



TORCS Racing

Computational Intelligence

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(Grop 39)



Agenda

- What Controllers were used?
- How we measured their Accuracy?
- What Fitness Function was used?
- What we did to improve performance?
- What is the final outcome?



Controllers

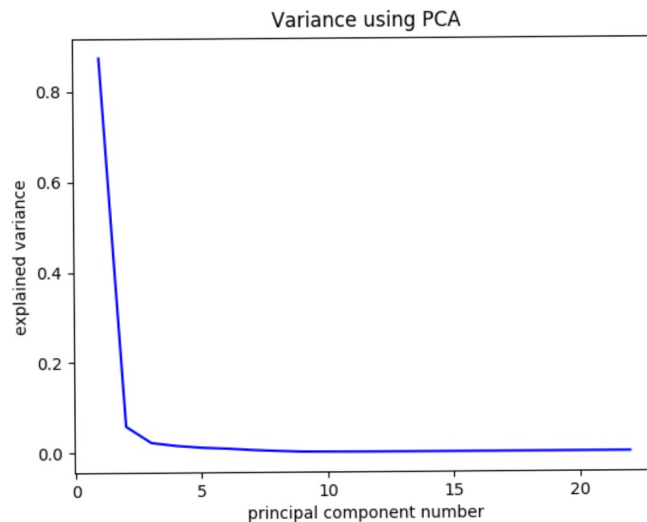
- Neural Networks
 - Recurrent Neural Network (Pyrenn) using RTRL
 - Echo State Network (Pyesn)
- Evolutionary Computing
 - NEAT and HyperNEAT
- Swarm Behaviour
 - Emergent Collective Behaviour

Accuracy Measure

- Neural Networks
 - 80% training and 20% splitting, measure of MSE after 100 generations
- Evolutionary Computing
 - Evolved a Recurrent NN from scratch
 - Fitness function = Maximum Distance Travelled
 - Constrain = Car should stay within track edge
 - Tested the network on 20% of test data to visualize the output
- Swarm Behaviour
 - No measure on accuracy, but only created an Emergent collective behaviour

Performance Improvement

- Feature Extraction
 - PCA
 - New features from Sensor 8,9 and 10



- Activation Functions
 - Tanh, Sigmoid, clamped and Sin
 - Sin performed the best for our network

Performance Improvement

- Normalization of Inputs
 - $\text{Angle} = \text{Angle} / \pi$
 - $\text{Speed} = (\max(0, \min(\text{Speed}, 200)) / 100) - 1$
 - $\text{D_center} = \max(\min(\text{D_center} / 2, 1), -1)$
 - $\text{D_Edge} = ((\text{D_Edge} + 1) / 100.5) - 1$

