# USING CONVOLUTIONAL NEURAL NETWORKS FOR IMAGE RECOGNITION, SENTIMENT ANALYSIS AND EMOTION DETECTION

By

Aaron Ward

Supervisor(s): Stephen Sheridan

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**Declaration**

I herby certify that this material, which I now submit for assessment on the programme of study leading to the award of **B.Sc in Computing and Information Technology** in the Institute of Technology Blanchardstown, is entirely my own work except where otherwise stated, and has not been submitted for assessment for an academic purpose at this or any other academic institution other than in partial fulfillment of the requirements of that stated above.

Dated: 2017

Author: Aaron Ward

# Background

The field of artificial intelligence and machine learning has become exponentially prominent in our daily lives. From business to social media, machine learning algorithms are being used to change the definition of efficiency and user experience. For example, Artificial intelligence algorithms are utilised by many companies such as Facebook and Google to optimize the experience with image and voice recognition and photo searching (Deshpande, 2016). Also, Motor companies such as Tesla Motors use computer vision for their self driving cars, which is a form of artificial intelligence. The following proposal will highlight and explain the research at hand with a number of sections. Initially, The main research questions will be introduced to lay the groundwork for the motivation of this research. Justification to why the research being proposed shall also be given. An account on feasibility shall be brought forward to indicate the technical requirements, followed by the proposed methodologies, which gives insight as to how the research project shall be implemented. Furthermore, the last section shall provide the expected results, conclusion and references. A project plan is also set in place to illustrate the scope and outlook of the project.

# Main research question(s)

- How can sentiment analysis, using artificial intelligence, improve business models for customer service based systems?
- What can neural networks do to provide more accurate representations of business productivity?
- How can businesses use artificial intelligence to improve marketing campaigns and can it be used to distinguish disingenuous customer feedback?

# Justification/Benefits

## Popularity

The field of neural network machine learning algorithms have become subsequently popular in recent years, especially in the subset of convolutional neural network (CNN's). Figure 1 below displays the Google trends graphs of the search term "Convolutional Neural Network". As seen in the graph, the scale from 0 to 100 represents the least to the highest level of interest from 2004 to the present year. A upsurge occurs approximately around January of 2016 (tre, 2017).

