

Design Decisions for a Hands-On Evolutionary Robotics course for Undergraduates in Engineering

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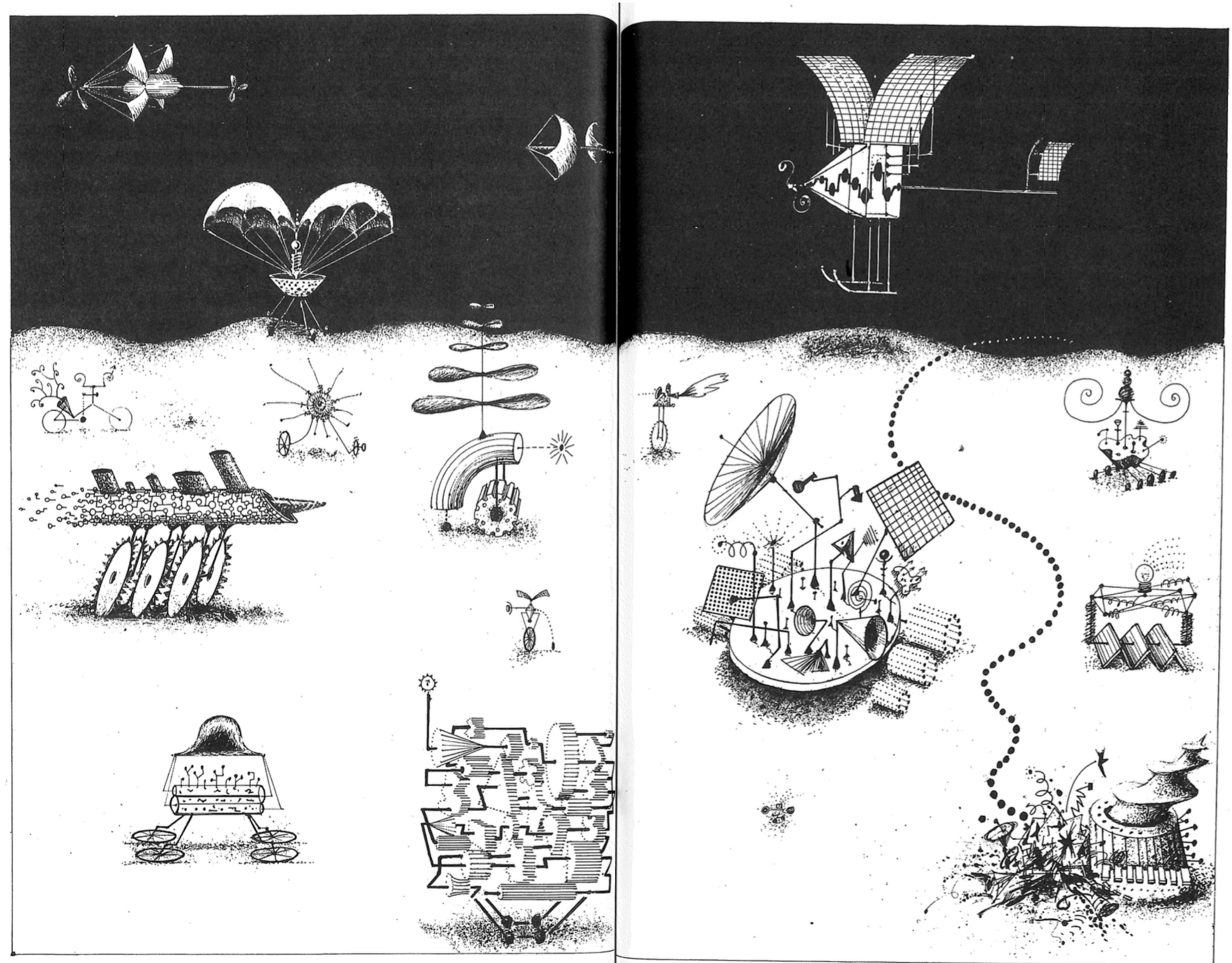
Evolutionary Robotics

(Robot Learning, NeuroRobotics, Embodied AI)

Explore the *automated design of autonomous robots*, integrating topics in **Artificial Intelligence**, **Robotics**, and **Cognitive Science**.

