ENG 4000

Sprint 6 Review

Automobiles Making Decisions (AMD 2)

Yahya Ismail

Chris Posca

Sean O'Brien

Manmeet Singh

Sprint Review

This Sprint review will cover up all the work completed in the following work weeks:

1. Week of January 7th, 2019
2. Week of January 14th, 2019
3. Week of January 21st, 2019

For this sprint review Manmeet acted as the Scrum Master and Yahya acted as the stakeholder. The Sprint review meeting was held on January 23rd 2019 and each group member was allotted time to discuss the progress they had made toward their assigned sprint goals. A lot of important issues were discussed during this meeting and the remaining time was dedicated to plan one of the more important upcoming Sprint 7. During Sprint 6, we also received the news regarding one of our team mates – Max Munits, dropping engineering and switching to computer science and how he would not be able to support our team any longer.

During this sprint, we were able to complete the following:

1. Refine our overall vision to define our MVP.
2. Get feedback on our MVP ideation from our academic supervisor.
3. Resolve any pending issues with our academic supervisor with the help of course directors.
4. Resolve disputes related to our industry partners AMD with the help of course directors.
5. Develop preliminary algorithms for number plate detection.
6. Develop Simulated environment within a game engine to perform testing.
7. Present and discuss our MVP and progress made to our peers and course director to get their feedback.
8. Reviewing work done, and best practices during this sprint along with gathering feedback for the upcoming sprints and other important deliverable.

New Vision Description

During this sprint our idea has undergone an evolution into something we feel better meets the requirements and solves the problem more effectively. We feel our initially proposed system accurately matches the sponsor's statement of work, but we have opted to move away from

relying on the statement of work due to circumstances that have made getting a clearer problem definition quite difficult. This sort of problem pops up in the engineering field all of the time, where requirements elicitation with a customer becomes a challenging process. The initial system that we wanted to build was a system that altered camera parameters automatically based on changing conditions in the camera's view. This met our requirements at the time, but we felt we would just be building what every digital camera company has been including in their devices for the past ten years. Our group felt a dissatisfaction with this idea, and so we decided to pivot our team's focus to a new but very related problem.

During a group discussion in a sprint meeting, all members of our group expressed similar negative feelings about working on a project which already had an available solution, when one member proposed we change our focus. They proposed we switch our focus to an area where there is still much work to be done, and the area they proposed we focus on was the operation of LIDAR detectors in snowstorms, sandstorms, and dust storms (extreme weather conditions). After discussing, we all felt that this was a much more interesting and useful problem to work on, and so we requested a meeting with the course directors to get approval for this pivot. After meeting with the directors, we had the approval and feedback to work on this problem.

The idea at this stage was to utilize the camera to determine when the LIDAR is providing incorrect values to the system. This would be done using the front-facing camera to estimate the distance from the camera to the closest vehicle. The distance can estimated by recognizing the license plate of the car and calculating the pixel size of the plate, inferring the plate's distance from the camera because the system knows the approximate dimensions of a license plate. Once the computer onboard the vehicle has an estimate of how far the closest vehicle is, it can reject outlier data caused by floating objects like snowflakes getting in the way of the light rays.

This solution does run into an immediate problem, LIDAR sensors cost thousands of dollars which would make testing extremely costly. Our solution to this problem is to represent the camera and the LIDAR inside of a game engine. This way we can develop our algorithm in a cost-effective way, and by the end of development our system will be able to handle real LIDAR data and camera images.

