

26 Min-max Multi-Objective Optimization

Select the best candidate solution below [A-F], based on min-max optimization. This exercise presents some of the considerations you might encounter in the purchase of a large machine, such as an engine. The objectives are to minimize weight and cost, while maximizing the other attributes. A high score in reputation means the company and product have a good reputation, and a high score in specification means that the product fits the application very well. Hence, candidate D has a terrific machine on paper for the application, but with a rather poor reputation relative to the others. Do you agree with what the min-max calculation finds?

	A	B	C	D	E	F
Weight (N)	1260	1190	1470	1540	952	1358
Cost (dollars)	24700	23920	28860	33800	24700	27300
Reputation (nom=1)	1.1	0.7	1.2	0.5	0.8	0.9
Warranty (years)	5	6	8	5	3	6
Efficiency (pct.)	0.51	0.52	0.38	0.36	0.45	0.41
Specifications (nom=1)	1	1.1	1.2	1.4	0.85	1.1

The maximum normalized deviation from peak performance, for each of the six candidates is [0.72, 0.71, 0.88, 1.0, 1.0, 0.69], and so Candidate F is the winner. See the attached code. You might not agree with this result. Perhaps we can weight the deviations to distinguish between those properties that are important vs. those that are not? The purist will say that the less important performance measures shouldn't even make it onto the chart!

```
%-----
% minMax optimization
%
clear all;

% give properties for each candidate

weight = [.9 .85 1.05 1.1 .68 .97] * 1400 ;
cost = [.95 .92 1.11 1.3 .95 1.05] * 26000 ;
reputation = [1.1 .7 1.2 .5 .8 .9] * 1 ;
warranty = [5 6 8 5 3 6] ;
efficiency = [.91 .92 .78 .76 .85 .81]-.4;
spec = [1 1.1 1.2 1.4 .85 1.1] ;

% write this data to a file for latex
f = fopen('minMax.dat','w');
fprintf(f,'Weight (N)');fprintf(f,' & %g',weight) ;
fprintf(f,'\\ \\ \\ \\ \n');
```

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fprintf(f,'Cost (dollars)');fprintf(f,' & %g',cost) ;
fprintf(f,'\\ \\ \\ \\ \n');
fprintf(f,'Reputation (nom=1)');fprintf(f,' & %g',reputation) ;
fprintf(f,'\\ \\ \\ \\ \n');
fprintf(f,'Warranty (years)');fprintf(f,' & %g',warranty) ;
fprintf(f,'\\ \\ \\ \\ \n');
fprintf(f,'Efficiency (pct.)');fprintf(f,' & %g',efficiency) ;
fprintf(f,'\\ \\ \\ \\ \n');
fprintf(f,'Specifications (nom=1)');fprintf(f,' & %g',spec) ;
fclose(f);

% make matrix:  each candidate gets a column, each attribute is a row.
perf = [-weight ; -cost ; reputation; warranty ; efficiency ; spec]

meanPerf = sum(perf')' ;

maxPerf = max(perf')' ; % the maximum for each attribute
minPerf = min(perf')' ; % minimum for each attribute
rangePerf = maxPerf-minPerf ; % range for each attribute

devPerf = maxPerf*ones(1,size(perf,2)) - perf ; % deviation from peak,
                                                % all cand. and attributes

normDevPerf = devPerf ./ (rangePerf*ones(1,size(perf,2)))
    % normalize deviations with attribute ranges

maxNormDevPerf = max(normDevPerf)           % get the max deviation for the
                                                % candidates

[junk,ind] = sort(maxNormDevPerf) ;
disp(sprintf('The best min-max candidate is Candidate %d', ind(1)));

%-----

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