Using Machine Learning to Quantify Colorimetric Assays from Cell Phone Photos

Rachel Fisher, Biomedical Engineering
Mentor: Dr. Jennifer Blain Christen, Associate Professor, School of Electrical, Computer and Energy Engineering

Abstract:

Finding a method to objectively quantify results of colorimetric assays without special equipment is important to increasing the accessibility and portability of point-of-care testing. Point-of-care testing is inexpensive, has quick response times, and has numerous applications ranging from roadside alcohol testing to detecting infections such as COVID-19 or HPV. The focus of this study is to train a machine learning algorithm that can quantify the concentration of samples on colorimetric alcohol test strips from cell phone photos taken under non-standard conditions. The accuracy of this algorithm will be evaluated and is expected to be able to adequately provide quantitative results.

Background:

1. Lateral flow immunoassays (LFA) are currently one of the most prominent methods for early detection of diseases within point-of-care testing due to their inexpensive cost, quick response time, and portability [1].
2. Current solutions typically consist of creating a reader that can standardize the conditions of the strips before they are measured in some way, which increases the cost and decreases the portability and accessibility of LFAs.
3. Machine learning techniques such as deep learning and convolutional neural network have previously been used and shown to be successful for medical imaging processing and analysis [2].

Methods:

Data Collection: Videos→ Photos

Model Selected: Convolutional Neural Network (CNN)

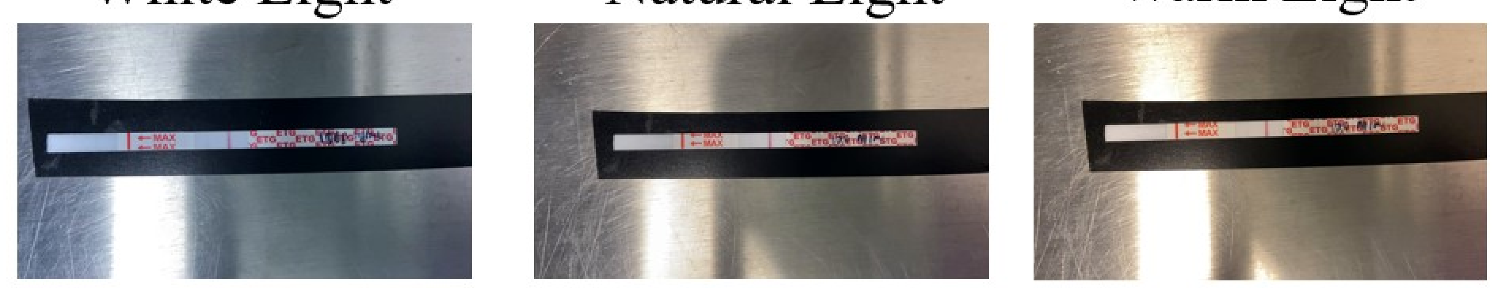
Keras | TensorFlow | Spyder

ETG
Training Data: 35,119 photos
Testing Data: 10,034 photos
Validation Data: 5,017 photos

EtOH
Training Data: 47,920 photos
Testing Data: 13,691 photos
Validation Data: 6,846 photos

