Computer Vision Quality Inspection for Thermo Fisher Scientific

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Agenda

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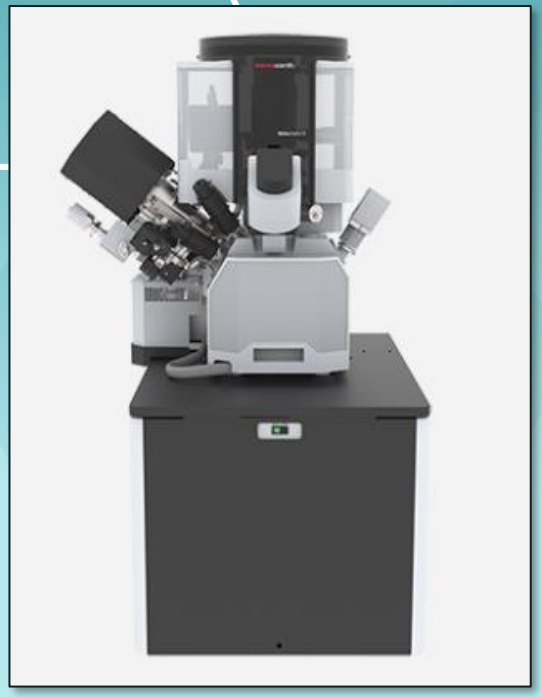
01 Business Problem

Thermo Fisher Scientific (TFS) in Hillsboro OR manufactures cutting edge 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 prone to human error.

Goal:

