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Motivation

Develop a model capable of capturing faults in a fermentation batch in real time, to save time and money

Goals

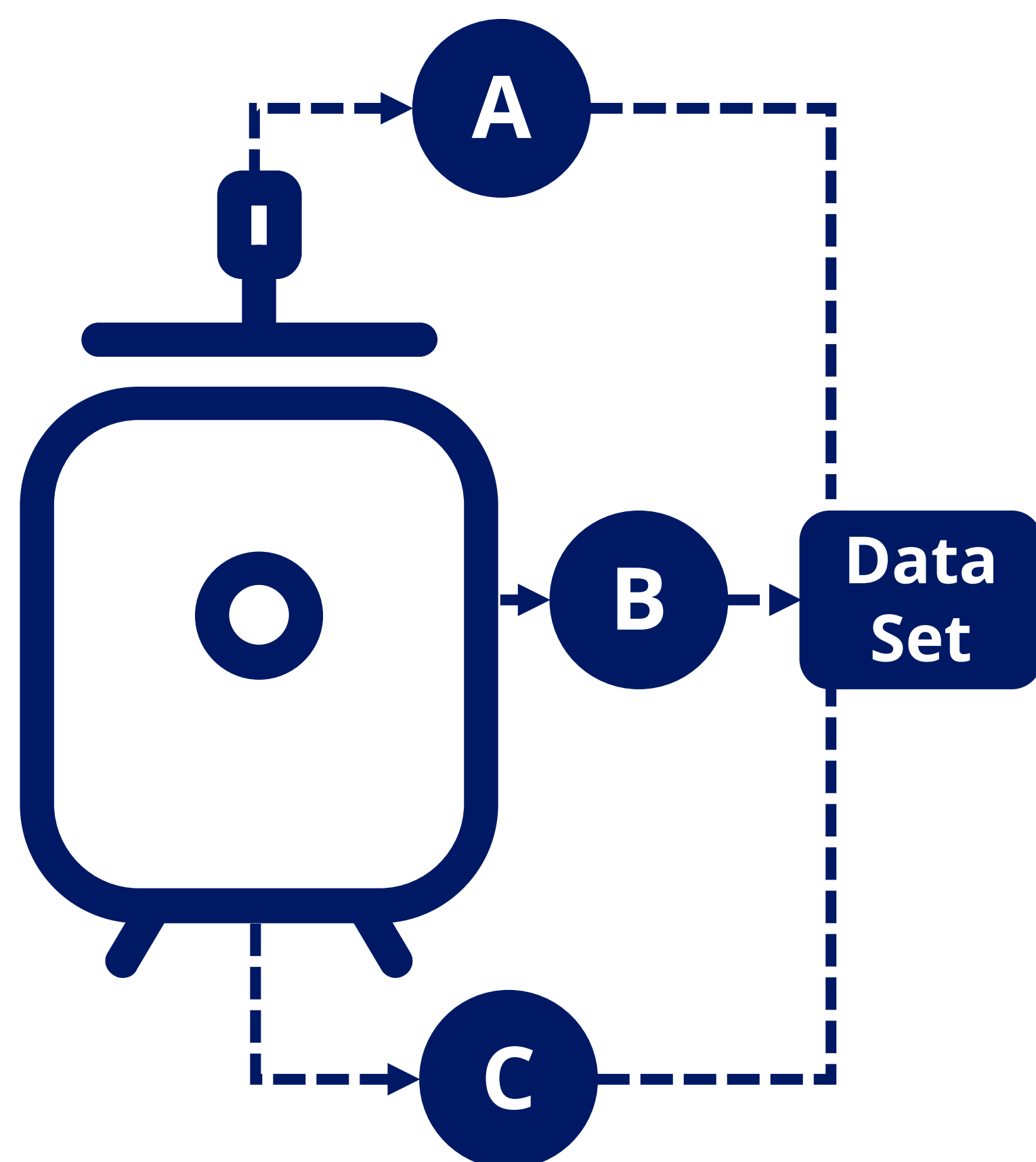
- Gain process understanding
- Explore model types to find best fit for the process
- Create model for main fermenter continuous phase