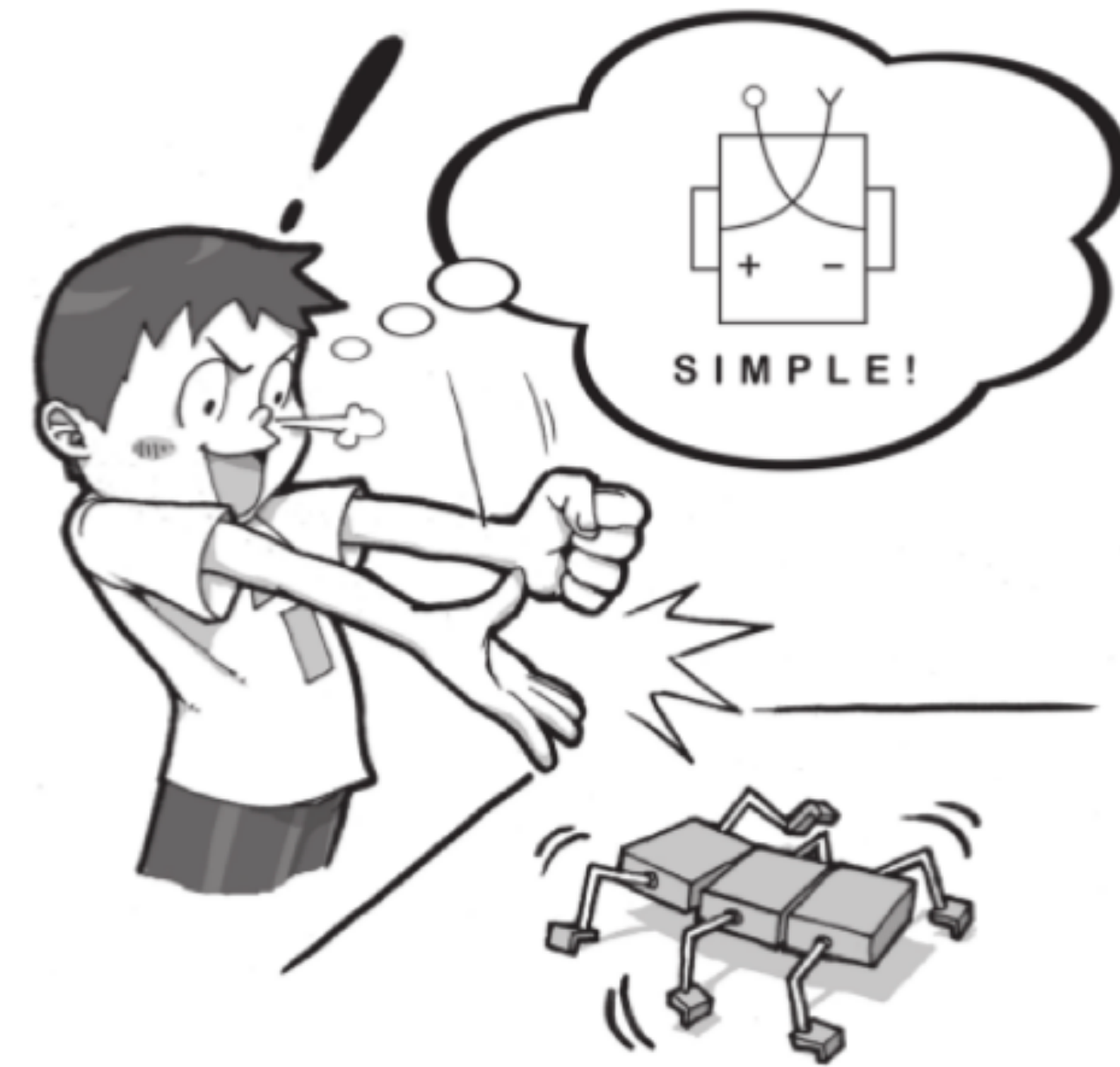
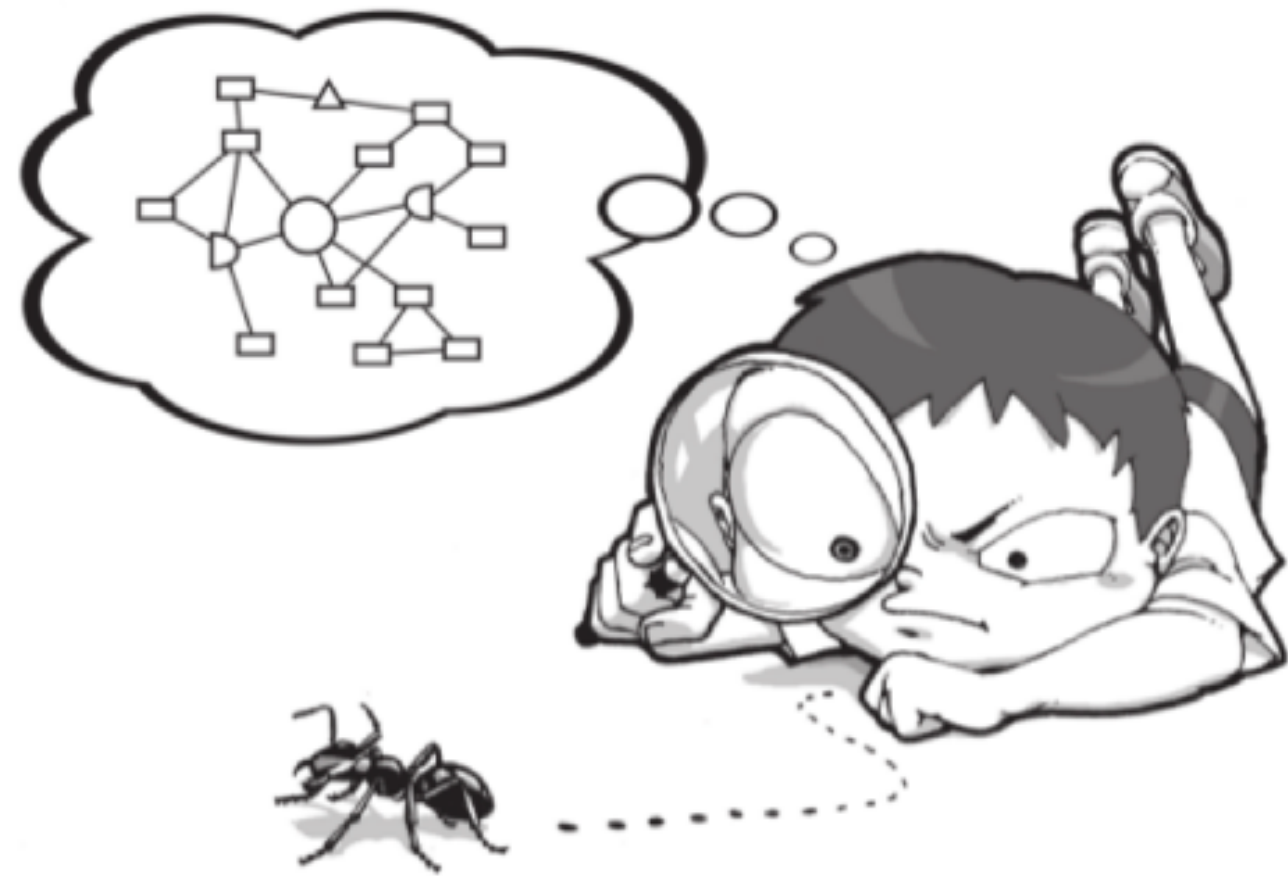
Topics such as the design of **robot morphologies**, **neural controllers**, **evolutionary computation**, **autonomous embodied agents**, **physical simulations**, and **computer-designed organisms**.

