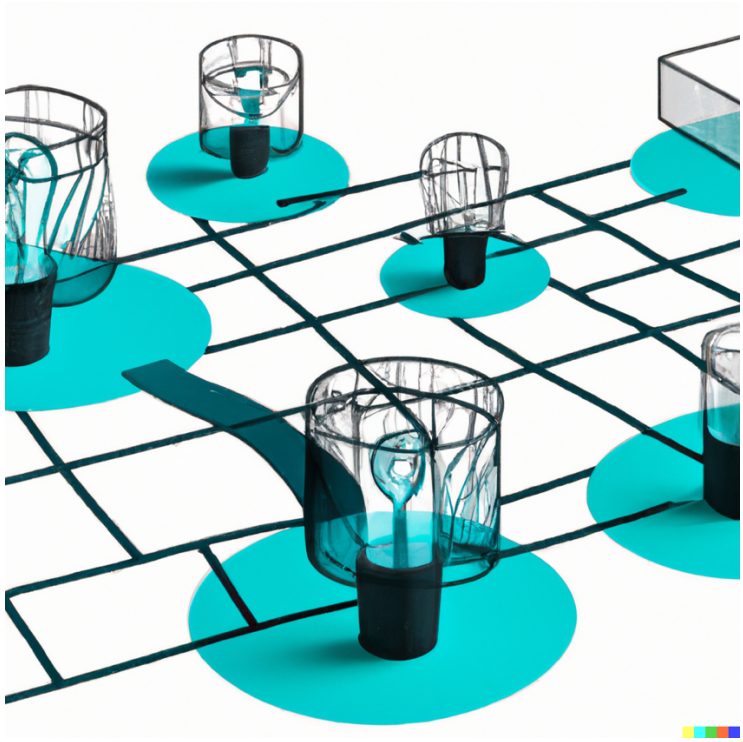
Predictions V2 – By Nitzan

Intro

Welcome to Predictions, an advanced simulation engine designed for researchers who want to model and simulate complex scenarios. This platform provides a powerful and customizable framework for creating diverse simulations by simply uploading an XML file that describes the world. Whether you're simulating ecological systems, social dynamics, or other phenomena, Predictions is the perfect tool to turn your research concepts into dynamic simulations.



About The Project:

Student Name: Nitzan Ainemer (ניצן איינמר) 313289472

Email: Nitzan63@Gmail.com

Bonuses Implemented: Simulate Single Tick (5), Animations (2) and Themes (1).

Design Overview:

There are three modules implemented in this project:

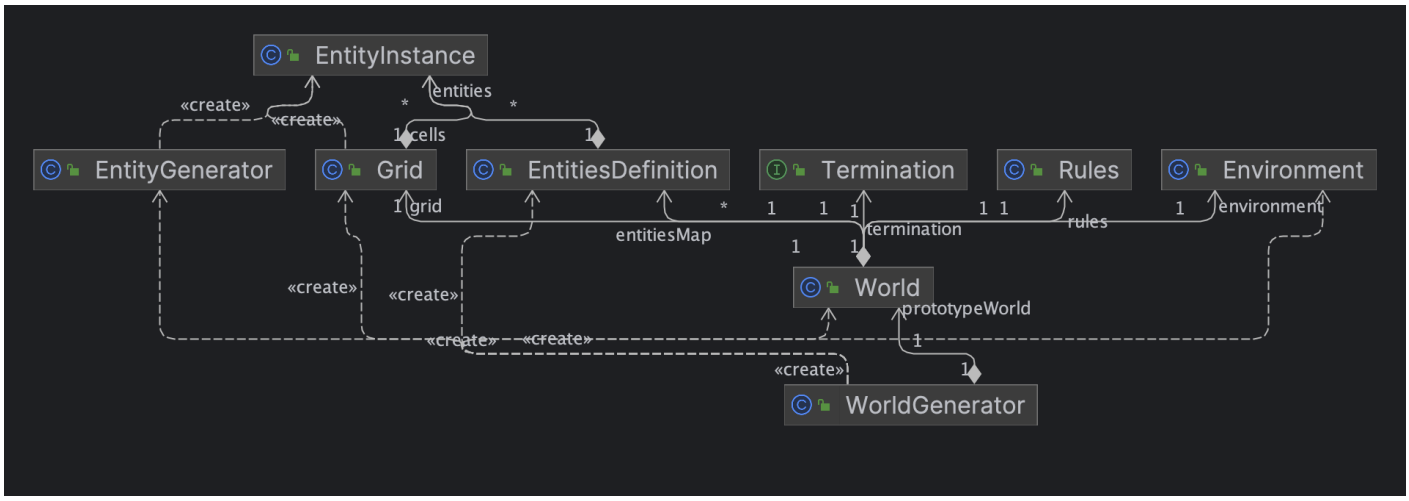
1. Engine Module – the “heart” of the project. The Engine runs all the logic of the program. From handling file and validating data to running the simulation.
2. GUI – the graphic user interface of the program. It manages the interaction with the user and displaying the simulation results.
3. DTO – data transfer objects module, a module designed to be the “buffer” between the engine and the UI. Any data that the engine needs to provide for the user, it does that using the DTO, and the other way around.

