Autonomous Virtual Humans

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Contents

- Introduction
- Implementation
  - 3D Graphics
  - Simulated Physics
  - Neural Networks
  - Genetic Algorithms
- Results
- Future Work

Introduction

- Project goal: to create motor control systems for virtual humans to allow them to control their behaviors without using pre-scripted animations

- Simulations take place in a graphical 3D environment with simulated physics

- Control systems are artificial neural networks evolved with genetic algorithms

Implementation (1/4)

- C++, Windows & Linux
- Graphics: OpenGL
- Physics: Open Dynamics Engine
  - Simple ODE demo
  - Limp virtual human demo

Implementation (2/4)

- Artificial neural network control system

Body part positions,
head velocity, etc.
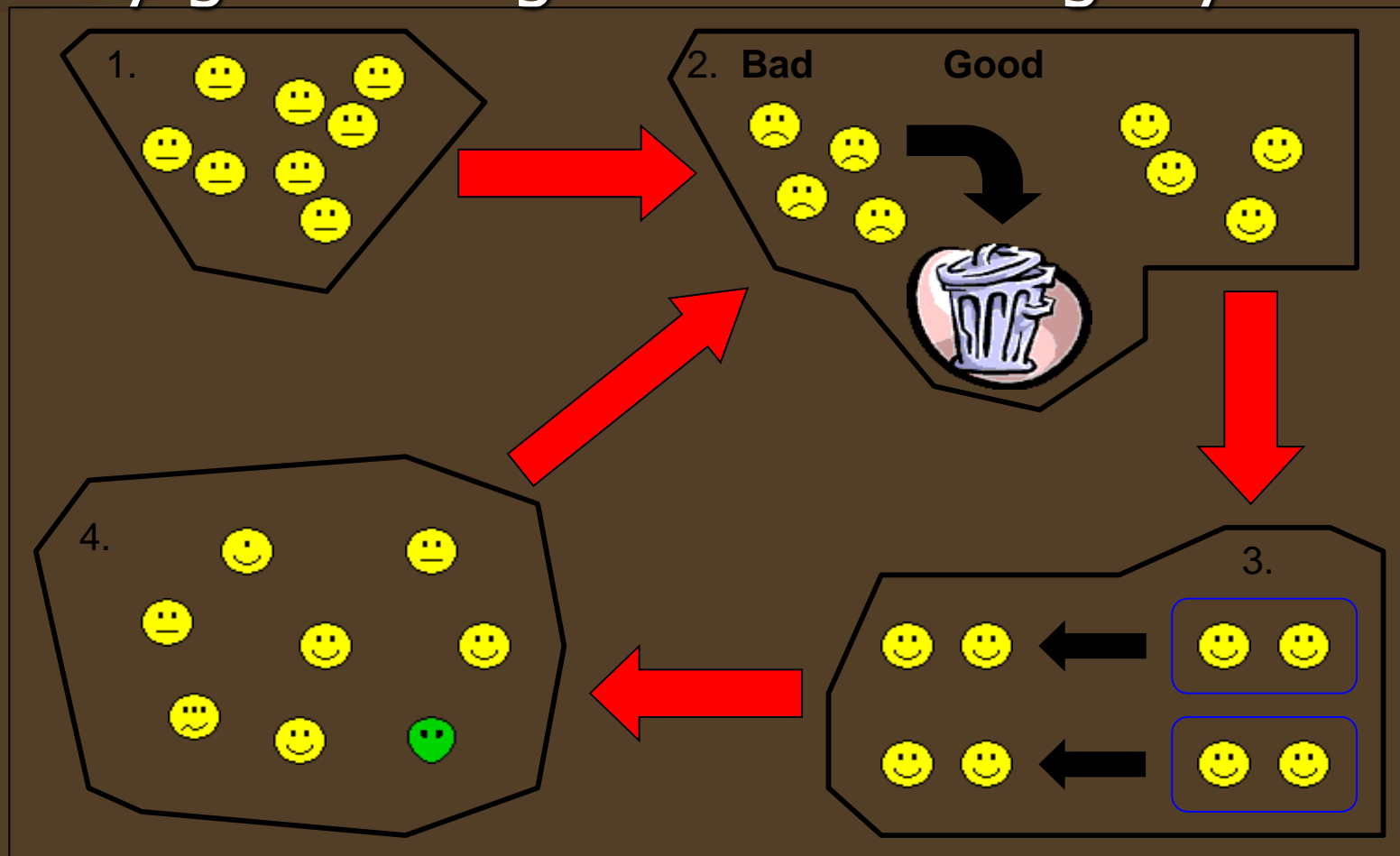
Joint torques
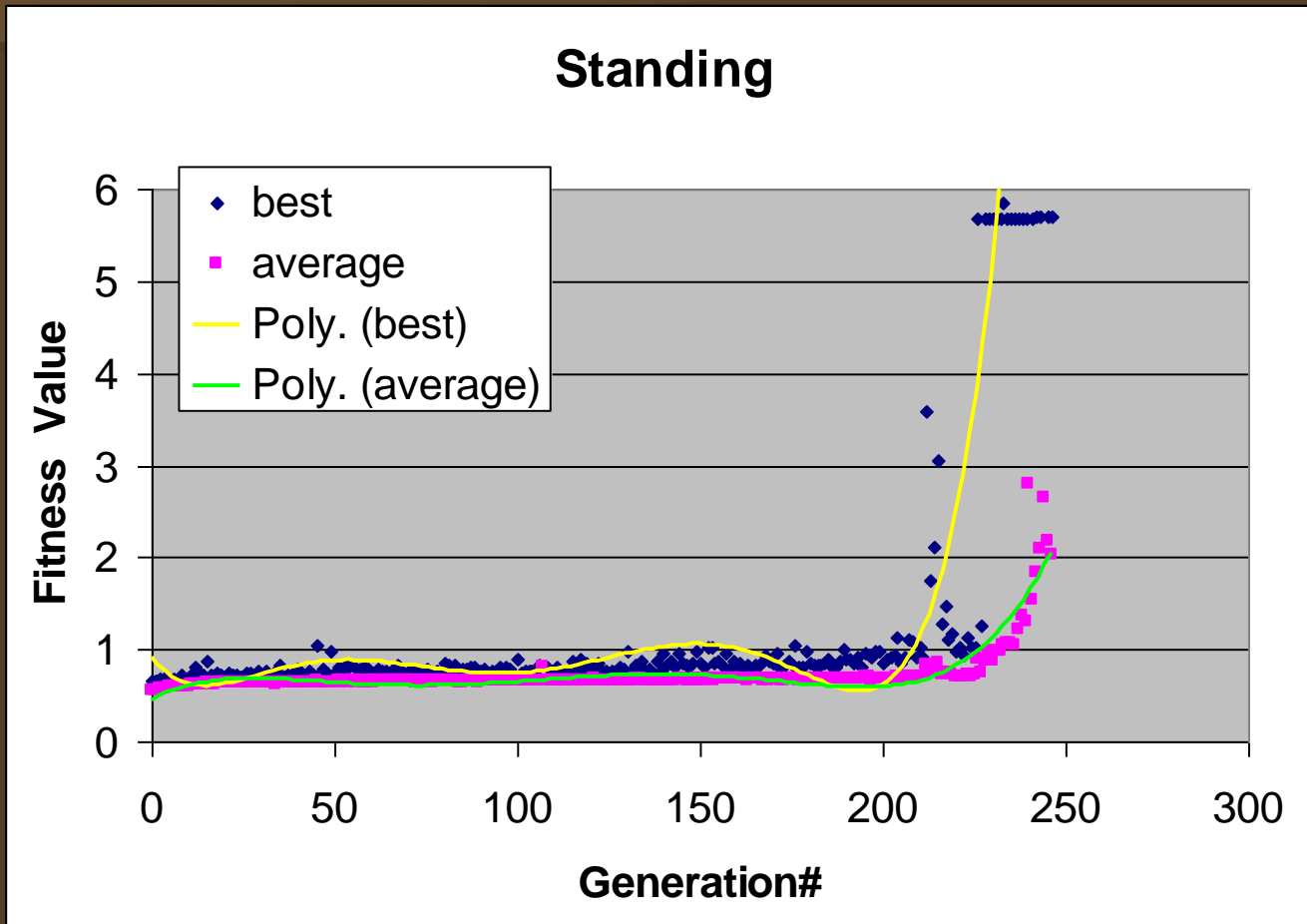("muscles")
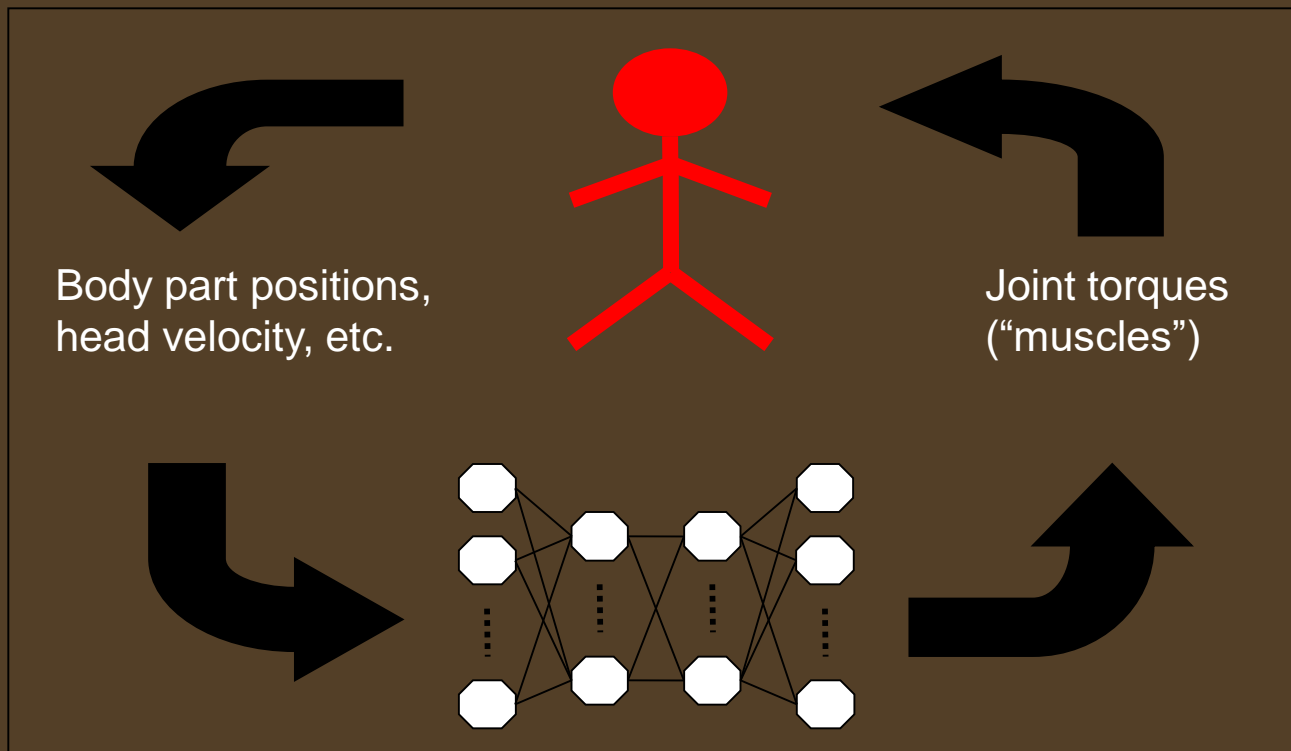
Implementation (3/4)

