Ai-OPs

Southeast Florida Utility Council

TRINOVA +

Making Your Facility Ready for AI Control

Through AI-Powered Solutions

5 Reasons for AI Control Readiness

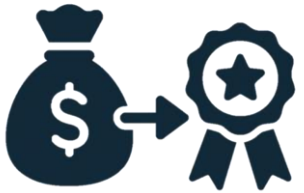
Energy & Labor

Rising Costs…
AI Enables “more with less”

Regulations

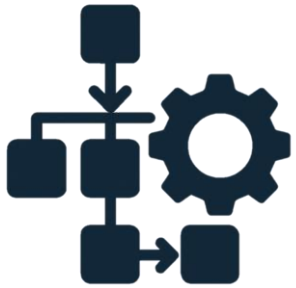
Standards require precision…
AI control, unmatched precision

State Funding



FDACS, FRWA Grants…
AI readiness improves funding

System Complexity

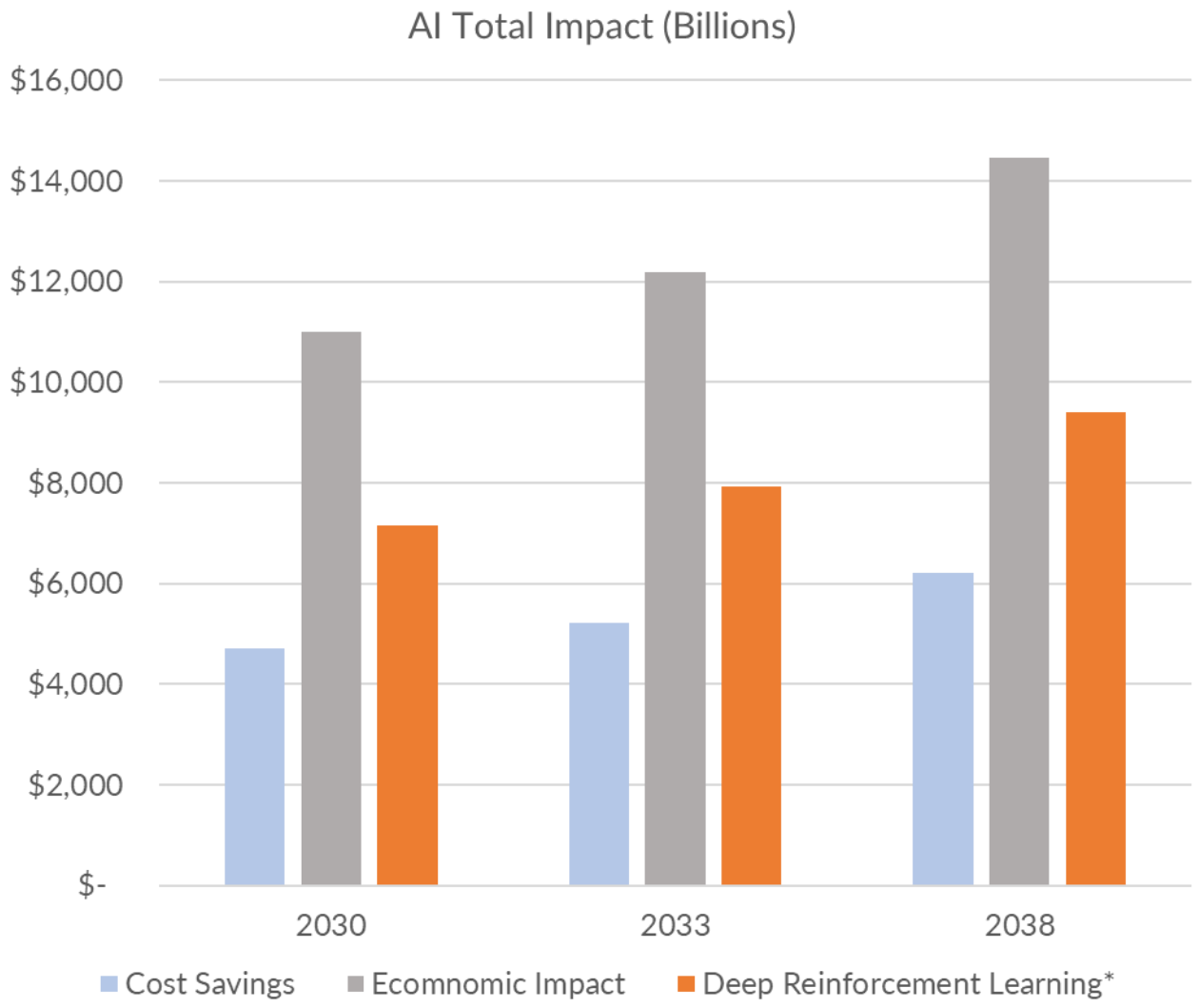


Struggle to adapt controls…
AI handles complexity

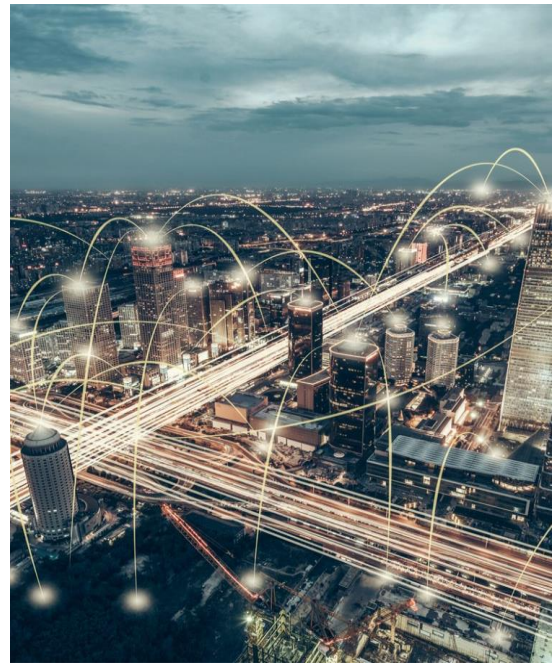
Knowledge Transfer

Retirement happens…
AI control assist new operators

The Economic Impact of Industrial AI – FI's Opportunity



- **By 2030**: Up to **$15.7 trillion** added to the global economy through productivity gains and innovation.
  (Source: PWC, 2017)
- **By 2040**: Annual economic impact of **$15.5–$22.9 trillion**, driven by AI software and services.
  (Source: McKinsey, 2023)
- **By 2030**: AI to contribute **3.5% of global GDP**, transforming industries worldwide.
  (Source: IDC, 2024)



