Project Scope and Deliverables | Fall 2023 AI Studio

This document is designed to help your team understand, internalize, and align on the scope, goals, and technical aspects of your AI Studio Project Challenge.

Complete all 4 sections as a team based on information you have gathered through:

* The project overview doc(s) provided in your team’s Project Folder in Google Drive (e.g., company video or slides);
* Insights gained during your first Challenge Advisor meeting during Bridge to Studio;
* Referring back to your Machine Learning Foundations summer course modules;
* Additional research done by your team related to the project/industry

Once you’re done, one team member should submit it through the assignment page in your AI Studio course in Canvas (“Business Understanding” module) by **September 3rd**. Your team’s AI Studio TA will review your submission and provide some initial feedback.

During your team’s first “Full Group” meeting during the week of September 4th with your Challenge Advisor (and AI Studio TA if they’re available), review your completed Project Scope and Deliverables document together and make updates / fill in any gaps as needed.

| **Project Title:** | Classify Object Behavior to Enhance the Safety of Autonomous Vehicles |
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| **Team Members:** | 1. Vanessa Bellotti (she/her/hers) 2. Kashish Gupta (she/her/hers) 3. Pamela Melgar (she/her/hers) 4. Rachel Ma (she/her/hers) 5. Elena Wang (she/her/hers) 6. Nyah Lalimarmo |
| **Challenge Advisor(s):** | 1. Maria Elena Gavilan-Alfonso, Technical Program Manager, [mgavilan@mathworks.com](mailto:mgavilan@mathworks.com) |
| **AI Studio TA:**  *(aka Tutor or Course Support)* | Keith Murray |

**PART 1: PROJECT OVERVIEW**

**Project Description**

In your own words, what are you trying to accomplish? What type of ML problem is this? (e.g., “Supervised Learning: Classification”, “Unsupervised Learning: Clustering”, etc.)

| The objective of this project is to develop a machine learning model that can ultimately classify the safety of objects in front of autonomous vehicles. The project will be split into 3 main phases with a tentative fourth phase as suggested by our advisor. Phase 1 will focus on detecting and classifying objects as either pedestrians or not using datasets from Motional’s nuScenes. Phase 2, while still focusing on classifying objects as pedestrians, will use simulated datasets from the Automated Driving Toolbox from Mathworks. Phase 3 will label the pedestrians as safe or unsafe on one or both of the datasets mentioned before, and a tentative Phase 4 will incorporate a tracking algorithm using videos and LIDAR to detect *potential* unsafe intent from a pedestrian.  These four phases will be using unsupervised and deep learning techniques in order to complete the objective of this project. We will be using computer vision and object detection as well. |
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**Purpose of Project**

Why is this project important or relevant to your AI Studio host company/org?

| The Mathworks Automated Driving Toolbox provides algorithms and tools for designing, simulating, and testing ADAS and autonomous driving systems. Therefore, given the company’s work in the AV space and providing tools for companies to develop these solutions, it would be critical to ensure that safety is baked into these prebuilt algorithms and tools, thus making our problem of AV safety important. |
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**Ethics Considerations**

Are there any potential ethics-related considerations to take into account for your project?

| There are many ethical concerns around AVs, such as what decision would they make in a situation when turning to avoid hitting a person would lead to hitting more people. This scenario might have to be accounted for in our project, especially if the dataset provides examples of pedestrians on both sides of the car jaywalking, or other scenarios that might not be in the normal training set of the AV. Other than this, there is also a data privacy ethical concern of pedestrians in the image in that they might not have consented to be photographed from on-board cameras, so their faces might have to be blurred as a result. The accuracy of the classification of the safety of objects in relation to autonomous vehicles must be high as well, as if the vehicle fails to recognize a pedestrian and causes an accident, it can lead to many ethical concerns about who the culprit in the scenario is: the passenger or the car. These concerns must be taken into consideration as we begin this project in order to build the best machine learning algorithm possible. |
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**PART 2: PROJECT SCOPE**

**Project Requirements**

What is your Challenge Advisor expecting your team to deliver by December? Are there specific algorithms that you might use as part of model training/testing? (e.g, Linear Regression, KNN) How might you evaluate your model(s)? (e.g., F1 Score, RSME)

| Our challenge advisor, Maria, is expecting 3 main deliverables by December. She is expecting our team to build a model that detects pedestrians (and/or cyclists, depending on whether we include them in our dataset) on two different datasets: the real-life dataset by Motional, and the simulated dataset in the Automated Driving Toolbox. Those 2 models, while similar, will produce different results and allow us to compare the two datasets and their advantages/disadvantages. Maria also expects us to classify the behavior of the pedestrians/cyclists as safe or unsafe, which will be a different ML model from the previous two. The fourth deliverable, which will be made if there is enough time and resources, is to build a model that classifies the *intent* of the pedestrians as safe and unsafe using videos and LIDAR. Our final product will be a presentation with an example of our code, which will most likely be in both Python and MATLAB.  We are currently still exploring TensorFlow and the different types of deep learning techniques that could be useful to the project. However, our model will be a type of neural network that will enable us to use computer vision and scan the images in the dataset that we use. We might evaluate our models using the standard statistical methods like RMSE, R2 score, etc. |
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**Python Libraries**

What Python libraries do you expect to use? (e.g., Pandas, NumPy, Scikit-learn, NLTK)

| We are expecting to use the Pandas, Numpy and TensorFlow libraries as part of this project. Maria also mentioned transferring the written Python code from Google Collab to MATLAB later on in the project, in which we will use other MATLAB specific packages as well. |
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**Other Resources**