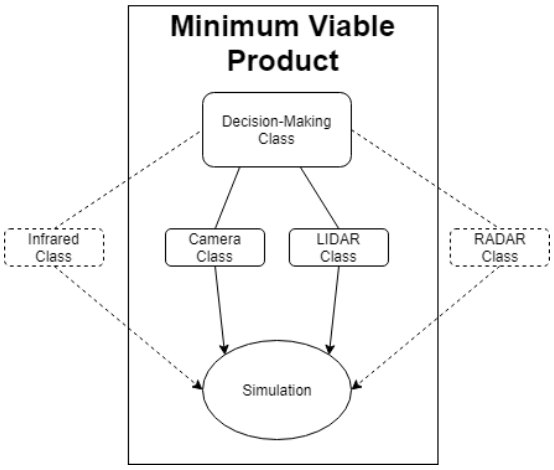

Figure 1 - MVP Architecture Outline

The idea would undergo one more evolution thanks to feedback that we received. We were advised to make the program as lightweight as we can so that it can run on the vehicle's computer without needing too much of the resources. This philosophy contradicts with our goal of ensuring user safety, because our algorithm provides the highest accuracy we can get, but it is very resource demanding. Later in a meeting with our advisor, we came across a way the algorithm can be both safe and lightweight. It would be through trading individual sensor accuracy and therefore resource usage, in favor of having multiple sensors working together. This meant the possibility of introducing other sensors to the system, and we opted to include sensors common on autonomous vehicles, RADAR and infrared. This resource optimization is beneficial, but the basis of the system is still the camera and LIDAR, so we would only consider those two to be a part of the minimum viable product.

Simulated environment within a game engine.

Yahya led this initiative with support from Chris, in order to develop a simulated environment to test our final MVP. As discussed earlier, the team decided that it would be very hard to develop a hardware project during the remainder of the time, and the lack of budget to successfully build something meaningful.

Figure 2 - Simulated environment within a game engine

The figure above shows preliminary work being completed in order to have a simulation environment that allows us to deploy and test our machine learning algorithm. Work is still under progress to incorporate different features of our MVP within the simulation.

Preliminary Machine Learning and Computer Vision algorithm for analyzing number plates.

This initiative is led by Sean and Manmeet, with support from Chris in order to develop an algorithm that has the capabilities of detecting number plates from different regions and compute pixel information to determine how far/close the car is in view.

