Evolving Spiking Neural Networks for Robot Sensory-motor Decision Tasks of Varying Difficulty

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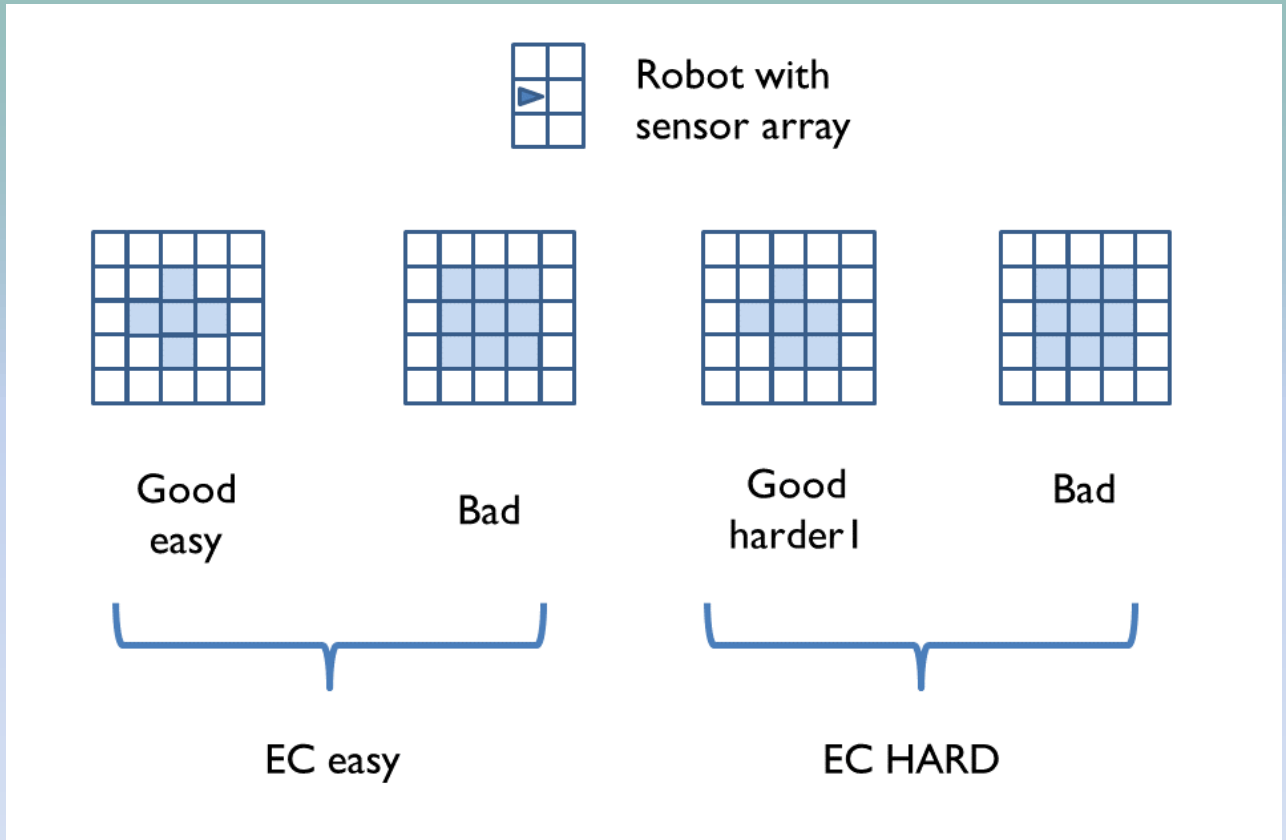
A simple robot task



B. Fullmer and R. Miikkulainen, Using Marker-based Genetic Encoding of Neural Networks to Evolve Finite-State Behavior, ECAL 1991.

