

Business Simulations

ISYS2001 Introduction to Business Programming

Due Date: Friday 24 May 23:59

Overview

In this assignment, you will utilise the [Simulacra python package](#) to conduct simulations across various business scenarios. You will select a simulation type, set parameters to model realistic situations, visualise outcomes, analyse the effects of parameter changes, and extract insights to support decision-making processes. Your work will be compiled in a Google Colab Notebook and saved to a dedicated GitHub repository.

Objectives

- Understand and apply simulation techniques in business contexts.
- Analyse the impact of different variables in simulation models.
- Develop skills in data visualisation and interpretation.

Assignment Tasks

1. Setup:

- Create a new **PRIVATE** GitHub repository specifically for this assignment.
- Clone the repository in your Google Colab environment to ensure all changes are version-controlled.
- Install the Simulacra package from our class GitHub repository. Follow the provided setup instructions to prepare your environment for running simulations.

2. Choose Your Simulation:

- Decide which simulation you want to explore, Choose **one** simulation:
 - Stock Market Simulation
 - Resource Fluctuations Simulation
 - Product Popularity Simulation

3. Familiarise Yourself with the Simulation:

- Read the detailed documentation for your selected simulation type within the Simulacra package. Run the related [starter notebook](#) Understand the role and typical range of each parameter.

4. Execute the Simulation:

- Instantiate your chosen simulation class with initial parameters reflecting a realistic scenario.
- Execute the simulation by calling the `run_simulation()` method and collect the output data.

5. Visualise the Simulation Data:

- Use various plotting techniques (e.g., line plots, bar charts) to visualise key trends and dynamics within the data.
- Highlight any significant effects due to specific events or interventions, if relevant.

6. Analytical Experimentation:

- Modify parameters to explore how changes influence simulation outcomes.
- Analyse key metrics derived from the data (like peak values, averages, variability).
- Model potential strategies or interventions and assess their impact.

7. Compile and Report Your Findings:

- Assemble your work into a Jupyter Notebook that includes:
 - Code implementations along with detailed comments.
 - Visualisations with captions explaining each figure.
 - A comprehensive analysis section discussing parameter choices, observed results, and their implications.
 - A reflection on the simulation's limitations and suggestions for improvement.

- Commit regularly to your GitHub repository to maintain a log of your progress.
- Submit a zip of your GitHub repository to capture all logs for analysis of your commit frequency and development progress.

Starter Notebooks

Here is the [Simulacra starter notebooks GitHub repository](#). You have three possible starter notebooks to choose from: the [Product Popularity Simulator](#), the [Stock Market Simulator](#), and the [Resource Fluctuations Simulator](#). Below is a general overview of how to utilize these notebooks effectively:

Getting Started:

1. **Select Your Simulation:** Choose the notebook corresponding to the simulation you want to explore: Product Popularity, Stock Market, or Resource Fluctuations.
2. **Run the Simulation:** Each notebook contains classes or functions to run the simulation. Follow the instructions provided to generate simulated data and explore various scenarios.
3. **Visualize the Results:** Utilize the plotting functions within each notebook to graph and analyze the simulated data. These visualizations help you understand trends and patterns in the simulated scenarios.

Objectives:

- Analyze different aspects of the chosen simulation, such as consumer behavior, market trends, or resource management.
- Develop skills in data analysis and interpretation within specific domains.
- Enhance your programming proficiency, especially in utilizing Python libraries for simulation and visualization.

Using Google Colab:

- These notebooks are designed to be run on Google Colab, a cloud-based platform for executing Python code. You can work on these notebooks without any specific setups on your local machine.
- Remember to save a copy of the notebook in your Assignment GitHub repository to preserve your work and data.

Preparation:

- Familiarize yourself with the notebook's user interface and features, especially if you're new to Google Colab.
- Review the provided code snippets and accompanying explanatory texts within the notebook to understand how the simulation and plotting functions work.

Submission Instructions

- Complete all sections of the assessment.
- The report and code are required to be a notebook that can execute in a Google Colab environment.
- Download a zip of your private repository and submit via the submission link on the units Blackboard site.
- Submit your completed assessment via the designated upload links by 23:59 Friday 24th May 2024.

Evaluation Criteria

- **Functionality and Code Clarity:** Clear, efficient, and well-documented code.
- **Visualisation Quality:** Accurate and insightful visual representations of the data.
- **Depth of Analysis:** Thorough exploration and nuanced understanding of how parameter variations affect outcomes.
- **Reflective Discussion:** Insightful discussion on the real-world applicability and limitations of the models.
- **Overall Presentation:** Coherence, logical structure, and professionalism in the presentation of the report.