Figure 3 - Number Plate Detection Algorithm test image 1

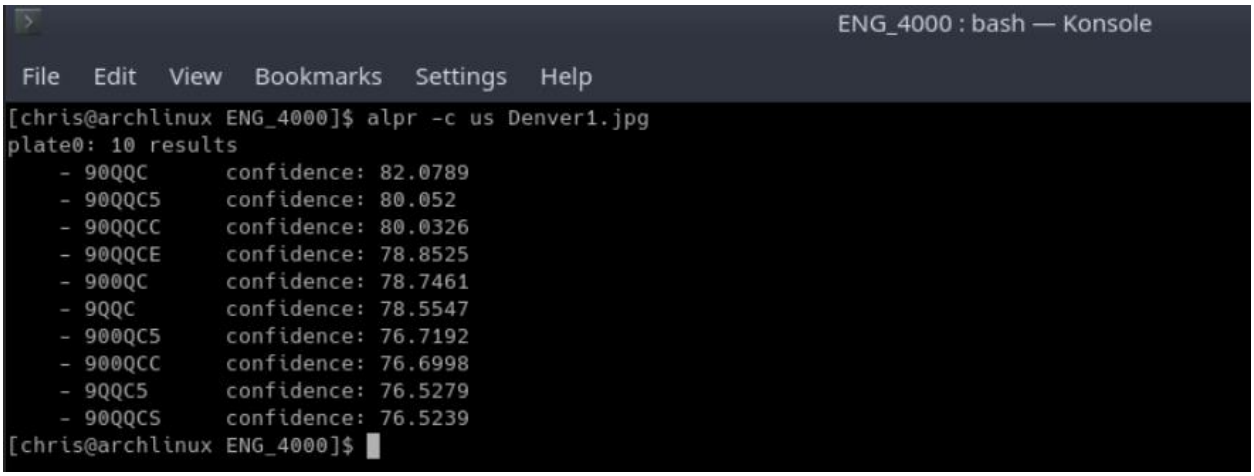

Figure 4 - Number Plate Detection Algorithm Preliminary results

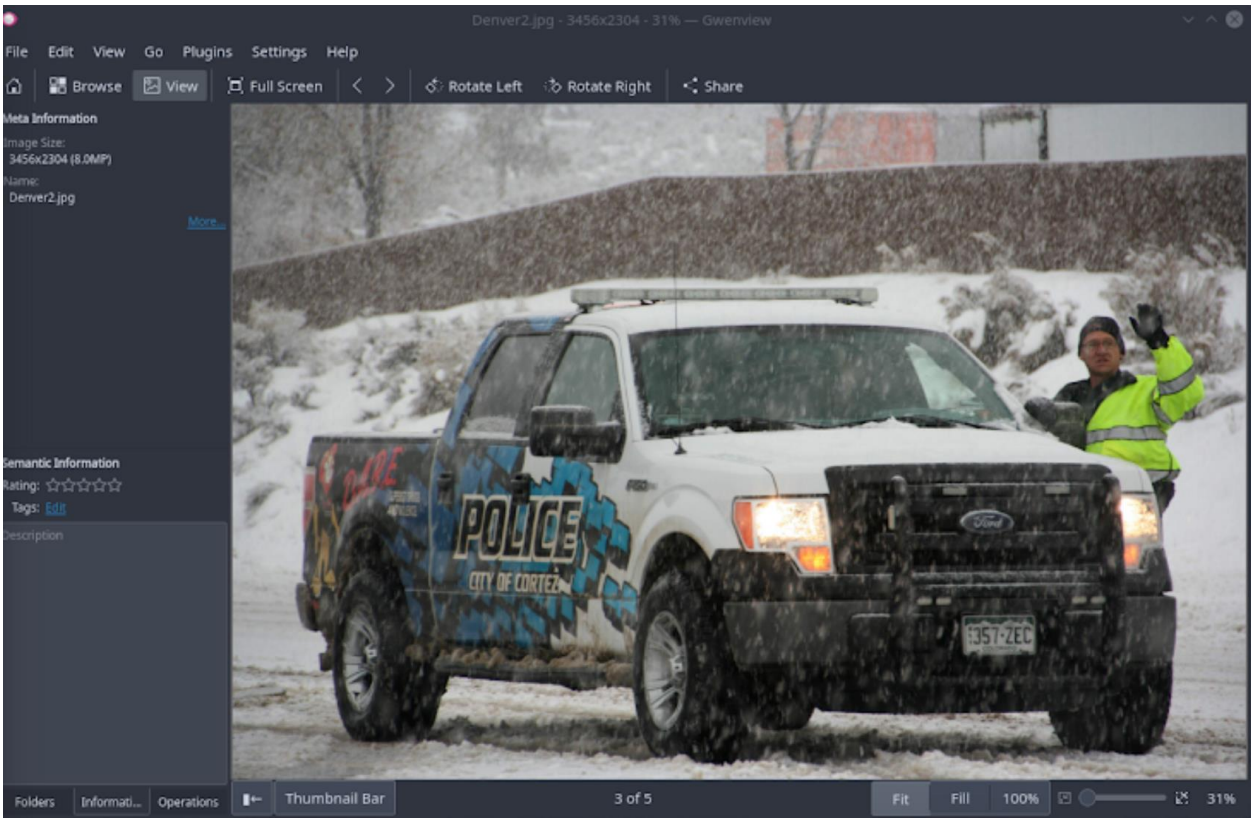

Figure 5 - Number Plate Detection Algorithm Test Image 2

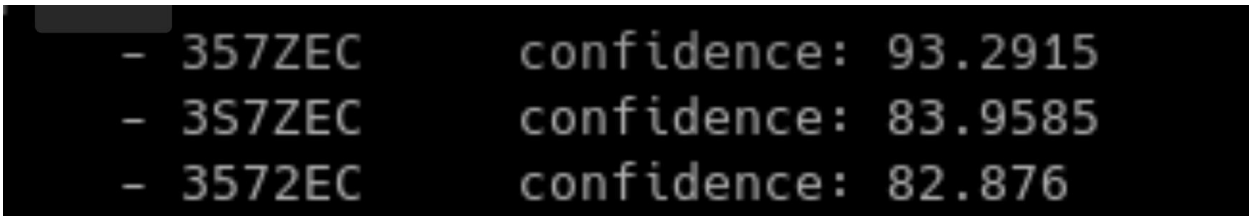

Figure 6 - Number Plate Detection Algorithm Preliminary results for Test Image 2

The preliminary algorithm requires more work in order to improve its overall accuracy and then build upon it to analyze image pixels to compute distance. Work is currently under progress.