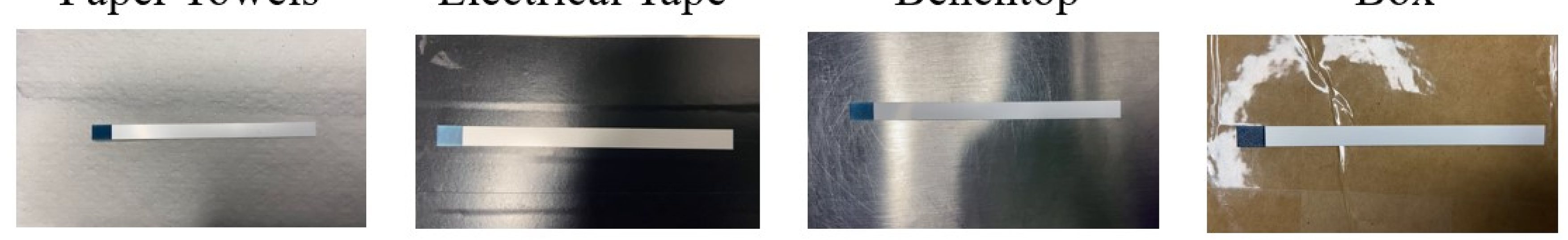
50% Brightness | 100% Brightness

White Light | Natural Light | Warm Light



Close Up | Full Strip | Close Up | Full Strip

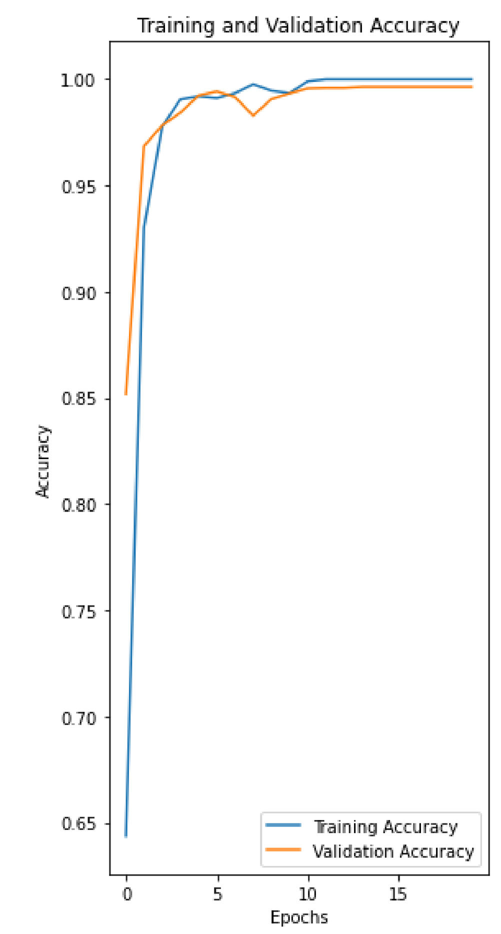
Paper Towels | Electrical Tape | Benchtop | Box

