Agent Based Modeling & Simulations

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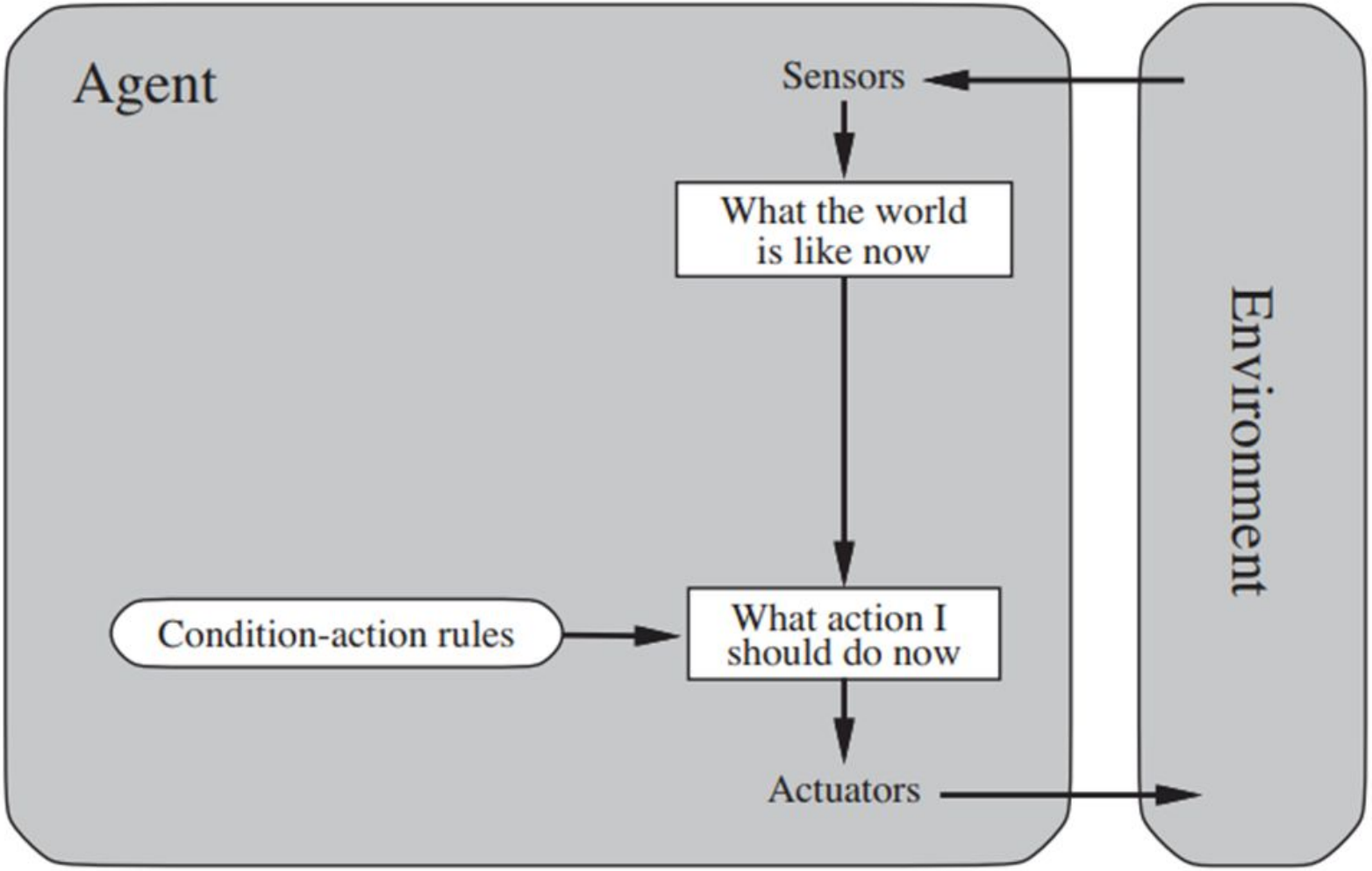
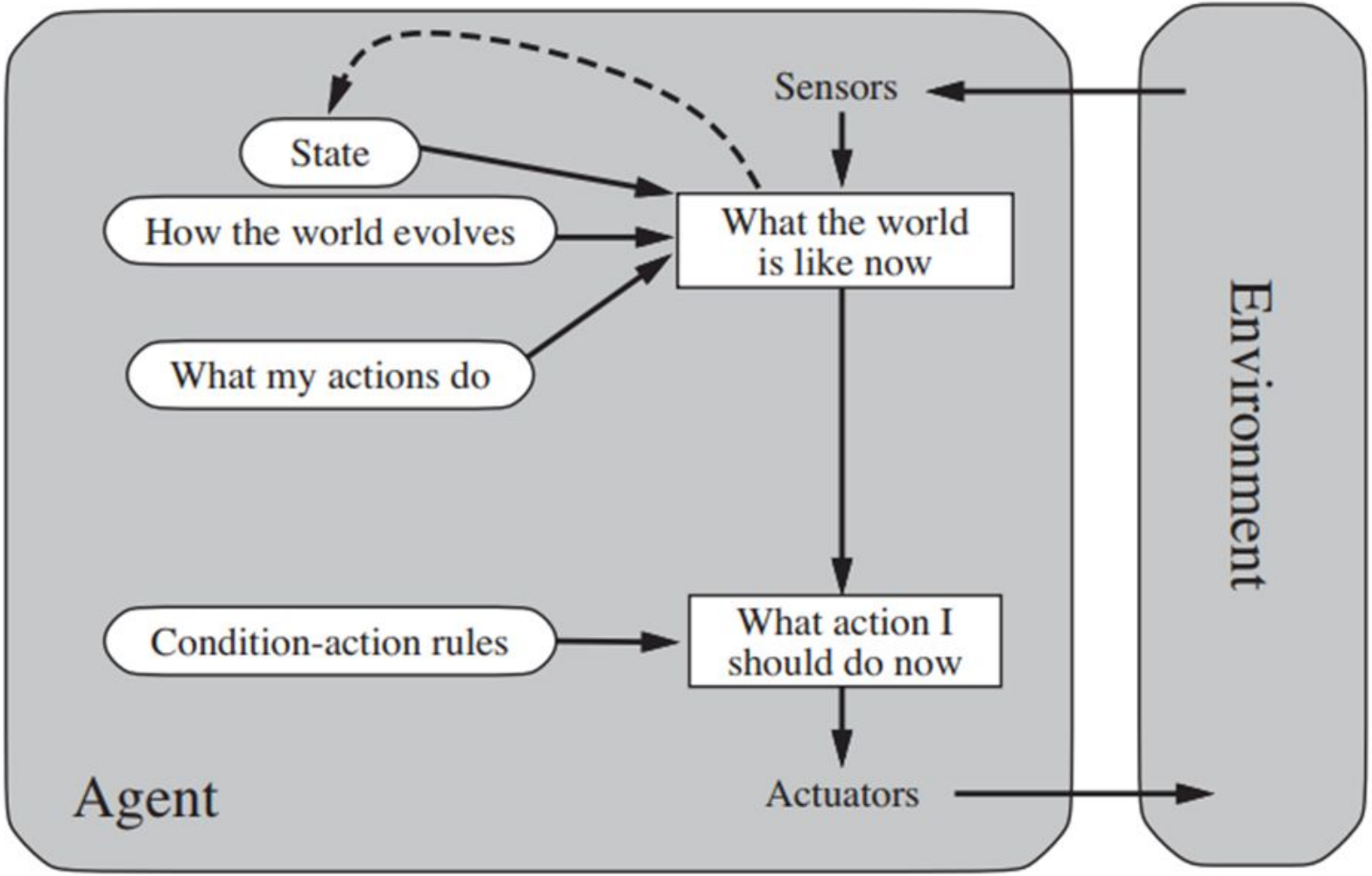
