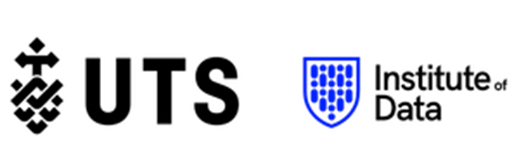
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**Capstone Project Documentation**

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**Identify Formula One Driver through**

**Deep Learning**

Ricky Khanh Nguyen

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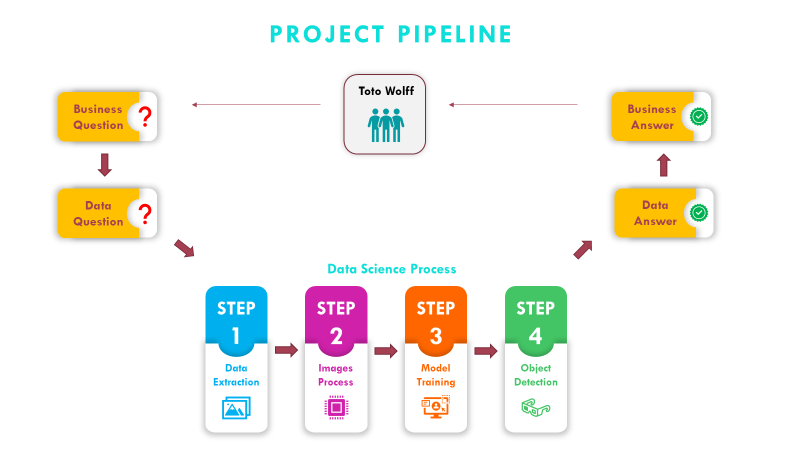
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# Introduction

Formula One is the world most popular motorsport with significant marketing exposure for car manufacture. The project objective is to improve the decision-making of the driver during the race. Thus, we are looking at the communication between the engineer and the driver. Hence, provide a solution and opportunity for improvement from this perspective.

# Process overview

The following diagram shows the overall end-to-end process for defining, designing and delivering the Capstone project.

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# Problem statement

The responsibility of the Formula One Engineer is tremendous during the race. They are required to monitor:

* Brake’s temperature
* Tyres condition
* Fuel consumption
* Engine & parts durability
* Racing Strategy
* Weather condition
* Speed and lap’s time at every track’s sectors
* X2 since there are always 2 drivers from each team
* Management of pit lane
* Regulations and compliances
* Inform driver on rival’ status

As the result, miscommunication happened between engineer and driver. Especially, when it come to rival status information.

# Industry

* FIA Formula One World Championship is the economically ninth most important sports industry
* Total revenue is estimated to be approx. $ 2 billion U.S dollars in 2019
* The highest class of international automobile racing with constant regulation adjustment and update.
* The goal is to be the 1st driver to reach the chequered flag.
* Re-fuel is prohibited which mean the main key factors to win the race are tyres and fuel consumption during the race.

# Stakeholders

The main stakeholder is the Mercedes AMG Petronas Formula One Team:

* Team Principle & CEO: Toto Wolff
* Managing Director: Andy Cowell
* Technical Director: James Allison
* Driver 1: Lewis Hamilton
* Driver 2: Valtteri Bottas

# Business Question

**“**How can we reduce miscommunication between the engineer and driver, thus improve the decision-making of the driver?**”**

# Data Question

**“**How can we use artificial intelligence to identify driver on the track**?”**

# Data science process

## Data extraction

* Images were extracted from recorded video and google search engine
* The data range between 2017-2019
* The pipeline is reusable to extract data from 2019 onward.

