Transportation of handicapped persons

María Soto Marc Sevaux André Rossi

Université de Bretagne-Sud
Lab-STICC – Lorient – FRANCE

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Handicapped person transportation

M. Soto
M. Sevaux
A. Rossi

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A potential collaboration with KERPAPE

KERPAPE is a medical unit for reeducation in poly-traumatology

- full time patients
- patients on daily programs

Transportation of handicapped persons

Medical units should organize daily the transportation of more than 75 patients:

- from home to medical center
- from medical center to home

Transportation of handicapped persons (cont'd)

- Human factor is very important
- Specialized service
- Individual needs
- Time and medical constraints

Cost of transportation

Cost is calculated from many factors

- transportation duration
- transportation distance
- number of vehicle used
- type of vehicles
- capacity of vehicles

- but most of the transportation is done by taxis. . .

Problem description

Objective

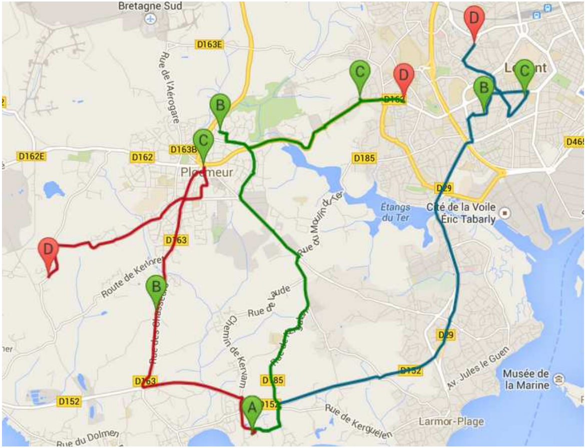
Design vehicle tours to ensure daily transportation of patients while minimizing the total transportation cost

Constraints

- vehicle capacity

Route structure

Open routes: cost is paid only from home to medical center or from medical center to home (back route is not paid)



OVRP-1

In the case of transportation of handicapped persons, we have the following constraints:

- open routes (Open VRP)
- demand is always one
- no service time
- no constraints on route duration
- homogeneous fleet

Metaheuristics: ILS-TSMN

Iterated Local Search is combined with Tabu Search and Tabu search is run on multiple neighborhoods

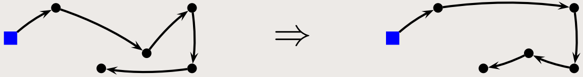
Algorithm 1: ILS-TSMN

Define the $k_{\max}$ neighborhoods $N_1, N_2, \cdots, N_{k_{\max}}$
Compute initial solution s
Save best solution $s^\star \leftarrow s$
while *stopping conditions not satisfied* **do**
    for $k \leftarrow 1$ **to** $k_{\max}$ **do**
        $s \leftarrow$ TabuSearch(N_k,s)
        if $f(s) < f(s^\star)$ **then** $s^\star \leftarrow s$
    end
    $s \leftarrow$ Mutation($s^\star$)
end

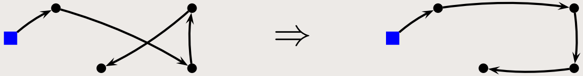
List of neighborhoods

Intra route moves

Relocate



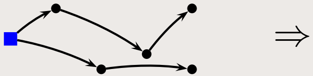
2-Opt



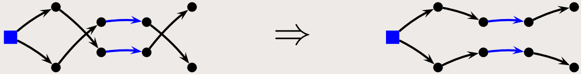
List of neighborhoods (cont'd)

Inter route moves

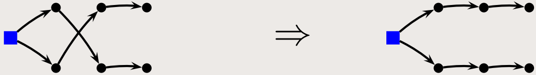
Relocate (feasible)



Path-Exchange – Cross/ICross Exchange (feasible)



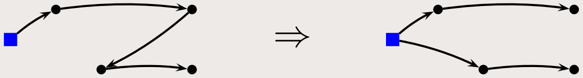
2-Opt* (feasible)



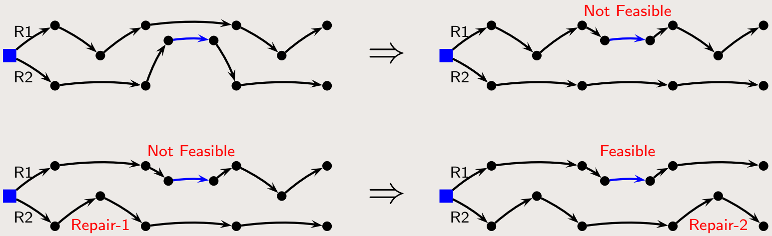
List of neighborhoods (cont'd)

Inter/Intra route moves

Split route (feasible)



Ejection chains (not feasible)



Best work to date

A hybrid (1+1)-evolutionary strategy for the OVRP

A. Reinholz and H. Schneider (2013). In L. Di Gaspero, A. Schaerf, and T. Stützle, editors, Advances in Metaheuristics, volume 53 of Operations Research/Computer Science Interfaces Series, pages 127-141. Springer

Similar work on OVRP

- no constraint on route length/duration
- no service time
- unlimited number of vehicles
- homogeneous fleet

