Exam INF379 - Metaheuristics

An Simulated Annealing solution to a Pickup and Delivery Problem with Time Windows

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Overview

- **Main Components**
- **Operators**
- **Results**
- **Improvements**

Main Components

Simulated Annealing

Why Simulated Anealing?

- V.R. Bons 2014

Found SA to perform well in benchmark tests for PDPTW.

- M.I.Hosny 2010

Found SA and GA to be the best approaches to Multi vehicle PDPTW.

Main Components

(Improved) Simulated Annealing

- Cooling schedule
  - Exponential curve
  - Max_iterations kept low
  - Cooling kept long
- Solution generation
  - Generated solutions using different operators
  - Operator selection
- Standard SA Acceptance Criteria

Operators

Best/First insertion
 - Operator that tries to find a good(best) way to insert a call
 - On failure tries to insert at a good (first) fit
Reinsert (large)
 - Operator that removes x=calls/5 amount of calls then reinserts them
 - Uses same insert method as above
Switcheroo
 - Changes pickup/delivery of two calls
 - Not feasible
3-Exchange
 - performs a 3-swap
 - Not feasible

Further Improvement Possibilities

Main Components
- Adaptive model (model adapts more to the input case)
- Operator Selection
- Initial Solution generation
- Restart Algorithm

Operators
- More/better insertion methods
- Reinsertion of different sizes
- 2-Opt/3-Opt
- Swap and Exchange with feasible solutions

And so on...

Results

Seed = 10
Iterations = 20 000
Runtime < 30 seconds

Inst	Run_1	Run_2	Run_3	Run_4	Run_5	Run_6	Run_7	Run_8	Run_9	Run_10
Call_007_Ve	1256139	1256140	1256139	1256139	1256139	1256139	1256140	1256140	1256140	1256139
Call_018_Ve	2400016	2495703	2400016	2543127	2637174	2495703	2641890	2400016	2505763	2400016
Call_035_Ve	4865296	4846719	5019269	4909637	5042653	4943707	4844072	5326115	5220374	5177184
Call_080_Ve	13646972	13555917	13870909	13380160	13784530	13469572	13804718	14250032	13816096	14082222
Call_130_Ve	21408163	18512390	21454900	18568336	18323534	18888107	21123235	18705323	18239498	18635150

Inst	Ini_obj	Avrg_Obj	Avrg_Impr	Best_Obj	Best_Impr	Avrg_time
Call_007_Ve	3760286	1256139.4	66.5946	1256139	66.5946	0.69552
Call_018_Ve	8761492	2491942.4	71.558	2400016	72.6072	1.6723
Call_035_Ve	18322178	5019502.6	72.6042	4844072	73.5617	3.0386
Call_080_Ve	42211425	13766112.8	67.3877	13380160	68.302	8.8915
Call_130_Ve	75446687	19385863.6	74.3052	18239498	75.8247	15.6683

Change of iterations -> Change in results

		Iterations = 10 000		Iterations = 20 000		Iterations = 30 000		Iterations = 40 000		Iterations = 50 000		Iterations = 60 000		Iterations = 100 000		Iterations = 150 000	
Inst	Ini_obj	Obj	Impr	Obj	Impr	Obj	Impr	Obj	Impr	Obj	Impr	Obj	Impr	Obj	Impr	Obj	Impr
Call_007_Ve	3760286	1256139	66.5946	1256139	66.5946	1256139	66.5946	1256139	66.5946	1256139	66.5946	1256139	66.5946	1256139	66.5946	1256139	66.5946
Call_018_Ve	8761492	2498293	71.4855	2400016	72.6072	2400016	72.6072	2400016	72.6072	2400016	72.6072	2400016	72.6072	2400016	72.6072	2400016	72.6072
Call_035_Ve	18322178	5038215	72.5021	5019269	72.6055	4835057	73.6109	4750095	74.0746	4852504	73.5157	4840819	73.5795	5030327	72.5451	4828945	73.6443
Call_080_Ve	42211425	13451819	68.1323	13870909	67.1394	13449106	68.1387	13120030	68.9183	13110807	68.9401	13080851	69.0111	12658556	70.0115	12831402	69.6021
Call_130_Ve	75446687	20187157	73.2431	21454900	71.5628	18181947	75.9009	18195508	75.883	17970267	76.1815	17896252	76.2796	17810703	76.393	17810616	76.3931

Inst	Ini_obj	Avrg_Obj	Avrg_Impr	Best_Obj	Best_Impr	Avrg_time
Call_007_Ve	3760286	1256139.4	66.5946	1256139	66.5946	3.6249
Call_018_Ve	8761492	2473865	71.7643	2400016	72.6072	9.4222
Call_035_Ve	18322178	4818805.3	73.6996	4679647	74.4591	16.8669
Call_080_Ve	42211425	13115632.6	68.9287	12658556	70.0115	47.2169
Call_130_Ve	75446687	18152079.9	75.9405	17715281	76.5195	71.7715

Tendency: Increased iterations lead to more stable high results:
Iterations: 100 000
Runtime < 150 seconds

Further Improvement Possibilities

Main Components
- Adaptive model (model adapts more to the input case)
- Operator Selection
- Initial Solution generation
- Restart Algorithm
- Temperature experimentation

Operators
- More/better insertion methods
- Reinsertion of different sizes
- Removal with similarity factor
- 2-Opt/3-Opt
- Swap and Exchange with feasible solutions

And so on...

Thank you for your attention…

Questions….?