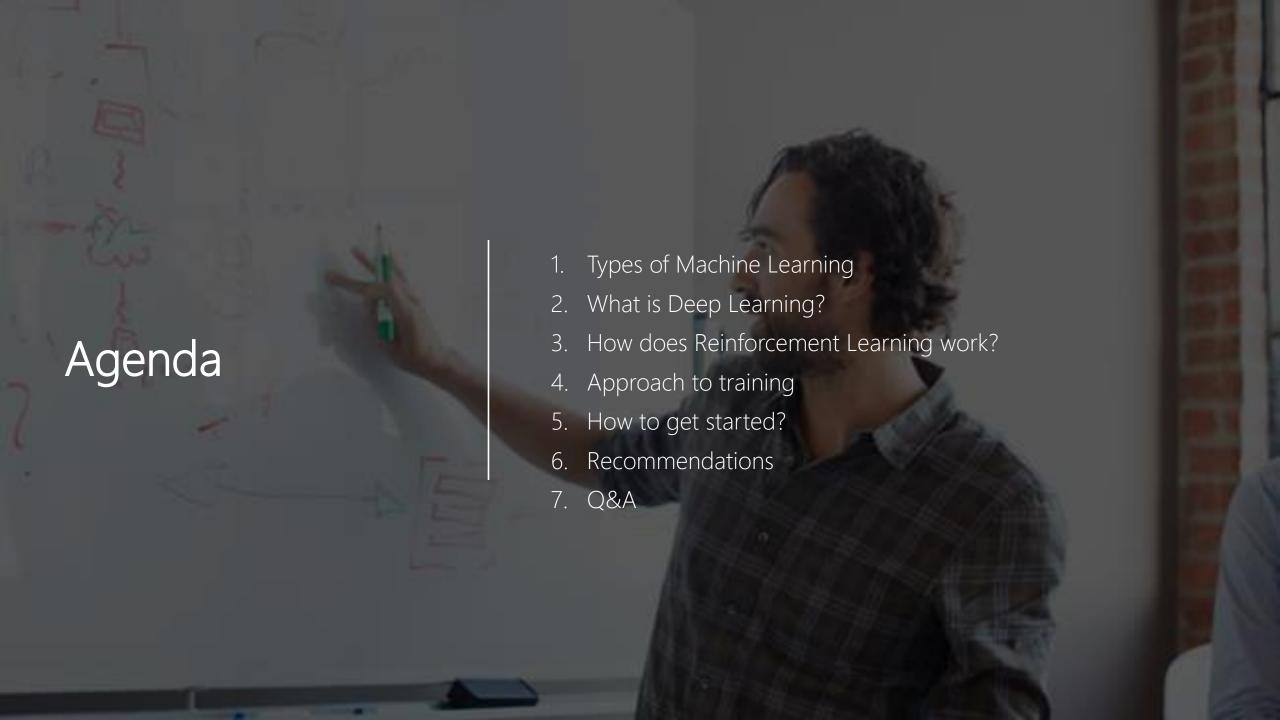
Deep Reinforcement Learning -Optimising underground crushers