* Ai-OPs estimate: 65% of industrial value will be delivered by Neural Networked – Deep Reinforcement Learning

Importance of Florida's Wastewater Efficiency

Energy & Chemical Cost

Per Million Gallons
Energy: ~ $120 - $200/ MG
Chemical: ~$50 - $100 / MG

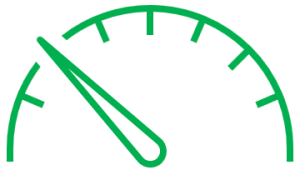
Assumptions:
$0.08/kWh
$10 - $30 / MG of Chlorine Cost

FDACS, FRWA, and DEP

Current Optimizations
~$50k - $200k / site

Retrofits (blowers, motors, pumps)
Process Control (Aeration/DO)
Staff Training and Best Practices
Alt. Disinfection, Chem Optimization
State Support, Audits and Funding

WWTP Process Optimization

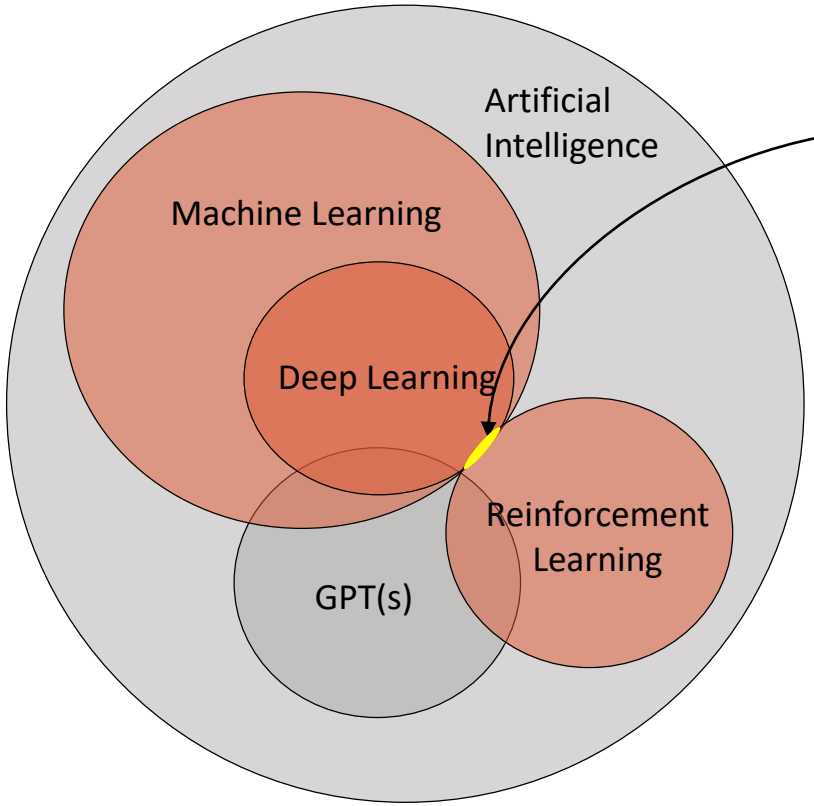


Artificial Intelligence
DRL Savings: ~$200k – 300k / site

Real-time optimizations
Capture Knowledge Transfer
↑AI Optimization ↓Grid Power
Cost efficient, and robust solutions
Extends to much more than energy (outfalls, chemical usage, etc.)

Our Niche (DRL) – A Process Optimization Game Changer

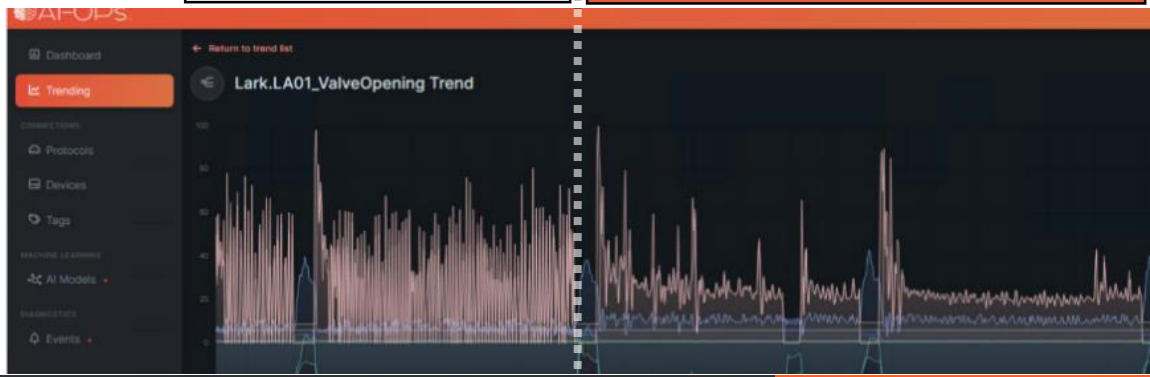
PID & Linear Optimizations



Deep Reinforcement Learning

- Real-Time Decisions
- Game Optimization
- Skill Acquisition
- Learning Tasks
- Robot Navigation