Engine Module:

The Engine Has many roles and functions. In this section I will present the main components of the Engine module.

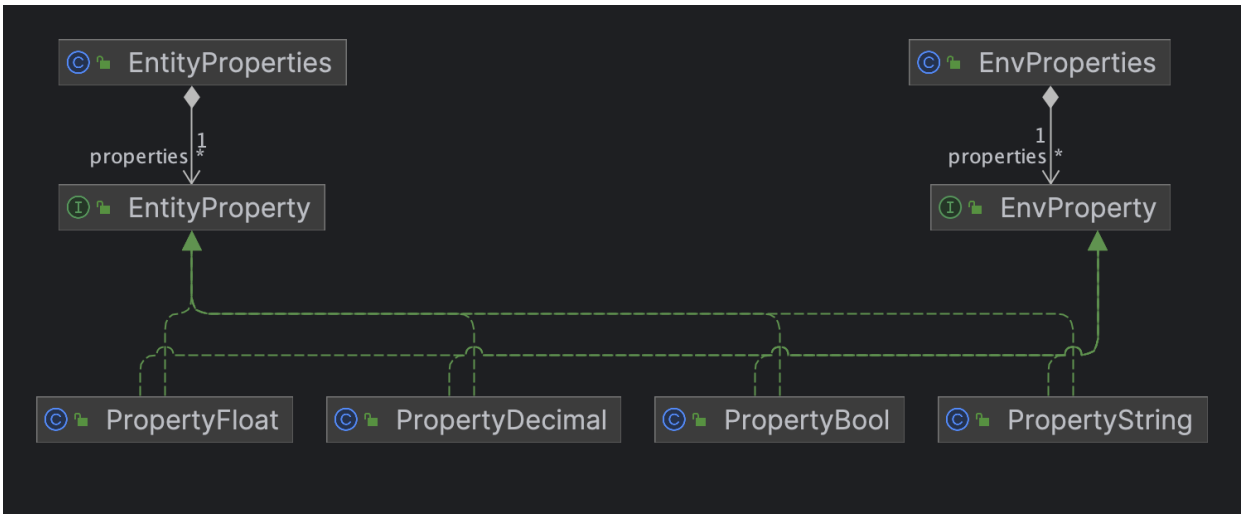
1. **File Handling:**
   a. The engine gets a path to a file and uses JAXB to unmarshall it to JAXB classes.
   b. After the unmarshalling, the engine runs a “static” validation system that validates the data loaded to the JAXB classes. If it fails – it throws Exceptions from the engine to the UI, using a class in the DTO called ErrorDTO.
      If the “static” validation succeeded, we move on.
   c. Mapping – the Engine maps the JAXB classes to the domain classes (That will be presented in this file).
   d. After mapping validation – the engine runs another validation, that requires the domain objects to be “alive”. For example – this is where the “byExpression” validation happens.
   e. The world created by the XML processor is a prototype world, which will be the base for the world instances that the simulation will actually simulate.

2. **WORLD:**
    a. The engine holds and manages all the domain classes of the “world”. Here Is a class diagram to represent the classes and relations to “World”:

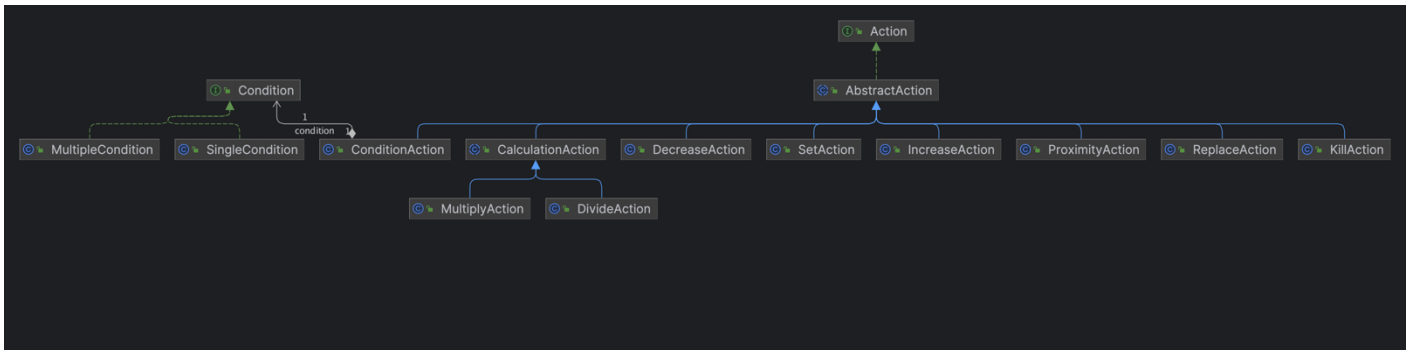


3. **World Generator**
    a. The world generator uses the prototype world to generate a world instance, for each simulation run.
    b. There is a “helper” Entity Generator that is dedicated to generating the entity instances.

