Framework for Scheduling Problems

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This thesis proposes several improvements of algorithms used in solving scheduling problems – deterministic heuristics NEH and 2-opt are accelerated by parallel implementation on CUDA, DABC algorithm is enhanced using chaos based PRNG, finally ABC algorithm is modified using complex network analysis applied to population control.

Deterministic Heuristics Acceleration

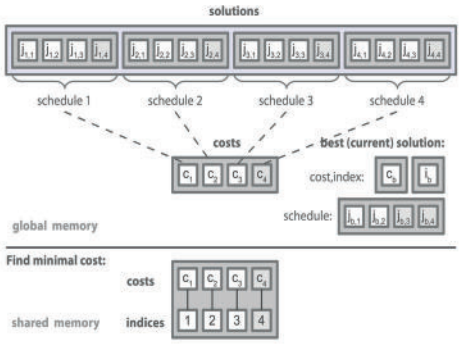
NEH

NEH

- constructive deterministic heuristic for solving flowshop scheduling
- optimal ordering of first two jobs, one job longer schedule is created in each iteration by attempting insertion of the next job into different positions and selecting the most optimal solution, until full solution is built

CUDA based NEH

- creates and evaluates possible solutions in each iteration in parallel
- applied to FSS, from 20 jobs x 5 machines to 1000 jobs x 20 machines
- up to 6.19 times speedup over sequential implementation reached for large instances



2-opt

2-opt

- local improvement technique
- selects the best solution obtained by swapping any two jobs in the schedule in each iteration (swap neighbourhood)
- terminates when no better solution found

CUDA based 2-opt

- swap neighbourhood of current solution searched in parallel
- applied to FSS, from 20 x 5 to 200 x 20
- up to 14.32 times speedup

Stochasticity in Evolutionary Algorithms

Chaos Driven DABC

DABC algorithm

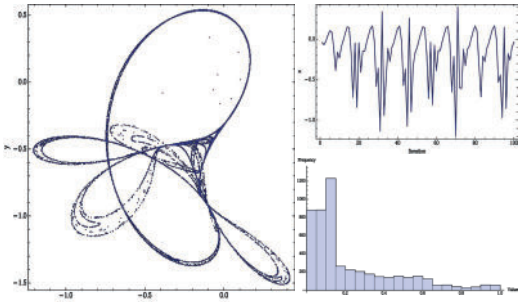
- combinatorial optimisation modification of the ABC population based evolutionary algorithm, inspired by bees
- heavy use of stochasticity

Chaos maps

- set of linear equations

$$X_{n+1} = X_n^2 - Y_n^2 + a X_n + b Y_n$$
$$Y_{n+1} = 2 X_n Y_n + c X_n + d Y_n$$

Tinkerbell equation



Tinkerbell plots

CDABC

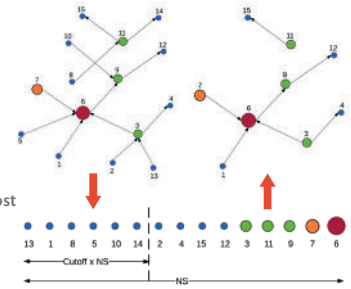
- nine different chaos maps based CPRNGs implemented : Arnold's Cat, Burgers, Delayed Logistic, Dissipative, Henon, Ikeda, Lozi, Sinai, Tinkerbell => embedded into DABC => 9 DABC variants: CDABCX, X = chaos map abbreviation
- CDABC's compared on different problems: FSSLS (Lozi and Dissipative datasets), FSSNW, CVRP, QAP
- T, B, DL and L CDABC variants improved upon DABC with MT for all problems
- order of performance varies by problem

Complex Networks Analysis in EA

Centralities Based ABC

- solution evaluated by its contribution to the population development, not just by cost
- solutions form network – communication links.
- solution evaluated by vertex centrality: Degree (weighted), Closeness, Betweenness
- least contributing solutions erased
- tested on standard CO test functions, 10-100 dim.

- **Adaptive ABC 1:** 3 centralities, 1 population
- **Adaptive ABC 2:** ensemble 3 centralities, 3 populations
- **Adaptive ABC 3:** selective centrality
- **Adaptive ABC 3.b, 3c:** elitism: centrality + cost
- **outperform ABC for most of tests**
- **AABC 3.b and 3.c significantly better than ABC**



Published Results

M. Metlicka and D. Davendra. Chaos driven discrete artificial bee algorithm for location and assignment optimisation problems. *Swarm and Evolutionary Computation*, In Press. doi:10.1016/j.swevo.2015.03.002.

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D. Davendra, I. Zelinka, **M. Metlicka**, R. Senkerik and M. Pluhacek. Complex Network Analysis of Differential Evolution Algorithm applied to Flowshop with No-Wait Problem. In *2014 IEEE Symposium on Computational Intelligence in Differential Evolution (SDE), Orlando, Florida, USA*, 9-12 Dec, pages 65-72.