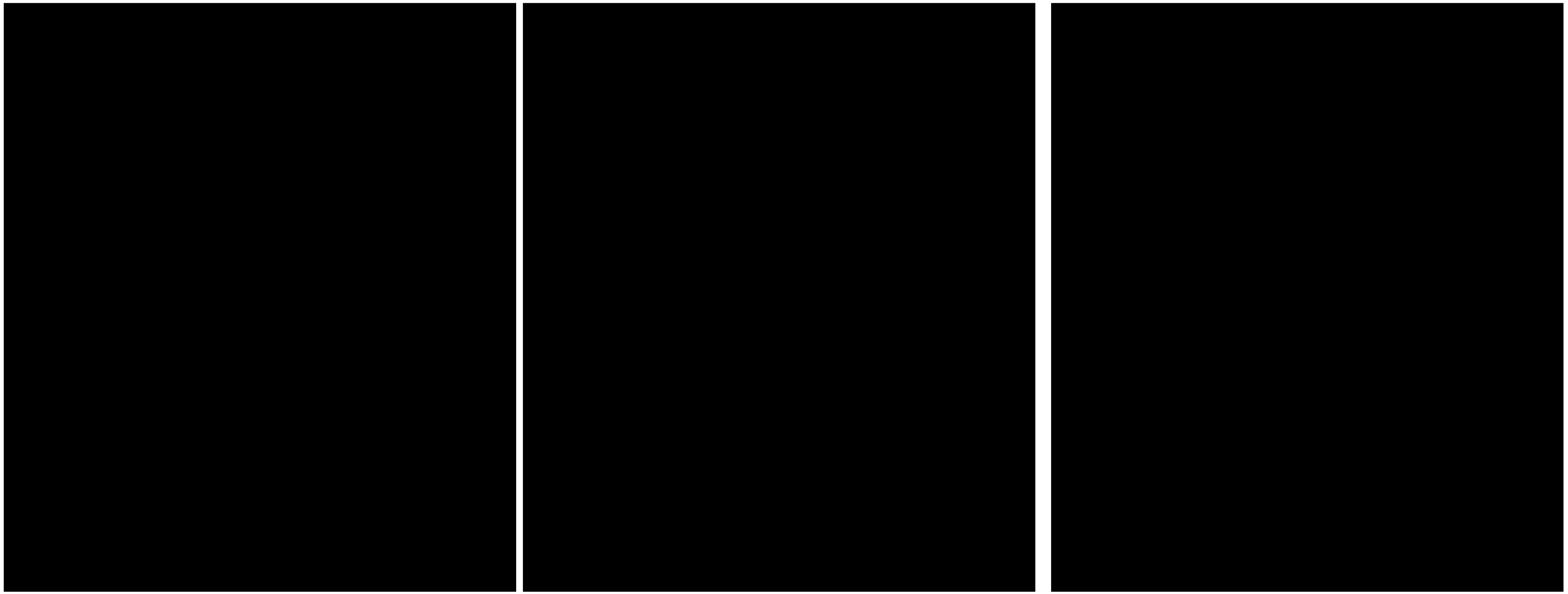
PID Control | Deep Reinforcement Learning



