School of Computing

Year 4 Project Proposal Form

SECTION A

Project Title: Recognising human activity via wearable sensor technology based on Symbolic Aggregate Approximation (SAA) and Machine Vision.

Student Name: Shane Creedon

Student ID: 15337356 **Stream:**CASE

Project Supervisor Name: Tomas Ward

[Note: It is the student's responsibility to ensure that the Supervisor accepts your project and this is only recognised once the Supervisor assigns herself/himself via the project dashboard. Project proposals without an assigned Supervisor will not be accepted for presentation to the Approval Panel.]

SECTION B

Proposal Description

General area covered by the project

The project area covered revolves around the concept of using wearable technology (PPGs) to monitor human activity. A Photoplethysmogram (PPG) is an optically obtained plethysmogram, a volumetric measurement of an organ.

I want to use this technology to recognise a given human activity from a predefined set of activities (Such as Walking, Running, Cycling etc…) through using Machine Learning and Machine Vision techniques. Rather than a traditional numeric approach to the quantifying of the data, I will be using Symbolic Aggregate Approximation (SAX) for a time-series over the data acquired.

The basic implementation will involve finding a dataset viable that represents different human activities as mentioned above. With this dataset, we can build various time-series charts representing each of the exercises with respect to the data generated from the PPG. Normalising the data and applying the Symbolic Aggregate Approximation (SAX) to quantify the data will be performed. The string representation output will then be used to generate bitmap images and clusters that can be used for machine vision / machine learning.

Outline of the proposed project

- **Background**
  I've always been interested in Human Activity Recognition and technology to improve human health. I came up with an idea to build a health-based project revolving around X-ray image classification using Convolutional Neural Networks (CNN). The idea was appreciated but I was instead recommended to convert the idea into a research project and to involve myself with one member of the data science team.

  I went to Tomas Ward who took some aspects of my project I.E. The Neural Network side of things and came up with a new idea involving Human Activity Recognition which we both agreed to work together on.

- **Achievements**
  - *Integrating Symbolic Aggregate Approximation (SAX).*
    Symbolic Aggregate approXimation (SAX) is an algorithm which takes some input time series and transforms it into a string of characters. The application of this algorithm to eventually achieve Human Activity Recognition would be a primary achievement.

  - *Determine Human Activity Recognition without use of inertia sensors.*
    Generally sensor technology found in wrist bands / smart watches
    Is comprised of two important pieces. These pieces include:
    1) The Photoplethysmogram (PPG) optical sensor.
    2) An inertia sensor to adjust to any change in velocity.

    One of the goals we strive to achieve for is to remove the need for an inertia sensor and base the activity off a machine learning model to determine which activity a person is performing (Walk, Run, Slow cycle, Fast cycle).

  - *Use of Machine Vision / Bitmap Image Classification techniques.*
    Using Symbolic Aggregate ApproXimation (SAX), we can catagorize our PPG data and extract a string of letters based off which category they fall in over a time-series.

    With the string generated from our SAX algorithm, we can build a bitmap image based off the letters and perform a machine learning model over it to justify the human activity.

  - *Real-time machine vision model that can tell you which activity you are performing while wearing the PPG technology.*
    We hope to achieve a real-time based display that can track which of the 4 activities (Walk, Run Slow cycle, Fast cycle) you are doing at that moment in time. This achievement is very challenging and may not be completed by the submission date, but I will try my best.

- **Justification**

  Implementing an optical sensor only in the design of these wearables leads to a trade off in classification performance, but in turn, grants the potential to simplify the overall design of activity monitoring and classification systems in the future.

  Human activity recognition (HAR) is a very important technology in pervasive computing because it can be applied to many real-life, human-centric problems such as eldercare and healthcare. There are many reasons why Human Activity Recognition is an important field and it is one I am Personally very curious about.

  Implementing and utilising the Symbolic Aggregate ApproXimation algorithm Will be useful for research in DCU specifically for the Data Science department. With this project, I hope to demonstrate the power of SAX and how it can be used in relation to Machine Vision.

  There are several application domains where HAR concepts are investigated and the systems are developed. We divide them roughly into four categories: *active and assisted living (AAL) systems for smart homes, healthcare monitoring applications, monitoring and surveillance systems for indoor and outdoor activities, and tele-immersion (TI) applications*.

Programming language(s)

- *Python*
- *R (Possibly?)*

Programming tools / Tech stack

- *Python Interpreter*
- *Gitlab*
- *TensorFlow*
- *Django*
- *SaxPy Library (Possibly)*
- *Keras (Possibly)*
- *SciPy*

Learning Challenges

- To improve my Python skill set to a great height to be able to solve real world data science problems.
- Improving my Data Mining skills for analysis of data sets.
- Involve myself with Machine Learning concepts such as Convolutional Neural Networks.

- Effective utilisation of a large Machine Learning Python framework such as TensorFlow and Machine Learning libraries like Keras.
- Understanding how Human Activity Recognition works in relation to sensor technology.
- Building the project based on Symbolic Aggregate ApproXimation (SAX).
- Understanding how to apply Machine Learning Image Classification over the bitmap images generated from the SAX string cluster.
- Improving the accuracy of the Machine Learning model while reducing overfitting. Really a strong understanding of Machine Learning and how it is being used by today's standards.

Hardware / software platform

- *Desktops / Laptops*
- Windows / Linux

Special hardware / software requirements

- A Photoplethysmogram (PPG) optical sensor for real-time activity recognition.
- Wristband PPG technology (Arduino / Raspberry PI possibly)