How AI can boost your productivity, reduce costs & make your employees happy

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The Ultimate American Road Trip
A data genius computes the ultimate American road trip

By Ana Swanson  March 10, 2015  Follow @ansewanson

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.
Road trip for 50 landmarks, monuments, etc.
Traditional algorithm: 271h 35m 16s
Is it optimal?
Olson's trip: 232h 43m 10s
⇒ 38h 52m 6s faster (14% faster)
Is it optimal?
Better algorithms

Olson
232h 43m 10s
Better algorithms

Olson
232h 43m 10s

OptaPlanner
231h 7m 30s

- 1h 35m 40s
Road are asymmetric

To location A
Road are asymmetric

To location A

From location A
Road are asymmetric

Use symmetric data

231h 7m 30s
(asymmetric calculation)
Road are asymmetric

Use symmetric data
231h 7m 30s
(asymmetric calculation)

Use asymmetric data
230h 17m 54s
- 49m 36s
Olson's trip: 232h 43m 10s
Not optimal
OptaPlanner's trip: 230h 17m 54s
⇒ Another 2h 25m 16s faster (1% ⇒ 15% in total)
Optimal, also 33km 710m (= 20.95 miles) shorter
15% less driving time
Now imagine this scenario ...
You got stuck in a bad traffic jam ...

https://themindcircle.com/abandoned-cars/
Your GPS suggests a faster route

Save 11 minutes?
Your GPS suggests a faster route

Would you take the suggested new route?

Save 11 minutes?
HOW WE RESPOND TO CHANGE

**Pause**
- Risk
- Insecurity
- We lose what we achieved so far

**Pounce**
- We could be the first!
- It’s worth the risk
- It’s an adventure
15% less driving time
Any enterprise with vehicles can use constraint solving AI to reduce their driving time by a significant margin.
The Vehicle Routing Problem (VRP)
Vehicle routing

Assign the delivery order of vehicles more efficiently.
Vehicle routing

Assign the delivery order of vehicles more efficiently.

- Driver wage: 20$ / hour
- Optional: Can wait till tomorrow
- Time window: Deliver between 8 AM and 10 AM
- Capacity: ≤ 20 ton
- 10 ton
- 3 ton
- Armored vehicle
- Expensive delivery
Vehicle routing

Assign the delivery order of vehicles more efficiently.

Users

Supermarkets & retail stores

Freight transportation

Buses, taxi’s & airlines

Technicians on the road
Vehicle routing
Assign the delivery order of vehicles more efficiently.

Users
Supermarkets & retail stores
Freight transportation
Buses, taxi’s & airlines
Technicians on the road

VehicleRouting benchmark (Belgium datasets)  
Driving time
OptaPlanner versus traditional algorithm with domain knowledge

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

Don’t believe us? Run our open benchmarks yourself: http://www.optaplanner.org/code/benchmarks.html
Technician vehicle routing

● Major Digital Service provider

● 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 CO² emissions
    ● 11000 ton / year
  ■ 10k+ less technicians (same workload)
    ● Results in $100M+ savings per year
OptaWeb Vehicle Routing Demo

https://github.com/kiegroup/optaweb-vehicle-routing
Available on RHPDS
Other planning problems?
Constraint solver AI
What is a planning problem?

Optimize **Goals**  
With limited **Resources**  
Under **Constraints**
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
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
The right A.I. for the job

One Artificial Intelligence algorithm does not fit all use cases.
The right A.I. for the job

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Full text search

"cat"
The right A.I. for the job

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Full text search

"cat"

The secret life of felines
felines.pdf
Felines, or cats as they are more commonly known, are carnivorous ...
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- **Full text search**
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    - felines.pdf
    - Felines, or *cats* as they are more commonly known, are carnivorous ...

- **Image recognition**
  - "Dog"

- **Vehicle routing problem**
  - Driver wage 20$/hour
  - Delivery locations
  - Capacity ≤ 20 tpm
  - Depot
  - 10 ton
  - 3 ton
The right A.I. for the job

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Vehicle routing problem

15% less driving time

Driver wage 20$ / hour

Delivery locations
Capacity ≤ 20 tpm

Depot

10 ton

3 ton
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**Vector Space Model**
Full text search

"cat"

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**Neural Net**
Image recognition

"Dog"

**Constraint Solver**
Vehicle routing problem

15% less driving time

Driver wage
20$ / hour

Delivery locations
Capacity ≤ 20 ton

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Neural Net
Image recognition

"Dog"

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

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

Constraint Solver
Vehicle routing problem

Delivery locations
Capacity ≤ 20 tpm
Depot

Driver wage 20$/hour

10 ton

3 ton

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, ...
The right A.I. for the job

One Artificial Intelligence algorithm does not fit all use cases.