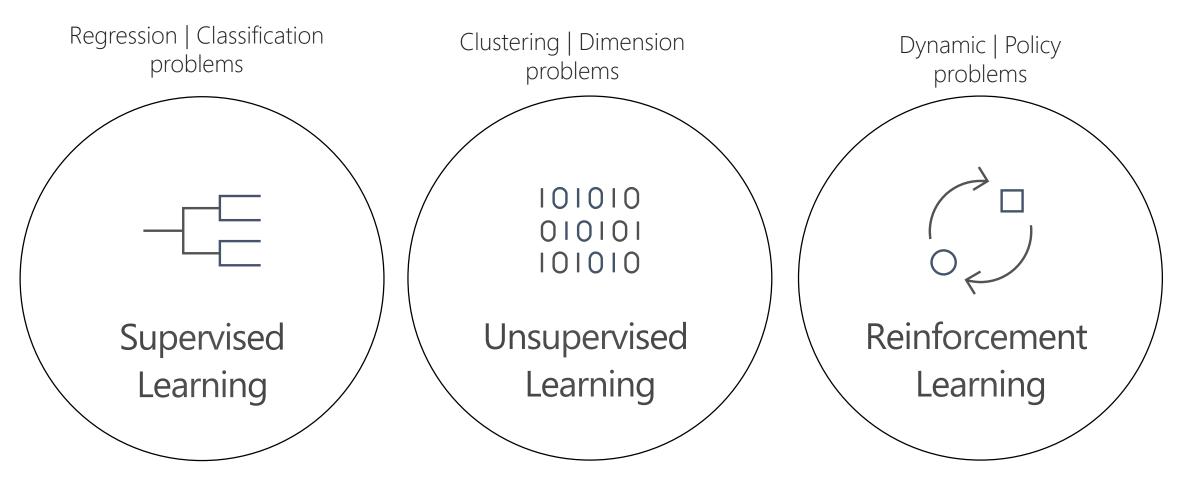
March 2019







# What are the types of Machine Learning?

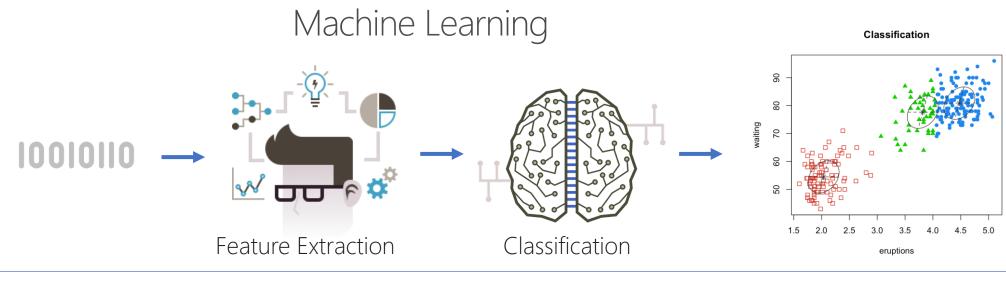


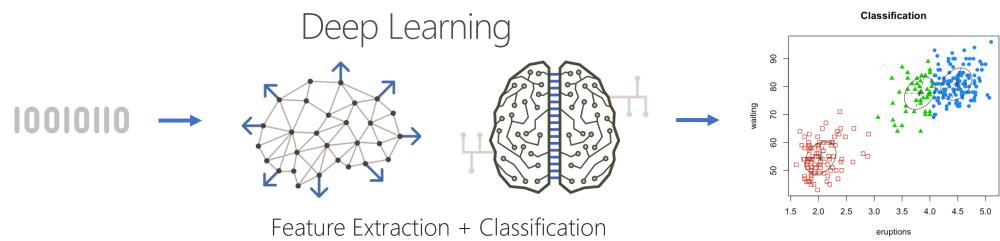
Infers a function from labelled training data consisting of a set of example data.

Draw inferences from datasets consisting of input data without labelled responses via selforganization.

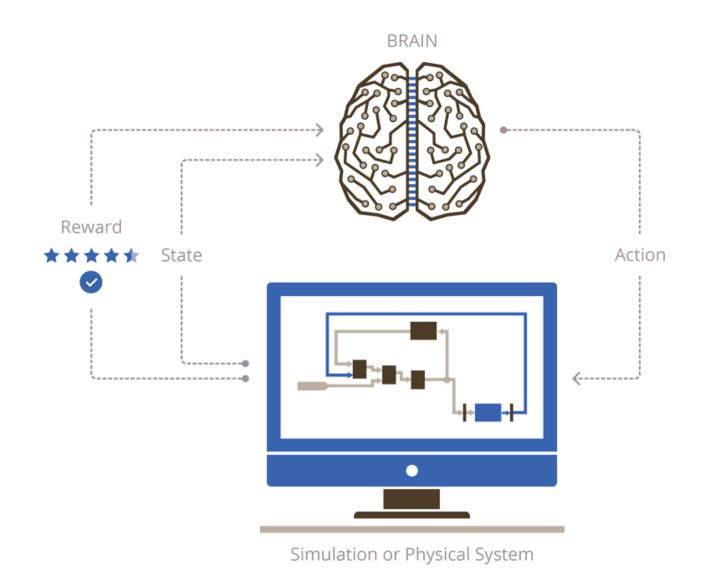
Using a value function a software agent explores the maximum value of action space – Learning from its mistakes.