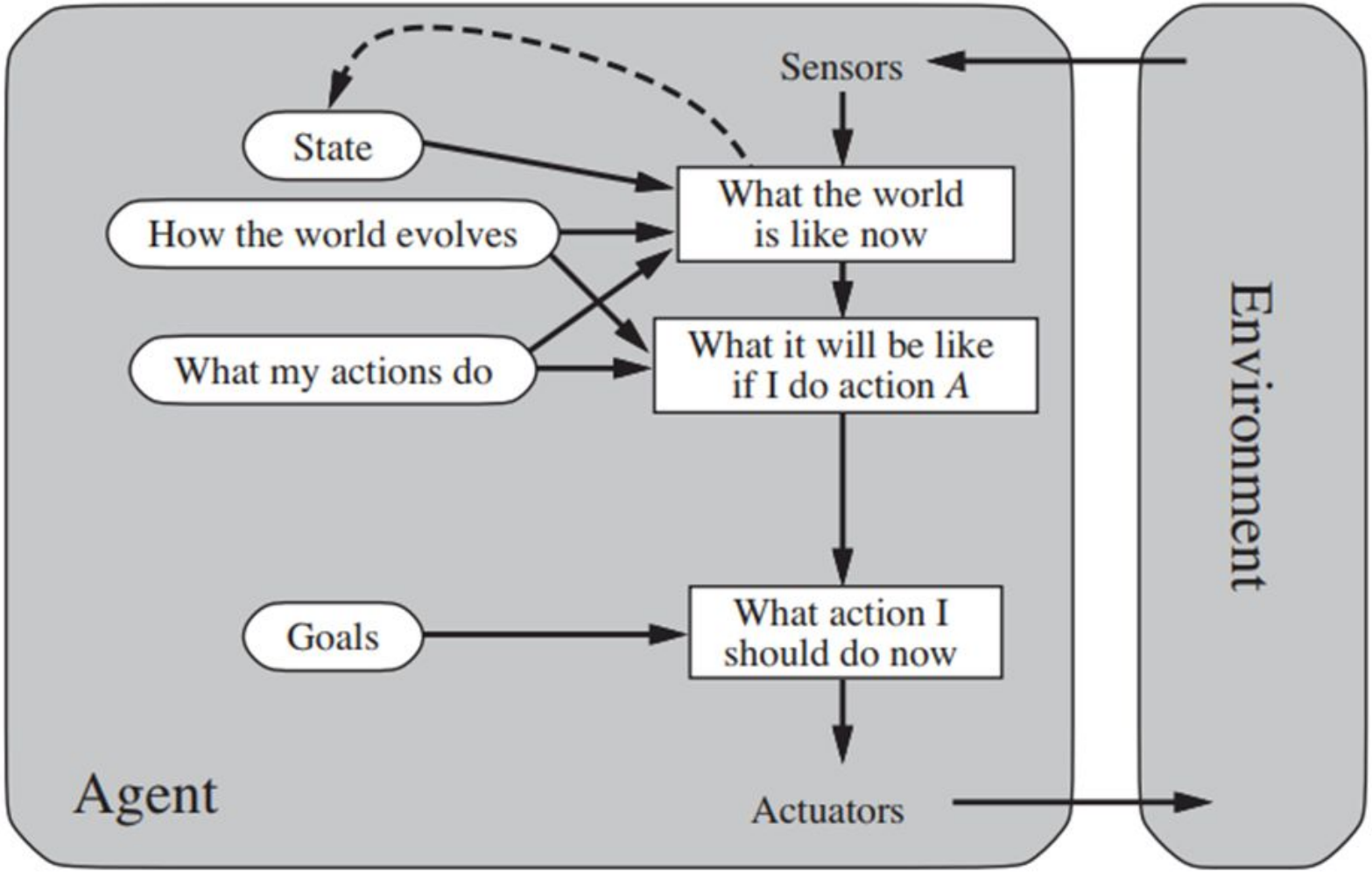
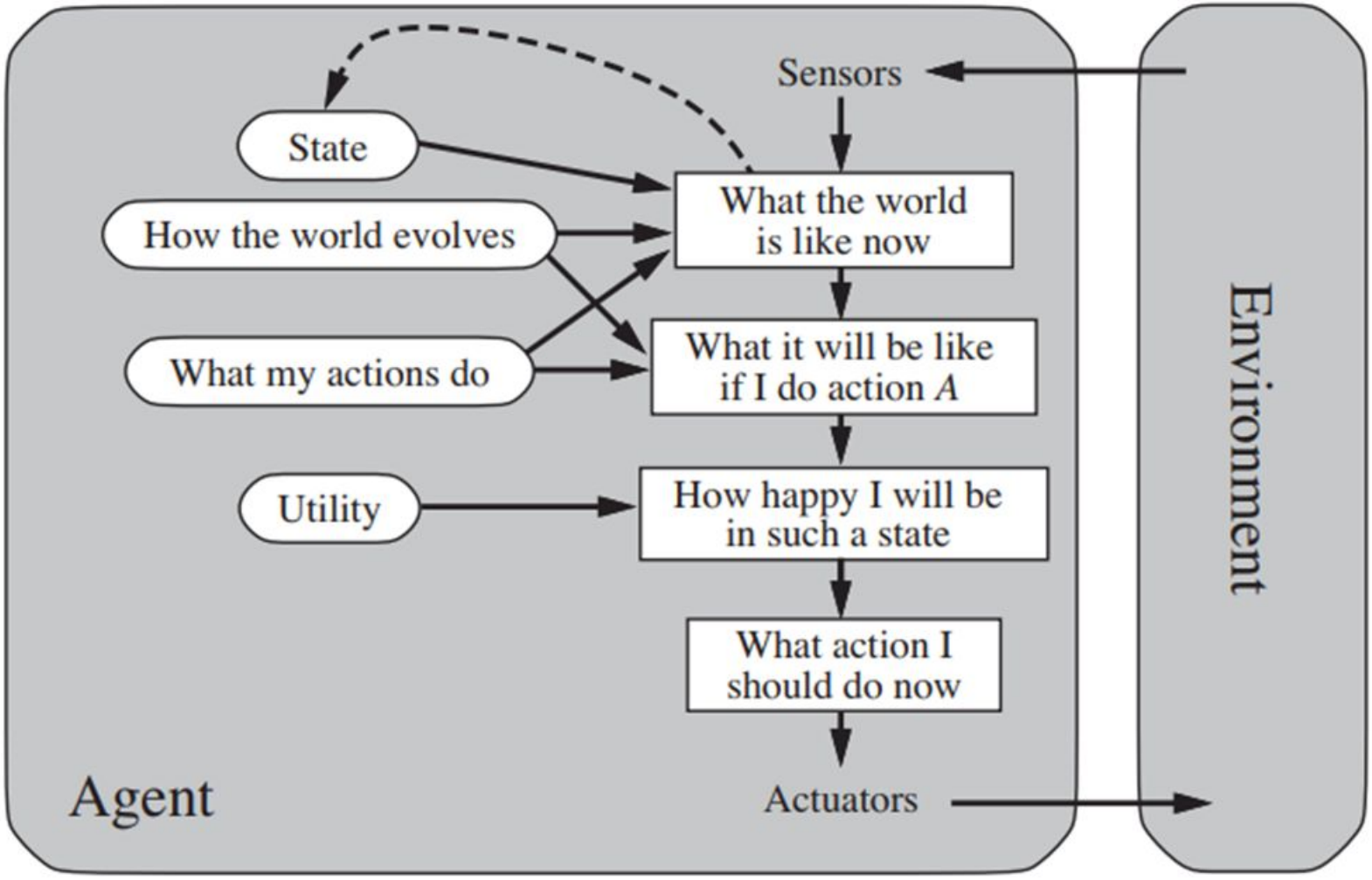
What is an Agent?

