

## Introduction

### What is Agent-Based Modelling (ABM)?

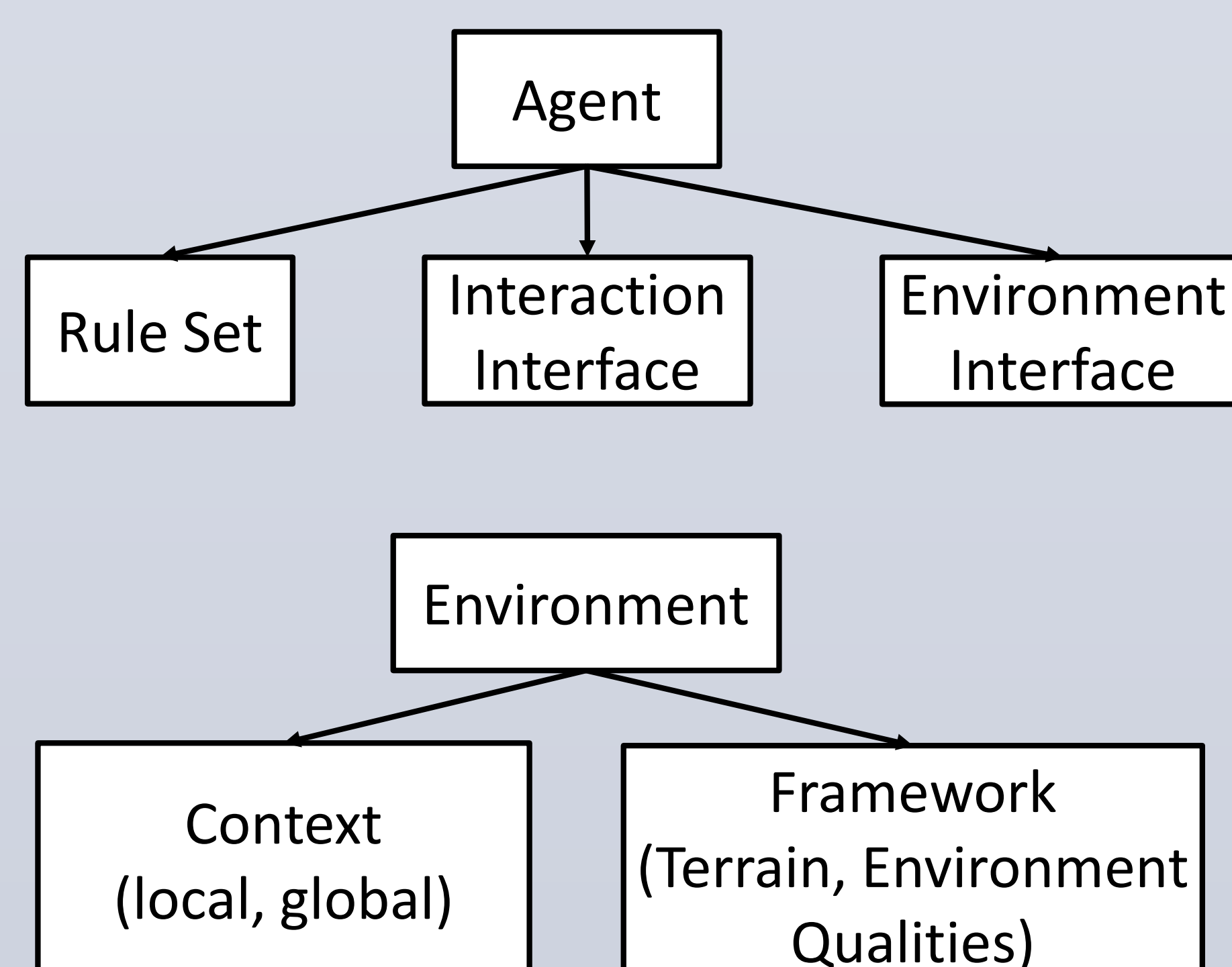
- Method of **simulation** that focuses on **breaking up simulation into smaller** parts that can be handled by **autonomous agents**
- Large groups of agents operate in tandem with each other, to perform a simulation.
- These **agents draw data** from their **simulated environment** to guide their behavior, generating a **solution** from their interactions.
- This behavior can take many forms, ranging from free spatial movement to relations wholly divorced from spatial movement.