EC Lessons

Restrict SNN complexity

- chromosome-drives growth

Left/right symmetry

- not zero or 100% -- gene controlled

Fitness function

- hierarchical vector – still exploring

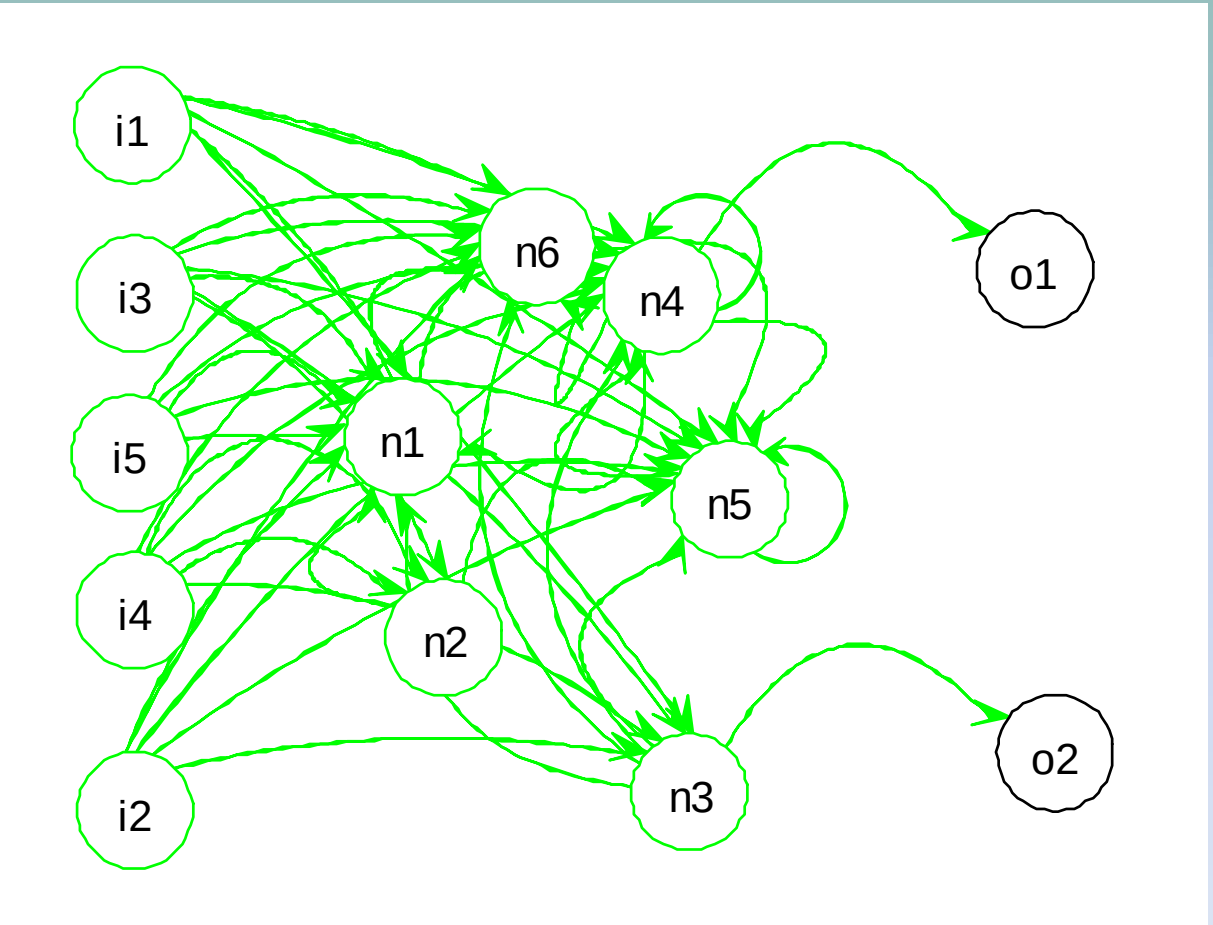
Crossover

- not too vigorous, or too little

Sensors

- richer information helps -- scaleup

One Evolved SNN



Artificial Psychology

48 successful trials of 1 SNN

Freq of 48	Unique move sequences
5	1nm,33st
22	2nm,32st
12	1nm,1cc,32st
7	1nm,1st,1cl,31st
2	1nm,1cc,1st,2cl,29st

