Computer Vision Quality Inspection for Thermo Fisher Scientific

Dale DeFord
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Agenda

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01 Business Problem

Thermo Fisher Scientific (TFS) in Hillsboro OR manufactures Scanning Electron Microscopes (SEM). In production, Liquid Metal Ion Source (LMIS) units are imaged at a SEM and human inspected for quality issues. This process is costly and can be problematic due to varying human biases.

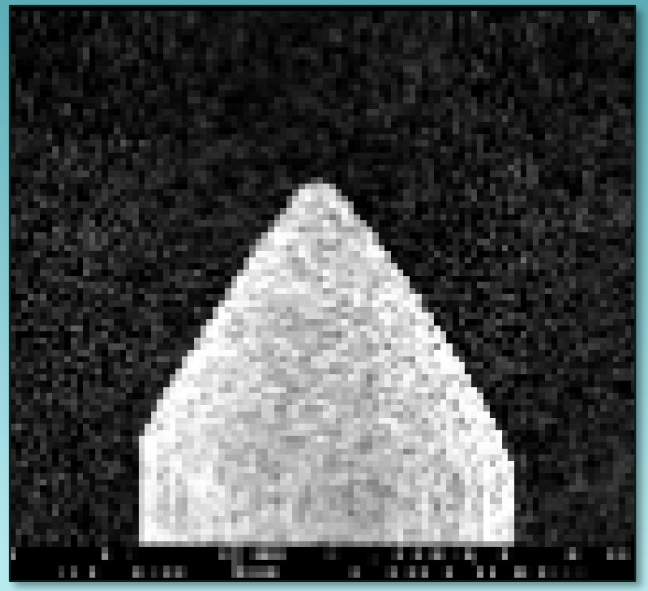
Goal:

- Create an automated Computer Vision process that will accurately classify LMIS SEM images, thus reducing cost incurred in man-hours and quality problems due to varying human inspection biases.

02 Data Analysis

LMIS SEM images were downloaded from TFS under Non-Disclosure Agreement (NDA).

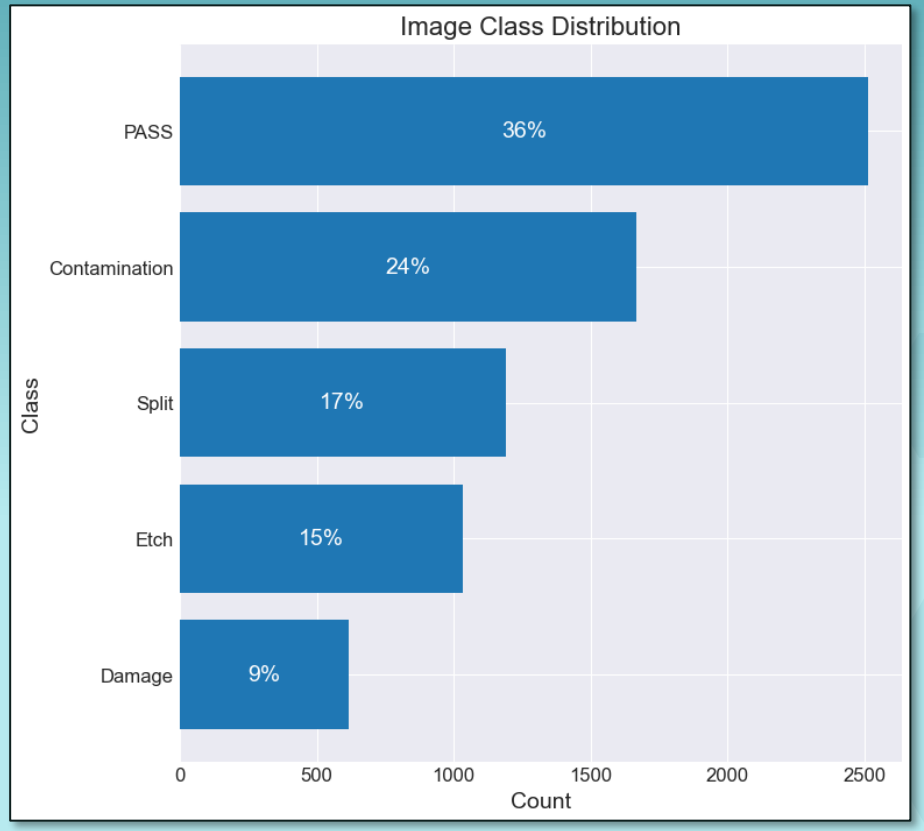
- 7,019 grayscale SEM image files
- Images labeled and sorted into 5 class folders
- Details will be omitted or intentionally vague due to NDA