DRL – Learning, Mastering and Strategizing

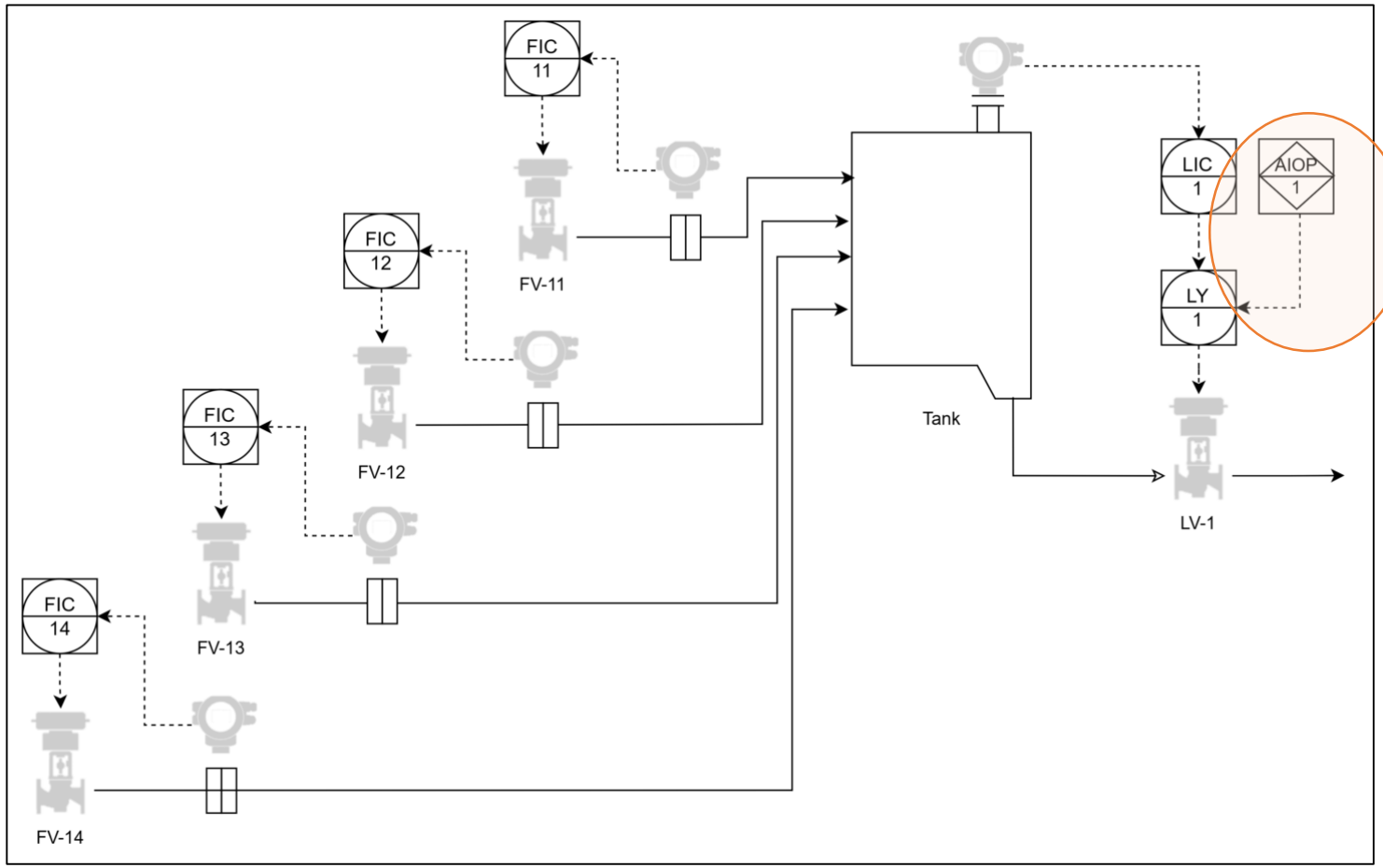
- 2014 Google demonstrated DRL
- Challenged ATARI's Break Out game

Google DeepMind VS ATARI



10 min of DRL training → **120 min of DRL training** → **240 min of DRL training**

DRL – Transferring Video Games to Real Process Control



Incorporate a DRL controller to control the level drain valve. Bumpless transfer for PID shed mode.

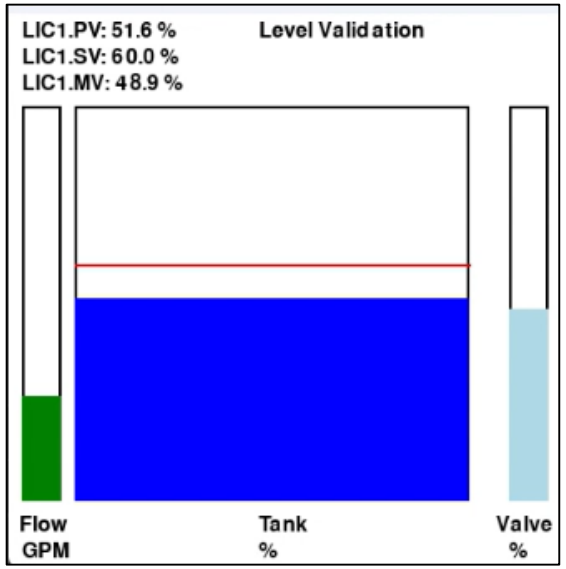
Challenge:
Maintain stable setpoint regardless of Set Point Value and in coming flow conditions.

Payback:
Savings in downstream chemical dosing. When the level isn't controlled right at set point the skimmer cannot effectively skim, and dirty water makes its way downstream, ultimately requiring heavier treatment for stable and compliant water outfall.