- Genetic algorithms
  - Start with random population of solutions
  - Evaluate each individual's "fitness"
  - Throw away bad solutions
  - "Mate" good solutions to produce offspring
  - Randomly mutate new offspring
- Algorithm is stochastic hill-climbing, so it can find ways to get out of local maxima

Implementation (4/4)

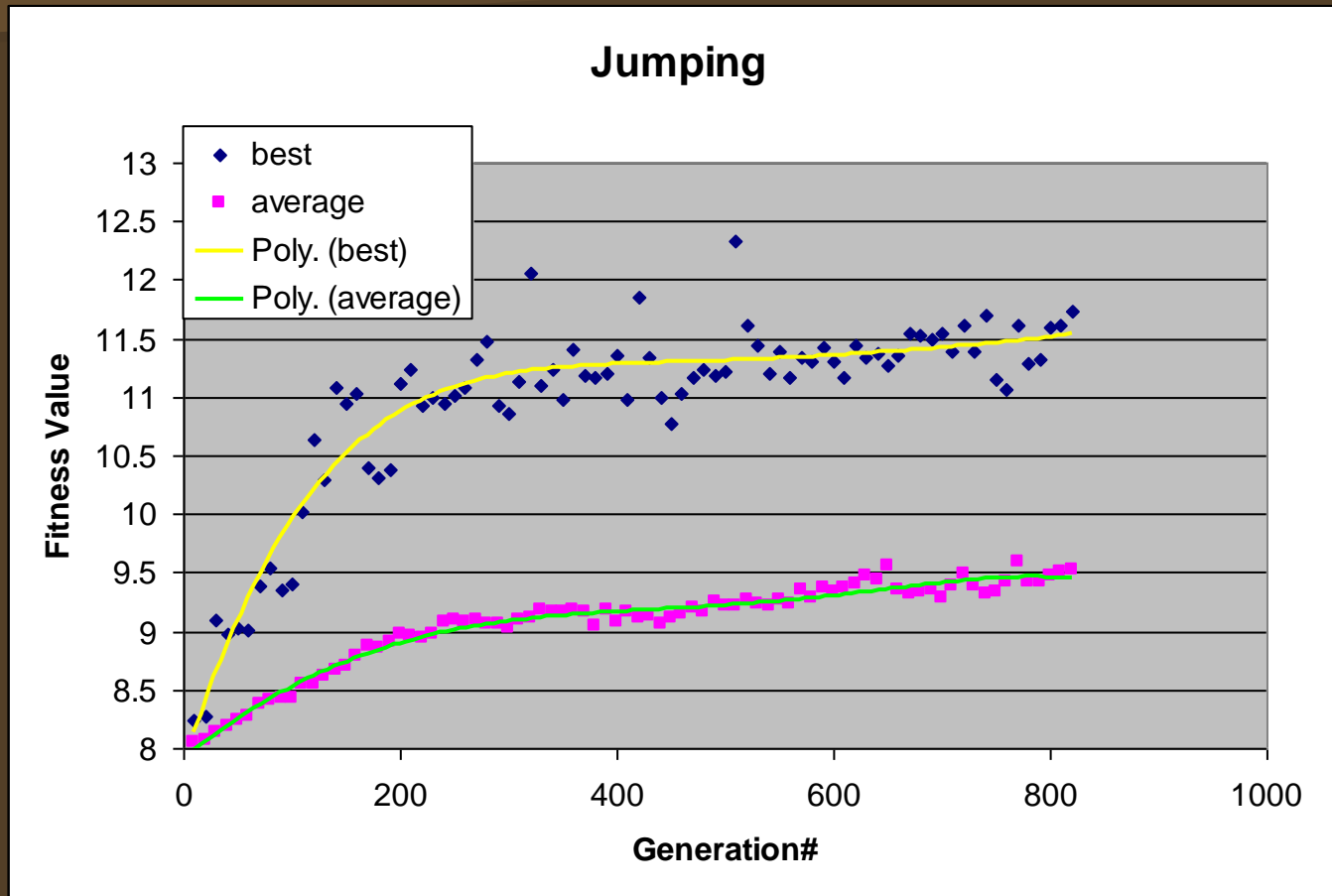- My genetic algorithm "learning" system

Results (1/4)