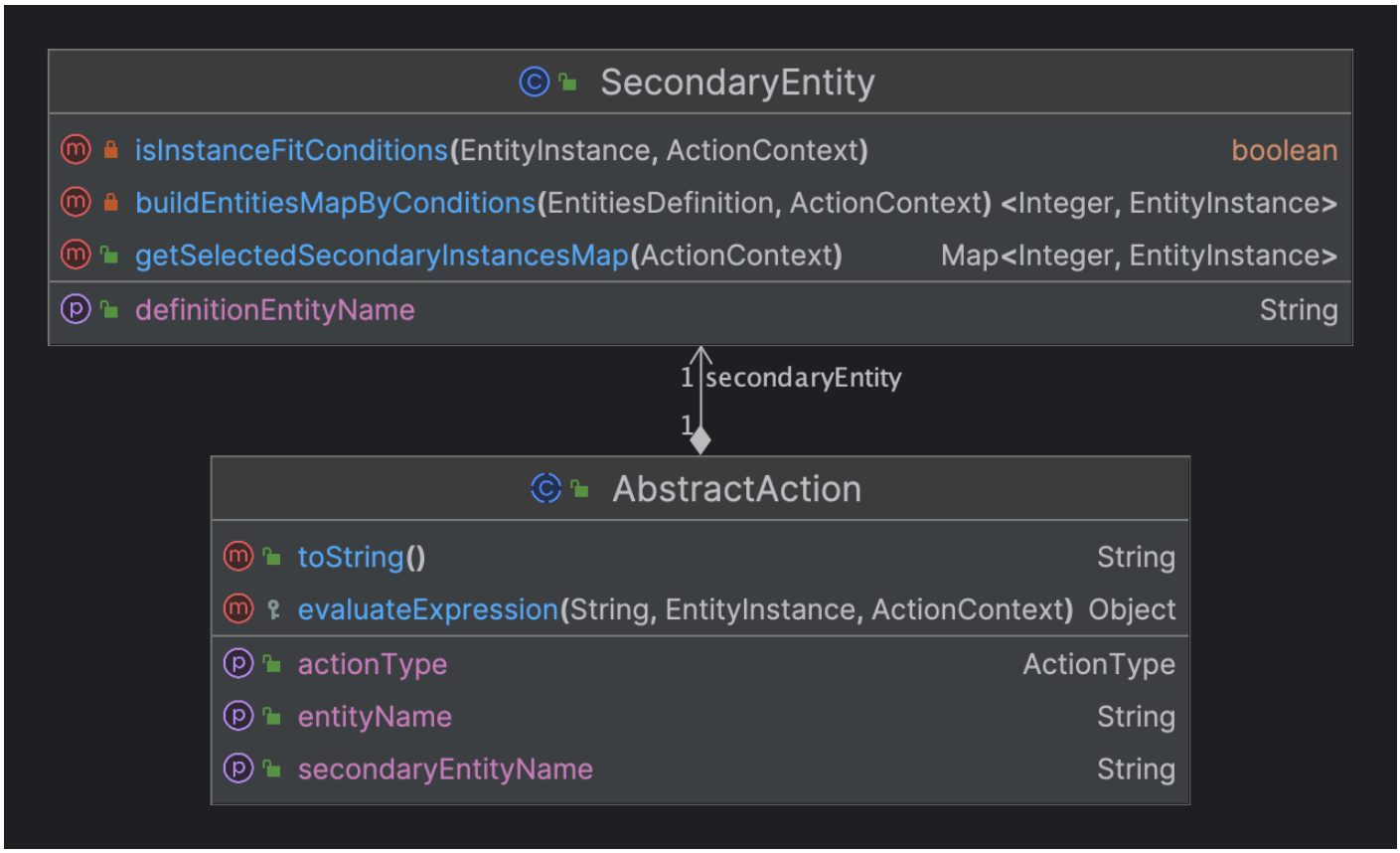
4. **Entities, Environment and properties:**
    a. In my implementation, I have created a class called EntitiesDefinition, which holds the name of the entity, the population and a Map that holds all the EntityInstance-s.
    b. The Environment class holds a list of EnvProperties.
    c. For the properties – I've created different interfaces for entity properties and environment properties. For the implementation I've used the same classes for them:



5. **Rules and actions:**
    a. Rules and Actions where one of the most challenging implementation in the domain class and logics.
    b. I managed to use interfaces and abstract classes to simplify it and make it work.
    c. Here is a diagram that represents the relations between them:



