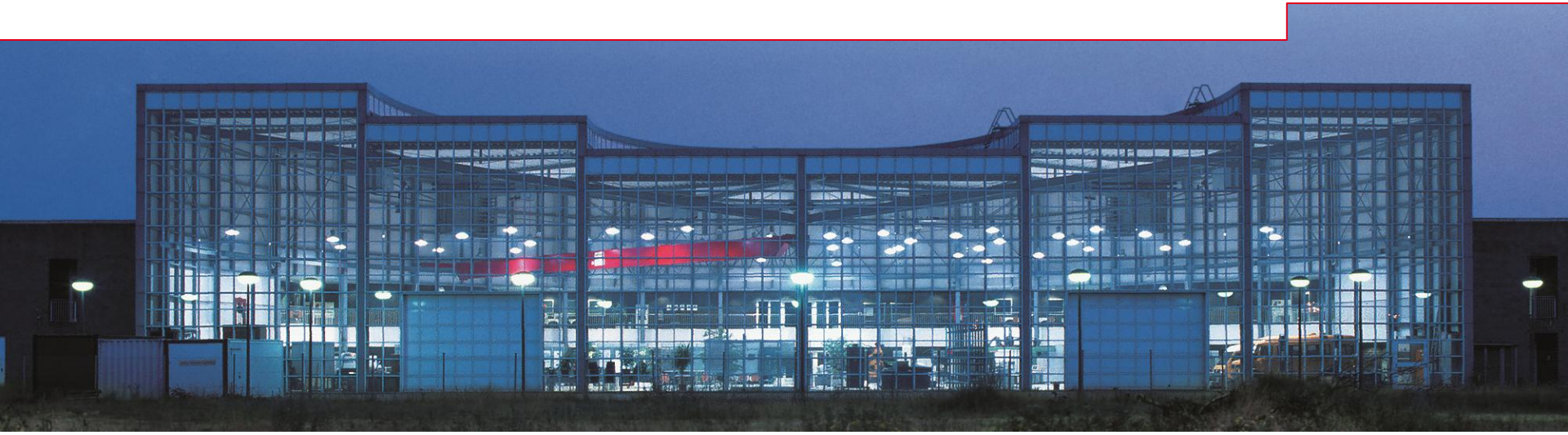

7th “Humies” Award, Entry No. 6

Evolving Dispatching Rules to Schedule Complex Manufacturing Systems using Genetic Programming

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Citation

Torsten Hildebrandt, Jens Heger und Bernd Scholz-Reiter:
Towards Improved Dispatching Rules for Complex Shop Floor Scenarios—a Genetic Programming Approach
In: Proceedings of the 2010 Genetic and Evolutionary Computation Conference (GECCO), Portland, USA, 2010. (accepted paper, to appear)

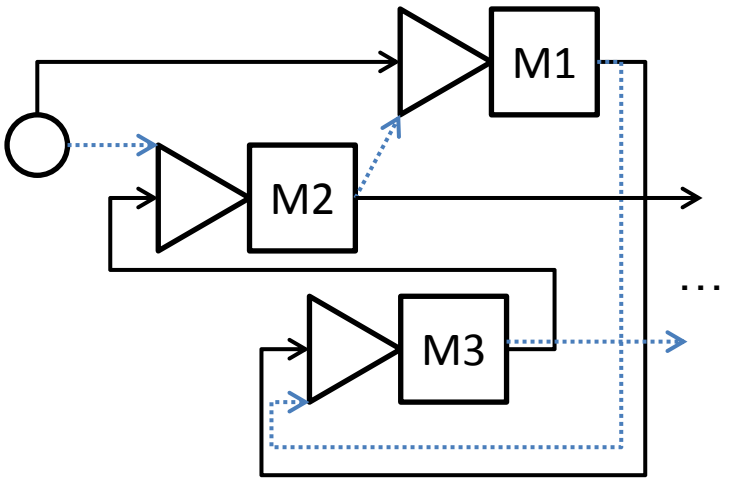
➔ detailed presentation: Sunday 11th, 14:00; Combinatorial Optimization and Metaheuristics track; room: Meadowlark

Problem Description

- dynamic, stochastic job shop scheduling

- thoroughly researched job shop scenarios by Holthaus and Rajendran 1999
  - 10 machines, 2500 jobs
  - job arrival, processing times, machine order are stochastic processes