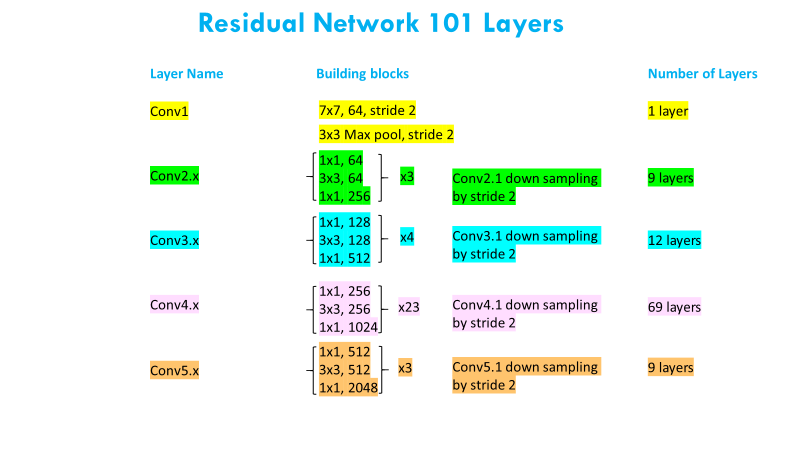
## Images Preprocessing

* Resize images to 600x900 pixels to preserve features and less computational power.
* Label bounding boxes for individual images with their respective classes.
* Normalization images by 255 to reduce the variance in pixel.
* Generate xml files with the coordinate of the bounding boxes from individual image.
* Transform xml files to csv files (Data frame format where each row is an image, and each column is a class label, coordination of xmin, xmax, ymin, ymax)
* Transform csv files to TFrecords which required as an input into Tensor flow model.

## Model Architecture

**Diagram

Description automatically generated**



## Modelling

* The model took 24 hours of training
* The model was train on Window 10 OS with a single GPU
* The total loss graph indicated the model is consistent return the loss score of 0.4~0.6
* Compare detection speed with RCNN and Fast RCNN model.
* The optimal model in term of accuracy, computational power, and speed is Faster RCNN ResNet101.

## Outcomes

* The model correctly predicted F1 driver from different camera angles on unseen data.

## Implementation

* Have front and rear camera of the car to connected to a GPU computer.
* Provide an indicator on the car’s dashboard
* The model will compute on GPU then feed the result to the indicator
* Driver can observe the indicator to identify rival’ s status for decision-making.
* Engineer can also have this indicator on their control panel for strategy assessment.

# Data answer

* Take advantage of Computer Vision in object detection we can accurately identify driver on the track.
* Train faster-RCNN model to identify driver.

# Business answer

* Eliminate the rival status responsibility from engineer.

# Recommendations to stakeholders

* Depend on the objectives of the stakeholders. We can continue to train the model to improve accuracy.
* By taking advantage of the technology, we can improve decision-making of driver & engineer during the race

# End-to-end solution

* We are not reducing the miscommunication between engineer and driver. We have simply REMOVE it from the equation.
* Once the accuracy is optimal, we can incorporate the model directly into the car’s dashboard.
* The model will continuously inform the driver on his rival through real-time detection.

# References

Data Sources:

* 2012 Belgium Grand Prix
* 2018 Belgian Grand Prix
* 2018 Australian Grand Prix
* 2019 Singapore Grand Prix
* 2020 Emilia Romagna Grand Prix
* 2020 Turkish Grand Prix
* Google’s search

TensorFlow Git + Model:

* https://github.com/tensorflow/models
* Faster-RCNN ResNET101 v1 800x1333 COCO17 GPU-8
* Deep Residual Learning for Image Recognition Paper 2015 by Kaiming He, Xiangyu Zhang, Shaoqing Ren, Jian Sun from Microsoft Research
* Updated Tensorflow-v2 codes available on <https://github.com/RickFSA/Capstone_Object_Detection>

Request:

* Acquisition of source data & inference graph please forward request to [ricky.nguyen558@gmail.com](mailto:ricky.nguyen558@gmail.com)

Articles:

https://www.mercedesamgf1.com/en/news/2018/11/insight-the-trackside-engineers/

<https://www.theguardian.com/sport/2020/apr/16/f1-teams-fail-to-agree-budget-cap-reduction-as-race-cancellations-bite>.

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