# Dissertation Proposal: Develop a Machine Learning Application that is Able to Detect Real-Time Anomalies in User Behaviour.

## Motivation

In the United Kingdom, an estimated 4.2 million surveillance cameras watch us every day (Clive Norris & Michael McCahill, 2006). Found in businesses, homes, shops and on high streets we are one of the most watched nations in the world. CCTV is actively available in 96% of homicide investigations, where it added value to the case 80% of the time (Scotland Yard, 2010). However, this statistic does not hold true for all crimes within the UK, with reports showing that CCTV only solves one in every 1000 crimes. (Press Association, 2009) It is fair to say that the work force allocated to high profile crimes makes it possible to find, collect and search all the archived video footage for evidence. This illuminates the problem at hand; CCTV is solely deployed in a traceability capacity when it has the potential to provide a much richer source of information. If we were able to understand video footage as it occurred, then we can start making smarter decisions that can lead to earlier crime detection and reduce the need to store such vast amounts of video footage on file.

The problem we need to solve to achieve this is, once presented with a set of data points representing the events that have occurred in a video frame, how can we detect whether what we are shown is anomalous in nature? Furthermore, can we apply this on an individual basis and detect when a single person on video is acting out of the ordinary? If we can solve this, we are in a capacity to create a system that could alert a vested party of an anomaly in real-time, allowing for the event to be investigated and any necessary action to be taken. This creates a much more proactive approach to detecting crime along with removing the need for archival of video footage.

My approach will be to develop a system that can detect users in a video stream, extrapolate data points about them, and then apply machine learning models to classify their behaviour as anomalous or normal. I will be focusing on unsupervised learning methodologies, evaluating which models provide the highest level of accuracy while being as high performance as possible. The system will use a micro-service based architecture in order to provide scalability and high-performance data throughput, a key success criteria for a real-time system. To develop a suitable and achievable application in the given timeframe I will confine the problem to a single room environment with a set of configured subjects for facial recognition.

## Aim and Objectives

**Aim:** To develop a machine learning application that is able to detect real-time anomalies in user behaviour.

**Objectives:**

1. To research existing video processing techniques and available software in order to obtain as many data points with the highest degree of accuracy from a video stream.
2. To research machine learning techniques for detecting anomalies in time series data that can be applied to data sets produced from objective 1.
3. Develop testing scenarios that will allow the evaluation of machine learning models in their ability to detect anomalies in real-time.
4. Develop a micro-service based solution that allows interaction of services encapsulating video processing, machine learning models, an interactive web service and an anomaly notification service.
5. Using the test scenarios defined in objective 3, evaluate the applications ability to detect anomalies and alert users in real-time.
6. Compare and contrast the performance and storage requirements of the final system against existing CCTV systems and methodologies.

We are aiming to accomplish the development of a real world applicable system that will outperform existing solutions and methodologies when it comes to video processing and anomaly detection. To achieve this, we need to focus on objectives; 3, 4, 5 and 6 as a minimum, as they are concerned with producing the final product and evaluating its success in regard to the aim of this dissertation. The objectives preceding them provide support and increase the solutions chance of success, but time could be withdrawn from them once a single viable methodology has been found.

