<div align="center">**Research Review**</div>

Key Developments in AI Planning and Search

1. Development of Genetic Fuzzy Tree Methodology have allowed fuzzy logic based artificial Intelligences to be developed that can be applied to incredibly complex problems.
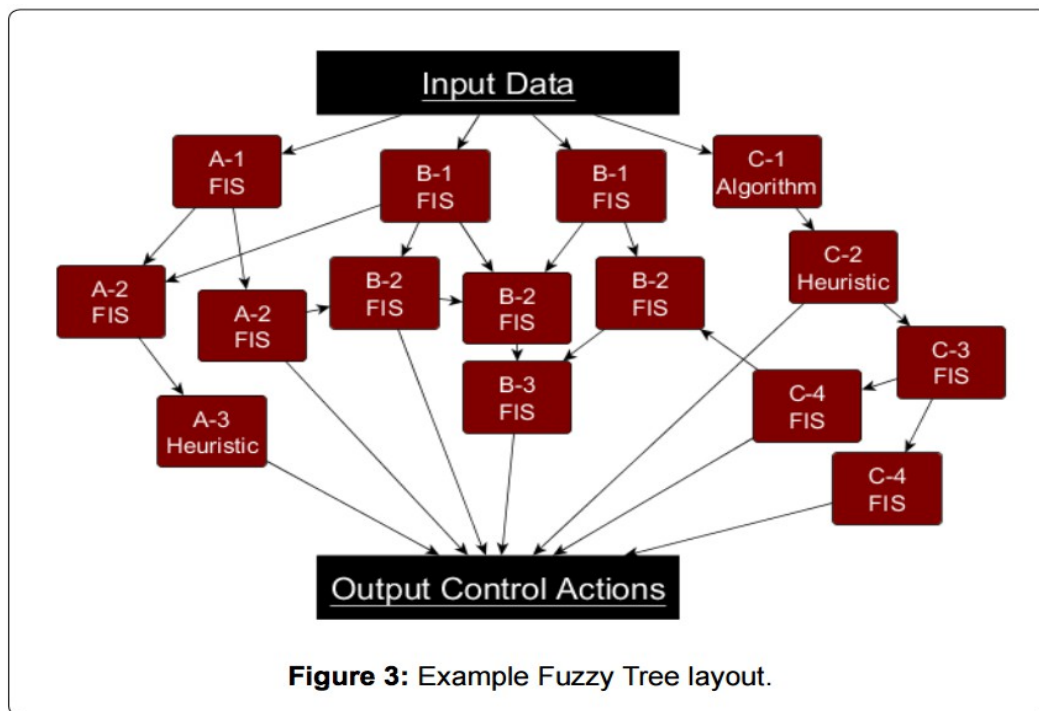
ALPHA an artificial intelligence that controls flight of Unmanned Combat Aerial Vehicles in aerial combat missions within an extreme-fidelity simulation environment was developed and assessed by a human expert.

Problem and Domain:

In Unmanned Combat Aerial Vehicles (UCAV) or drones millisecond long timeframes for critical decisions in addition to average human visual reaction time of 0.15 to 0.30 seconds plus the time to come up with a optimal plan causes huge latency.

AI Solution:

- ALPHA uses Genetic Fuzzy Tree (GFT) . A collection of Fuzzy Interface Systems (FIS) with varying levels of connectivity is employed to train each FIS simultaneously.
- By Breaking up the problem into many sub-decisions, the solution space is significantly reduced.

Figure 3: Example Fuzzy Tree layout.

References:

Ernest N, Carroll D, Schumacher C, Clark M, Cohen K, et al. (2016) Genetic Fuzzy based Artificial Intelligence for Unmanned Combat Aerial Vehicle Control in Simulated Air Combat Missions. J Def Manag 6: 144. doi:10.4172/2167-0374.1000144

https://www.omicsgroup.org/journals/genetic-fuzzy-based-artificial-intelligence-for-unmanned-combat-aerialvehicle-control-in-simulated-air-combat-missions-2167-0374-1000144.pdf

2. Overcome 'Catastrophic Forgetting'. Intelligent agents must demonstrate a capacity for learn consecutive tasks without forgetting how to perform previously trained tasks (This forgetting is called 'Catastrophic Forgetting') to achieve general Intelligence (GI).

Algorithm called Elastic Weight Consolidation (EWC) was developed that computes how important each connection in a neural network is to the task that it has just learned and then assigns this connection a mathematical weight proportional to its importance. The weight slows down the rate at which the value of that particular node in the neural network can be altered. In this way, the network is able to retain knowledge while learning a new task.

Problem and Domain:

Use the same AI agent to play 10 Atari Video games and perform at human- level.

AI Solution:

- EWC enabled software was able to learn all ten games from scratch demonstrating General Intelligence over the domain (10 Atari games) and perform at human level.

References:

http://www.pnas.org/content/114/13/3521.full.pdf

https://www.bloomberg.com/news/articles/2017-03-14/deepmind-finds-way-to-overcome-ai-s-forgetfulness-problem

3. Improvement over partially Observable Markov decision process (POMDP) for online planning under uncertainty leading to near optimal best policy output.

Solving POMDP is computational intractable. Determinized Sparse Partially Observable Tree (DESPOT) provides a near optimal best policy.

Problem:
- POMDP has the problem of 'Curse of dimensionality'. State space is large and grows exponentially with the number of state variables.
- POMDP has the problem of 'Curse of history', the number of action-observation histories under

consideration grow exponentially with the planning horizon.
These curses result in exponential growth of computational complexity and is a barrier for large scale planning.

Solution:

- DESPOT speeds up look-ahead search by providing a sparse approximation to the standard belief tree. Construction leverages a set of randomly sampled scenarios.
- To further improve lookahead search, anytime heuristic algorithm is used, whenever maximum planning time is reached, it outputs the action with the best regularized value based on the partially constructed DESPOT. If search heuristic is admissible, given sufficient time, algorithm finds optimal action. If the heuristic is not admissible. Performance of the algorithms degrades gracefully.

DESPOT: ONLINE POMDP PLANNING WITH REGULARIZATION

Figure 2: DESPOT running in real time on an autonomous golf-cart among many pedestrians.

References:

http://www.jair.org/media/5328/live-5328-9824-jair.pdf