The Data Revolution Within Electronics Manufacturing: Digitization + AI/ML

Ryan Gamble
Intraratio Corporation

rgamble@intraratio.com
858 324-1051

©2024 INTRARATIO CORPORATION

Agenda

- Introduction: Digitization + AI/ML
- AI/ML In Manufacturing
- Manufacturing Data Infrastructure For AI/ML
- AI/ML Data Flow
- Getting AI/ML Into Production
- Real ML Application: Outlier Detection
- Path To Advanced AI/ML Predictions
- Summary & Case Studies
- Q & A

©2024 Intraratio Corporation

Introduction: Digitization + AI/ML

- **Factory Digitization:**
  - Real-time data capture, contextual data storage
  - Reporting / advanced analytics
- **Data sources:**
  - Machines: assembly, test, AOI, AXI, etc.
  - Sensors: environment, power & vibration monitors, etc.
  - People: scanners, manual data entry
  - Suppliers: inventory registrations, conformance reports
- **AI/ML requires contextual data**

©2024 Intraratio Corporation

AI/ML In Manufacturing

- **What's driving this?**
  - Increasing design and manufacturing complexity
  - Higher quality and reliability requirements
  - Supply chain traceability, risk mitigation
  - Talent shortages, voluntary exits, knowledge transference
  - Competition: Talent, Price and Time to market
- **Requirements to Implement:**
  - Data infrastructure
  - Skilled personnel or vendor
  - Planning: practical with clear goals and milestones

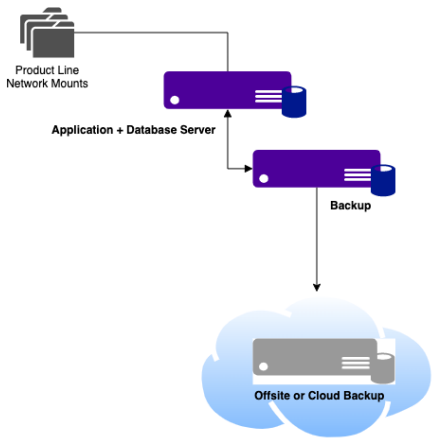
©2024 Intraratio Corporation

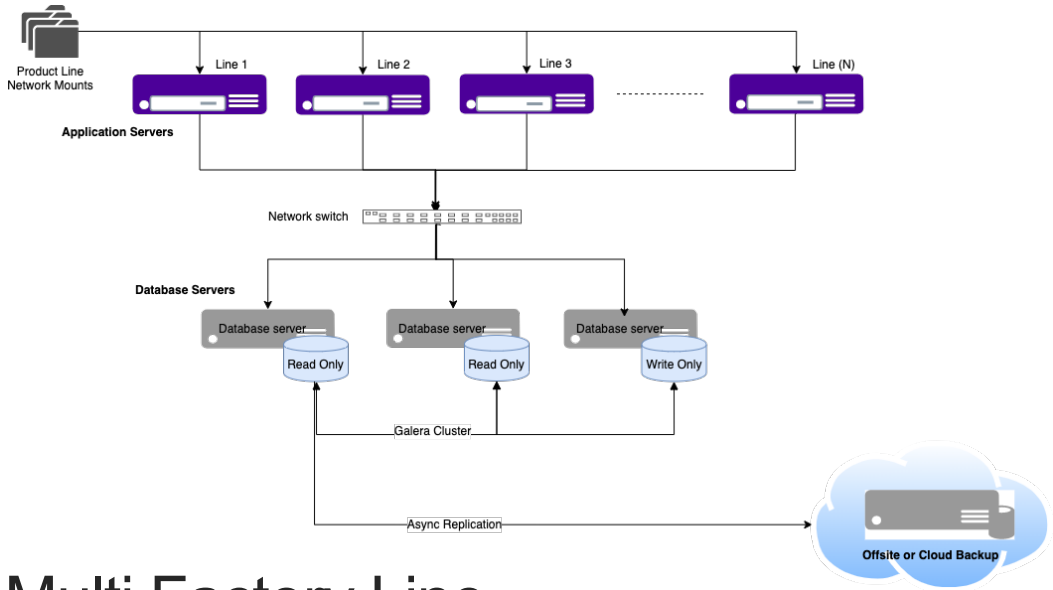
Manufacturing Data Infrastructure For AI/ML