Comparison Hybrid (1+1)-ES *vs.* ILS-TSMN

Hybrid (1+1)-ES	**ILS-TSMN**
(1+1)-Evolutionary	Iterated Local Search
Random search with multiple neighborhoods	Tabu search with multiple neighborhoods
Path exchange neighborhoods • 2-Opt • relocate • exchanges • path exchange with the final node	Ejection chains and path exchange neighborhoods • 2-Opt • relocate • split a route • ejection chains with 1, 2 nodes up to the final node

Comparison on OVRP instances

Classical instances of OVRP from the literature

Instances			Hybrid (1+1)-Evolutionary			ILS-TSMN			Δ
Name	Size	Duration	# routes	Objective	CPU*	# routes	Objective	CPU	%
C01	50	-	6	412.95	4.29	6	412.96	10.68	**0.00**
C02	75	-	11	564.06	13.23	11	564.06	17.64	**0.00**
C03	100	-	9	639.25	887.92	9	639.25	23.12	**0.00**
C04	150	-	12	733.13	476.48	12	733.13	38.01	**0.00**
C05	200	-	17	868.44	4317.27	17	868.11	1074.74	**-0.04**
C06	50	200	6	412.95	2.87	6	412.96	10.69	**0.00**
C07	75	160	11	566.93	41.92	11	566.94	17.44	**0.00**
C08	100	230	9	642.11	357.98	9	642.39	440.48	0.04
C09	150	200	14	741.44	946.1	13	741.44	35.90	**0.00**
C10	200	200	18	871.58	4334.55	17	869.94	1052.18	**-0.19**
C11	120	-	10	678.54	66.06	9	685.08	348.48	0.96
C12	100	-	10	534.24	4.36	10	534.24	45.85	**0.00**
C13	120	720	11	836.55	1948.05	12	837.01	479.27	0.05
C14	100	1040	11	552.64	23.68	11	552.64	16.22	**0.00**
F11	72	-	4	177.00	309.74	4	177.00	34.42	**0.00**
F12	135	-	7	769.55	1677.04	8	765.44	47.40	**-0.53**
Average					963.22			230.78	0.019%

*CPU times are scales according to Linpack results

OVRP-1: comparison ILP *vs.* ILS-TSMN

Instances		ILP			ILS-TSMN		Δ
Name	Size	**Objective**	**CPU**	**Opt.**	**Objective**	**CPU**	%
A6	37	464.60	0.75	**yes**	464.60	2.61	**0.00**
A7	37	508.44	658.10	**yes**	508.44	2.36	**0.00**
A8	38	432.06	8.12	**yes**	432.06	3.52	**0.00**
A9	39	510.82	10.19	**yes**	510.82	2.88	**0.00**
A10	39	500.12	19.13	**yes**	500.12	2.51	**0.00**
A11	44	564.56	167.88	**yes**	564.56	2.89	**0.00**
A12	45	538.08	10.30	**yes**	538.08	2.76	**0.00**
P8	40	344.39	0.70	**yes**	344.39	3.20	**0.00**
P9	45	383.88	1.14	**yes**	383.88	3.44	**0.00**
P10	50	377.50	5.85	**yes**	377.50	4.47	**0.00**
P11	50	381.36	41.80	**yes**	381.36	5.43	**0.00**
P12	50	385.15	193.52	**yes**	385.15	4.75	**0.00**
P14	55	401.89	77.40	**yes**	401.89	5.09	**0.00**
B22	68	572.10	3600.01	no	551.10	5.88	**-3.67**
B23	78	614.57	3600.01	no	591.12	9.59	**-3.82**
A27	80	922.28	3600.01	no	914.03	7.93	**-0.89**
F3	135	712.90	3600.02	no	699.74	18.63	**-1.85**
C5	200	880.54	3600.76	no	850.37	152.77	**-3.43**
C9	151	752.53	3600.20	no	724.43	20.35	**-3.73**
C12	101	499.98	3600.01	no	493.03	10.23	**-1.39**
C13	121	-	-	no	919.75	15.73	-
C14	101	-	-	no	542.84	11.64	-
Average			1319.79			13.56	-2.68%

Are web services the future of interfaces?

- collaborative project with Google Research
- web interface based on the Google API
- designed in html, php, javascript and AJAX

- end-users are all familiar with Google Maps
- realistic usage
- future standard for interfaces?

Main difficulties

- compute distances from the Google API

Demo

- `http://labsticc.univ-ubs.fr/ovrp/webOVRP/`

Conclusion

- OVRP-1 not new but less attention than OVRP
- efficient method ILS-TSMN
- power of two operators SPLIT and Ejection chains

- ILS-TSMN is comparable to Hybrid (1+1)-ES (Objective)
- ILS-TSMN is much better than Hybrid (1+1)-ES (CPU)
- ILS-TSMN is a good candidate for OVRP-1

- web service is necessary for end-users

Perspectives

Still so many constraints

- time windows
- maximum route duration
- service time

- incompatibility between patients
- equipment for patients
- heterogeneous fleet (with modularity)

Future of our collaboration

Solve the problem at the **political** level

- convince Kerpape that the cost could be reduced
- . . . but they do not care, they do not pay for it. . .
- taxis are paid by the social security (us)
- convince the social security
- trade unions do not want to loose positions. . . and taxis are really against it. . .
- so is it a dead-end?
- No, we will do it progressively ;-)

Future of our collaboration

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Visit us

OR-Group@Lab-STICC

http://www.univ-ubs.fr/or/

Contacts:

marc.sevaux@univ-ubs.fr

maria.soto@univ-ubs.fr