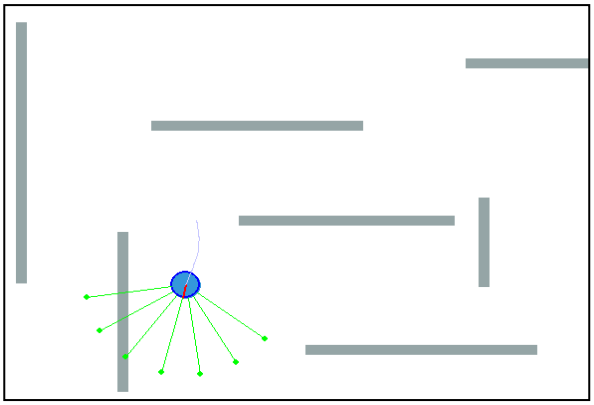
AMITY CENTRE FOR ARTIFICIAL INTELLIGENCE

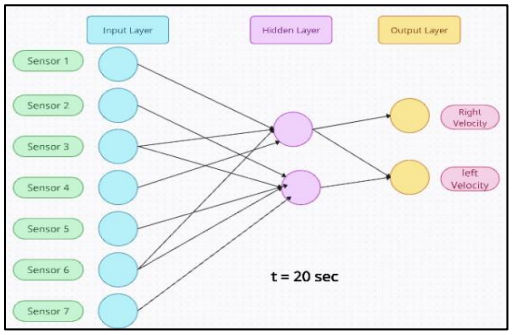
USRF-2025

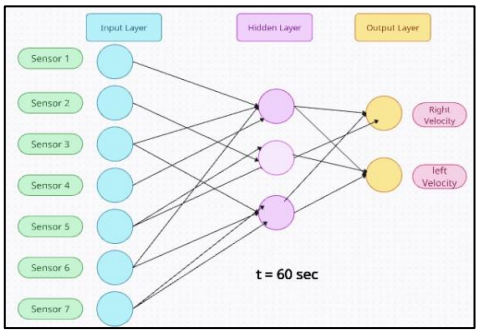
NeuroEvolution of Augmenting Topologies Based Autonomous Robot Obstacle Avoidance in Cluttered Environments

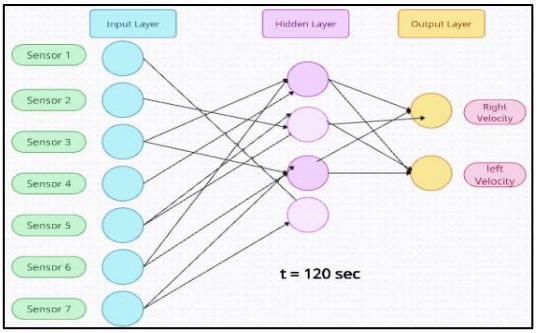
Overview:

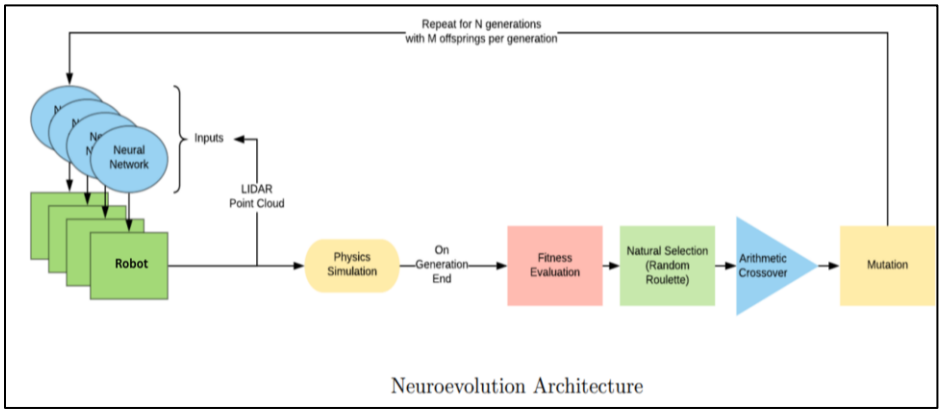
- Evolved an intelligent mobile robot using NEAT for autonomous
- Built a custom 2D top-down simulator in Pygame + PyMunk with randomly placed obstacles in a bounded arena.
- Implemented dynamic sensor input weighting in the neural network to mimic biological attention for improved spatial awareness.
- Designed a reward system favoring forward movement, obstacle avoidance, and exploration; penalized idle or repetitive actions..
- Added real-time visualization of sensor rays and path tracking, with planned neural topology visualization for interpretability.

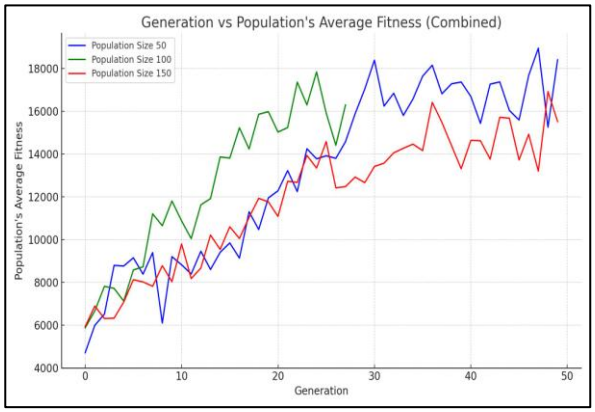












Descriptions / Inference

- The robot successfully learned autonomous navigation through neuroevolution, adapting to different obstacle environments without explicit programming.
- Integrating the attention mechanism significantly improved decision-making by enabling the network to focus on the most relevant sensor inputs.
- The evolved neural networks demonstrated emergent intelligent behaviour, such as turning before obstacles and choosing wider paths for safe traversal.
- NEAT's ability to evolve both topology and weights allowed for flexible and adaptive neural architectures, avoiding overfitting to specific maps.
- The simulation provides a low-cost and scalable environment for testing bio-inspired learning approaches in robotics

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Results :

- Robot successfully learns to navigate unseen environments.
- NEAT with enhanced sensor resolution (7 sensors) performs better in complex layouts compared to earlier low-sensor-count models. Improved fitness growth curve and general behavior observed.