



**Oregon State**  
University

## CS CAPSTONE REQUIREMENTS DOCUMENT

APRIL 18, 2019

# PEDESTRIAN COUNTING AND PRIVACY PRESERVATION

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### Abstract

The City of Portland is updating their data gathering system to better integrate data and technology into the decisions made by the city. One issue that arises is that privacy preservation is often at odds with data gathering. Our task is to provide data on, and hopefully a solution to, this issue. Mainly our concern is manipulation of data so the collected data can be stored and analyzed without violating privacy portions of the city's social contract. Our solution uses YOLOv3 and masking to remove identifying information about the citizens in the videos.

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## 1 CHANGE LOG

Section	Original	New
Surveys	<ul style="list-style-type: none"> <li>Detailed our plan to conduct surveys with people to determine citizens' perspective on privacy concerns of pedestrian footage.</li> <li>Section discussed our plan to gather survey participants, develop survey with objective questions, and conduct surveys throughout different stages of our project.</li> </ul>	<ul style="list-style-type: none"> <li>Survey section was fully removed and is no longer a part of our project.</li> <li>Decision to remove the social survey section came after a goal reset and re-focus of the scope of our project with our client.</li> </ul>
Generating Datasets using CARLA	<ul style="list-style-type: none"> <li>Generating datasets using CARLA, a simulation tool, to process unbiased dataset for training our models.</li> <li>Section discussed our plan to using CARLA to generate a dataset, controlling the simulation environment, and applying data augmentation to remove any biases within datasets.</li> </ul>	<ul style="list-style-type: none"> <li>We have stopped using CARLA due to the lack of useful functionality to control and process unbiased datasets. In addition, it is a time consuming to develop models of a simulation environment.</li> <li>We gained access to a well-established dataset developed by New York University and NVIDIA that answers our needs of an unbiased dataset for training and testing.</li> </ul>
API	<ul style="list-style-type: none"> <li>Added a section detailing the requirements of our web-API</li> </ul>	<ul style="list-style-type: none"> <li>Although the API was a key point from the beginning of our project, it was not detailed in the original requirements document. This was an oversight and is now remedied.</li> </ul>

## 2 INTRODUCTION

The software described in this document, Facial Detector and Obfuscator, is a project under the advisement of Chanh Kim (Georgia Tech) and Dr. Fuxin Li (Oregon State University). The client for this project is the City of Portland, which wants a proof of concept for a way to transform the data from their traffic cameras so the city may store the data without storing identifying information about the citizens in the footage. The software will be based largely on YOLOv3 [1].

## 2.1 System Purpose

Our team will design a pedestrian/vehicle detection model which is able to obfuscate all identifying features of pedestrians and vehicles for a given video feed. This will allow for storage of the video data without storing identifying information on the pedestrians

## 2.2 System Scope

The scope for this project is immediately to have a system that results in information on pedestrian movements that can be stored for open access by the public. An update that is not necessary, but is desirable, is the ability to provide data on traffic as well.

## 2.3 Definitions

Term	Definition
<b>Car Learning to Act (CARLA)</b>	An open simulator for urban driving. CARLA has been developed from the ground up to support training, prototyping, and validation of autonomous driving models, including both perception and control [2].
<b>Convolutional Neural Network (CNN)</b>	A class of deep, feed-forward artificial neural networks, most commonly applied to analyzing visual imagery [3].
<b>Facial Keypoints Detection</b>	Facial detection through the use of multiple key points on a persons face [4].
<b>mean Average Precision (mAP)</b>	The mean for a metric denoting percentage of objects precisely identified, a ubiquitous standard used by object detection models [1].
<b>Obfuscation and Mangling</b>	Used interchangeably. The irreparable destruction of data. Specifically used in relation to identifying features of objects.
<b>VGGFace2</b>	A large-scale face recognition dataset [4].
<b>You Only Look Once (YOLOv3)</b>	A state of the art object detection model which can classify objects with a high degree of fidelity in a time sensitive environment [1].

