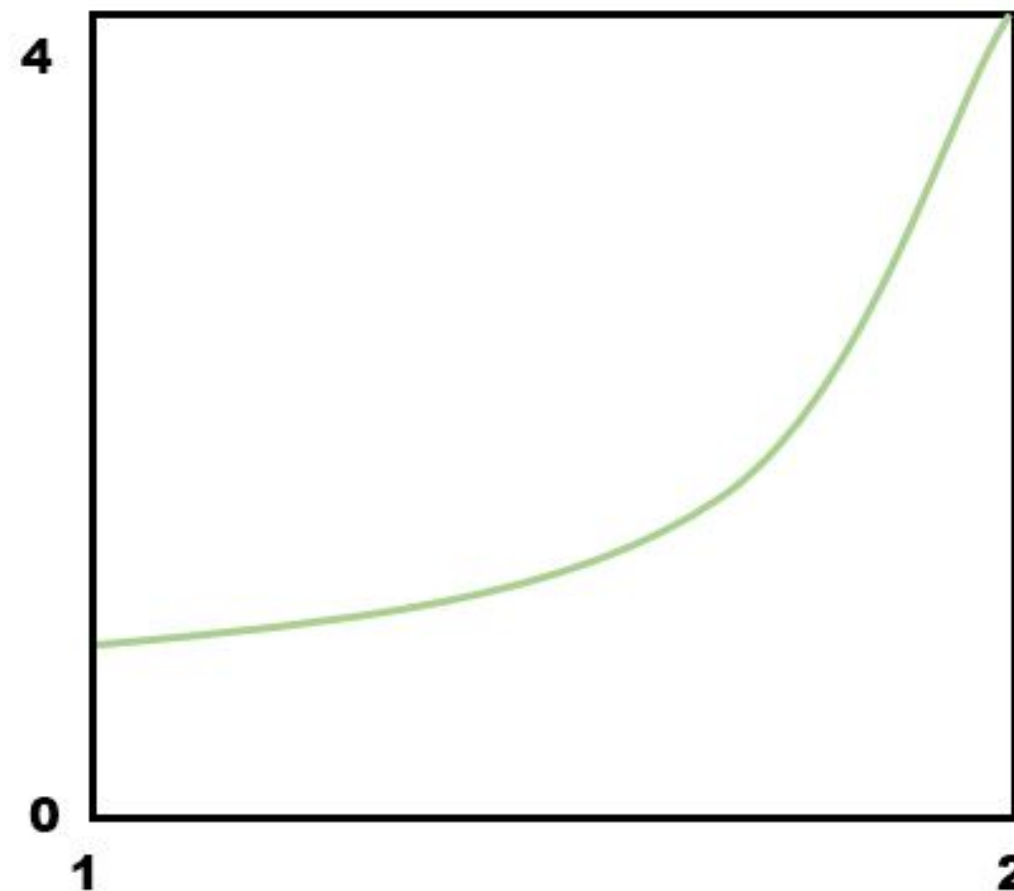
$$\int_1^2 x^2 dx = \frac{x^3}{3} \Big|_1^2 = \frac{7}{3} \approx 2.3333$$



