Problem owner name

Thomas Shaw, Centre for Advanced Imaging, The University of Queensland

Problem title

"Machine Learning for Medical Imaging, MLMedic", an easy-to-use GUI to help clinicians and scientists measure and visualize the brain using advanced machine learning (ML) techniques.

What is the problem you want to solve?

Magnetic Resonance Imaging (MRI) scans are used by clinicians to diagnose and treat many common neurodegenerative diseases and disorders including Alzheimer's dementia. To measure the progress of these, and to understand healthy brain functioning, brain images can be 'segmented' and visualized using many software packages and tools in Linux. Brain segmentations can also be used to track tumor location and growth automatically, and take a lot of the manual labor out of identifying abnormalities in the brain.
Recently, ML algorithms have been able to segment brain images orders of magnitude faster than other methods, though the available ML models and packages are largely unusable for clinicians. These brain segmentations are a useful tool for clinicians to make judgements about disease progression and diagnosis. We would like to make using these models easy in the clinic.

Why do you want to solve this problem?

Brain image segmentation has high clinical impact and assists in diagnosis and disease tracking of many neurodegenerative diseases and disorders. Similarly, scientists need these measurements of brain structures for answering important research question about the mind. Unfortunately, using ML for brain segmentation is limited to institutions with the requisite expertise for such tasks. Clinicians and researchers often do not have the time or expertise to process data in this way, and need portable and easy-to-use interfaces for interacting with these tools. We want to put these powerful tools into the hands of clinicians.

What do you envision as the ideal solution for this problem?

We would like to implement a user-friendly cross-platform interface that reads-in MRI (DICOM) data from a clinic or research institution, and provides accurate brain segmentations using ML that can be used as an assistive tool for diagnosis and tracking of disease and disorder. We will call this "MLMedic" https://github.com/MLMedic/MLMedic: For example, MLMedic could automatically detect tumors and growths and measure their size and shape. This could be solved by using nodes.js / tensorflow.js / python. We would like to design a GUI that applies pre-made ML models on data collected in the clinic for an easy ML interface for the masses.
We would also like to implement an online model 'zoo' that hosts available ML models and translates existing models to the format we require in our interface.

What sort of Open Source solution do you think can be created in 48 hours, by a small team of developers, designers and data analysts?

It is now possible to implement ML methods on moderately high-end consumer grade computers, which is why for MLMedic to function, the end user (clinics) must have access to appropriate hardware for ML (e.g., GPUs).

Overall: MLMedic is a GUI that ingests MRI (DICOM) data and provides a segmentation of the brain. This can be broken up into sub-sections.

1) A cross-platform interface (e.g. node.js/tensorflow.js) for clinicians to apply convolutional neural networks for brain segmentation to DICOM data and view results.
2) A model zoo for the model weights of ML algorithms.
3) A working prototype for one such brain segmentation pipeline using ML (e.g. skull stripping).

What are the current solutions for handling this problem?

Many tools can handle brain segmentation, including Freesurfer, FSL, SPM, ANTs, MATLAB, etc. These packages are sometimes relying on software that is 20+ years old and may take days to compute image segmentations. Many models have been developed for training CNNs to do these segmentations far more quickly. However, a tool that is easy to use for clinicians has not yet been developed. The key barriers preventing clinics using these tools are time, and knowledge of ML methods. We hope to solve this through an easy-to-use GUI that simplifies the whole process for the clinician.

Summary for website (up to ~ 1 page)

PROBLEM

Magnetic Resonance Imaging (MRI) scans are used by clinicians to diagnose and treat many common neurodegenerative diseases and disorders including Alzheimer's dementia. To measure the progress of these, and to understand healthy brain functioning, brain images can be 'segmented' and visualized using many software packages and tools in Linux with specific dependencies.

Brain image segmentations can also be used to track tumor location and growth automatically, and take a lot of the manual labor out of identifying abnormalities in the brain. Unfortunately, these tools often take up to 24 hours on a standard computer to produce these segmentations, and require specific expertise.

Recently, ML algorithms have been able to segment brain images orders of magnitude faster than other methods, though the available ML models and packages are largely unusable for clinicians. Clinicians and researchers often do not have the time or expertise to process data in this way. These brain segmentations are an incredibly useful tool for clinicians to make judgements about disease progression and diagnosis. We would like to make using ML easy in the clinic.

We would like to implement a user-friendly cross-platform interface that reads-in MRI (DICOM) data from a clinic or research institution, and provides accurate brain segmentations using ML that can be used as an assistive tool for diagnosis and tracking of disease and disorder. We will call this “Machine Learning for Medical Imaging”, MLMedic, which could automatically detect tumors and growths and measure their size and shape. We would like to design a GUI that applies pre-trained ML models on data collected in the clinic for an easy ML interface for the masses.