Multiobjective Optimization

CS 5764
Evolutionary Computation
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Project Logistics

- Nov 1 – Progress presentation 1
- Nov 15 – Progress presentation 2
- Nov 27,29 – Final presentations
- Dec 14 - Last day to submit final project report
  - GECCO 2013 format
  - Paper accepted? Automatic A+
Multiple Objectives

• In bridge construction, a good design is characterized by low total mass and high stiffness.
Multiple Objectives

- Aircraft design requires simultaneous optimization of fuel efficiency, payload, and weight.
Multiple Objectives

• In chemical plant design, or in design of a groundwater remediation facility, objectives to be considered include total investment and net operating costs.
Multiple Objectives

- A good sunroof design in a car could aim to minimize the noise the driver hears and maximize the ventilation.
- The traditional portfolio optimization problem attempts to simultaneously minimize the risk and maximize the fiscal return.
Weighting Schemes

- \( F = w_1 f_1(x) + w_2 f_2(x) \)
- \( F = f_1(x) f_2(x) \)
- \( F = f_1(x)^{w_1} f_2(x)^{w_2} \)
Unknown Weighting

• Vary Randomly
• Vary Gradually
• Continuation Methods
CARS

Efficiency

Power

Pareto front

A

B

D

C
Multi-objective

Market Pareto Front

Market dominated by Motor 6

Market Niche of Motor 4

This motor has no niche in this market (it is dominated by 7 & 10)

Dominated Area

Max Power [W]

Efficiency [%]
Implementation

• Select based on distance from front
• Thinning and sampling
Non-dominated Sorting Genetic Algorithm-II (NSGA-II)

• Select by Pareto-rank and Crowding distance
  – The population is sorted into a hierarchy of sub-populations based on the ordering of Pareto dominance.
  – Similarity between members of each sub-group is evaluated on the Pareto front
  – The resulting groups and similarity measures are used to promote a diverse front of non-dominated solutions
Remember ALPS?

Hornby et al. (2006)
Age-Fitness Pareto
Meta objectives

• Regardless of what you are evolving, there are some objectives that are always good
  – Simplicity
  – Evolvability
  – Novelty / Diversity
  – Robustness / sensitivity
  – Modularity
  – Cost of manufacturing
Novelty = Maximum correlation of residual errors of the nearest fitness neighbor
Objectives:
E: Error
A: Age
C: Complexity
N: Novelty
Pareto Coevolution

• What happens when other individuals are used as dimensions of multi-objective evolution?
Pareto Coevolution

• Evolve partial solutions
• Keep a partial solution as long as there is no other partial solution better than it in all contexts
  – i.e., component is best in at least one context