IE 607 Heuristic Optimization

Evolutionary Computation

Origins and Inspiration from Biological Evolution

- Inspired by biological evolution – population of solutions that change based on (a) goodness (fitness) and (b) chance

- This term (EC) was invented in 1991, and a journal named after it was published in 1993 (MIT Press)

Common Characteristics of EC

- Reproduction (crossover)
- Random variation (mutation)
- Competition (fitness evaluation)
- Selection of contending individuals in a population

Classifications of EC

- **Forerunners of EC**

Fraser(1957), Canberra, Australia

Friedberg(1958)

Bremermann(1962), Berkeley, U. of California

- **Genetic Algorithms (GA)**

Holland(1962), Ann Arbor, U. of Michigan

- **Genetic Programming (GP)**

Koza(1989) President of Genetic Programming Inc. and Professor at Stanford U.

Classifications of EC

- **Evolutionary Strategies (ES)**

Schwefel, Rechenberg, & Bienert (1965), Technical U. of Berlin, Germany

- **Evolutionary Programming (EP)**

Lawrence Fogel (Sr) (1962), San Diego, U. of California

David Fogel (Jr.) (1992), Natural Selection Inc., California

References

- Evolutionary Algorithms in Theory & Pactice (Bäck, 1996)
- Handbook of Evolutionary Computation (Bäck, Fogel & Michalewicz, 1997)
- Evolutionary Computation 1 & 2 (Bäck, Fogel & Michalewicz, 2000)
- Genetic Programming I & II (Koza, 1992 & 1994)
- Adaptation in Natural and Artificial Systems (Holland, 1975)

References (cont.)

- Genetic Algorithms in Search, Optimization and Machine Learning (Goldberg, 1989)
- Genetic Algorithms + Data Structures = Evolution Programs (Michalewicz, 1996)
- A Practical Guide to Genetic Algorithms in C++ (Lawton, 1996)
- Genetic Algorithms & Engineering Design (Gen & Cheng, 1997)

Conferences

- International Conference on Parallel Problem Solving from Nature (PPSN)
- International Conference on Computational Intelligence and Natural Computing (CINC)
- Congress on Evolutionary Computation (CEC)
- Genetic and Evolutionary Computation Conference (GECCO)
- International Conference on Genetic Algorithms (ICGA)
- Annual Conference on Evolutionary Programming (EP)
- Annual Genetic Programming Conference (GP)

Journals

- Evolutionary Computation
- Evolutionary Optimization
- IEEE Transactions on Evolutionary Computation

General Structure

a. **encoding**

b. **objective function (*fitness*)** – evaluation

c. initial **population** of solutions

number of solutions

generating solutions

General Structure (cont.)

d. evolution operators (move operators)

- **mutation** – stochastic perturbation, usually to neighboring solution →ES, EP a lot; GA, GP a little. “asexual”
- **recombination** – selection of *parent* solutions and blending to form *child* solutions →GA, GP a lot. “sexual”
- **population maintenance** method – replacing old solutions with new solutions
- **termination** method

General Procedure

generate initial population
evaluate
until stopping criteria is met
{
select solutions for recombination and / or mutation
recombine
mutate
evaluate
replace
}