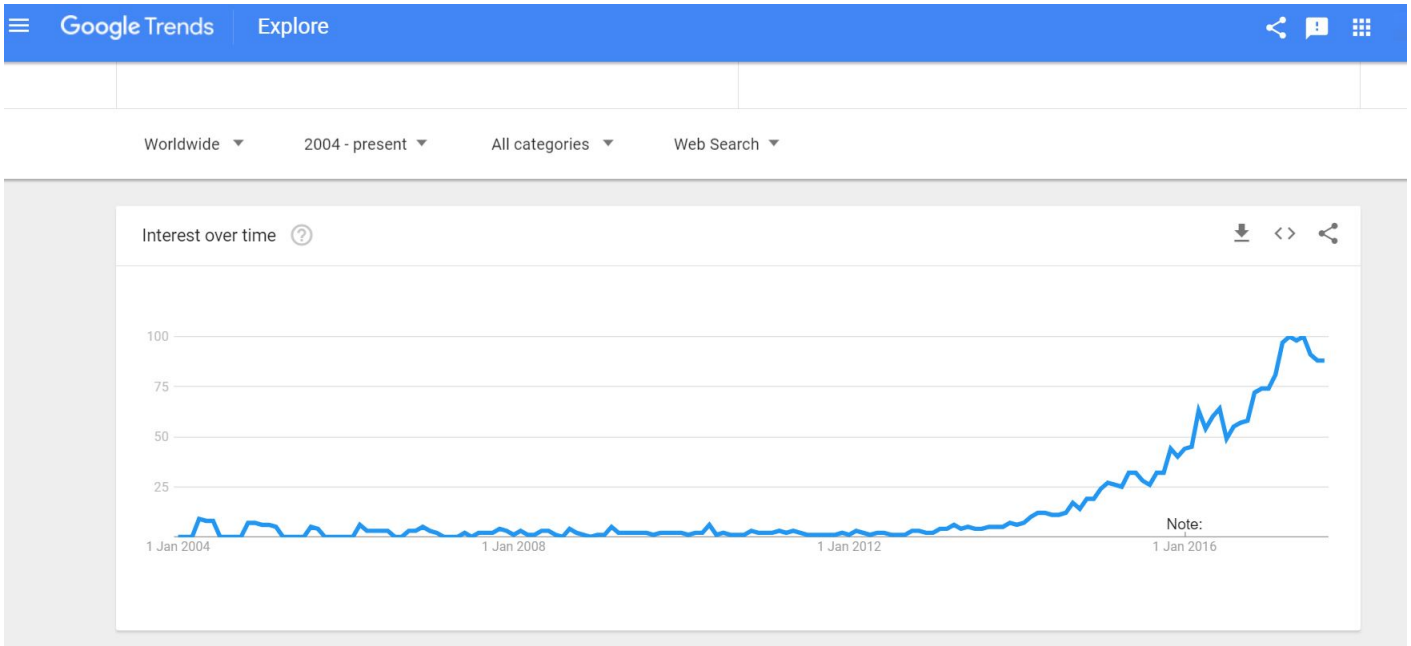


Figure 1: Google Trends Graph of Search Queries for CNN's

### Social Media

The researcher and founded of convolutional neural networks (CNN's), Yann LeCun, became the director of Facebook's Artificial Intelligence department in 2013, and it is said believed that Facebook uses CNN's for it's facial recognition, user classification and tagging features (Deshpande, 2016). CNN's, in conjunction with recurrent nets, are also used for Facebooks DeepText feature. DeepText is a deep learning text-understanding engine used to comprehend and classify human generated textual content in over 20 languages (Abdulkader et al., 2017).

## Medicine

In recent year, neural network have been used in the field of medicine to better predict diagnoses and detection of cancerous tumours. For example, CNN's have been used by researchers for brain tumor segmentation (Havaei et al., 2015). Havaei et al state in their research that difficulties may arise when utilising regular magnetic resonance imaging (MRI) to segment glioblastomas (GBM) tumours from the rest of the brain as may appear in different areas and sizes. CNN's were trained and have learned to better approach the problem with segmentation. The use of CNN's proved appropriate methods for tumour segmentation as the results can be given from a range of 25 seconds to 3 minutes (Havaei et al., 2015).
Furthermore, artificial neural networks have been used by radiologists for Computer-Aided detections systems (CADe) and Computer-aided Diagnosis systems (CADx) to improve the accuracy of diagnoses, early detections and to minimize the time spent on evaluation by doctors (Firmino et al., 2014). Although the use of these computational systems prove to be advantageous, Firmino et al. state that further work is needed to better improve the practicality of these detection methodologies. Some of the challenges and improvements needed, to name a few, are integration of CADe and CADx systems to a hospital environments, further work on reducing the number of false positive results and larger databases to be provided for a more accurate prognosis.

# Business

Many businesses depend on artificial neural networks for their business model. Artificial neural networks can be applied to many industries and disciplines. According to Bhargava and Gupta (2017) artificial neural networks are used in the following range of business applications:

### Marketing

- Forecasting of sales
- Classification of spending patterns
- market targeting

### Finance

- Risk Analysis
- Financial Forecasting - The estimation of future revenue expenditures trends.
- Bankruptcy prediction.

## Workplace Productivity

Neural networks have been used for emotion detection within organizations to boost productivity. According to studies, emotions have strong influence on a competitive marketplace. These factors are intellectual capital, customer service, organizational reactivity, production, appeal of the employee and retentivity (Subhashini and Niveditha, 2015). Subhashini and Niveditha suggest in their proposal that facial detection software could be used by organizations to better observe the overall emotions of their employees and to prevent negative sentiment to affect company productivity.