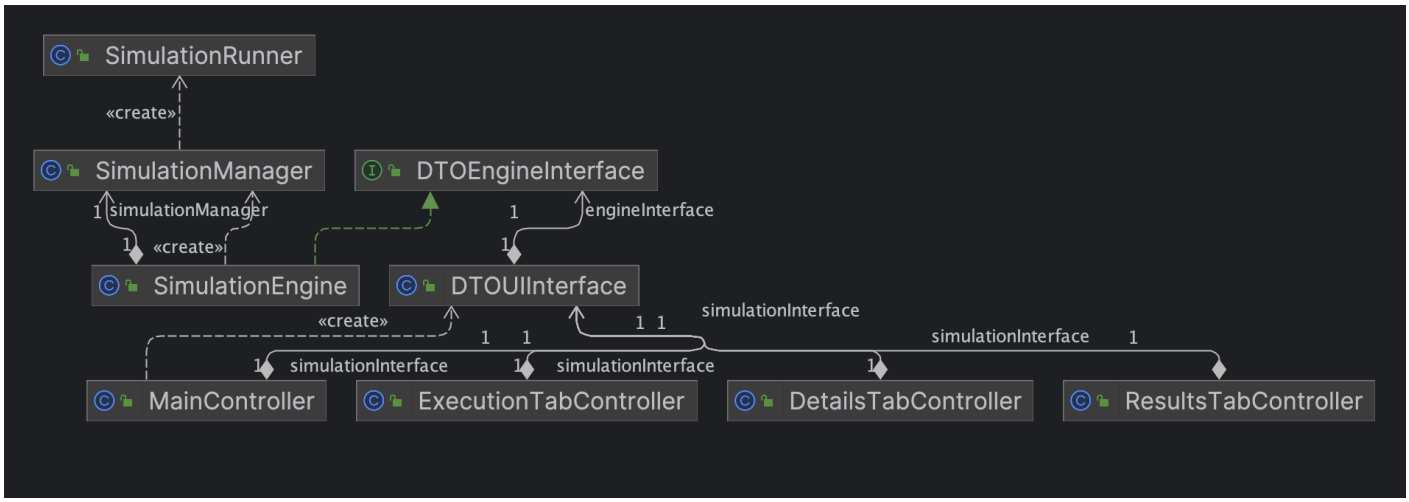
    d. Also added secondary entity class, which holds the logic of how to select the number of secondary entity instances, and then delivers them to the actual actions to perform:



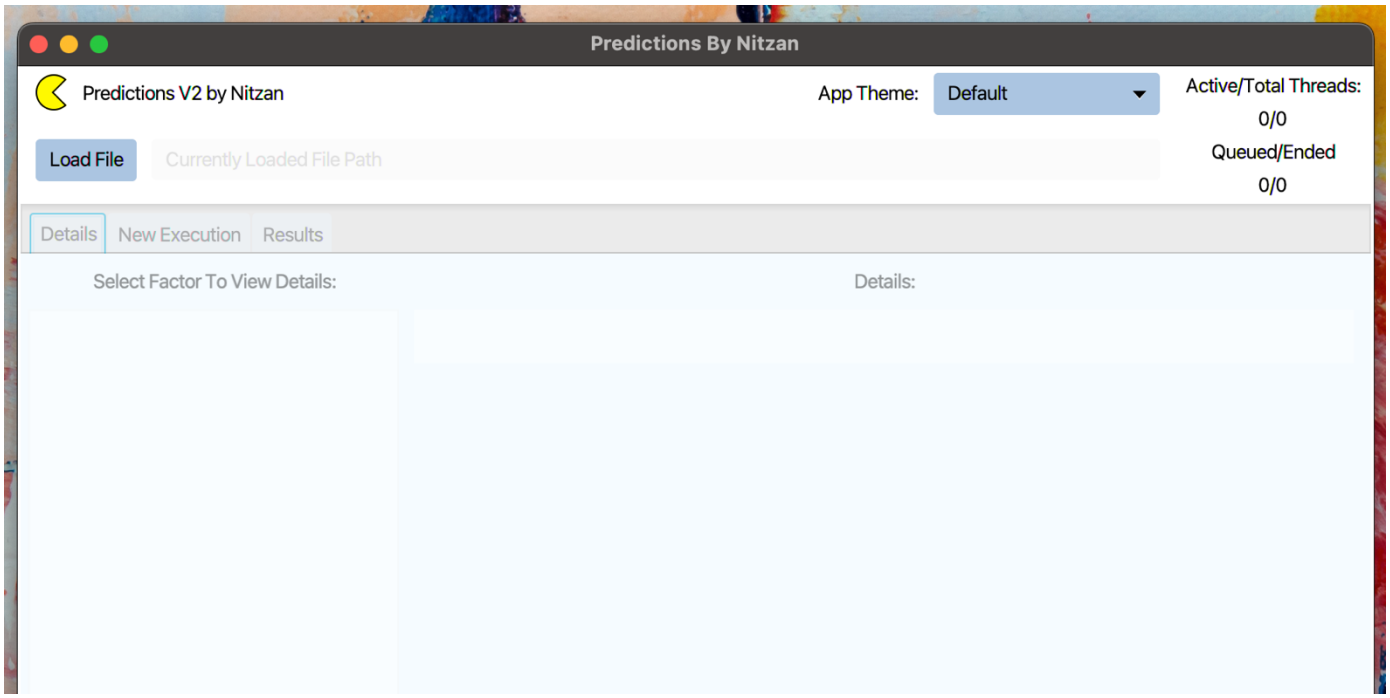
6. **Threads:**
    a. The program let's the user to run many simulation simultaniously.
    b. It's done by using multiple threads – managed in a thread pool.
    c. The number of threads is set by the xml file.
    d. When a user starts a new simulation, the simulation can be in a 4 different states:
        i. QUEUED
        ii. LIVE
        iii. PAUSED
        iv. COMPLETED
    e. At first, the simulation is queued. When there is an available thread in the thread pool, it takes the simulation and runs it.
    f. The user can pause and resume the simulation as he wants, using wait() and notifyAll() logic.
    g. The simulation can be completed in 2 different ways – stopped by the user or reached termination condition (if exists).
    h. When a simulation is done, the thread is released to take a new simulation that is queued.