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

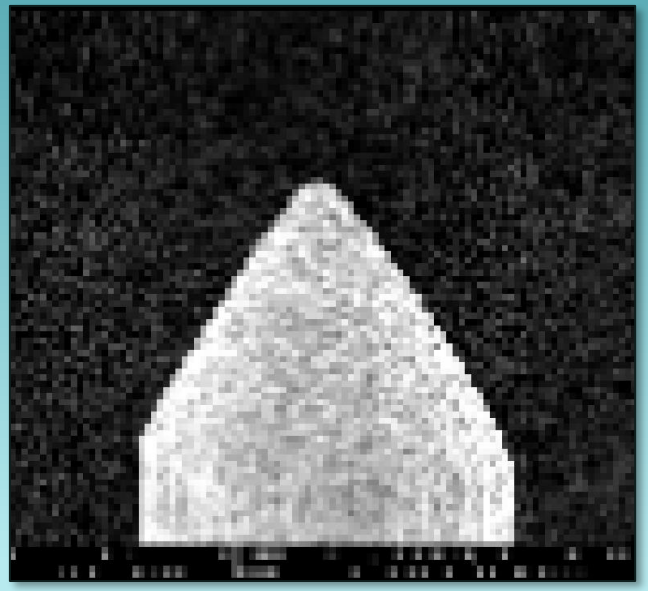


SEM System Manufactured at TFS

02 Data Analysis

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

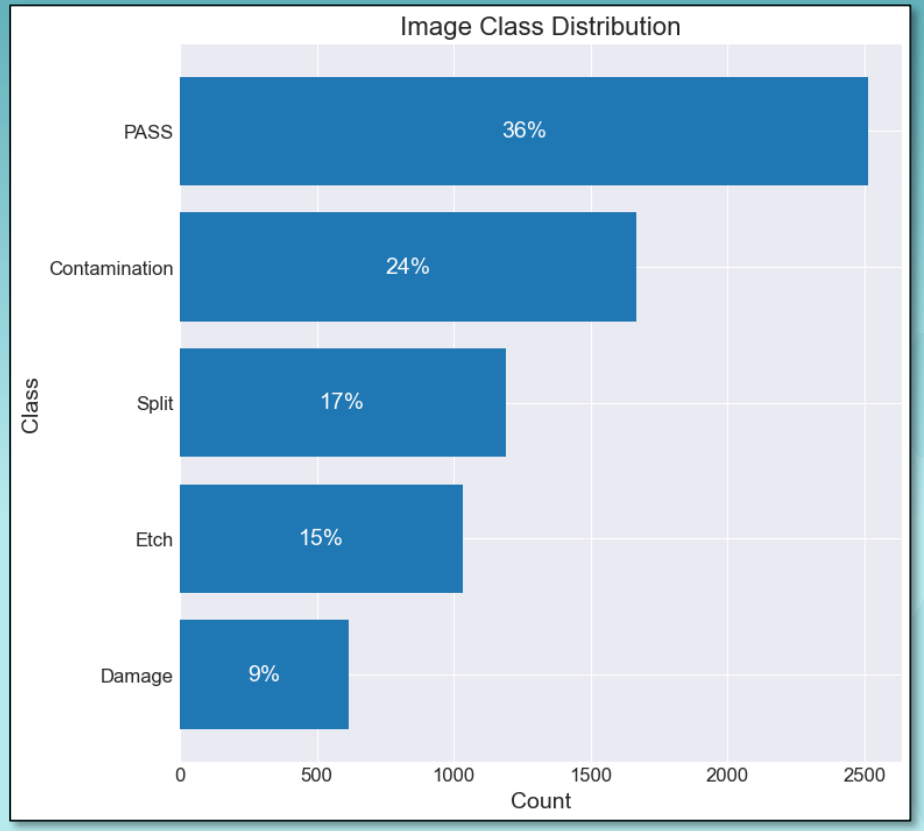
- 7,019 grayscale SEM image files
- Images labeled and sorted into 5 class folders
- Details will be omitted or intentionally vague due to NDA



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!



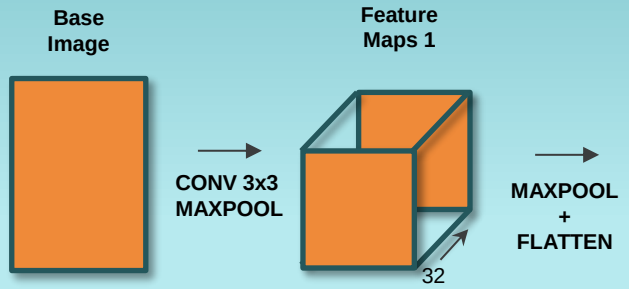
03 Predictive Modeling

BUSINESS REQUIREMENT:

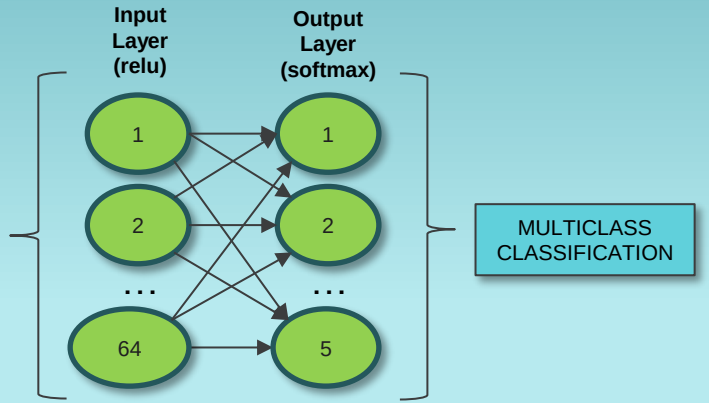
- Minimization of false-positives in the PASS class:
  - Top priority: avoid shipping non-PASS units to the customer.
  - False-Positive rate within PASS class must be < 1%
- Scoring Metric: Accuracy