Challenges

The team faced a lot of challenges during Sprint 6 regarding academic supervisor and industry partners, which were eventually resolved by the completion of this sprint. The team is optimistic with the new vision for the MVP and look forward to working with our academic supervisor to complete tasks as scheduled in Sprint 7 plan. The team does not identify any challenges while we look forward to transitioning into Sprint 7.

Supervisor Meeting Summaries

January 18th 2019 - Professors Newland, Sadek, and Allison

This meeting was conducted after the lecture had concluded, the focus of the meeting was on the viability of pivoting our original idea to our new one. The feedback we received was that the original topic cannot be thrown away, but that it can evolve into something new. It was mentioned that as an agile group, we had to update the agile roadmap at the end anyways, and that the agile format is very compatible with an evolving product idea. The Professors told us that we may develop a software-only product, but to consider that it will likely have to run on an embedded system. In this meeting we were advised to minimize our dependence on our sponsor/industry partner - AMD, and to utilize all of the time remaining. We were also advised that the industry supervisor may have experienced similar organizational issues and they may be able to advise us through this experience.

January 18th 2019 - Professor Kassiri

This meeting served as an introduction to our team and our new idea. It was unscheduled so we only briefly introduced him to the concept, and he seemed to think it was an interesting idea. We were able to schedule another meeting where we could go into further detail and receive constructive feedback from Professor Kassiri.

January 21st 2019 - Professor Kassiri

This meeting was very useful in evolving our understanding of the problem and how our solution could solve it. We outlined the structure of our proposed solution and showed a demo of the simulation environment. After listening to our proposed solution, Professor Kassiri pointed out the areas where we could encounter serious computational or timing trade-offs. After this, he gave us a piece of very useful advice which has changed the way we view the entire system we are building. The advice we received was that you will encounter diminishing returns if you try to make a single sensor as accurate as it can be, and that a system with multiple sensors with good but not optimal error rates will give much better performance. This discussion caused us to focus on reducing the error rate of the entire system which manages the sensors, not the specific sensors themselves. We had been so focused on specific sensors that we had not considered the higher-level goal of a calibration system which is to reduce errors. Professor Kassiri also pointed out some useful outlier cases that we must ensure our system performs in. Since this is a safety system, it must be resilient to rare events because if a system like this is widely applied over a long period of time it is bound to encounter these rare events.

January 25th 2019 - Professor Newland + Other Agile Groups

In this meeting we presented our new idea to Professor Newland and the other agile groups and received their feedback and ideas. Professor Newland seemed pleasantly surprised by the idea and commented that he felt that we had finally determined where we want to take this project and that it seemed like a good place. Professor Newland also stated that we still had a lot of work to do to get to that place, which we agree with. Professor Newland also cautioned us about a few areas where our solution could prove inadequate, one of these being license plates in other countries. As a result, we have begun testing the plate recognition software with very unusual license plates and are getting good results. This advice is similar to the advice we received from Professor Kassiri which reinforces our belief that rare cases are important to consider when designing a safety system.

Scrum Record

Team Member	Task	Week of 7th Jan	
		Monday	**Thursday**
Yahya Ismail	Specify Sprint #	6	6
	What did you do previously?	Driving Simulation	Driving Simulation
	What Will you work on next?	Driving Simulation	Driving Simulation
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time	None at this time
Chris Posca	Specify Sprint #	6	6
	What did you do previously?	Manually Calibrating Edge-Finding Algorithm	Manually Calibrating Edge-Finding Algorithm
	What Will you work on next?	Manually Calibrating Edge-Finding Algorithm	Manually Calibrating Edge-Finding Algorithm
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time	None at this time
Sean O'Brien	Specify Sprint #	6	6
	What did you do previously?	Manually Calibrating Edge-Finding Algorithm	Manually Calibrating Edge-Finding Algorithm
	What will you work on next?	Manually Calibrating Edge-Finding Algorithm	Manually Calibrating Edge-Finding Algorithm
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time	None at this time
Manmeet Singh	Specify Sprint #	6	6
	What did you do previously?	Rudimentary Car Decision Maker	Rudimentary Car Decision Maker
	What will you work on next?	Rudimentary Car Decision Maker	Operating System Interface
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time	None at this time