# What is Deep Learning?



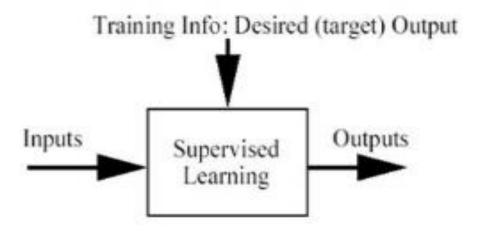


# How does Reinforcement Learning work?



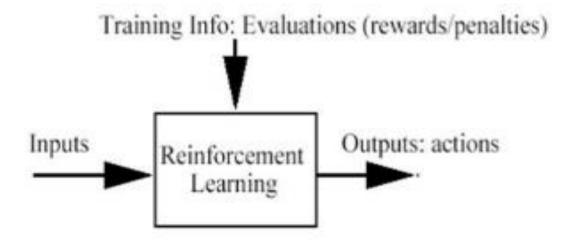
# How does Reinforcement Learning work?

Supervised Learning



Error = (target output - actual output)

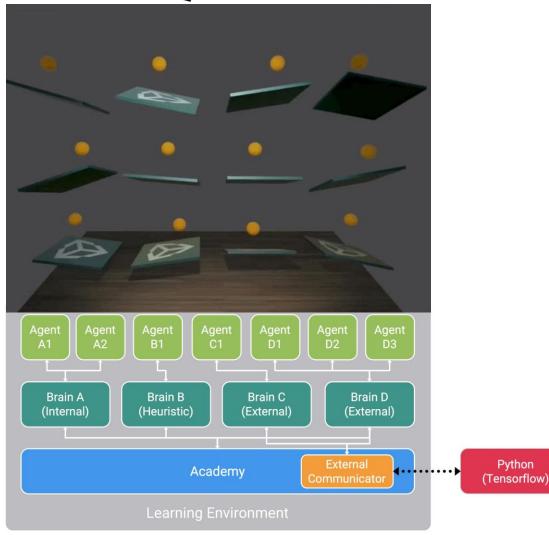
Reinforcement Learning



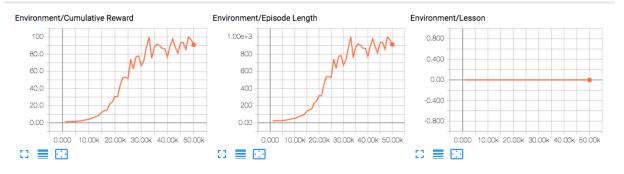
Objective: Get as much reward as possible

# Approach to training

### **d** unity



#### Environment



#### Losses



#### Policy



https://unity3d.com/machine-learning



# Why this approach?

### Deep Reinforcement Learning Approaches for Process Control

by

Steven Spielberg Pon Kumar

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF APPLIED SCIENCE

in

The Faculty of Graduate and Postdoctoral Studies

(Chemical and Biological Engineering)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

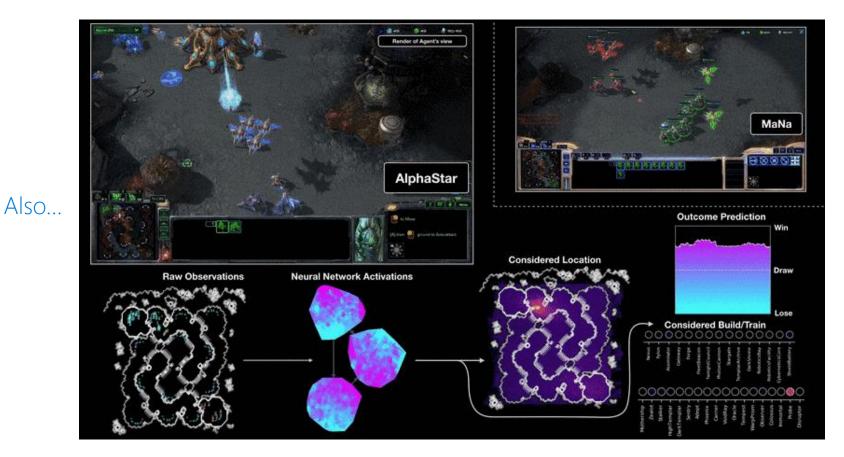
December 2017

© Steven Spielberg Pon Kumar 2017

### **University of British Columbia research**

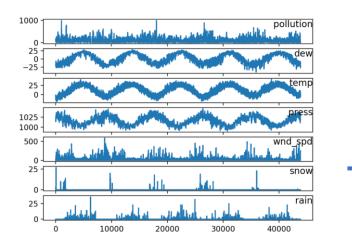
Theory of using Reinforcement Learning for APC