### Problem Definition

- ABMs are employed in many different fields and there **currently doesn't exist a defacto standard** for describing their design or implementation.
- The **overall goal** of this project is to create a **standard** by designing a language within which researchers can **create new models** and run them on various computing systems.
- Ideally, the **language is general enough** to describe any ABM that someone may want to model.
- The **final product** is designed for researchers to create new models and thus, will also need to be easy enough to use for someone with little programming experience.

### Taxonomy

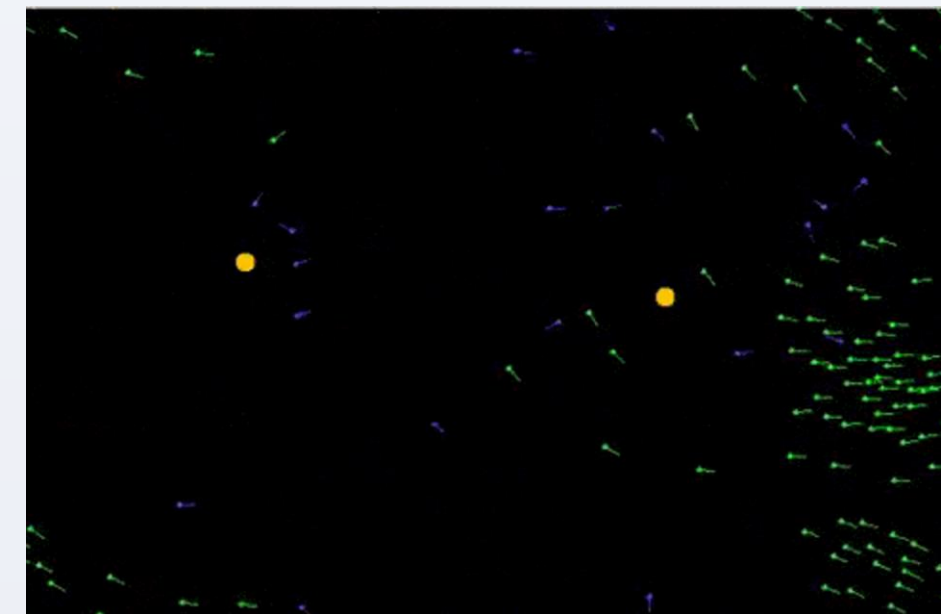
- We focus on **four reference designs** and their implementation using ABM: SIR Modelling, Boids Algorithm, Cellular Automata, and Quorum Sensing.
- The AGASC system is based on a **broader, general purpose, ABM taxonomy** (Hare, Moya, Sulistio).



## Reference Designs

### Boids Algorithm

- Boids is used to **model flocks** of birds, schools of fish, and herds of animals.
- Follows 3 basic rules: separation, cohesion, and alignment.
- These rules and the interactions they dictate give rise to emergent phenomena such as flocking.



