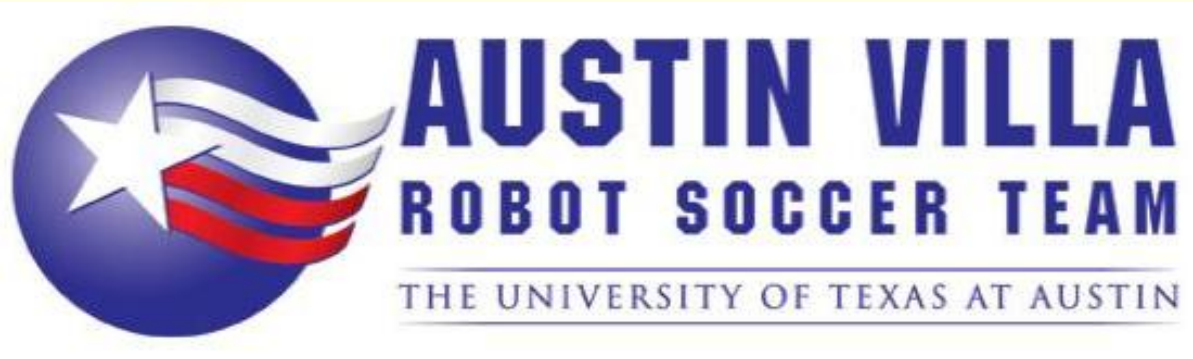
Machine Learning through Morphing of Heterogeneous Robot Models

Patrick MacAlpine

Department of Computer Science, The University of Texas at Austin

June 27, 2013



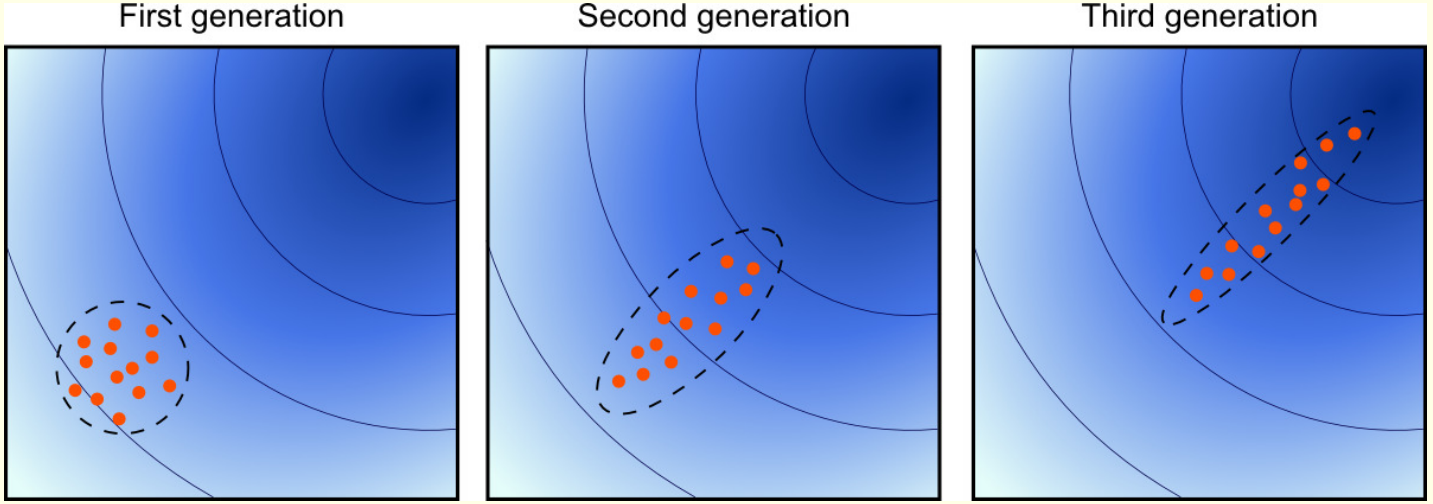
Heterogeneous Models

- New for the 2013 3D Simulation League
- Models only released about a week before the competition