- dispatching rules as a scheduling heuristic
  - whenever a machines becomes idle choose waiting job with highest priority to process next
  - easy to understand and implement
  - computationally very efficient, real-time scheduling heuristics
  - satisfactory results



machine buffer job source

Solution Approach

- GP used as a hyper-heuristic, i.e. the solution is a dispatching heuristic
- simulation-based optimization of dispatching rules with expensive fitness evaluations
  - length of a simulation run
  - random influences require multiple replications

- GP implementation of ECJ (http://cs.gmu.edu/~eclab/projects/ecj/) coupled with our own implementation of an efficient discrete-event simulation
- transparent utilization of multi-core/multi-processor machines

Human Competitiveness (1/2)

(G) The result solves a problem of indisputable difficulty in its field.

- dynamic job shop scheduling is np-complete
- scheduling very important in practice, subject to decades of research
- finding dispatching rules tedious, largely manual task requiring substantial experience and technical skills

Human Competitiveness (2/2)

(B) The result is equal to or better than a result that was accepted as a new scientific result at the time when it was published in a peer-reviewed scientific journal.

(E) The result is equal to or better than the most recent human-created solution to a long-standing problem for which there has been a succession of increasingly better human-created solutions.

(F) The result is equal to or better than a result that was considered an achievement in its field at the time it was first discovered.

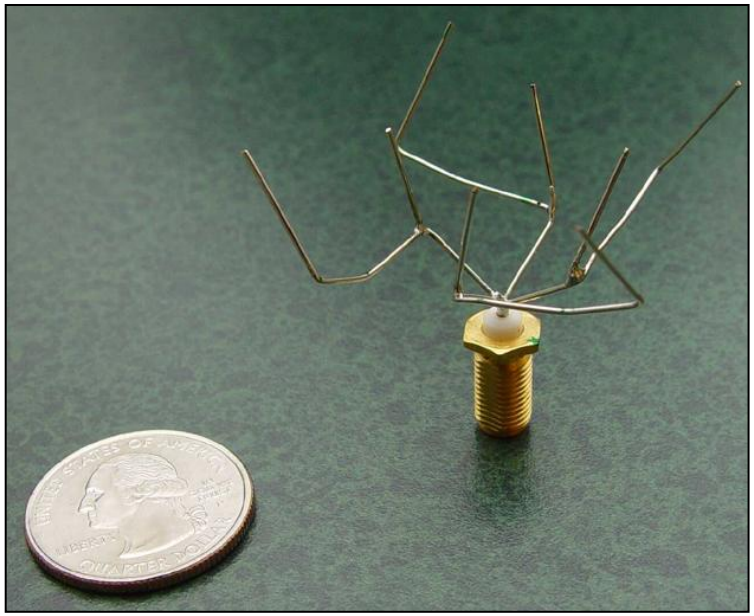
- C. Rajendran and O. Holthaus. A comparative study of dispatching rules in dynamic flowshops and jobshops.
  In: European Journal of Operational Research, 116(1):156-170, July 1999
- O. Holthaus and C. Rajendran. Efficient jobshop dispatching rules: further developments. In: Production Planning & Control, 11(2):171-178, 2000.

- Our results:
  - their best rule improved mean flowtime by 6.3% over SPT (Shortest Processing Time first)
  - we could reduce mean flowtime over their best rule by another 8.5% (14.3% if compared with SPT)
  - rules found are robust

Why should we win the prize?

- problem solved is of high practical importance
- GP can help to capture the true potential of dispatching rule-based scheduling
  - routinely create not just human-comparable but even better-than-human machine solutions
  - GP used as a hyper-heuristic is a valuable tool for scheduling researchers and practitioners to evolve real-time scheduling heuristics

GP-evolved antenna (2004 award winner):



2004 award winners Lohn, Hornby, Linden

≙ ?

GP-evolved dispatching rule:

$$Z = -p_{i,j}\left[\left(p_{i+1,j} - \frac{p_{i+1,j}}{p_{i,j}}\right) w + \left[\max\left(p_{i,j}, n_j^L - \mathrm{tiq}\right) \times \left(\max\left(p_{i,j} - p_{i+1,j}, \frac{p_{i,j}}{p_{i,j} + \mathrm{tis}}\right) + 1\right) + 1\right]\right]$$

Thank you!

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