Criteria	Fail (Unsatisfactory)	Pass (Satisfactory)	Credit (Good)	Distinction (Very Good)	High Distinction (Excellent)
Functionality and Code Clarity	Code does not execute, contains multiple errors, and lacks comments.	Code executes with minor issues, meets basic requirements, and has minimal comments.	Code is mostly correct, with some advanced elements; well-commented to explain the functionality.	Code runs perfectly, includes advanced features, and is clearly commented to explain complex logic.	Code not only runs flawlessly but also displays innovative approaches, exceptional efficiency, and is exemplary in clarity and structure.

	Fail (Unsatisfactory)	Pass (Satisfactory)	Credit (Good)	Distinction (Very Good)	High Distinction (Excellent)
Visualisation Quality	Visualisations are incorrect or missing.	Visualisations are correct but basic and lack clarity or detail.	Visualisations are correct, clear, and provide useful insights into the data.	Visualisations are detailed, very clear, and enhance understanding of the simulation outcomes with thoughtful layouts.	Visualisations are outstanding, providing deep insights and are professionally presented with exceptional attention to detail.
Depth of Analysis	Analysis is missing or incorrect. Demonstrates a lack of understanding.	Analysis is correct but superficial. Shows basic understanding without significant insight.	Good analysis that correctly interprets data and explores effects of parameter changes with some depth.	Very thorough analysis, showing a deep understanding of simulation dynamics and thoughtful exploration of parameter impacts.	Exceptional analysis that offers profound insights, linking simulation results to real-world implications and theoretical concepts.
Reflective Discussion	Lacks reflection; no consideration of the limitations or applicability of the simulations.	Limited reflection on the limitations and real-world applicability of the simulations.	Reflects on limitations and applicability, making reasonable suggestions for improvement.	In-depth reflection on limitations and applicability; offers well-considered improvements and shows understanding of broader context.	Extensive and insightful reflection, critically assessing all aspects of the simulations and suggesting innovative improvements.

	Fail (Unsatisfactory)	Pass (Satisfactory)	Credit (Good)	Distinction (Very Good)	High Distinction (Excellent)
Overall Presentation and Engagement	Work is disorganised, poorly presented, and lacks evidence of version control engagement.	Work is organised with minor errors in presentation and basic use of GitHub with infrequent commits.	Work is well-organised, clear, presented in a logically structured manner with regular commits and clear GitHub usage.	Work is very well-organised, presented with high professionalism, excellent use of GitHub including branch management.	Work is exceptionally presented, showcasing outstanding professionalism, narrative, and exemplary GitHub practices including regular commits and branches.

Additional Guidelines

- **Collaboration Policy:** Collaboration among students is encouraged to foster peer learning, however, all submitted work must be independently created.
- **Exploratory Approach:** You are encouraged to explore deeper into any specific aspects of the simulations that pique your interest. Investigate additional questions or scenarios beyond the basic assignment requirements.

Appendix A: Resource Fluctuations Simulation

Purpose

This simulation models the price fluctuations of a critical resource for a business. It is applicable to commodities, raw materials, or any essential business input, helping students understand market dynamics and pricing strategies.

Parameters

- **start_price**: The initial price of the resource.
- **days**: The duration of the simulation.
- **volatility**: Controls the severity of day-to-day price fluctuations.
- **drift**: Indicates the general upward or downward trend in price over time.
- **supply_disruption_day**: Specifies the day on which a supply disruption event occurs (optional).
- **disruption_severity**: The magnitude of the supply disruption's impact on the price, positive indicating a shortage and negative indicating a surplus.

Tasks

For this assignment you need to conduct a visual analysis and report your findings of:

1. Assess the impact of volatility on the stability of resource prices by experimenting with different volatility values.
2. Model a supply disruption event and analyse how it affects the price trend and the impact of the disruption's severity.
3. (Optional) Explore simple strategies a business might use to hedge against price fluctuations.

Example Code

```
from simulacra import ResourceSimulation
import matplotlib.pyplot as plt

# Setting up a moderate volatility and upward drift scenario with a supply disruption.
sim = ResourceSimulation(start_price=100, days=250, volatility=0.015,
                        drift=0.0003, supply_disruption_day=100, disruption_severity=0.3)
```

```

prices = sim.run_simulation()

# Visualising the price simulation
plt.figure(figsize=(10, 6))
plt.plot(prices, label='Resource Price')
plt.axvline(x=sim.supply_disruption_day, color='r', linestyle='--', label='Supply Disruption')
plt.xlabel('Days')
plt.ylabel('Price')
plt.title('Resource Price Simulation')
plt.legend()
plt.show()

```

Conducting Visual Analysis Using the Simulation:

Experiment! Use the simulation to explore and test various scenarios. Adjust parameters, try different strategies, and analyse the outcomes to gain deeper insights into resource management under fluctuating conditions.