Open to students in ALL engineering majors with some programming experience.



Broad Motivation

Better understand adaptive behavior in living organisms through the generation of artificial systems with their robustness, flexibility, and adaptability, and intelligence.



Objectives

Nature-
inspired
Problem
Solving

Automated
Design of
Autonomous
Machines

Simulation
Models in
Science &
Eng.

Every week, regardless of topic, students get to practice the scientific workflow:

Hypothesis: What do you expect to happen, and why?

Experiment: Run it, log it, version it

Visualization: Fitness curves, behavior videos, comparative plots

Lab notebook: Some form of keeping thoughts and data and visualizations together

Reflection: What surprised you? What would you change?

Planned Schedule for a 10-week Quarter

**Evolutionary Algorithms:
Exploring the Space of Possibilities**

**Neural Networks:
Learning from Experience**

**Neuroevolution for Classic Control:
Putting Brain & Body Together**

**Reinforcement Learning:
A Different Lens and Comparisons**

**MuJoCo and Legged Locomotion:
A More Complex Body**

**Parallel Evolution:
Multiple Bodies in Physics Engine**

**Building a Robot:
Custom MuJoCo Models**

**Navigation: Evolving a
Controller for the Custom Robot**

Sim-to-Real Transfer

Final Project

Weekly Pace

Lect.

Demo

Disc.

Present

Tutorial

Libraries, Stack, Robots, and Tools

Evolutionary Algorithms:

DEAP



DISTRIBUTED
EVOLUTIONARY
ALGORITHMS IN
PYTHON

Neural Networks:

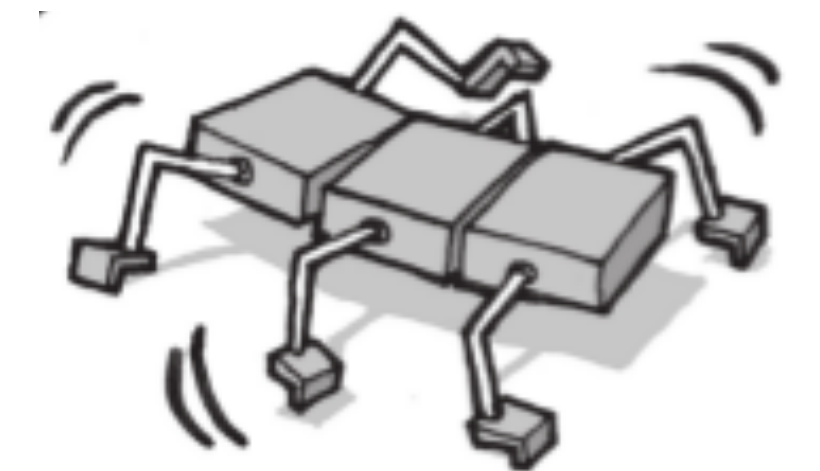
PyTorch



Body and Environment Simulations:

Gymnasium

Mujoco



Robotic Hardware:
Hand-built wheeled robot, a robotic
arm, and legged walker

MuJoCo

Advanced physics simulation

