Assessing Ventilator-Associated Pneumonia (VAP) Using Deep Learning

Computer Integrated Surgery II
Spring 2019
Members: Suraj Shah
Mentors: Drs. Mathias Unberath, Jules Bergmann, and Jim Fackler

Introduction

• There is currently a lack of machine-augmented techniques that can be applied in critical-care settings (ICU and PICU) to classify pneumonia
• To address this problem, I implemented several deep learning techniques to classify pneumonia with high accuracy and visualize the actual features on which the machine detected pneumonia
• This was built with an adult chest X-ray pipeline, but can be applied to pediatrics (with enough data)

Problem

• Chest X-rays are the empirical standard in diagnosing pneumonia but are subject to trained radiologist diagnoses
• Mechanical ventilation is a critical, life-sustaining ICU therapy (more than half of patients ventilated within 24 hours) but results in increased mortality for many
• 10-20% of patients every year are diagnosed with VAP, and contracting VAP amplifies risk of mortality by 30%
• Radiologists are often unavailable to diagnose chest X-rays in real-time in critical-care settings
• Thus, there is a need for an automatic classifier to diagnose VAP in these situations

The Solution

Overview of Transfer Learning

• First, assembled a pipeline for easy manipulation of publicly available data; able to sort data easily into model-ready inputs after assembly
• Built models off of existing pre-trained convolutional neural networks, and adjusted feature size and optimization accordingly, example implementation is shown below
• After training the model, ran class activation algorithms to display to physicians where feature extraction most occurs
• Models were tested and cross-verified across both datasets

Outcomes and Results

Achieved 94% accuracy on binary classification (trained on 65K images)

Future Work

• I will be graduating and starting a full-time job in August, so cannot continue work on my own
• Computational: include applying deep clustering methods on top of the neural network to extract most relevant features
• Experimental: testing on a more robust set of pediatric patients (especially validating on patients who are specifically ventilated)

Lessons Learned

• Generalization of convolutional neural networks derives a convenient way to train own datasets
• Publicly available time-series data is difficult to ingest
• Very accurate diagnosis of pneumonia can often depend on non-imaging data points

Support by and Acknowledgements

• Thank you to my mentors Drs. Mathias Unberath, Jules Bergmann, and Jim Fackler
• Special thanks to Dr. Russell Taylor for instructing the class and providing valuable feedback throughout the course