

λ *Lounge*

Evolutionary Algorithms

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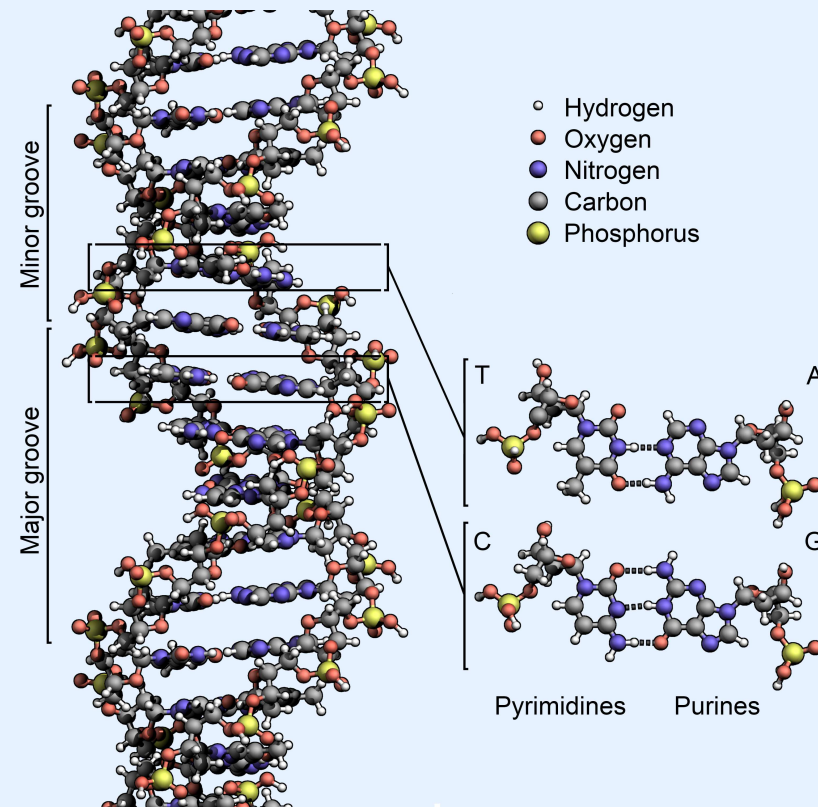
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Thursday, March 1, AD 2012

Evolutionary Algorithms Are Cool!



Why Use and Evolutionary Algorithm?

- The evaluation is very time-consuming.
- The problem is computationally difficult.
- You don't understand the problem.
- You are working with a real-world system.
- You just want to study evolutionary processes themselves.

Where Are Evolutionary Algorithms Used?

- Artificial Intelligence.
- Financial modeling.
- Military applications.
- Complex engineering systems.
- Etc.

The Evolutionary Algorithm

1. Population Initialization: generate a new population.
2. Fitness Evaluation: rate each member of the population.
3. Repeatedly:
 - (a) Parent Selection: choose who to breed.
 - (b) Recombination: cross the parents.
 - (c) Mutation: applied to the offspring.
 - (d) Fitness Evaluation: usually just the new offspring.
 - (e) Survivor Selection: kill off the weak.

Population Initialization

- Intelligently seed the population.
Think Adam and Eve.
Pro: you can start off the population somewhere useful.
Con: you have to know where “*somewhere useful*” is.
- Randomly generate the population.
This is usually easy and usually doesn't cost too many generations.
- Doing both at the same time isn't uncommon.

Fitness Evaluation

We need to determine the fitness of our solutions.

- Minimum or maximum direct value.
- Simulation of an environment.
- Some fitness heuristic.
- Head-to-head competition.

Parent Selection

- Breed the most fit.
- Don't be too selective: you'll get stuck on local optima.
- Wide-population breeding encourages exploration.
- Local breeding encourages optimization.

