Prof. Dr. E. Zitzler

Bioinspired Optimization and Design FS 2009

Project 2: Knapsack Problem - Part II

Issue Date:	March 17, 2009
Discussion Date:	March 31 (Task 1), April 7 (Task 2)
Submission Date:	March 26 (Task 1), April 2 (Task 2)

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Project Description The knapsack problem is a well-known combinatorial optimization problem. Given is a set of items, each of which has a weight and a profit associated to it, and an upper bound for the capacity of the knapsack. The task is to find a subset of items which maximizes the total of the profits in the subset, yet all selected items fit into the knapsack, i.e., the total weight does not exceed the given capacity. In this second project, population-based evolutionary algorithms have to be implemented for the knapsack problem using mutation, recombination and selection operators. We will investigate fitness assignment techniques that can handle constraints as well as multiple objectives.

Task 1: Evolutionary Algorithms and Constraint Handling (70 points)

The aim of this task is to develop a population-based evolutionary algorithm for the knapsack problem.

a) Define a mutation operator for the knapsack problem. Note: you can make use of the neighborhood function from the first project.
b) Define a recombination operator, which produces two offspring solutions from a given pair of parent solutions.
c) Define a mating selection operator.
d) Define an environmental selection operator.
e) Implement an evolutionary algorithm with population size 100 and the operators you defined in a) – d). Use the objective function from project 1 as the fitness function. Run the algorithm on the problem instance given on the lecture website for 1000 generations. Create a plot to show how the best objective function value of the population develops over time. To that end, plot the number of generations versus the best objective value found so far.
f) How would you classify the constraint handling technique used so far? Suggest an alternative constraint handling technique and describe how you would have to change the algorithm accordingly.
g) Run the modified algorithm on the same instance of e) and produce a similar plot. What differences do you see?
h) Competition I: Optimize the knapsack problem given in the problem instance on the website. You can either use the EA developed in this task, or some other optimization algorithm of your choice. Report the best solution found (both the chosen items and the objective value). Note: you can run the algorithm as long as you like, there is no limit to the number of iterations.

Task 2: Multiobjective Optimization (supplementary task) (30 points)

In this task, the knapsack problem is viewed as a multiobjective optimization problem, where the objectives are to simultaneously maximize the profit and minimize the weight. Since the weight is now an objective and not a constraint anymore, all solutions are feasible. The aim is to find a good approximation of the Pareto front.

a) We want to re-use the algorithm from Task 1. Describe which parts of the algorithm have to be modified and how.
b) Run the algorithm on the problem instance given on the website. Report the Pareto front approximation found after 500 and after 1000 generations as a two dimensional plot, where the x-axis denotes the profit and the y-axis the weight.