Dec 2017



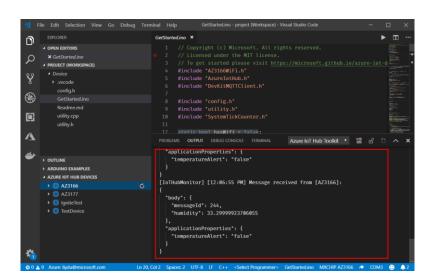


# Data & Connectivity



Time Series Database (Process Historian)

```
Raw Data Export_07_01_2018 00_00_00.csv - Notepad
File Edit Format View Help
[Data],,,
Tagname, TimeStamp, Value, Quality
TIGER.IMPORT TAG1.F CV, 06/22/18 15:00,95.00,Good
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TIGER.IMPORT_TAG1.F_CV, 06/25/18 12:00,90.00,Good
```

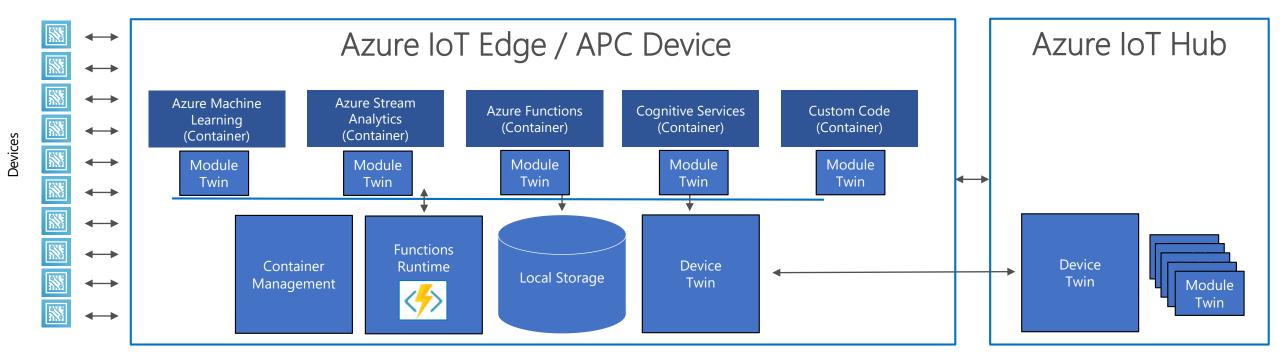


A program to replay history or Real-time data (IoT Edge + IoT Hub)

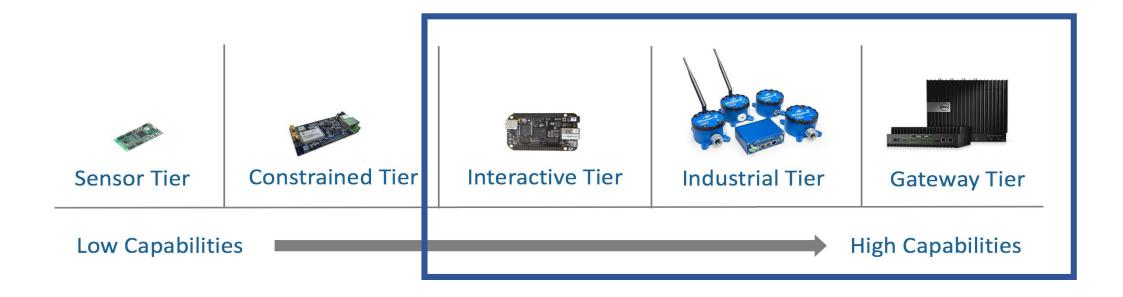
# Edge Processing Architecture

- Container based modules
- Azure Functions
- Azure Stream Analytics
- Azure Machine Learning
- Cognitive Services

- Offline / Synchronized Device Twins
- Local Storage
- Cloud Management & Deployment
- High Availability / Fault Tolerance
- Cloud Dev/Test Support



