7th “Humies” Award, Entry No. 6

Evolving Dispatching Rules to Schedule Complex Manufacturing Systems using Genetic Programming

Torsten Hildebrandt, Jens Heger, Bernd Scholz-Reiter
Bremen Institute of Production and Logistics – BIBA
at the University of Bremen
Hochschulring 20
28359 Bremen, Germany
{hil,heg,bsr}@biba.uni-bremen.de
Torsten Hildebrandt, Jens Heger und Bernd Scholz-Reiter:  
**Towards Improved Dispatching Rules for Complex Shop Floor Scenarios—a Genetic Programming Approach**  

- 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 machine 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
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
(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.


- 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):

GP-evolved dispatching rule:

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

2004 award winners Lohn, Hornby, Linden
Thank you!

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