- Ensure data infrastructure is robust + well structured
  - Unstructured data storage solutions are a contradiction in manufacturing, resulting is excessive cost and high risk of failure
  - Cloud deployments become expensive quickly (data I/O, CPU)
- Prioritize Open-Source based technology solutions
  - Accessible, low cost, rapidly deployable on premise, scaleable
  - Vetted by millions, rich sources of documentation + support
- Ensure collection of both transactional and parametric data is supported (MES + IoT, Test, Inspection, etc.)

©2024 Intraratio Corporation

Ex. Open Source Infrastructure

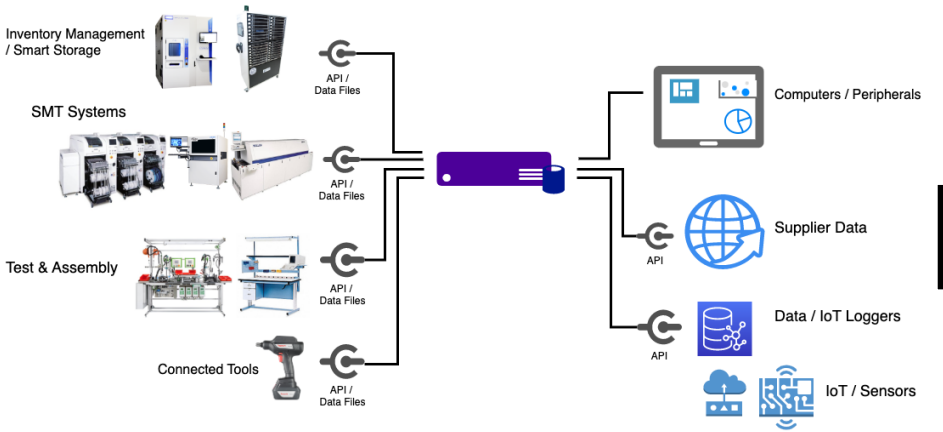




Open-Source: Single To Multi Factory Line
Same Hardware + Software!