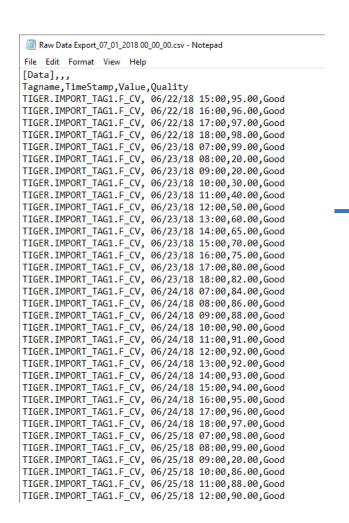
# Edge Processing Hardware Tiers

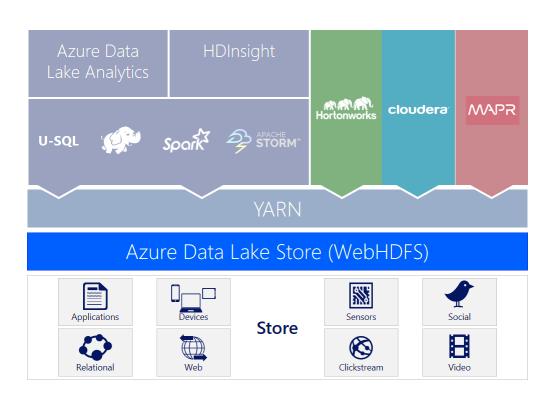


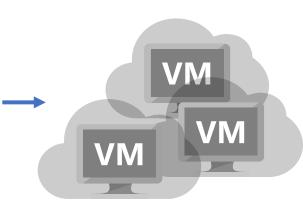
Interactive Tier (Single CPU, 128MB Memory)