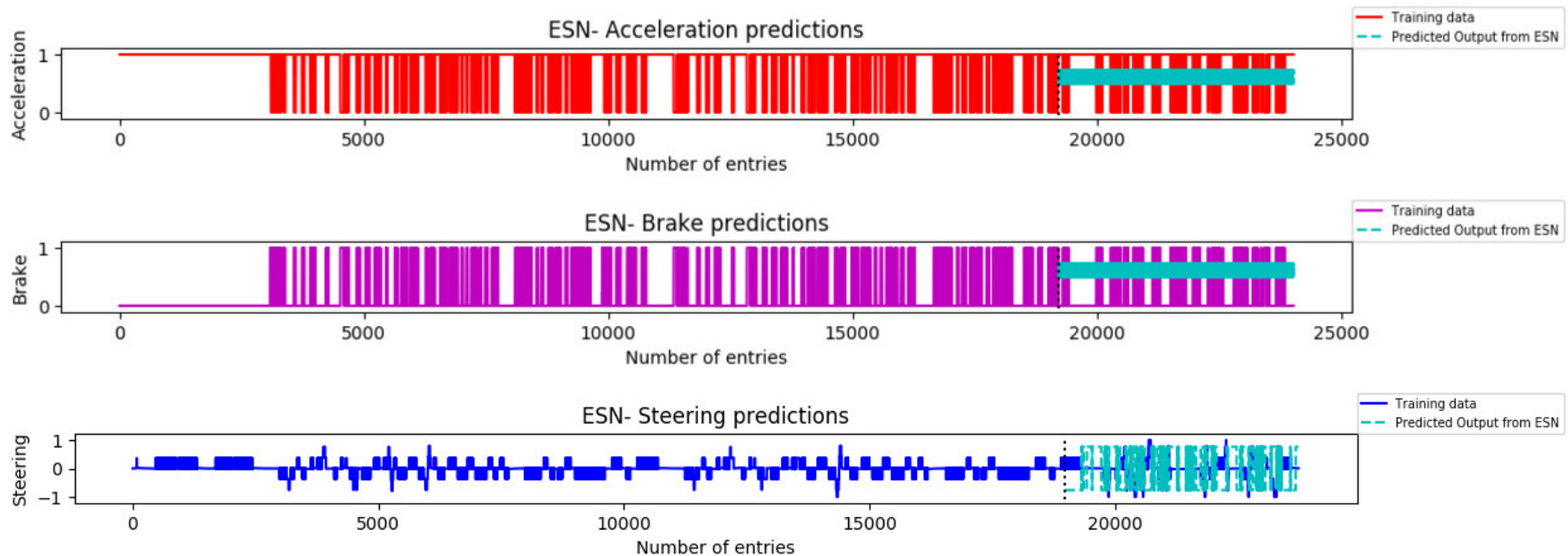


Fitness Function

- Constraint Optimization problem
- Maximize the fitness function
 - Fitness = Distance travelled in a lap
 - Constrain = Stay within the track edges