# Feasibility

## Technical Requirements

There are a number technologies and services that will be required in order to achieve the end goal of this research project. For a better understanding, the requirements are broken into categories that provide the a brief technical background on how they work and what they will be used for.

### Language

For a data science project, there are many languages that accommodate fast calculation speeds and handling of big data sets. Two of the most prevalent languages for data science Python and R (Verma, 2017). Each language has their strengths and weaknesses.

#### Python

Python is highly recommended for data science projects as it is heavily documented, holds a large community and it is considered to easier to learn than R. Python supports many machine learning libraries that are regularly maintained. Furthermore, Python is renowned for is capability of handling big data in contrast to R.

#### R

R is considered to be the most prominent language for data science. Although it is regarded as a strong candidate for this project, the main downfalls it has is its lack of ability to handle

large data loads like Python, and because it is looked upon as a harder language to grasp. Some benefits of this language be the computation speed it provides, unlike Python.

## Machine Learning Libraries

Software libraries prove to be very beneficial in implementing machine learning (ML) models as they reduce the complexity and program length (Jain, 2017). The most prominent ML libraries used today are Caffe, Scikit Learn and Tensorflow.

### TensorFlow

TensorFlow is an open source machine learning library developed by the Google Brain team. It can be run on CPUs, GPUs and mobile platforms. For machine learning algorithms, such as gradient descent, TensorFlow provides automatic differentiation which can prove to be very advantageous in comparison to other ML libraries. It also supports multiple languages such as Python, Java and C++ and Go (Jain, 2017). Graph visualisation is also supported. Multi-threading is also achievable with the use of TensorFlow

### Scikit Learn

Scikit Learn is an open source machine intelligence built on top of other libraries such as Matplotlib, SciPy and NumPy. A good feature that Scikit Learn incorporates is the ability of evaluating, chaining and adjusting model hyper parameters (Jain, 2017).

### Caffe

Caffe is a ML library that focuses on speed and modularity and is mainly utilized for convolutional neural networks and computer vision. Another selling point for Caffe is it's pre-trained models that do not require any coding or training. It supports GPU and CPU computations but a disadvantage of this library is that it is specifically for application implementation, not for research and development (**?**).

## Web Frameworks

A web framework will required to run the application on a server, and to aid in building the front end. The framework should be lightweight, fast and easy to implement to reduce time consumption in the development of the project. A number of considerable web frameworks for this project revolve either in Node.JS or Python.

### Flask

Flask is a modular Python web framework that known for being very easy to set up. Flask provides the option of have or not have an ORM. It is highly supported and considered to be one of the most popular frameworks for ease of use (**?**). A downfall of this framework is its design to not support asynchronous programming.

### Express

Express is a powerful Node.JS module that provides route building for RESTful API development. Express is seen as a relatively old module therefore it has a strong community backing. It is also considered to be a very straightforward and uncomplicated framework and would be benign to the implementation of the project (**?**).

## Training Platform/Setup

For model training, there are two approaches that can be taken in order to train and improve the accuracy of the model: to train locally on the host machine or to use a cloud platform. The are pros and cons to both approaches. Training locally is the cheaper option, but it requires exceptional computing power in order to train a convolutional neural network due to the large image dataset, which may not be accessible. The through a cloud platform provides dedicated hardware for training and they are highly accessible, they do require payment for anything beyond the basic tier plans. Additionally, a labelled dataset of human emotional expression is required for training.

### Distributed TesnorFlow

For training locally, TensorFlow provides the mean to create your own cluster of servers in order to divide the work load of your training to implement distributed deep learning (TensorFlow, 2017). Each node in the cluster are known as ”tasks”. There is a master node that distributes jobs to each task accordingly. A node in the cluster can receive either one or more jobs to do and run that task's hardware.

