ECE Capstone Program
Spring 2018
Project Abstract & Info

Please provide the following information to be shared with on capstone information exchange platform:

1. Project number:

S19-16

2. Project title (as will appear on the poster):

Machine Learning Applied to Material Analysis

3. Team members:

Jonathan Alcantara, Fareen Pourmoussavian, Ben Merberg, Kevin Honeker, David Marrero

4. Adviser(s) name(s):

Matteo Turilli
Optimal Solutions

5. Up to 5 keywords that will help to classify the project scope:

Machine Learning, Partial Least Squares, Neural Networks

6. Project abstract (up to 250 words) to be shared with judges:

Material analysis is critical to enable the production of safe and quality goods and today, companies use cumbersome, time-consuming, and error-prone methods to analyze materials using expensive analytical laboratories. Companies have a pressing need to measure material properties (like the composition of wine samples and properties of pharmaceutical powders) throughout their supply chains. Modern, near infrared sensors, offer affordable and portable means to gather absorption data from liquids and solids. It is well-known that such absorption data can be used to predict the properties of liquid and solid samples. Such relationships are complex and nonlinear and hence machine learning techniques can add immense value.

Our overall objective is to bring to market a cutting-edge material analysis application which produces accurate, near real-time readings. Our approach is to use machine learning algorithms to process data gathered from handheld infrared sensors for rapid material analysis, which includes absorption data at different wavelengths. Initially, the data used will be of various types of wine and then possibly expanded to other liquids or solids. Rapid material analysis enables companies to produce quality products safely. The confluence ML and handheld sensors' data is at the center of our approach.

Our goals (in increasing order of complexity):

1. Develop machine learning based calibration models for the portable sensors
    a. Use supervised learning to maximize predictability
    b. Apply data pre-processing to remove noise
    c. Deal with cases in which we have limited data

    d. Deal with outliers and missing data
2. Expand the model across sensors using transfer learning and deep learning
3. Use unsupervised learning (like autoencoders) to develop general purpose algorithms to de-noise and de-correlate input data
4. Combine supervised and unsupervised learning techniques to improve prediction capability