Team Member	Task	**Week of 14th Jan**	
		Monday	**Thursday**
Yahya Ismail	Specify Sprint #	6	6
	What did you do previously?	Driving Simulation	Driving Simulation
	What Will you work on next?	Driving Simulation	Driving Simulation
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time	None at this time
Chris Posca	Specify Sprint #	6	6
	What did you do previously?	Manually Calibrating Edge-Finding Algorithm	Refining Edge finding Algorithm
	What Will you work on next?	Refining Edge finding Algorithm	Refining Edge finding Algorithm
	Do you have any obstacles you need help with?	Busy schedule.	Busy schedule.
	Any Important Lesson learnt that you want to share with the team	None at this time.	None at this time.
Sean O'Brien	Specify Sprint #	6	6
	What did you do previously?	Manually Calibrating Edge-Finding Algorithm	Refining Edge finding Algorithm
	What will you work on next?	Refining Edge finding Algorithm	Refining Edge finding Algorithm
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time.	None at this time.
Manmeet Singh	Specify Sprint #	6	6
	What did you do previously?	Operating System Interface	Distance Calculator Algorithm
	What will you work on next?	Distance Calculator Algorithm	Distance Calculator Algorithm
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time.	None at this time.

Team Member	Task	**Week of 21st Jan**	
		Monday	**Thursday**
Yahya Ismail	Specify Sprint #	6	6
	What did you do previously?	Driving Simulation	Driving Simulation
	What Will you work on next?	Driving Simulation	LIDAR Simulation
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time	None at this time
Chris Posca	Specify Sprint #	6	6
	What did you do previously?	Refining Edge finding Algorithm	Refining Edge finding Algorithm
	What Will you work on next?	Refining Edge finding Algorithm	Incorporate edge finding algorithm within the simulation environment
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time.	None at this time.
Sean O'Brien	Specify Sprint #	6	6
	What did you do previously?	Refining Edge finding Algorithm	Refining Edge finding Algorithm
	What will you work on next?	Refining Edge finding Algorithm	Build decision maker for the individual sensor classes within the simulation environment
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time.	None at this time.
Manmeet Singh	Specify Sprint #	6	6
	What did you do previously?	Distance Calculator Algorithm	Distance Calculator Algorithm
	What will you work on next?	Distance Calculator Algorithm	Distance Calculator Algorithm
	Do you have any obstacles you need help with?	No	No
	Any Important Lesson learnt that you want to share with the team	None at this time.	None at this time.

Sprint 6 Retrospective

Sprint 6 was an effective sprint since we accomplished the majority of the tasks we set out to complete. We were able to complete the following:

Simulated environment with harsh weather conditions

Preliminary Edge finding algorithm

Resolve issues with academic advisor and receive feedback from him and course directors.

We moved two items to the backlog, but they are of the lowest priority and might not be a part of the MVP. We spread out the work based on different member's expertise and availability, and we completed the highest priority tasks.

In this sprint we were finally able to define our MVP and move on to our development and implementation phase. The team is confident about the direction of the vision of the MVP and are working cohesively as a single unit to meet high priority deliverables. During this sprint, each team member was able to contribute effectively primarily due to the light study load associated to the start of the winter semester. For Sprint 7, the team is planning to effectively navigate through midterms and meet the goals set out in the Sprint 7 plan. The team also plans to use the same strategy used in Sprint 6 to develop important deliverable of the overall solution and make the solution test ready as soon as possible.

In this sprint we were able to receive a lot of feedback from our academic supervisor and course directors, who have acknowledged our challenges of the past and have agreed with the collective vision of our MVP. We plan to work closely with our academic supervisor for Sprint 7 to gauge his domain knowledge and refine our MVP as much as possible.

The team plans to share progress every week and identify challenges they may face during Sprint 7. We are planning to have our Scrum meeting on February 6th in order to understand and address any challenges that may show up.