Problem

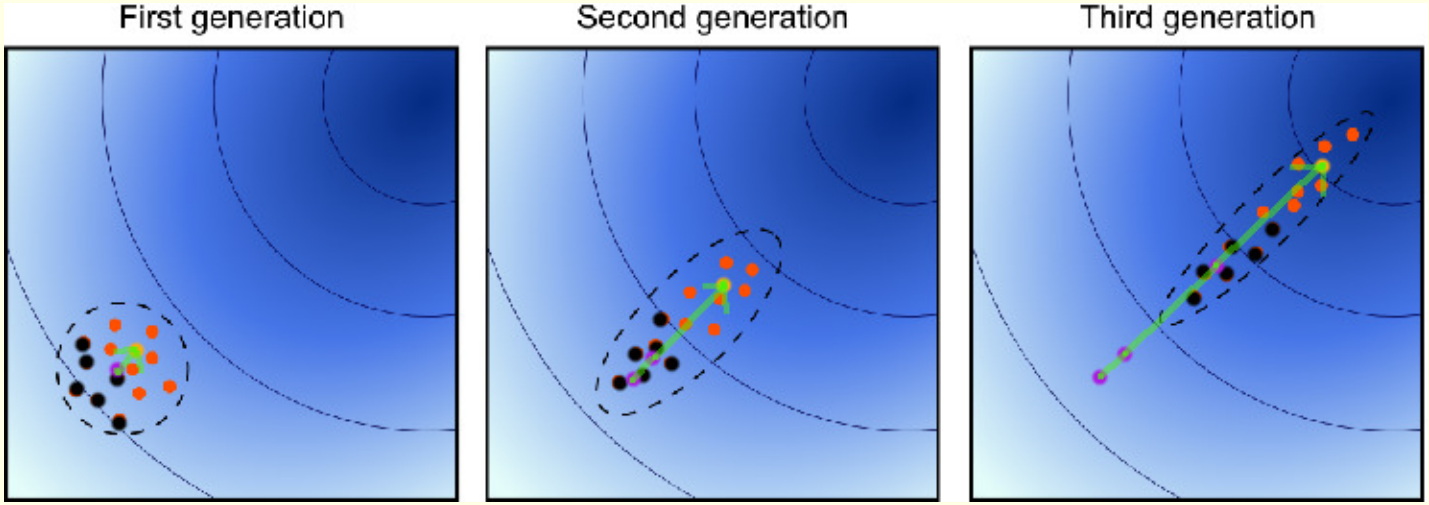
- Changing a robot's model breaks learned locomotion primitives such as walking, kicking, and getting up
- Want to develop new motion primitives with machine learning techniques but need a good seed
- Need to be able to get up after falling to learn most motion primitives

CMA-ES (Covariance Marix Adaptation Evolutionary Strategy)