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

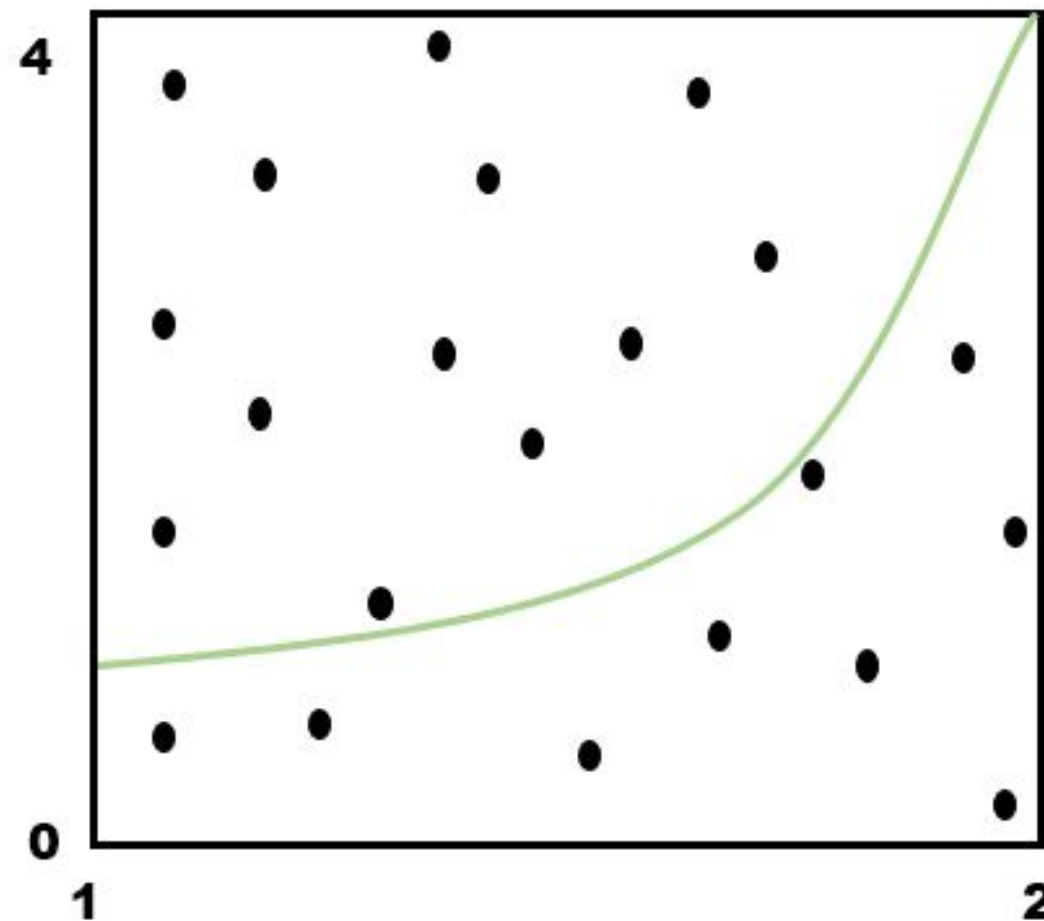
- $\int_1^2 x^2 dx$
- $x_{min} = 1, x_{max} = 2$
- $\min(0, f_{min}(x)) = 0, f_{max}(x) = 4$
- Overall Area = 4



