Building BRAINs for Autonomous Systems

Microsoft Autonomous System Toolchain Overview

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Evolution of industrial systems

**Manual systems**
- Labor intensive
- Error prone
- Difficult to scale

**Automated systems**
- Task specific installations
- Effective and scalable
- Programmed behavior
- Limited in scope and flexibility

**Autonomous systems**
- Solve previously unsolvable problems
- Robust and flexible decision making
- Learned policy
- Human in the loop
Microsoft platform for autonomous systems

Scale Human Expertise

Trustworthy Autonomy

Real World Scenarios
Autonomous systems scenarios

Motion control  Smart buildings  Machine calibration  Process control  Industrial robotics
BUILDING INTELLIGENCE FOR AUTONOMOUS SYSTEMS DEMANDS A FUNDAMENTALLY DIFFERENT APPROACH

1. A technique that can combine human and machine intelligence

2. Simulation integration and scalability for training

3. Automated generation and management of neural networks and DRL algorithms

4. A runtime to deploy and scale your models in the real world
Autonomous Systems toolchain

**Cloud**
- Expert
- Teach
- AI Model
- State
- Action
- Reward
- Evaluate

**Edge**
- Deployed Model
- State
- Action
- Physical Device
Reward functions

Cobra effect
You get what you incentivize, not what you intend.
Case study
CNC machine calibration

Business problem
CNC machines cut metal with spinning tools. Friction reduces precision and periodically demands recalibration. An expert operator must travel to calibrate the machine, repeatedly turn the knobs and take measurements until the machine regains precision.

Objective
Build autonomous system to calibrate machine to offset friction error to within 2 microns.

Results
A manual process requiring human operators—averaging 20–25 iterative steps over 2 hours—was fully automated to an average of 4–5 iterative steps over 13 seconds.

Above was achieved at 2 micron precision—the system could achieve superhuman precision (1 micron) in <10 iterative steps.

All built by a non-RL expert (mechanical engineer SME)
Case study

Smart buildings/homes

Business problem

HVAC systems comprise most of commercial energy consumption. Traditional controls struggle to save energy keep CO2 levels safe while keeping occupants comfortable.

Objective

Train autonomous system to reduce energy consumption while maintaining occupant comfort and CO2 safety in a conference room.

Results

System was architected as a combination of deep neural networks and classical control systems.

By considering the room occupancy, the system learned to turn off the system when the room was unoccupied, while also preserving comfort and high air quality when it mattered the most.

System learned to control HVAC for improved comfort and air quality with 22% lower energy consumption.
Industrial Simulations
Available across a broad range of verticals and systems

Mechanical & electrical engineering
Autonomous vehicles
Security & networking
Discrete event simulations
Transportation & logistics
Robotics
Microsoft and The MathWorks are collaborating to deliver a best in class User Experience for building Autonomous Systems

- Easy to use Simulink Toolbox provided by Microsoft
- Microsoft service deliver highly scalable training environment for Simulink and MATLAB based models

Preview available at: https://aka.ms/as/preview