©2024 Intraratio Corporation

Ex. Contextualized Data Storage



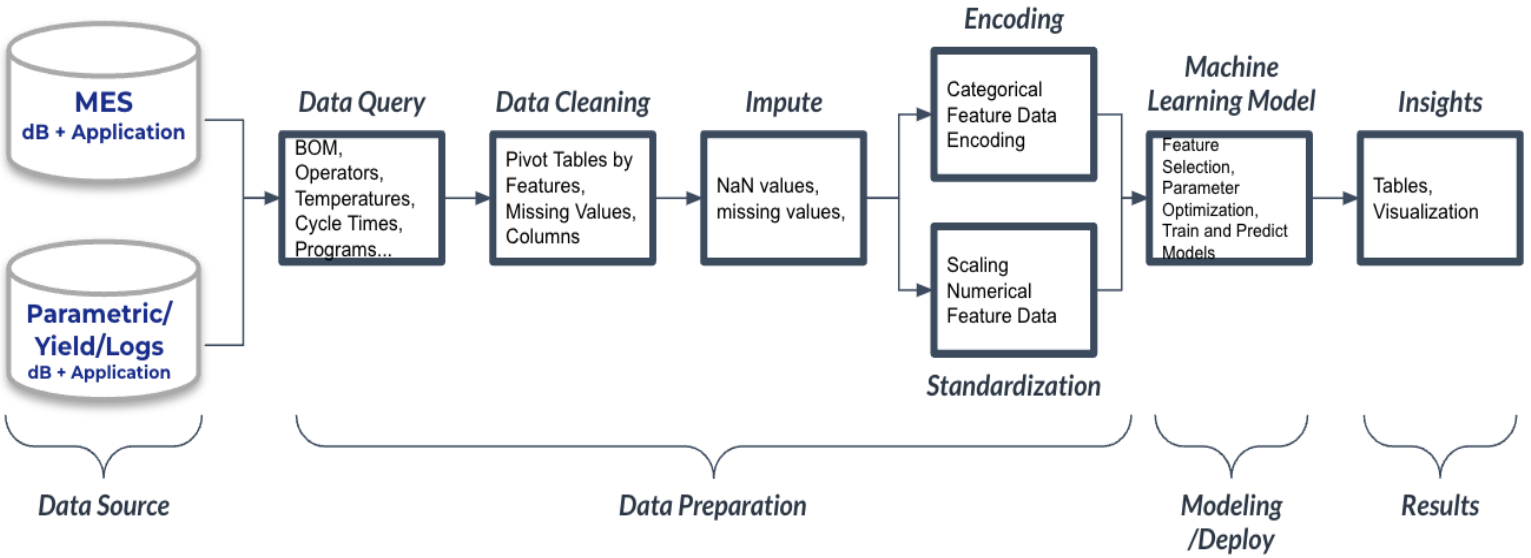
©2024 Intraratio Corporation

AI/ML Data Flow

- ML algorithms are sensitive to the quality of the data
  - Missing values require imputation (replacement) or removal
  - Data transformations often needed in order to feed into specific ML models
  - Categorical data requires encoding (numerical)
- The complexity (and cost) of this undertaking is a function of how contextualized and properly catalogued your data is

©2024 Intraratio Corporation

AI/ML Data Flow: Example



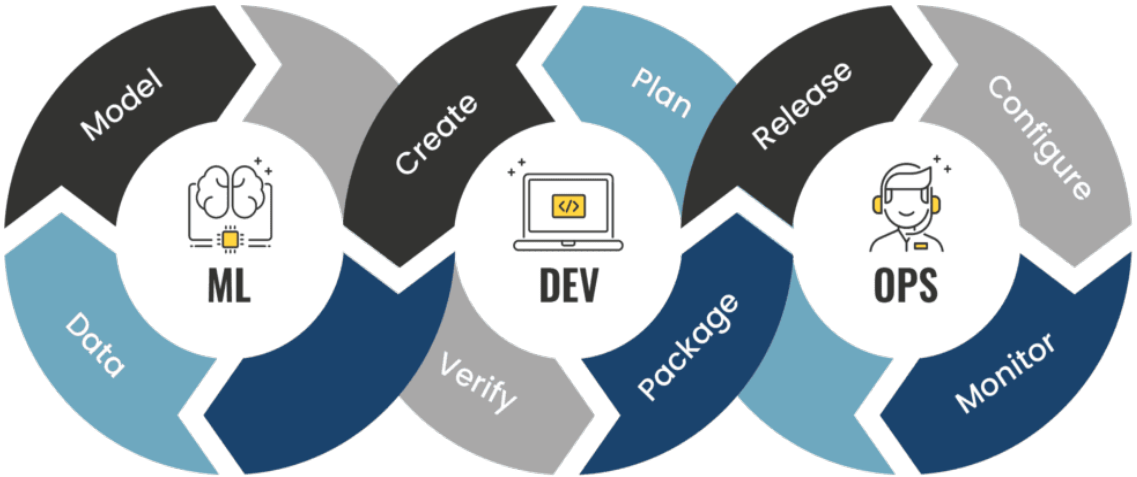
©2024 Intraratio Corporation

Getting AI/ML Into Production

- **Key challenges:**
  - **Adapting to shifting data patterns: ex. BOM item changes**
  - **Managing large data sets**
  - **Security and integrity of the data**
  - **Continuous monitoring and maintenance of ML model performance and accuracy**
  - **Deployment options: finding the right technology solutions and/or vendor**

©2024 Intraratio Corporation

ML Model Deployment Overview



©2024 Intraratio Corporation

ML Application: Outlier Detection

- Well suited for identifying likely causes of scrap
- Transaction and parametric data can be utilized
- Unsupervised learning: applicable, quick to deploy
- Results can be categorized per the 6 M's
  - *Manpower* (Workforce): operator IDs (training), work shift, time
  - *Machine*: equipment ID, type, maintenance records
  - *Material*: lot or batch ID, supplier, exp. date, MSD level
  - Method: recipe or program, rework events
  - Measurement: machine or tester results, inspection, calibration
  - Mother Nature: temperature, humidity, particle sensor readings