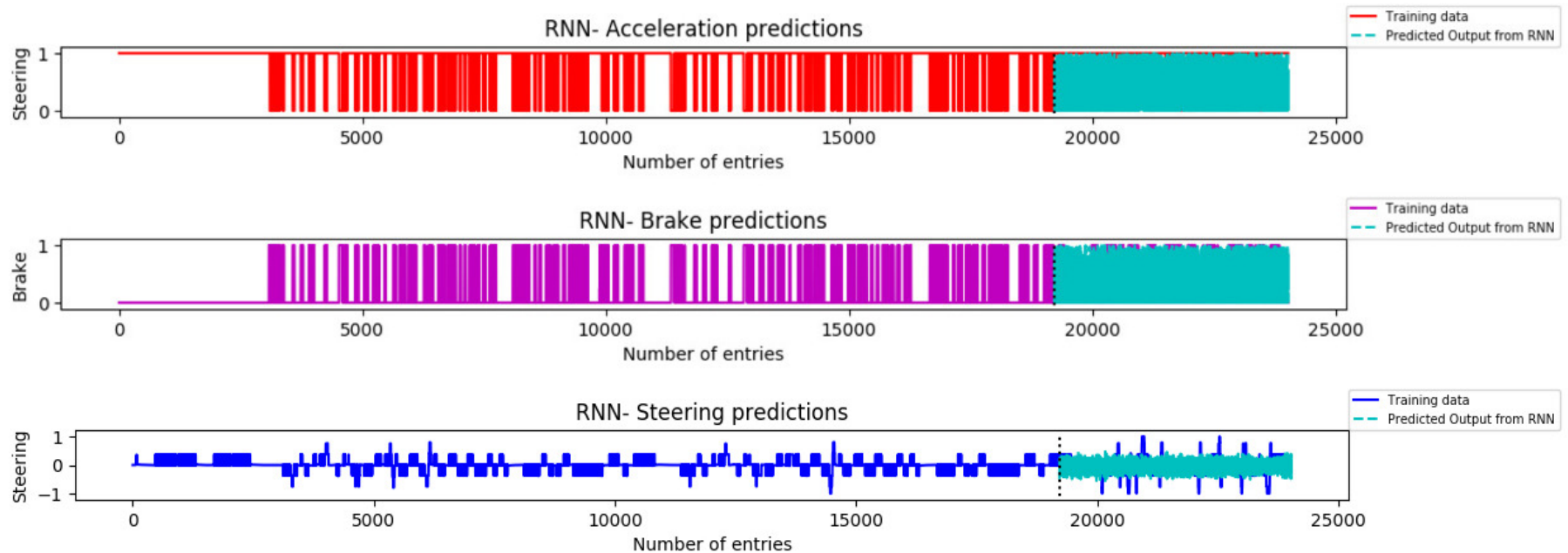
Results

- Predictions of ESN



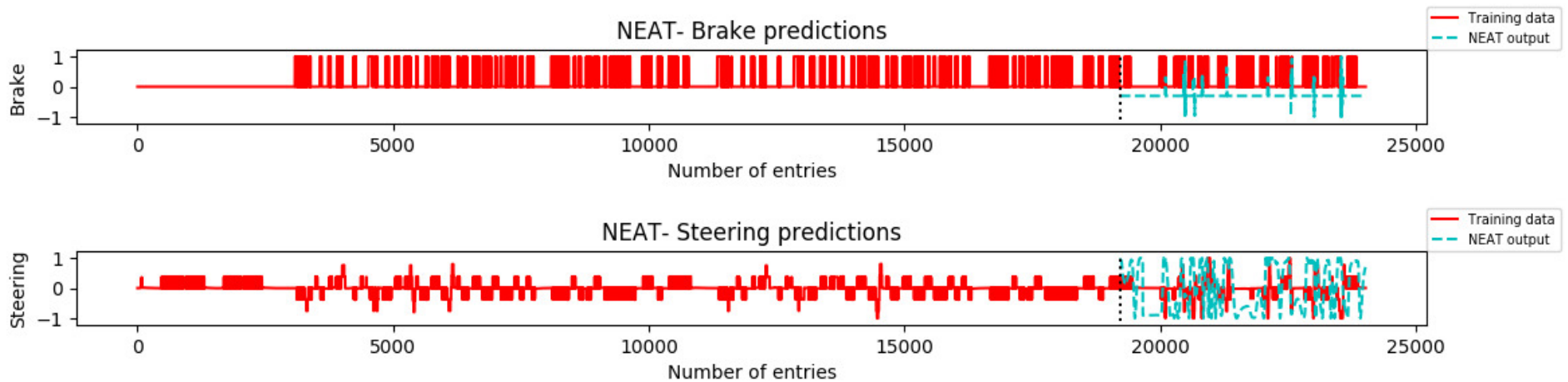
Results

- Predictions of RNN



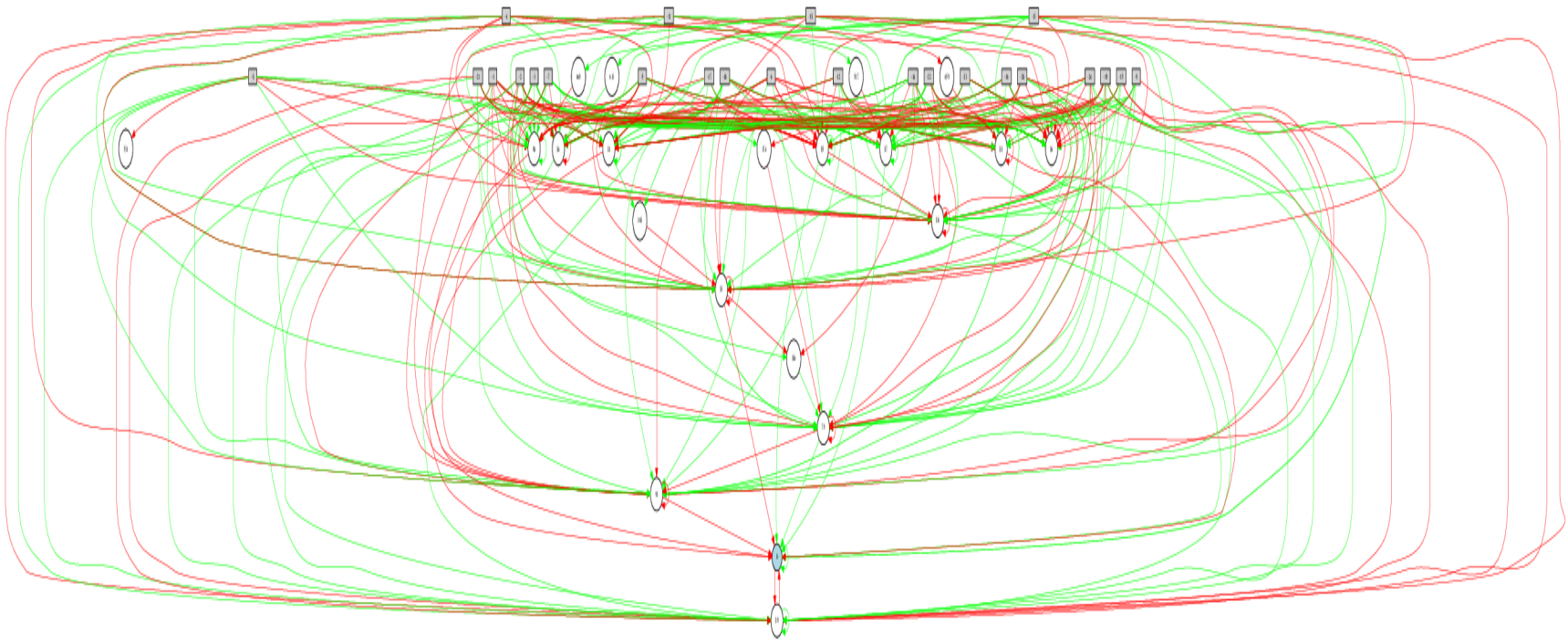
