



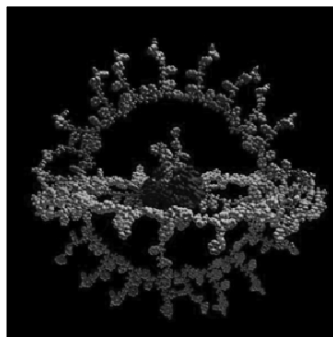
A Developmental Genetics-Inspired Approach to Robot Control

Sanjeev Kumar
Genetic and Evolutionary Computation Conference, 2005
Washington, D.C.

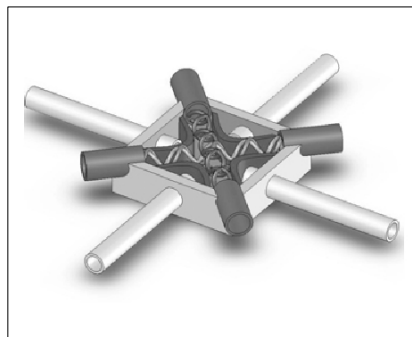
Filip Jagodzinski
29 June 2007

Laboratory for Perceptual Robotics – Department of Computer Science

Nanonrobotics; Intelligence

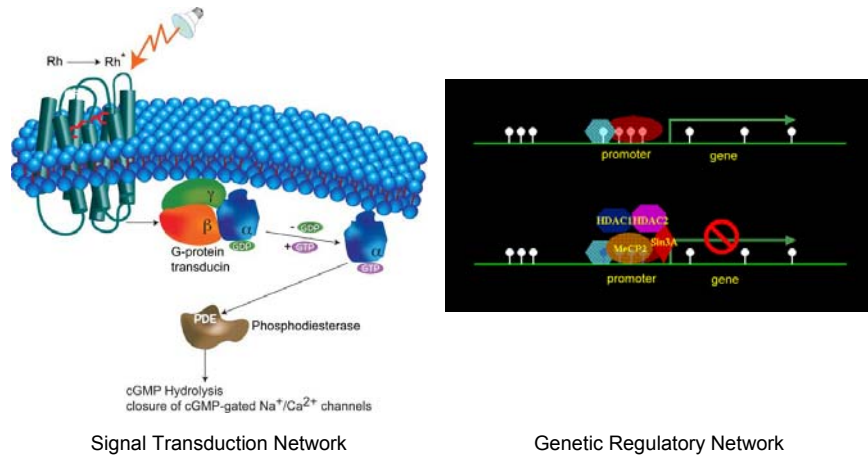


Modular Design - Nanorobots

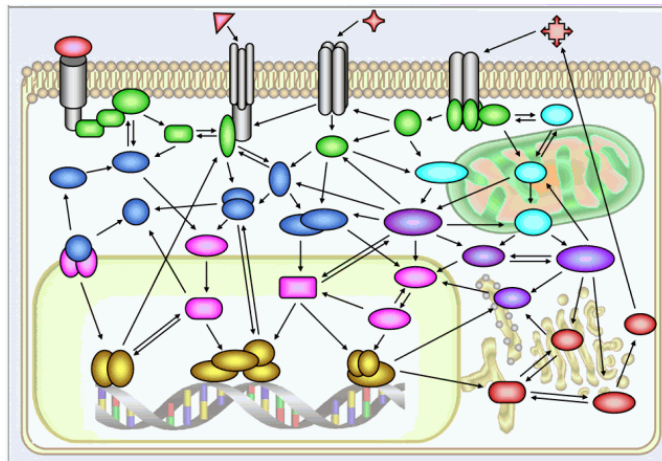


Intelligence - Genetics

STNs and GRNs



Gene Network



Paper Outline

Goal: Adapt processes and mechanisms from developmental biology to help build scalable, complex technologies.

Target: Reactive Robot Control

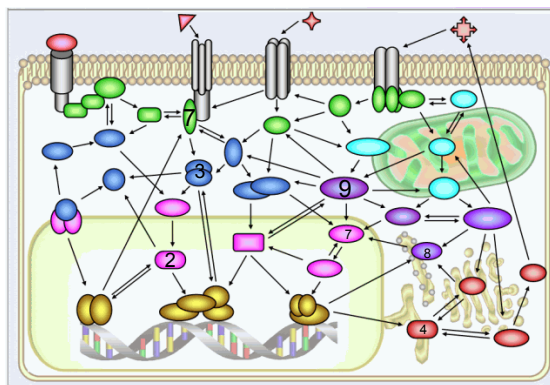
Platform: Pioneer 2DX & Amigobot



Goal: Explore ability of GRNs to specify reactive robot behaviors through the evolution of general purpose obstacle avoidance GRN controller.

