Karma Model Simulation

An experimental Python implementation of a **Karmic-Psychological Dynamical System** inspired by an extended SEIRS framework. This model simulates interacting mental variables—merit, wisdom, altruism, vulnerability, influence, social pressure, empathy—and a cumulative memory kernel (Psi), using a mixture of deterministic ODEs and stochastic SDEs.

Documentation Overview

Introduction

This repository provides a tool to explore the **dynamics of psychological and karmic processes** through a formal systems approach. By generalizing the SEIRS compartmental model from epidemiology, we treat mental states as vector-valued compartments that evolve under nonlinear feedback and random fluctuations.

The simulation helps investigate: - How wisdom attenuates or amplifies other mental variables. - The interplay between altruism, vulnerability, and social influence. - Emergence of collective behavior in multi-agent networks. - Memory-accumulating effects of latent karma via an exponential kernel.

Model Description

Equations

The system consists of seven coupled equations (ODEs/SDEs):

1. **Merit** m_i :

$$\frac{dm_i}{dt} = \kappa A_i - \gamma_m m_i(1 + \tanh(w_i)) - \epsilon V_i m_i$$

2. **Wisdom** w_i :

$$\frac{dw_i}{dt} = \eta_M \text{ Meditation}_i - \mu w_i - \lambda_w I_i w_i$$

3. **Altruism** A_i (SDE):

$$dA_i = [\alpha_A A_i + \beta_{AP} A_i \tanh(m_i) - \gamma_A w_i A_i]dt + \sigma_A A_i dW_{A,i}$$

4. **Vulnerability** V_i (SDE):

$$dV_i = [\alpha_V V_i + \beta_{VE} V_i E_i(t-\tau) - \gamma_V w_i V_i + \theta S(m_i)]dt + \sigma_V V_i dW_{V,i}$$

where $S(m) = \frac{1}{1+e^{-0.5(m-5)}}$.

5. **Influence** I_i (SDE):

$$dI_i = [\alpha_I I_i + \beta_{IP} \tanh(I_i P_i) + \delta \sum_j C_{ij}(I_j - I_i) - \gamma_I w_i I_i]dt + \sigma_I I_i dW_{I,i}$$

6. **Social Pressure** P_i :

$$\frac{dP_i}{dt} = \alpha_P P_i + \sum_j C_{ij} \operatorname{sign}(P_j - P_i) - \gamma_P w_i P_i$$

7. **Empathy** E_i with exponential memory:

$$\Psi_i(t) = \int_0^t e^{-\lambda_\Psi (t-s)} V_i(s) ds, \quad \frac{dE_i}{dt} = \alpha_E E_i + \beta_{EV} \frac{\Psi_i(t) E_i}{1 + \Psi_i(t)} - \gamma_E w_i E_i$$

Variables and Parameters

- **State variables**: $m_i, w_i, A_i, V_i, I_i, P_i, E_i, \Psi_i$ for each agent i .
- **Noise terms**: Gaussian Wiener processes $dW_{X,i}$ with intensities σ_X .
- **Connectivity**: Matrix C_{ij} encodes social ties.
- Full parameter list and descriptions are located in the script header (`karma_model_simulation.py`).

Installation

1. Clone the repository:

```
git clone https://github.com/<your-username>/karma_model_simulation.git
cd karma_model_simulation
```

2. (Optional) Create and activate a virtual environment:

```
python3 -m venv venv
source venv/bin/activate
```

3. Install dependencies:

```
pip install numpy matplotlib
```

Usage

Configuration

Edit the top of `karma_model_simulation.py` to set: - **Simulation parameters**: `N`, `T`, `dt` . - **Model parameters**: `kappa, gamma_m, ..., lambda_Psi` . - **Initial conditions**: dictionary `init_vals` .

Running the Simulation

```
python karma_model_simulation.py
```

Generates three plots: 1. Merit & Wisdom over time 2. Altruism, Vulnerability & Influence trajectories 3. Social Pressure, Empathy & Memory potential

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Visualization

The script uses Matplotlib. To customize plots, modify or extend the `plot` section at the end of the script.

Extending the Model

- **Network coupling**: set `delta>0` and define `C` matrix.
- **Alternative memory kernels**: replace exponential with Weibull, Gamma, Log-Normal, or Hawkes process.
- **Multi-agent studies**: increase `N` and analyze collective patterns.
- **Parameter sweeps**: integrate with `itertools` or `joblib` for batch runs.

Development and Testing

- Unit tests: none yet; consider using `pytest` to validate deterministic drift functions.
- Code style: follows PEP8. Use `flake8` for linting.

• Contributions: fork the repo, create feature branches, and submit pull requests.

License

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