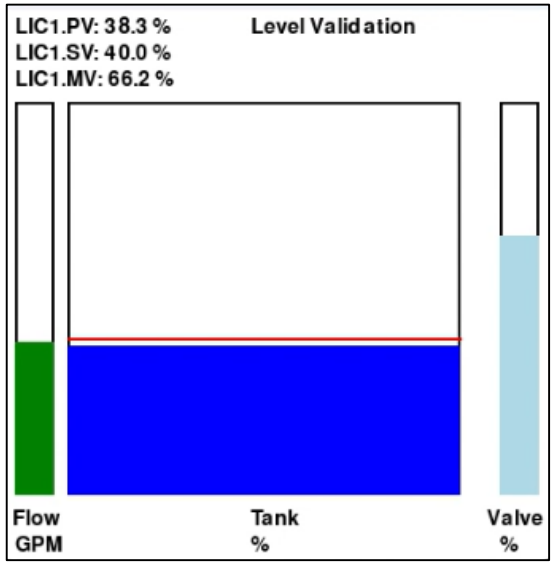
DRL – Learning, Mastering Level Control

- Challenge is to maintain Level Control regardless influent flow

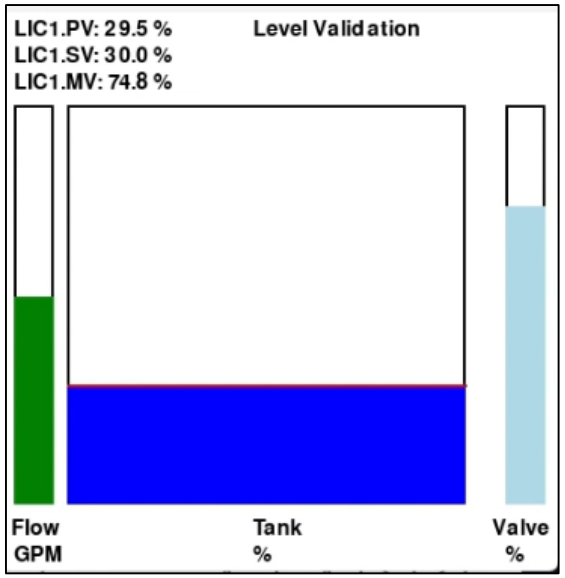
15 Seconds of Training



1 Minute of Training (PID-Like Capabilities)



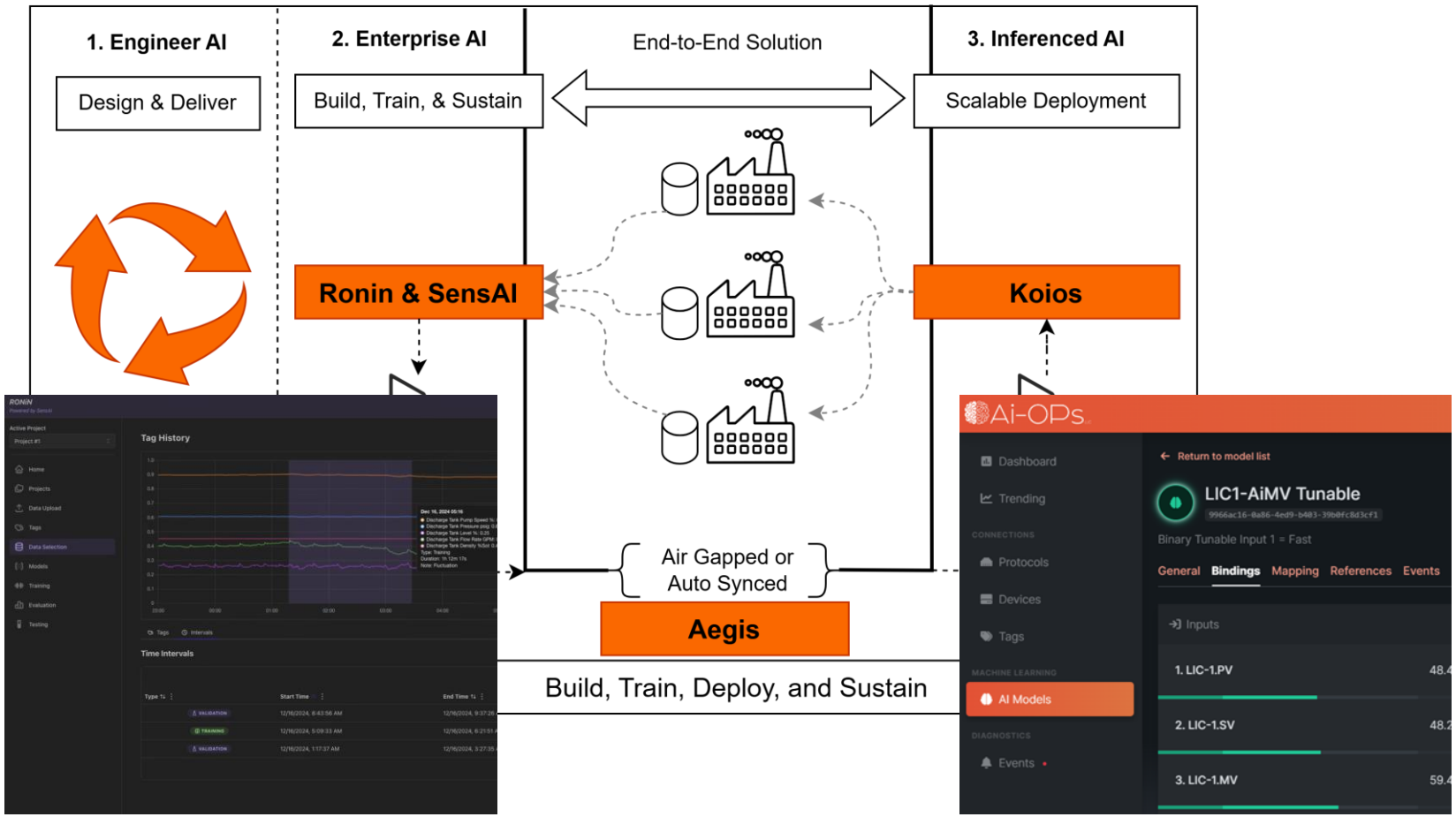
10 Minutes of Training



Ready to Deploy On Ai-OPs' Koios!!!

10k Timesteps → **50k Timesteps** → **500k Timesteps**

Ai-OPs – Product and Software Delivery



Ronin and SensAI

- **Build and maintain your own AI solutions** for process control and optimization.
- Ronin is Ai-OPs' user interface for engineering workflows for building AI for process control
- SensAI is Ai-OPs' API for access to the Ai-OPs' training libraries and methods.

Aegis

- Optionally connect your Koios to your Ronin and SensAI organization for remote management.

