Systems Sciences Introduction
Semester 2025-I
Workshop No. 2 — Dynamical Systems Analysis & Design

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Welcome to the second workshop of the *Systems Sciences Introduction* course! Building upon your work in **Workshop #1** (systems design for an *Autonomous Adaptive Agent Simulation*), this session focuses on **dynamical systems analysis and design**. By incorporating methods from systems sciences and cybernetic theory, you will deepen your understanding of how real-time changes, feedback loops, and non-linear behaviors affect autonomous agents.

Workshop Scope and Objectives:

- **Dynamical Systems Framework:** Study how the agent's state evolves over discrete time steps, identifying equilibrium points or stable cycles that may arise.
- **Chaos & Sensitivity:** Explore the system's sensitivity to initial conditions, reflecting on how small changes can influence long-term outcomes.
- **Advanced Feedback Mechanisms:** Expand your existing cybernetic loops to adapt more rapidly under uncertain or volatile conditions.
- **Integration with Reinforcement Learning:** Assess how Q-learning or DQN can be coupled with dynamic models to achieve robust, long-term stability and performance.

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Any comment or concern about this document can be sent to Carlos A. Sierra at: *cavirguezs@udistrital.edu.co*.

Methodology and Deliverables:

1. **System Dynamics Analysis:**
   - *Mathematical/Simulation Model:* Formulate or extend the existing model from *Workshop #1* to include non-linear or time-dependent factors.
   - *Phase Portraits or Diagrams:* Illustrate how the agent's state space unfolds with varying inputs, highlighting attractors or chaotic regimes.
2. **Feedback Loop Refinement:**
   - *Enhanced Control Mechanisms:* Incorporate additional sensors or more granular reward signals that respond quickly to changes in the environment.
   - *Stability and Convergence:* Define criteria for agent stability (e.g., bounded or convergent behavior), supported by theoretical or practical evaluations.
3. **Iterative Design Outline:**
   - Update your project plan to include any new data structures, algorithms, or frameworks needed to implement advanced dynamic behaviors in your agent.
   - Discuss how you will test these dynamics (simulation parameters, random seeds, scenario variations).
4. **GitHub Repository:**
   - Add a new folder, `Workshop-2`, to your existing GitHub repository. Include revised system diagrams, notes on dynamic modeling, and revised plans from this workshop.
   - Place any references or external code snippets you used (e.g., numerical methods or dynamic simulations) in the `Workshop-2` folder.

Deadline: Friday, May 9th, 2025, 8:00. Late submissions may incur penalties under course guidelines.

Notes:

- Keep your deliverables in **English** and submit them as a single **PDF** report.
- Remember to cite any resources (articles, software libraries, academic papers) that support your modeling or analysis.
- This workshop lays the groundwork for more advanced simulation and learning paradigms. The agent's ability to adapt dynamically now sets the stage for deeper complexity in future sessions.

Good luck, and be prepared to expand your agent's behavior models. The deeper your understanding of ***dynamical systems*** *and* ***adaptive feedback loops****, the more resilient your final project will become.*