Medical image multi-label classification

Background and project definition

Serious complications can occur as a result of malpositioned lines and tubes in patients. Doctors and nurses frequently use checklists for placement of lifesaving equipment to ensure they follow protocol in managing patients. Yet, these steps can be time consuming and are still prone to human error, especially in stressful situations when hospitals are at capacity.

Hospital patients can have catheters and lines inserted during the course of their admission and serious complications can arise if they are positioned incorrectly. Nasogastric tube malpositioning into the airways has been reported in up to 3% of cases, with up to 40% of these cases demonstrating complications. Airway tube malposition in adult patients intubated outside the operating room is seen in up to 25% of cases. The likelihood of complication is directly related to both the experience level and specialty of the proceduralist. Early recognition of malpositioned tubes is the key to preventing risky complications (even death), even more so now that millions of COVID-19 patients are in need of these tubes and lines.

In this project we will investigate a real world application by developing a deep learning model able to identify the presence or absence of different lines and tubes on chest radiographs as well as whether there is or is not a malpositioned line or tube.

Goals of the project:

Clinicians are interested in the performance of the classification pipeline, particularly in the ability to detect if each line and tube is present, as well as if a malpositioned line or tube is present.

The tasks include:

1. Gathering and cleaning data from the web
2. Exploratory data analysis
3. Extract conventional features e.g. gray scale, shape, texture etc, as well as features obtained through deep learning e.g. location of the tips of each tube, coordinate location of each point for each tube
4. Create a model capable of identifying each line and tube and whether a malpositioned version of each line and tube exists.
5. Identify the features that are most used by deep learning models through interrogation of saliency maps, image occlusion, or pseudohealthy patient synthesis.
6. Measure the contribution of some of these features through ablation studies.
7. Discuss the appropriate metric to use in evaluation of a multi-label problem, taking into the consideration that cases with malpositioned lines and tubes are a subset of cases with that line and tube present at all.

Data

A large labelled dataset of chest radiographs with accompanying image level as well as instance level annotations have been provided at https://www.kaggle.com/c/ranzcr-clip-catheter-line-classification/

You will only need to work with the training dataset.