What resources (e.g., online forums, recommended research papers, example code) does your team plan to consult while working on the project? Be specific where possible (e.g., listing a specific research paper relevant to your project)

| * <https://github.com/mathworks/MATLAB-Simulink-Challenge-Project-Hub/tree/b90a4b5482081c3c668c37bd5ef0c5ab4b5a7e67/projects/Classify%20Object%20Behavior%20to%20Enhance%20the%20Safety%20of%20Autonomous%20Vehicles> * [Automated Vehicles and Pedestrian Safety: Exploring the Promise and Limits of Pedestrian Detection - ScienceDirect](https://www.sciencedirect.com/science/article/pii/S0749379718320932) * [Prediction of stopping distance for autonomous emergency braking using stereo camera pedestrian detection - ScienceDirect](https://www.sciencedirect.com/science/article/abs/pii/S2214785321050707) * [Sensors | Free Full-Text | A Machine Learning Approach to Pedestrian Detection for Autonomous Vehicles Using High-Definition 3D Range Data (mdpi.com)](https://www.mdpi.com/1424-8220/17/1/18) * [[1906.10490] Age and gender bias in pedestrian detection algorithms (arxiv.org)](https://arxiv.org/abs/1906.10490) * [Sensors | Free Full-Text | Pedestrian and Vehicle Detection in Autonomous Vehicle Perception Systems—A Review (mdpi.com)](https://www.mdpi.com/1424-8220/21/21/7267) * [Pedestrian Detection Using Image Fusion and Stereo Vision in Autonomous Vehicles | IEEE Conference Publication | IEEE Xplore](https://ieeexplore.ieee.org/abstract/document/8661069) * <https://ieeexplore.ieee.org/abstract/document/10099089> |
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**Timeline and Deliverables**

What tasks and outcomes do you plan to accomplish in the first few weeks? The first couple of months? List out specific steps for achieving your objectives.

| **Task**  (what will be done) | | **Outcome**  (expected result of task) | | **Start Date** | **Target Completion Date** |
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| **Tensorflow + DNN tutorial** | | **Be equipped to use deep learning technologies** | | **9-14** | **10-7** |
| **Start with Motional Data** | | **Processed and ready to be used in a model** | | **9-27** | **10/22** |
| **Start with simulated data** | | **Created using Unreal and Matlab;** | | **10/23** | **11/6** |
| **Compare simulated and real data** | | **Conduct some analysis to compare the two models to put in presentation** | | **11/4** | **11/11** |
| **Start with model for classifying safe and unsafe in data** | | **Have a working model with both Motional and simulated data** | | **10/22** | **11/20** |
| **Start with determining suitable metrics for safe/unsafe intent model evaluation** | | **List of criteria for model** | | **11/21** | **11/26** |
| **Process and prepare dataset of videos and LIDAR** | | **Processed data and ready to be used in the model** | | **11/27** | **12/4** |
| **Start to build model that classifies safety intent of pedestrians** | | **Model created with accurate results** | | **12/4** | **12/10 (?)** |
| **Have a phase 3 presentation** | | **Finished presentation** | | **11/26** | **12/10** |

**PART 3: DATA UNDERSTANDING**

**Data Structure and Source**

What is the source of the data? What is the data type? (e.g., numerical, time series, text, images, etc.) What is the data format? (e.g. tabular, nested, array, etc.) How much data has been or will be provided? Where will it be stored and in what format? (e.g., csv files)

| The source of the data is twofold. Our first model will be using Motional’s dataset called nuScenes consisting of images, LIDAR, RADAR, IMU and GPS, though we will only use images and LIDAR for our purposes. All of the data present in Motional is available to us as it is free for educational use. It consists of data from both Singapore and Boston, which diversifies our data immensely. |
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**Data Understanding**

What are some of the variables/features of the dataset(s)?

| Variables and features include lighting conditions, various road traffic patterns, jaywalkers, pedestrians, cyclists, variations in the weather, different kinds of vehicles (trucks, sedans, SUVs), etc. |
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**Data Preparation**

What data preprocessing steps will be required? (e.g. cleaning, missing value imputation, feature engineering, etc.)

| * take 20s GIFS -> static images * LIDAR: fix to certain FOV to deal with angles * The Motional data is generally very clean already, so these steps will be more to best utilize the resources we were provided. |
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**PART 4: WAYS OF WORKING**

**Biweekly Meeting Details**

What will be the recurring meeting day and time for your 2 monthly virtual check-in meetings with your Challenge Advisor (“Full Group” meeting in week 1 and Challenge Advisor meeting in week 3)? Please note if these meetings will not happen in weeks 1 and 3 because of scheduling difficulties or preferences.

| The 2 monthly virtual check-in meetings will be happening on Thursdays at 6:15-7:15 PM. We have already had our full group meeting on the week of September 11th, and are continuously having our group meetings every week on Tuesday. We will be having our TA meeting this week, and will schedule a meeting with Maria on Week 4. |
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**Challenge Advisor Communications**

How will you communicate with your Challenge Advisor outside of your biweekly virtual check-in meetings - do they prefer Slack and/or email? How will you share your meeting agendas with them 48 hours prior to each meeting - Slack, email, or a Google Drive link?

| We will communicate with Maria mainly through Slack outside of our biweekly virtual meetings. Our meeting agendas will be sent out via Slack. The meeting invites will be sent at least 72 hours in advance in order to confirm that everyone can join. |
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**Additional Project Stakeholders**

Are there any other stakeholders from your host company/org that your Challenge Advisor mentioned, and who your team might want to connect with to discuss the project?

| As of right now, there are no other stakeholders from Mathworks that Maria has mentioned. However, we would love to work and connect with other people from Mathworks to discuss our project and the direction it is going in along with Maria. |
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