Brain Tumor Classification

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Research Problem

Problem Choice

Brain tumor has long been recognized as one of the most vicious diseases faced by mankind. This project aimed at deriving robust Machine Learning models serving as better alternatives of the error-prone manual classification.

Data Description

- Comprises 394 pieces of testing data and 2870 pieces of training data.
- RGB colored MRI scan in JPEG format.
- Response: four possible tumor classes: Glioma, Meningioma, Pituitary and No tumor
- Predictors: Image pixels(numerical value/3 entries vectors).

Data Pre-processing

- Rescaling, Flattening and Standardisation.

Data Limitations

- 2D sections of 3D MRI scans
- Imbalanced categories and insufficient data size.

Overview of Model Performances

Summary of Results

Model	Accuracy	F1-score
Residual Neural Network (ResNet)	80.4%	78.2%
K-Nearest Neighbour (KNN)	79.4%	77.4%
Random Forest (RF)	78.7%	73.9%
Support Vector Machine (SVM)	71.1%	70.8%
Vision Transformer (ViT)	60.2%	57.5%

Confusion Matrix for Optimal Model (RestNet34)

Predicted/Observed	glioma	meningioma	pituitary	none
glioma	37	0	0	0
meningioma	48	115	8	0
pituitary	0	0	60	0
none	15	0	6	105

Residual Neural Network (ResNet)

Convolutional Neural Network(CNN) - Feature Extractor

- Convolutional layer
- Batch Normalization
  (has regularization effect)
- Activation
  (ReLU, softmax)
- Pooling
  (max pooling, average pooling, etc.)

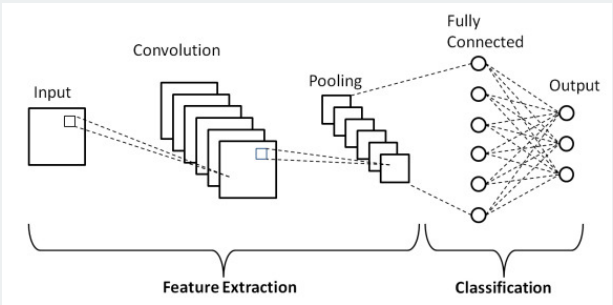

Figure: Infographics for CNN[1]

ResNet34

- Residual block: learns $F(x) - x$ instead of $F(x)$
- Shallower layers learn the texture while deeper layers could extract more abstract features. e.g., below are input and feature maps from conv1-5 layers after activation.

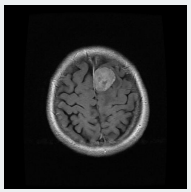

Figure: input

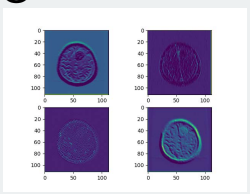

Figure: conv1

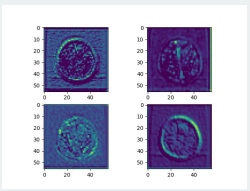

Figure: conv2

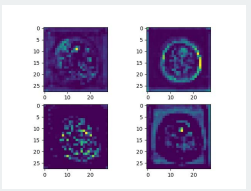

Figure: conv3

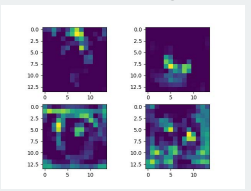

Figure: conv4

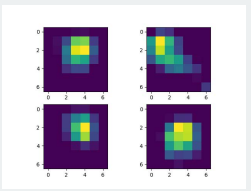

Figure: conv5

Vision Transformer (ViT)

Algorithm Illustration

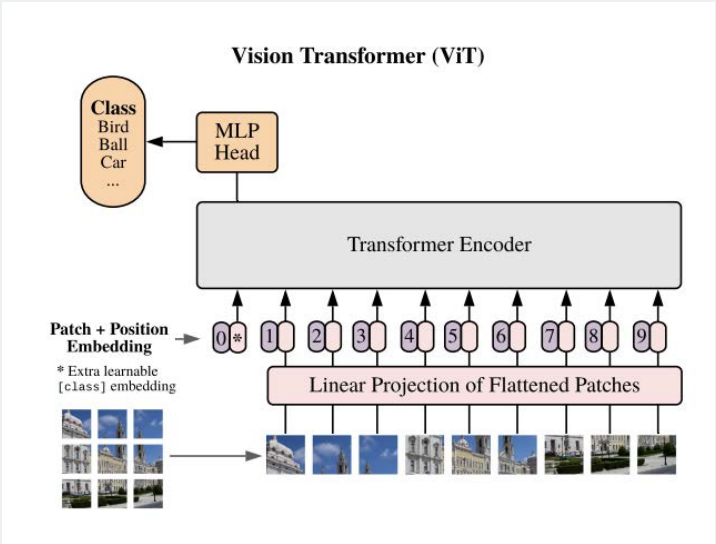

Figure: ViT

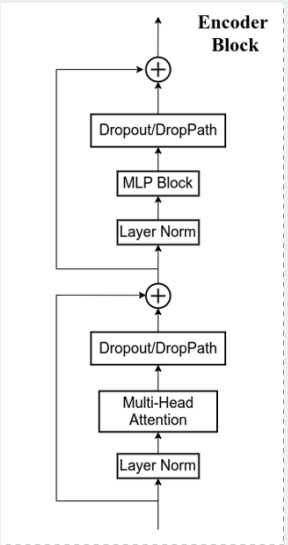

Figure: Transformer Encoder

Characteristics of ViT

- Image process as a sequence of patches
- Adoption of Transformer Encoder as used in Natural Language Process (NLP)
- Macro integration of image features