Results

- Predictions from NEAT



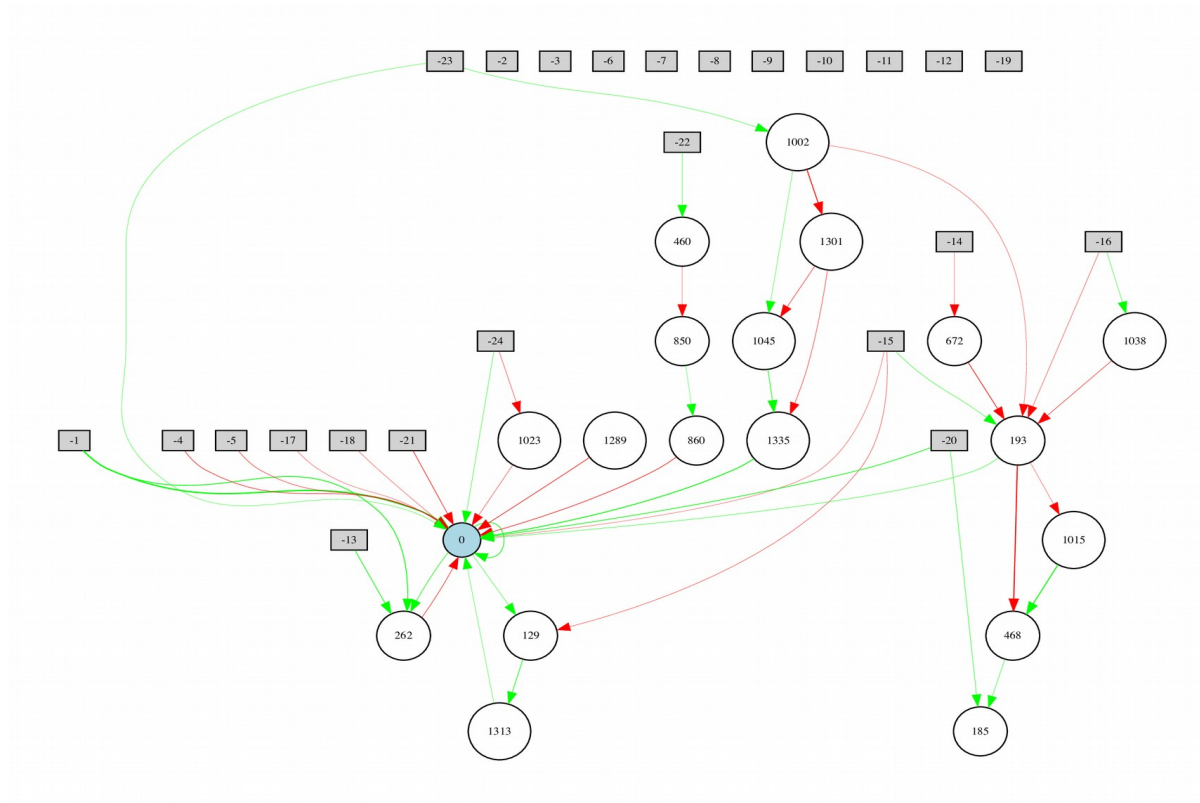
Results

- NEAT- Steering Topology



Results

- NEAT- Brake Topology



Results

Emergent Collective Behaviour