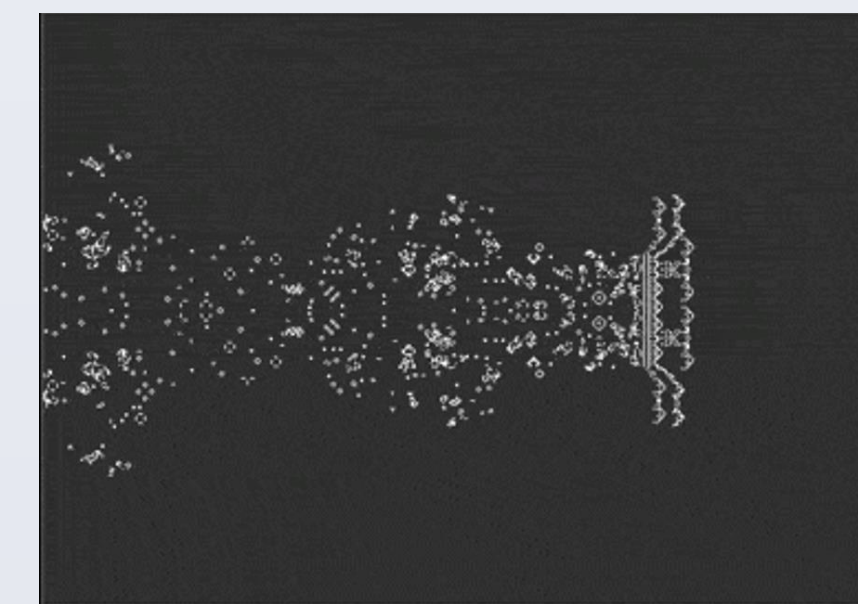
### SIR Modelling

- The SIR model is a subsection of mathematical models used in epidemiology to model infectious diseases.
- S represents the number of agents that are **susceptible**, I is **infectious**, and R is **resistant**.



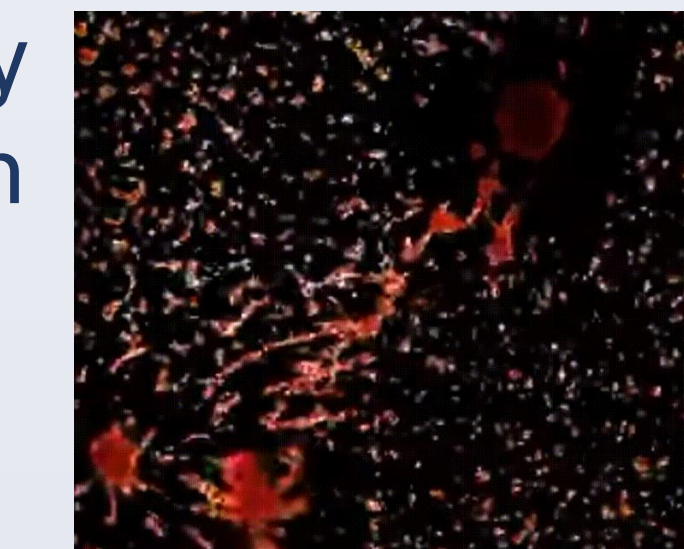
### Cellular Automata

- A cellular automaton is a **collection of cells** with a fixed position on some universal grid.
- These cells have a finite number of states that they can express, and an identical evaluation function that dictates how they change from one to another.



### Quorum Sensing

- Quorum sensing is a method by which **cells communicate** with one another **by releasing and sensing chemicals** in the environment.
- Quorum sensing **relies on modifying external environment** variables rather than engaging in direct agent-to-agent communication.