Standing — scatter plot of Fitness Value vs Generation# showing "best", "average", "Poly. (best)", and "Poly. (average)" series.
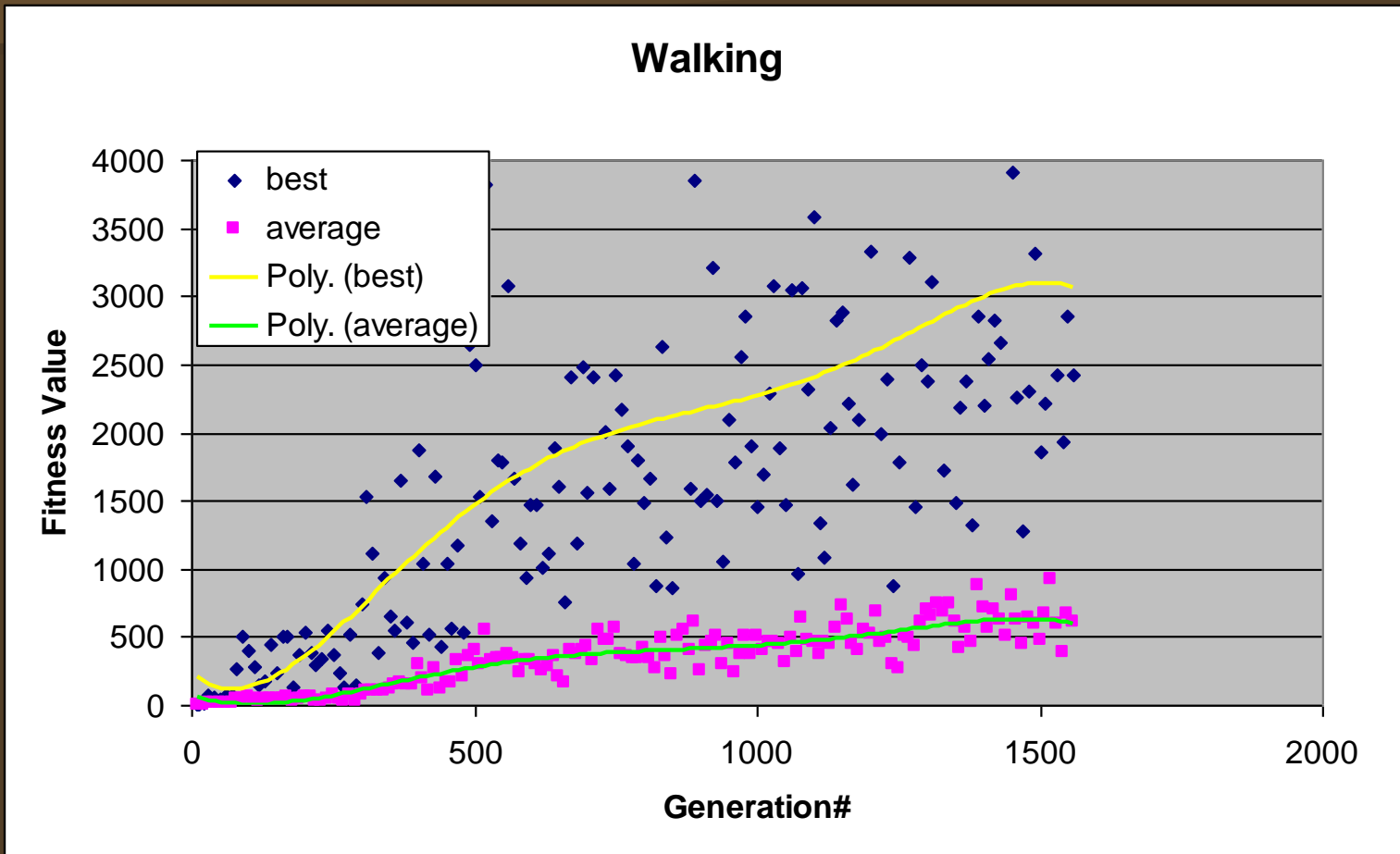
Results (2/4)

Results (3/4)

Results (4/4)

- **Video Demonstrations**
  - Standing Video
  - Jumping Video
  - Walking Video

Future Work (1/2)

- Try more complex behaviors
  - Staying balanced when pushed
  - Walking across uneven terrain
  - Carrying objects
  - Jumping over obstacles
  - Operating virtual machinery
- Use A* to guide paths
- Competitions between virtual humans

Future Work (2/2)

- Create a hierarchy of neural nets to perform tasks with multiple steps
- New sensory inputs to neural net
  - Sense of touch
  - Sense of sight
- More complex bodies
- Try simulated annealing instead of ANNs

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