

Agent Based Modeling & Simulations

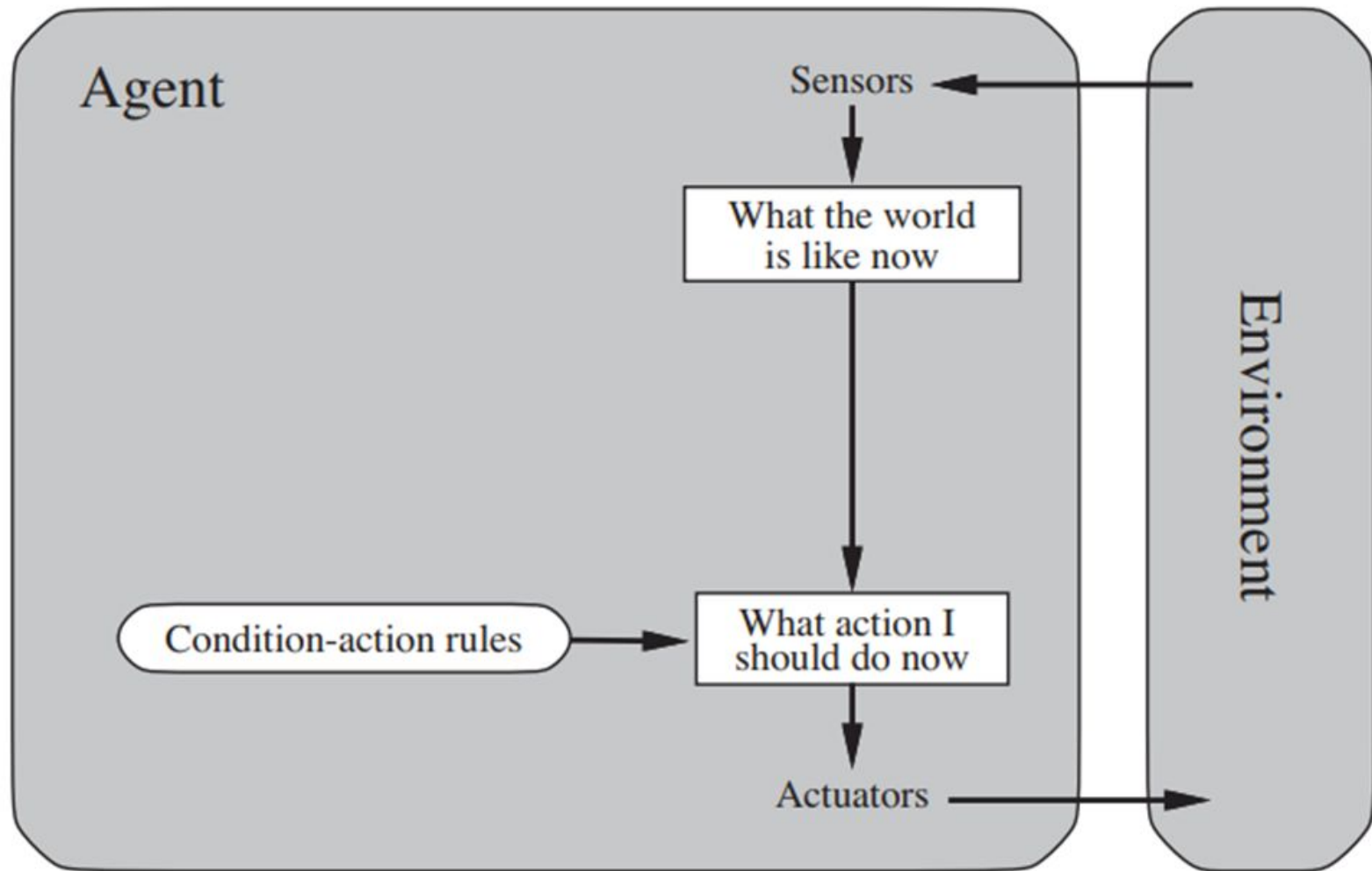
Dr. Subu Kandaswamy

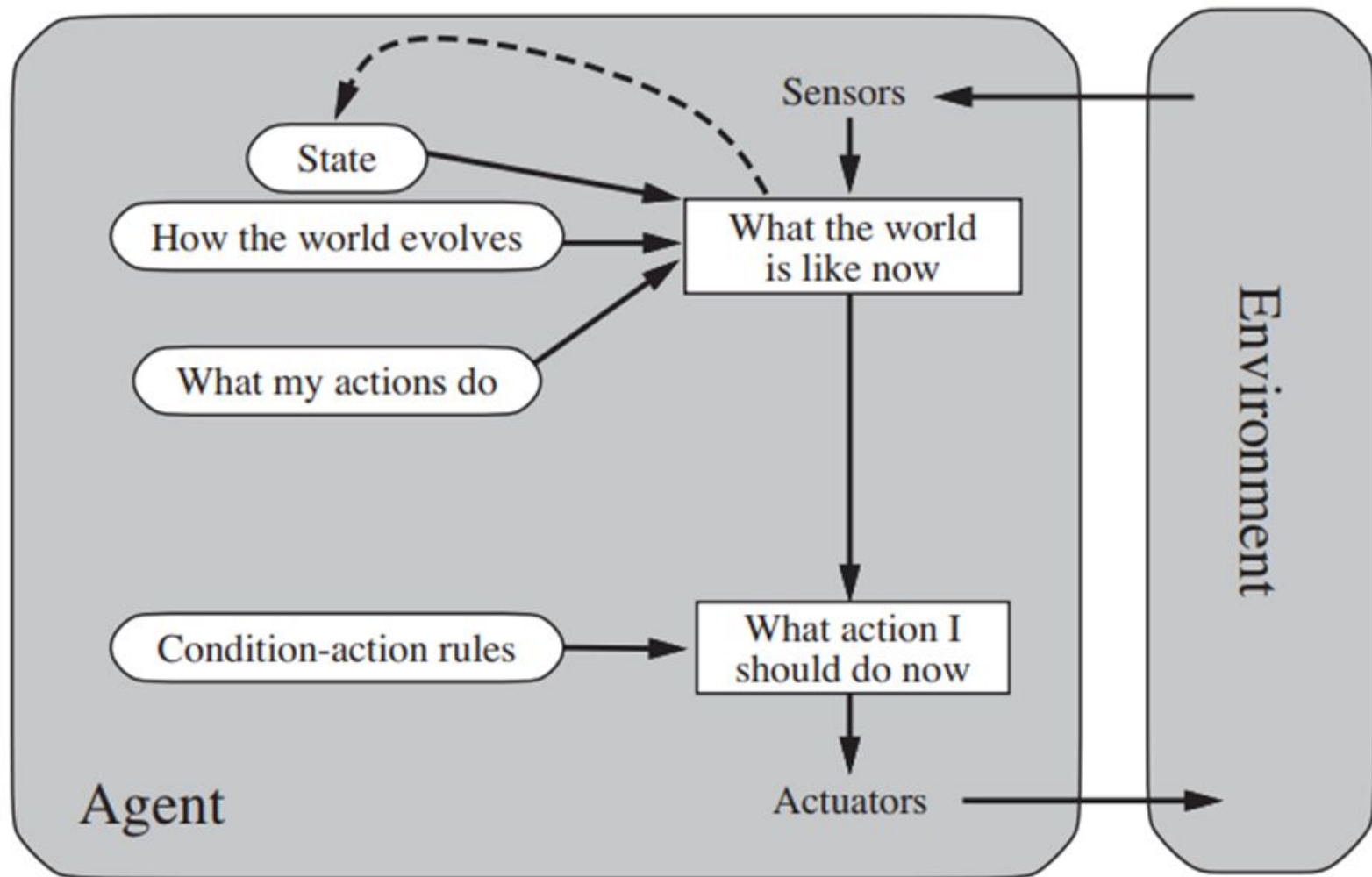


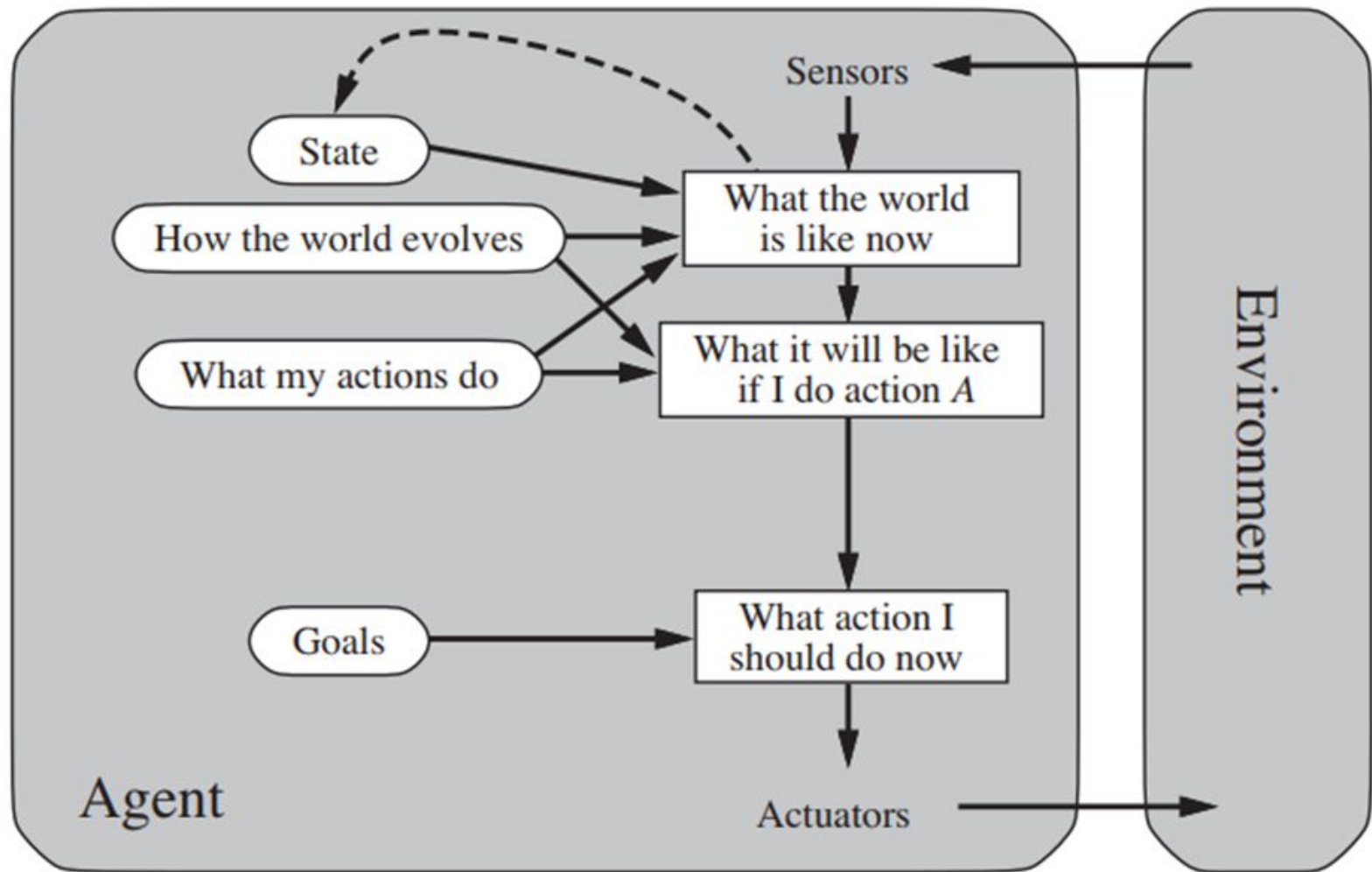


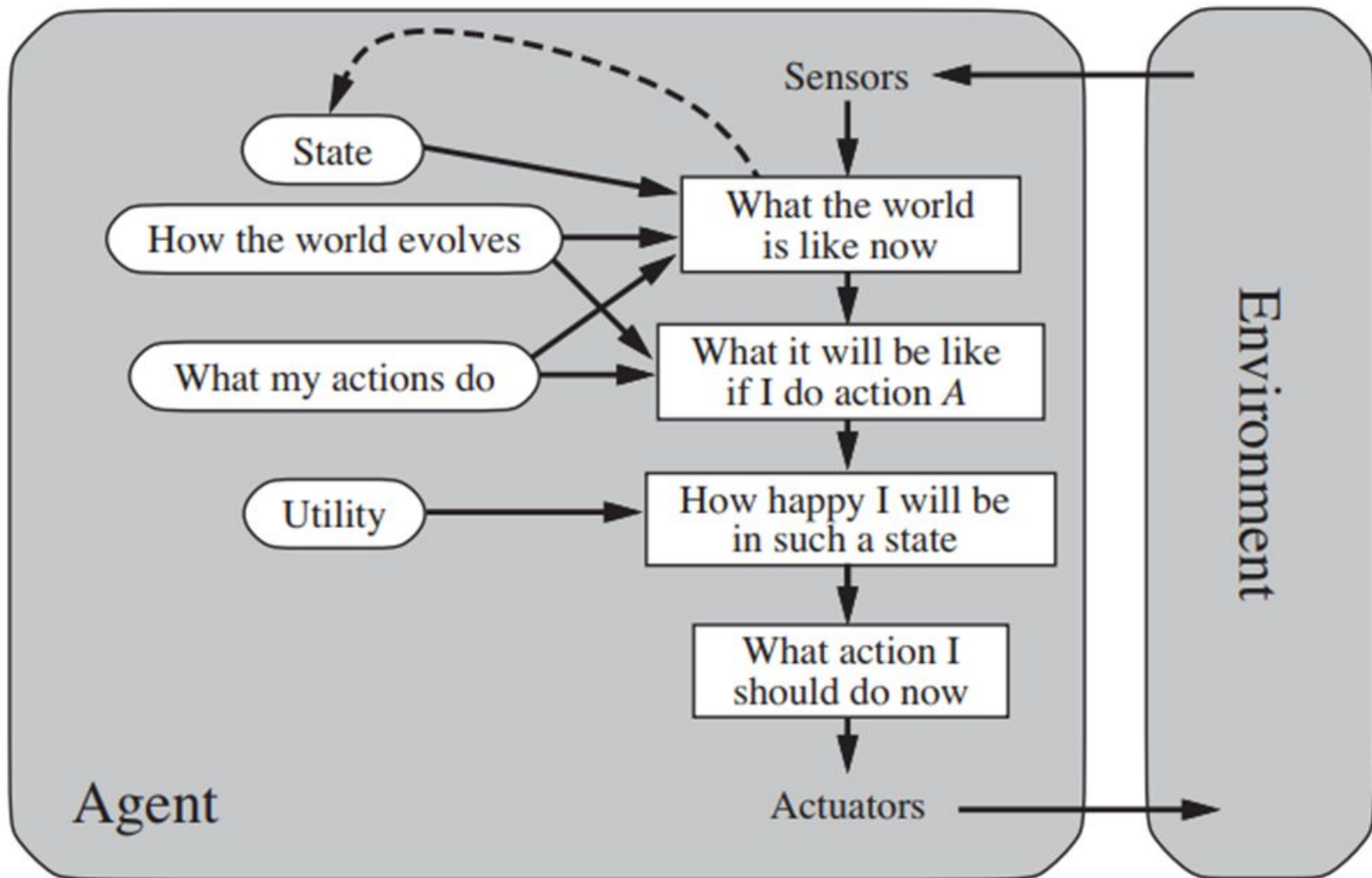
What is an Agent?

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











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

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- 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

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- 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



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- 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



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- 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



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- 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



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- 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



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- **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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Misc & Course Plan

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- (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!