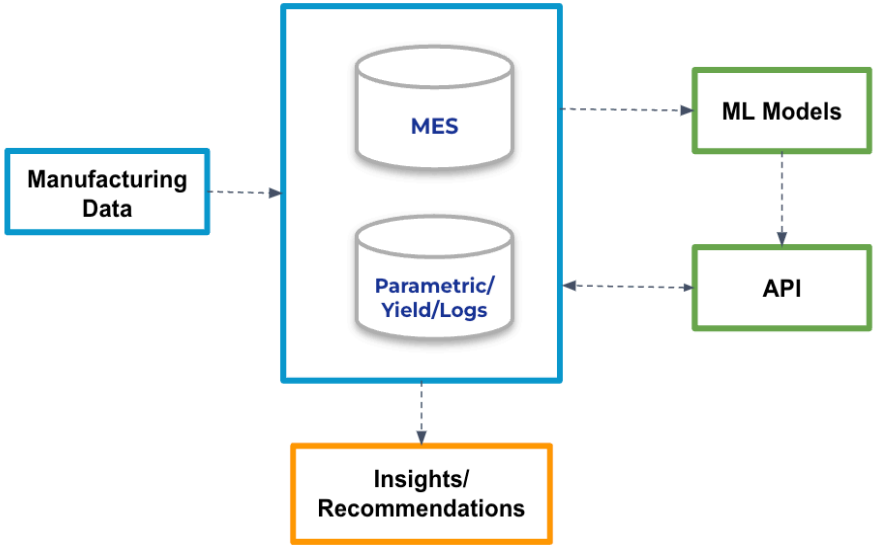
©2024 Intraratio Corporation

Path To Advanced AI/ML Predictions

- Outlier Detection models: rapid ROI
- Predictive models: more work to train, very powerful, yielding further ROI
  - Predictive machine maintenance
  - Forecasting scrap failures, supply chain disruptions, etc.
- Ensure collection of both transactional and parametric data is supported (MES + IoT, Test, Inspection)
- Importance of data quality cannot be overstated

©2024 Intraratio Corporation

ML Production Deployment



©2024 Intraratio Corporation

Summary

- AI/ML in a manufacturing environment is established and accessible
- Requirements to achieve:
  - Robust, scalable and secure data infrastructure
  - Highly contextual and well catalogued data
  - Skilled personnel or vendor with deep understanding of manufacturing data
  - Planning: practical, clear goals and milestones
  - Commitment
- Results in significant competitive advantages

©2024 Intraratio Corporation

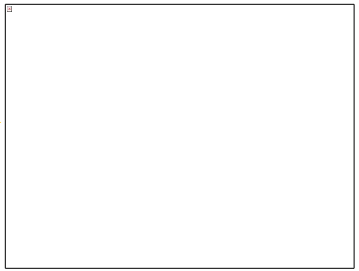
Case Study: ML applied to SMT Work Order

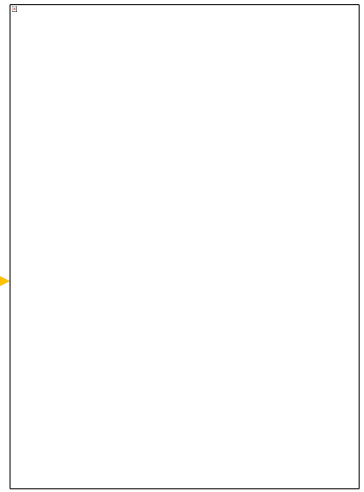
7184 PCBAs Produced

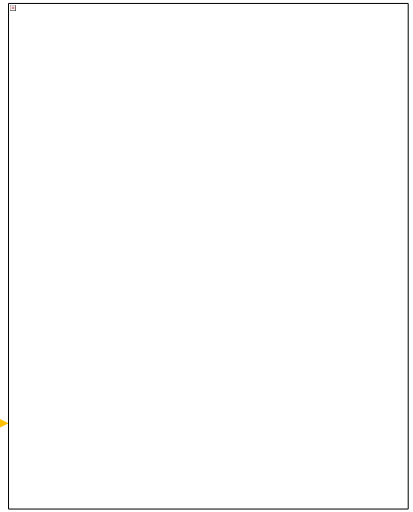
Component lot changes observed for:
54 boards: different lot for PN 64630
8 boards: different lot for PN 82620

