**Instructor’s Manual: High-Level Internship Activities**

**Outline**

**Week 1**

Lecture ⇒ Software Engineering and its Impacts on Different Industries

Task ⇒ Students download the software to their computers

**Week 2**

Lecture ⇒ AI and its societal and ethical impacts

Task ⇒ Download and run a DonkeyCar simulator

**Week 3**

Lecture ⇒ Supply-chain dynamics

Task ⇒ Build the hardware (DonkeyCar) using the instruction manual

**Week 4**

Lecture ⇒ Hardware and software requirements

Task ⇒ Integrate the software downloaded to the Raspberry Pi

* Steps: Create the DonkeyCar App, Calibrate the Car *(refer to the Instruction’s Manual)*

**Week 5**

Lecture ⇒ Engineering Problem Solving – Grand Challenges

Task ⇒ Finalize integration and drive the car

* Steps: Finalize Calibrate the Car and Get Driving *(refer to the Instruction’s Manual)*

**Week 6**

Lecture ⇒ The Race

Task ⇒ Get the students and their cars to the race track for the final activity

**Activity #1: Setting Up The Software**

**Learning Objective**

Understand how software engineering impacts different industries, specially the automotive industry, and to plan a software engineering project. Also, to learn how to use the command line interface to install software while following instructions carefully and accurately to prevent errors, and finally learn how to troubleshoot any bugs.

**Skills To Be Learned**

* Software management
* Command line interface

**Description**

The students will be introduced to their first engineering lesson, the impact of software engineering in the car industry. This lesson will make students think critically about software engineering and car manufacturing. Moreover, they will learn how to structure their software projects based on different steps. Then, students will read over the instructions and start installing the software. After downloading the necessary software and applications, they will learn how to run the simulation program.

**Instructions**

1. Presentation: present to the students the presentation on software engineering and its impact on the car industry. The [presentation](https://docs.google.com/presentation/d/1D5EmFXLviNGD67-hWTH4N03otFEad-GxTX6WvZBISvc/edit#slide=id.p) can be found on the folder Activity #1 and each slide has a note with a link that points to more information regarding the slide.
2. Engineering Activity: Introduce to the students the steps for making software and then have them think and write 3-4 sentences (for each step) about how they plan to do their project based on these steps. This work should be saved for the final report of the internship.
3. Software Installation: Have the students go over the installation manual and video for them to install the Donkey-Car Kit software.

**Activity #2: Running The Simulations**

**Learning Objective**

To comprehend the different biases in AI training while learning how society, ethics, and engineering blend. Also, to begin working with AI recognition and on-device model training while training models through data collection and model deployment directly on the car to improve performance.

**Skills To Be Learned**

* Data collection
* Simulation control
* Software testing

**Description**

Instructor will expose students to bias in AI training before running the simulations. Follow instructions below to conduct the lesson. After the lesson, students will begin work on their simulators. Students will go through the instructions for the simulator to code a car and see how it would respond to the coded commands through their screen. They will also be able to improve their simulator by testing how the car performs.

**Instructions**

1. Handout: provide worksheet activity along with the [case study](https://drive.google.com/file/d/1SnDA50YdyMObOlbHlrB5fE4y1AIebErd/view?usp=sharing) to the students. Read the introduction aloud. Then, review the bolded terms together before breaking up into groups (option: students volunteer to read each term). Students will read the case study individually. Then, discuss the questions verbally with their group.
2. Engineering Activity: 15 minute discussion with group members answering the handout questions. Then, circle back with the entire class to offer significant findings.
3. Simulations: Have the students go over the donkey car instructions for them to train the different machine learning models for the car simulator.

**Activity #3: Building The Hardware**

**Learning Objective**

To explore the parts of a supply chain to understand how all of the components came to be a part of the kit. Moreover, to identify how different physical parts interact with each other to successfully build the car, create and test a circuit containing a power source, inputs, outputs and wires, while constructing a prototype of a self-driving vehicle using a scaled car kit, test the prototypes and make improvements.

**Skills To Be Learned**

* Parts of a supply chain
* Hardware Assembly

**Description**

Students will begin by outlining the parts of a supply chain to understand how the different components that make up the hardware they will be using to assemble the donkey car. After gaining an understanding of production, students will each receive a hardware kit that will contain all the components necessary to assemble the donkey car. Students will proceed to follow along Adam Conway’s assembly video “[Donkey Car Assembly Video](https://www.youtube.com/watch?v=OaVqWiR2rS0)” to assemble their own car.