Koios:

- On-premises (No Internet Required!) or connect through Aegis to your organizations Ronin and SensAI.
- Standard protocols
  - EtherIP, OPC-UA, XML, SQL
- Long-term historian
- Scales well, **run 100's of models**
- Requires little management time

Application 1 – Aeration Control Optimization

The Challenges:

Energy Inefficiency:

- Existing PID-based control systems for the blowers are reactive and incapable of dynamically adapting to fluctuating oxygen demands.

Overuse of Equipment:

- Frequent cycling of blowers lead to premature wear and higher maintenance costs.

Compliance Risk:

- Maintaining consistent biological oxygen demand (BOD) and dissolved oxygen (DO) levels are critical to meeting discharge regulations.

The Solution:

Dynamic Optimization:

- DRL models predict oxygen demand fluctuations and adjusted blower speed and output in real-time.

Energy Efficiency:

- The AI model prioritizes achieving the required DO levels with minimal energy usage.

Closed-Loop Control:

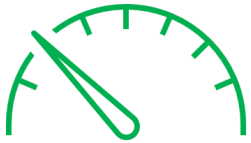
- Seamless integration with existing control systems ensures smooth operation without disruptions.

Anomaly Detection:

- Additional models can be deployed to monitor the health of the blowers and basin.

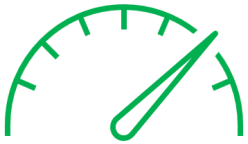
Key Benefits

Energy Reduction



As much as 25%

Compliance



DO Consistency

Application 2 – Chemical Dosing

The Challenges:

Reactive Nature:

- This reactive behavior often leads to overshooting or undershooting the target, resulting in inefficiencies and wasted chemicals.

Nonlinear Dynamics:

- The relationship between chemical dosing and process outcomes (e.g., pH or residual chlorine levels) is nonlinear.

Lag and Dead Time:

- Chemical reactions, mixing times, and sensor delays introduce dead time between dosing and the measurable response.

The Solution:

Dynamic Optimization:

- The DRL model adapts in real time to changing process conditions, such as shifts in flow rate, buffering capacity, or chlorine demand.

Multi-Variable Control:

- Optimizes multiple variables, ensuring that chemicals are balanced for maximum efficiency and effectiveness.

Closed-Loop Control:

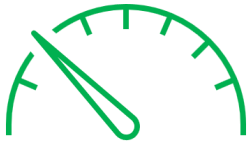
- Seamless integration with existing control systems ensures smooth operation without disruptions.

Anomaly Detection:

- Additional models can be deployed to monitor the health of the dosing system.

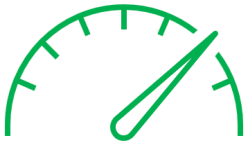
Key Benefits

Chemical Usage



As much as 20% usage reduction

Compliance



Increased adherence to constraints

Application 3 – Energy Balancing

The Challenges:

High Energy Consumption:

- Aeration systems, pumps, and sludge processing accounted for over 50% of the plant's total energy use, peak demands leading to increased operational costs.

Limited Control Over Demand Management:

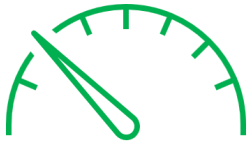
- Traditional PID and Model Predictive Control (MPC) struggled to adjust aeration and pumping schedules dynamically.

Regulatory Constraints & Operational Complexity:

- The plant needed to maintain strict effluent quality while minimizing energy usage

Key Benefits

Peak Demand Charges



As much as 10% charge reduction

Compliance

keep effluent within constraints

The Solution:

Dynamic Optimization:

- The DRL model adapts in real time to shift energy loads away from peak hours where possible.

Multi-Variable Control:

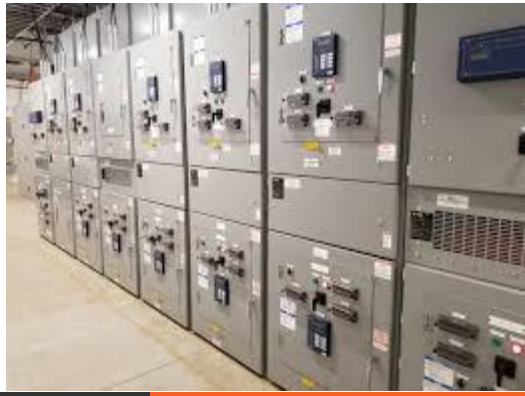
- Optimizes multiple variables, ensuring that big energy users are balanced for maximum efficiency.

Closed-Loop Control:

- Seamless integration with existing control systems ensures smooth operation without disruptions.

Peak Demand Reduction:

- AI with DRL can automatically adjust blower and pump usage to operate at off-peak rates when possible.



Application 4 – Preventive Maintenance

The Challenges:

Frequent Equipment Failures:

- Blowers and pumps experienced unexpected breakdowns, leading to unplanned downtime and costly emergency repairs.

Inefficient Maintenance Scheduling:

- The plant relied on fixed-interval preventive maintenance instead of condition-based monitoring.

High Repair and Replacement Costs:

- Premature equipment replacements due to undetected wear and tear cost the plant over $500,000 per year.
- Emergency repairs increased labor costs by 30% compared to planned maintenance.

The Solution:

Anomaly Detection & Fault Prediction:

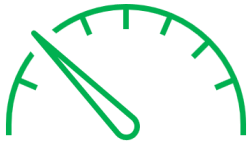
- Anomaly Detection detect deviations from normal operating patterns.
- Time-Series Forecasting predict future wear and degradation weeks or months in advance.

Predictive Maintenance Optimization:

- Instead of calendar-based maintenance, AI-enabled and recommended optimal service intervals can be utilized instead.
- Easy integration to existing control systems passes alarms and notifications directly to operations and maintenance.