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



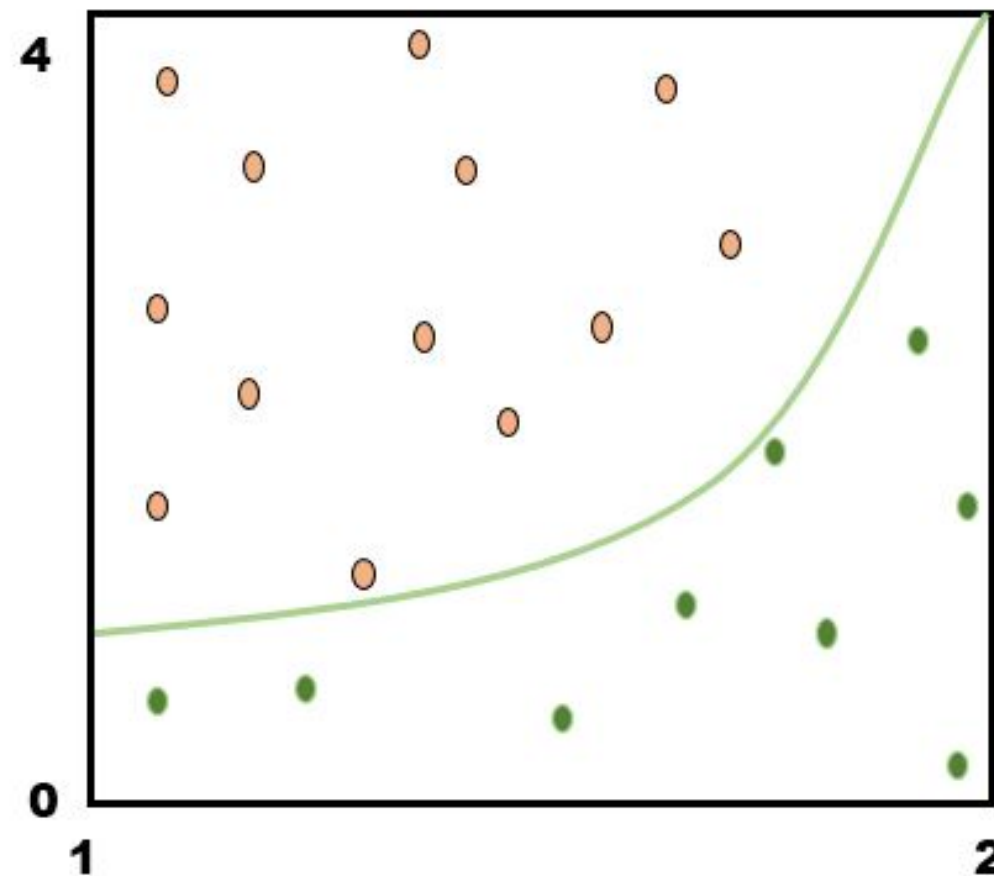
Monte Carlo integration

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

FRACTION OF AREA

Overall Area \times fraction of points under curve = 2.303