NOTE: SEM image has been intentionally scaled down to protect intellectual property

Image Data Class Distribution

- NOTE: Many non-PASS images contained features from multiple classes
- Imagine trying to classify CAT vs DOG, and many of your images have a CAT and a DOG!



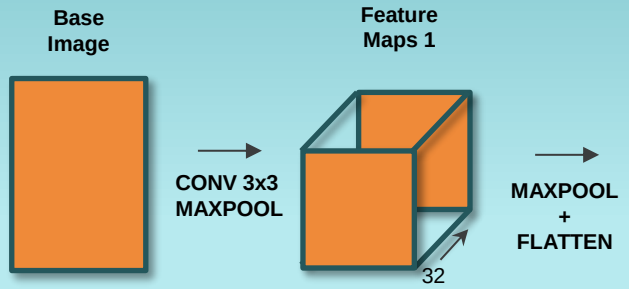
03 Predictive Modeling

BUSINESS REQUIREMENT:

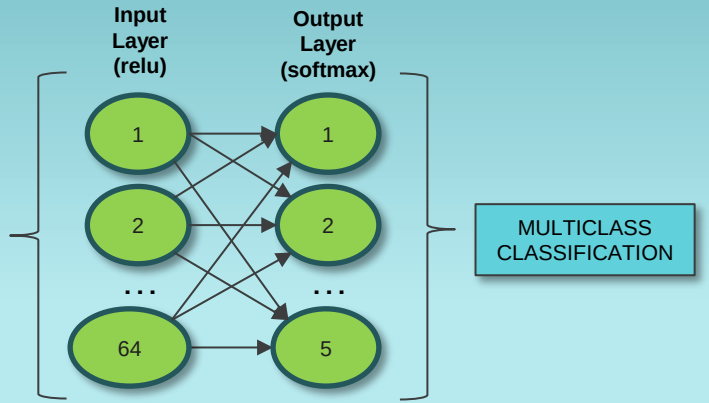
- Minimization of false-positives in the PASS class:
  - Top priority: avoid shipping non-PASS units to the customer.
  - False-Positive rate within PASS class must be < 1%
- Scoring Metric: Accuracy