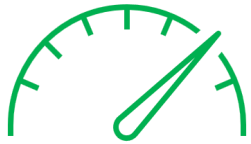
Key Benefits

Emergency Repair Costs



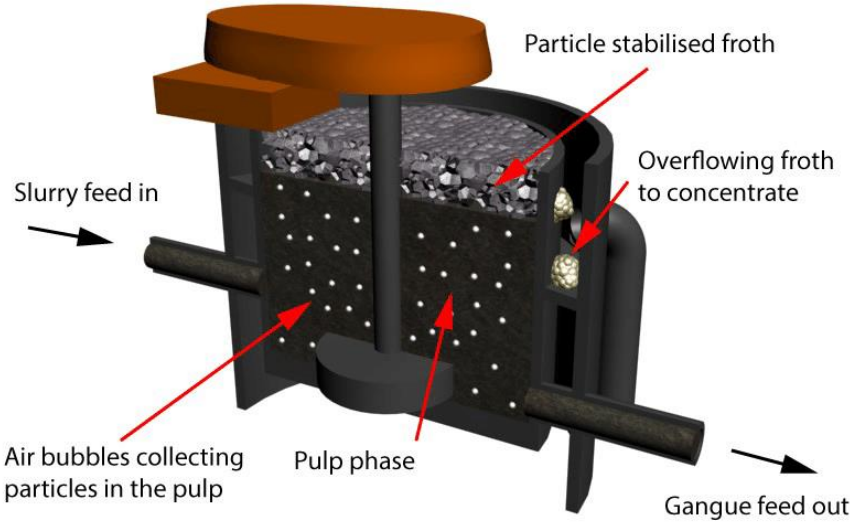
As much as 20% reduction

Equipment Lifespan



Longer equipment use.

Case Study 1 - Floatation Cell Optimization



Picture by Alexander Norori-McCormac – Ph.D. Thesis 2015*

CIM – The Future of Floatation – Nov 04 2016

Flotation Cell - Background

- Ore reactor and a selective separators
- Chemical and physical properties of target metals exploited
- Target metals adsorb to bubbles and are concentrated
- Gangue is separated from downstream processing

Processor Challenges

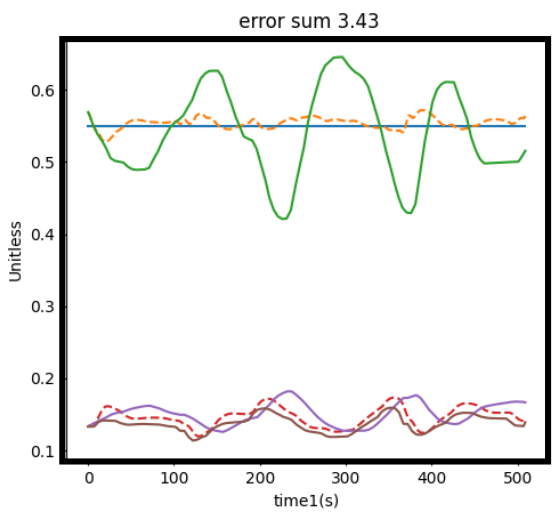
- Process water and slurry feed controls
- Slurry level and Froth depth controls
- Bank controls with diminishing metals
- Multiple banks – Rougher-Scavenger-Cleaner

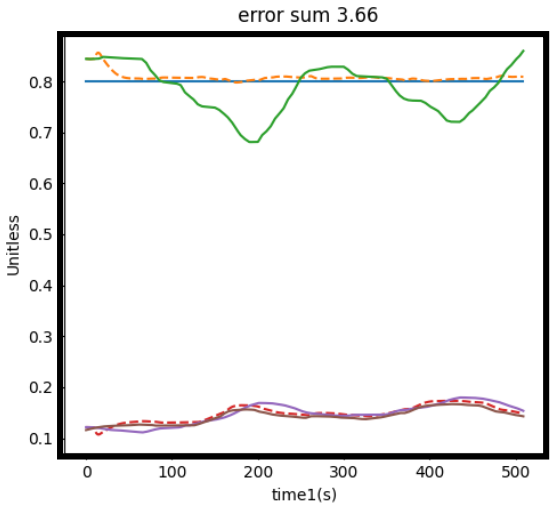
*** The relationship between particle size, cell design and air recovery: the effect on flotation performance -** August 2015

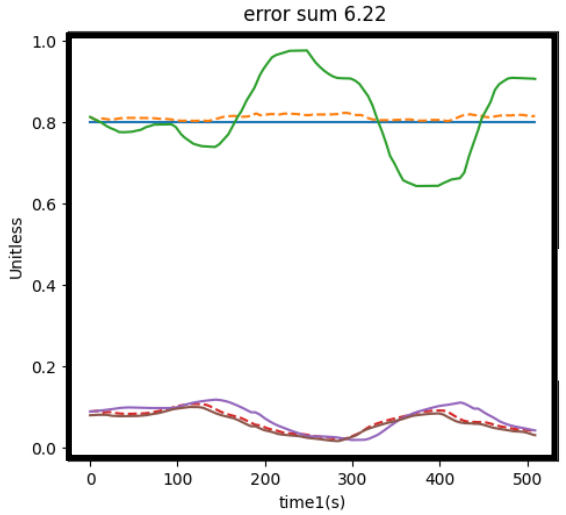
Case Study 1 - Floatation Cell Optimization

Case Challenge

- Valve input and output lag times
- Current Froth Depth control has a high degree of variability
- Non optimized control – Loss of valuable metals?