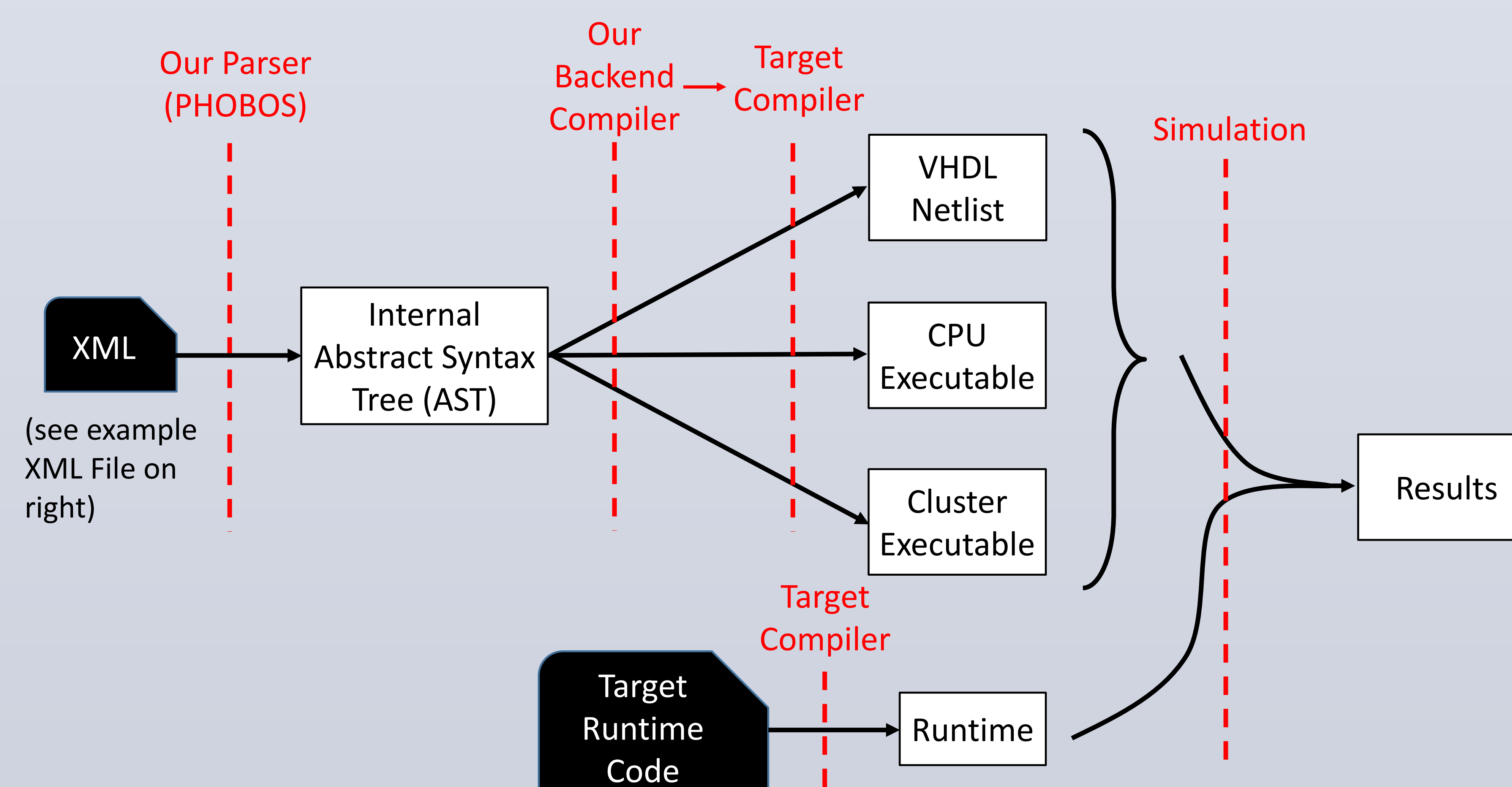
## Our Language

### Semantic Properties

- Declarative
- General enough to describe any arbitrary ABM
  - Including simulation's spatial dimensions and communication
- Procedural
- Program Abstraction

### Syntax

- Decided to use XML markup language for our descriptive constructs
- Allows us to use libraries of already-made parsers for XML



## Sample XML File

```

<ModelDefinition>
  <Environment> ... </Environment>
  <AgentDefinitions>
    <agent> ... </agent>
    ...
  </AgentDefinitions>
</ModelDefinition>
<AgentDefinition>
  <Agent type=...>
    <AgentScope> ... </AgentScope>
    <Rules>
      <State name=...>
        <StateScope> ... </StateScope>
        <Logic> ... </Logic>
      </State>
      ...
    </Rules>
    <InteractionsInterface neighborhood=...>
      <Question name=...> <Logic> ... </Logic>
    </Question>
    ...
    <Answer> <Logic> ... </Logic> </Answer>
    ...
  </InteractionsInterface>
</Agent>
...
</AgentDefinition>
  
```

## Conclusion

- ABMs** are used extensively throughout many **different disciplines** and the **tools available** to researchers for their simulations can **vary dramatically**.
- As such, **our language** can prove very beneficial as it is **capable of describing** their **behavior** and is **independent** of **software** frameworks or of the **hardware**.
- The **efficacy** of our language can be seen by our **test implementation** and **simulation** of the four reference designs

## Future Work

- Implementation** of **other ABMs** using our language and compiler
- Over time, the run-time **libraries** will need to be **expanded** for **more general** use
- While the reference designs cover a variety of models, the **language** needs to be **developed more** in order to support more **complex spatial structures**
- Currently, the only target we support is the CPU. The **HDL** and **Cluster targets** need to be **implemented**

Github: [github.com/firephys/ABMProject](https://github.com/firephys/ABMProject)

References: <http://tiny.cc/ABMProject>