Simulation Run

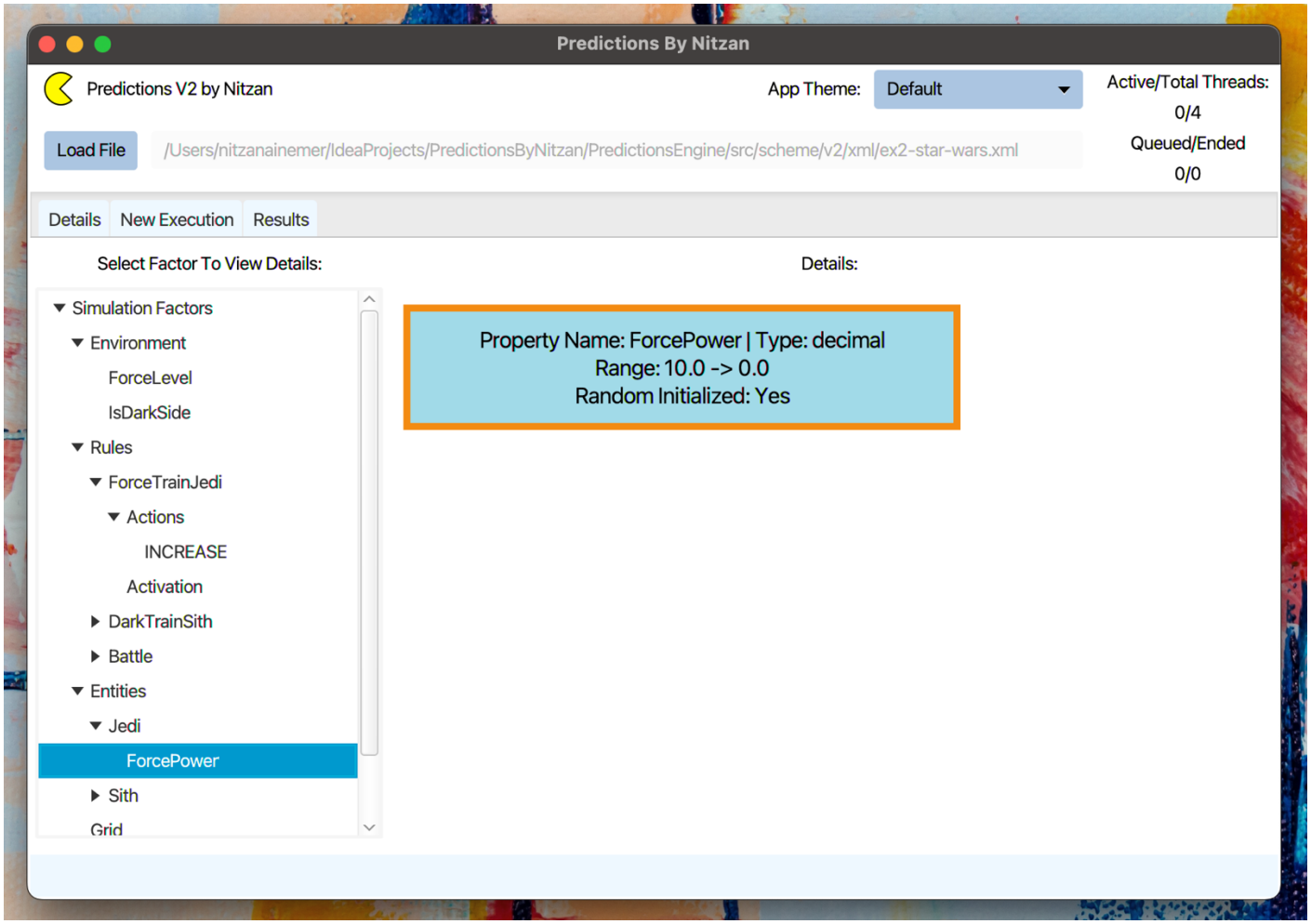
In the design of the simulation run, I designed a separated classes that interfaces between each other in a way that keeps the engine separated from the UI, and the opposite. Here is a diagram that shoes the layout of the classes from the GUI to the Simulation Runner.