Baseline CNN Architecture

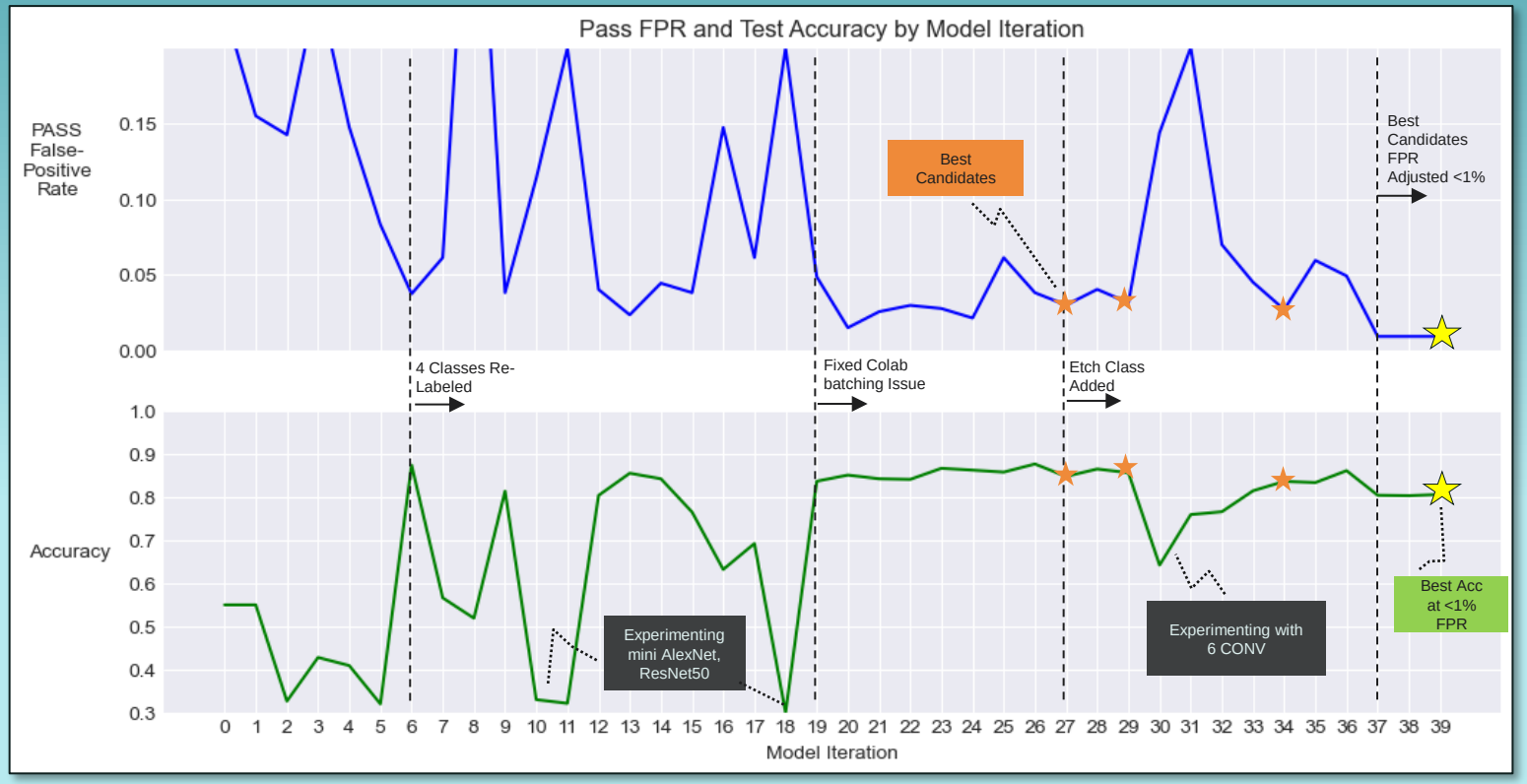
Feature Extraction Architecture:



Classification Architecture:



Model Iteration Trends

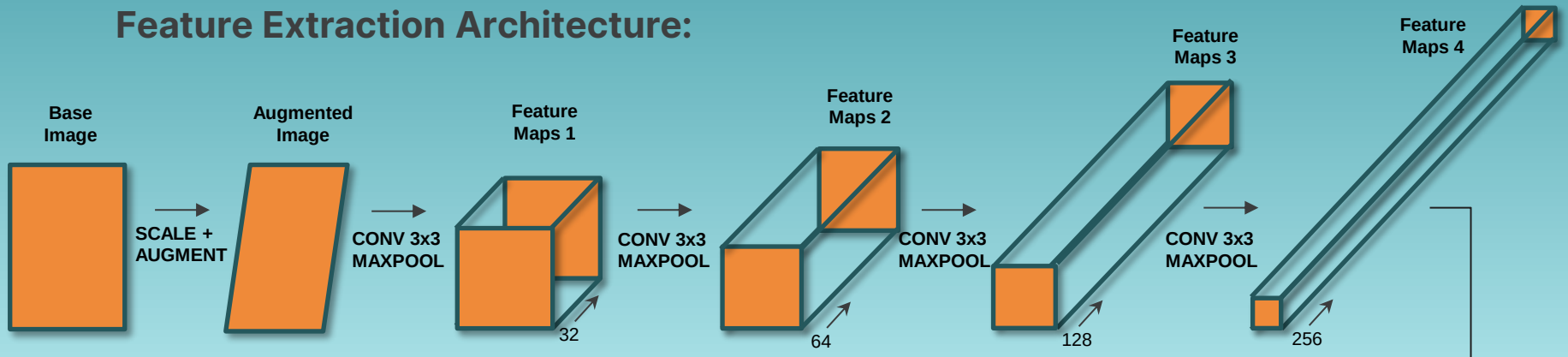


Minimize

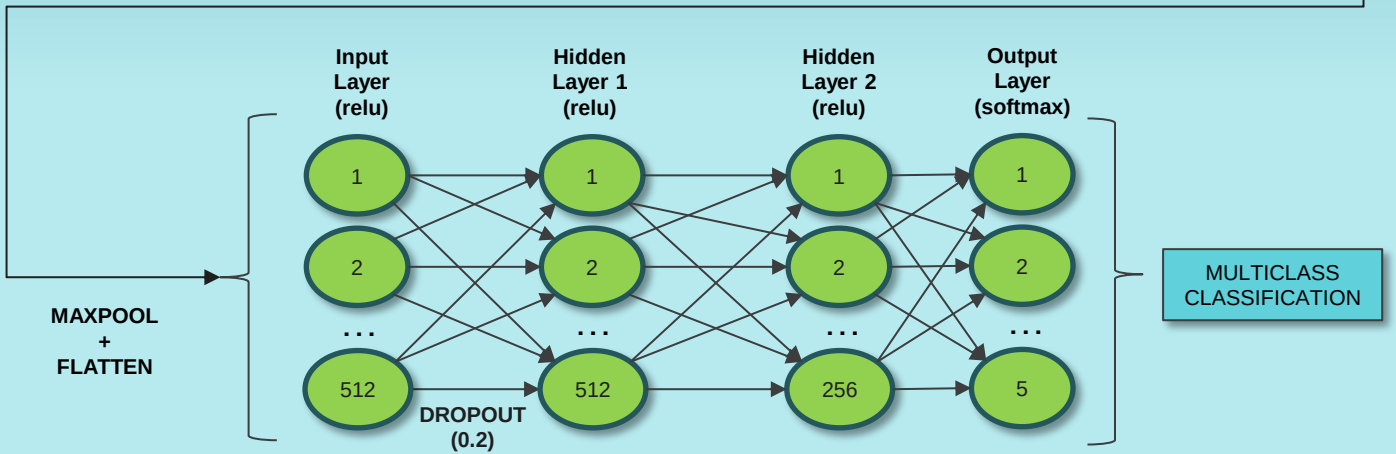
Maximize

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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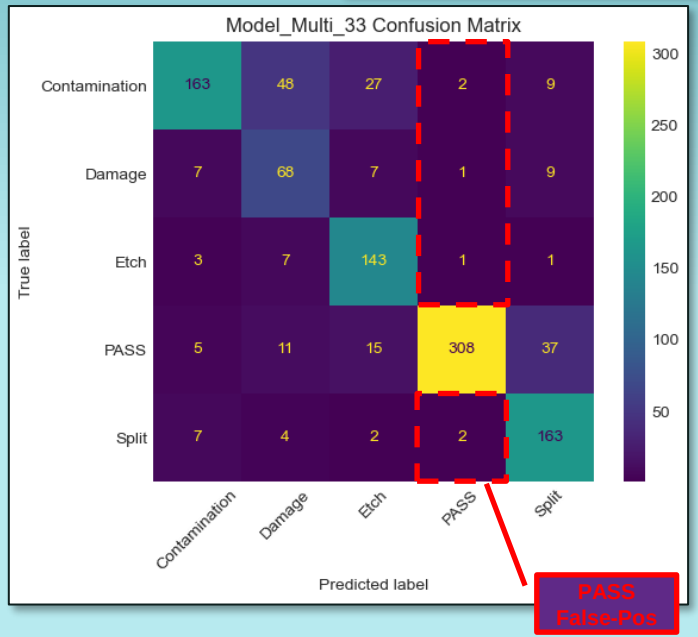