**Instructions**

1. Presentation: present to the students the presentation on supply chain management and its contribution to hardware for donkey car assembly. The [presentation](https://docs.google.com/presentation/u/0/d/1Ciuslg7RX2UY_HziuecpYQojMBWF8C_AmQNS8JdV--4/edit) can be found on the folder Activity #3. The presentation also includes a video that will guide students through the assembly of the donkey car hardware.
2. Engineering Activity (within the presentation): have the class have a 15 minute discussion on the steps necessary to acquire everyday products. Discussion will be followed by an introduction to supply chain management and students will proceed to sketch a diagram that outlines the steps involved in acquiring parts to assemble a donkey kit. In the second session, students will watch “[Donkey Car Assembly Video](https://www.youtube.com/watch?v=OaVqWiR2rS0)” and follow along to assemble their cars.
3. Building the hardware: have the students take their kits and follow the building instructions from the video and manual.

**Activity #4: Integrating The Software And Hardware**

**Learning Objective**

To learn about the different hardware and software high and low level requirements while thinking critically about the project. Also, to link software to the hardware successfully and to apply computing knowledge to control the car using software.

**Skills To Be Learned**

* Into level of programming
* Software and hardware integration

**Description**

Introduce the students to the different hardware and software requirements with a presentation. Then have the students think critically on the high and low level requirements for the Donkey-Car kit. Based on the instructions, students will learn how to integrate the software (the programming) to the hardware (the physical Donkey Car that they just assembled). The Donkey Car should be able to perform certain movements based on how in depth the students want to go. For example, the car should be able to move around a circuit while avoiding obstacles and changing its path as needed.

**Instructions**

1. Presentation: Give the students an introduction to the hardware and software requirements. Also teach them the allocation of system requirements to software/hardware subsystems.
2. Engineering activitiy: Have the students decompose the higher-level requirements and assign them to lower-level functions by mapping each general component of the car to the software and hardware subsystems.
3. Testing: Make the students test the integration by running the software and observing the functioning of the Donkey Car. A successful hardware implementation should follow the software instructions.

**Activity #5: Feedback With Instructors To Improve/Fix Problems**

**Learning Objective**

To learn about the engineering challenges of this decade while learning how to problem solve. Improve problem solving skills to later evaluate the instructors’ feedback and improve the system on hand. Test the prototypes, problem solve with a group, and make improvements.

**Skills To Be Learned**

* Problem-solving
* Communication
* Active listening

**Description**

Students will initially receive a presentation where they will be introduced to the Grand Challenges in Engineering. The presentation will be followed by a case study on personalized learning. After the presentation sessions, students will start driving their cars through the track. After a few trial runs, students will meet with their instructors in 15-minute feedback sessions to see how they can improve their Donkey Car or solve issues that they have faced.. If the students are facing any problem during building hardware or integrating the software and hardware, they can reach out for help from the instructors as well. If all the procedures go well and no problem needs to be solved, the students may start to think about how to improve the whole process.

**Instructions**

1. [Presentation](https://docs.google.com/presentation/u/0/d/1ipCfE29YKSuDY9XEGOlOWNfiBy49dn5bCMxdGo0vJ48/edit): go over the powerpoint and introduce each engineering challenge to the students with the problem solving framework.
2. Engineering Activity: Present a small case of personalized learning on application to the students and have a class discussion on three questions about how to approach this problem.
3. Get the students to start driving their calibrated car.
4. Finally, have a 15-minute feedback session reviewing this activity and the Donkey Car, telling students where and how they can improve. Do troubleshooting with the students if they faced any problems not referred to on the manual.
5. Improve/Fix Problems: Have a session with the students for them to mention some problems or fixes that they need to do to their programs or kits. Have them collect data on their improved products to see results.

**Activity #6: The Race**

**Learning Objective**

To learn about how software and hardware work during the internship and how they behave in real life utilization when driving their car. After learning this through the drive, the interns will analyze their performance and also present to the class.

**Skills To Be Learned**

* Good Sportsmanship
* Resilience
* Perseverance
* Motivation theory
* Learning via iteration and mirroring
* Movie-editing software
* Presenting and communication

**Description**

A fun and friendly competition between each student or each group to see which one has the most stable-functioning or fast Donkey Car. In order to motivate the students to do their best, a small award may be given to the best individuals or the best group.

**Instructions**

1. Presentation: Go over the rules for presentations and race day! Should be fun and lighthearted.
2. Race Day Fair: Students should turn a report in with an introduction, content (all of the activities), and their main takeaways. The report will consist of a 2-3 minute video and a poster of their world. If the internship is conducted in person, the students will make a poster board and present their donkey car in a science-fair esque closing ceremony. If online, this report will be either directly sent to the instructor or shared in a zoom format.
   1. Spend 30 minutes walking around and seeing each others’ cars.
3. Engineering Activity:
   1. Now, after the race, have students fill in a sheet of paper with the results from the race including:
      1. time elapsed
      2. list down an issue with your driving performance
      3. how you would fix it( Is it something to change with the car or your navigation?)
   2. Watch a Youtube video of a DonkeyCar race and take notes on what the cars do well. Now, race again with your newfound knowledge and calculate the difference in time!
4. Closing Activity: Awards ceremony! Get trophies to the kids and have a pizza/food party to wrap up the summer!