- Hopefully all of you remember the definition of agents from Artificial Intelligence!
- Let’s recap!


Agent
Sensors
What the world is like now
Condition-action rules
What action I should do now
Actuators
Environment


Sensors
State
How the world evolves
What the world is like now
What my actions do
Environment
Condition-action rules
What action I should do now
Agent
Actuators


Sensors
State
What the world is like now
How the world evolves
What my actions do
What it will be like if I do action A
Goals
What action I should do now
Agent
Actuators
Environment


Sensors
State
How the world evolves
What my actions do
What the world is like now
What it will be like if I do action A
Utility
How happy I will be in such a state
What action I should do now
Agent
Actuators
Environment

What are some of the other ways to classify agents?

- We may classify them by the nature of the environment
  - Deterministic vs stochastic
  - Fully Observable vs Partially Observable
  - Single Agent vs Multi Agent
- Multi-Agent could be one of the following
  - Adversarial
  - Cooperative
- Multi Agent environment involves multiple agents with defined roles/behavior interacting with each other

Multi Agent Systems vs Agent-based modeling

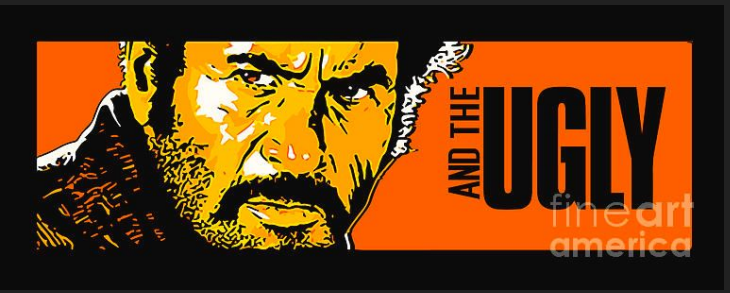
- Multiple interacting intelligent agents working towards achieving a common goal
- Multi agent *modeling* is a ***sub-area*** of multi-agent systems
  - Multi agent modeling is synonymous to **Agent based modeling** (some would argue that there is a minor difference)
  - A **model** is a simplified representation of a system so as to understand, test and predict
  - **Agent Based Modeling** allows us to model (complex) systems as consisting of multiple interacting agents
    - Allows us to understand and study **emergent** phenomenon