BAD Object
5 distinct behaviors

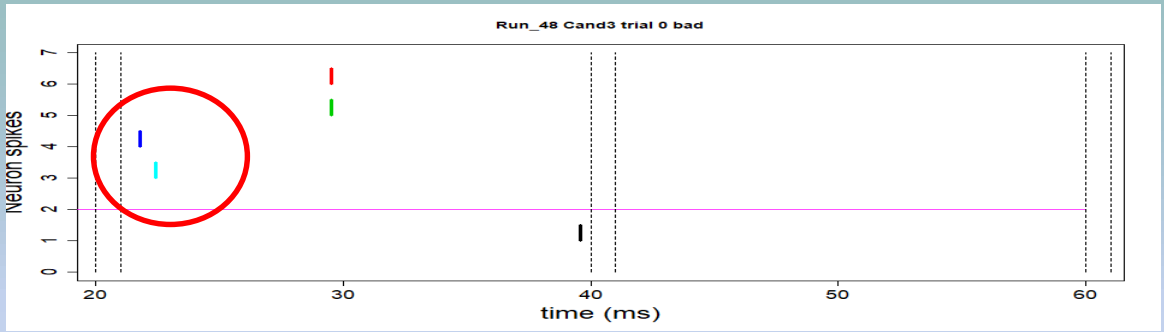
GOOD Object
31 distinct behaviors

Freq of 48	Unique move sequences
4	1nm,2st
2	1nm,1cc,1st
1	1nm,1cc,2st
2	1nm,1cc,3st
1	1nm,1st,1cl,1st
4	1nm,1st,1cl,2st
2	1nm,5st,1cl,2st
2	2nm,5st,1cl,1st
1	1nm,1cc,1st,1cl,2st
2	1nm,1cc,3st,1cl,1st
1	1nm,1cc,4st,1cl,2st
2	1nm,1st,1cl,1st,1cl,2st
1	1nm,1st,2cl,2st,1cl,3st
1	1nm,1st,1cl,4st,1cl,3st
2	1nm,2st,2cl,4st,1cl,3st
1	2nm,3st,1cl,6st,1cl,3st
1	1nm,1st,1cl,2st,1cl,3st
1	1nm,1cc,3st,1cl,6st,1cl,3st
3	1nm,1cc,1st,2cl,10st,1cl,2st
1	1nm,1st,2cl,1st,1cl,1st,1cl,3st
1	1nm,1st,1cl,3st,1cl,2st,1cl,2st
1	1nm,1st,1cl,3st,1cl,2st,1cl,3st
1	1nm,1cc,1st,1cl,2st,1cl,1st,1cl,3st
2	1nm,1cc,2st,1cl,5st,1cl,2st,1cl,3st
1	1nm,1st,1cl,1st,1cl,1st,1cl,2st,1cl,3st
1	1nm,1st,1cl,1st,1cl,1st,1cl,2st,1cl,4st
1	1nm,1st,1cl,3st,1cl,1st,1cl,2st,1cl,3st
1	1nm,1st,1cl,1st,1cl,1st,1cl,6st,1cl,3st
1	1nm,1st,1cl,2st,1cl,1st,1cl,1st,1cl,2st,1cl,3st
1	1nm,1cc,1st,1cl,6st,1cl,1st,1cl,2st,2cl,1st,1cl,2st
2	1nm,1st,1cl,1st,1cl,1st,1cl,1st,1cl,1st,1cl,2st,1cl,3st

Artificial Neurology

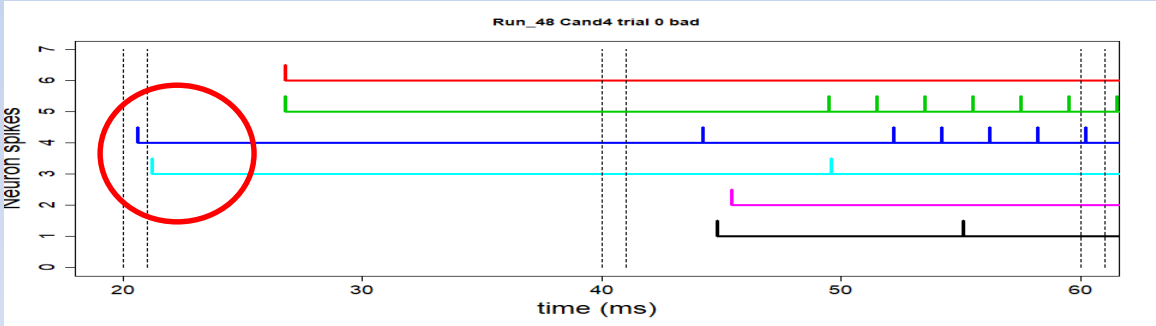
SNN internal dynamics

Cand1



O2 – N4
O1 – N3

Cand2



O1 – N4
O2 – N3

two spikes cause Cand1 step forward – WRONG MOVE
one spike causes Cand2 to turn – RIGHT MOVE

A Conjecture

We see evidence of a cognitive strategy:

- a hard-wired default behavior – used often
- special circuits override in special circumstances

This strategy in literature

- Konrad Lorenz – On Aggression 1963
- Daniel Kahneman – Thinking Fast and Slow 2011

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