1. Process Understanding

- Fermentation
- Process Monitoring
- Multivariate Methods
- Variable selection

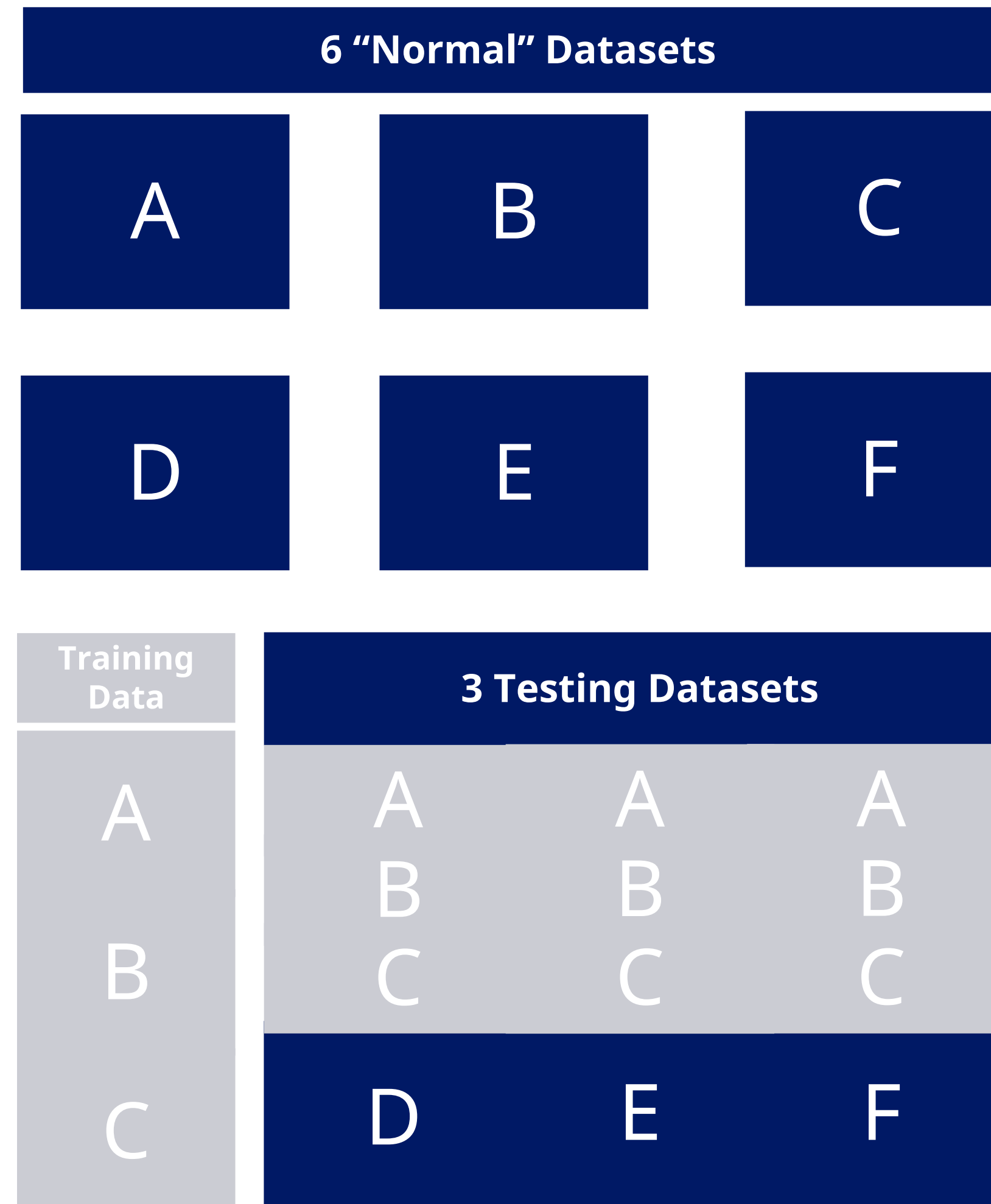
2. Data Analysis

- Deviation investigation
- Process data pulls and curation
- Outlier removal
- Create "normal" datasets



3. Model Development

- Combine three "good batches" to create historical dataset using Principal Component Analysis



4. Model Validation

- Test batches with no known faults against historical dataset
- Test batches with known faults to determine model effectiveness