Multi Agent Systems vs Agent-based modeling - examples

- Multi-Agent System: A swarm of autonomous aerial drones trying to scan an agricultural farm for disease identification. They can cooperate with each other to achieve the goal.
- Agent based Model:
    - A simulation of drones as software agents, which operate on a simulated farm terrain.
    - The simulation will allow us to compare strategies for their efficiency, reliability, etc.

The Good, The Bad & The Ugly

The Ugly



- Not for finding your very first fresher job
- There is no ‘ABMS junior engineer’ opportunities in indeed or monster
- Some of your interviewers may not even be aware of ABM or what you can do with it

The Bad

- The course is (**very**) inspired by
  - Designing and constructing models with multi agent languages @Northwestern University
- The NU course **does not have any exams**
- @ NU your final grade depends on Project & the Paper
- Our system does not allow for a full-project only course as an elective
- The class size w.r.t support also needs to be considered
- How can we make a project course a non-project exam-based-course ***for 108 students***?
  - Remember: we prefer the components to be as ‘objective’ as possible
  - Solution: A good percentage of the evaluation may circle around the knowledge of the preferred ABM platform
  - So, **learning NetLogo language is not at all an option**

The Bad

- Both exams and quizzes are Closed book with **programming** questions
  - Will remind you of your "Intro to Computer Programming using C" exams, but with **NetLogo**
- This means you may need to **memorize** some important syntax of NetLogo. But I'll usually allow using the help-menu and docs.
- There will be a (few) subjective questions. A problem/scenario will be presented and you need to outline how you would build an agent based model
  - What global variables, state variables
  - Procedures for behavior of agents (agent-agent and agent-environment)
  - Things that you will measure etc
- But, you need not use NetLogo syntax (general pseudocode is acceptable)
- (my definition: subjective questions are those which have **multiple** right answers)
- BTW, we still have a course project with 20% weightage

The Good

- ABMS is the kind of knowledge that will make your company appreciate you
- This will help you move up in the ladder
  - Operations Research/Operations Analysis is very very important
  - ABM is one important way of doing Operations Research
- The NorthwesternU follows Quarterly system: instead of 2 semesters we have 3 quarters every year
  - The course is designed for completion in one quarter
  - But usually the Quarters are more packed than a Sem
  - Anyway, the course is comparatively a light course
- I have enhanced the course contents with three things
  - More hands-on lectures
  - Important case studies on ABM
  - Slightly more deeper dive into the alternative (Competing) modeling approaches
- **Moreover ABM is so much fun!**

The Good

- **Mohammed, H., Reddy, V. H.,** & Kandaswamy, S. (2020). A Decentralized Strategy for Cooperative Driving among Autonomous Cars at Lane Closures. In 2020 IEEE 32nd International Conference on Tools with Artificial Intelligence (ICTAI) (pp. 905-910). IEEE.
- **Nair, D**., Yerragunta, S., Kandaswamy, S., and Venkataraman, H. (2020) Assessing the impact of heterogeneous traffic on highways via agent-based simulations. Proceedings of the 2020 Winter Simulation Conference, Florida , USA - 13-16 December 2020
- **Meegada, S**., and Kandaswamy, S.,Comparison of Viral Information Spreading Strategies in Social Media. Proceedings of the 2021 Social Simulation Conference (In Press - Recently accepted)

The Good

A Simple Agent Based Modeling Tool For Plastic And Debris Tracking In Oceans

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PAAMS 21
International Conference

Misc & Course Plan

- (important) we have 3 slots every week. I get to decide
  - which one is used for tutorials and which ones are used for lectures
  - I'll decide based on the flow of the course and importance of topics/components
- There is not too much theory, so I will be showing live demonstrations during the lecture hour itself
- The tutorials will be used like mini-labs. The students will be given exercises to work on
- Let's look at the course plan document!