Leveraging AI for Industrial IoT

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Level Set

Data → Machine Learning & Artificial Intelligence → Outcomes
AI/ML Algorithms

- Rule Based AI
- "Traditional" Machine Learning: SVMs, Random Forests, etc.
- Deep Learning: CNN, RNN, LSTM, etc.

Compute

Accuracy

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Example – Fraud Detection

Credit Card Transactions → Rule Based, Anomaly Detection → Flag Credit Card Fraud

Transaction Data, Descriptive
Example – Churn Prediction

Activity, Behavioral Data → Classification Techniques → Predict the probability of losing a customer

Transaction/Social Media Data, Predictive
Example – Product Recommendation

Collaborative Filtering

Social Media Data

Recommend ads, products, movies, etc.

Social Media Data, Prescriptive
Example – Autonomous Vehicles

Video, Lidar, etc. → Deep Neural Nets → Self Driving Cars

Sensor Data, Autonomous
## Impact

<table>
<thead>
<tr>
<th>Category</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Products &amp; Services</strong></td>
<td>Personalization of Services, Automation in Products</td>
</tr>
<tr>
<td><strong>Sales</strong></td>
<td>Up Sell, Cross Sell, Customer Retention</td>
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<tr>
<td><strong>Marketing</strong></td>
<td>Micro campaigns, Targeted Advertising</td>
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<tr>
<td><strong>Customer Support</strong></td>
<td>Fielding Service/Support Calls</td>
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<tr>
<td><strong>Human Resource</strong></td>
<td>Talent Acquisition &amp; Retention</td>
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<tr>
<td><strong>Operational</strong></td>
<td>...</td>
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Industrial IoT
Industrial Analytics

- Increase Asset Availability
- Increase Asset Utilization
- Improve Product Quality
- Increase Safety & Reliability of Operations
- Reduce Operations and Maintenance Cost
- Enhanced Operational Control & Planning
<table>
<thead>
<tr>
<th>Analytics</th>
<th>Maintenance</th>
<th>Operations</th>
<th>Quality</th>
</tr>
</thead>
</table>
| **Descriptive** | 1. Equipment Monitoring  
2. Performance Analytics  
3. Maintenance Analytics  
4. Equipment Failure Root Cause Analysis | 1. Operations Monitoring  
2. Characterize Process  
3. Operator Behavior  
4. Operation Failure Root Cause Analysis | 1. Quality Monitoring  
2. Testing Process Monitoring & Evaluation  
3. Detect Quality Loss  
4. Defect Root Cause Analysis |
| **Predictive** | 1. Predict Failures  
2. Estimate RUL  
3. Predict Failure Impact | 1. Predict Activity Time  
2. Predict Production KPI(s)  
3. Demand Forecasting  
4. Supply Chain Disruption | 1. Early Defect Detection  
2. Yield Quality Predict. |
| **Prescriptive** | 1. Reduce Failure Cost  
2. Reduce Failure Rate  
3. Repair Recommendation  
4. Optimize Maintenance | 1. Failure Rate Reduction  
2. Fuel/Energy Reduction  
3. Equipment Scheduling and Dynamic Dispatch  
2. Improve Testing |
Example – Maintenance Effectiveness Estimation

Determine the effectiveness of each maintenance activity, vendor, practice, etc. to improve maintenance operations.

Sensor Data, Descriptive
Example – Operator Profiling

Characterize the efficiency, safety of operator behavior to improve operations

Operations

Sensor Data/Video Data, Descriptive

Feature extraction

Machine Learning Data Model

Operator Behavior Profiling

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Example – Quality Test Failure Prediction

Predict failures earlier in process

Sensor Data, Predictive
Example – Repair Recommendation

Recommend the correct repair to reduce repair mistakes and cost of repairs.

- **Symptom (Free text)**
- **NLP**
- **Machine Learning**
- **Data Model**
- **Historical repair data**
- **Sensor/Maintenance Data, Prescriptive**

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Example – Mining Operations

Improve OEE for mining operations with automated dispatching

Operational/Simulation Data, Autonomous
Next Stage of Industrial AI

**Value of Insights = Business Impact**

- **Prescriptive Analytics**
  - Recommendation of best action
  - Maintenance Recommendation
  - Operating Envelope Recommendation

- **Predictive Analytics**
  - A view of the future
  - Failure Prediction
  - Activity Time Prediction
  - Batch Quality Prediction

- **Descriptive Analytics**
  - Insights on the present
  - Performance Monitoring
  - Operations Monitoring
  - Quality Monitoring

**Prescriptive analytics × AI Driven Control**

**Total Operation Optimization & Automation**

**Scope of Control**

- Individual
- Fleets
- End-to-end

**Predictive Maintenance**
**Operations Optimization**
**Quality Improvement**
Next Stage of Industrial AI

Al Driven
Control

Recommend actions to achieve multi-objective optimization with machine learning, AI, and simulation

Connected Industries

Geographically distributed production systems

Material
Equipment
Process
Product

Supply Chain & Logistics

Up to 85%

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Next Steps and Conclusions
Complexity of Automation

- Control (secs – mins)
- Operations (mins – days)
- Strategy (days – months)

Enterprise

AI/ML

Number of sub-components

Complexity of Automation

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Cost Tradeoffs

Failure Prediction: Accuracy-Gain tradeoff

- Failure Cost
- False Alarm Cost
- Total Cost

No Solution | Solution #1 | Solution #2 | Solution #3 | Solution #4 | Solution #5 | Solution #6
---|---|---|---|---|---|---
Cost | $0 | $20,000 | $40,000 | $60,000 | $80,000 | $100,000

Performance Degradation Detection: Accuracy-Latency tradeoff

- Degradation Cost
- Detection Error Cost
- Total Cost

No Solution | Solution #1 | Solution #2 | Solution #3 | Solution #4 | Solution #5 | Solution #6 | Solution #7 | Solution #8 | Solution #9
---|---|---|---|---|---|---|---|---|---
Cost | $0 | $20,000 | $40,000 | $60,000 | $80,000 | $100,000 | $120,000 | $140,000 | $160,000

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In Conclusion

“…I am very optimistic about the eventual outcome of the work on machine solution of intellectual problems. Within our lifetime machines may surpass us in general intelligence….”

– Marvin Minsky, 1967

It’s difficult to make predictions especially about the future
Thank You
NEXT 2017
LEAD WHAT'S NEXT