- 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%

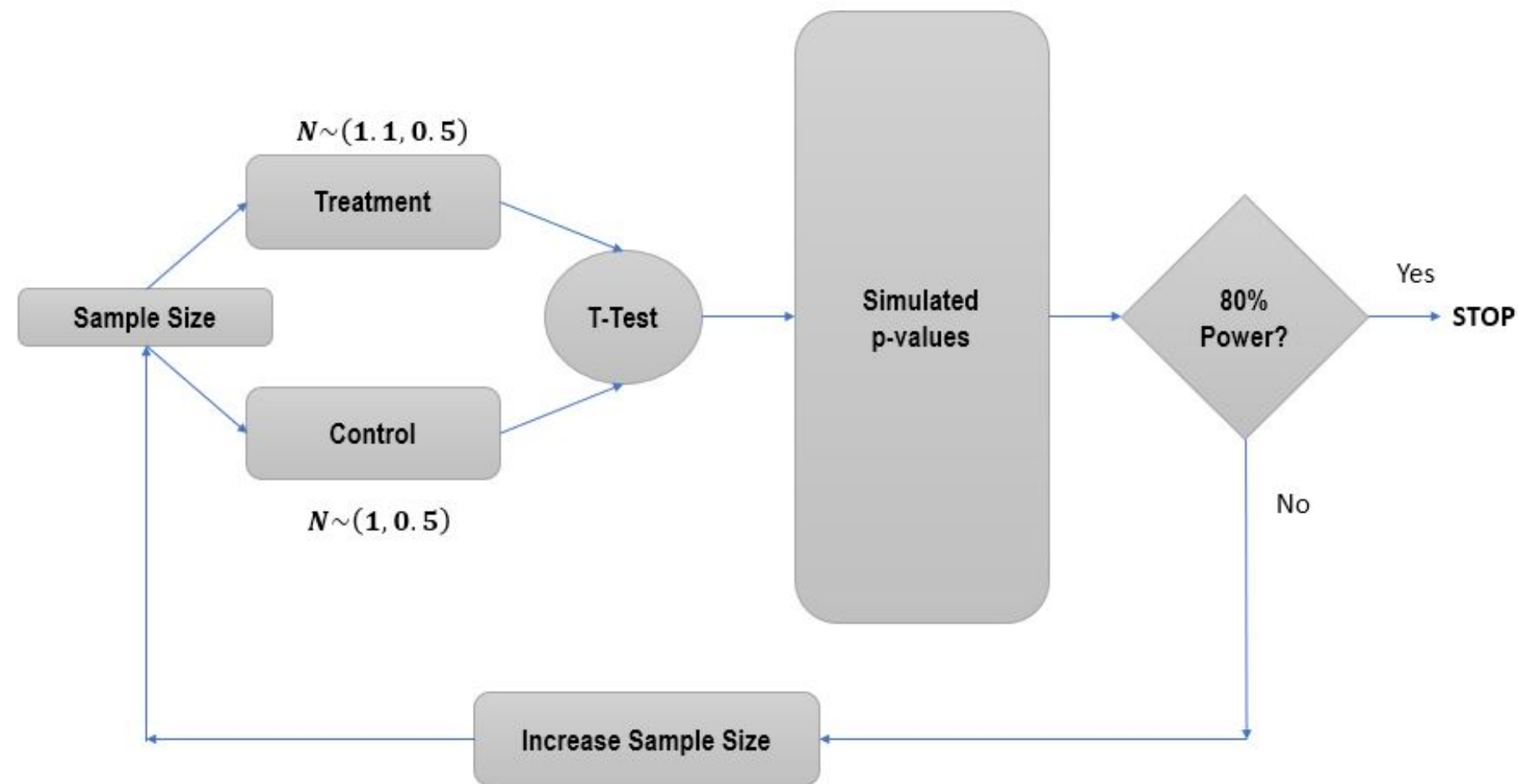
Sig Level: 0.05

Sample Size: ?





Simulation for power analysis





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STATISTICAL SIMULATION IN PYTHON

