Luke Lunn - lul12 Computer Science - G400 - CS39440

**Evaluating the reduction of data points in a motion analysis classification system.**

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**Project description**

The purpose of this project is to evaluate whether it is possible to classify data from a motion analysis system when the number of data points is reduced. The motivation for this project is related to a current system which uses a smartwatch and smartphone to record the motion of the wearer/user of these items. Current literature shows that using a system (such as from motion analysis corporation) for motion analysis with many data points in the relevant areas, can produce results that allow the person analysing the data to make various conclusions from the motion recorded. My question, asks whether when we have only a point on the wrist (simulating watch information) and a point on the hip (simulating phone information), it is still possible to accurately classify data into a set of simple classes such as walking, running, sit to stand etc.

The end goal would be to have firm evidence towards understanding the possibilities available with the smartwatch and smartphone system. I hope to prove that it is possible to make accurate classifications using only the two proposed data points. There are also a few benefits which are unrelated to the main goal of the project. For example, I should be able to create a machine learning algorithm which can take 2-D or 3-D data and perform feature extraction and classification on these data sets. This could hopefully be robust enough to classify new datasets and be used in the future. Another unexpected benefit would be providing a system which can be used to calibrate the smartwatch and smartphone system. Motion analysis systems are very accurate and can be used to adjust conclusions on the hardware sensors to increase accuracy.

The impact/relevance of the project is within its future use. At this stage I only look to be able to classify simple activities within motion data. Later (beyond the scope of major project), this system will be expanded to deal with diagnosis and gait analysis of people recovering from chronic diseases. By providing the foundations of a classification system capable of proving the effectiveness of wearable technology and providing an accurate understanding of what the recorded motion means, it may well be possible to perform less trivial diagnoses in the future.

**Proposed Tasks**

* Training and learning to use the motion capture systems
* Capturing the raw data which can be input into the program
* Learning to write python based feature extraction and classification algorithms
* Reading various papers which have performed similar analysis with similar data
* Improving the accuracy through evaluation and re-writing the program
* Evaluating the results and making conclusions

Use of the motion capture system is relatively complex and I will be undergoing a short 2 day training period to learn how to produce datasets. Once I am competent in this, it will simply be a case of gathering as much data as possible. With more data I will have more opportunity to test and evaluate the machine learning aspect of the project.

At the same time as my initiation into the use of the motion capture system I will also be learning about writing machine learning algorithms in Python. I hope to be able to write mostly my own code. This task will be ongoing until the end of the project as I wish to write as effective a program as possible. I will constantly be updating and evaluating my program and its methods, attempting new methods and trying to create something which is robust enough to properly evaluate the project question.

In the simplest terms possible, once I have enough data, have written a

machine learning program to extract features and classify the data, and have then tested the program on reduced data sets, then I will be able to evaluate the results and make a conclusion as to the feasibility of the smartwatch and smartphone system.

**Project Deliverables**

The first set of deliverables for the project is the datasets taken from the motion capture system, these will make up the raw inputs which I will be able to play with on python and adapt to my programs needs.

Once the datasets are created and available the next set of deliverables will involve the program itself. This will consist of various steps listed below:

* Converting raw data into csv format
* Loading csv files into matrices in python program
* Running feature extraction techniques on the matrices:
* Steps on foot based data
* Arm swing on arm based data
* Could also be reduced further (foot rising, foot falling, foot stationary, etc.)
* Features then become input into a data classification method
* This could be using neural networks
* Mathematical models
* Off-the-shelf classification programs
* Training and testing the program
* Evaluation metrics for accuracy and improvement of the program

After the data is gathered and the program is written, the next deliverable is a report which discusses the results and makes a conclusion about the project question.

**Annotated Bibliography**

[1]

<https://motionanalysis.com/movement-analysis/>

This is the official website of the motion capture system which has been made available to me. Useful in terms of providing technical details about the system and about the software (GaitTrak) that I will be making use of to gather the data for the project.

[2]

<https://ieeexplore.ieee.org/abstract/document/6471801>

Paper suggested by Neil Mac-Parthalain, could be quite relevant in terms of motion analysis techniques. Used for determining whether someone has fallen in a care home, used cameras to detect features of “falling”.

[3]

<https://blackboard.aber.ac.uk/webapps/blackboard/content/listContent.jsp?course_id=_21547_1&content_id=_1208158_1>

Contains the documentation suggested by Neil to read and assist with some of the aspects of the project. For example, things like managing the time and developing a methodology etc.

[4]

<https://www.sciencedirect.com/science/article/pii/S1746809418301162#tbl0005>

Scientific paper written about using machine learning to assess 3-D plots. May or may not contain relevant information about some of the systems I might be able to make use of when I get the motion data to play with. (Still need to read properly).

Has a few sub-papers which may be required or simply useful information later on:

<https://www.sciencedirect.com/topics/engineering/boltzmann>

<https://www.sciencedirect.com/topics/engineering/centroid>

<https://www.sciencedirect.com/topics/engineering/neurons>

<https://www.sciencedirect.com/topics/engineering/classification-performance>

<https://www.sciencedirect.com/topics/engineering/data-visualization>

<https://www.sciencedirect.com/topics/engineering/supervised-training>