- **Baseline Scenario Without Disruptions:** Begin by simulating the price path without any disruptions to establish a baseline for comparison with more complex scenarios.
- **Labeling and Annotations:** Ensure that your plots clearly show the days on the x-axis and price on the y-axis. Use lines or markers to indicate the day of a supply disruption or the implementation of a hedging strategy.
- **Interactive Exploration:** If tools are available, adjust parameters such as volatility and drift dynamically to observe how these changes affect the price simulation. This can help in understanding the immediate effects of each parameter.
- **Comparative Analysis:** Conduct side-by-side comparisons of scenarios with different levels of volatility or different strategies to visually assess their impact. This can make it easier to understand which conditions or strategies lead to the most favorable outcomes. Consider calculating and comparing statistics such as the average price before and after a disruption event to quantify its impact.

Task Specific Guidance

Assess the Impact of Volatility on Price Stability:

Start by exploring how different levels of volatility affect day-to-day price fluctuations. This will help you understand the sensitivity of resource prices to changes in market conditions. Questions to Consider:

- What trends do you notice as volatility increases? How does it affect the predictability of price movements?
- How do different volatility levels impact the overall risk profile of investing in this resource?

Model a Supply Disruption Event and Analyse Its Impact

Set up scenarios where a supply disruption occurs at a predetermined day. Change the severity of these disruptions to see how they influence resource prices. Questions to Consider:

- How does the timing of a supply disruption affect its impact on resource prices?
- Compare the prices before and after the disruption. What can you infer about the resilience of the market to sudden changes?

(Optional) Explore Hedging Strategies

Implement simple hedging strategies to see how they could mitigate the risks associated with price volatility and supply disruptions. Consider strategies like futures contracts or options. Questions to Consider:

- Which hedging strategy appears most effective in stabilising price fluctuations?
- How do the costs of these strategies compare to their benefits in terms of reduced price volatility?

Appendix B: Stock Market Simulation

Purpose

This simulation models the fluctuations of stock prices, enabling students to explore financial market dynamics and develop basic trading strategies. It serves as a practical tool for understanding the principles of market speculation and risk management.

Parameters

- **start_price:** The initial price of the stock.
- **days:** The duration of the simulation.
- **volatility:** The measure of price fluctuations, indicating how much the price can vary day-to-day.
- **drift:** Represents the overall trend in stock prices, whether upward or downward.
- **event_day:** Specifies the day on which a major market event occurs (optional).
- **event_impact:** The magnitude of the event's impact on stock prices, positive for beneficial events and negative for detrimental ones.

Tasks

For this assignment you need to conduct a visual analysis and report your findings of the following tasks.

1. Investigate how volatility affects stock price stability and the potential for investment gains or losses.
2. Simulate a major market event and analyse its immediate and long-term effects on stock prices.
3. (Optional) Develop simple trading strategies based on price trends and test their effectiveness over the simulation period.

Example Code

```
from simulacra import StockMarketSimulation
import matplotlib.pyplot as plt

# Example scenario: High volatility with a downward price trend and a significant market event
sim = StockMarketSimulation(start_price=100, days=365, volatility=0.03,
```

```

drift=-0.001, event_day=100, event_impact=-0.2)

prices = sim.run_simulation()

# Visualising the stock market fluctuations
plt.figure(figsize=(10, 6))
plt.plot(prices, label='Stock Price')
plt.axvline(x=sim.event_day, color='red', linestyle='--', label='Major Market Event')
plt.xlabel('Days')
plt.ylabel('Price ($)')
plt.title('Stock Market Simulation')
plt.legend()
plt.show()

```

Conducting Visual Analysis Using the Simulation:

Experiment! Use the simulation to explore and test various scenarios. Adjust parameters, try different strategies, and analyse the outcomes to gain deeper insights into resource management under fluctuating conditions.

- **Baseline Scenario Without Disruptions:** Begin by simulating the price path without any disruptions to establish a baseline for comparison with more complex scenarios.
- **Labeling and Annotations:** Ensure that your plots clearly show the days on the x-axis and price on the y-axis. Use lines or markers to indicate the day of the event or the implementation of a trading strategy.
- **Interactive Exploration:** If tools are available, adjust parameters such as volatility and drift dynamically to observe how these changes affect the price simulation. This can help in understanding the immediate effects of each parameter.
- **Comparative Analysis:** Conduct side-by-side comparisons of scenarios with different levels of volatility or different strategies to visually assess their impact. This can make it easier to understand which conditions or strategies lead to the most favorable outcomes. Consider calculating and comparing statistics such as the average price before and after a disruption event to quantify its impact.

