“Real-World AI - How to Use it Now for Real Advantage"

Hosted by: Liva Randrembason, IIBA

Sponsored & Presented by: Geoffrey De Smet, Red Hat

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Today's Presenter

Geoffrey de Smet

Principal Software Engineer and OptaPlanner lead at Red Hat

www.optplanner.com

Real-World AI with Business Optimizer
How to use AI now for real advantage

Geoffrey De Smet: OptaPlanner / Business Optimizer Lead

Phil Simpson: Product Marketing Manager

September 2019

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The Ultimate American Road Trip
redhat.

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Wonkblog

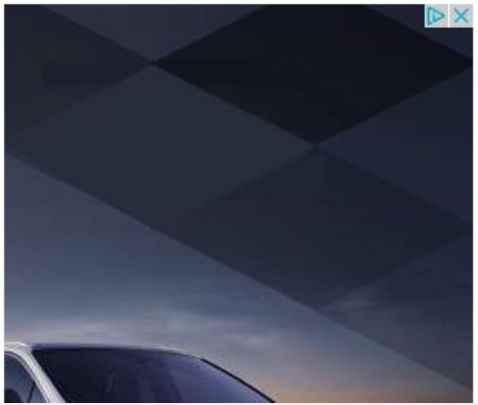
A data genius computes the ultimate American road trip

A Save for Later Reading List

By Ana Swanson March 10, 2015 Follow @anaswanson

This post comes via Know More, Wonkblog's social media site.

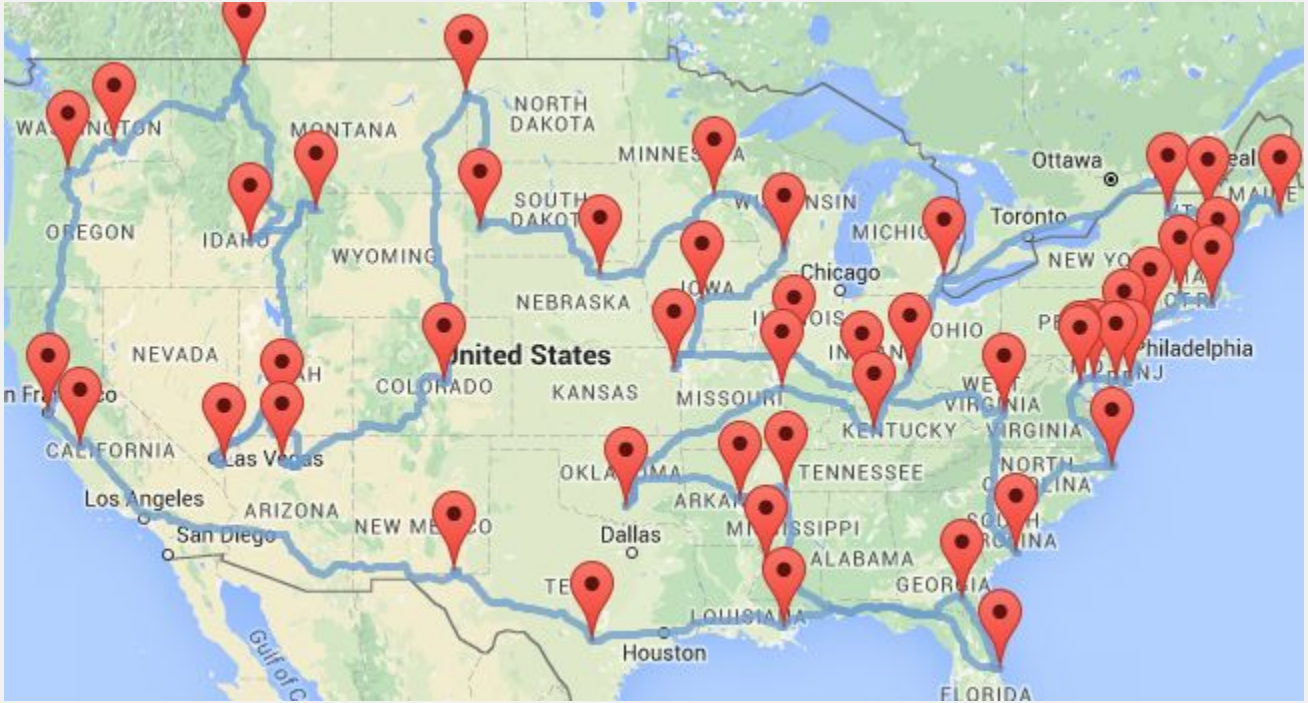
Who needs an atlas when you have an algorithm? Data tinkerer Randy Olson, who previously developed the optimal search path for finding the bespectacled main character of the "Where's Waldo?" books, has used this same algorithm to compute the ultimate American road trip.



redhat.

Road trip for 50 landmarks, monuments, etc.

redhat.



Traditional algorithm: 271h 35m 16s

Is it optimal?

redhat.

Olson's trip: 232h 43m 10s

⇒ 38h 52m 6s faster (**14% faster**)

Is it optimal?

redhat.

Better algorithms

Olson

232h 43m 10s

redhat.

Better algorithms

Olson

232h 43m 10s

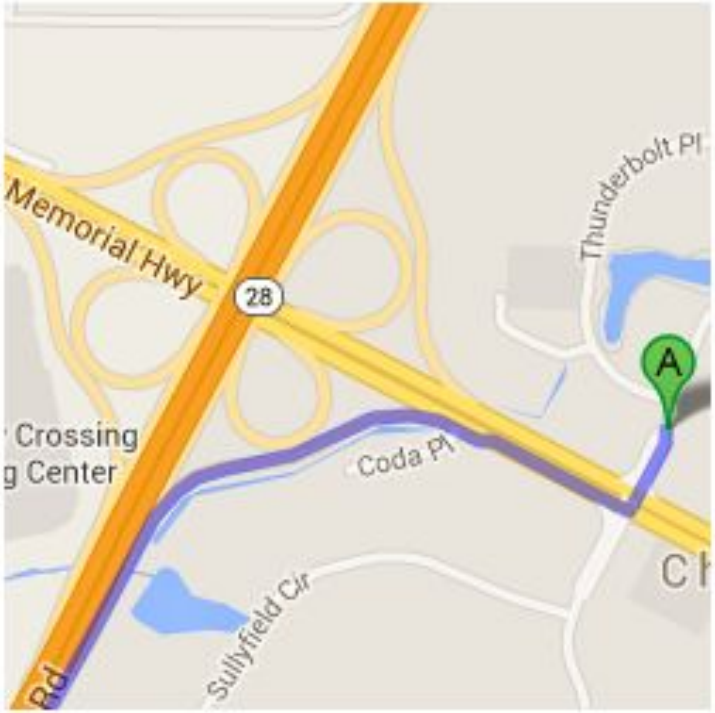
OptaPlanner

231h 7m 30s

- 1h 35m 40s

redhat.

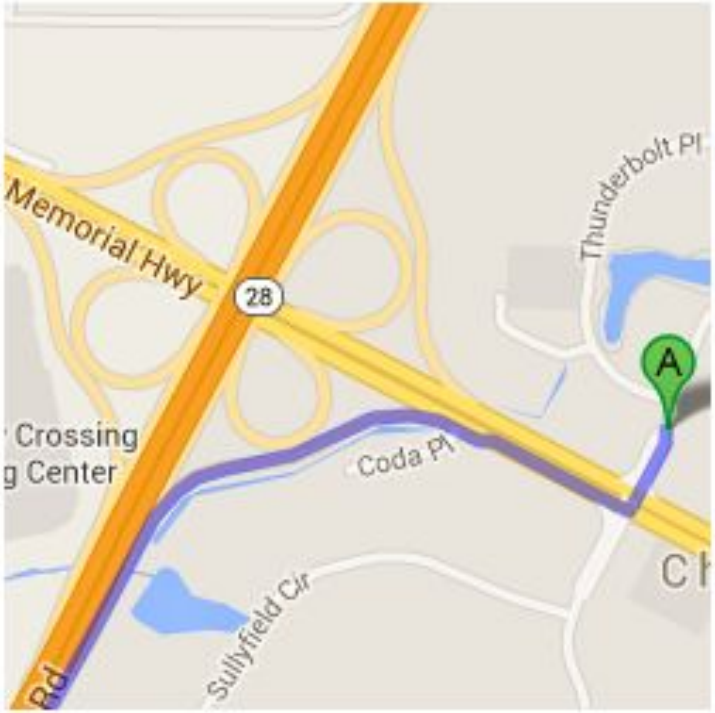
Road are asymmetric



To location A

redhat.

Road are asymmetric



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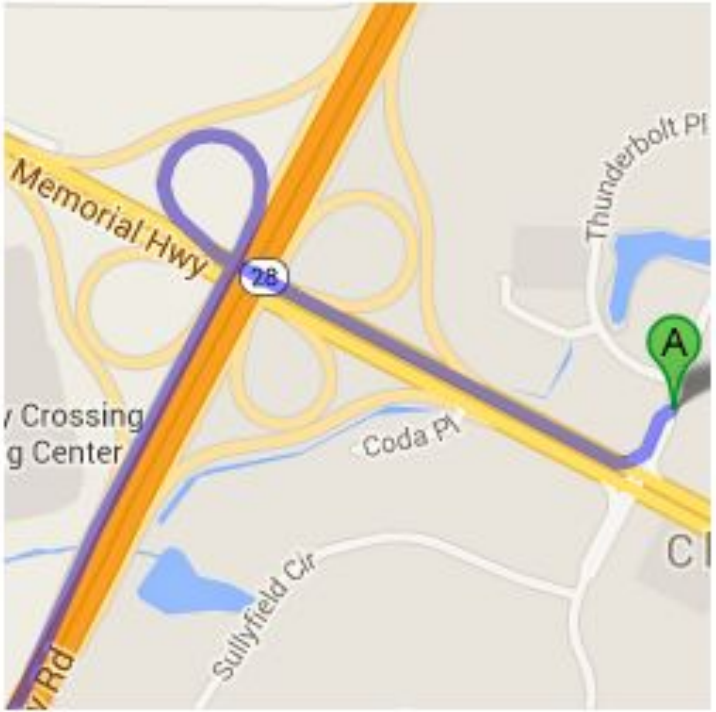
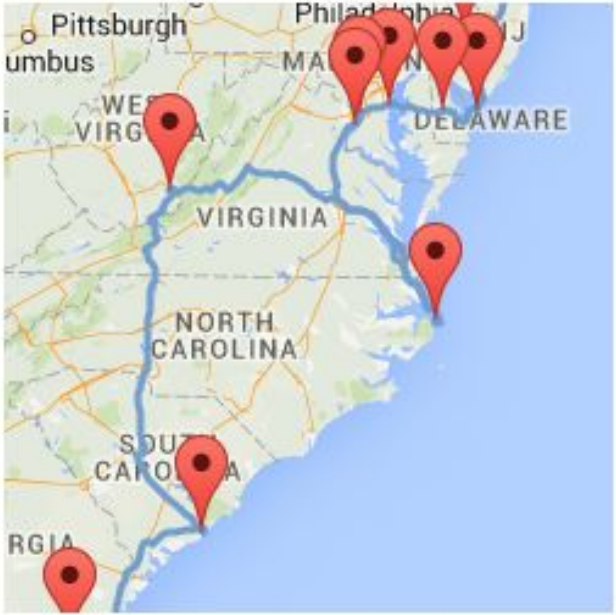


From location A

redhat.

Road are asymmetric



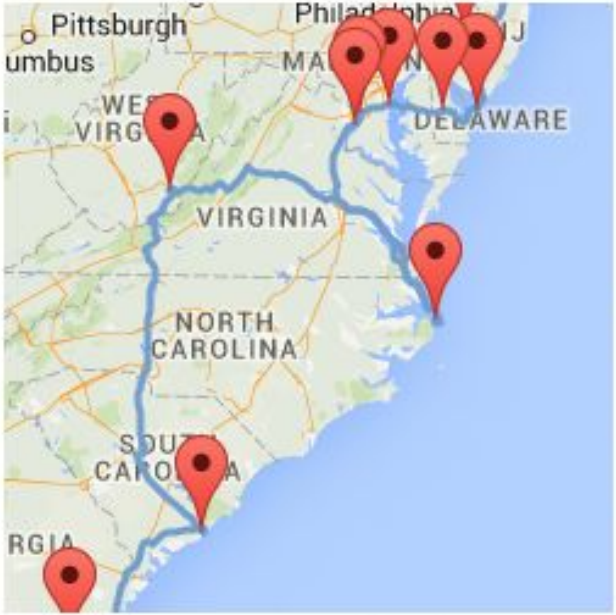
Use symmetric data

231h 7m 30s

(asymmetric calculation)

redhat.

Road are asymmetric



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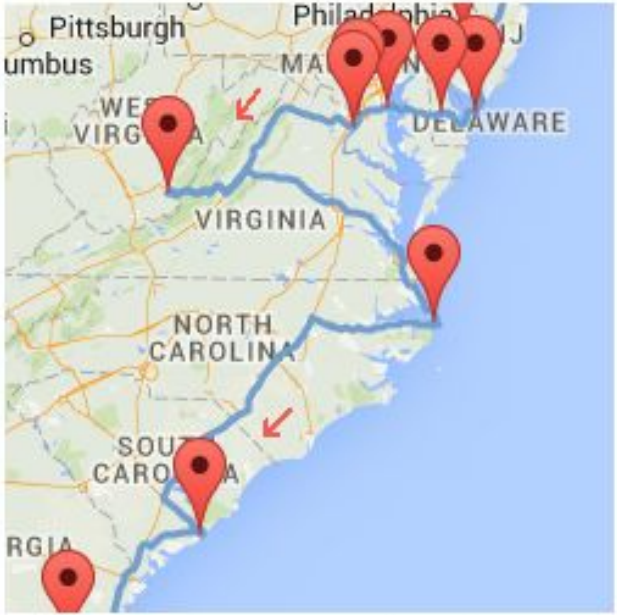

Use asymmetric data

230h 17m 54s

- 49m 36s

redhat.

Olson's trip: 232h 43m 10s
Not optimal

redhat.

OptaPlanner's trip: 230h 17m 54s

⇒ Another 2h 25m 16s faster (1% ⇒ **15% in total**)

Optimal, also 33km 710m (= 20.95 miles) shorter

redhat.

15% less driving time

redhat.

Any enterprise with vehicles can use constraint solving AI to reduce their driving time by a significant margin.

redhat.

The Vehicle Routing Problem (VRP)
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Vehicle routing

Assign the delivery order of vehicles more efficiently.

redhat.

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redhat.

Vehicle routing

Assign the delivery order of vehicles more efficiently.

Users

Supermarkets & retail stores

Freight transportation

Buses, taxi's & airlines

Technicians on the road

redhat.

Vehicle routing

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Freight transportation

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Technicians on the road

VehicleRouting benchmark (Belgium datasets)

	Average	Min/Max	# datasets	Biggest dataset
Driving time	-15%	-9% -18%	5	2750 deliveries 55 vehicles

OptaPlanner versus traditional algorithm with domain knowledge

5 mins Late Acceptance Nearby vs First Fit Decreasing

Don't believe us? Run our open benchmarks yourself: http://www.optaplanner.org/code/benchmarks.html

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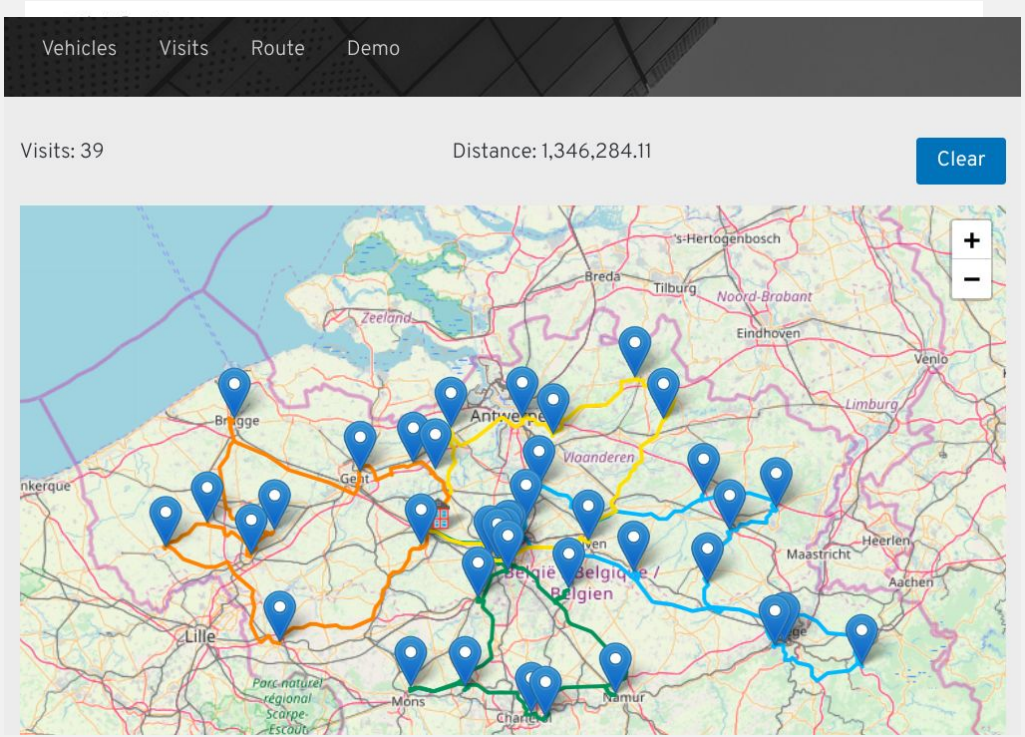
Technician vehicle routing

- Technician vehicle routing across US
  - In production since 2017
  - Constraints: Time windows, maximum shift duration, ...
- **Savings: 25-30% reducing driving time (they expected 1-2%).**
    - 25%+ lower CO^2 emissions
    - 10k+ less technicians (same workload)
      - **Results in $100M+ savings per year**

redhat.

OptaWeb Vehicle Routing Demo



https://github.com/kiegroup/optaweb-vehicle-routing

Available on RHPDS

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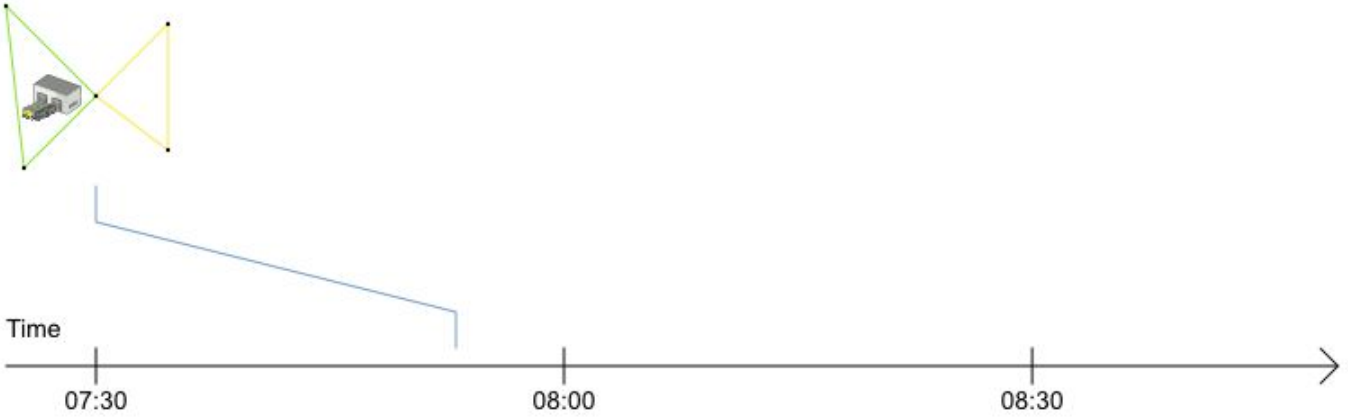
Real-time planning

When the problem changes in real-time, the plan is adjusted in real-time.

Nightly planning



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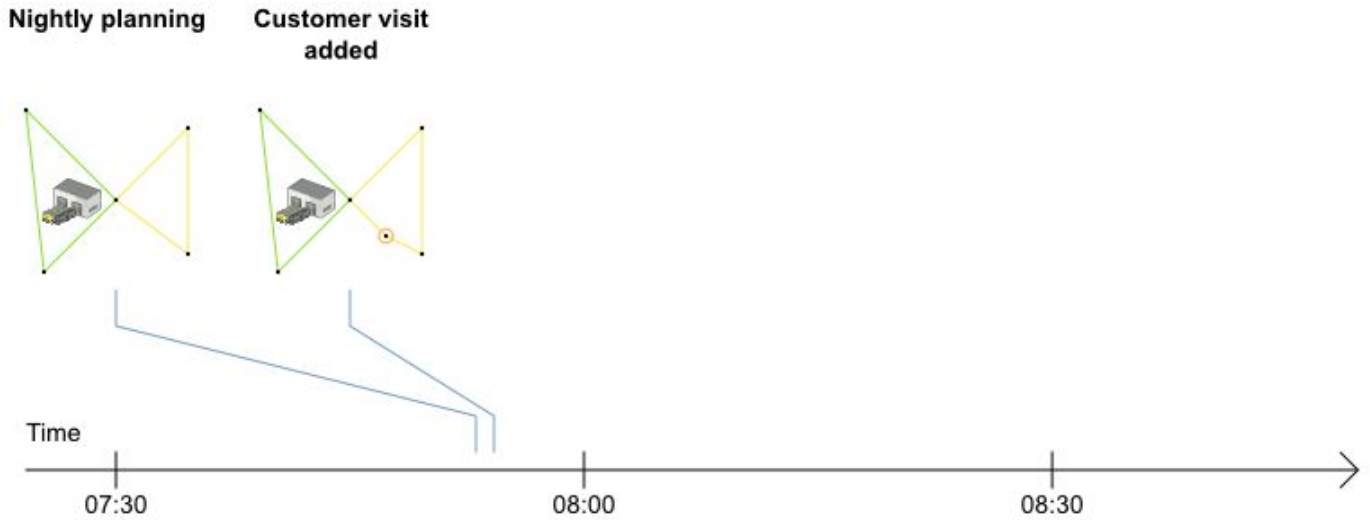

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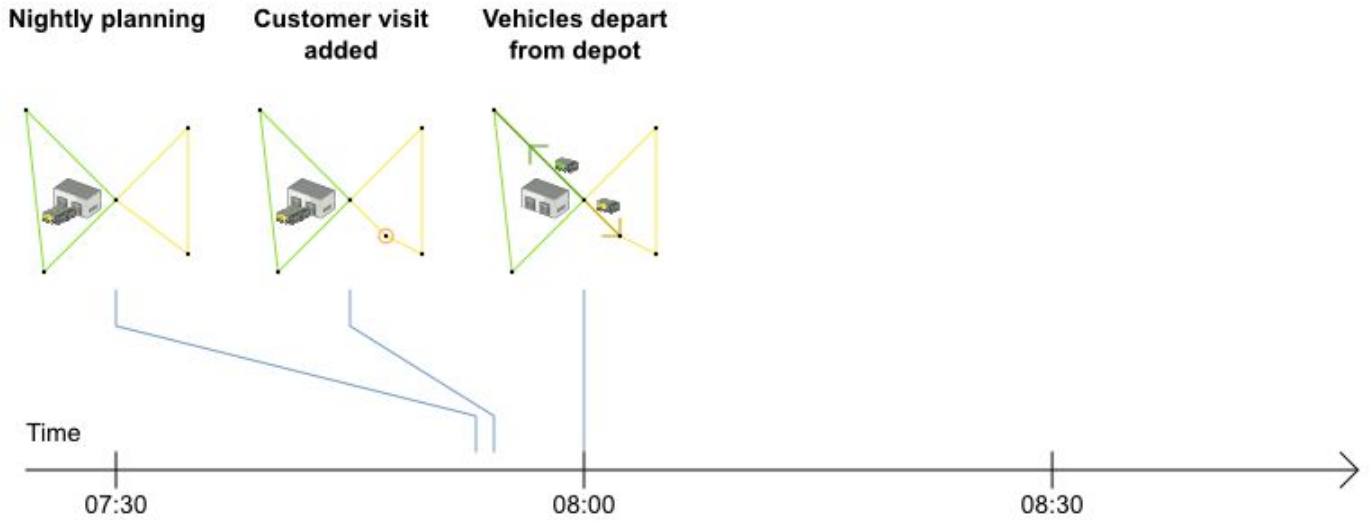

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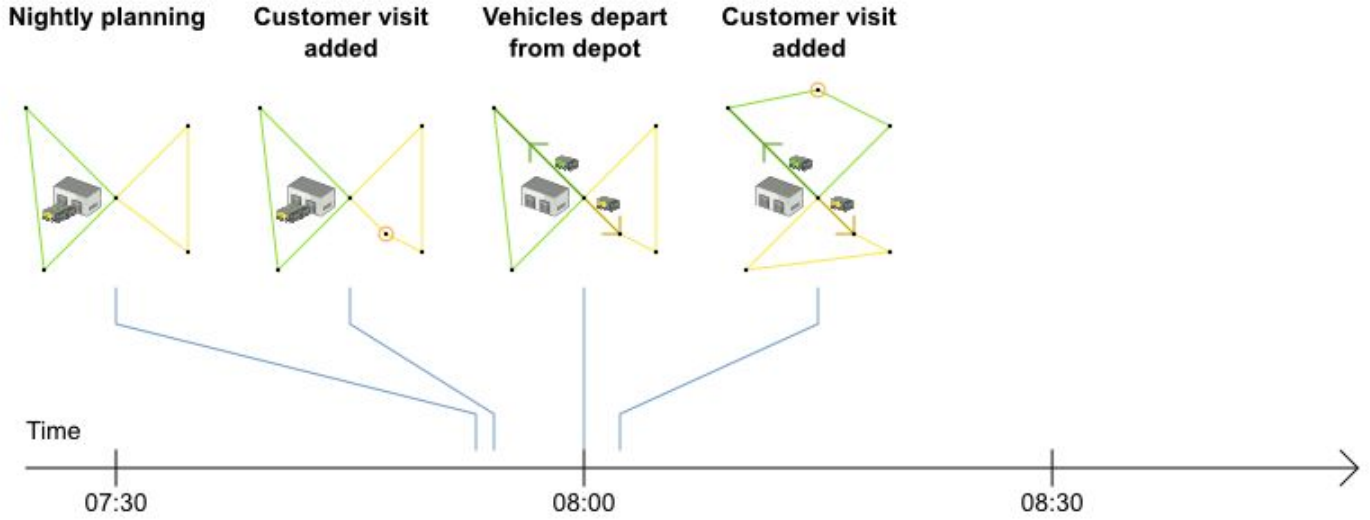

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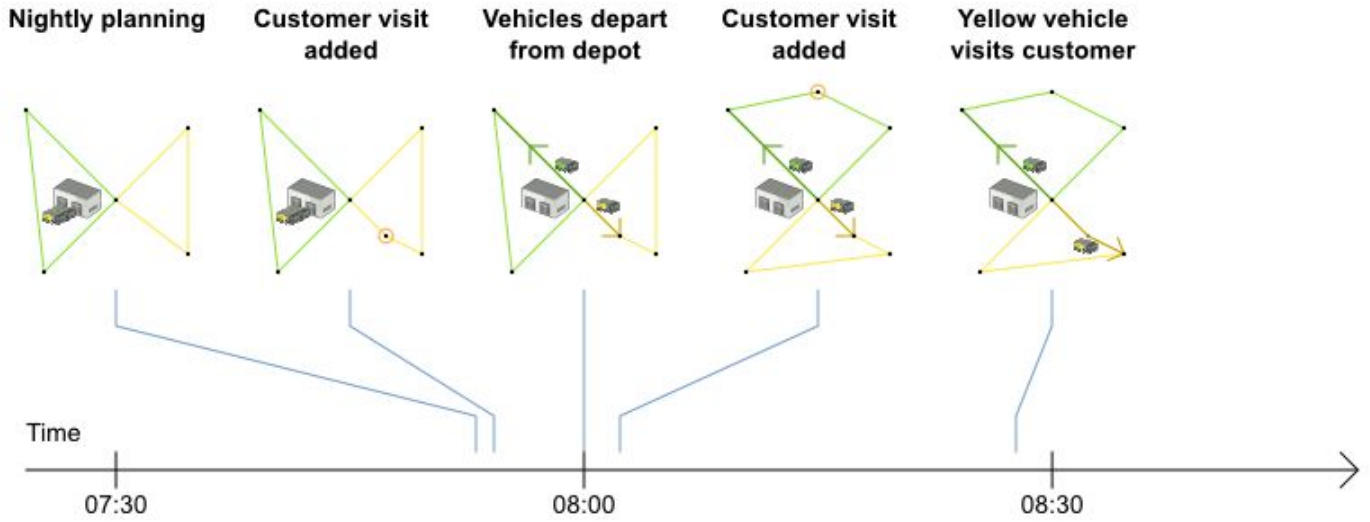

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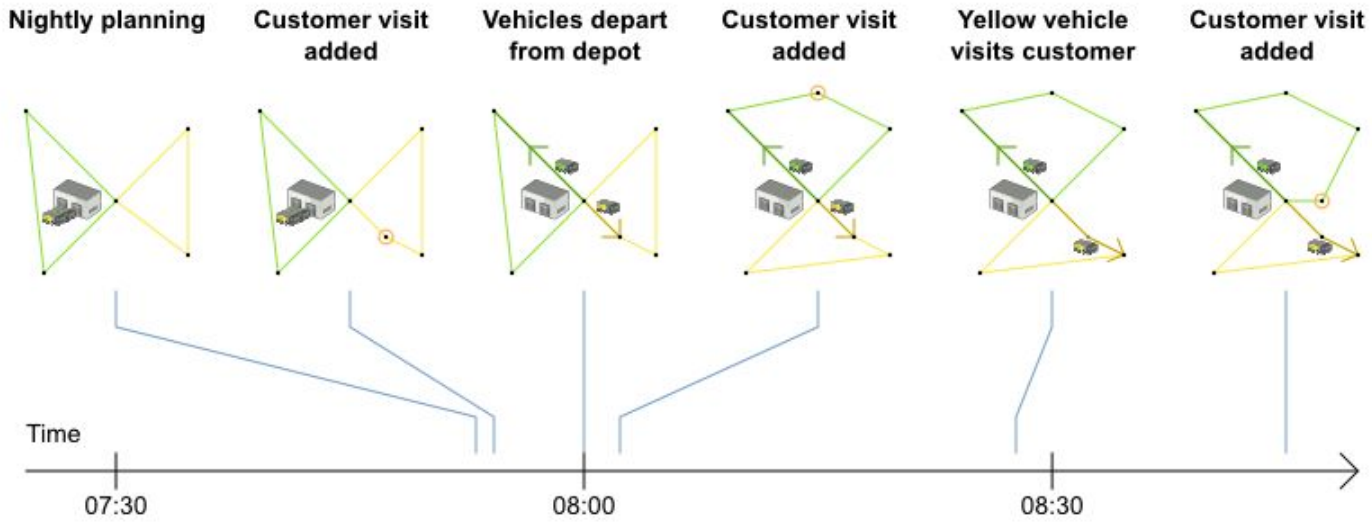

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Other planning problems?

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Constraint solver AI
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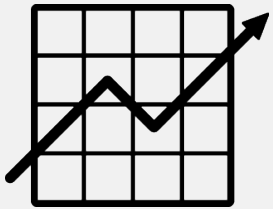
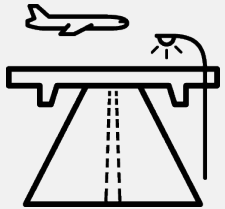
What is a planning problem?



Optimize **Goals**



With limited **Resources**

Under **Constraints**

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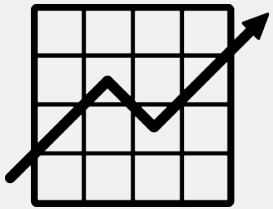
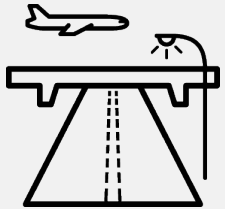
What is a planning problem?



Goals

Minimize driving time
Increase employee well-being
Improve resource utilization



Resources

Vehicles (capacity, fuel)
Employees (skill, FTE's)
Time

Constraints

Max 8 hrs consecutive driving
Laws & Regulations
Max vehicle capacity

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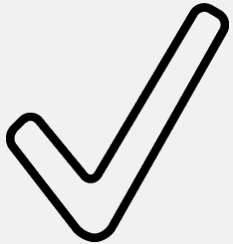
Some of the Business Benefits

Reduce Costs

Trucks
Fuel
Employee wages

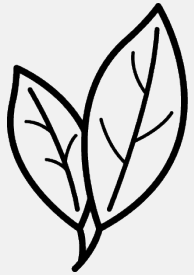
Improve Customer Satisfaction

Faster delivery
Assign employees with higher affinity



Improve Employee well-being

Reduce travel time
Honor day-off requests
Improve resting periods



Save the planet

Reduce CO^2 emissions

redhat.

Constraint solvers are AI

redhat.

Constraint solvers are AI

Constraint solvers are not ML

redhat.

Constraint solvers are AI

Constraint solvers are not ML

Constraint solvers are not deep learning neural nets

redhat.

The right A.I. for the job

One Artificial Intelligence algorithm does not fit all use cases.

redhat.

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Full text search

"cat"

redhat.

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The secret life of felines

felines.pdf

Felines, or **cats** as they are more commonly known, are carnivorous ...

redhat.

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15% less driving time

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Vector Space Model

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Neural Net

Image recognition

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Constraint Solver

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Other use cases include:
recommendations, similarties, ...

Neural Net

Image recognition

"Dog"

Other use cases include:
voice recognition, machine translation, ...

Constraint Solver

Vehicle routing problem

15% less driving time

Other use cases include:
employee rostering, job scheduling, ...

Other algorithms for other use cases:
A* Search for pathfinding, Rete/Phreak for production rule systems, k-means for cluster analysis, ...

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Implemented by:

Lucene

Neural Net

Image recognition

"Dog"

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Implemented by:
TensorFlow, Deeplearning4j

Constraint Solver

Vehicle routing problem

15% less driving time

Other use cases include:
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Implemented by:

OptaPlanner

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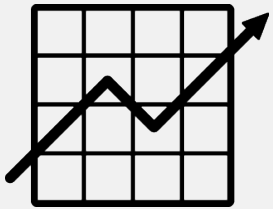
Employee rostering

For employees
that don't work 9 to 5

redhat.

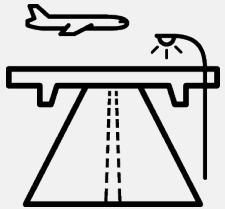
Employee rostering

Assign shift to employee more efficiently



Goals

Increase Employee well-being



Resources

Nurses

Constraints

Work 1 shift per day
Max consecutive working days
Requested days off

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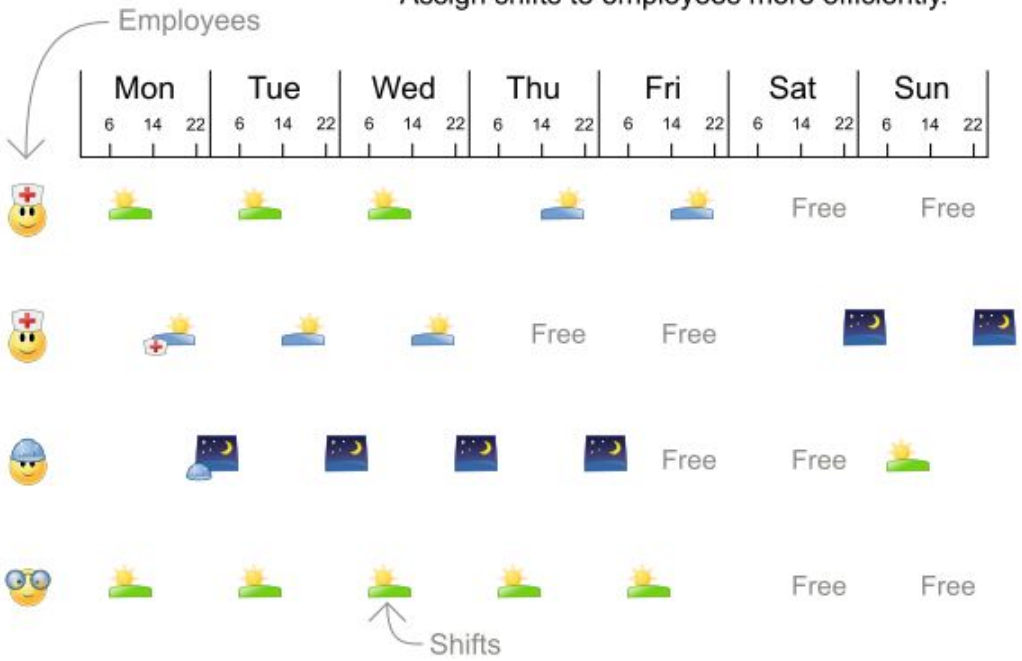
Employee rostering

Assign shifts to employees more efficiently.



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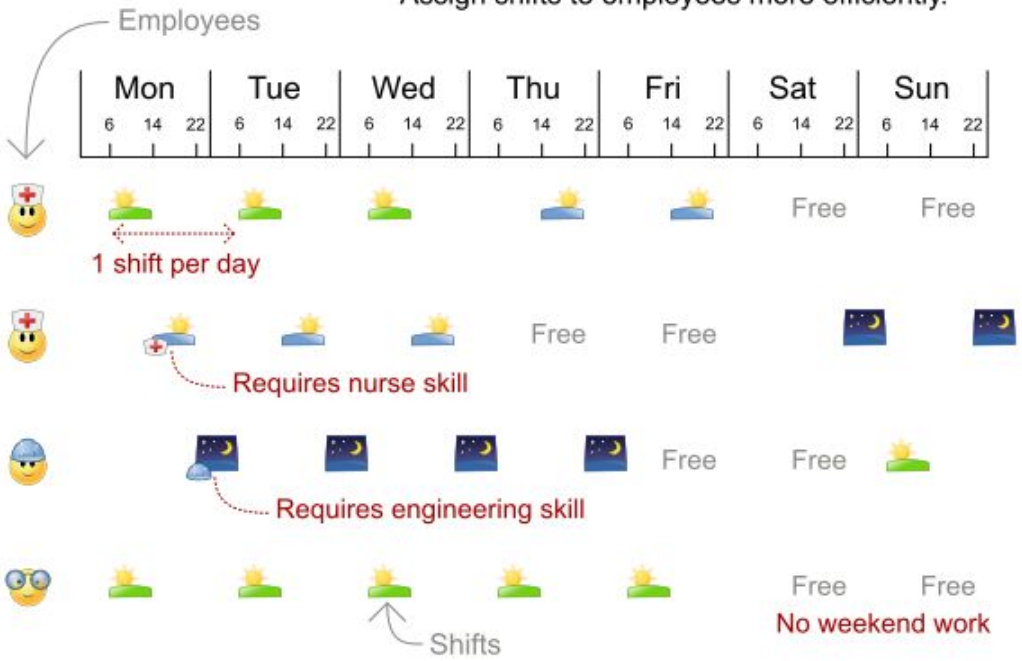

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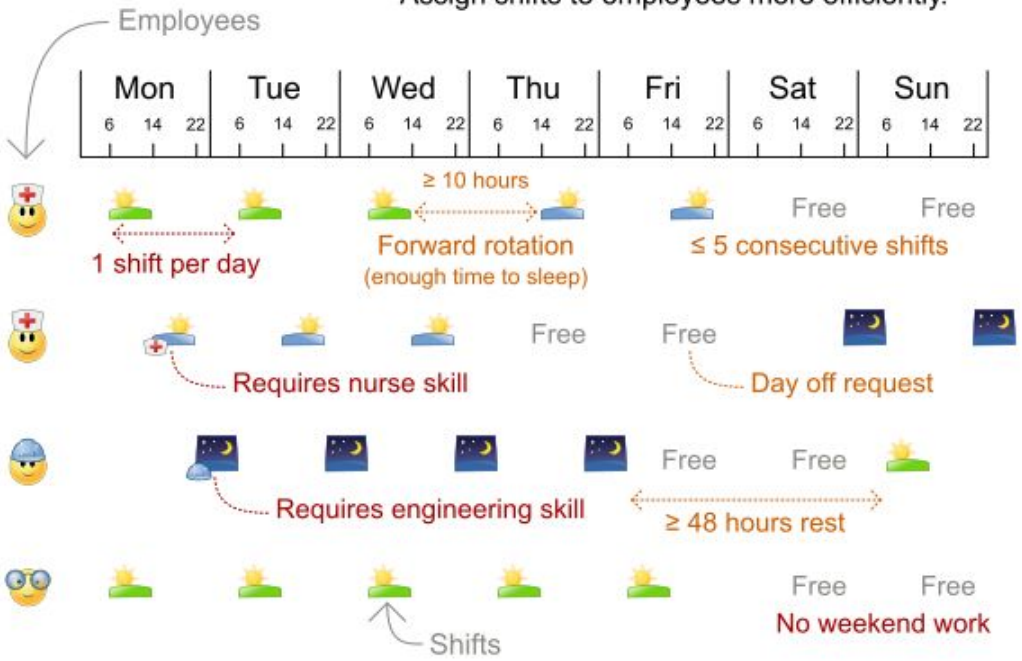

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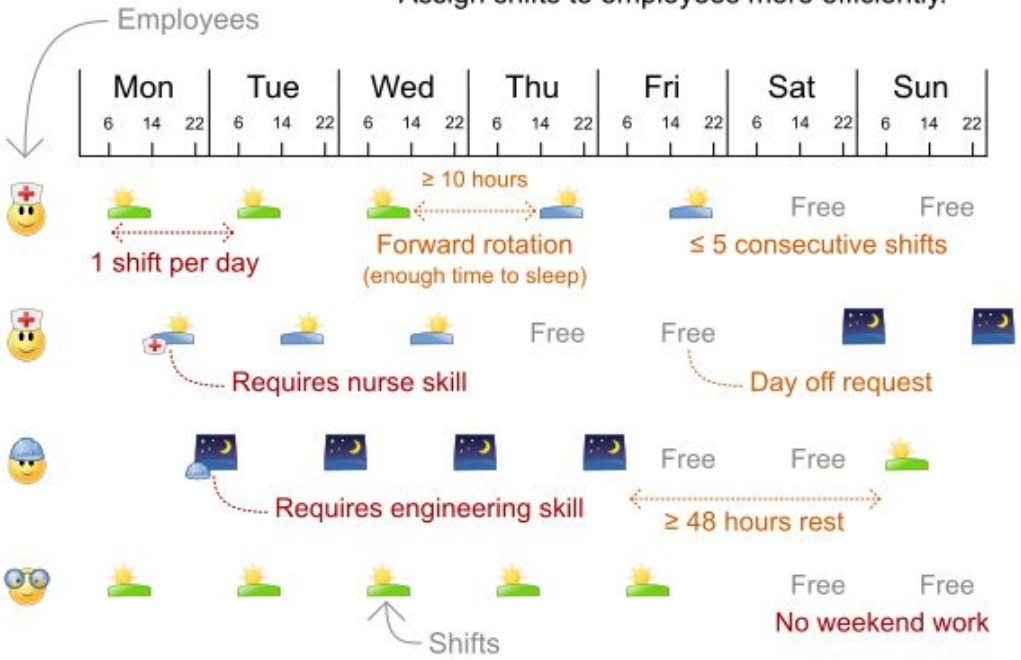

Users

Hospitals

Security guard firms

Call centers

Police and fire department

NurseRostering benchmark

	Average	Min/Max	# datasets	Biggest dataset
Employee well-being	+53%	+19% +85%	26	752 assignments 50 employees

OptaPlanner versus traditional algorithm with domain knowledge

5 mins Tabu Search vs First Fit Decreasing

Don't believe us? Run our open benchmarks yourself: https://www.optaplanner.org/code/benchmarks.html

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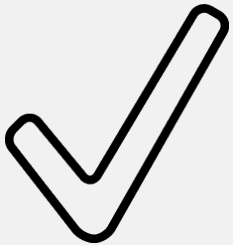
Business Benefits for Employee Rostering



Improve Employee well-being

Employee health and social life improved

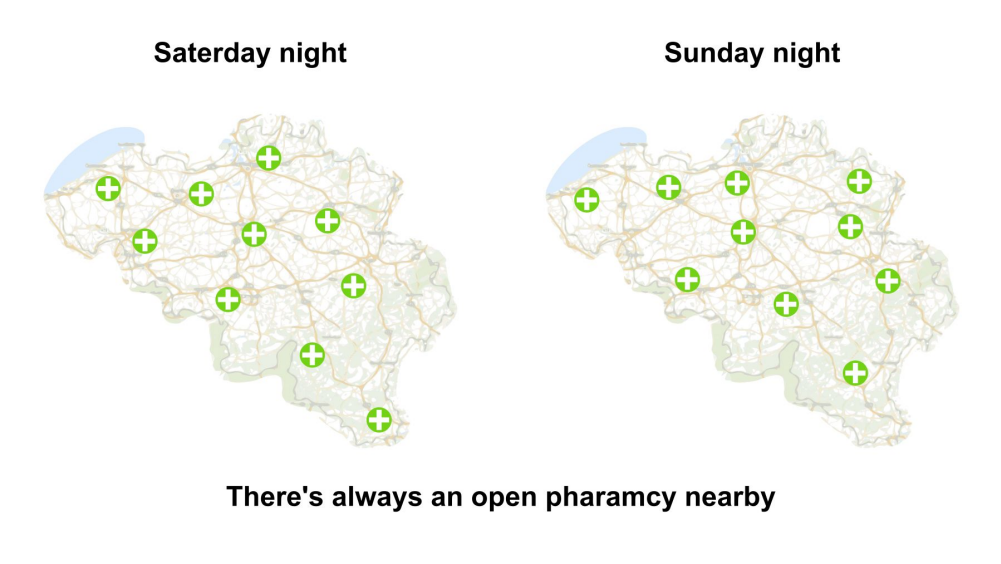
Improve Customer Satisfaction

Right employee at the right time

redhat.

Pharmacy on duty planning

- In use for all pharmacies in Flemish+Brussels (> 60% Belgium)
- Assigns night and weekend “waiting shifts” to pharmacies
  - So people can buy medication Saturday night at 3 AM.
- Constraints
  - Pharmacy availability
  - Location distribution



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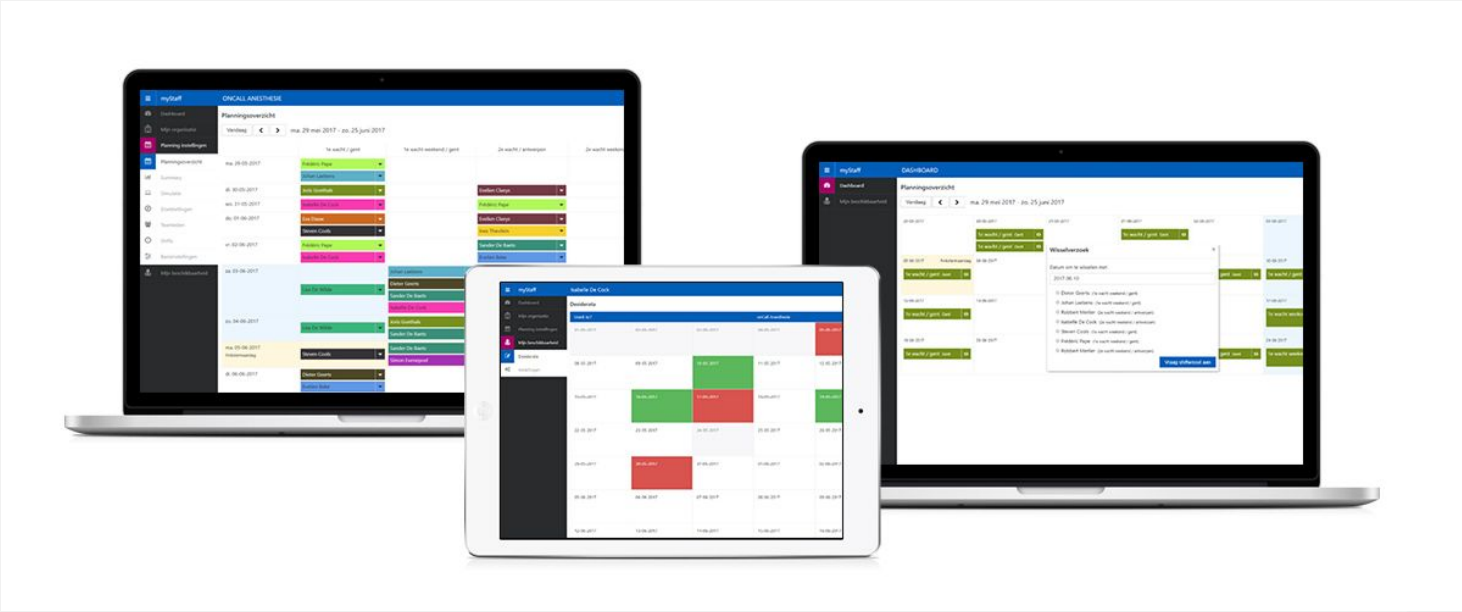
Shift rostering for anesthesiologists

- In use for Belgian hospitals
- Implementation: MyStaff by Axians BE (Red Hat partner)
  - https://healthcare.axians.be/solutions/mystaff/oncall/



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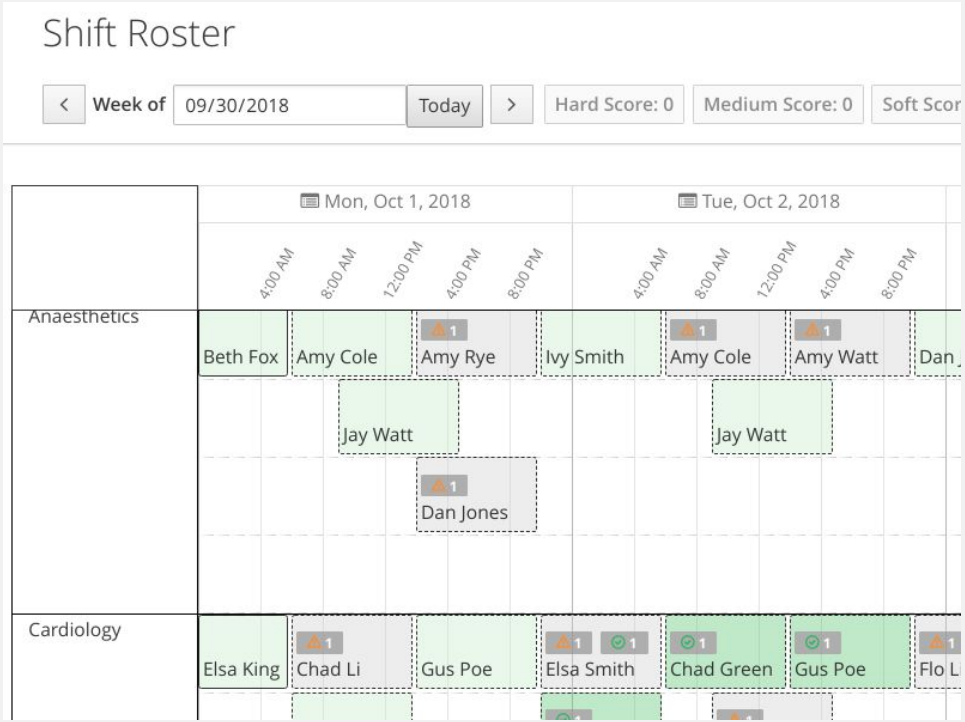
OptaWeb Employee Rostering



https://github.com/kiegroup/optaweb-employee-rostering

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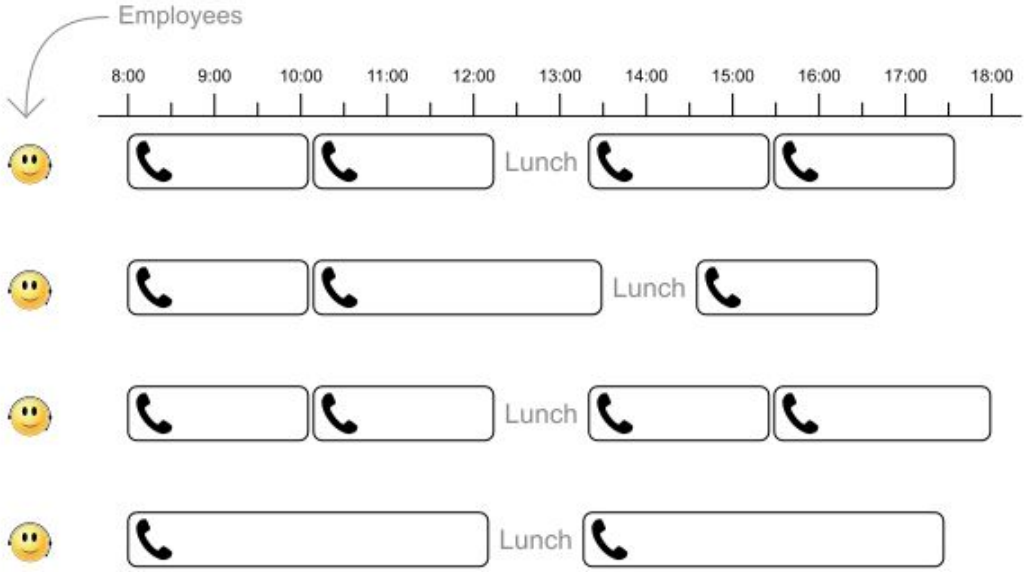
Task assignment

Task assigning

Optimize the task queue of every employee by reassigning and reordering tasks.



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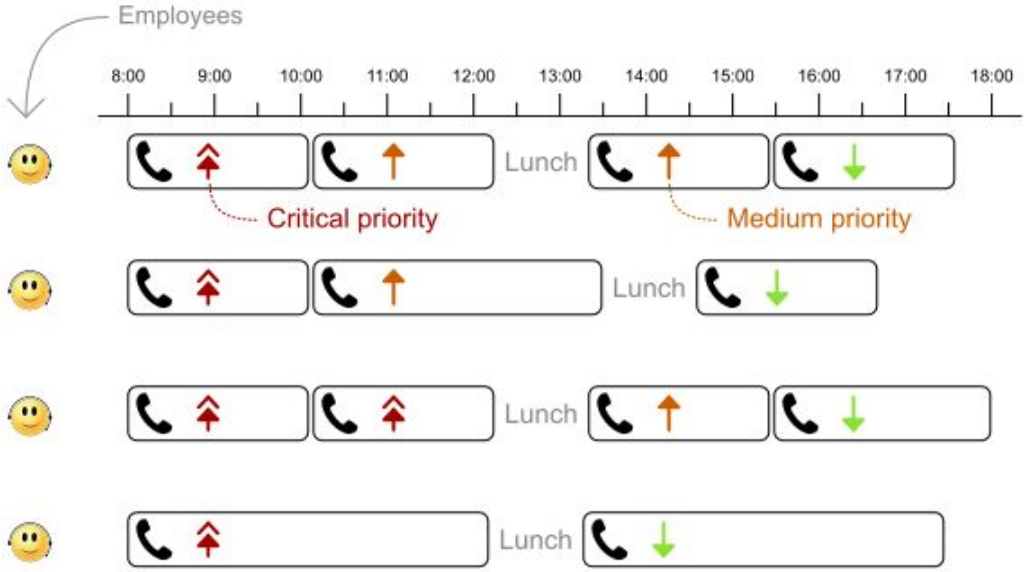

redhat.

Task assigning

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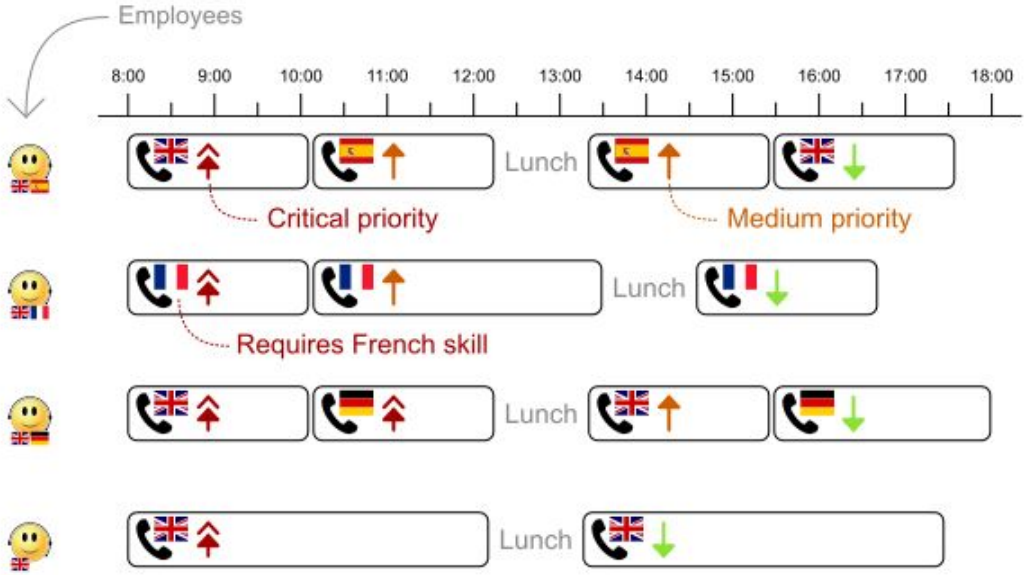

redhat.

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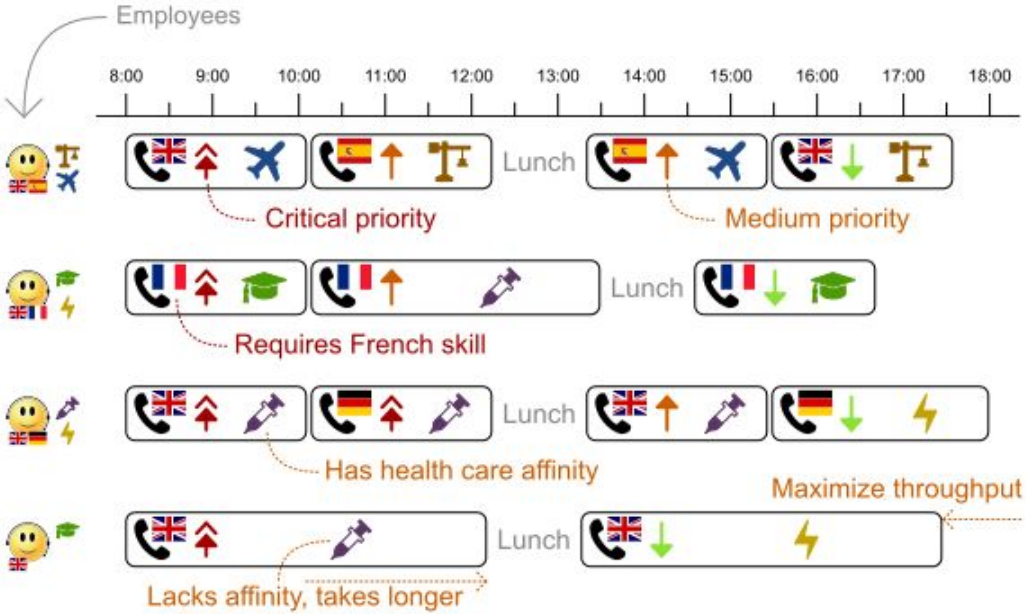

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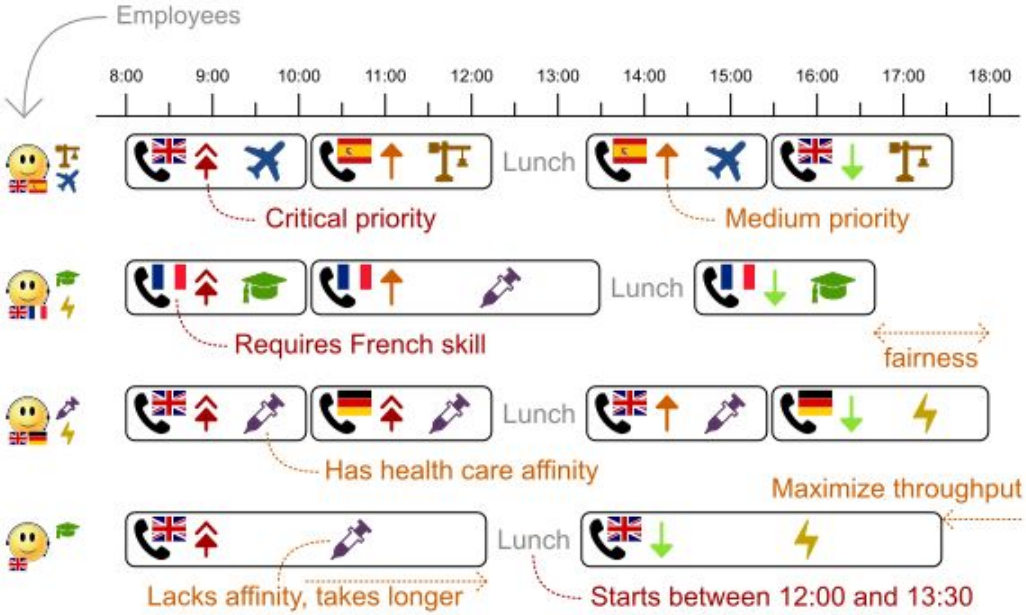

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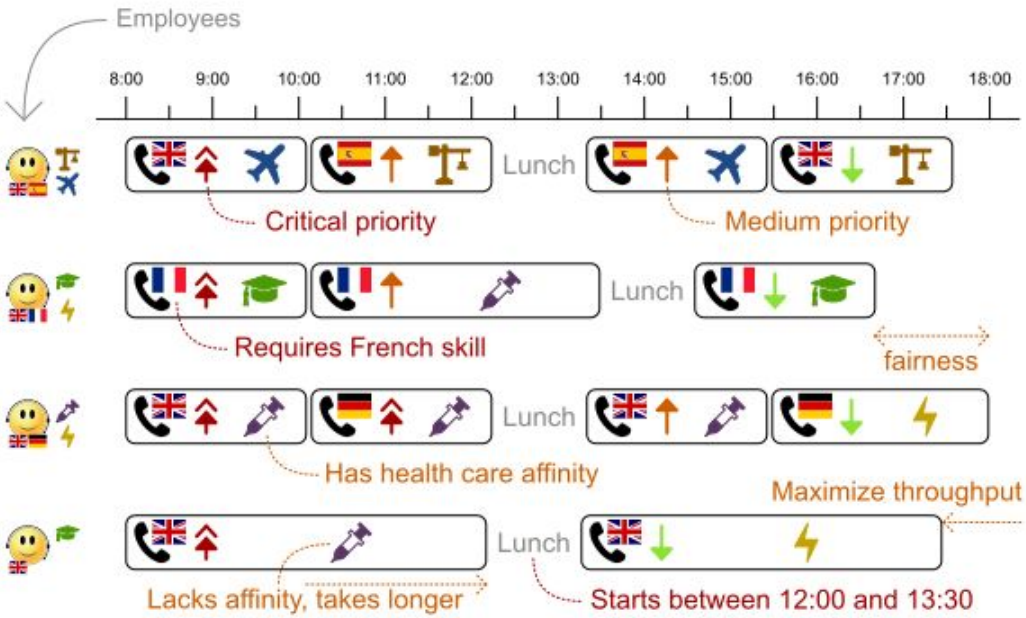

Users

Payroll services

Call centers

Tax auditers

Recruitement interviewing

Mortgage approval

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Maintenance scheduling

Machine maintenance scheduling

- 100K+ machines and 1000+ mechanics in North America
- Constraints
  - Maintenance frequency
  - SLA’s
- Benefits
  - **Completed maintenance rose by 25%**
  - Reduced contract cancellations

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Conclusion

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Real-World AI with Business Optimizer

- You can deliver real-world value today with optimization technologies
  - Greatly reduce manual effort
  - Solve seemingly impossible problems
  - Drive competitive advantage
- BA’s have an important role to play:
  - Problem & domain definition is critical

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Q&A

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