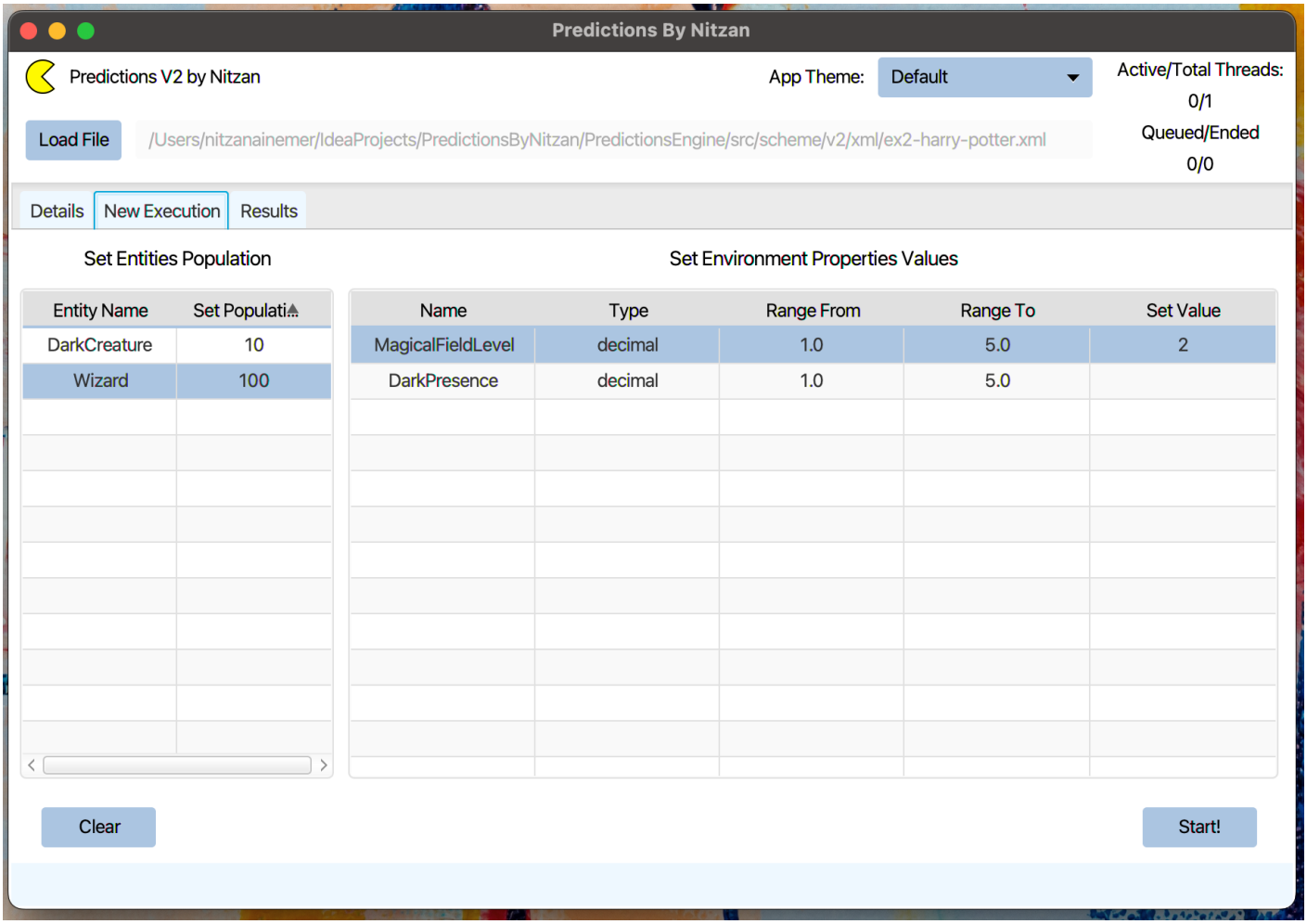
1. The SimulationGUI class (Not in this scheme) in the GUI module, has the Main function that starts the program running. It sets the stage and the scene:



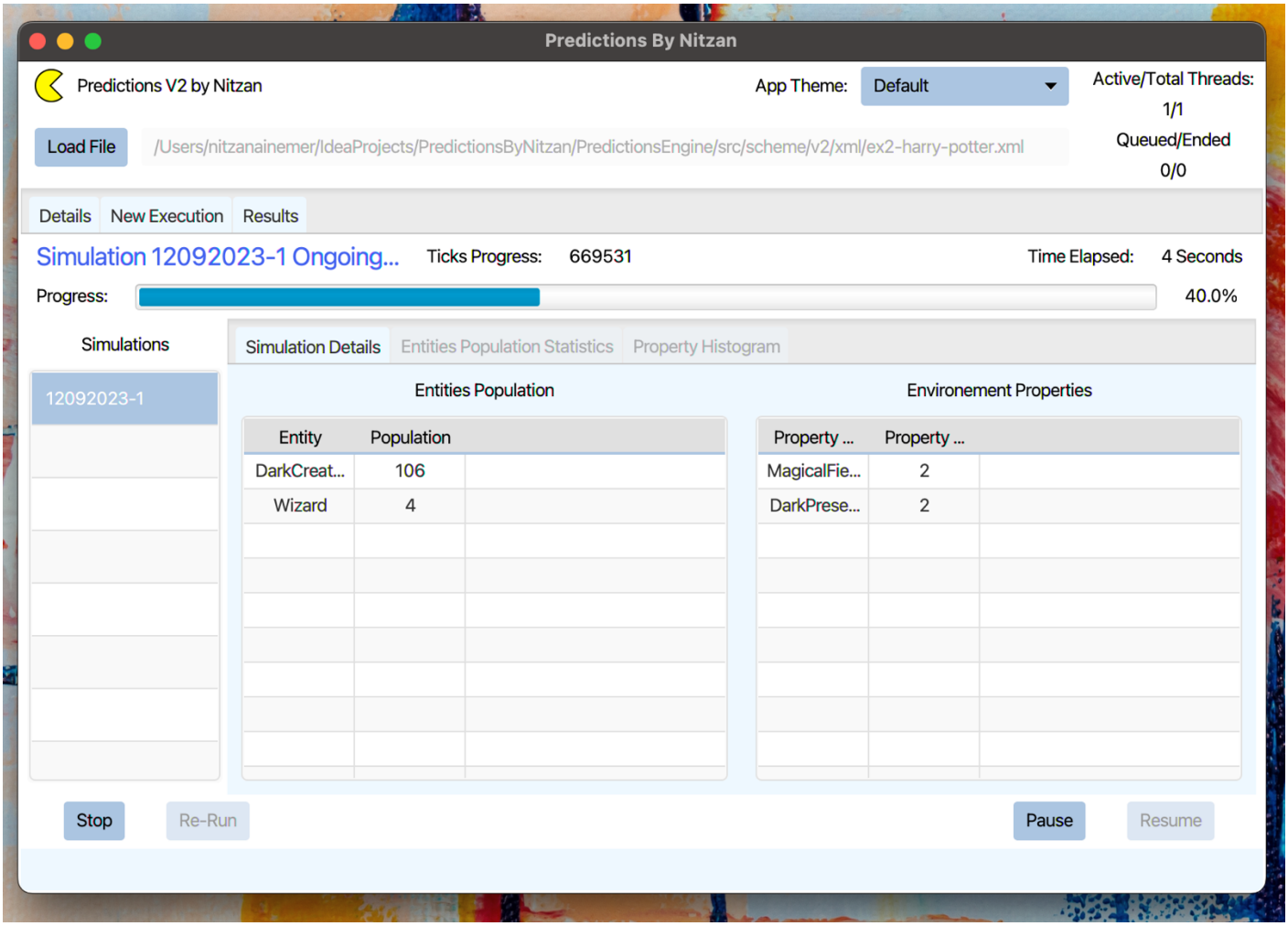
2. Once the user loaded a valid xml file, the simulation tabs are enabled and the user can see the simulation details:



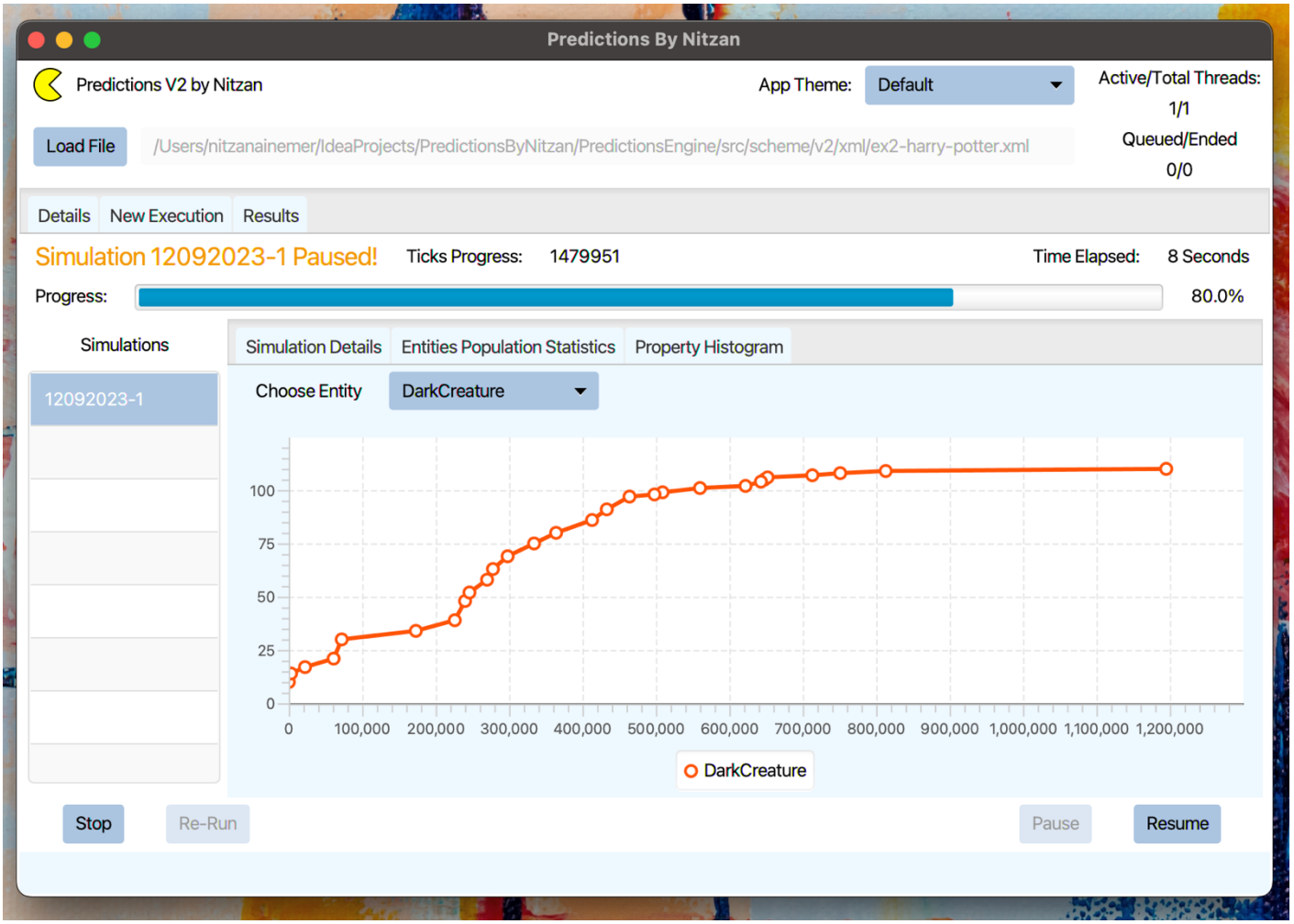
3. When the user wants to run a simulation, he goes to the new execution tab. There he can set the population of each entities (default is 0) and environment properties (default is random):



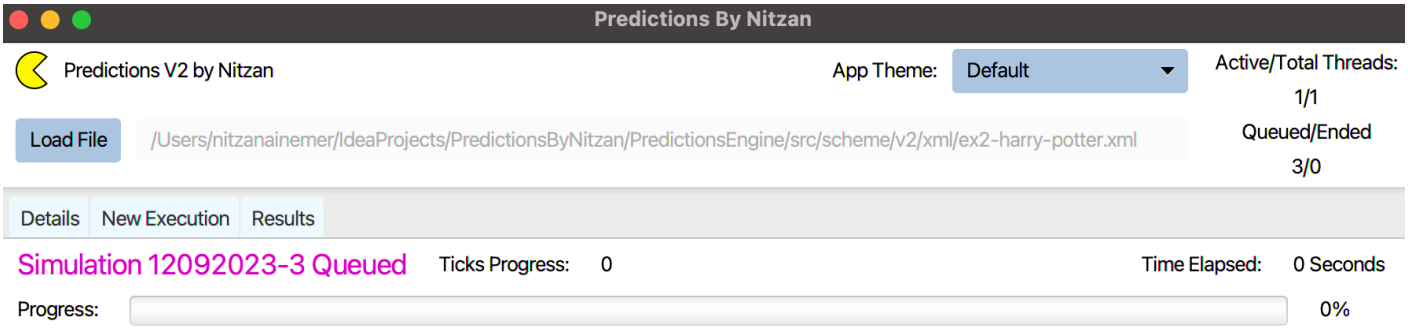
4. After pressing start, the simulation starts, and the user is automatically transferred to the results tab, there he can watch the final environment properties selected/generated and the live progress of the simulation and past runs:



5. The user can pause the simulation at any time while it's "live", and watch the current status of the entities population and properties:



6. When trying to run more simulations than there are available threads, a queue is formed:



7. Eventually, when the simulation ends, the user can see it's full details and results, while other simulation are live: