Skills and Knowledge Required for the SIR Model Numerical Simulation Project

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Note

Every individual is to read this and have an understanding of what we are supposed to do Note:

- Everyone will present
- Mosy importantly, we should all learn how to write algorithms and use flowcharts efficiently as it will aid and make this project go on smoothly for us
- We will all contribute to this project and no one will be left out
- Do well to bring your laptops to each meeting
- If you do not contribute fully to this project your name will not be included

1 Understanding the SIR Model and Epidemiology

- Knowledge of how infectious diseases spread in a population.
- Understanding of key parameters:
  - S (Susceptible individuals)
  - I (Infected individuals)
  - R (Recovered individuals)
  - β (Infection rate)
  - γ (Recovery rate)
- Familiarity with real-world epidemic examples (e.g., COVID-19, flu) to draw comparisons.

2 Mathematical and Computational Skills

2.1 Ordinary Differential Equations (ODEs)

- Understanding how to represent dynamic systems with differential equations.
- Ability to interpret and manipulate equations:

$$\frac{dS}{dt} = -\beta SI, \tag{1}$$

$$\frac{dI}{dt} = \beta SI - \gamma I, \tag{2}$$

$$\frac{dR}{dt} = \gamma I. \tag{3}$$

2.2 Numerical Methods for Solving ODEs

2.2.1 Euler's Method

- First-order approximation method.
- Formula:

$$X_{n+1} = X_n + hf(X_n, t_n) \tag{4}$$

2.2.2 Runge-Kutta Method (RK4)

- Higher-order method for better accuracy.
- Uses intermediate values k_1, k_2, k_3, k_4 for better approximations.

3 Algorithm Development and Programming

3.1 Writing and Understanding Algorithms

- Translating mathematical formulas into step-by-step computational procedures.
- Implementing iterative updates for numerical solutions.

3.2 Python or MATLAB Programming

- Implementing Euler's and RK4 methods in Python/MATLAB.
- Handling loops, functions, and numerical arrays.
- Writing modular, well-documented, and optimized code.

3.3 Data Visualization

- Using Python libraries like **Matplotlib** to plot:
  - $S(t)$, $I(t)$, and $R(t)$ over time.
  - Effects of different step sizes h.
- Understanding how to interpret and compare plots.

4 Project Management & Collaboration

4.1 Mathematical Formulation

- **Mathematical Modeler:** Develops and verifies differential equation models.
- **Parameter Analyst:** Determines values for β and γ based on real-world data.
- **Numerical Methods Specialist:** Ensures appropriate numerical techniques (Euler's Method, RK4) are applied.

4.2 Coding

- **Lead Programmer:** Writes core numerical implementation in Python/MATLAB.
- **Debugger:** Tests and optimizes code for efficiency and correctness.
- **System Integrator:** Ensures all components function correctly together.

4.3 Visualization

- **Data Visualizer:** Creates graphical representations of simulation results.
- **Graph Analyst:** Interprets data trends and peak infection rates.
- **Presentation Designer:** Ensures clarity and readability of graphical outputs.

4.4 Report Writing

- **Technical Writer:** Documents methodology, results, and interpretations.
- **Proofreader:** Reviews and refines documentation for clarity and consistency.
- **Researcher:** Provides relevant background information and references.

4.5 Academic Integrity

- **Ethics Officer:** Ensures compliance with integrity guidelines.
- **Peer Reviewer:** Validates originality and proper citations.

5 Conclusion

To excel in this project, an individual should be proficient in **epidemiological modeling, numerical methods, algorithm implementation, programming, and data visualization**. Strong analytical and teamwork skills are also necessary for success.

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