Detection of brain tumours with the use of AI

**Capstone Project Proposal**

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**Subject: Strategic Thinking**

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**Assessment Cover Page**

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## Introduction

This project addresses the use of artificial intelligence applied to medical imaging for the detection of brain tumours. The aim is to investigate and apply the best CNN model to detect and classify various brain tumours more accurately by achieving the highest probability of the model being correct. This document shows the complete process of data collection, model development and analysis of results. In addition, concepts about CNNs are explained for the understanding of the development of the system.

* Manual analysis of MRI scans for brain tumour detection is a complex and error-prone process, due to the variability of tumours and brain structures. In this study, the use of different CNN models to perform automatic brain tumour detection in medical images will be explored. Pre-trained models, such as VGG16, EfficientNetV2B3, and custom models creating a new CNN will be considered, and their performance on a problem-specific dataset will be evaluated. The use of pre-trained models allows taking advantage of prior knowledge acquired on large datasets, such as ImageNet, and adapting it to the brain tumour detection task.

## Objectives

The main objective of this project is to develop and evaluate a brain tumour detection system using Convolutional Neural Networks (CNN) and machine learning techniques. To achieve this goal, the following specific objectives are established:

* Collect and prepare a suitable dataset: a set of magnetic resonance imaging (MRI) medical images containing both positive cases of brain tumours and negative cases of normal brain tissue will be sought to be obtained. A pre-processing process of the images will be carried out to ensure their quality and homogeneity.
* Design and develop different CNN models: Several CNN models, including pre-trained models and customised sequential models, will be implemented in order to explore different architectures and approaches for brain tumour detection.
* Train and tune CNN models: A training process of the models will be carried out using the prepared dataset. The hyperparameters of the models will be adjusted to obtain the best possible performance.
* Evaluate and compare the models: A thorough evaluation of the trained models will be performed using appropriate performance metrics. The results obtained by the different models will be compared to determine which one is the most effective in brain tumour detection
* Analyse the results and draw conclusions: A detailed analysis of the results obtained will be carried out and the effectiveness of the CNN models evaluated will be discussed. Conclusions will be drawn on the feasibility and applicability of machine learning techniques in the detection of brain tumours in medical images.

## Problem definition

A brain tumour is an accumulation or mass of abnormal cells in the brain. The skull, which encloses the brain, is very rigid. Any growth within such a restricted space can cause problems. Brain tumours can be cancerous (malignant) or non-cancerous (benign). When benign or malignant tumours grow, they can increase pressure inside the skull. This can cause brain damage and be life-threatening. The system used for the study is designed to classify medical images according to four categories:

* Non-tumour
* Glioma
* Meningioma
* Pituitary

The problem is to develop a brain tumour detection system using Convolutional Neural Networks that is able to correctly classify brain tumours. In addition, the aim is to determine which CNN model and which image pre-processing techniques are most effective for this particular problem.

By addressing this problem, it is hoped to improve the early and accurate detection of brain tumours, which can contribute to faster diagnosis, more effective treatment and a better quality of life for patients.

## Scope

The scope of the project focuses on the development and evaluation of CNN models for the detection of brain tumours in medical magnetic resonance images. Different CNN models, image pre-processing techniques and machine learning approaches will be considered.

The project is carried out using machine learning and image processing tools and libraries, such as TensorFlow and Keras. A publicly available dataset on the Kaggle platform is used. The programming language used is Python.

## Methods

To carry out this project, various technologies and tools have been used to achieve the objectives of image classification.

The programming language selected is Python, as it is the standard in the world of artificial intelligence and has abundant libraries and frameworks for the development of deep learning tools.

* Libraries and Frameworks used

NumPy: Fundamental library for numerical computation in Python. It is widely used in

manipulating matrices and tensors, which are essential data structures for training machine learning models. It is used when importing data to convert it into simpler matrices to work with when training models.

Matplotlib: 2D plotting library that allows visualisation of data and model results. Can be used to create graphs, scatter plots, histograms and more.

Scikit-learn: Widely used library for machine learning in Python.

It provides a variety of machine learning algorithms, evaluation metrics and data preprocessing tools that can be used in combination with Keras. Used to import the function to create the confusion matrix and accuracy report.