Recombination



$$\begin{pmatrix} a \\ b \\ c \\ d \\ e \end{pmatrix} \oplus \begin{pmatrix} \alpha \\ \beta \\ \gamma \\ \delta \\ \epsilon \end{pmatrix} \rightarrow \begin{pmatrix} a \\ b \\ c \\ \delta \\ \epsilon \end{pmatrix}$$

Mutation



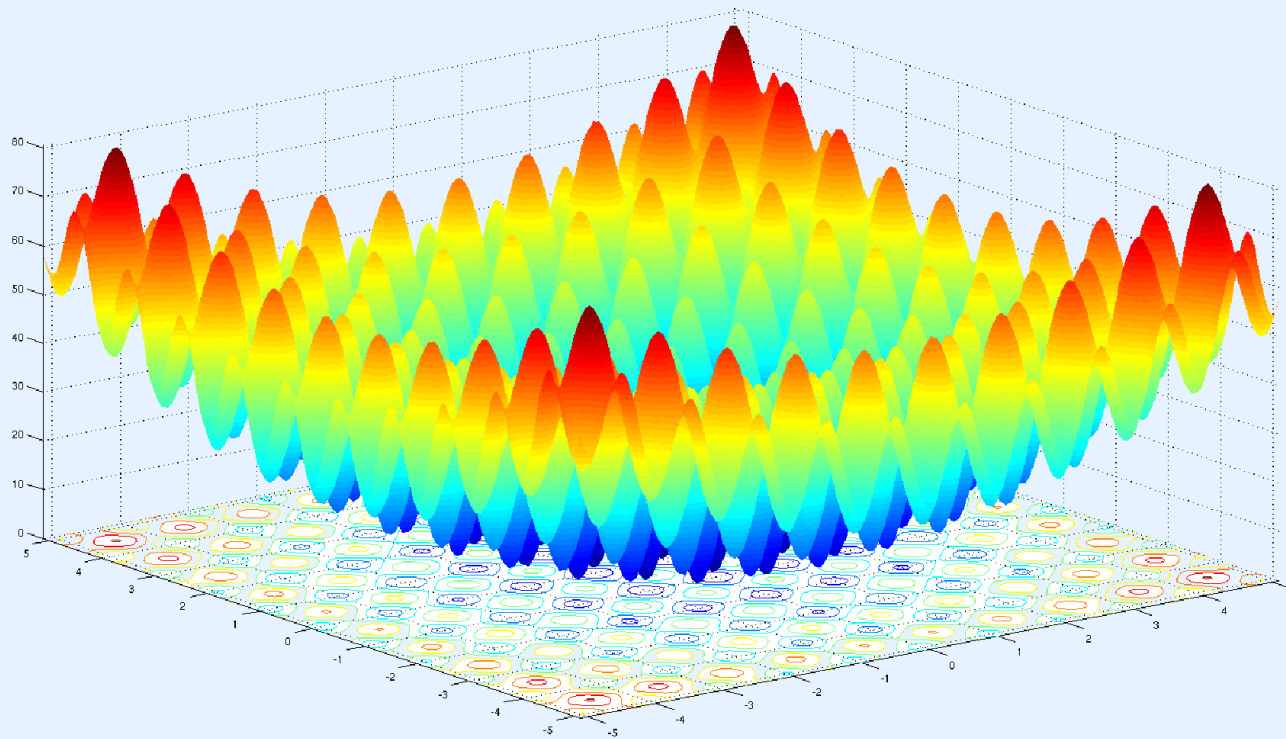
$$\begin{pmatrix} a \\ b \\ c \\ d \\ e \end{pmatrix} \rightarrow \begin{pmatrix} a \cdot 1.02 \\ b \\ c \cdot 0.975 \\ d \\ e \end{pmatrix}$$

Survivor Selection

- Remove the least fit from the population:
“cull the herd.”
- Often just reduce the population to some maximum size.
- Don't be too selective:
some population member may be useful for breeding later.

The Rastrigin Function

$$f(\mathbf{x}) = An + \sum_{i=1}^n [x_i^2 - A \cos(2\pi x_i)]$$



Let's Look at Some Code!

This is intentionally simple code.

- I want you to learn about evolutionary algorithms in this talk, not anything cool about Common Lisp.
- I want it to be an explanation, not an implementation.
- I want it to be as short and readable as possible.
- I want it to not use anything non-standard.

So in short, no, this isn't the best way to do things in the real world.

Questions?