Baseline CNN Architecture

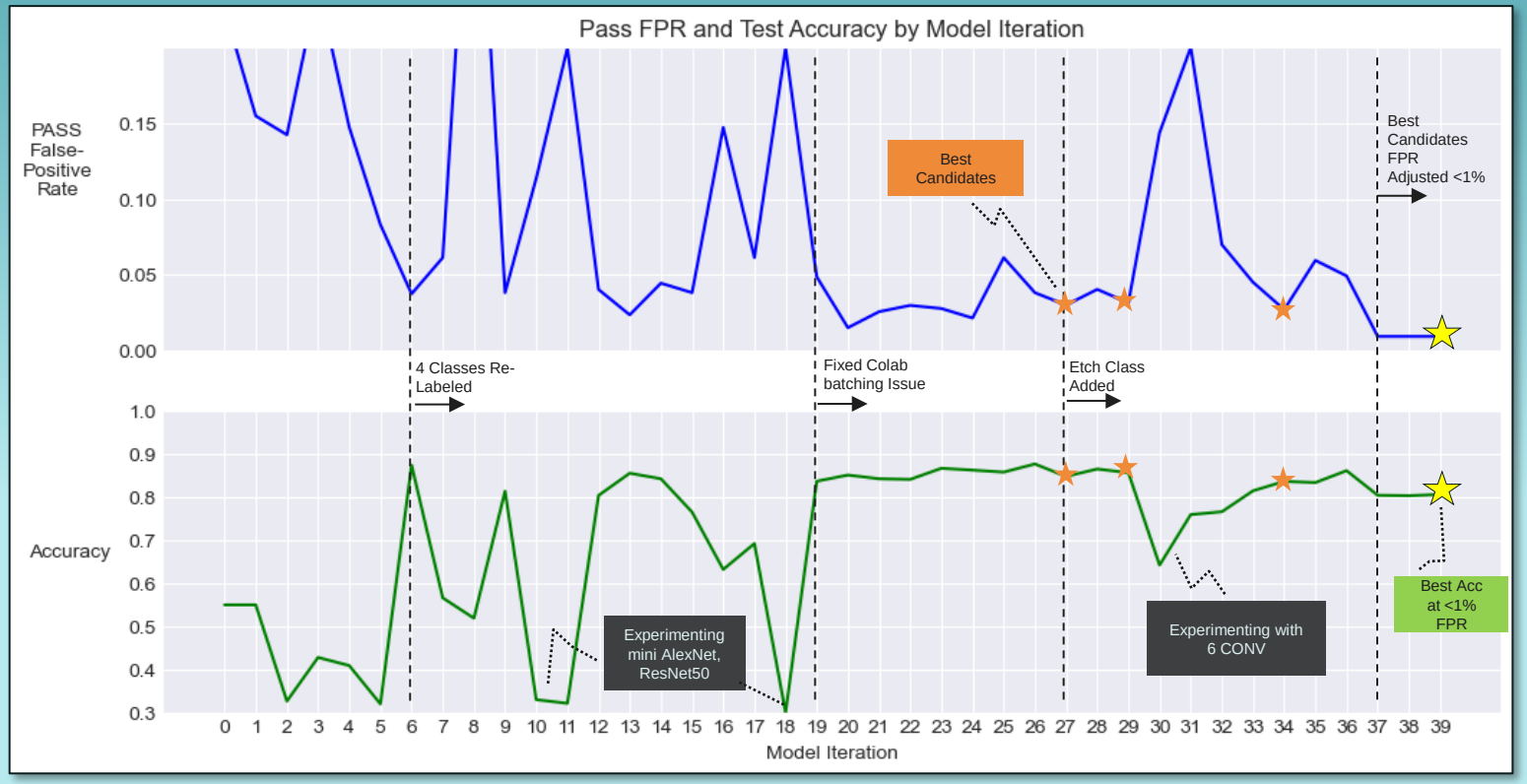
Feature Extraction Architecture:



Classification Architecture:



Model Iteration Trends

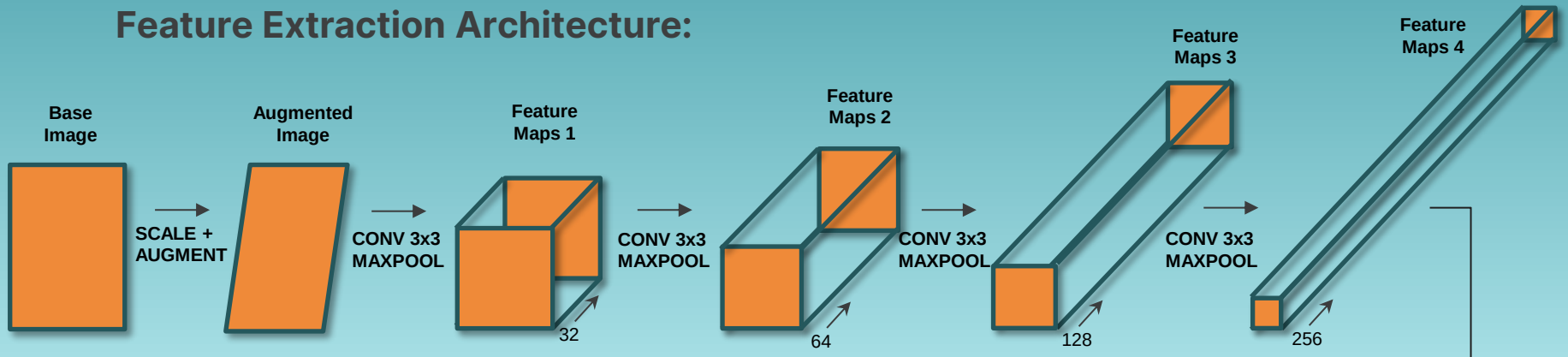


Minimize

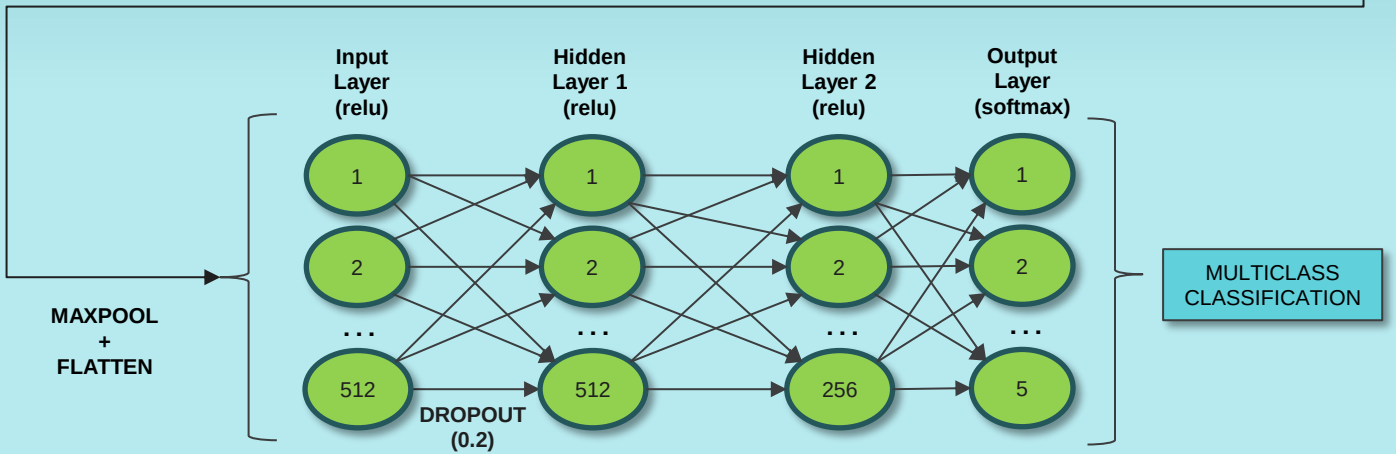
Maximize

Best CNN Architecture

Feature Extraction Architecture:



Classification Architecture:



Best Model Results

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Training Accuracy: 94.2%

Pre-FPR-Adjusted Test Accuracy: 83.5%

FPR-Adjusted Test Accuracy: 80.5%

PASS False-Pos Rate: 0.89%

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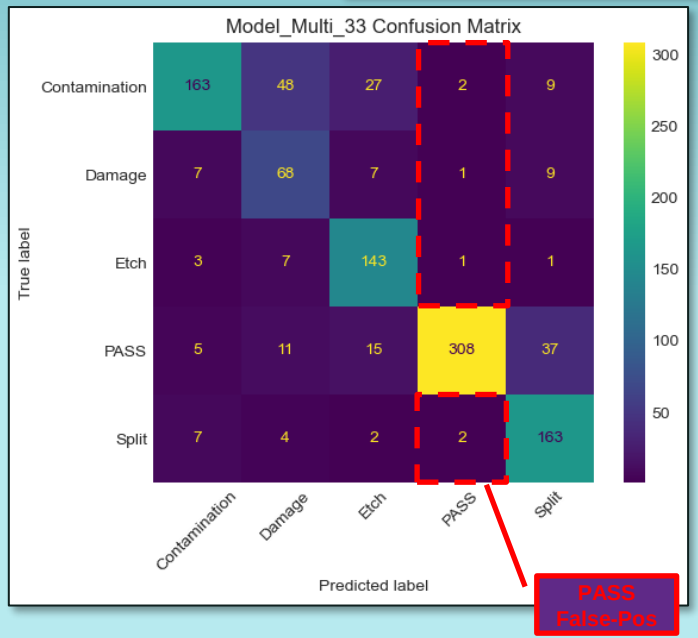
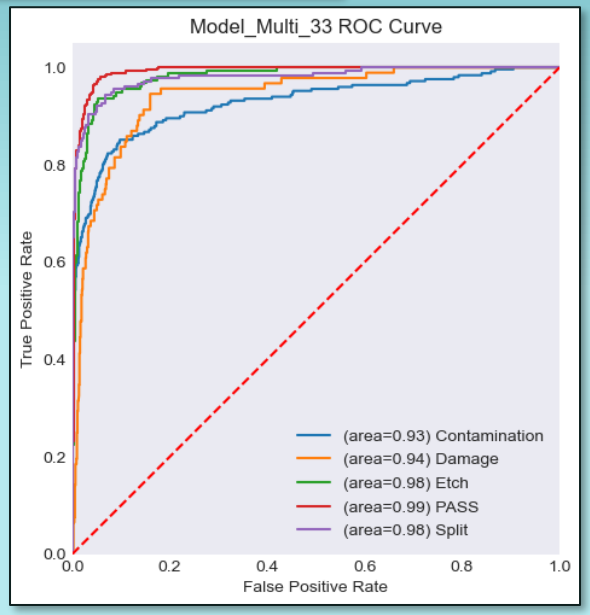
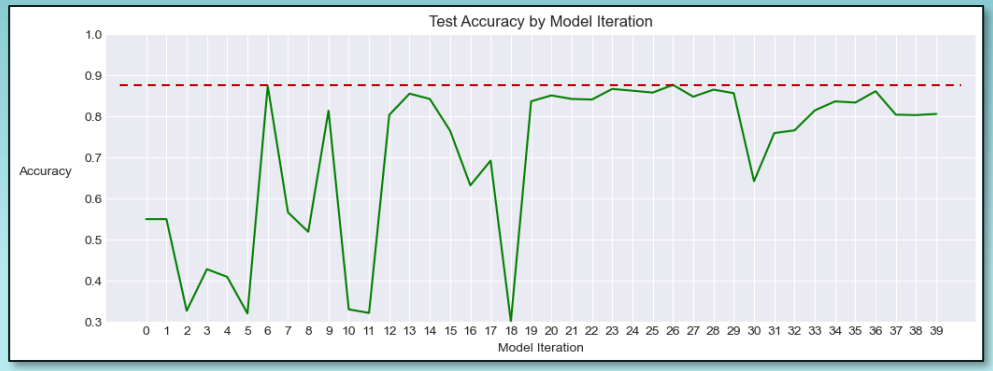




04 Conclusions

1. **Due to limited data sample size and crossover of classification types, model performance was capped at ~84 to 88% categorical accuracy**