TensorFlow: Open-source machine learning library developed by Google.

Keras can run on top of TensorFlow as a backend, allowing you to take advantage of all the capabilities of TensorFlow along with the ease of use and flexibility of Keras.

Keras: High-level neural network library written in Python. It provides a simple and modular

and modular interface for building and training deep learning models. Keras integrates seamlessly with TensorFlow as a backend, allowing you to leverage the power of TensorFlow while benefiting from the simplicity of Keras. Keras simplifies the process of designing and developing deep learning models by providing pre-defined layers, activation functions, optimisers and common metrics.

Seaborn: Data visualisation library based on Matplotlib. Seaborn provides a

high-level interface for creating attractive and informative statistical graphics. It is used in this case to display confusion matrices in colourful graphs to make it more visual.

* Tools used

Anaconda: Anaconda is a data science and software delivery platform that is widely used in the field of data science and machine learning. It provides a comprehensive development environment that includes the Anaconda package manager, with which popular scientific libraries and packages can be easily installed and managed.

Anaconda also includes the Jupyter Notebook integrated development environment (IDE), which allows users to create and run interactive notebooks. One of the advantages of Anaconda is that it facilitates the management of virtual environments and compatibility with different versions of libraries and packages, which helps to avoid dependency conflicts and allows for greater reproducibility in data science projects. This one in particular has been used for local testing.

* Collection and preparation of the dataset

This part explains the first process of developing the system by means of the models in order to obtain the data and then process them.

Here starts the code and experimentation part.

The following code is added which represents the generation of seeds for the system:

- `tf.random.set\_seed(42)`.

- `np.random.seed(42)`.

These are used to set a seed in the TensorFlow (tf) and NumPy (np) random number generators, respectively.

The seed is used to initialise the random number generator so that the same random numbers are produced for each execution of the code. This is useful to ensure reproducibility of results in machine learning projects, especially when working with algorithms that make use of random numbers, such as weight initialisation in neural networks.

Setting a seed ensures that, although the overall behaviour of machine learning algorithms may be stochastic due to randomness, the results will be consistent and reproducible across different runs.

Once the libraries and resources needed to start operating with the system have been imported, the process of obtaining the images to deal with them begins.

The Dataset is divided into Train and Test, so the Python function ‘splitfolder’ will be used to split Train into Train and Validation. This is done to improve the training of the models. This function is specifically designed for these cases of data processing as it splits the data balancing the images so that it does not take for example and split and in Validation only the images of Glioma, but it does it balanced and therefore there is a good sample to validate during the training.

To make the division of Train between Train and Validation, we have chosen to do it with 80% of the data for Train and 20% for Validation, as well as with 70% and 30% as this is what is usually done in these cases.

Gráfico, Gráfico circular

Descripción generada automáticamente

Image 1.Training set

## Data Source

For the development of this tumour prediction and classification system, a Dataset from the Kaggle platform is used.

* This Dataset is a set of several Datasets in order to obtain a larger number of tests and therefore achieve a more efficient solution with a better hit rate.
* This Dataset focuses on differentiating and classifying between ‘Glioma’, ‘Meningioma’, ‘Non-tumour’ and ‘Pituitary’. These are the four classes, and the aim is to get a high value of correct predictions by classifying these types.
* The images in this Dataset have different sizes so techniques have been applied to normalise values so that all images are treated in the same way.

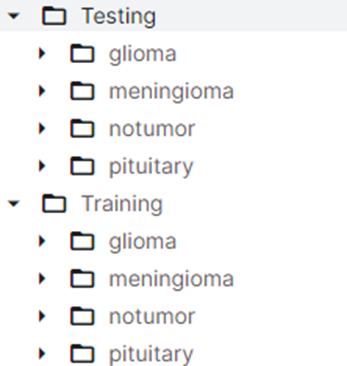


Image 2. Sample image dataset data used in this project

## Ethical Considerations

## Acronyms

* CNN: Convolutional Neural Network / Convolutional Neural Network
* ENV2B0: EfficientNetV2B0
* ENV2B3: EfficientNetV2B3
* AI: Artificial Intelligence
* ML: Machine Learning
* SDGs: Sustainable Development Goals

## References