Available “proteins” and their purpose

ID	Purpose
0	Move Forward
1	Move Backward
2	Rotate Counter-clockwise
3	Rotate Clockwise
4	No Purpose
5	Rear Left Sensor
6	Left Sensor
7	Front-Left Sensor 1
8	Front-Left Sensor 2
9	Front-Right Sensor 1
10	Front-Right Sensor 2
11	Right Sensor
12	Rear-Right Sensor



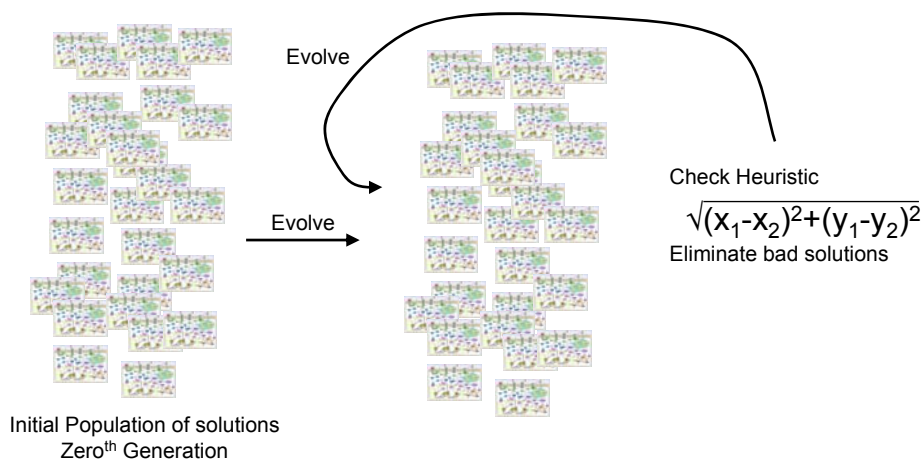
How do we build this network?

Building the Network

Genetic Algorithms (GA)

- Global Search Heuristics
 - Euclidean Distance = $\sqrt{(x_1-x_2)^2+(y_1-y_2)^2}$
 - Avoidance = $\sum(e + s + \text{SonarValue}_{\text{MAX}})$
- Evolutionary Algorithms
 - Inheritance
 - Mutation
 - Selection
 - Crossover
- Candidate solutions to an optimization problem evolve over time
- A single generation: one application of either a 2-point crossover or mutation
- GA initializes a population of solutions randomly, then improve it through repetitive generations

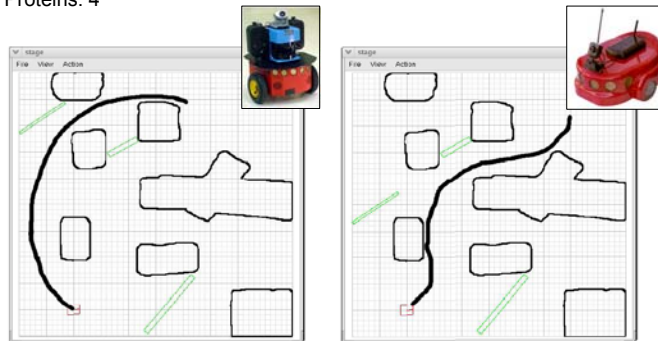
Building the Network – A Pictorial Representation



Experiment 1: Memorizing a Path

Evolution & Development

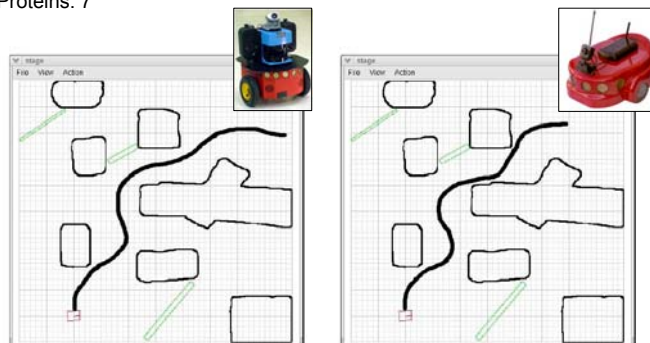
- Population Size: 100
- Generations: 100
- Num Genes: 10
- Num Proteins: 4



Experiment 2: System-Environment Interaction

Evolution & Development

- Population Size: 25
- Generations: 50
- Num Genes: 15
- Num Proteins: 7





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