Gateway Tier or Higher

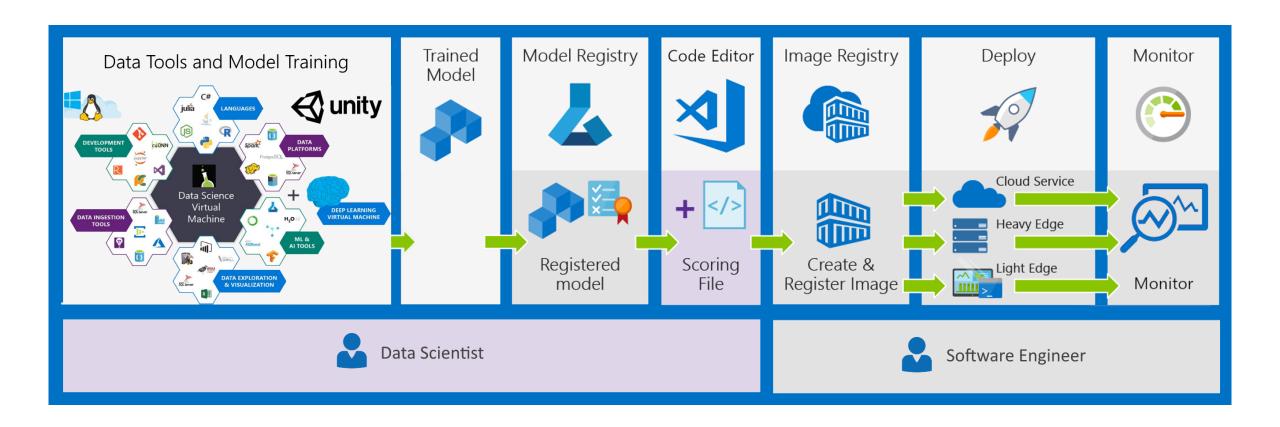
# Storage & Compute







### Data Science Workflow in Azure



### Powerful tools and infrastructure options

To accelerate training, model development, and drive consistency

Operationalize models as decision support tools

To inform users of insights and actions or even drive automation

### Azure specialized hardware...



**Entry Level VMs** 

Dev/Test Workolads



**General Purpose VMs** 

Common Applications, Web servers etc



**Compute Optimized VMs** 

Gaming, Analytics



**Large Memory VMs** 

**Large Databases** (Relational)

**Large Caches** 



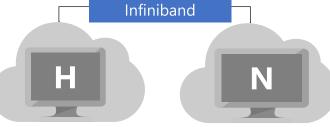
>80,000 IOPs **Premium Storage** 

Low latency, high throughput apps



### Storage optimized VMs

No SQL Databases (Cassandra, MongoDB), Data warehousing



### **High Performance VMs**

Batch processing, fluid dynamics, monte carlo simulation



### **GPU-enabled VMs**

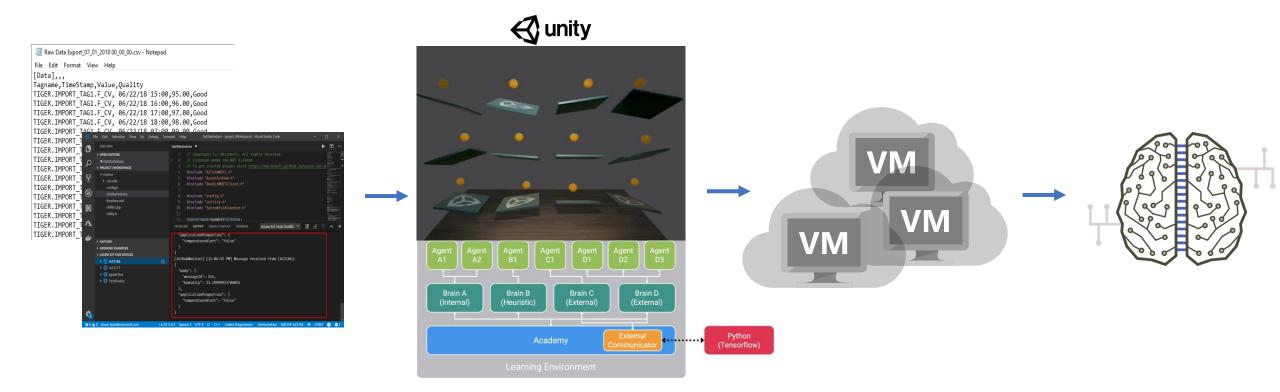
NV- Graphic based applications NC-Advanced simulation ND- Artificial Intelligence