## 3 REFERENCES

- [1] J. Redmon and A. Farhadi, "YOLOv3: An Incremental Improvement," *ArXiv e-prints*, Apr. 2018.
- [2] A. Dosovitskiy, G. Ros, F. Codevilla, A. Lopez, and V. Koltun, "CARLA: An Open Urban Driving Simulator," *ArXiv e-prints*, Nov. 2017.
- [3] D. Cornelisse, "An intuitive guide to convolutional neural networks," Available at <https://medium.freecodecamp.org/an-intuitive-guide-to-convolutional-neural-networks-260c2de0a050> (2018/04/24).
- [4] "Vggface2 about," Available at [http://www.robots.ox.ac.uk/~vgg/data/vgg\\_face2/](http://www.robots.ox.ac.uk/~vgg/data/vgg_face2/) (2018/10/30).

## 4 DATASET

### 4.1 Description

Our team will use a well-established dataset created by New York University and NVIDIA to train and test our detection models. This entails downloading and applying pre-processing to clean the data of unwanted noises and

data augmentation to generalize our model to increase accuracy. Although we will be using pre-trained models for Real-time Object Detection and Face Detection, applying training on more specific dataset that is related to our problem will increase of our model when performing the task.

## 4.2 User Stories

### Generate Pedestrians Dataset

As a developer, I want to use a pre-trained YOLOv3 on MS COCO, then train on NYU dataset.

### Gather Faces Dataset

As a developer, I want to use a pre-trained CNN on OpenFace, then train on NYU dataset.

### Data Pre-processing

As a developer, I want the data to be clean to suppress unwanted distortions or enhance some image features important to further processing.

## 5 PEDESTRIAN DETECTION

### 5.1 Description

Our team will employ the You Only Look Once (YOLOv3) [1] object detection model for identifying pedestrians. By employing this model we will aim to balance mean Average Precision (mAP) with the processing speed necessary to be effective in a real time detection environment.

### 5.2 User Stories

#### Setup the Configuration of YOLOv3

As a developer, I want to configure the *YOLOv3* convolutional network layers, confidence thresholds, input and output pipelines, so that I can begin feeding data to the model to begin training.

#### Training Model

As a developer, I want to use the selected (and labeled) data set to train *YOLOv3*. This will be a reiterative process as I interpret the output and discover how best to balance the mAP of the object detection model with processing speed.

#### Adapting Dataset

As a developer, I want to select a data set to train *YOLOv3*. This data set will need to be properly labeled and adapted to be fed into the object detection model.

#### Deploying Model

As a developer, I want to deploy the adequately trained *YOLOv3* object detection model.

#### Storing Data

As a city official, I want the resulting data to be useful for open machine learning for the public.

## 6 FACE DETECTION AND OBFUSCATION

### 6.1 Description

Our team will use a pre-trained convolutional neural network (CNN) with Facial Keypoints Detection to find pedestrian faces using the a Feature-based method. By using a feature-based method, faces can be detected from various environments and angles. Our team will finally apply an obfuscation technique to remove identifying information of the face from the data.

## 6.2 User Stories

### Determine facial detection method

As a developer, I want to determine facial detection method that will work well to detect faces in different types of environments or perspectives.

### Determine a pre-trained Neural Network

As a developer, I want determine a pre-trained neural network that will allow us to easily detect faces with a model that has been trained with a large dataset.

### Take in images and produce detected face

As a developer, I want develop a program that will take in input images and output a detected face, indicated with a box.

### Take in images and produce obfuscated face

As a developer, I want to develop a program that will take in images and output an obfuscated face so people are not easily identified.

### Test with different images

As a developer, I would like to test the detection program with different types of images with different depths and perspectives of pedestrians.

### Data removal

As a city official, I want the tool to destroy personally identifiable information from the data in an irreparable manner.

## 7 WEB API

### 7.1 Description

Our team will provide the City of Portland with an API which will allow the City to access, add, patch, delete, aggregate, sort, and compare data from the cameras. This will include accessing and adding frames of footage to the open-source data-set that the detection and obfuscation layer will output.

### 7.2 User Stories

#### Ease of Use

As a developer with the City of Portland, I want the API to be easy to understand and provide reasonable feedback. An example of such an API is a RESTful one.

#### Uniform Data

As a developer with the City of Portland, I want all the data in the database to be uniform and accessible in a JSON format.

#### Data Manipulation

As a developer with the City of Portland, I want to be able to access, remove, create, and delete data in the database.

#### Open-source Data-set

As an official with the City of Portland, I want to be able to download the entire database and have immediate access to all the frames of obfuscated footage.

8 TIMELINE