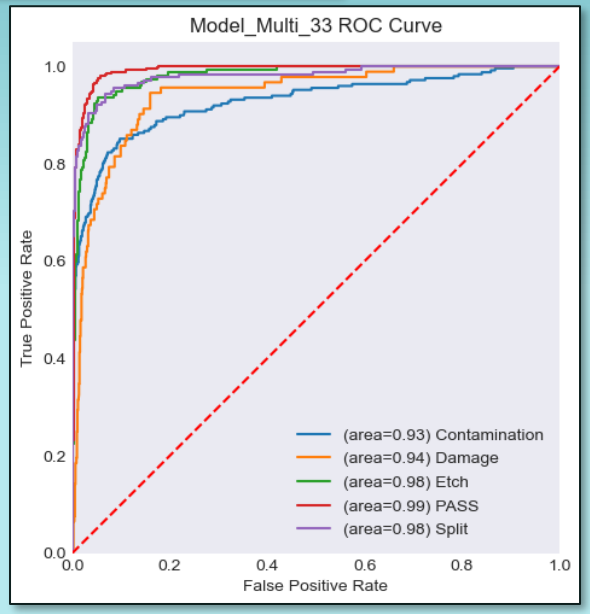
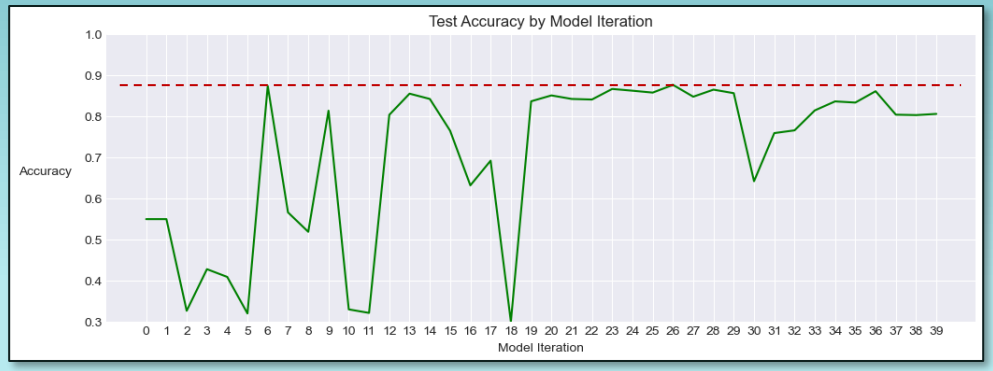




04 Conclusions

1. **Model performance likely capped due to limited data sample size and mixing of non-PASS classification types.**