### **Large Memory VMs**

**Large Databases SAP HANA** 

# Training Reinforcement Learning

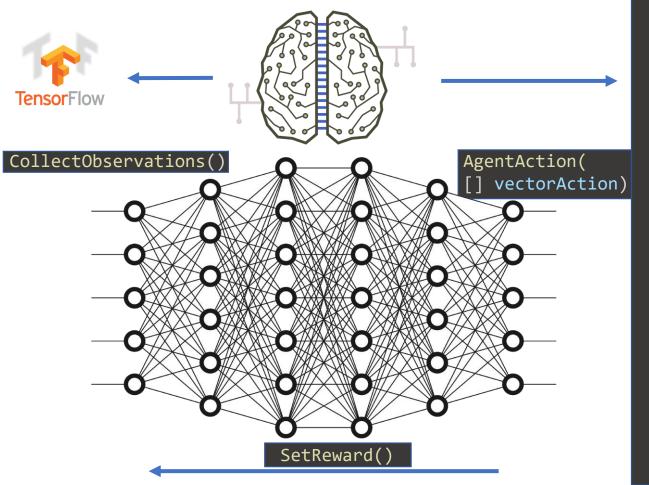


A program to replay history

Environment Simulator Big Compute

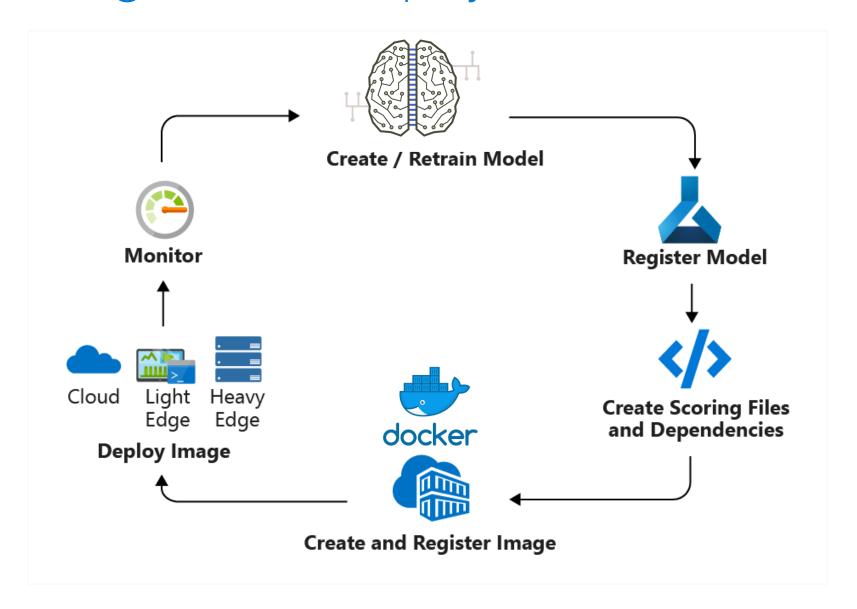
Model Output

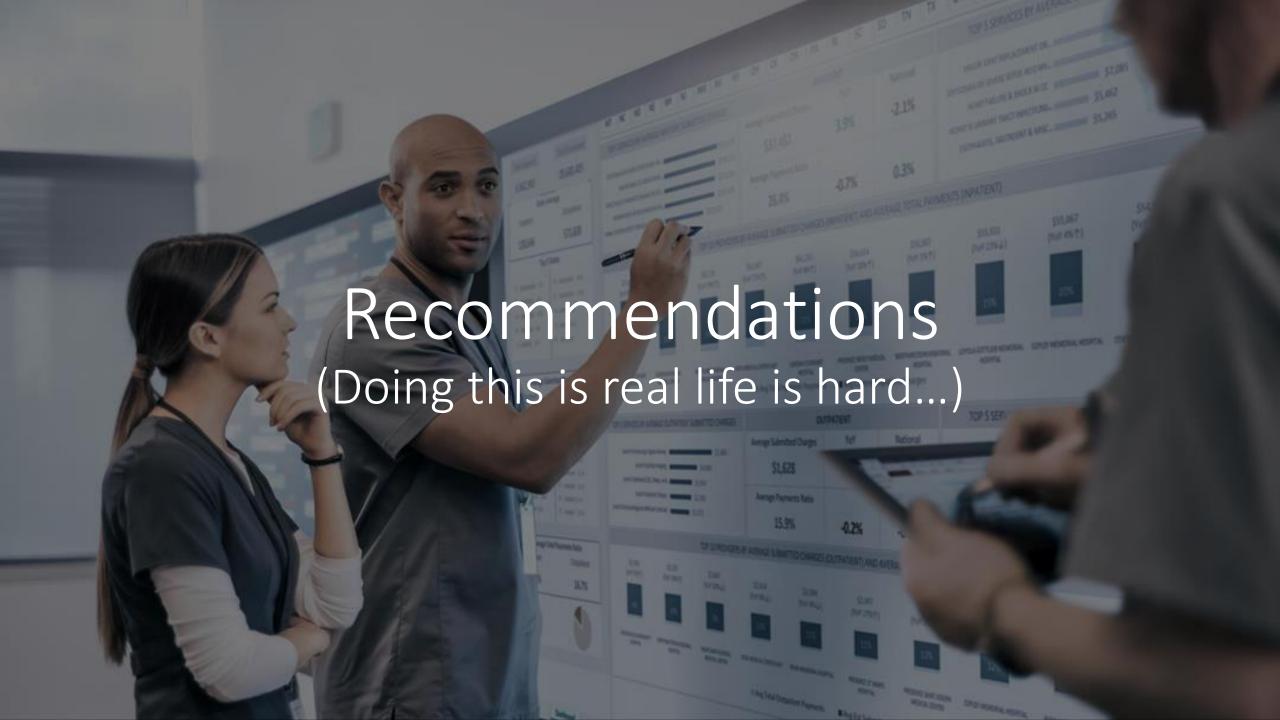
# Using Unity ML Agents for Reinforcement Learning



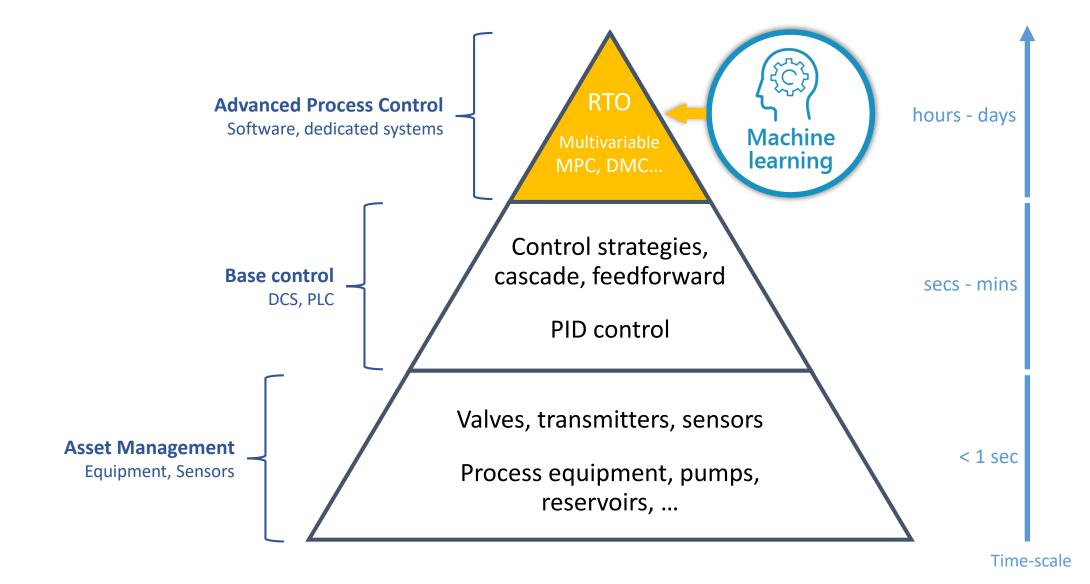
```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using MLAgents;
public class MyAgent : Agent
     public override void InitializeAgent()
           base.InitializeAgent();
     public override void CollectObservations()
          AddVectorObs(...);
     about its state in the world.
     // The vector observation is a vector of floating-point numbers
     which contain relevant information for the agent to make
     decisions.
     public override void AgentAction(float[] vectorAction, string
     textAction)
     // Perform action in the environment
           SetReward(...)
     public override void AgentReset()
     // Reset the agent state
```