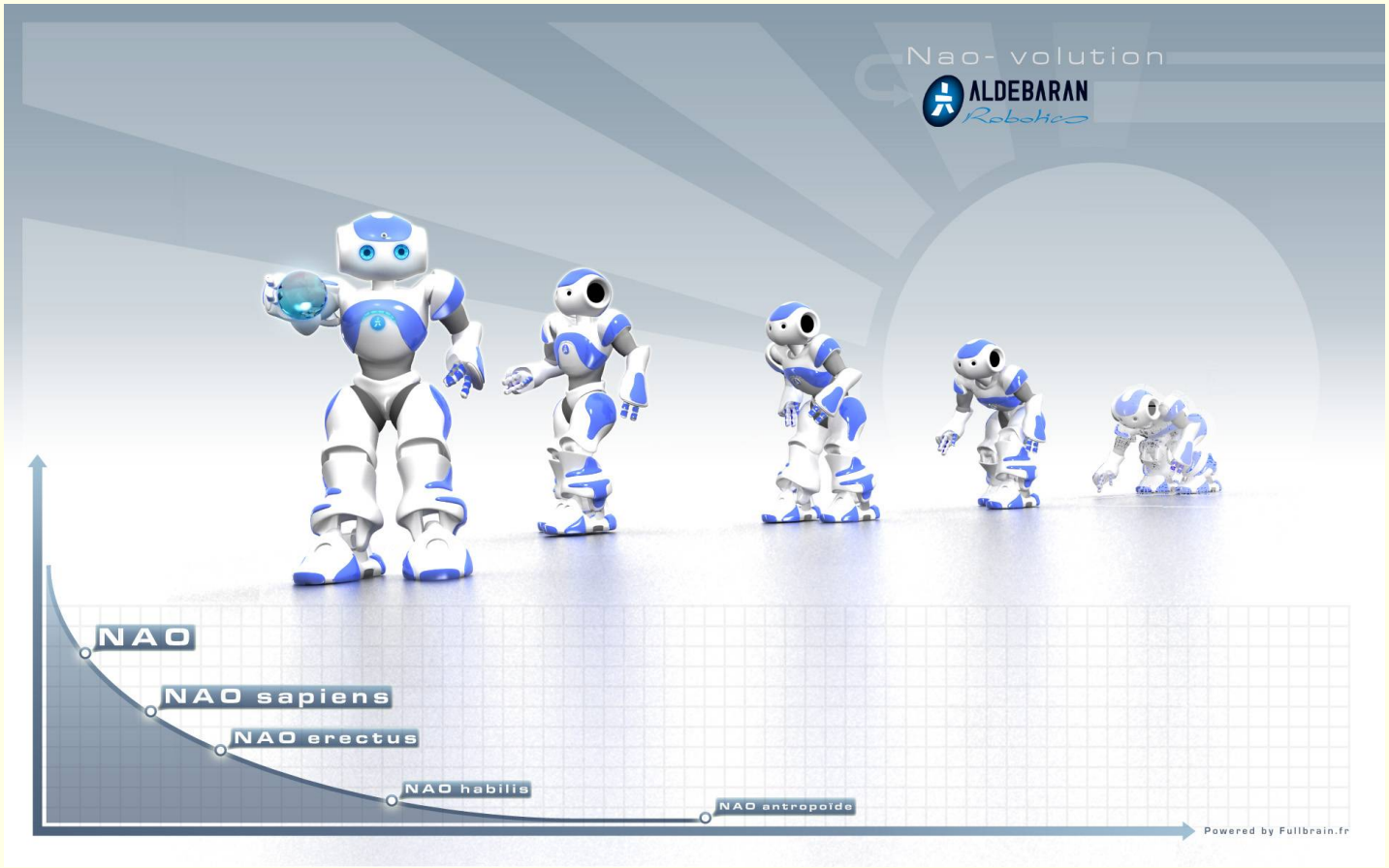
- A stochastic, derivative-free, evolutionary numerical optimization method for non-linear or non-convex problems
- In each generation, candidates are sampled from a multidimensional Gaussian and evaluated for their fitness
- Two main principles for parameter adaptation:
  - Mean maximizes the likelihood of previously successful candidates, Covariance maximizes the likelihood of previously successful search steps (Natural Gradient Decent)
  - Evolution paths are recorded and used as an information source

CMA-ES (Covariance Marix Adaptation Evolutionary Strategy)



- A stochastic, derivative-free, evolutionary numerical optimization method for non-linear or non-convex problems
- In each generation, candidates are sampled from a multidimensional Gaussian and evaluated for their fitness
- Two main principles for parameter adaptation:
  - Mean maximizes the likelihood of previously successful candidates, Covariance maximizes the likelihood of previously successful search steps (Natural Gradient Decent)
  - Evolution paths are recorded and used as an information source

Solution



- Can slowly morph or grow robot model from original model to target model during optimization
- Increment model whenever we reach a certain threshold of average fitness
- No longer need a new seed for target model!

Getup from Back

- Series of fixed poses assumed sequentially

Getup from Back

Getup from Front

- Series of fixed poses assumed sequentially

Getup from Front

More Information

UT Austin Villa 3D Simulation Team homepage:
www.cs.utexas.edu/~AustinVilla/sim/3dsimulation/

Email: patmac@cs.utexas.edu

This work has taken place in the Learning Agents Research Group (LARG) at UT Austin. LARG research is supported in part by NSF (IIS-0917122), ONR (N00014-09-1-0658), and the FHWA (DTFH61-07-H-00030).