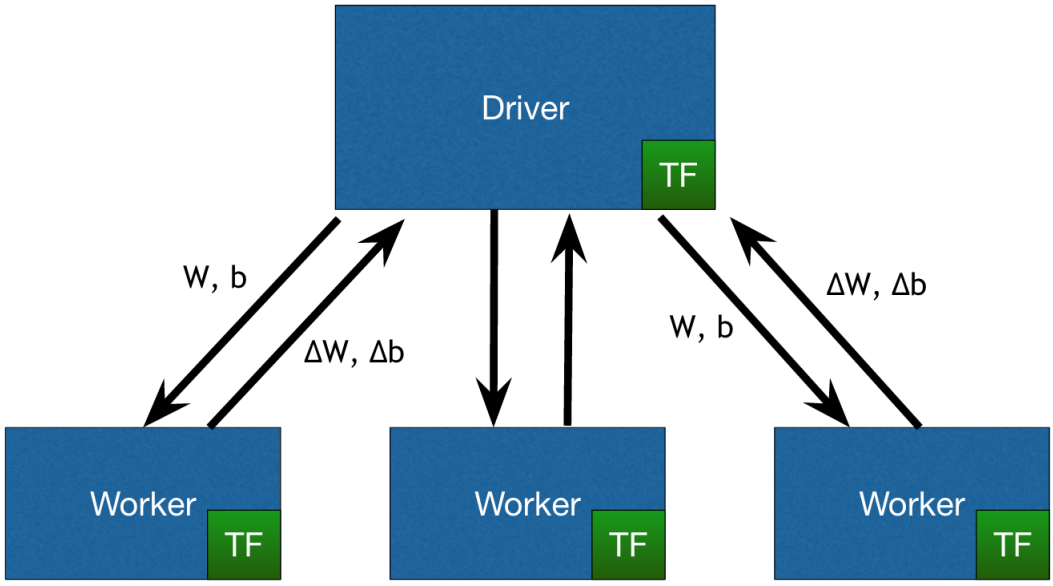


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Figure 2: Distributed TensorFlow Topology

### TensorPort

TensorPort is a distributed machine training platform specifically for TensorFlow developed by Good AI Lab. The free tier provides 10GB's of storage, five graphical processing units and twenty central processing units. Additionally, TensorPort allows a number of integrations. Git VCS and TensorBoard (Graph visualisation) is integrated on the online portal. Lastly, it also provides Keras support, should it be needed.

# Proposed Methodologies

The following proposed methodology will list the technologies used and how they shall be incorporated with each other, and shall also provide reason as to why they are believed to be the best option.

- The convolutional neural network shall be implemented in Python because it's fast, highly supported and provides excellent libraries for machine learning.
- The TensorFlow library shall be utilised for developing the CNN as it gives great flexibility and tools for the proposed software.
- Datasets of human facial expression shall be acquired, possibly from Kaggle.com.
- TensorPort shall be used for training. The model and dataset shall be pushed to the cloud and trained. This approach considerably more suited for this project as it can be difficult to allocate machines to training on campus repeatedly for training.
- For graphical visualisation, TensorBoard will be used as it is integrated to TensorPort and allows for in depth analysis of the neural network.
- A web application shall be developed with Node.JS and Express as is provided asynchronous programming, it is lightweight and easy to implement. The web app shall provide a simple interface for webcam recording and result displaying. This application shall be hosted on Heroku as it provides a free tier plan and is allows for effortless deployment.
- The application shall record the users face, and shall splice the video stream in intervals. These still images taken from the video stream shall be sent to the model and

their emotion/facial expression shall be classified accordingly. A result shall be sent back to the application and displayed.

# Expected Results

A number of results are possible with this research. Initially, the most expected result to be envisioned is that it goes according to the proposed methodology. The application records the humans face, and using the training convolutional neural network, can classify the emotions of the human. This however, may not be end result of the project. Depending on the time of the finished implementation, extra features may also be included in the software. This may include natural language processing, tone analyzing, speech-to-text or a chatbot-like feature, that shall allow the AI to respond in a human-like manner. Furthermore, should the training fail or surpass the free tier quota, the option of a pre-trained may be needed. Although this is not a desirable method, it would be needed in order to complete the project.

