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“Stay in Your Lane, Dude”

Automating Industry Processes using AI/ML

RIC Session: “Am I a Robot? – How Artificial Intelligence and Machine Learning Are Impacting the NRC and Nuclear Industry”

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Constellation Energy Generation

Stay in Your Lane, Dude … levels of autonomy

- **The algorithm does not need to be fully autonomous for condition report and work request screening applications**
- **Analogous to mid-level automotive autonomy (cruise control, lane keeping) … mission critical decisions under manual control**
- **Constellation applications are designed to keep subject matter experts engaged**

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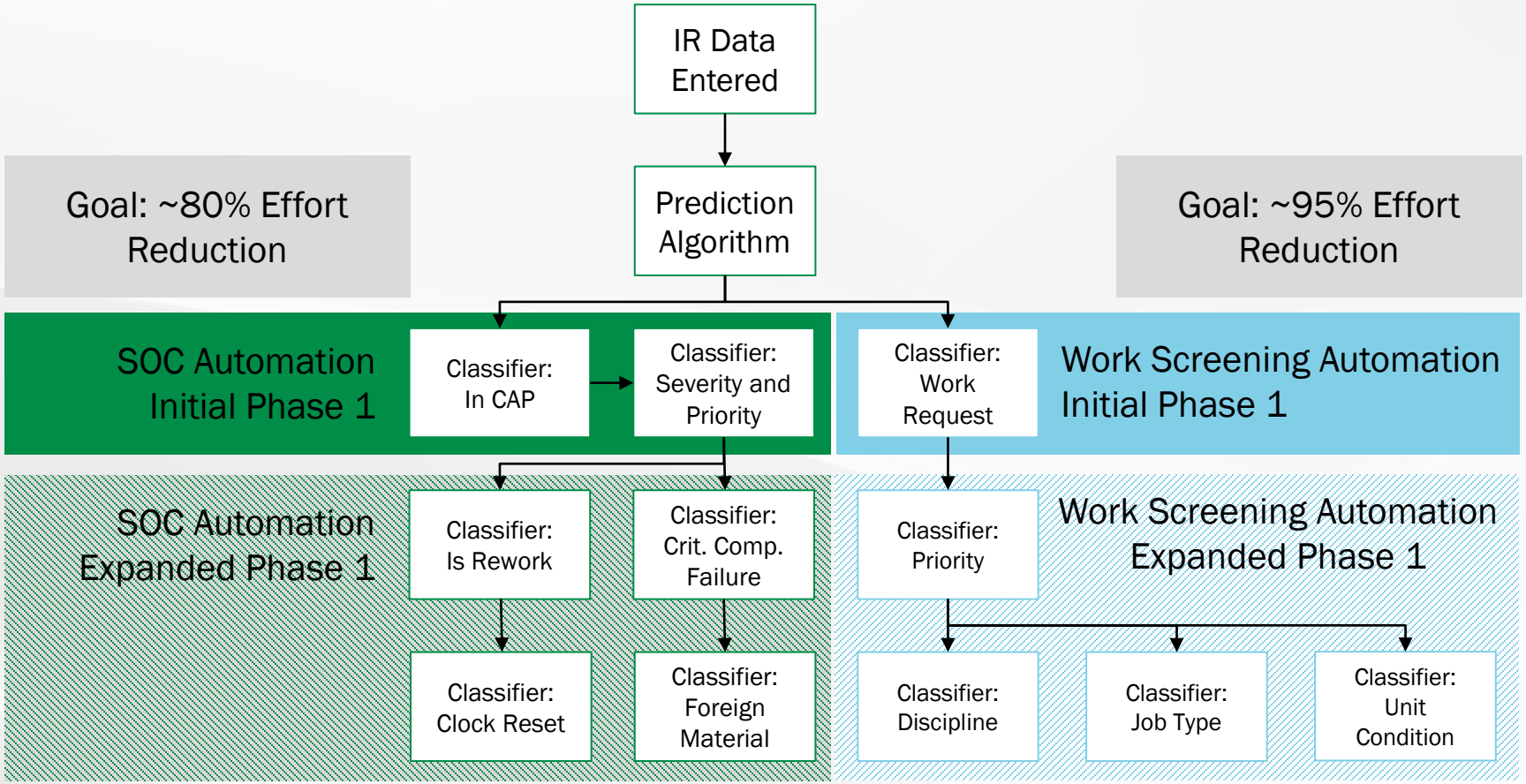
Engage the End Users … first lesson