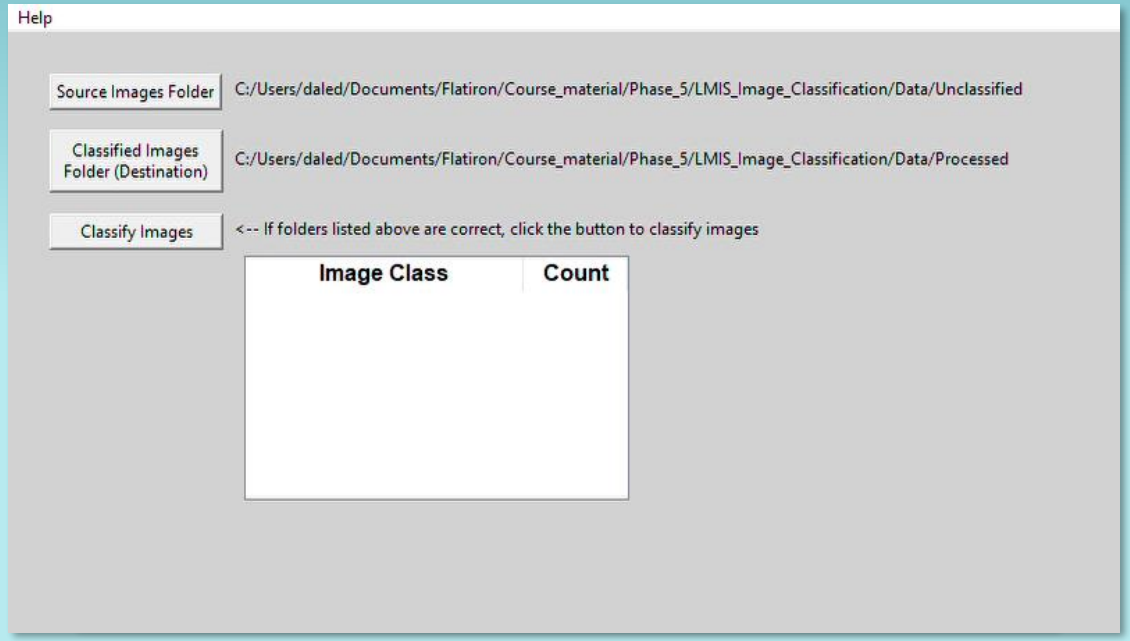


2. **Final Model Metrics:**

   - Accuracy: **80.5%**
   - PASS False-Positive Rate: **0.89%**

05 Recommendation

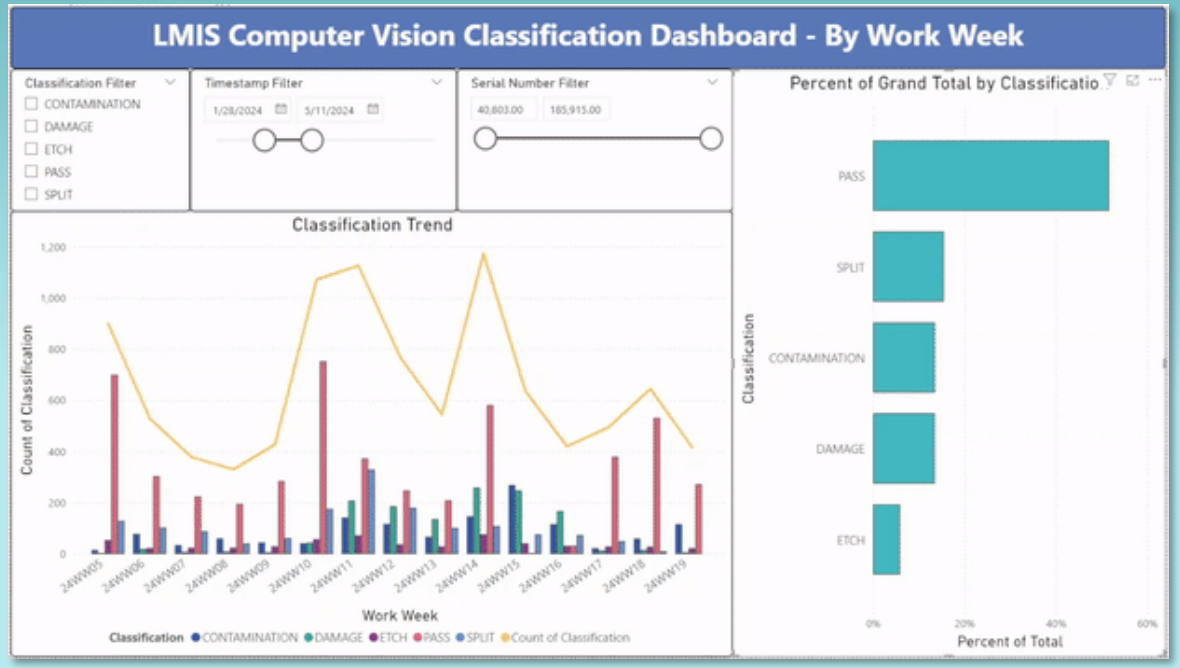
1. Initiate a production pilot evaluation of provided LMIS Image Classification executable and assess its performance vs. human; if accepted then discontinue human inspection of PASS class.



- Runs the best model, sorts images into class folders for human review
- Logs classification results to .cvs file

Recommendation

2. Monitor classification results via provided Power BI dashboard



NOTE: Fictitious data shown, not actual TFS production data

- Pulls production data from the csv log file
- Real-time monitor of classification trends and distributions
- Filter by class, date or unit serial number

06 Next Steps

1. Continue to improve the model:
    a) **Need more data!**
        I. **Subject matter expert labeling of many more images**
        II. **Train with ‘clean’ samples, i.e., no images that could be more than 1 class**

    b) Continue attempting transfer learning architectures, i.e., ResNet50

1. If adequate model accuracy can be achieved, implement another production pilot to eliminate human inspection of all images

Thanks!

Questions? Please contact me at:

Dale DeFord
daledeford@gmail.com