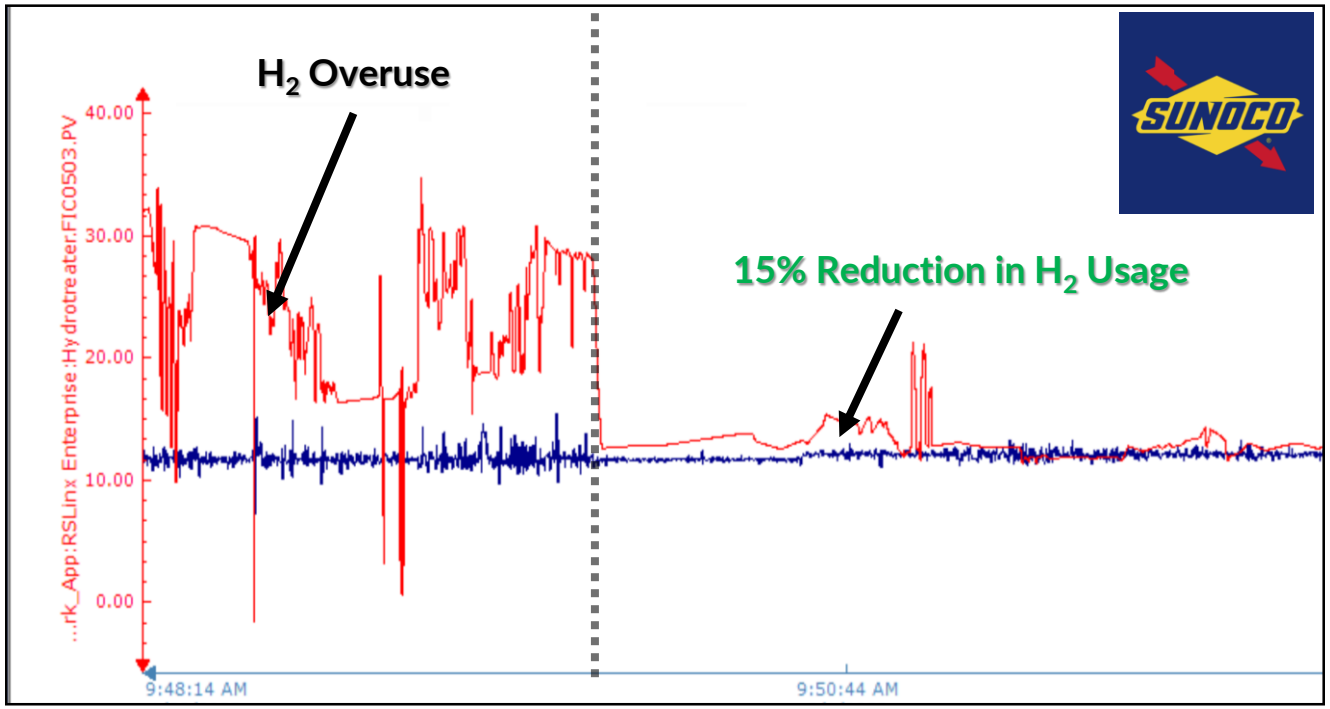
- Targeted Set Point
- Ai-Ops – New Froth Depth
- Old Froth Depth
- Ai-OPs – New Valve 2 Command
- Old Valve 1 Command
- Old Valve 2 Command

Result

- Koios employed DRL optimized to optimize valve 2 commands
- DRL learned perfect feed-forward action using valve 1 commands
- Validation Set demonstrates **> 80% reduction in error of Froth Depth!**

Case Study 2– Industrial Facility, H_2 & CO_2 Reductions

Old Control Technology → Ai-OPs, Koios AI Control



~ 5 Years of Use without Any Maintenance
Continues to deliver ongoing ROI

Goal = Reduce Operational Costs H_2

Challenge:
Payback in 2 Years

Result:
Payback in < 6 months

Additional Benefits*:
Reduced 346Tons of Carbon Emissions

*Hydrotreating Requires H_2 ~ 26LBs of Carbon to get 1 LB H2 Through SMR Production

Expanding AI Applications in the Sector

Water & Utilities
Level and Flow Control
Pump Controls
Dosing Optimizations

Boilers and Heaters
Fuel Control
Steam Demand and Header
Feedwater Control

Emissions
Leak Detection
Flue Gas Control
Flare Smoke Prevention

Opportunities and More

Plant Operations
Compressor and Pump Control
Valve Control
Advanced Alarming

Gen & Transmission
Power Factor Control
Load Shed and Balancing
Supply and Demand Predictions

Commercial
Refrigeration Control
Chiller and HVAC

Summary

Partnering with Ai-OPs provides

- Rapid Payback – Achieve ROI in under 6 months post-purchase.
- Measurable ROI – Koios Custom Solutions tailored for impactful results.
- Cost-Effective & Reliable – Robust solutions with minimal maintenance.
- Extend Equipment Life – Reduce OPEX and maximize asset longevity.
- Seamless Integration – Works with existing control loops, boosting redundancy.
- Hardware Agnostic – Koios works seamlessly across all platforms.
- Unmatched Security – Offline secure loops ensure ultimate protection.
- Eliminate Bottlenecks – Routinely solve long-term production hurdles.
- DRL: A Game-Changer – Faster, smarter control for complex processes.

Harnessing AI for production environments – Defining the Future of Control for Heavy Industry

Reflections

Questions?