5. Model Application

- Next step: implement model for real time process monitoring

8 Principal Component Scree Plot

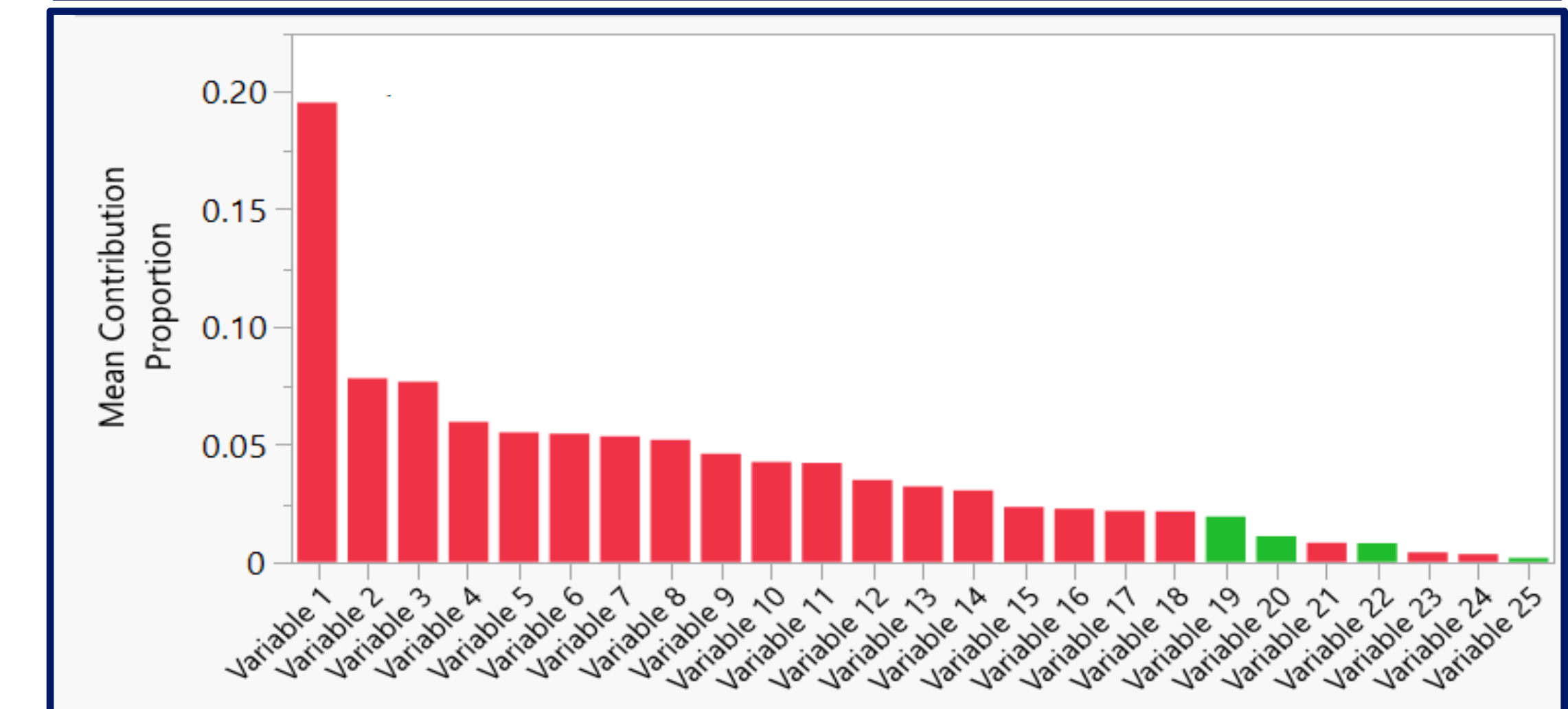
Number	Eigenvalue	Percent	20	40	60	80	Cum Percent
1	6.9080	27.632					27.632
2	4.8294	19.318					46.950
3	1.8143	7.257					54.207
4	1.4441	5.776					59.983
5	1.2639	5.056					65.039
6	1.1529	4.611					69.651
7	1.1204	4.482					74.132
8	1.0107	4.043					78.175