Task-Specific Guidance

Investigate How Volatility Affects Stock Price Stability

Begin by analysing how different levels of volatility impact the stability of stock prices and the potential for investment gains or losses. Questions to Consider:

- How do changes in volatility affect the frequency and magnitude of price swings?
- What implications does increased volatility have on the risk and potential returns of stock investments?

Simulate a Major Market Event and Analyse Its Impact

Set up scenarios where a significant market event affects stock prices on a specific day. Adjust the impact of these events to observe varying outcomes. Questions to Consider:

- How does the market respond to positive versus negative events?
- Analyse the recovery or further decline in stock prices following the event. What does this tell you about market sentiment and investor behavior?

(Optional) Develop and Test Trading Strategies

Explore basic trading strategies such as “buy and hold”, “moving average crossover”, or “momentum-based” strategies. Implement these strategies in your simulation to test their effectiveness over time. Questions to Consider:

- Which strategy performs best under stable versus volatile market conditions?
- How do these strategies perform in response to the simulated market events?

Appendix C: Product Popularity Simulation

Purpose

This simulation models the dynamics of product popularity, allowing students to explore factors affecting market demand and the effectiveness of marketing strategies.

Parameters

- `start_demand`: The initial demand for the product.
- `days`: The duration of the simulation.
- `growth_rate`: The rate at which product demand grows or declines naturally over time.
- `marketing_impact`: The impact of marketing efforts on demand, represented as a percentage increase.
- `promotion_day`: Specifies the day on which a major marketing campaign starts (optional).
- `promotion_effectiveness`: The effectiveness of the promotional campaign, impacting demand growth positively.

Tasks

For this assignment you need to conduct a visual analysis and report your findings of:

1. Examine how changes in the growth rate and marketing impact affect demand.
2. Simulate a major marketing campaign and analyze its effect on demand growth.
3. (Optional) Explore different marketing strategies and their cost-effectiveness in boosting product popularity.

Example Code

```
from simulacra import ProductPopularitySimulation
import matplotlib.pyplot as plt

# Setting up a scenario with moderate natural growth and a significant marketing campaign.
sim = ProductPopularitySimulation(start_demand=500, days=180, growth_rate=0.02,
                                  marketing_impact=0.1, promotion_day=30, promotion_effectiveness=0.5)
```

```

demand = sim.run_simulation()

# Visualizing product popularity
plt.figure(figsize=(10, 6))
plt.plot(demand, label='Product Demand')
plt.axvline(x=sim.promotion_day, color='blue', linestyle='--', label='Marketing Campaign Start')
plt.xlabel('Days')
plt.ylabel('Demand Units')
plt.title('Product Popularity Simulation')
plt.legend()
plt.show()

```

Conducting Visual Analysis Using the Simulation

Experiment! Use the simulation to explore and test various scenarios. Adjust parameters, try different strategies, and analyse the outcomes to gain deeper insights into resource management under fluctuating conditions.

- **Baseline Scenario Without Marketing Efforts:** Begin by running simulations without any marketing efforts to understand the natural demand growth. This baseline will help you compare the effectiveness of different marketing strategies.
- **Labeling and Annotations:** Make sure your plots are well-labeled with days on the x-axis and demand units on the y-axis. Use annotations or markers to highlight when significant marketing campaigns start and their duration if applicable.
- **Interactive Exploration:** If possible, use interactive tools to adjust the parameters like growth rate, marketing impact, and timing of campaigns dynamically. This can help visualize the immediate effects of these changes on the demand curve.
- **Comparative Analysis:** Run multiple scenarios side-by-side to directly compare different growth rates, marketing impacts, or strategies. This comparison can make it easier to visualize which scenarios are most effective. Consider calculating and comparing statistics such as the average price before and after a disruption event to quantify its impact.

Task-Specific Guidance

Examine How Changes in Growth Rate and Marketing Impact Affect Demand

Start by considering how natural growth influences demand over time. Introduce varying levels of marketing impact and observe how each setting alters the demand curve. Questions

to Consider:

- How does increasing the growth rate affect the overall demand by the end of the simulation?
- What happens when you combine high growth rates with strong marketing impacts?

Simulate a Major Marketing Campaign and Analyze Its Effect on Demand Growth

Set up a scenario where a marketing campaign kicks in at a specific day. Vary the effectiveness of these campaigns to see different outcomes. Questions to Consider:

- How does the timing of a marketing campaign influence its effectiveness?
- Compare the demand before and after the promotion day. What insights can you gain about the campaign's impact?

(Optional) Explore Different Marketing Strategies and Their Cost-Effectiveness**

Implement various hypothetical marketing strategies with assumed costs and effectiveness. Calculate the return on investment (ROI) for each strategy based on the increase in demand they generate versus their costs. Questions to Consider:

- Which marketing strategy offers the best ROI?
- How does the cost of a strategy relate to its effectiveness in boosting demand?