Optimizing routing and scheduling decisions in Homecare

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POLYTECHNIQUE MONTRÉAL

CANADA RESEARCH CHAIR IN HEALTHCARE ANALYTICS AND LOGISTICS

HANALOG

KlayaCare

KlayaCare NIAGARA FALLS SEPTEMBER 22-23 BETTER OUTCOMES 2016

SERVICES

Nursing
Rehab Services
Personal Support
Extreme Cleaning

HISTORY

Founded in
1925

EMPLOYEES

2,300+

VHA Home HealthCare

Creating More Independence

REACH

Ontario Based

Servicing 8 CCAC/LHIN Regions

CLIENTS

91,671
Served Annually

VALUED

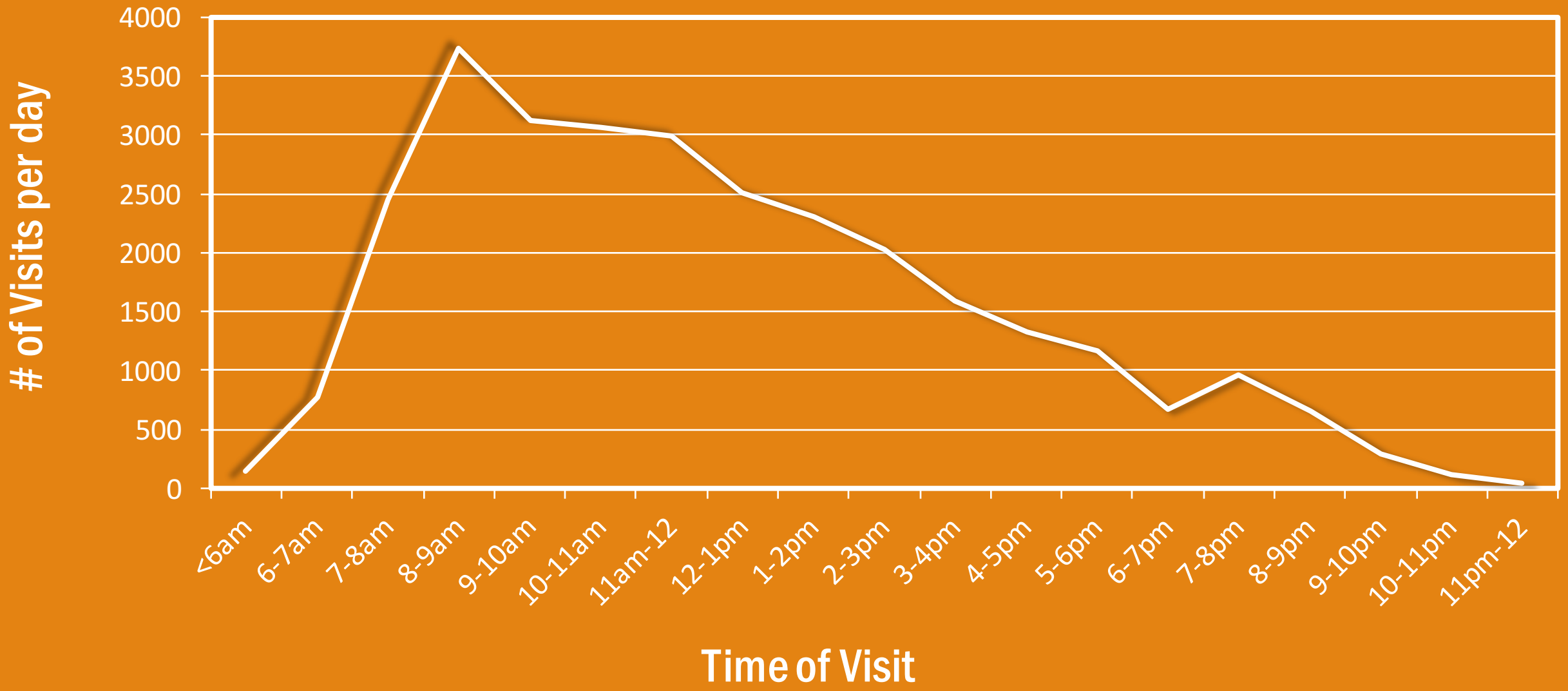
ACCREDITED WITH EXEMPLARY STANDING
ACCREDITATION CANADA
AGRÉMENT CANADA
AGRÉÉ AVEC MENTION D'HONNEUR

BPSO RNAO BEST PRACTICE SPOTLIGHT ORGANIZATION

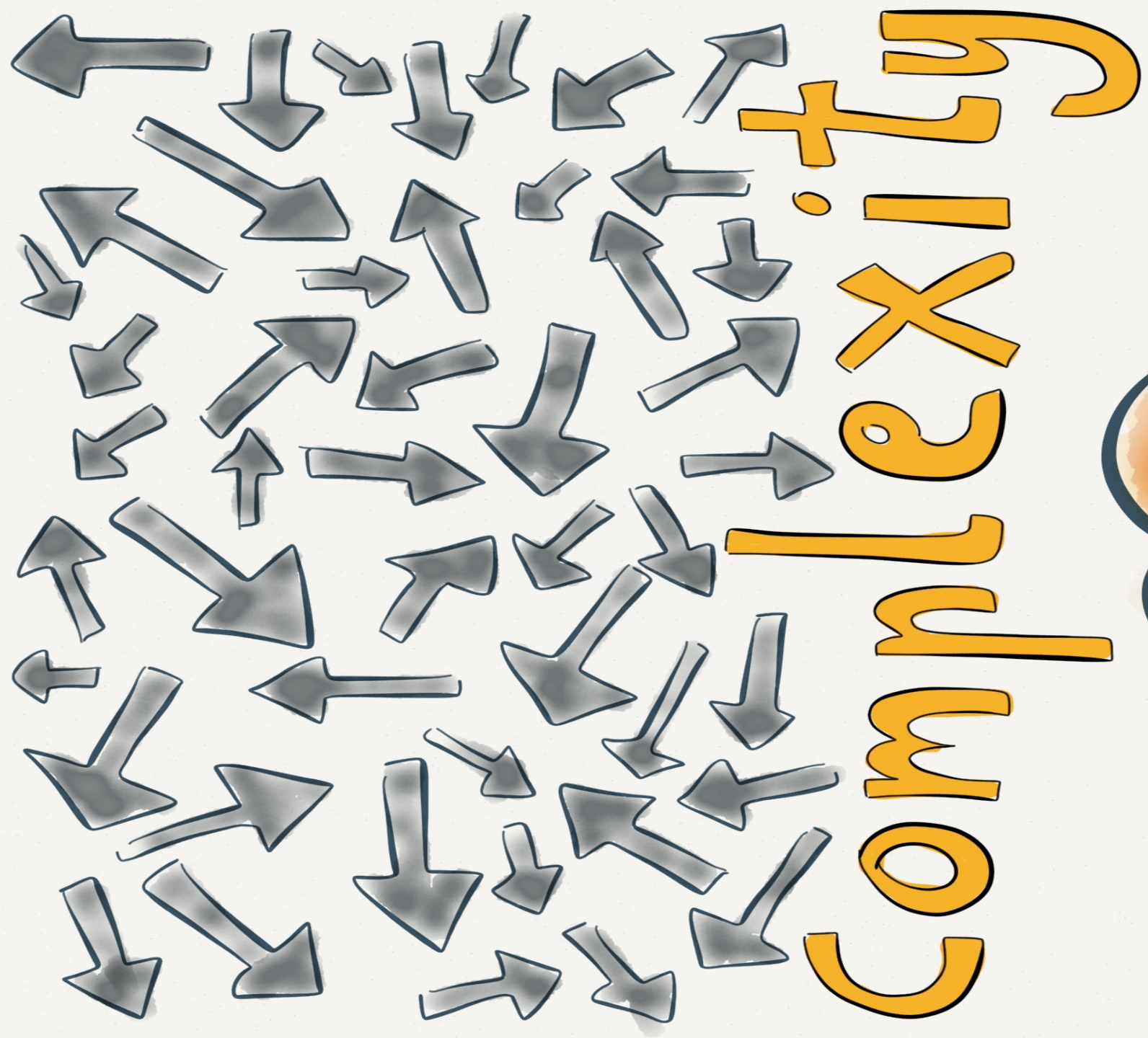
United Way Toronto & York Region


Staff Availability
Client Needs and Preferences
Travel Routes
1,200,000
PS Visits / Year
Continuity of Care
Union Rules
Complex Recurrence Patterns

Visit Demand



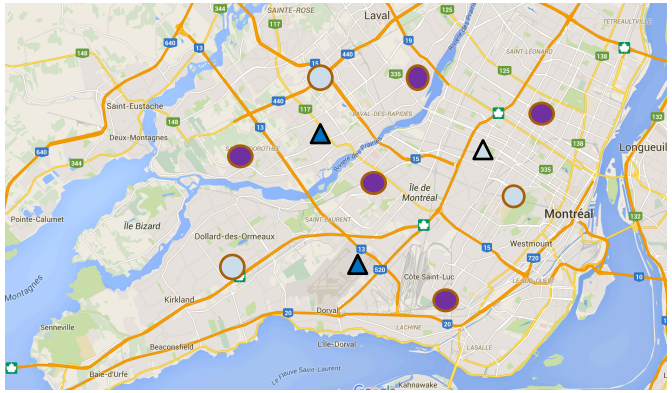

Staff Utilization Optimized
Happy Staff
Travel Routes Optimized
Outcomes
Client Needs and Preferences Met
Happy Clients
Continuity of Care Commitments Met



Simplicity


AlayaCare
NIAGARA FALLS
SEPTEMBER 22-23
BETTER OUTCOMES 2016
A two-day event inspiring an outcome-focused home healthcare industry.

Monday



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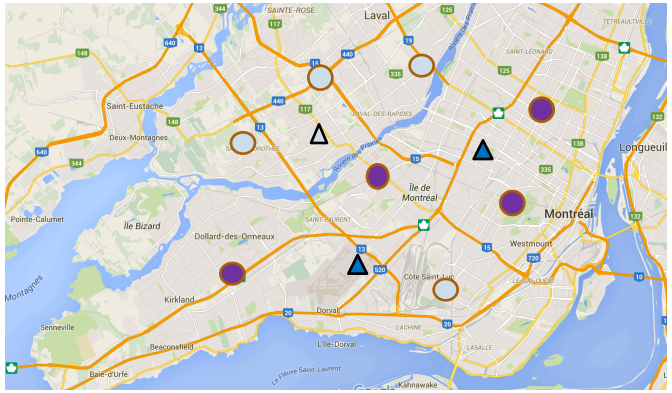

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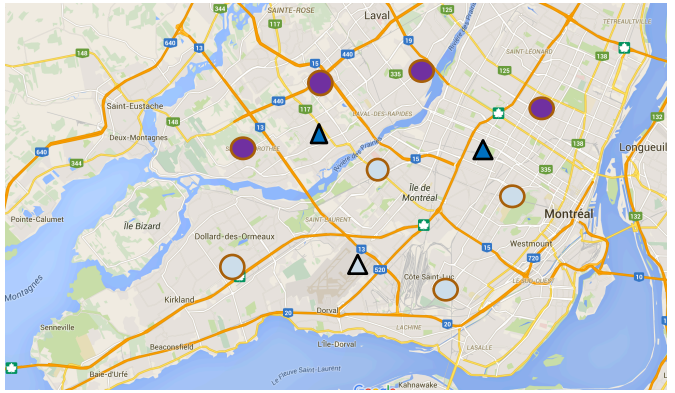

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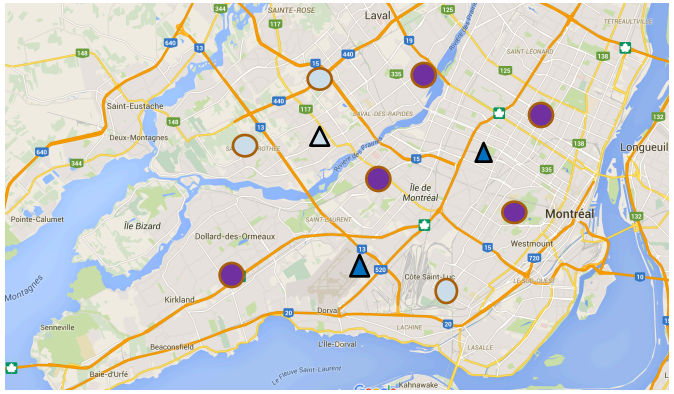

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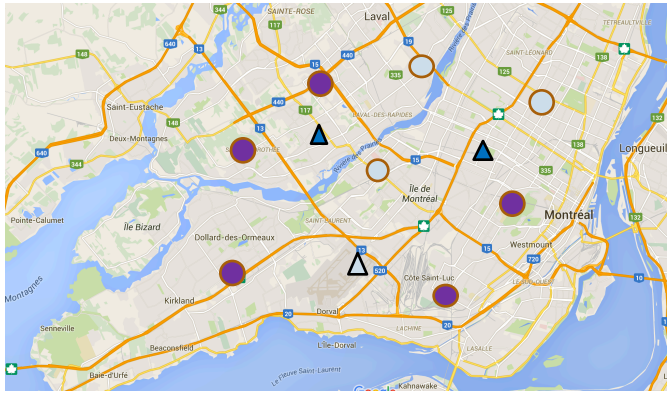

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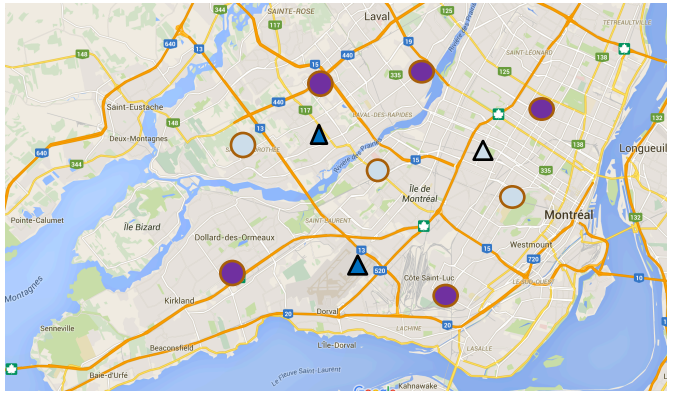

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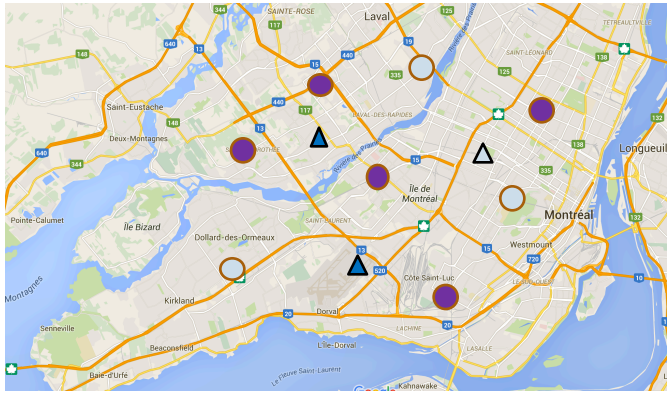

○△ Patient/Nurse not available

● Available day for the service

▲ Work day of the nurse

Each service needs 3 visits

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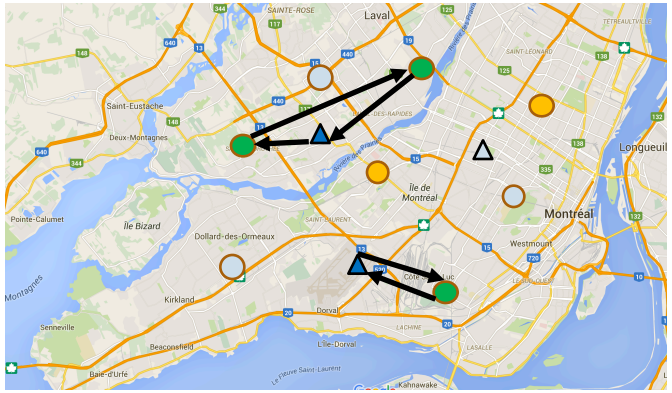
Monday



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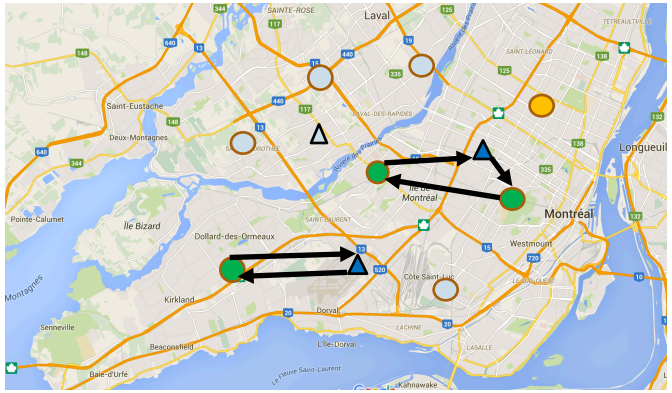

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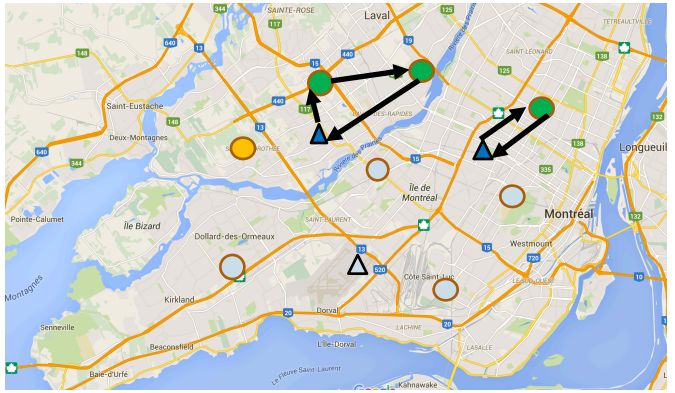

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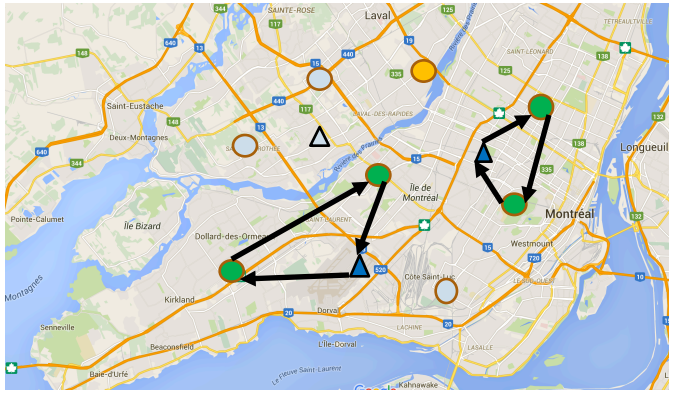

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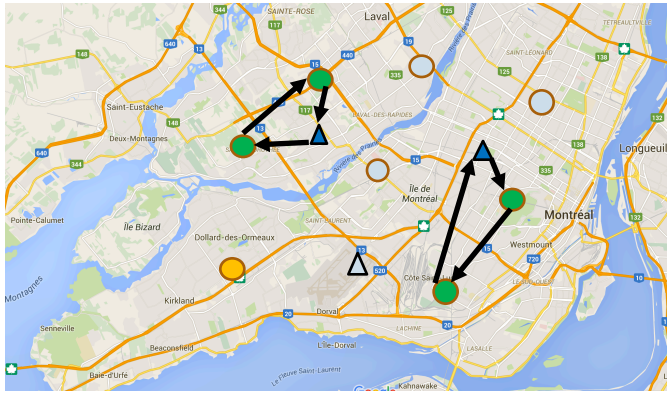

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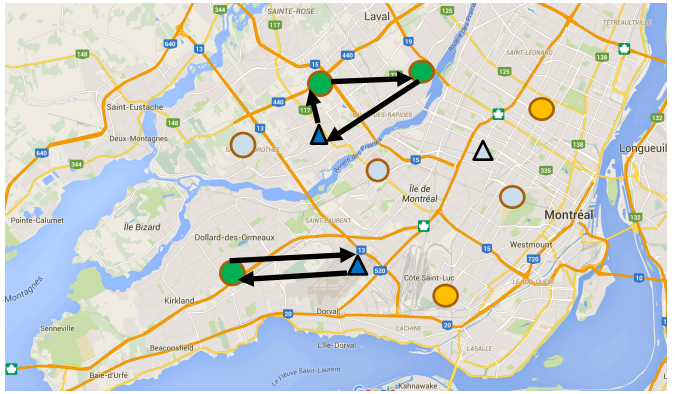

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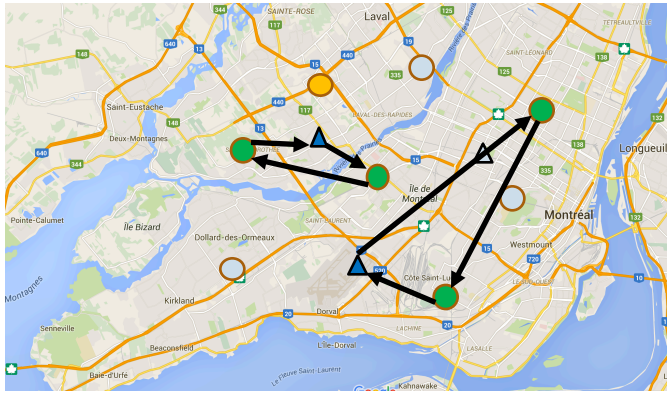

Patient/Nurse not available

Unused available day

Used available day

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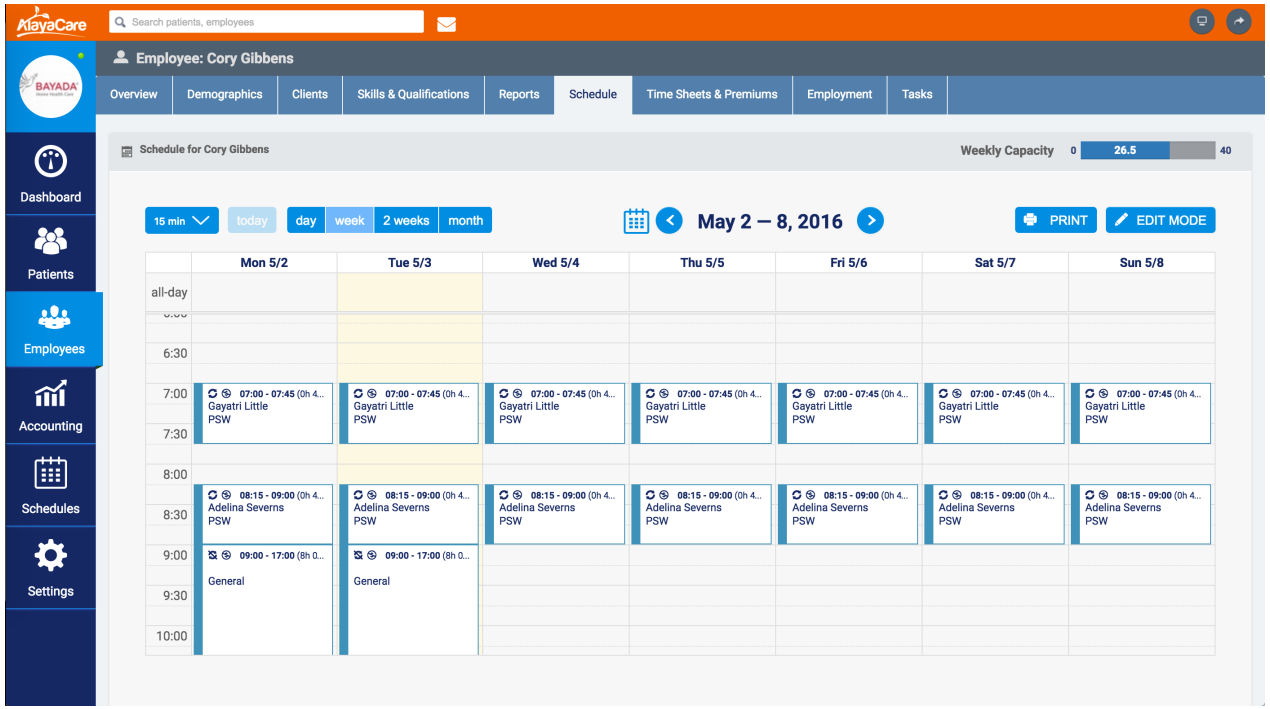
The home health care problem

- Could be see as a mix between a multi-attribute VRP and an assignment problem

- For each service visit, we need to decide :
  - Which day in the week ?
  - Who is the care giver ?
  - At what time ?



Hard constraints of the problem

Allocation

Scheduling

Mandatory Expertises

Care giver's list

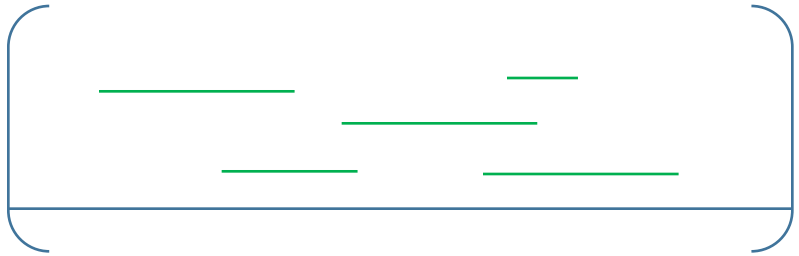
- Nursing
- English
- French

$\subset$

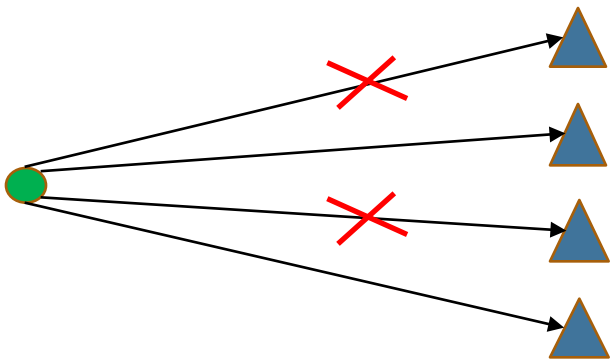
Service's mandatory list

- Nursing

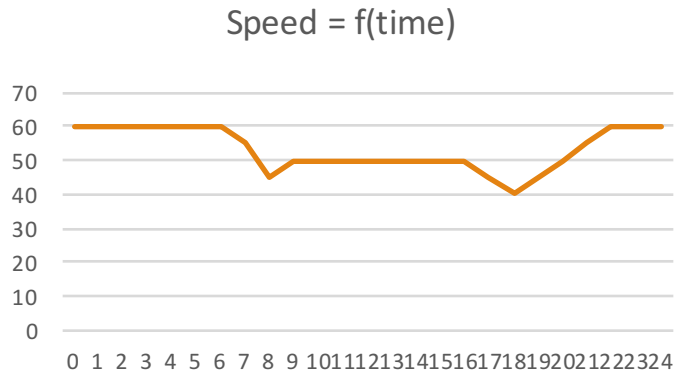
Hard Time Windows



Forbidden Nurses



Time-dependent travel time



Soft constraints of the problem

Allocation

Optional Expertises

Care giver's list

- Nursing
- English
- French

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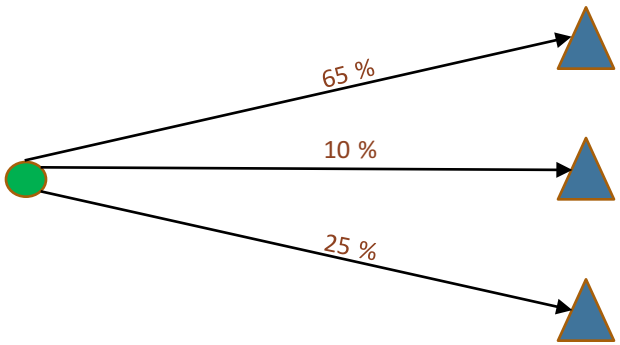
Service's optional list

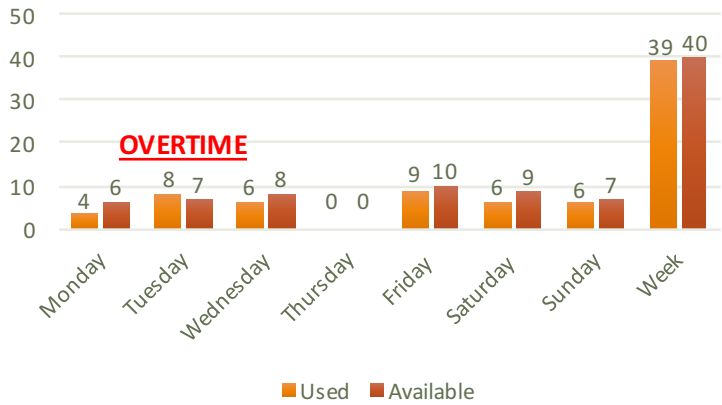
- French

Continuity of care



Scheduling

Work time contracts

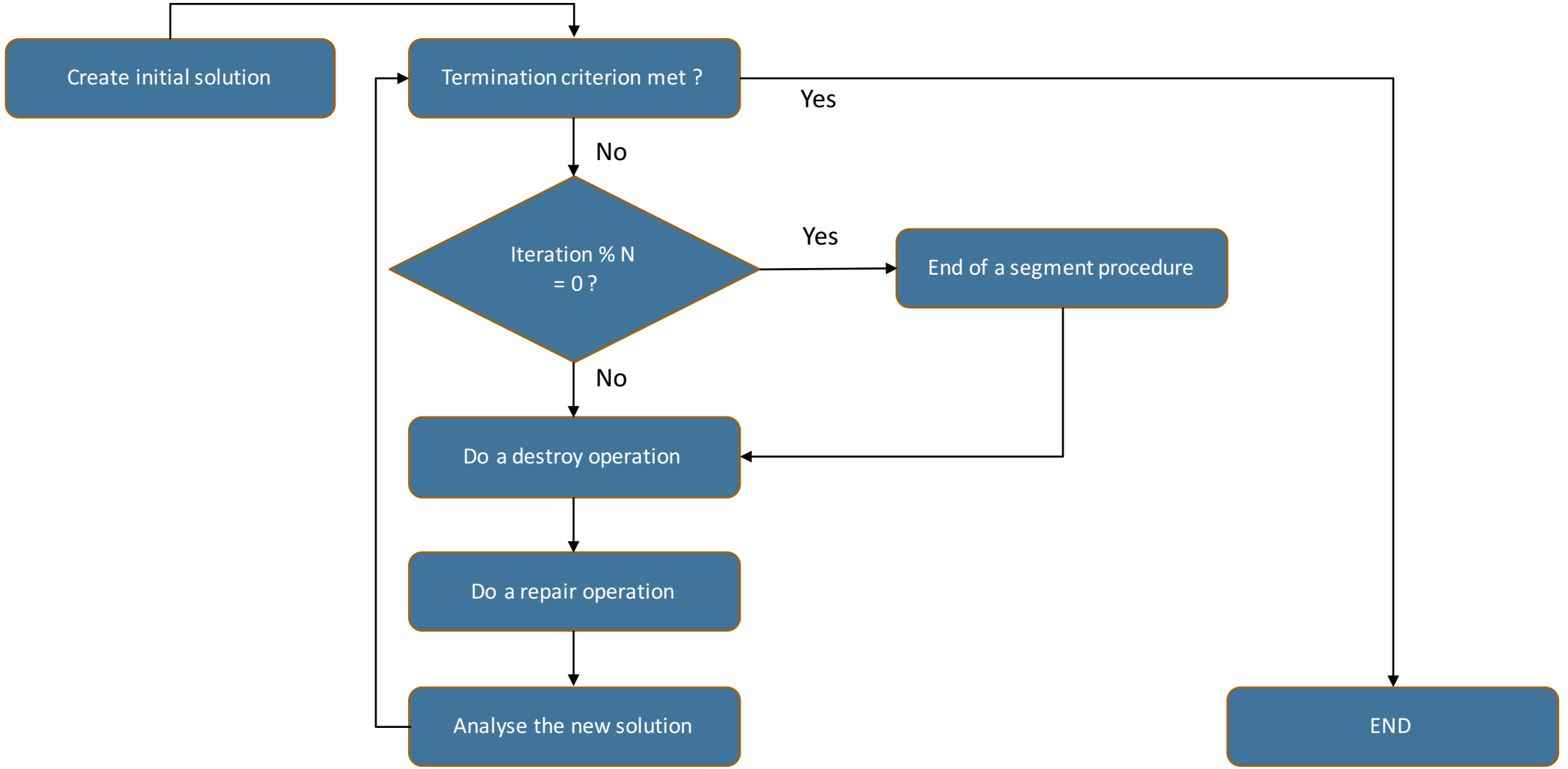


Our method of resolution

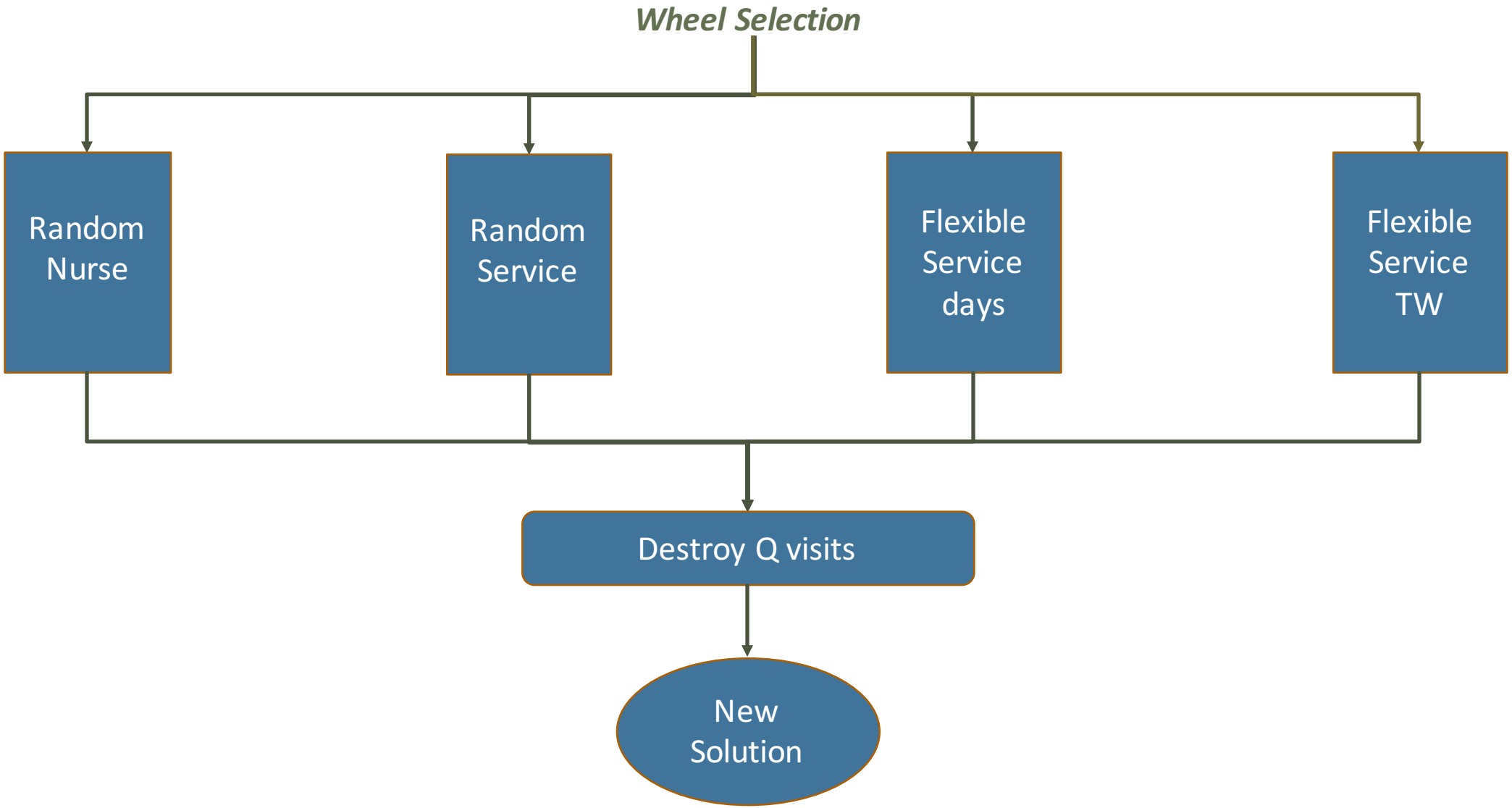
The Adaptive Large Neighborhood Search

- The ALNS has been introduced by Ropke & Pisinger in 2006 for the PDPTW
- Permits to take into account a great number of visits
- Very flexible, permits to easily add new constraints and new operators

ALNS Routine



Destroy Operators



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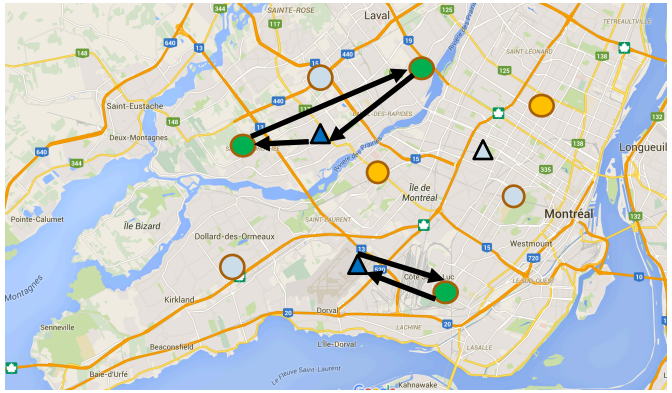

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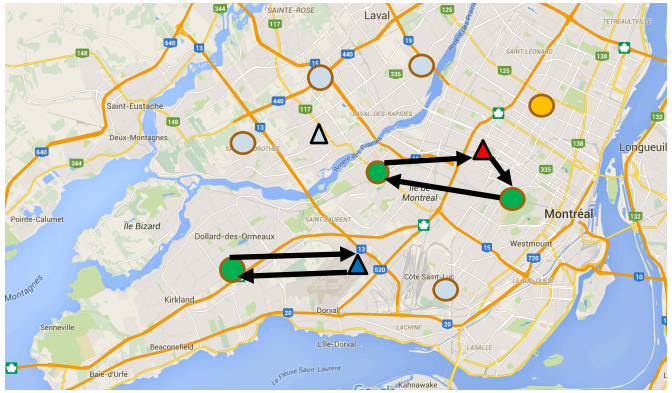

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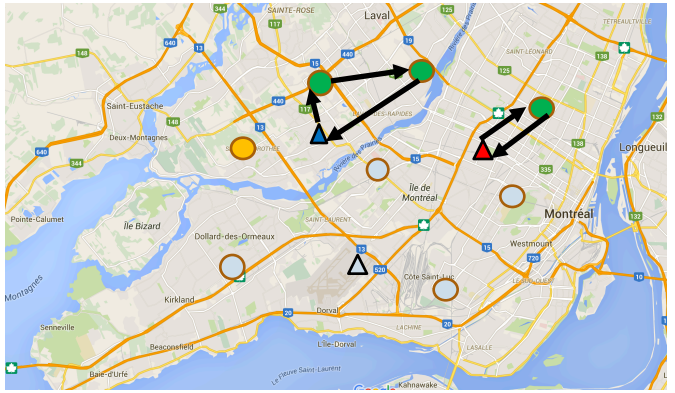

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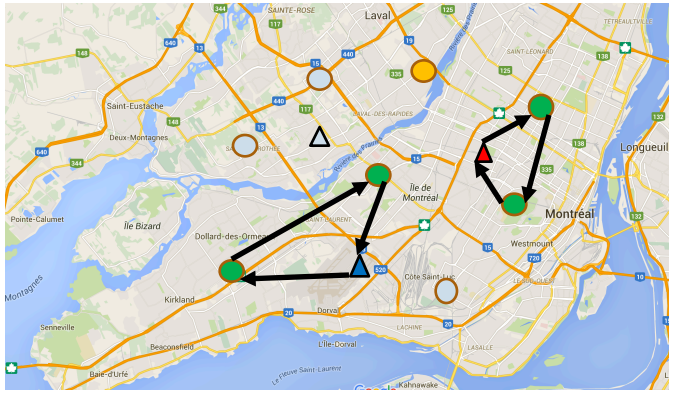

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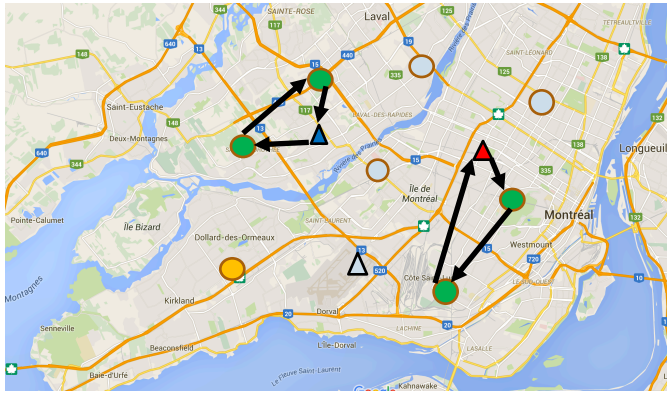

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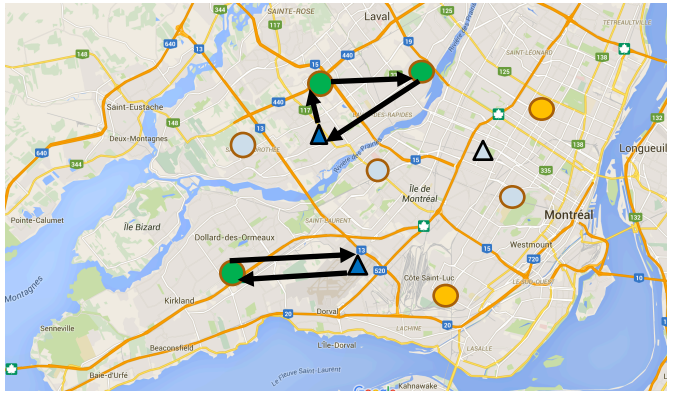

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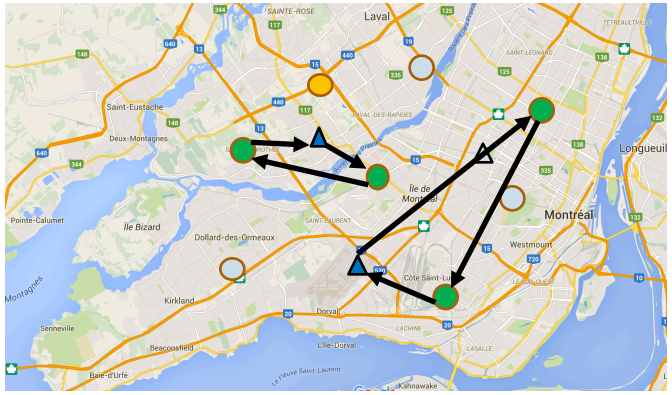

- Choosen nurse
- Unused available day
- Used available day

Random Nurse example

HANALOG AlayaCare

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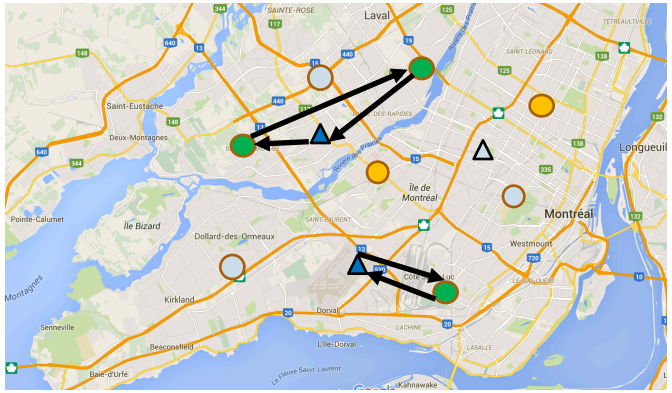

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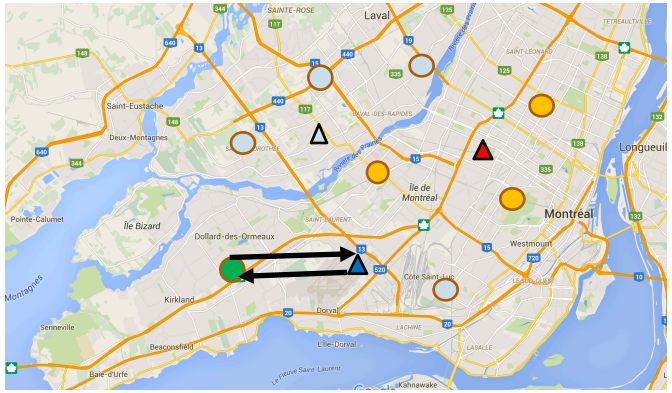

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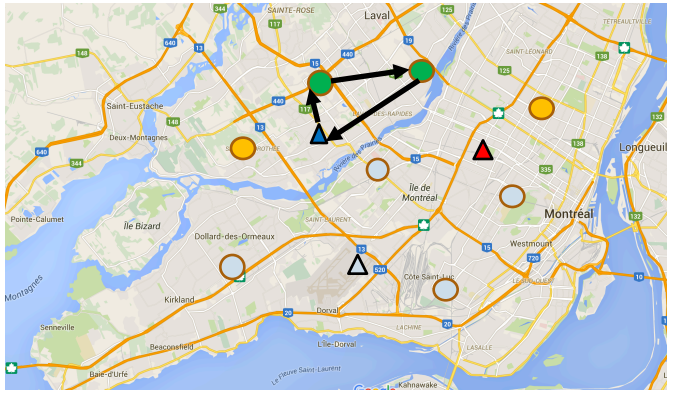

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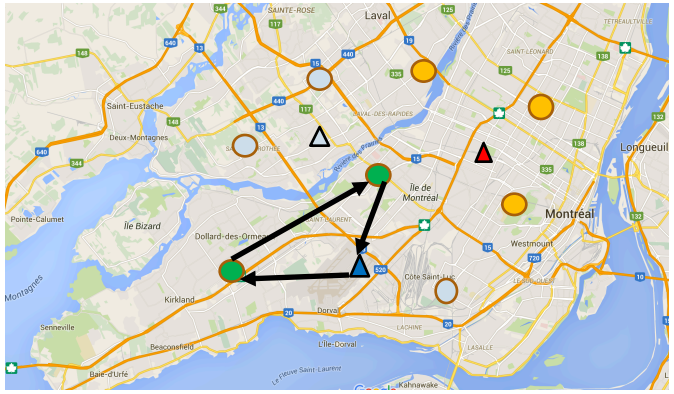

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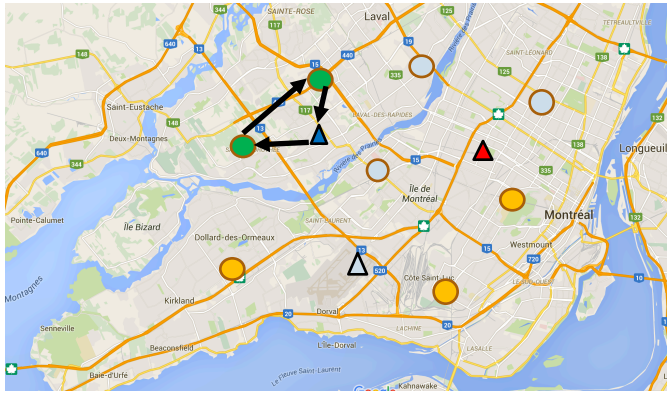

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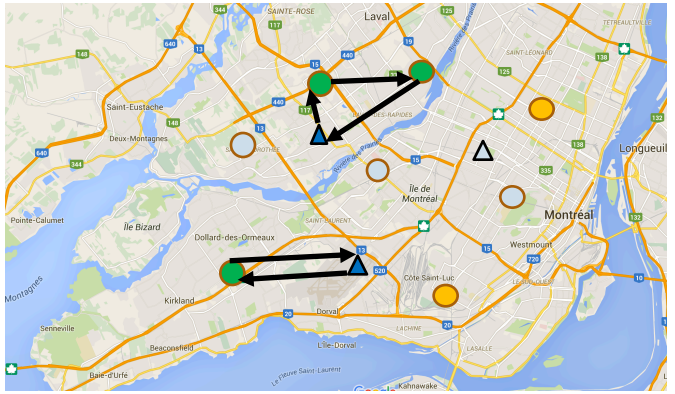

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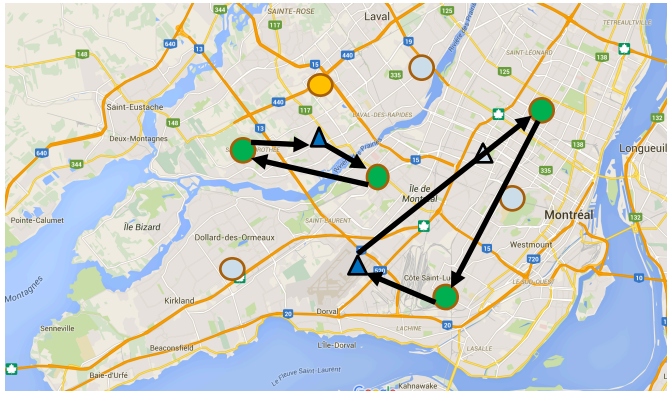

- Choosen nurse
- Unused available day
- Used available day

Random Nurse example

HANALOG AlayaCare

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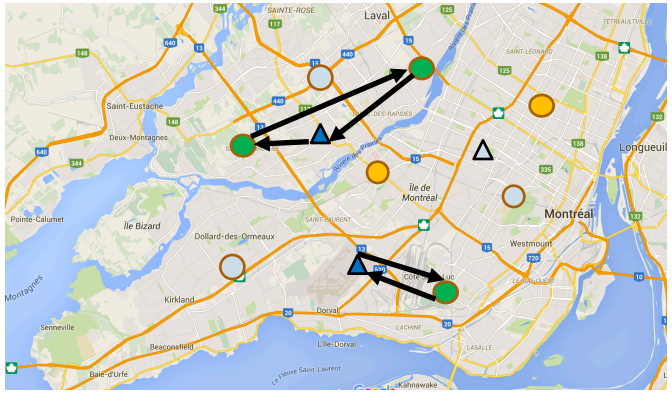

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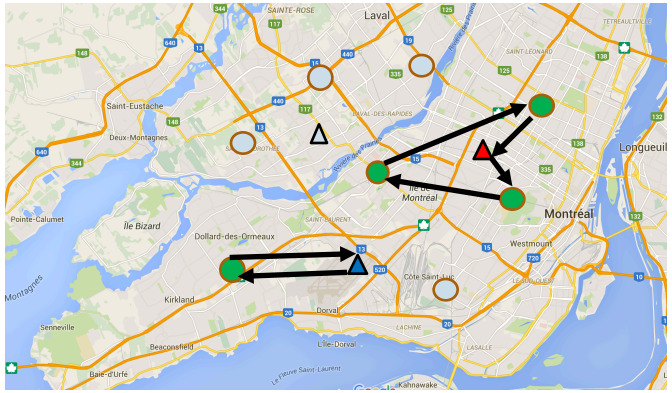

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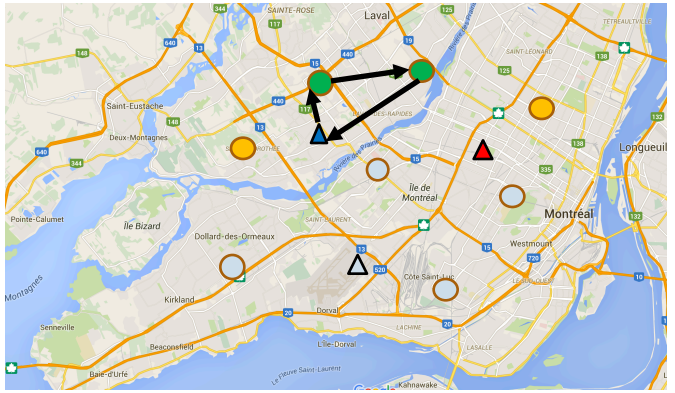

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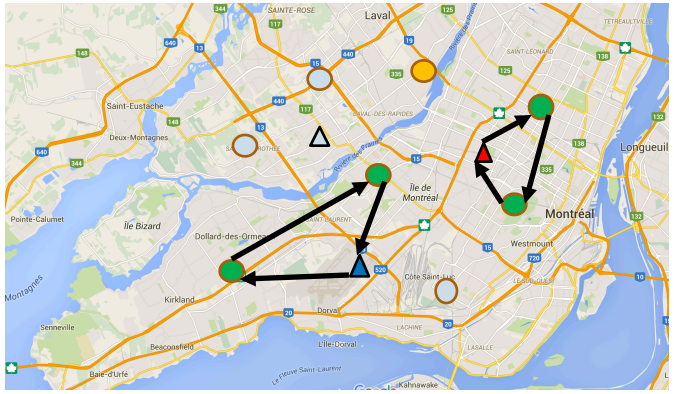

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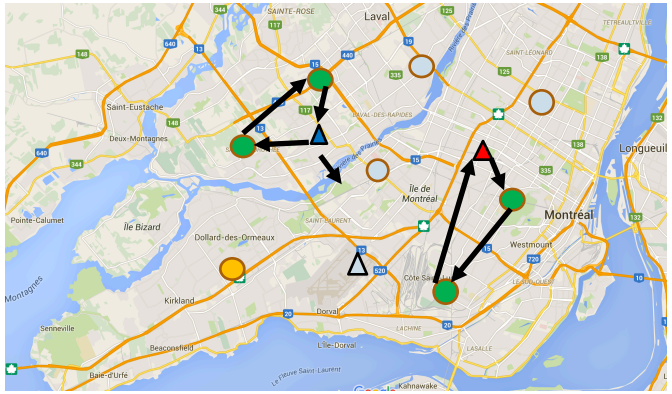

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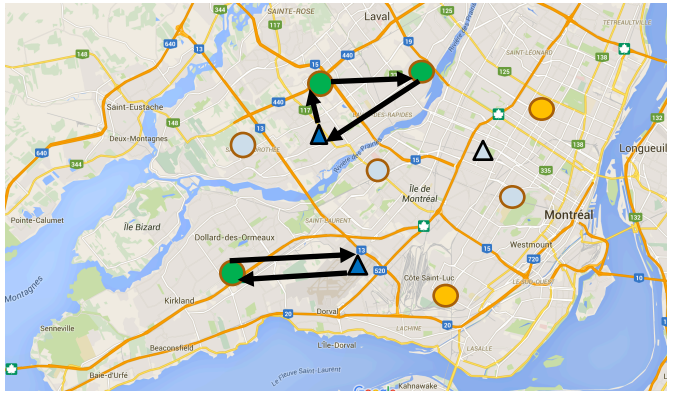

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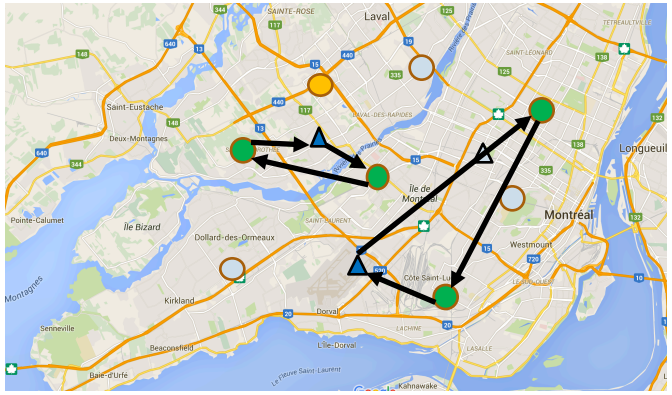

- Choosen nurse
- Unused available day
- Used available day

Random Nurse example

New solution

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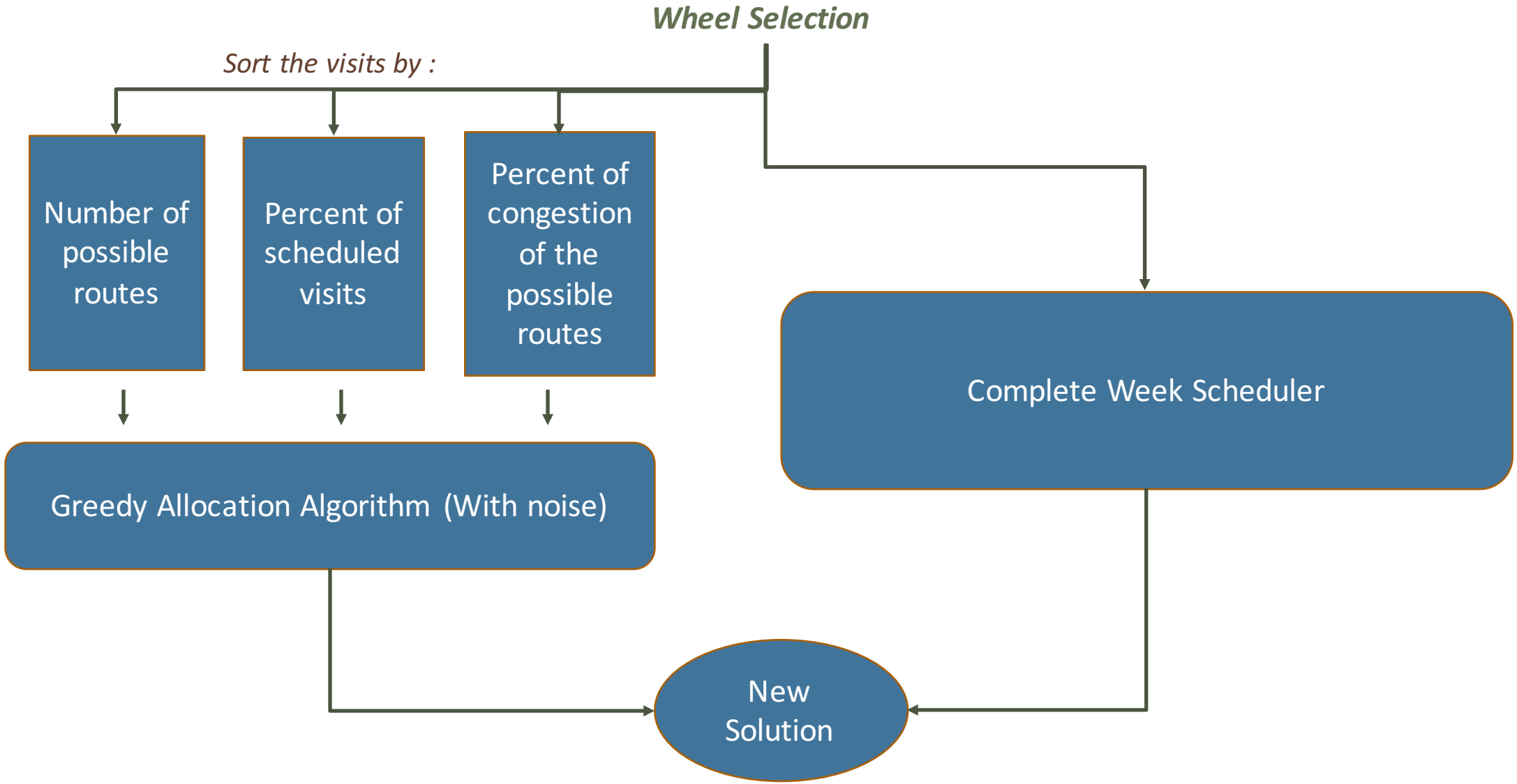
Repair Operators



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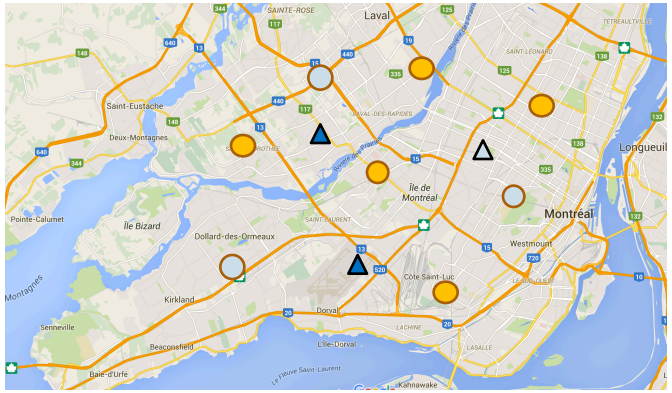

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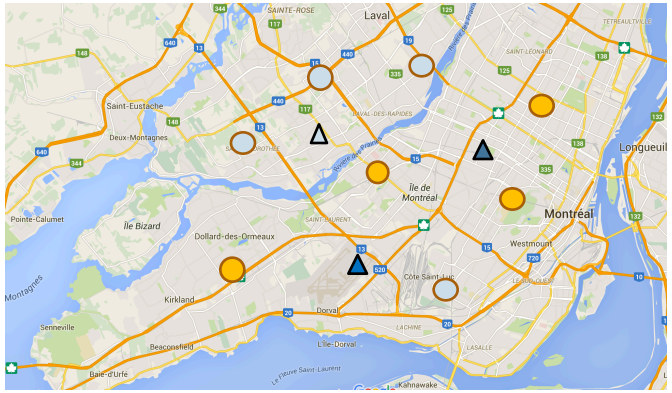

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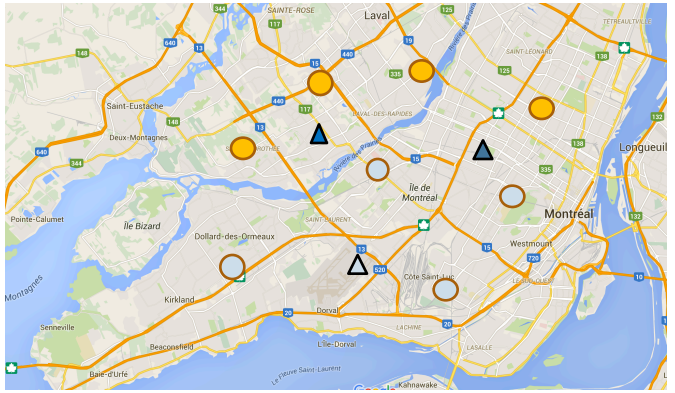

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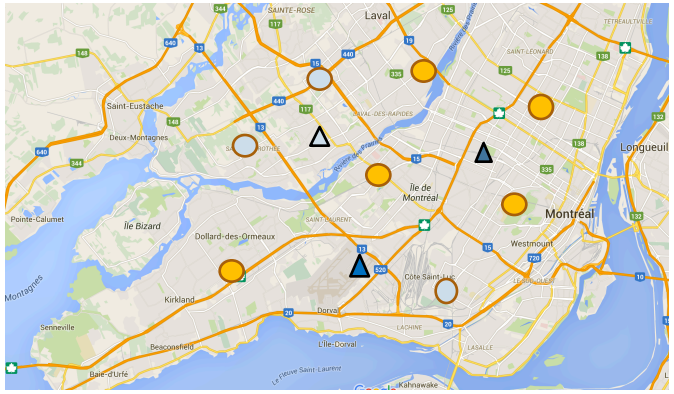

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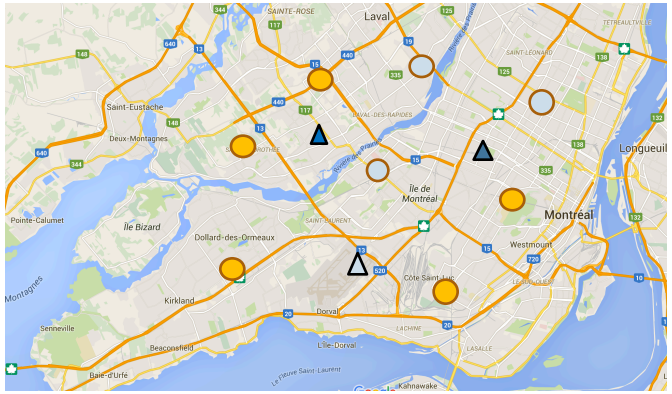

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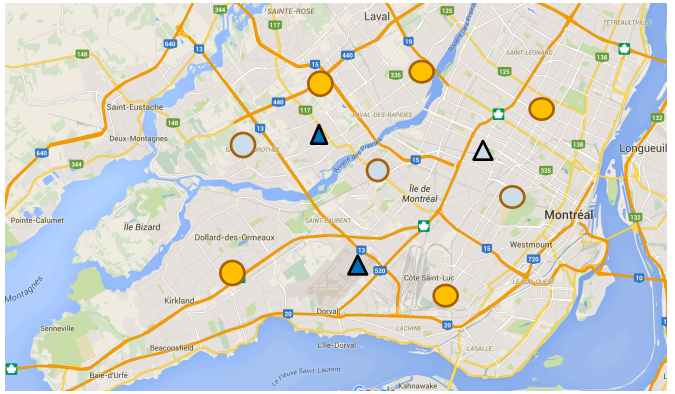

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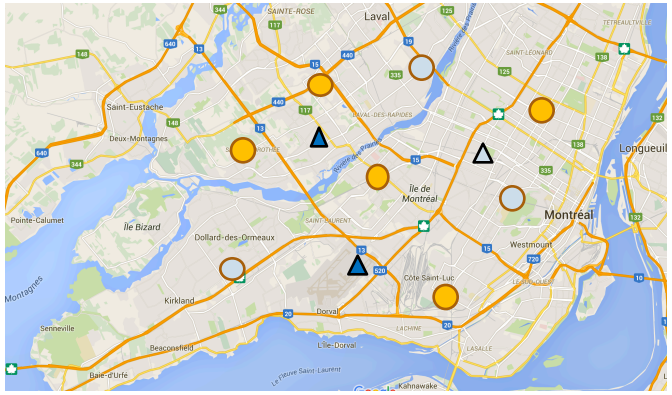

○△ Patient/Nurse not available

● Unused available day

● Used available day

Complete Week Scheduler

HANALOG AlayaCare

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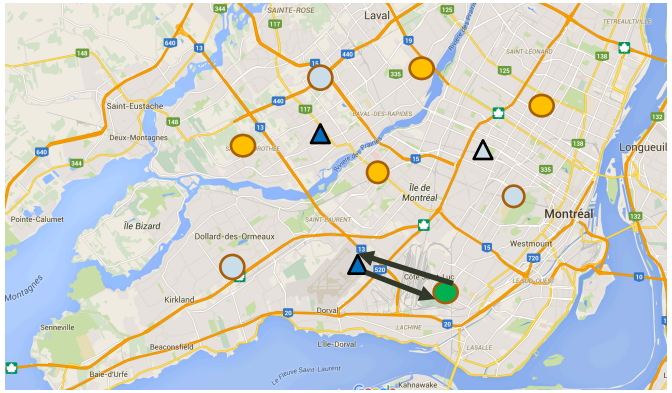

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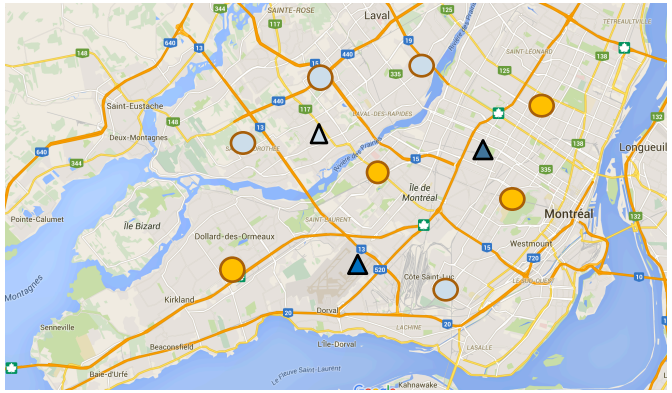
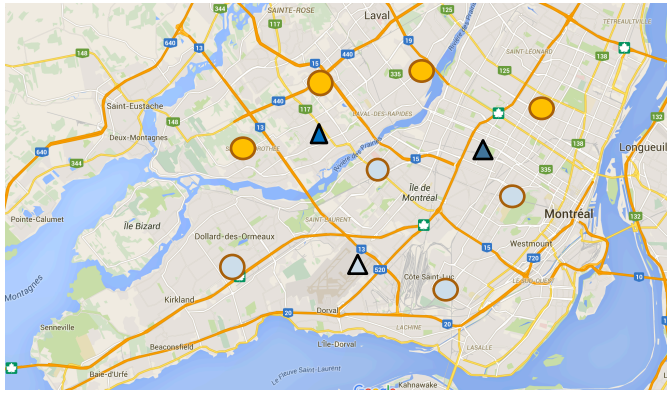


Wednesday



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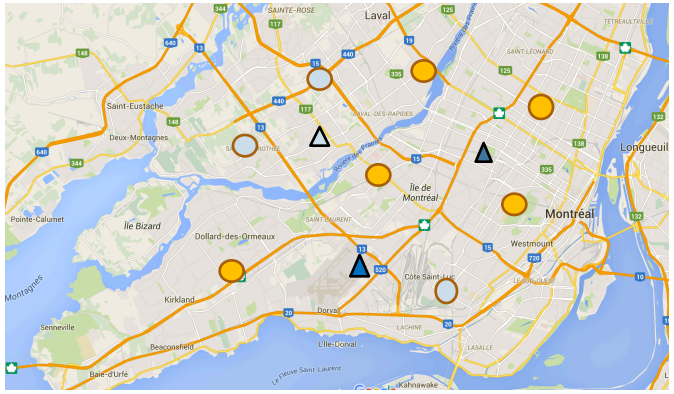

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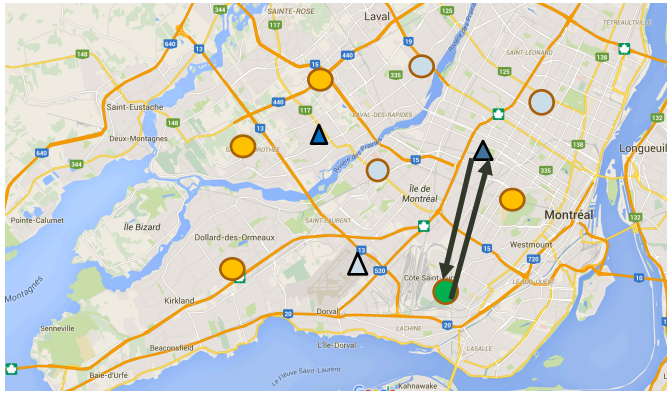

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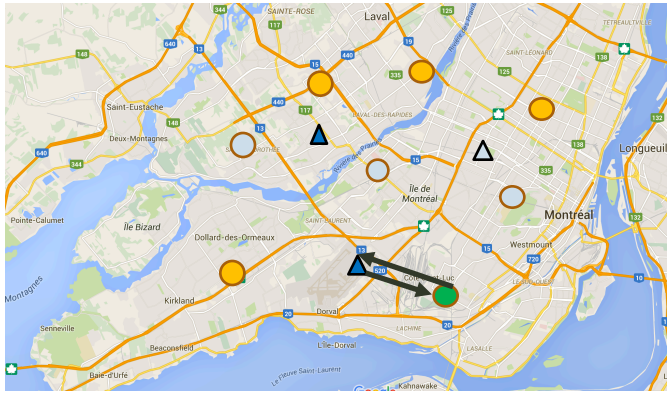

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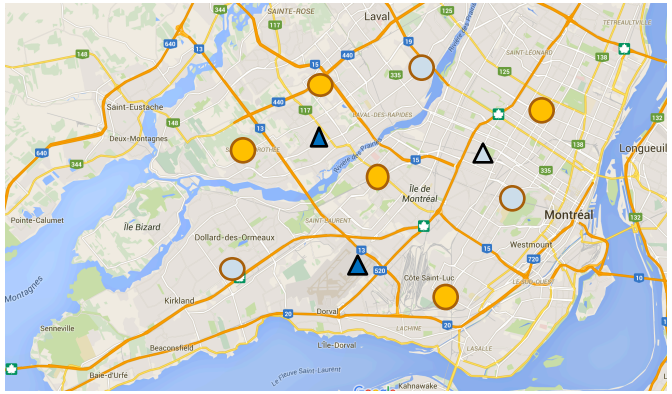


Patient/Nurse not available

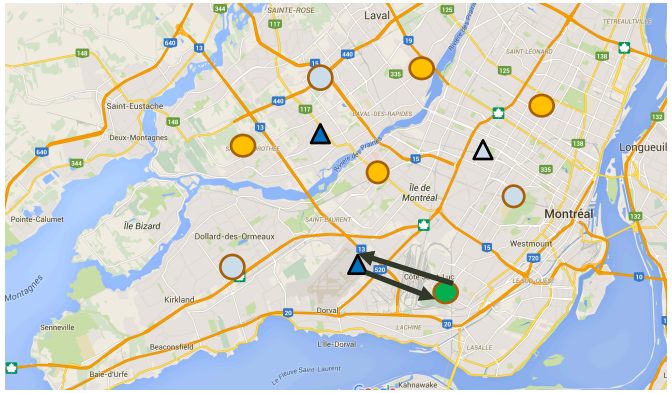
Unused available day

Used available day

Complete Week Scheduler

HANALOG AlayaCare

Monday



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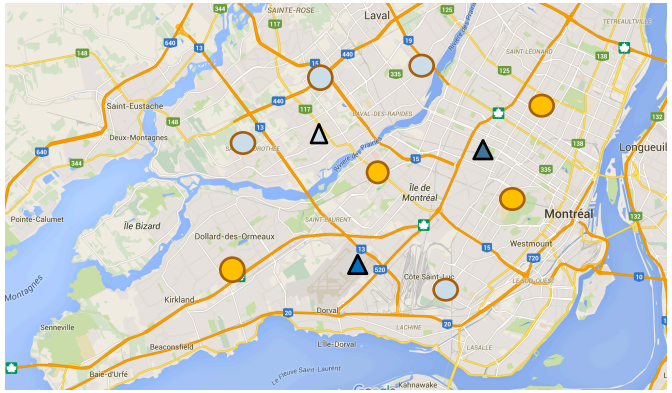

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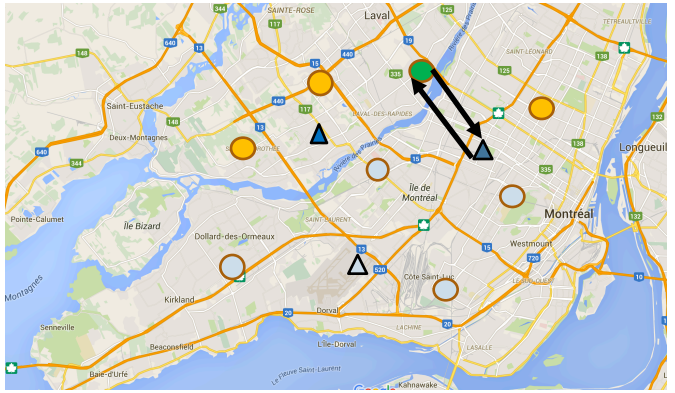

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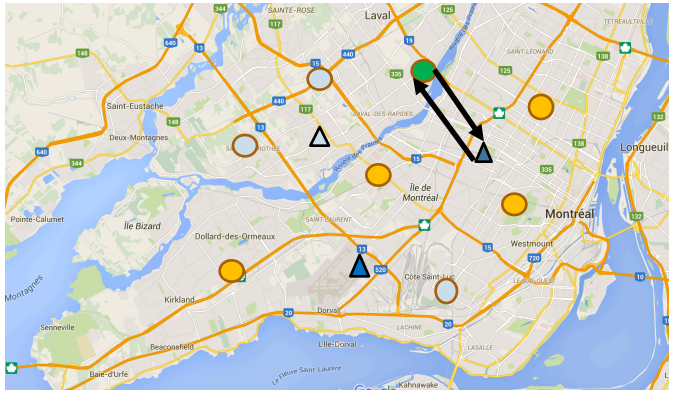

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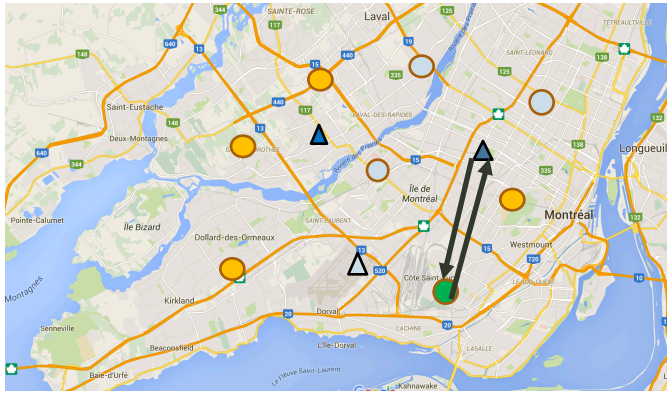

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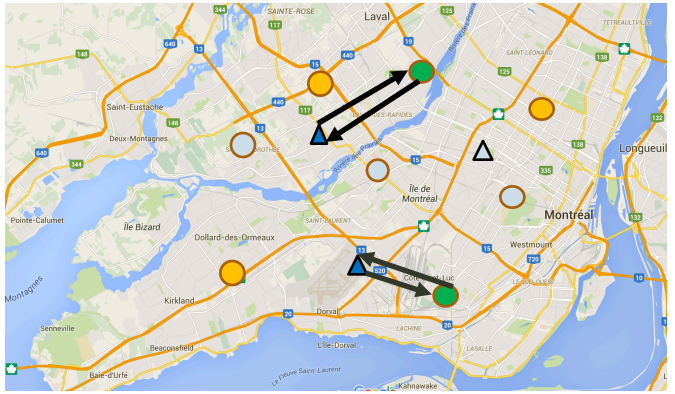

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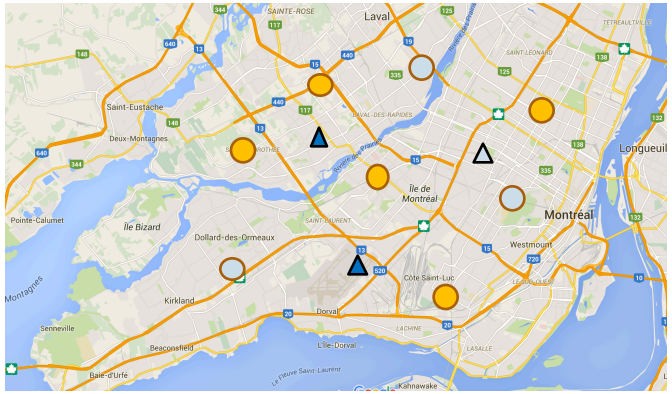


Patient/Nurse not available

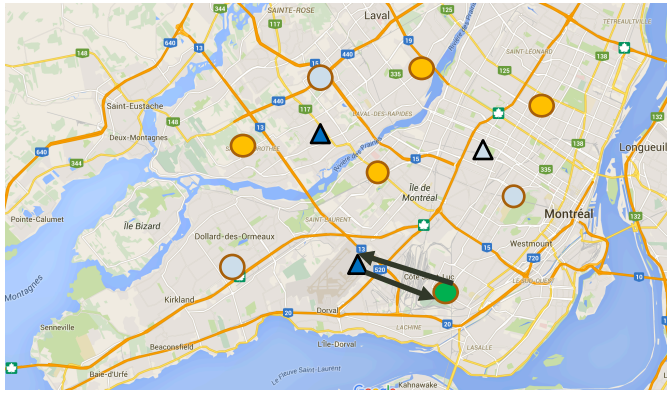
Unused available day

Used available day

Complete Week Scheduler

HANALOG AlayaCare

Monday



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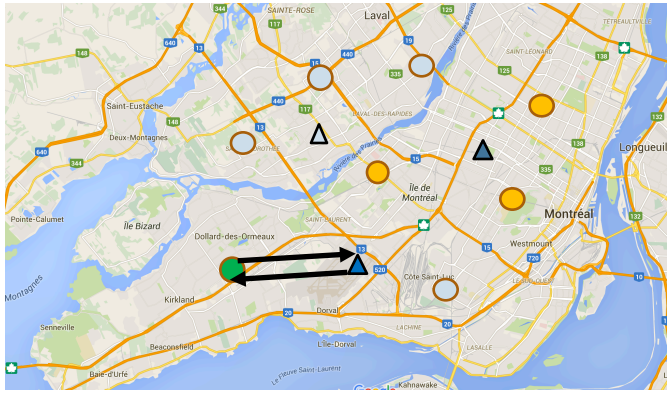

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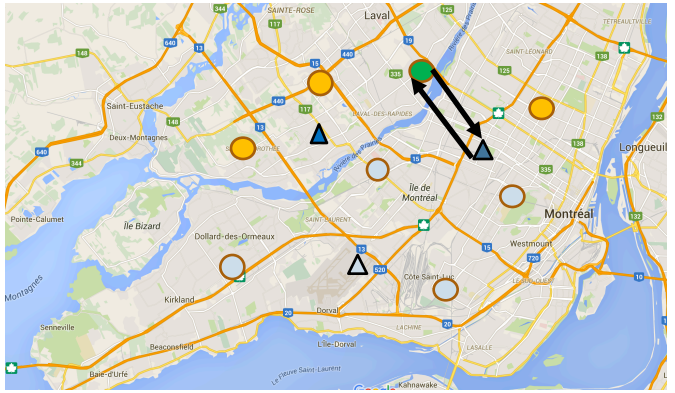

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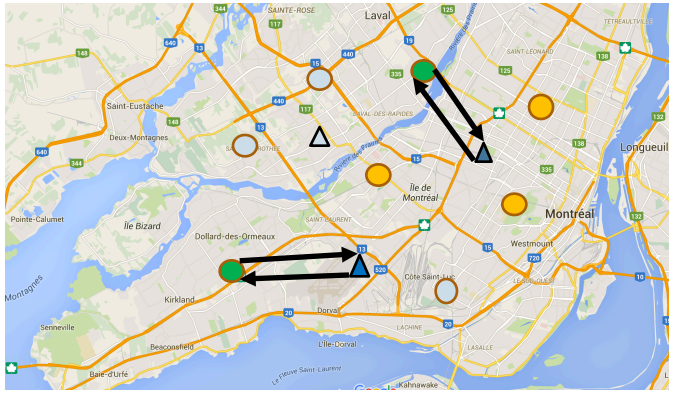

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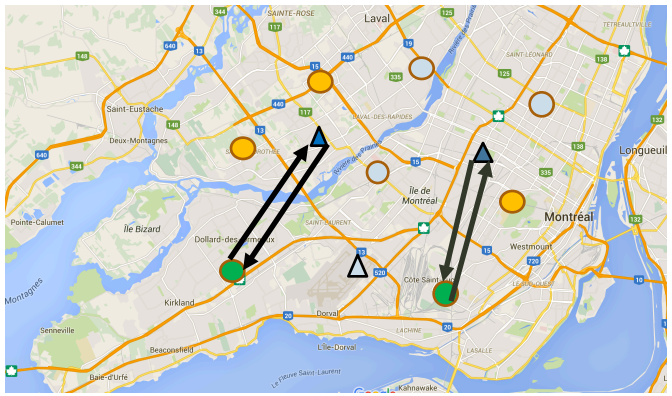

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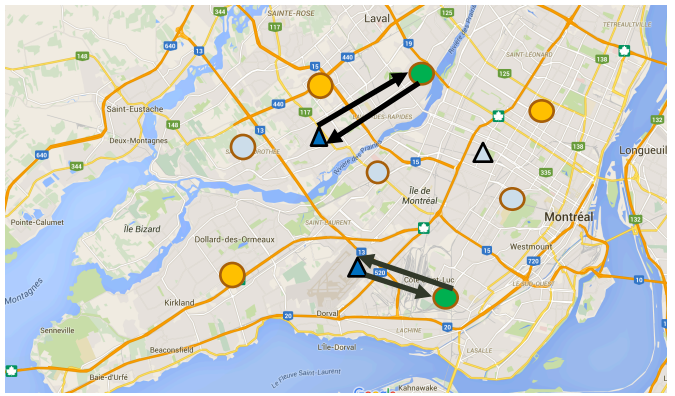

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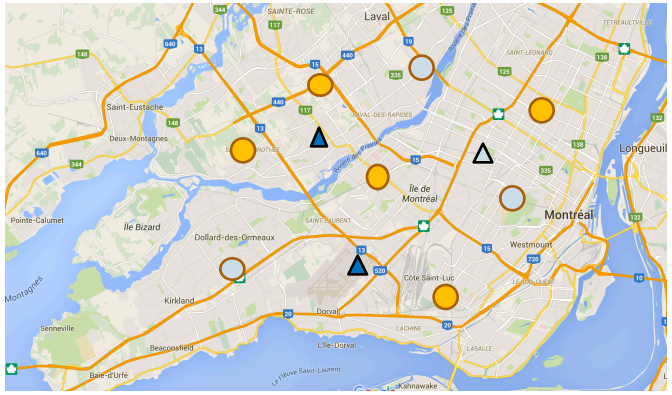


Patient/Nurse not available

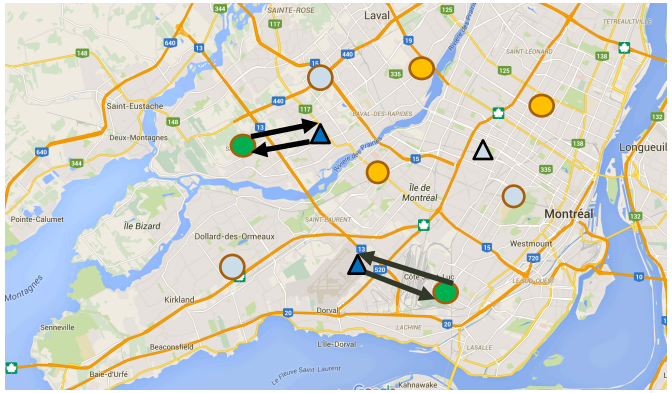
Unused available day

Used available day

Complete Week Scheduler

HANALOG AlayaCare

Monday



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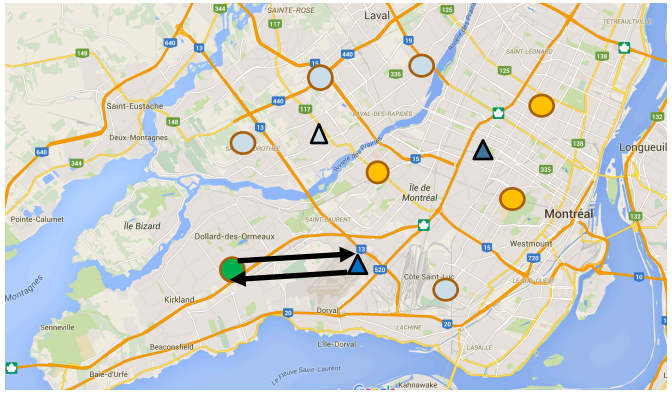

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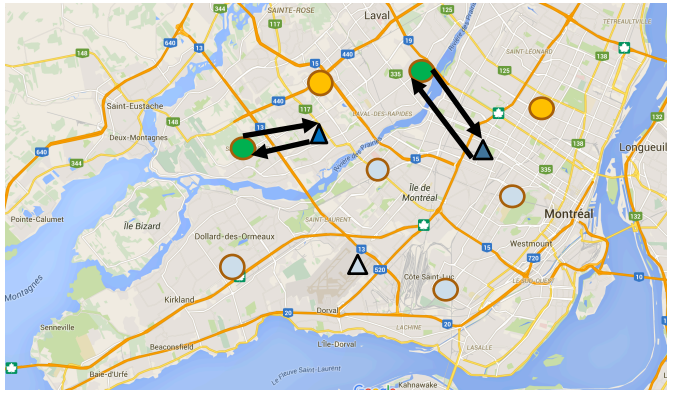

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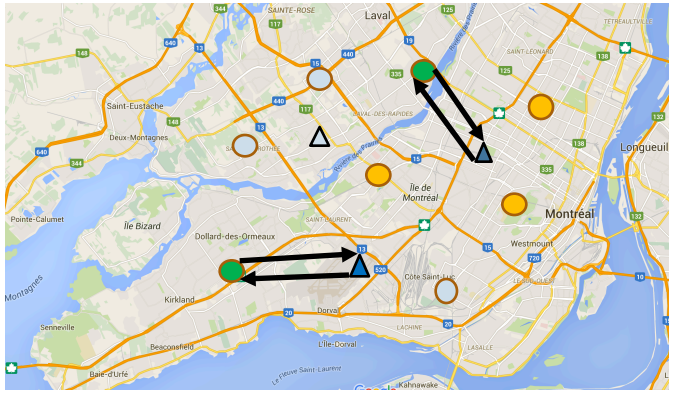

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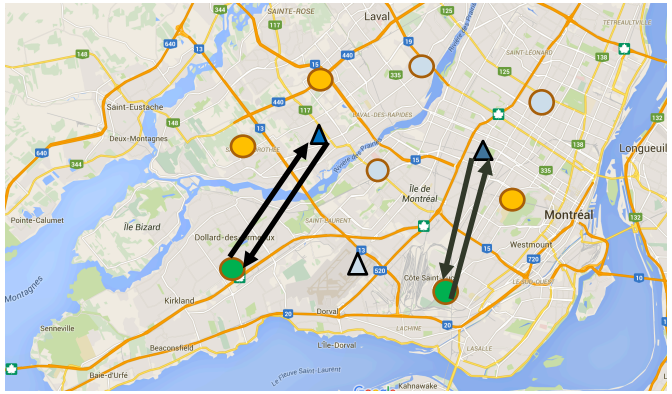

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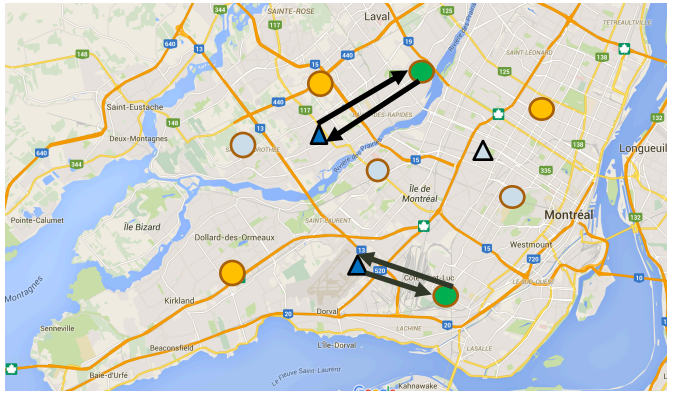

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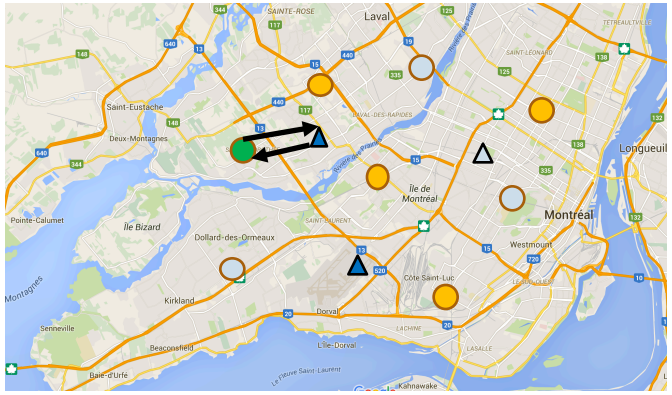


Patient/Nurse not available

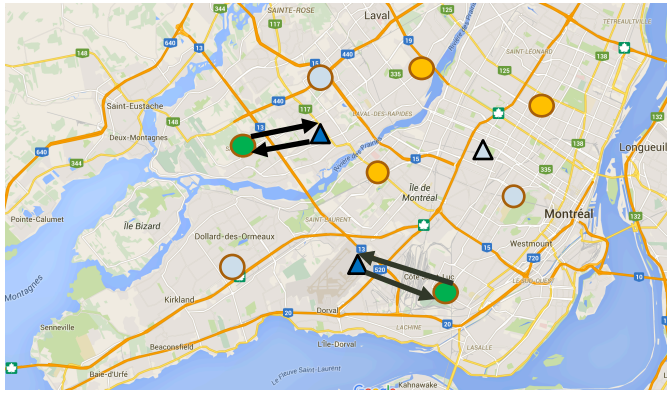
Unused available day

Used available day

Complete Week Scheduler

HANALOG AlayaCare

Monday



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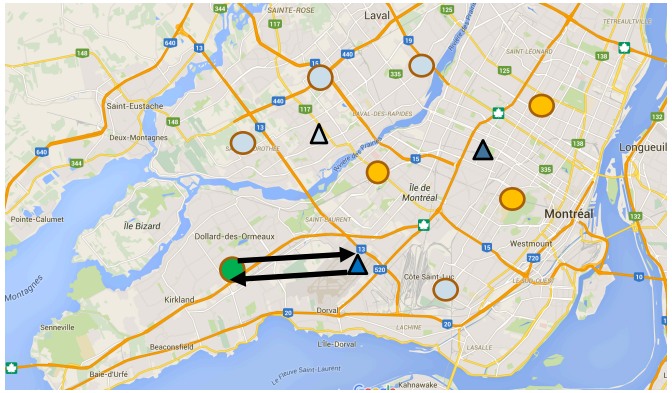

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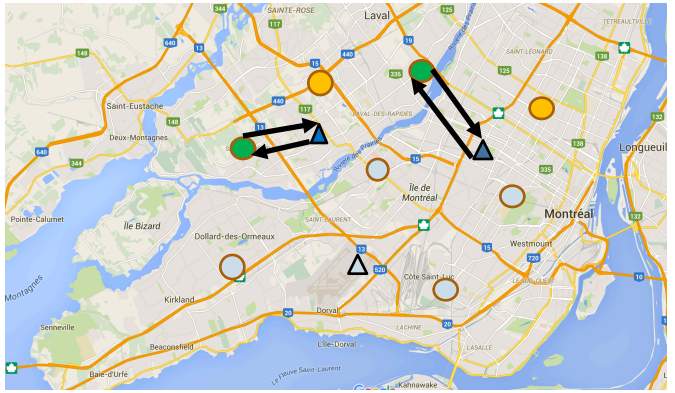

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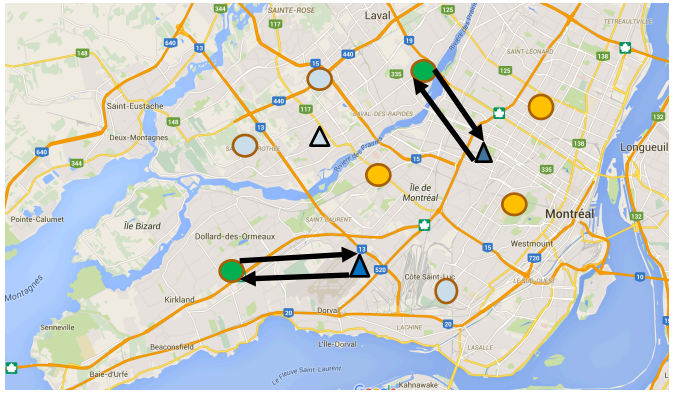

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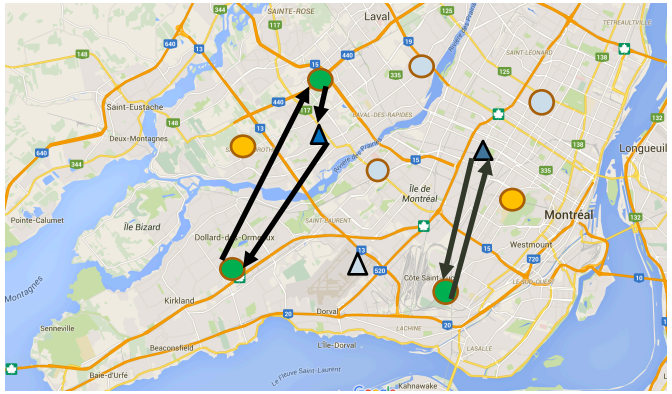

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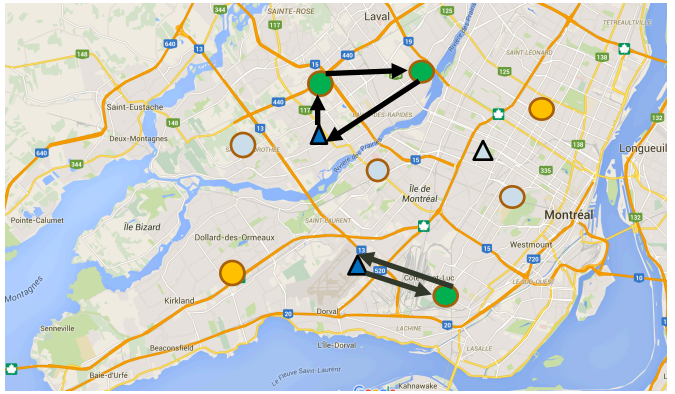

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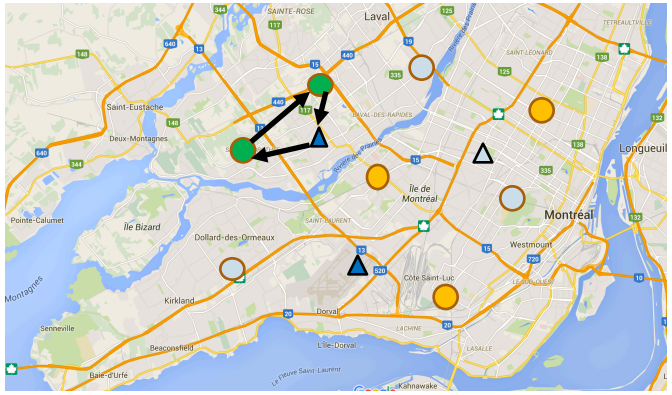


Patient/Nurse not available

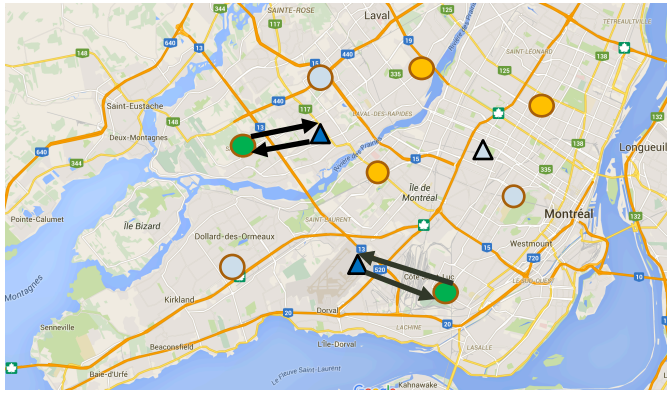
Unused available day

Used available day

Complete Week Scheduler

HANALOG AlayaCare

Monday



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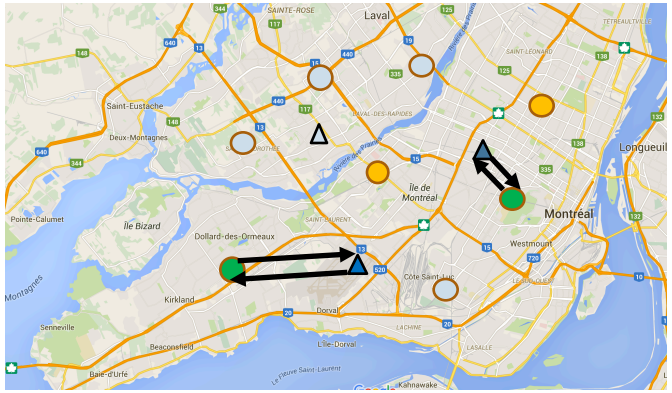

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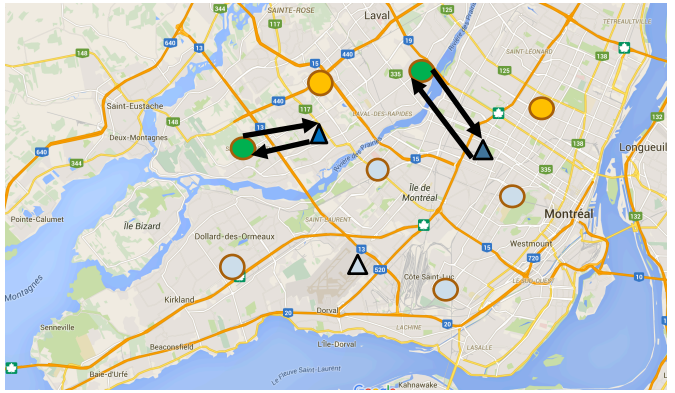

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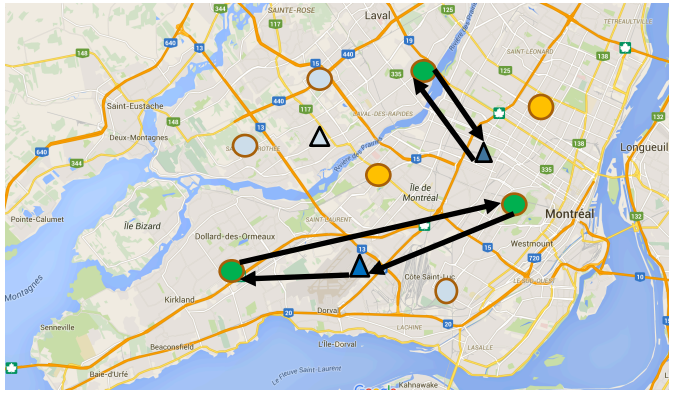

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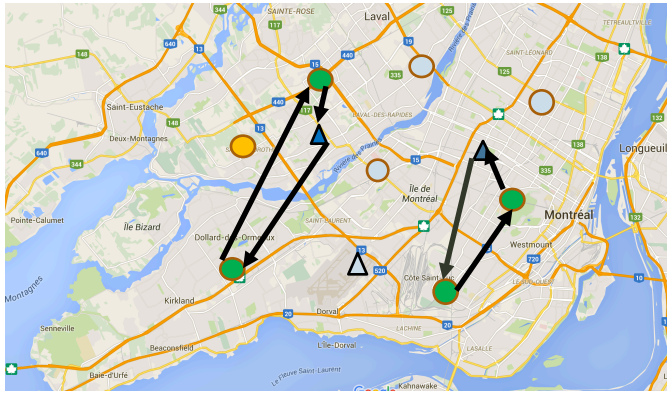

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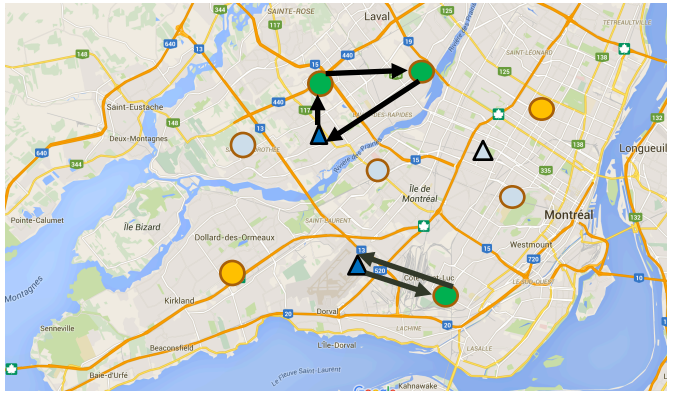

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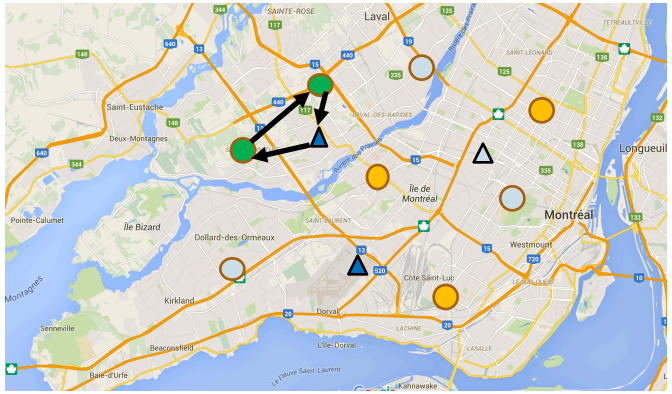


Patient/Nurse not available

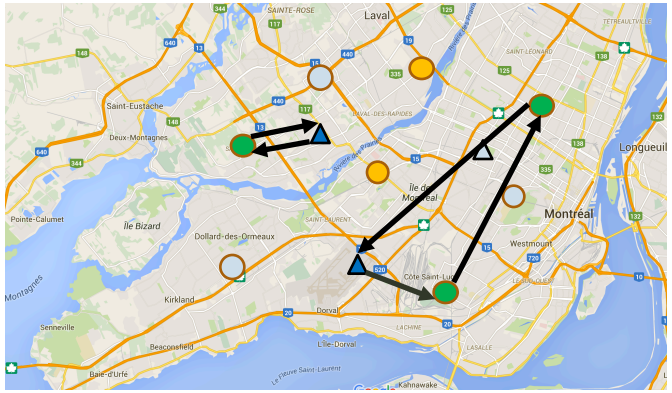
Unused available day

Used available day

Complete Week Scheduler

HANALOG AlayaCare

Monday



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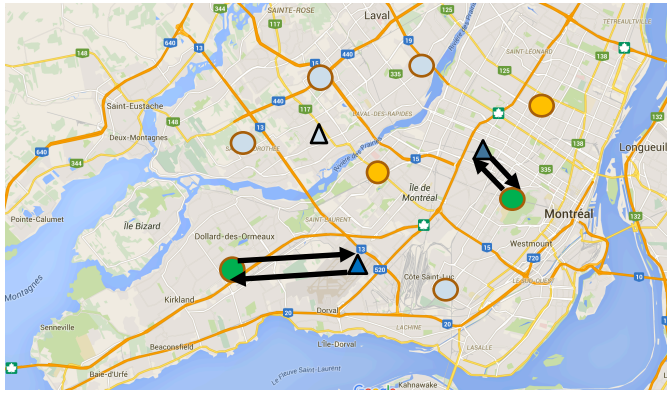
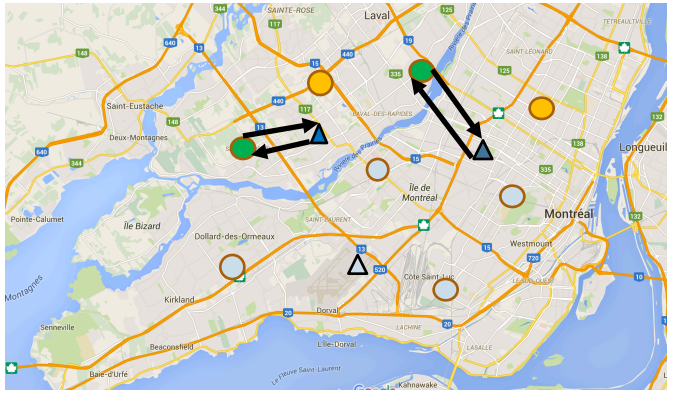
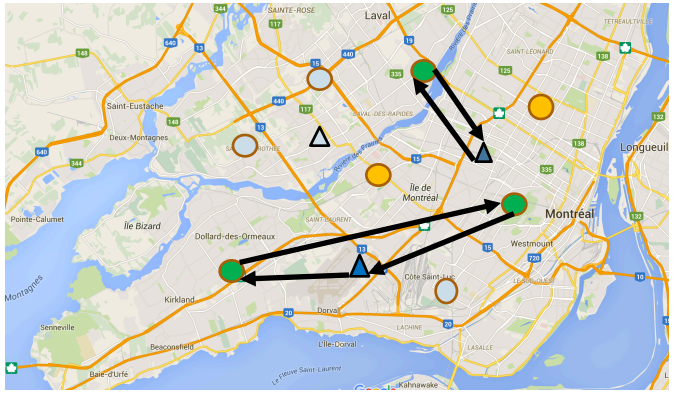


Wednesday



Thursday



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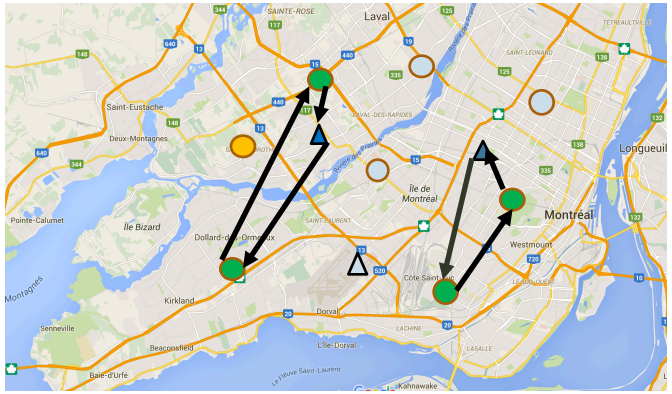
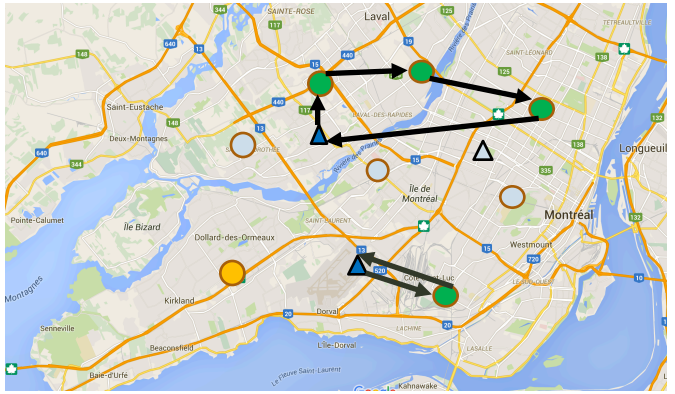
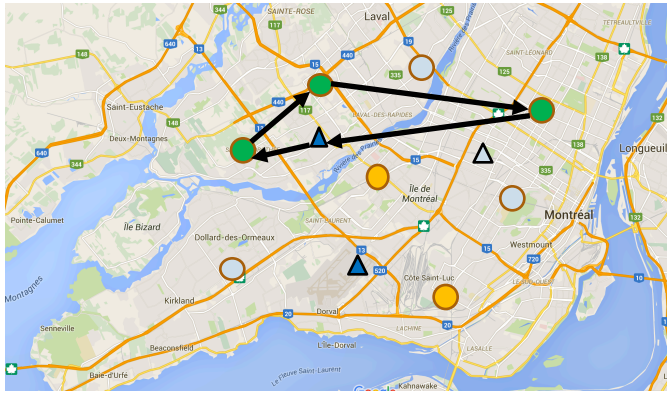


Saturday



Sunday



Patient/Nurse not available

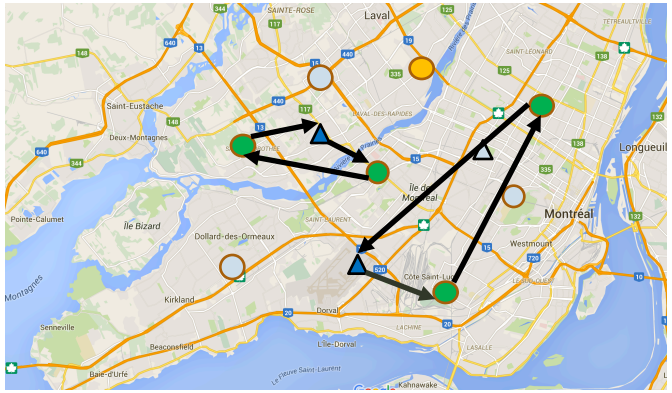
Unused available day

Used available day

Complete Week Scheduler

HANALOG AlayaCare

Monday



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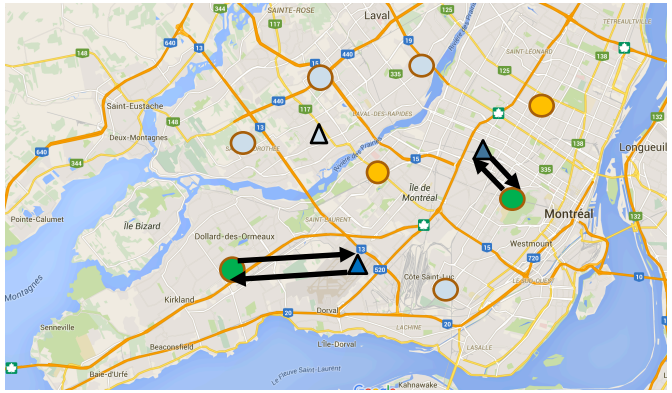

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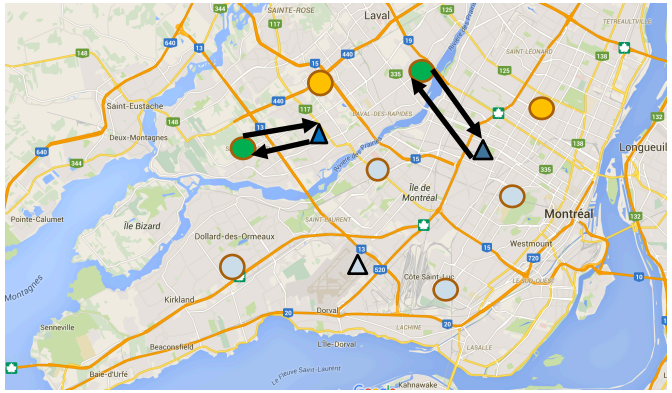

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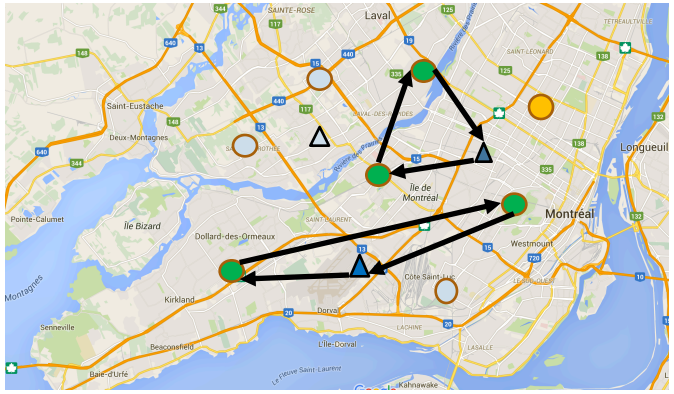
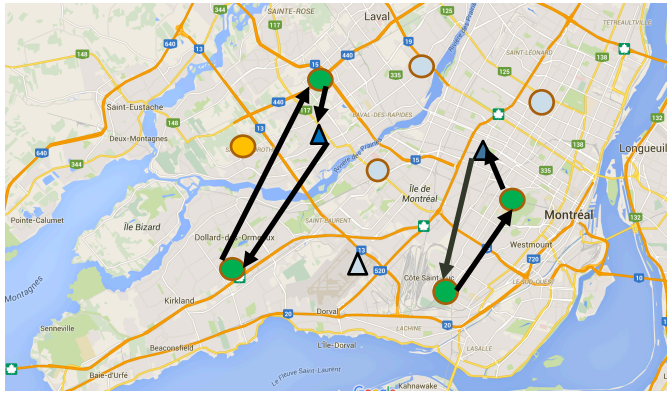
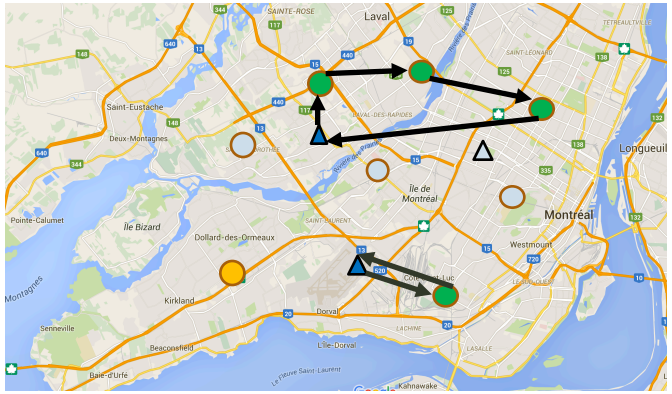


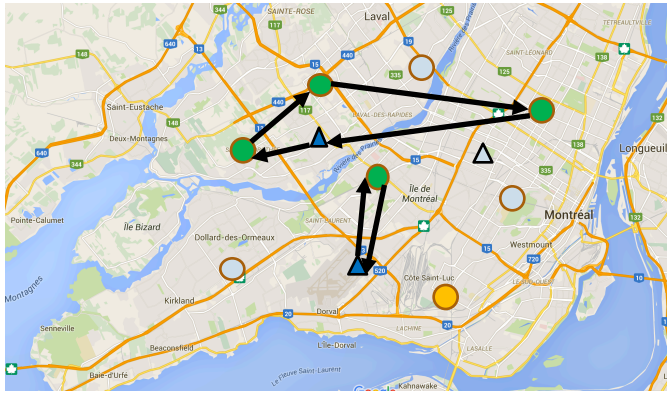
Friday



Saturday



Sunday



Patient/Nurse not available

Unused available day

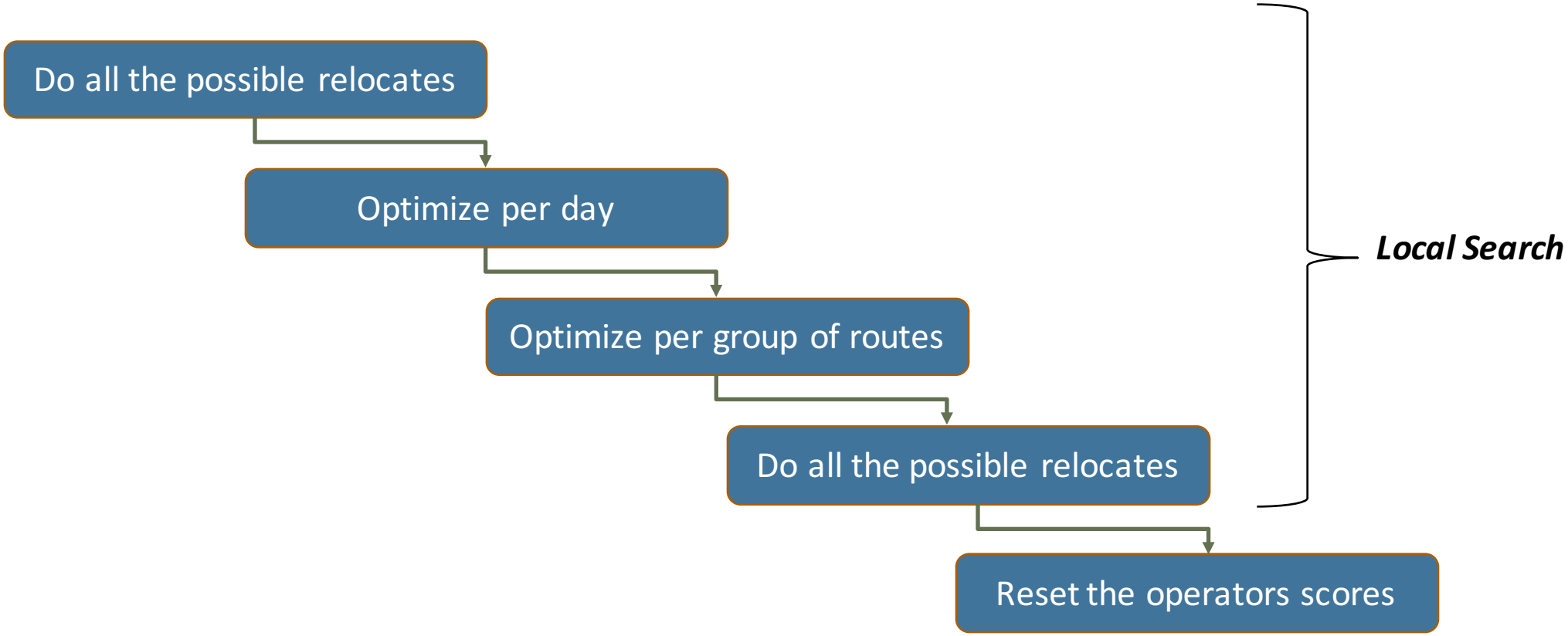
Used available day

Complete Week Scheduler

New Solution

HANALOG AlayaCare

End of a segment procedure



Tests and results

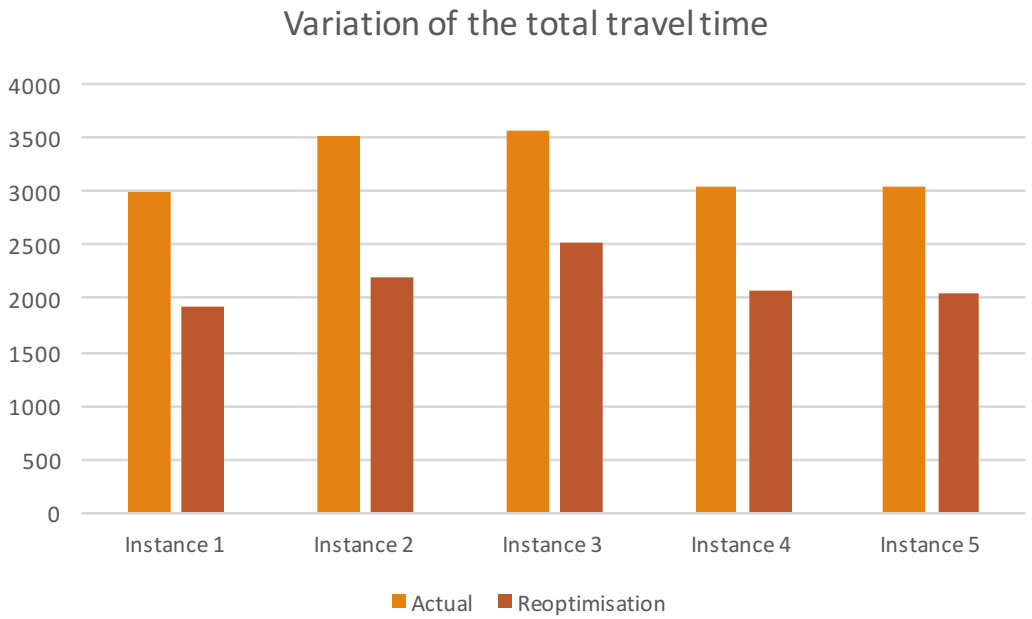
Real instances

1 instance = 1 real week

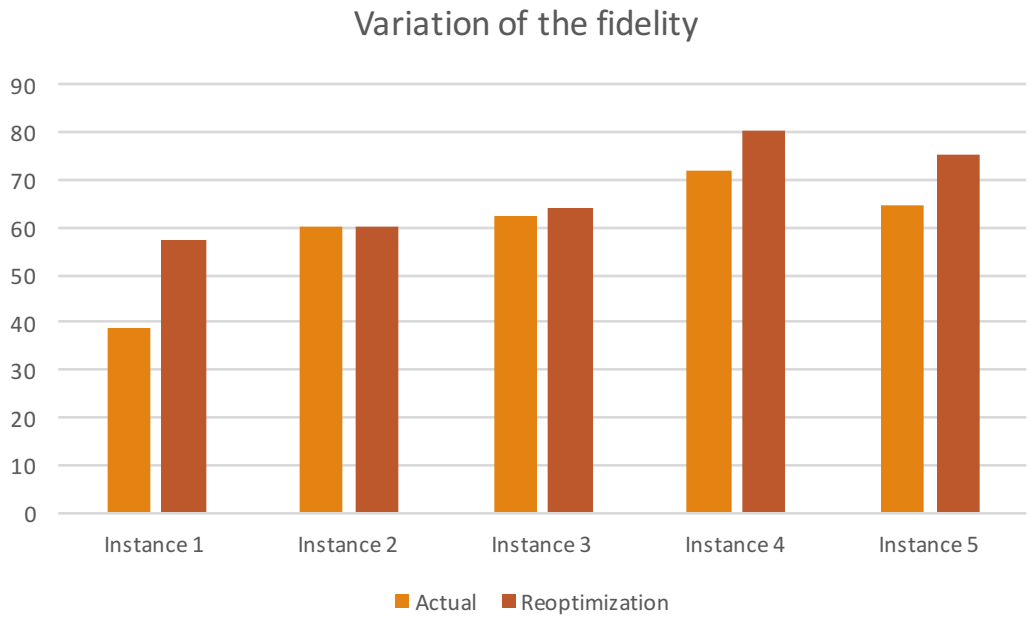
Instance	Nb Services	Nb Nurses	Nb Visits	Nb Routes	Available days	Mean Duration
1	119	9	272	36	272	39,36
2	149	11	325	40	325	39,48
3	137	11	340	40	340	38,52
4	145	11	311	35	311	38,03
5	146	11	324	40	324	37,65

300 sec, 30000 iter.

Real Instances



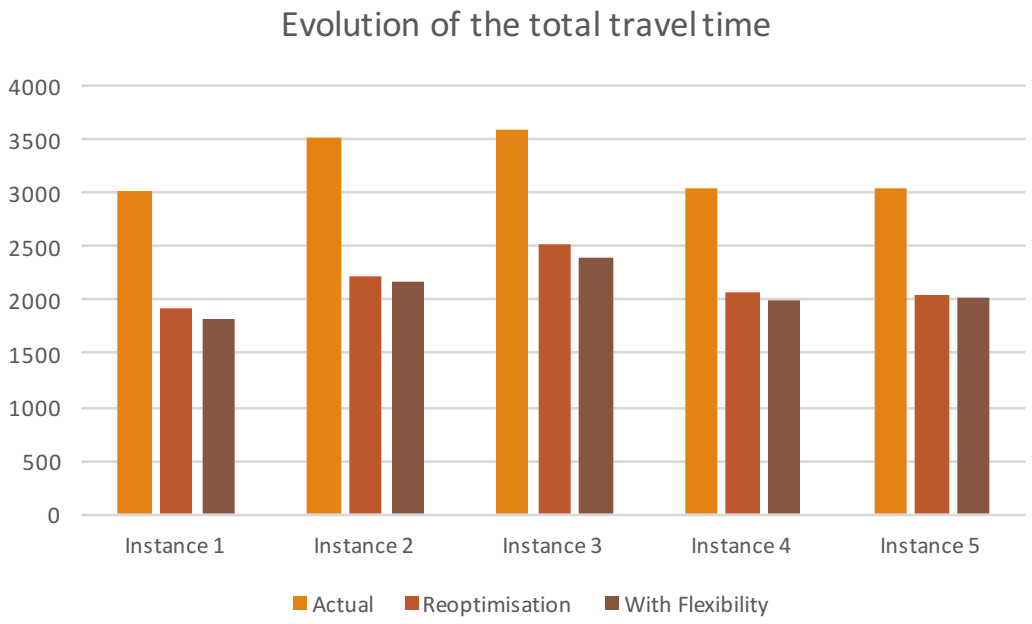
Reduction of the travel time by **33,49%** in comparaison with the actual solution



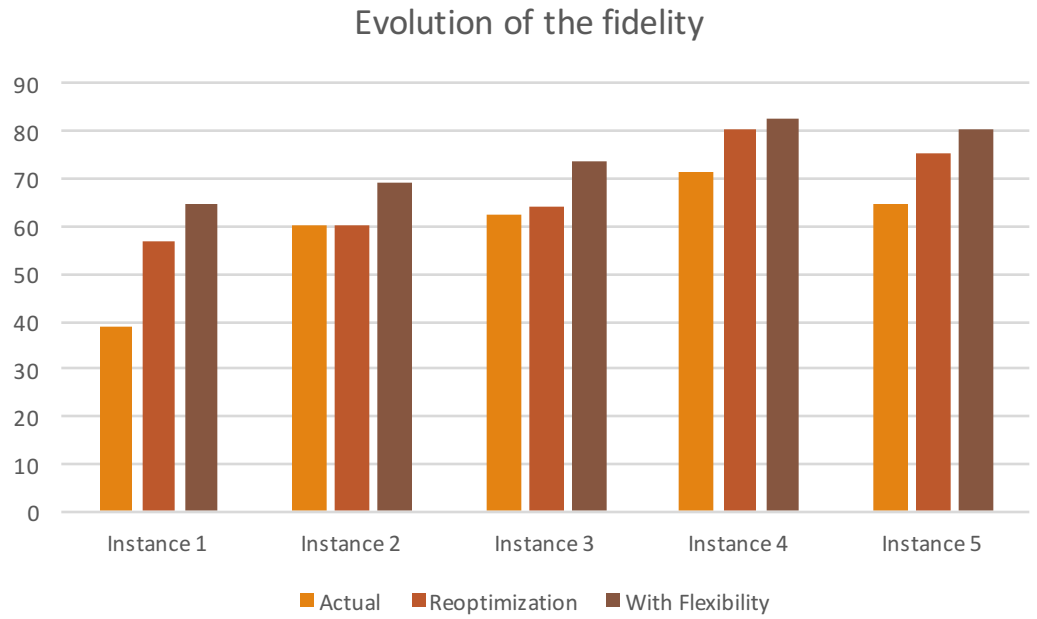
Increase of the continuity of care by **15,92%** in comparaison with the actual solution

300 sec, 30000 iter.
Plus 2 available days for
40% of the services

Real Instances



Reduction of the travel time by **35,61%** in comparaison with the actual solution

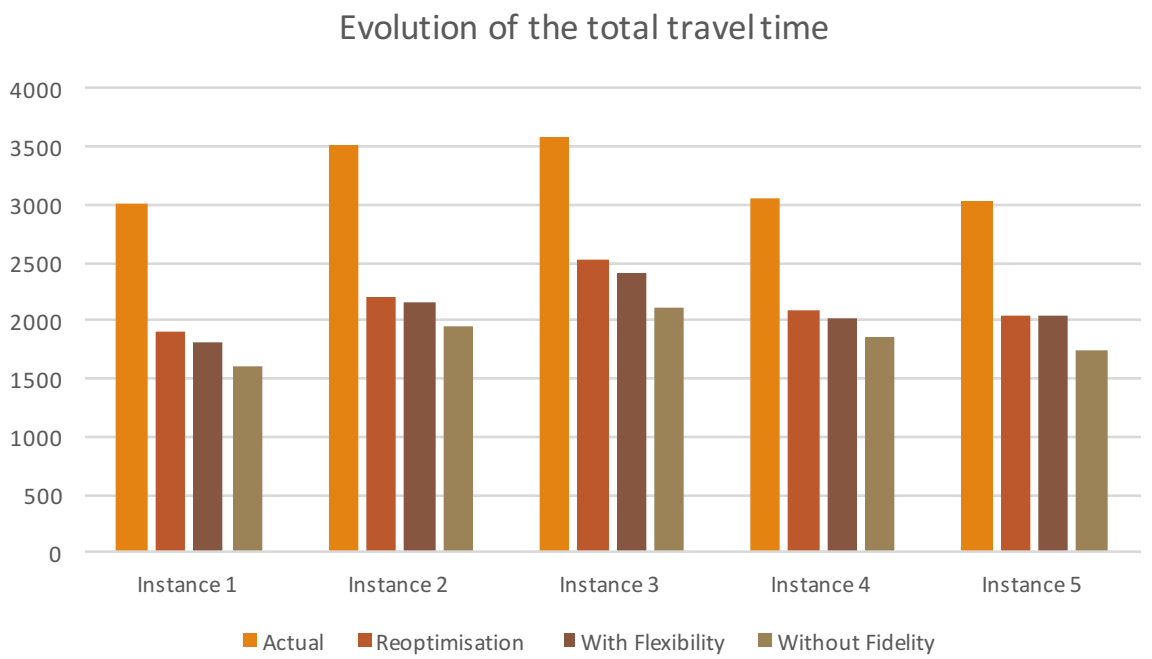


Increase of continuity of care by **27,99%** in comparaison with the actual solution

HANALOG AlayaCare

300 sec, 30000 iter.
We don't take into account the past continuity.

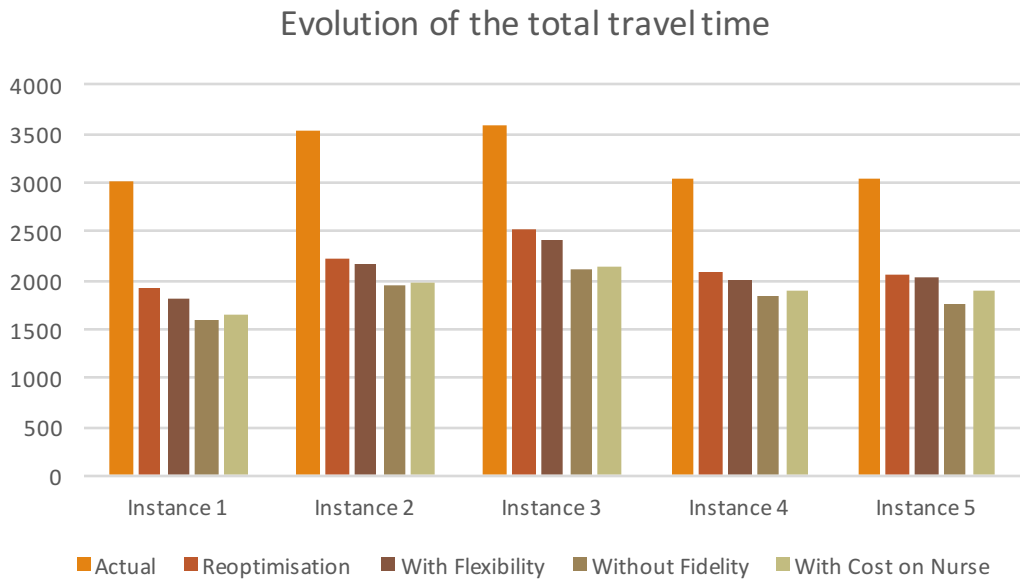
Real Instances



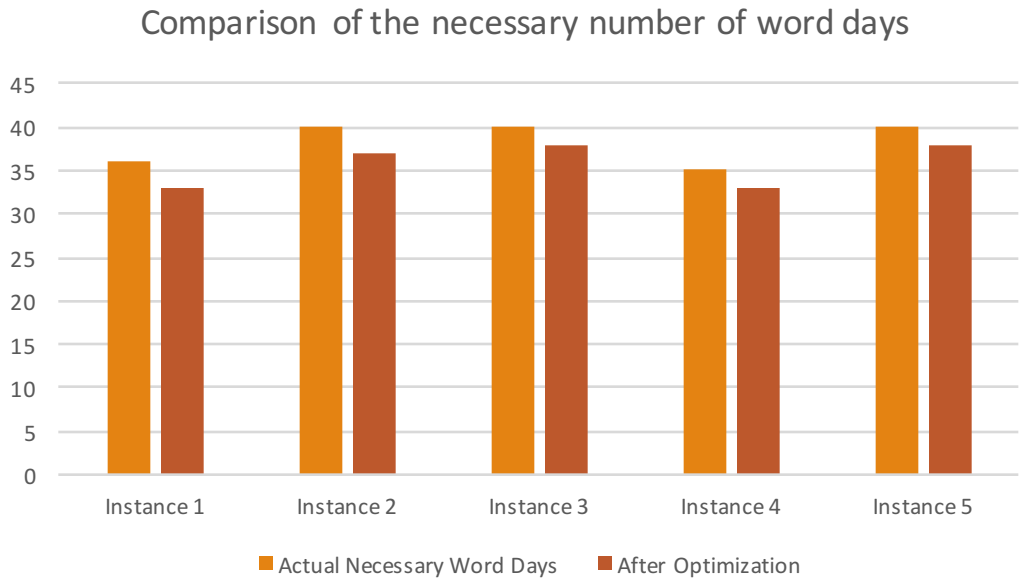
Reduction of the travel time by **42,88%** in comparaison with the actual solution

300 sec, 30000 iter.
We add a cost on the utilization of a nurse work day

Real Instances



Reduction of the travel time by **42,88%** in comparaison with the actual solution



Reduction of the number of used work days by **6,31%** in comparaison with the actual solution

Conclusion

- We have developped an algorithm to solve the home health care problem

- **Early test** shows that our algorithm seems effective and permits to save at least **33% of the care givers travel time and increase continuité of care.**