Economics

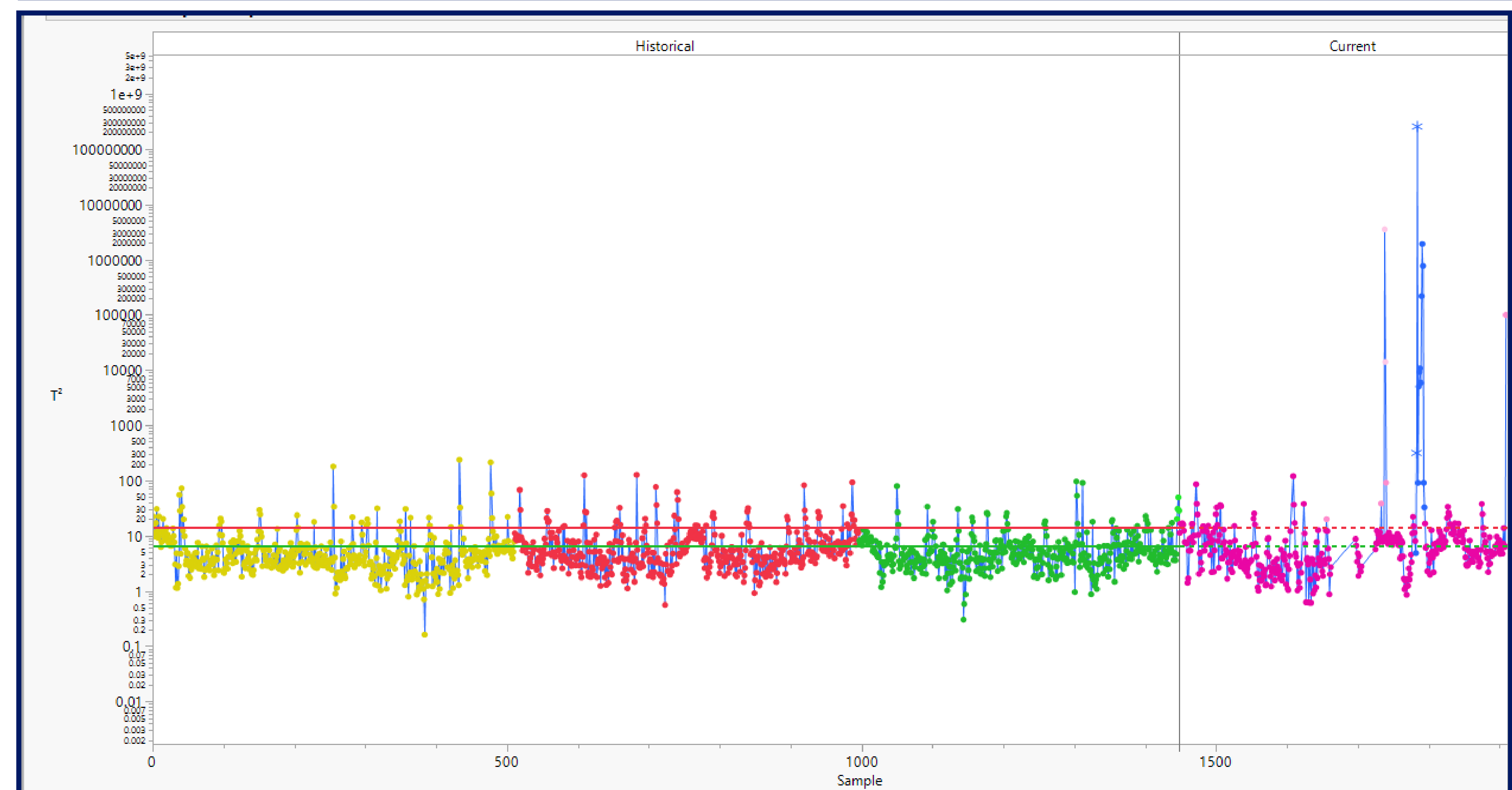
Model aims to prevent lost revenue from failed batches. In a hypothetical scenario, if the model saves one batch/year

Metrics per Batch	Value
Cost of Raw Materials	X
Value of Batch	6.7x
Value Gained via Model	0.17x
Potential Value Saved/Year	3%

Mean Contribution Plot For Faulty Data Point



Main Fermenter Multivariate T² Control Chart



Conclusion

- Model was effective at identifying issues in batches where values deviated from the norm
- Unable to capture infections due to time required for it to affect process variables
- Principal Component Analysis (PCA) with 8 PCs was determined a viable approach
- Higher alpha values give higher false alarm rates, but capture more faults, our team recommends an alpha value between 0.005 and 0.001
- This process should be investigated further for other phases and fermenters outside the main fermenter via an Auto-Regressive or Kernel PCA model

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