# Model Management & Deployment

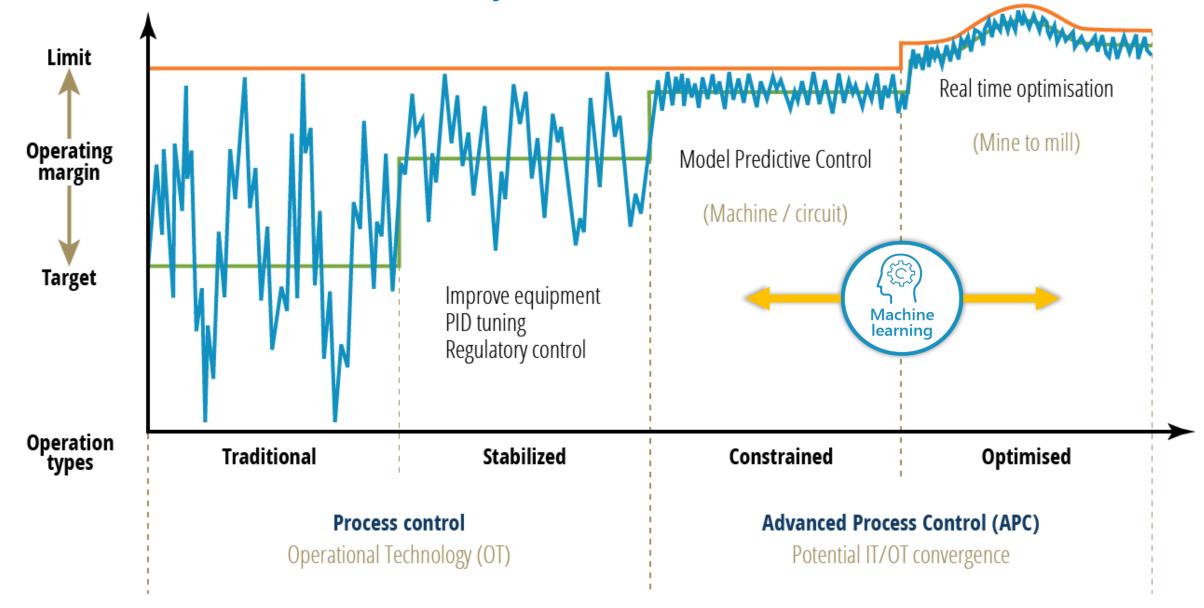




# Process Control Hierarchy



# Process Control Maturity



# Learning and Tools

Environments & Simulators







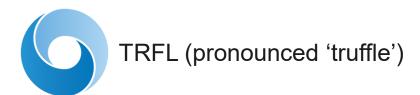
https://gym.openai.com/

https://www.bons.ai/

Frameworks



https://github.com/ keras-rl/keras-rl



https://github.com/deepmind/trfl/

Math / Theory

Web search for "RL— Introduction to Deep Reinforcement Learning" https://medium.com/@jonathan\_hui/rlintroduction-to-deep-reinforcement-learning-35c25e04c199

# Q&A – Thanks!



Azure Developer Lead
Engagement and Enablement | Microsoft Australia
Twitter: @gigaflare
LinkedIn: elliot-wood-a2160347

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