CAP and New Work Screening stakeholder input expands scope

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Why Corrective Action Program Data?

- "Big data" source
- Cornerstone of the Reactor Oversight Process (ROP)
- Automating and strengthening CAP will:
  - Improve consistency in processing incoming CRs
  - Better highlight trends in existing CAP data
  - Allow focus on the more significant conditions

	Severity 1	Severity 2	Severity 3	Severity 4	Total (CAQ)
Priority A	3	66	25	1	95
Priority B	0	123	371	41	535
Priority D	0	49	3528	300, 364	303, 941

Data from 2017 to present for 12 Stations

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Functional Failure Analyzer … added lessons

- **In place successfully for two years**
- **The software is *not* making failure determinations … its pre-screening/flagging CR's worthy of human review**
- **Equipment monitoring still occurs (i.e., human element backstopped)**
- **Confidence in results is gained through continuous feedback**
- **Biased towards high safety significant component failures**

Reference: "Use of Machine Learning to Evaluate Maintenance Rule Functional Failures at Exelon", S. Hess and Jonathan Hodges, Jensen Hughes; Scott Diven and Jenna Burr, Exelon. Presented at PSA 2021 (August 2021

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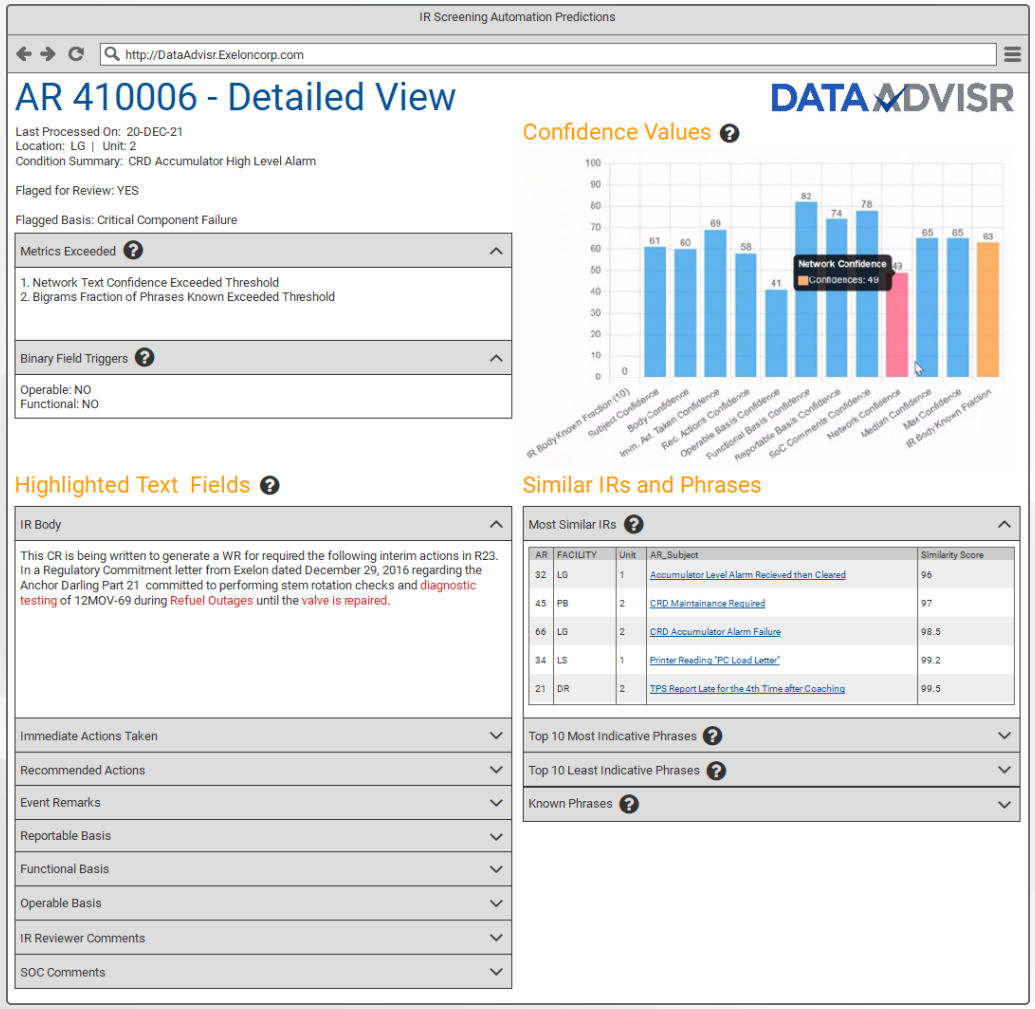
Graphical User Interface



