# APPLICATION OF AI BASED SIMULATIONS

## FOR MILITARY LOGISTIC SUPPLY NETWORK DECISION MAKING

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# AGENDA

- Background
- Research Objectives
- Tools and Techniques
- Modelling Military Logistics Scenarios in Unity
- Research Review

# Background

- Human Machine Teams research seeks to exploit the capabilities of humans and machines to outperform opponents [5]
- A Synthetic Environment for Logistics will provide grounds for scenario planning and decision support in rapid decision making
- Interoperability within a coalition relies on confidence in each other's techniques and tactics

Sir David Richards outlined :

> "With the capability to 'punch' hard and not be a logistical or tactical drag on a coalition, we will be especially welcomed by our friends and feared by our enemies."

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# Research Objectives

**Demo Synthetic Environment (SE) for MLSN Decision Making**

- Support rapid decision making with computer generated response plans to disrupted operations
- Support cooperative scenario planning for coalition operations
- Solve Reinforcement Learning Problems within SE

# Key Tools

**Game Engine**

- Unity Pro 2019.3 | C# Object Oriented Programming

**Packages**

- AI Planner v. 0.2.3
- Pro Builder
- Terrain Tools

**Assets**

- EasyRoads3D
- SNAPS

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# Key Techniques

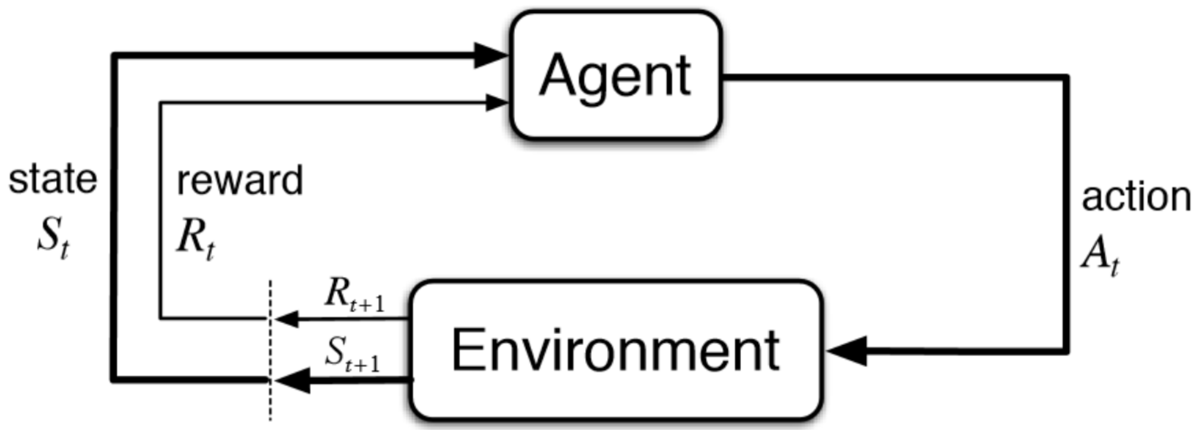
- AI Behavior Planning [3]: AI Planner enabled agent planning, dynamic programming concepts, and capability to solve a Markov Decision Process.

- Graph Theory [1]: A waypoint system with nodes with uni or bidirectional edges are incorporated to enable the vehicles to drive on the correct side of the road to add realism. Nodes also enable computation of path distances and the ability to work with zones. Some waypoint systems in Unity are too generalized to do this.

- A* Algorithm to compute the Shortest Path [1]

- Validation: The plan visualizer enables the ability to verify computations and look ahead to future planning periods. Additionally after each action, a result may be printed out from the state representation to log any value

# Reinforcement Learning Concept [2]



# Unity AI Planner Package

"The AI Planner package can generate optimal plans for use in agent AI, storyline generation/management, game/simulation validation, tutorial creation, automated testing, and many more. A generic planner framework, authoring tools, and a plan visualizer are provided in the package [4]"

**Features**

- Uses state-of-the-art Algorithm, Trial-based Heuristic Tree Search (THTS)—generalization of the Monte Carlo Tree Search [3].
- Provides Framework to represent Markov Decision Processes which are fundamental to solving Reinforcement Learning problems [6,7].
- Employs Directed Acyclic Graphs which auto constructs linkages
- Accessible State Representation
- Versatile (e.g. time, uncertainty, cells, system planning, cooperative, adversarial behavior)

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# AI Planner Terms to Know

- Environment
- Agent
- State Representation (Current / Future)
- Action (Preconditions, Effects on Environment)
- Delayed Reward
- Terminal Condition
- Plan
- Trait
- Heuristic
- Discount Factor
- Expectation vs. Uncertainty
- Abstract Planning
- World State

# Scenarios Modelled:

**Scenario 1:** Vehicle Breakdown and Recovery

**Scenario 2:** Vehicle Routing Problem, Cooperative Water Distribution

**Scenario 3:** Threat Zones

# VIDEO / Model Presentation

## Challenges and Future Work

- Cloud resources required
- Tool compatibility was an issue at times.
- Waypoint system is effective but very slow to build out. Automate in the future by point click to add waypoint to graph / network.
- Collision Detection not programmed due to time
- Physics Behaviors were limited due to time
- COVID prevented use of Manchester's Data Observation Lab for this project.
- Scenario 3 is outlined only; deleting the waypoints caused errors. Alternative solution was to update the A* algorithms cost to avoid bad paths due to threat.

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# Summary

- Developed demo of a Synthetic Environment for MLSNs
- Orchestrated Scenarios and solved MDPs with Unity AI Planner
- Demonstrated Human Machine Teaming Concept

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