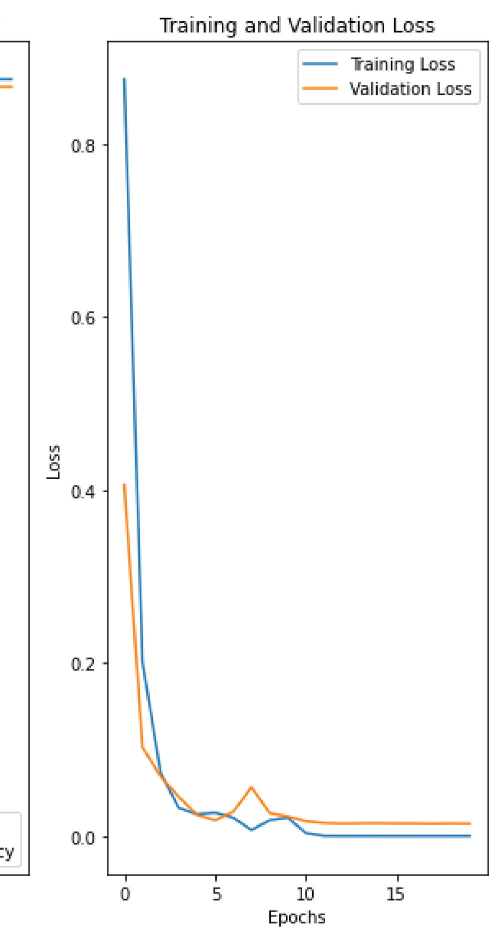


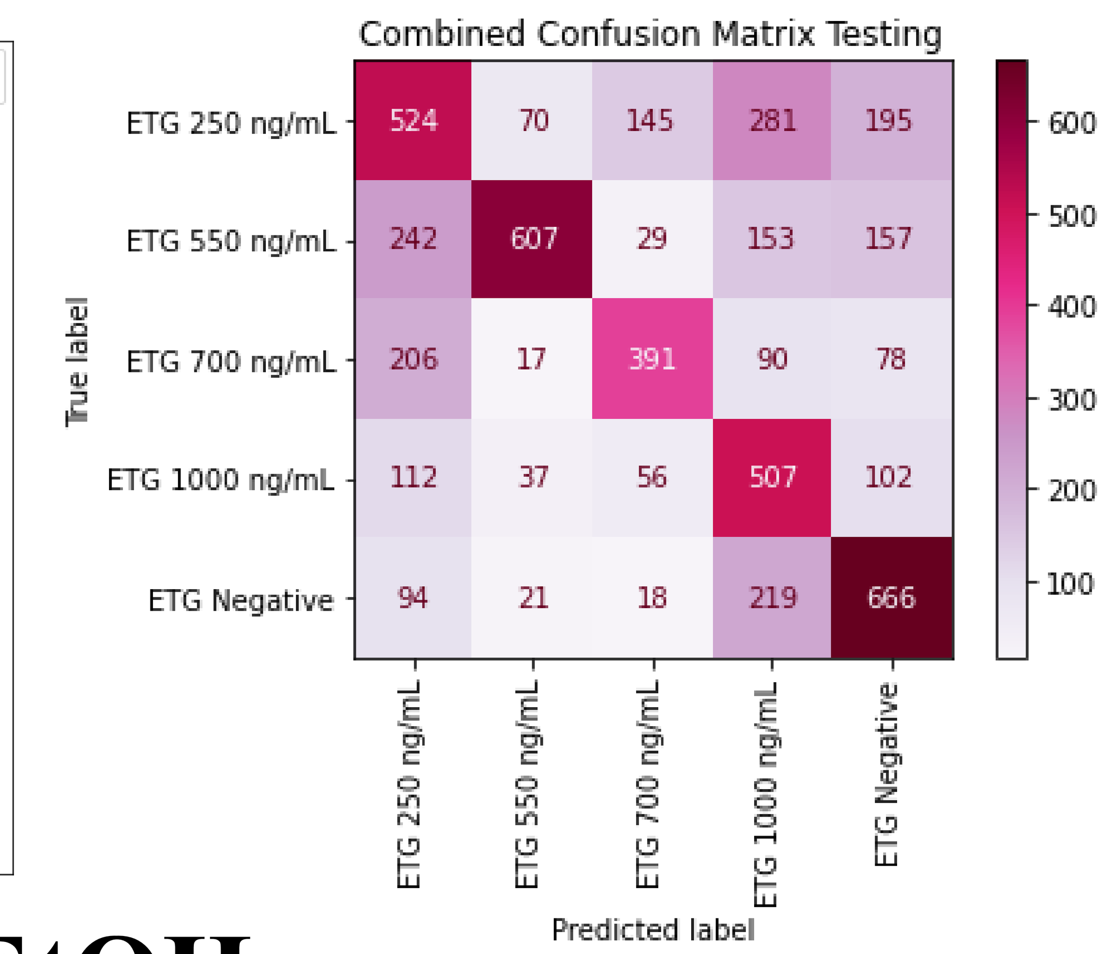
Future Work:
Accuracy | Multiple Strip Types | Invalid

Results:

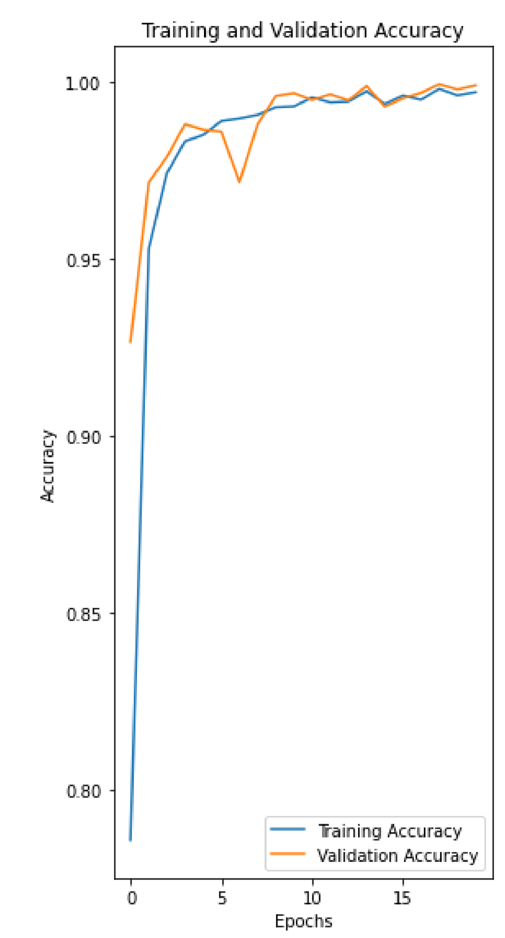
ETG

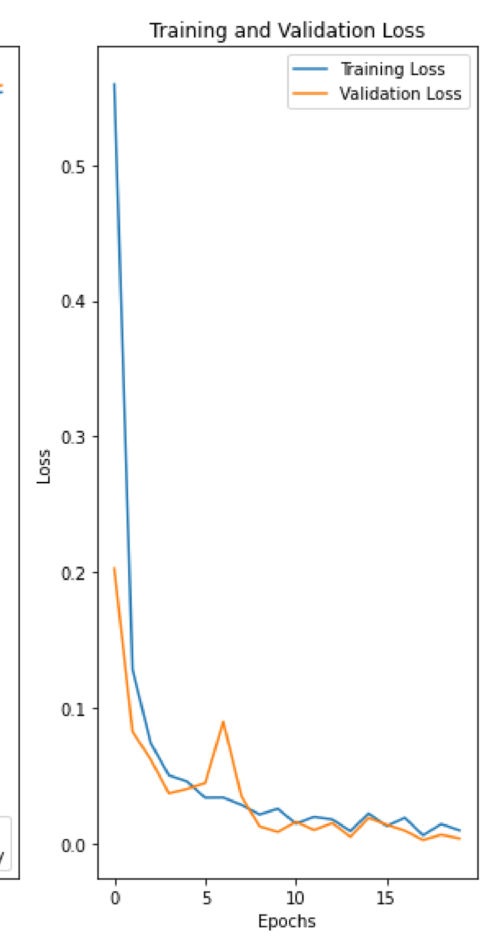


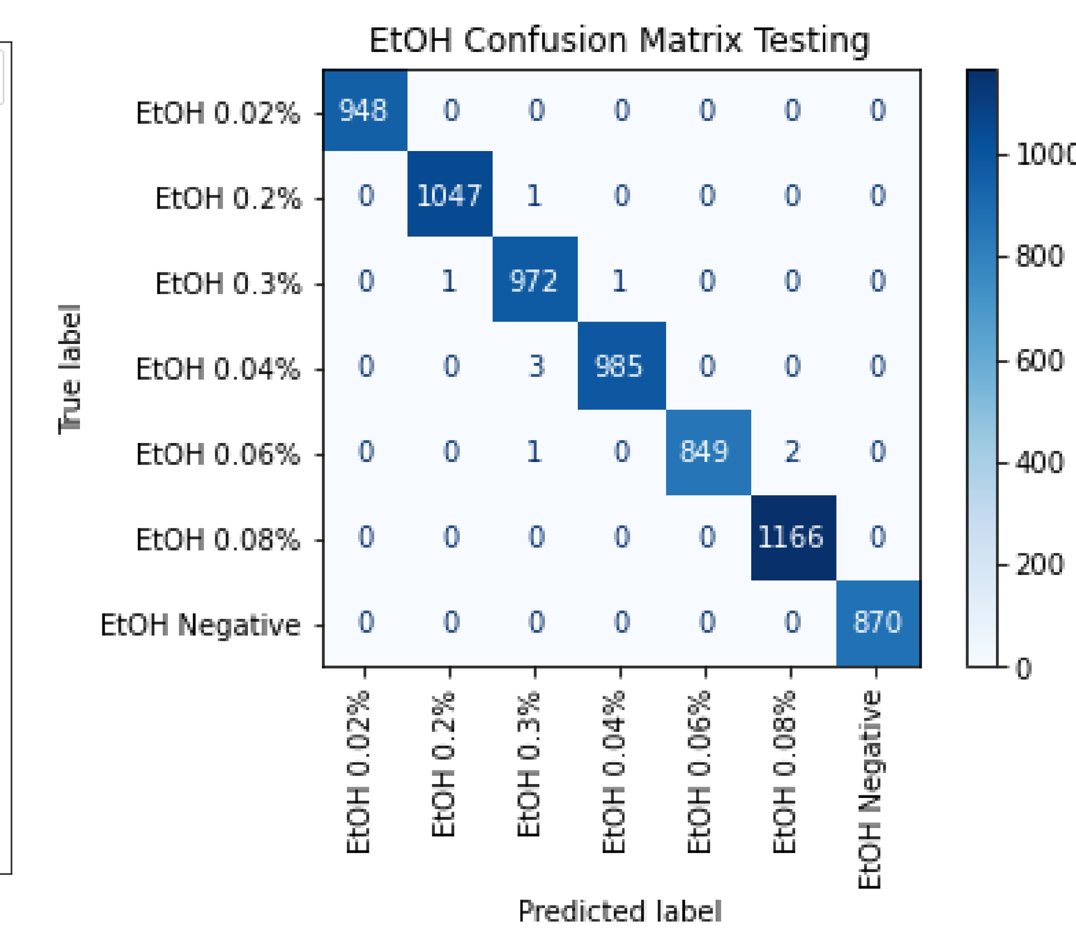




EtOH







Acknowledgements:
A sincere thank you to everyone in Dr. Jennifer Blain Christen & Dr. Karen Anderson's lab!

References:

[1] Koczula, K. M., & Gallotta, A. (2016). Lateral flow assays. *Essays in biochemistry*, *60*(1), 111–120. https://doi.org/10.1042/EBC20150012
[2] Razzak, Muhammad & Naz, Saeeda & Zaib, Ahmad. (2018). Deep Learning for Medical Image Processing: Overview, Challenges and the Future. Retrieved from https://arxiv.org/abs/1704.06825