Additional actions / transactions observed for:
15 boards at AXI
8 boards at conformal coat
8 boards at solder print side#1
50 boards at SPI
48 boards at Reflow
16 boards at solder print side#2

Parametric shifts observed for:
Reflow Oven - thermal shifts identified for up to 26 boards



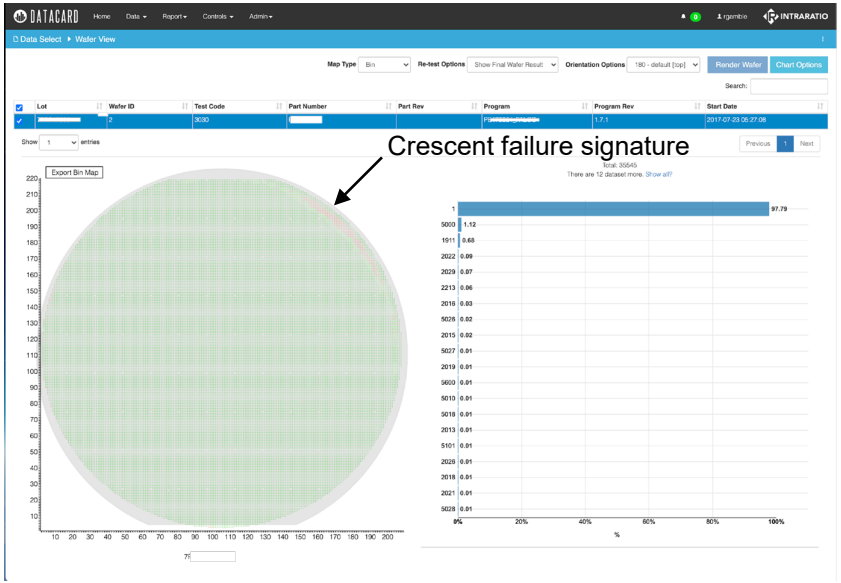




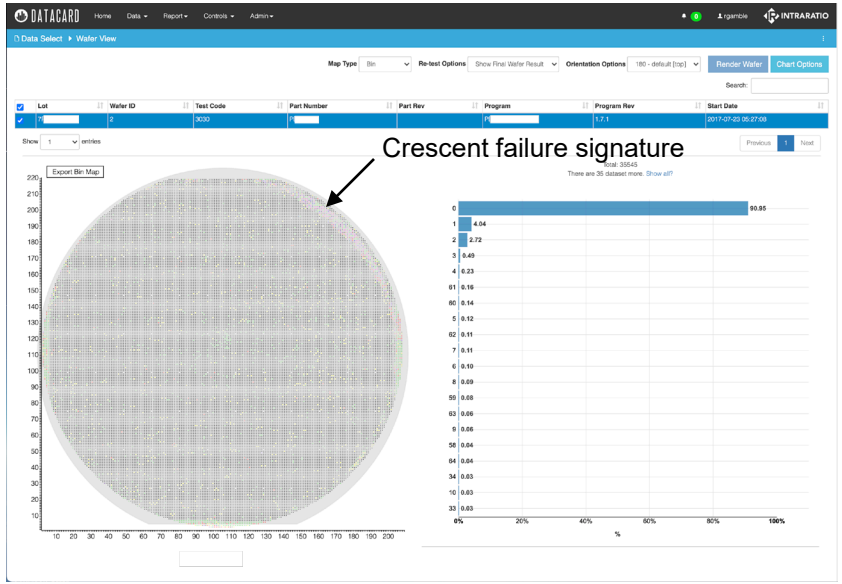
©2024 Intraratio Corporation

Case Study: ML applied to wafer test data

Original Test Results



ML (Outlier Detection) Results



©2024 Intraratio Corporation

Q & A

©2024 Intraratio Corporation

THANK YOU!

Ryan Gamble

CEO | Founder, Intraratio Corporation
rgamble@intraratio.com
858 324-1051

©2024 Intraratio Corporation