Knowledge Base Search Advisors for Design Exploration Systems (DES)

This article may be found at
http://www.soton.ac.uk/~cedc/posters.html

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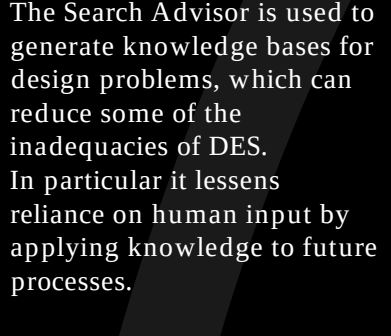
UTP for design

CEDC

The Search Advisor is used to generate knowledge bases for design problems, which can reduce some of the inadequacies of DES.
In particular it lessens reliance on human input by applying knowledge to future processes.

The advisor has been tested on two existing engineering design problem domains: Aircraft Wing Design and Ship Hull Form Design, demonstrating that it can also improve design processes both in speed and design quality. Results are presented here for the wing design case study.

Proposed Domain Knowledge Modelling Methodology for Optimizer Selection



Minimizing Wing Drag - Application to Aircraft Wing Design

Strategy I, Best Performance Search Strategy (BPS):

The best Search Techniques are chosen based on the performance of all 30 search techniques available in the OPTIONS DES across a range of design parameters; height, mach number and fuel weight fraction. Four potential metrics for selecting the 'Best' search technique have been adopted:

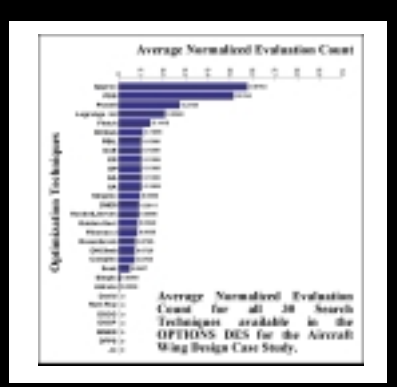
(A) Best-Speed Scheme (BSS) - generates a feasible design within the shortest period of time;
(B) Best-Quality Scheme (BQS) - generates the most-optimal or highest quality design at the expense of speed;
(C) Balanced-Overall-Quality Scheme (BOQS) - a compromise between speed and design quality;
(D) Reliability-First Scheme (RFS) – opts for search techniques that are found to be robust across the range of related design problems.

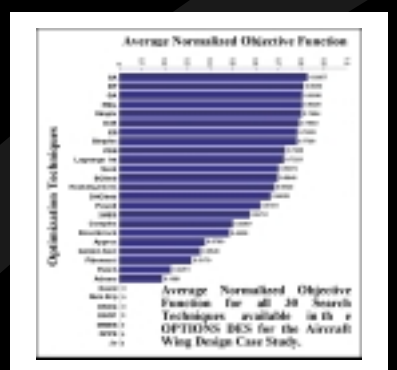
Note that all four schemes are used to form the Knowledge Base for each design problem domain.

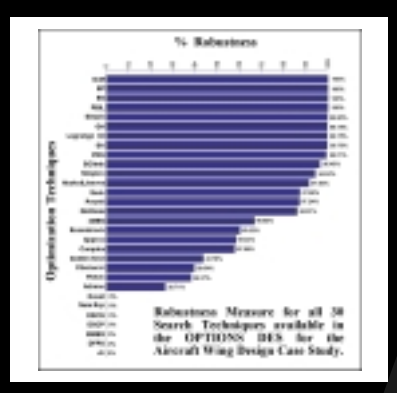
Strategy II, Artificial Intelligence Machine Learning Strategy (AIML):

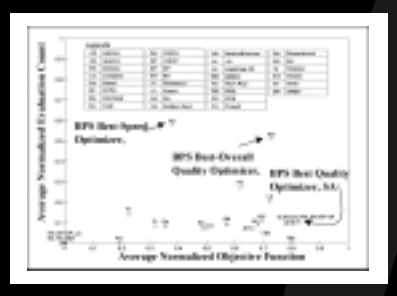
The AIML Strategy is based on the hypothesis that different search techniques will emerge as the 'Best', method for different design problems (i.e. for different set of values of design parameters) within a design problem domain.
Therefore the 'Best', search technique for the four metrics is chosen based on performance of all 30 search techniques available in the OPTIONS DES for each set of design parameters.
After evaluations on many machine learning algorithms, C4.5 has been found to be most suitable to this application and thus used to produce decision trees that can be validated by experts and help enhance human designers' knowledge of the optimization and design problem domain.

More Experimental Results









Ranking in descending order

Summarized Performance Measures of the derived AIML Knowledge Models and BPS Knowledge Models in comparison with (CDS1) Random Guess; (CDS2) Stick to Single Search Technique that gives a feasible design the first time; (CDS3) Stick to a Well Known Robust Search Technique (i.e. Evolutionary Programming); (CDS4) Designer's favorite (i.e. Genetic Algorithm); (CDS5) Stick to the fastest known Search Technique (i.e. Successive Linear Approximation).

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