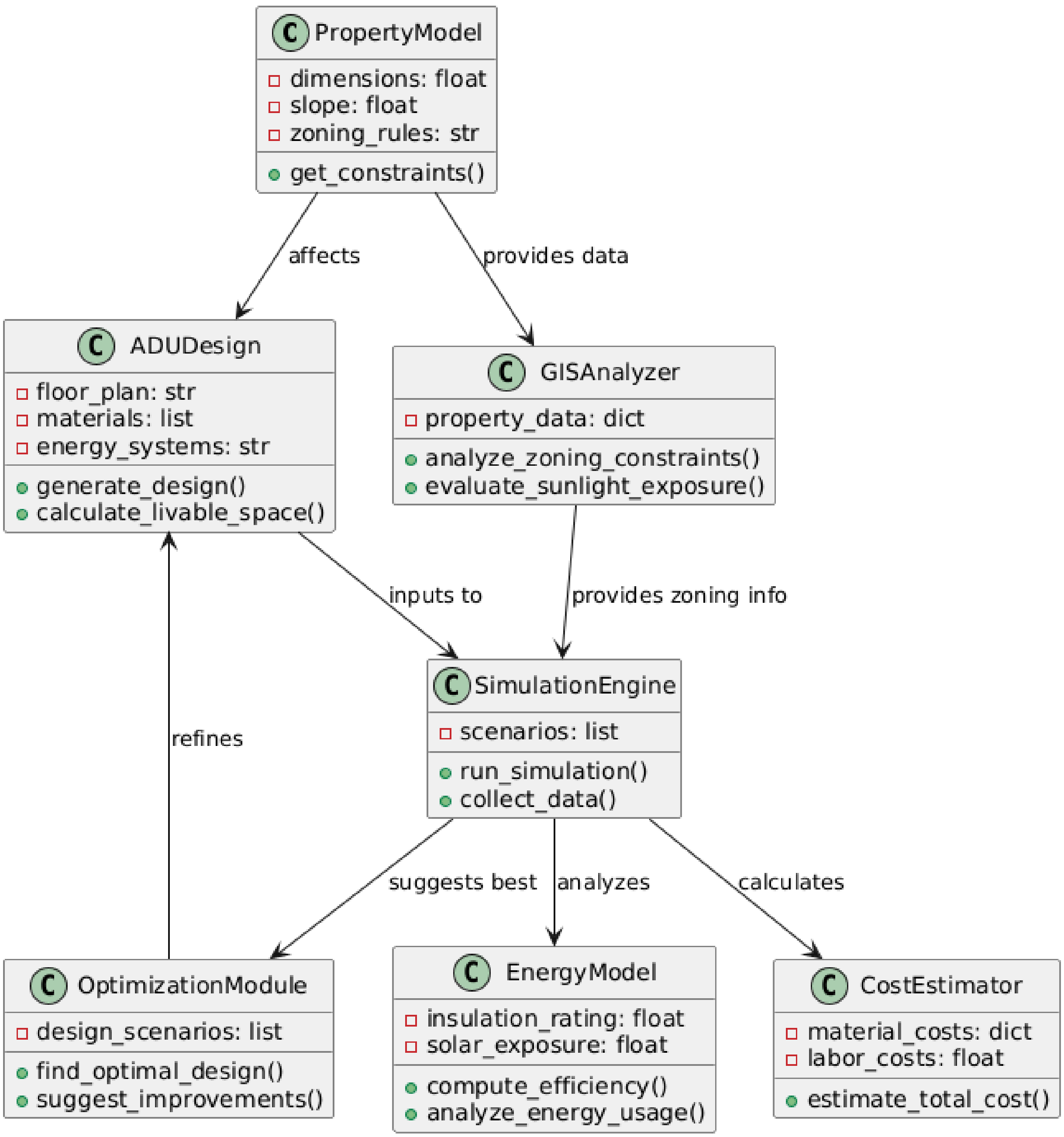
Milestone 3 - UML Diagram and initial design

CS 4632 WO1 Modeling and Simulation

19 February 2024

Kevin Syhavong



UML Design Documentation for Efficient ADU Design Simulation

1. Introduction The purpose of this document is to provide a structured overview of the UML class diagram for the Efficient ADU Design Simulation project. This model supports the simulation of Accessory Dwelling Units (ADUs) by evaluating placement feasibility, energy efficiency, and cost-effectiveness. The document outlines the key system components, their interactions, and how they align with the project's objectives.

2. System Overview The Efficient ADU Design Simulation aims to optimize the design and placement of ADUs by considering zoning regulations, energy consumption, construction costs, and spatial constraints. The simulation uses a combination of discrete-event modeling and continuous energy modeling to analyze ADU feasibility.

3. UML Class Diagram Explanation

3.1. Classes and Their Responsibilities

1. **PropertyModel**
   - Represents physical constraints of a property, such as dimensions, slope, and zoning regulations.
   - Provides relevant data for evaluating ADU placement feasibility.
   - **Methods:** get_constraints()
2. **ADUDesign**
   - Handles design components including floor plans, material selection, and energy systems.
   - **Methods:** generate_design(), calculate_livable_space()
3. **SimulationEngine**
   - Core engine that executes various ADU design scenarios.
   - Collects and processes simulation results.
   - **Methods:** run_simulation(), collect_data()
4. **EnergyModel**
   - Computes energy efficiency metrics based on ADU design choices.
   - Analyzes factors such as insulation, HVAC performance, and solar exposure.
   - **Methods:** compute_efficiency(), analyze_energy_usage()
5. **CostEstimator**
   - Evaluates total construction costs based on material pricing and labor expenses.
   - **Methods:** estimate_total_cost()
6. **GISAnalyzer**
   - Uses geospatial data to assess zoning constraints and environmental factors.

- **Methods:** analyze_zoning_constraints(), evaluate_sunlight_exposure()

7. **OptimizationModule**
   - Identifies optimal ADU configurations based on performance metrics.
   - **Methods:** find_optimal_design(), suggest_improvements()

3.2. Relationships Between Components

- **PropertyModel** provides spatial constraints to **GISAnalyzer**.
- **PropertyModel** influences **ADUDesign**, ensuring compliance with zoning rules.
- **ADUDesign** inputs data into **SimulationEngine** for evaluation.
- **SimulationEngine** interacts with **EnergyModel** and **CostEstimator** to analyze efficiency and costs.
- **GISAnalyzer** assists **SimulationEngine** by providing zoning and geographic insights.
- **SimulationEngine** shares results with **OptimizationModule** to refine ADU configurations.
- **OptimizationModule** updates **ADUDesign** with recommended improvements.

4. Alignment with Project Objectives The UML diagram effectively represents the modular approach taken in the Efficient ADU Design Simulation. The interactions between components ensure:

- **Zoning Compliance:** Property constraints and geospatial analysis prevent placement conflicts.
- **Energy Optimization:** The simulation considers solar exposure and HVAC performance.
- **Cost Analysis:** Construction feasibility is evaluated through financial modeling.
- **Design Efficiency:** The model iterates through optimal design solutions using an optimization module.

5. Conclusion This UML diagram serves as the foundation for developing the simulation model. It ensures that all key aspects of ADU feasibility—design, costs, zoning, and energy efficiency—are effectively captured and analyzed. Future iterations may introduce additional refinements to enhance the simulation’s accuracy and usability.