Sprint 7 Plan

Product Features Monitoring

Feature Goal	Associated Sprint #	Duration		Story Points	Release Status
Simulation Environment Create road geography and markings, lighting and weather conditions for environment.	Sprint 6	Nov29	Jan 15	High	Completed
Plate Recognition Implementation Implement OpenCV and OpenALPR libraries in C++, such that the plate recognition software is operational.	Sprint 6	Nov 29	Jan 15	High	Completed
LIDAR Simulation using Ray-Tracing Write script to simulate LIDAR and pass distance travelled by rays to master software.	Sprint 7	Jan 29	Feb 8	Medium	Underway
Sensor Accuracy Decision Making System Write class to make decisions about the accuracy of the sensors in the system.	Sprint 7	Jan 29	Feb 8	High	Starting

Sprint Tasks Monitoring

Sprint #7						
Priority	**Feature Goal**	**User Story**	**Success Criteria**	**Owner**	**Duration**	
Medium	**Pass Images Taken in Simulation to C++** Write script/function to pass in-engine camera images to the plate recognition software.	The software needs to process snapshots of the road ahead to ensure a safe distance is preserved.	When the simulation is running, the camera feed should be captured in an image and viewed by the plate detection software.	**Chris** Jan 30 - 9-1130pm, Jan 31 - 9-1130pm, Feb 2 - 4-7pm, Feb 6 - 9-1130pm, Feb 7 - 9-1130om	Jan 29	Feb 8
High	**Build 'Owner' Class in C++** Write C++ class which will act as the monitor and decision maker for the individual sensor classes.	The software needs to make decisions about which sensors are providing good data and which should be temporarily ignored.	When the sensor classes are completed, and this class is accurately determining when there is an obstruction in the LIDAR's view.	**Sean** Jan 31 - 530-8pm Feb 1 - 530-8pm Feb 3 - 7-1130pm, Feb 4 - 530-8pm Feb 5 - 530-8pm	Jan 29	Feb 8
Medium	**Distance Calculator from Plate Dimensions** Write C++ class for containing camera data and performing distance calculations	The software needs to determine the distance of the closest car in order to preserve passenger safety and validate the LIDAR data.	This is considered successful when the calculated distance consistently matches the distance between the vehicle and camera in the sensor.	**Manmeet** Jan 30 - 1-2:30pm, Jan 31 - 9-11:30am, Feb 2 - 12-4pm, Feb 4 - 5-7pm, Feb 6 - 1-2:30pm, Feb 7 - 9-11:20am	Jan 29	Feb 8

High	**LIDAR Simulation** Write Unity script for collecting information about the path of light rays.	The system is being designed to operate under conditions where light rays are obstructed by small objects.	This is considered successful when the simulation returns similar data to a LIDAR sensor.	**Yahya** Feb 2 - 10am-6pm, Feb 3 - 12pm-5pm,	Jan 29	Feb 8

Sprint Backlog Tasks

Sprint #7						
Priority	**Feature Goal**	**User Story**	**Success Criteria**	**Owner**	**Duration**	
Low	**RADAR Sensor Class**	We want the sensor to work in the event of a storm where there is little visibility.	This is considered successful when the system can successfully determine the accuracy of the LIDAR data without the camera.	If a member finishes their assignment for the week, they will be assigned this task.	Jan 29	Feb 8
Lowest	**Infrared Sensor Class**	We want the sensor to work in the event of a storm where there are no vehicles ahead of the camera.	This is considered successful when the system can determine the accuracy of the LIDAR data without the camera or RADAR.	If a second member finishes their assignment early, they will move onto this task.	Jan 29	Feb 8

Self-Evaluation

Criterion	Self-evaluation ranking	Justification
Sprint Review	Meeting Expectations	Detailed explanation was provided to account for the achievements during Sprint 6. We also provided the level of completion of all the tasks set out to be completed during sprint 6. We then explained the challenges encountered during this sprint compared to previous ones and how they were resolved.
Sprint Retrospective Plan	Meeting Expectations	We carefully reviewed our team strategy during Sprint 6 and therefore acknowledged the amount of work done during a period of 3 weeks. We then suggested to continue using the same strategy for Sprint 7 while carefully managing time to account for upcoming midterms.
Sprint Plan	Meeting Expectations	We carefully analyzed the deliverables required to make our MVP test ready and then divided the team into subgroups based on expertise and assigned them to tasks that take advantage of that.