# Conclusion

In conclusion, this proposal has highlighted a background of artificial intelligence and gave a brief introduction as to how the paper would be structured. The main research questions were concisely brought to light. Followed by the justification of the project, explaining how neural networks and artificial intelligence are used today in a wide range of disciplines. An in-depth feasibility is provided to elaborate on the technologies that are essential to completing the goal of this project, ranging from software libraries for machine learning to training. The methodology of the project, although fairly uncertain, is explained to better understand the scope and implementation of the project and lastly, the results that should be expected have been given.

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# Project plan

The plan is listed below giving a over view of the expected approach to the project. Please note that this is subject to change.

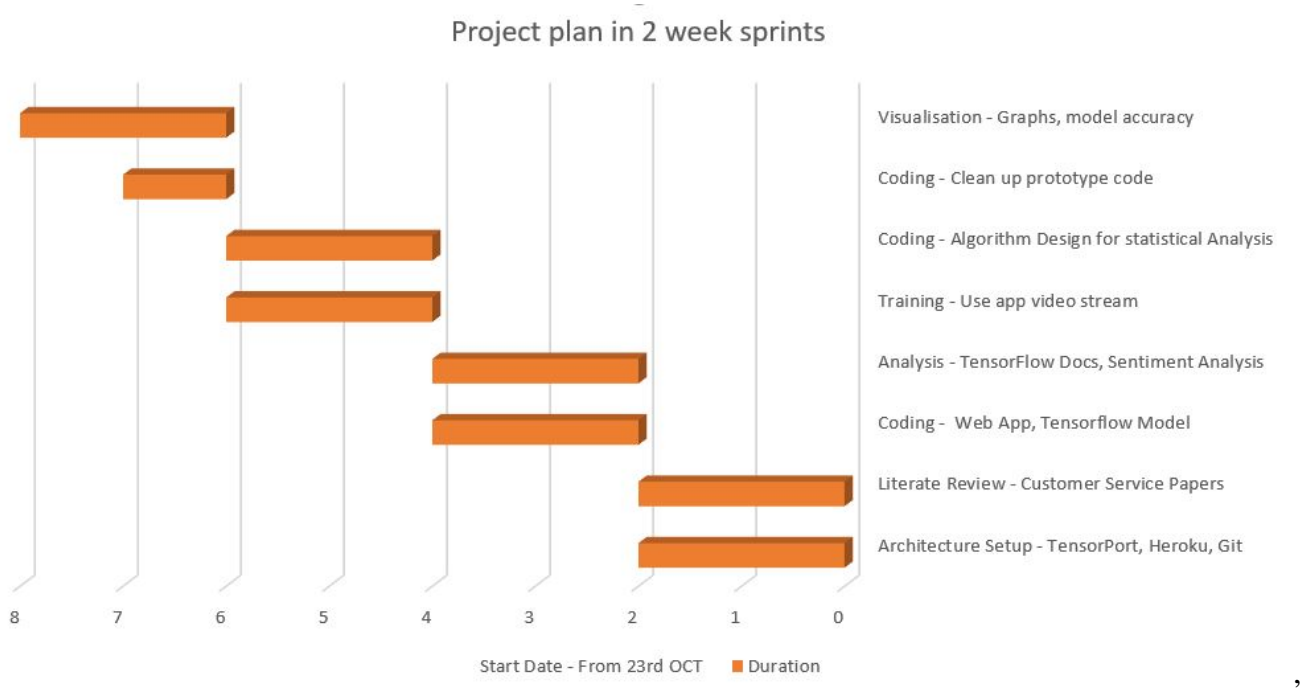


Figure 3: Project plan in gantt chart format