- Results display confidence values and explain the reason for ‘flagging’ (as a potential decision)
- Software provides textual comment explaining how decision is made
- Shows top 25 ‘wordgrams’
- Results must be revisited
  - Procedure and rule changes
  - Changes in performance (i.e., data)
  - Humans validate model predications

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Making the Business Case

The lure of adoption may be the promise of enhanced efficiency and greater productivity but the real added value comes in the form of unexpected data results that become insightful business intelligence through clever analysis. – "When it Comes to ML/AI, One Size Does Not Fit All", April 2019

- **Opportunity to eliminate considerable amount of low value work**
- **Process-oriented nuclear business offers many opportunities**
- **Process improvement enhances data quality, improves decision-making, and increases employee bandwidth**
- **Having several stations is a force multiplier for scalable solutions**

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Collaboration … one size does not fit all

There is no best method or one size fits all. Finding the right algorithm is partly just trial and error. Algorithm selection depends on the size and type of data you're working with, the insights you want to get from the data, and how those insights will be used. – "What Is Machine Learning? 3 things you need to know", MathWorks

- **The line between unsupervised and supervised learning is blurry**
- **Jensen Hughes uses a "classifier" algorithm (*DataAdvisr)* to automatically screen condition reports (CR) via supervised learning**
- **DOE/INL uses a combination of supervised (*Cortex*) and unsupervised learning (Latent Dirichlet allocation) to create trends**
- **Leveraging both approaches allows for independent validation**

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Where we are headed …

Highly ambitious moon shots are less likely to be successful than "low-hanging fruit" projects that enhance business processes. - Hewlett Packard Overview of AI/ML

- **Build upon lessons from the Maintenance Rule analyzer**
- **Explore INL keyword trends pertinent to NRC inspection**
- **Additional areas of automation revealed with experience**

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Its not a matter of if …

Tesla has algorithmically created accurate and large-scale 'ground truth data' by combining information from the car's sensors using state-of-the-art techniques to build a robust planning and decision-making system that operates in complicated real-world situations under uncertainty. - Tesla Autopilot

- **Allows more focus on what's important**
- **Wisdom embedded in algorithm as it learns (i.e., knowledge retention, tribal knowledge)**
- **Opportunity for a powerful industry outcome**
- **The new math …**

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Acronyms

- Artificial Intelligence (AI)
- Corrective Action program (CAP)
- Condition Report (CR)
- High Safety Significant (HSS)
- Idaho National Laboratory (INL)
- Incident Report (IR)
- Low Safety Significant (LSS)
- Machine learning (ML)
- Reactor Oversight Process (ROP)
- Station Ownership Committee (SOC)

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