**Vector Space Model**
Full text search

"cat"

↓

*The secret life of felines*  
*felines.pdf*

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

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

Implemented by:  
*Lucene*

**Neural Net**
Image recognition

"Dog"

↓

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

Implemented by:  
*TensorFlow*,  
*Deeplearning4j*

**Constraint Solver**
Vehicle routing problem

↓

*Driver wage 20$/hour*  
*Delivery locations*  
*Capacity ≤ 20 tpm*  
*Depot*  
*10 ton*  
*3 ton*  

15% less driving time

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

Implemented by:  
*OptaPlanner*
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
Employee rostering
For employees that don't work 9 to 5
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
Employee rostering
Assign shifts to employees more efficiently.

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<tr>
<th>Mon</th>
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- Free
- Shifts

Emojis represent employees:
- Nurse
- Day shift
- Night shift
- Free time
Employee rostering

Assign shifts to employees more efficiently.

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<td></td>
<td></td>
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1 shift per day

Requires nurse skill

Requires engineering skill

Shifts

No weekend work
Employee rostering

Assign shifts to employees more efficiently.

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Employees

- 1 shift per day
- Forward rotation (enough time to sleep)
- Requires nurse skill
- Requires engineering skill

- ≥ 10 hours
- ≤ 5 consecutive shifts
- Day off request
- ≥ 48 hours rest
- No weekend work

Shifts
Employee rostering
Assign shifts to employees more efficiently.

Employees

- **Mon**
  - 6
  - 14
  - 22

- **Tue**
  - 6
  - 14
  - 22

- **Wed**
  - 6
  - 14
  - 22

- **Thu**
  - 6
  - 14
  - 22

- **Fri**
  - 6
  - 14
  - 22

- **Sat**
  - 6
  - 14
  - 22

- **Sun**
  - 6
  - 14
  - 22

1 shift per day

- Forward rotation (enough time to sleep) ≥ 10 hours

- Day off request

- No weekend work

- ≥ 48 hours rest

- ≤ 5 consecutive shifts

- Requires nurse skill

- Requires engineering skill

Users

- Hospitals
- Security guard firms
- Call centers
- Police and fire department

NurseRostering benchmark

**Employee well-being** +53%

OptaPlanner versus traditional algorithm with domain knowledge

Average Min/Max # datasets Biggest dataset
+19% +85% 26 752 assignments 50 employees

5 mins Tabu Search vs First Fit Decreasing

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

- **Improve Employee well-being**
  - Employee health and social life improved

- **Improve Customer Satisfaction**
  - Right employee at the right time
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
Shift rostering for anesthesiologists

- In use for Belgian hospitals (Saint-Jean UZ Brussel, OLV Aalst, …)
- Implementation: MyStaff by Axians BE (Red Hat partner)
Schedule hearings

- 10K+ magistrates in UK
- Assigns all court cases to magistrates
- Constraints
  - Judge expertise
  - Holidays
  - Work hour preferences
  - Distance to court
OptaWeb Employee Rostering

https://github.com/kiegroup/optaweb-employee-rostering
Technology overview
Business Optimizer
Part of Business Automation portfolio

- Complex event processing
- Business rules
- Business optimization
- Process/Case management
- Entando UX platform
Red Hat Application Development

CREATE THE APPLICATION LANDSCAPE YOU NEED

Application Modernization and Migration

APPLICATION RUNTIMES
BUILD & MIGRATE APPS

INTEGRATION
COMPOSE & INTEGRATE APPS & DATA

PROCESS AUTOMATION
AUTOMATE & OPTIMIZE BUSINESS PROCESSES

RED HAT® MIDDLEWARE

CONTAINER PLATFORM
PHYSICAL
VIRTUAL
PRIVATE CLOUD
PUBLIC CLOUD
Conclusion
Real-World AI with Business Optimizer

- 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
- Don’t forget - this is also about change management
Want to learn more?

Homepage  www.optaplanner.org
Slides  www.optaplanner.org/learn/slides.html

See also Red Hat Decision Manager, our commercially supported product

Attend a 3 day Business Optimizer Bootcamp (in Kontich) provided by InfoFarm/The Campus.

Feedback  @GeoffreyDeSmet
LinkedIn  Ronald Meuwsen & Geoffrey De Smet
ReBoot
Customer Experience with Open Source

Virtual Hackathon September - December 2019
ReBoot Customer Experience with Open Source

How would you reinvent customer experience so users (like yourself) love it? Take the opportunity to compete against the best developers in EMEA, and stand to win awesome prizes!

Sky's the limit. You choose the area. You choose the app, service, frameworks or programming languages. Level up your game with the power of open source technology provided by Red Hat.

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