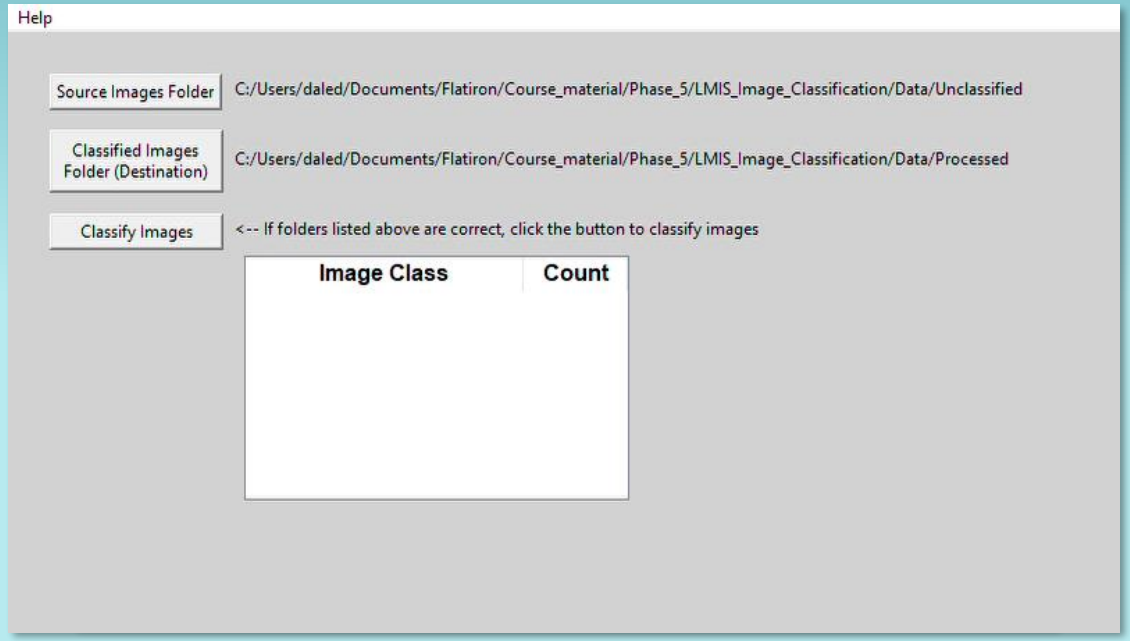


2. **Final Model Metrics:**

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

05 Recommendation

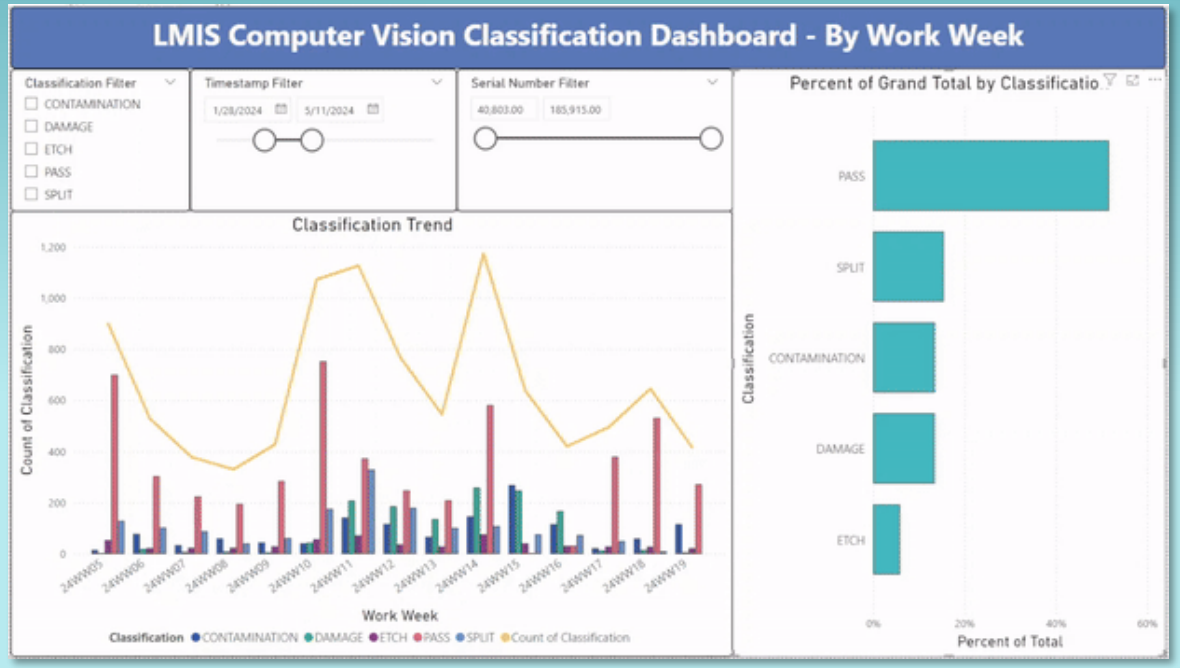
1. Initiate a production pilot evaluation of provided LMIS Image Classification executable and assess its performance vs. human; if accepted then discontinue human inspection of PASS class.



- 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 ~2000 images each class**
        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!

A special thanks to collaborators at TFS:

- Jessica Panther, Manufacturing Engineering Supervisor

- Scott Gibson, Sr Engineering Mgr

Questions? Please contact me at:

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