Applications in Finance



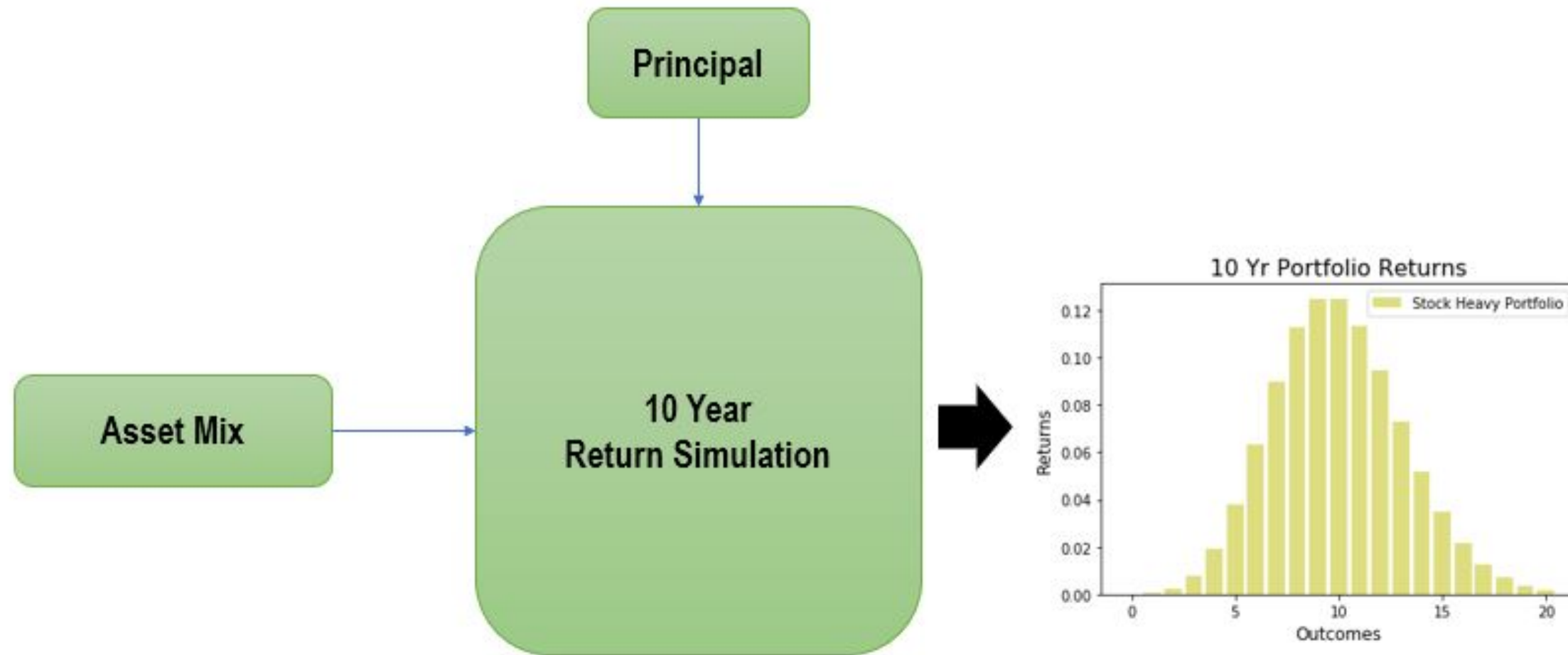
Applications in Finance

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



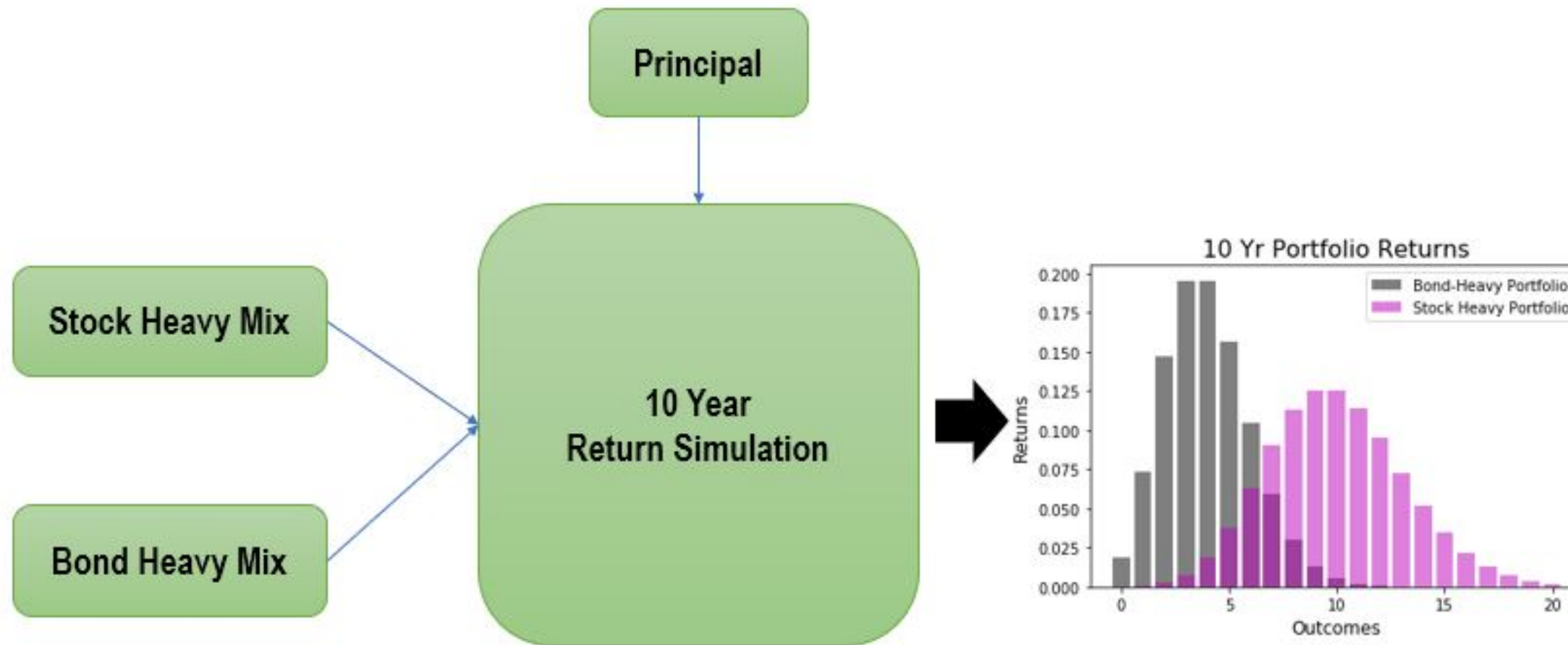


Portfolio Simulation





Portfolio Simulation





STATISTICAL SIMULATION IN PYTHON

Let's practice!



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**



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Thank You & Good Luck!