Functional Requirements

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# Buildings

## Requirements

The task involves creating a simulation that includes a variety of building types, each with distinct purposes and roles. These building types include *residential buildings*, such as houses; *commercial buildings*, including shops and offices; *industrial buildings* like factories, and plants; and *landmarks*, such as parks and monuments.

Each building type should have specific attributes and behaviours that contribute uniquely to the simulation, impacting factors such as citizen satisfaction, economic growth, and resource consumption.

## Solution

We made use of the Composite design pattern to ensure uniform treatment of each type of building as well at each building unit to create tree-like, part-whole hierarchies.

# Utilities

## Requirements

The task requires us to model essential utilities that are critical to the city’s functioning. These utilities include power plants, a water supply system, waste management, and sewage systems. Each of these utilities should interact dynamically with buildings and citizens in the simulation, influencing both the functionality of the city and the satisfaction of the citizens.

## Solution

Chain of responsibility was used to allow for the building units to have their requests handled by the appropriate utility receiver to equip each unit with the needed resources to be a functional unit.

# Resources

## Requirements

The simulation must include resource management to ensure sustainable city operations. Key resources to track include *materials*, such as wood, steel, concrete; as well as energy, water, and the city’s budget. Efficient management of these resources will support city expansion and the effective provision of services to its citizens.

## Solution

Seeing that the resource’s quantity state was a determining factor to if more needed to be created before the use of the resource, the state pattern was used to ensure

# Citizens

## Requirements

Citizens are central to the city’s vitality, creating demand for housing, jobs, and services. The simulation should model population growth, reflecting a dynamic increase based on various influencing factors. Employment opportunities, driven by industrial and commercial buildings, will play a role in citizens’ livelihoods, while essential services such as healthcare, education, security, and entertainment meet their daily needs. Citizen satisfaction, influenced by taxes, amenities, and overall quality of life, should also be tracked. Additionally, citizens will react to government policies, economic shifts, and infrastructure changes, creating a responsive and evolving city environment.

## Solution

We made use of a combination of the Prototype design pattern and the Factory Method for both a uniform creation of citizen objects but also for the transferral of uniquely assigned members to other members to create family-like structures.

# Transport

## Requirements

Efficient transportation is crucial for city mobility and economic growth. The simulation should feature **roads** as essential infrastructure for vehicles, alongside **public transit** options like buses and taxis to reduce congestion. **Trains** for both freight and passenger travel will improve regional connectivity, while **airports** support air travel and cargo transport. Together, these systems should impact traffic flow, commute times, and citywide connectivity, creating a more efficient urban environment.

## Solution

Template pattern was used to allow various forms of transport to redefine steps of the move() method without changing the structure of the move() algorithm

# Government

## Requirements

The government system within the simulation is responsible for overseeing city governance, encompassing several key functions. This includes taxation, where the government sets and collects taxes from both citizens and businesses; budget management, which involves allocating financial resources for various city services and projects; and policy implementation, where laws and regulations are established to shape city dynamics. Additionally, the government manages public services such as healthcare, education, and law enforcement. The decisions made by the government should significantly influence citizen satisfaction, economic growth, and the overall development of the city, creating a complex interplay between governance and community well-being.

## Solution

Government should be the central mediator for all processes in the system to promote loose coupling, hence making the government aware of all processes and communications that occur within the city

# Taxes

## Requirements

Taxation serves as a vital mechanism for funding city services and infrastructure within the simulation. It should model various aspects of taxation, including adjustable tax rates for different categories, such as income, property, and sales. The simulation must also incorporate mechanisms for tax collection from both citizens and businesses, as well as the allocation of collected taxes to various city departments and projects. Furthermore, the impact of tax changes on citizen satisfaction and economic activity should be analysed, highlighting how these financial decisions influence the overall functioning and prosperity of the city.

## Solution

We used the Strategy Design, as it allows interchangeability between the different types of tax strategies. We use a common calculateTax() method, where each class has its own implementation of said function. It is also independent to the client’s use of it.

# City Growth

## Requirements

City growth in the simulation should be portrayed as a dynamic process shaped by various interrelated factors. Population growth will be driven by birth rates, migration patterns, and economic opportunities. As the population increases, housing needs will necessitate the expansion of residential buildings to accommodate residents. Economic development will also play a crucial role, with the growth of commercial and industrial sectors leading to the creation of more jobs. Additionally, infrastructure expansion, including the development of utilities and transportation systems, is essential to support this growth. The mechanics of growth should ensure a cascading effect, where each aspect of the city influences the others, resulting in a realistic simulation of urban development.

## Solution

We used the Template Design Pattern, which ensures that the steps are deferred to the subclasses. Each subclass (Population, Housing, Economic and Infrastructure) have their own implementation of the derived methods (get() shrink() and grow())