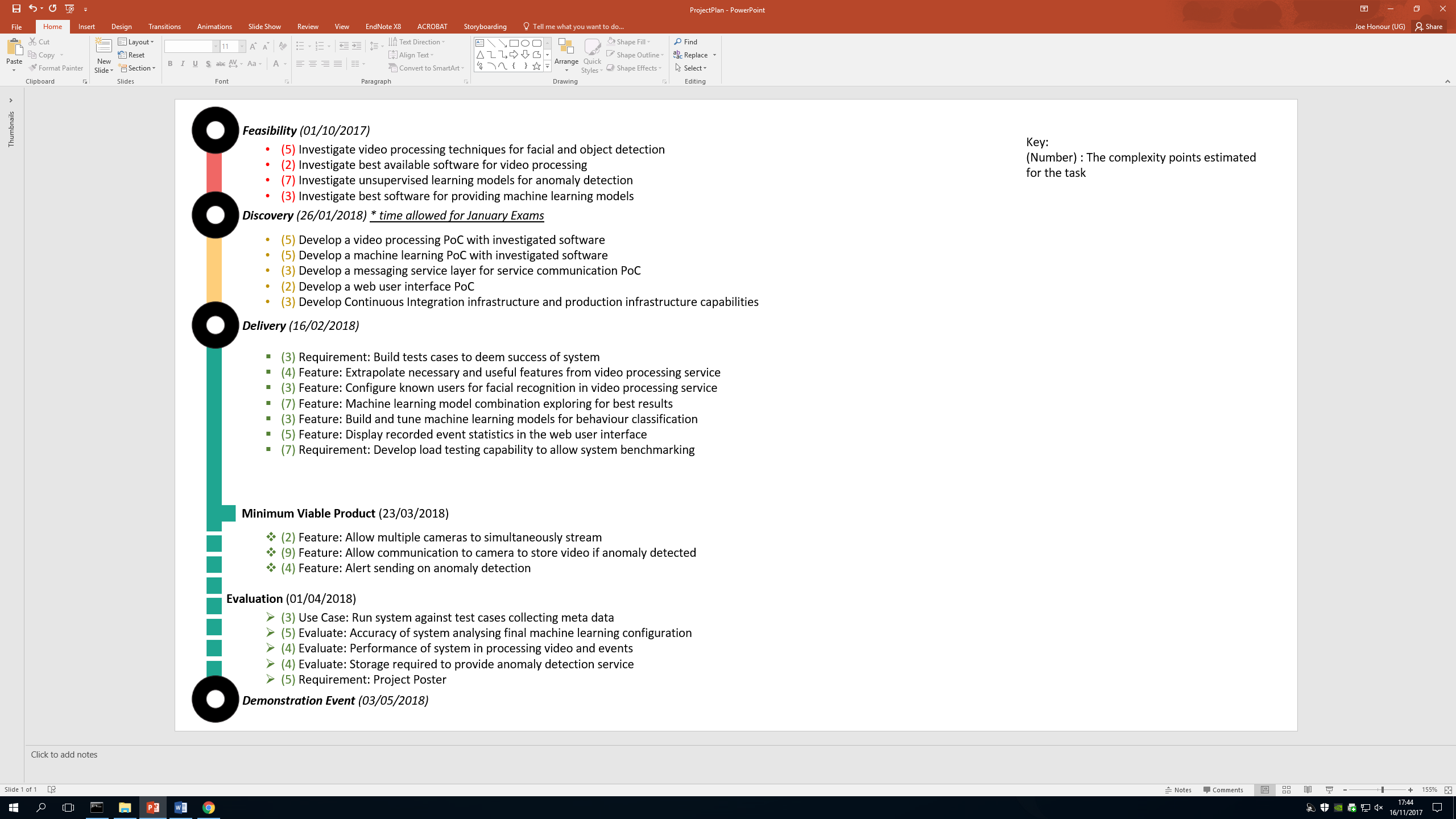
## Background

**Paper:** A survey on Behaviour Analysis in Video Surveillance for Homeland Security Applications

**Description:** The paper shows an overall look at the stages involved in creating an intelligent video stream solution. It gives insight into object classification, object tracking, extracting motion information, and behaviour analysis.

**Relevance:** My project will have to utilise a lot of the discussed algorithms, and this paper gives a great insight into high level overviews of possible algorithms when attempting to extrapolate information from real-time video streams.

## Project Plan



KEY:

* (NUMBER) = Estimates the amount of work required to complete the task.
* (N/NUMBER) = The amount of work done towards completing the task.
* PoC = Proof of Concept

I am currently working through the feasibility phase of the project lifecycle. You can see from the above diagram, based on the Enterprise Agile model (BJSS, 2008), that I have completed tasks within the feasibility stage of the project and will be moving onto the discovery phase after the January exam period.

I have chosen this delivery methodology as it allows me an achievable and measurable journey to completion, while allowing the flexibility to adapt to change as I move through the phases of delivery. The Discovery phase enables me to prove the technologies are compatible and work for their chosen tasks, and if they don’t I am able to pivot quickly to replace them. This development style is also known as a fail fast approach.

Once I have a proven technology stack I move on to the core of the implementation, developing features in the priority displayed in the project plan, however this priority can change at any time based on problems I may encounter or future knowledge gain. I believe this gives me the greatest chance of success, not only in completing the dissertation, but in producing a viable end result.

## References

Clive Norris, Michael McCahill; CCTV: Beyond Penal Modernism?, The British Journal of Criminology, Volume 46, Issue 1, 1 January 2006, Pages 97–118.

Retrieved from <https://doi.org/10.1093/bjc/azi047>

Scotland Yard (2010) CCTV in Homicide investigations.

Retrieved from: <https://goo.gl/oS5Tgn> (Accessed: 15th November 2017).

Press Association (2009) 'CCTV cameras help to solve one in every 1000 crimes', The Independent, 24 August 2009

Retrieved from: <https://goo.gl/cRnpaE> (Accessed: 15th November 2017)

Wilson, N. (2016) *BJSS Enterprise Agile*, 4th edition., Leeds, United Kingdom: BJSS Limited.

ISBN: 978-0-9565371-2-6

//applications of technology 1ST

//technologies needed and background into it 2ND

//distributed messaging solve the problem better than previous applications 3RD

//look at data processing speed against the effectiveness of model (motivation) 4TH

//keep important parts of the data over the original video as that’s important

//when it comes to background lets look for micro service based architecture

TODO:

* Update diagram with newest version of project
* Finish reading and researching background material
* Add references for all background papers
* Apply all of Mats comments found above