Business use cases and the impact of Optaplanner

Satish Kale

Manager, Specialist Solutions Architect, NA Telco

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About me

Greatly interested in technology. But not much talented, hence into sales. :-)

- 12+ years in Red Hat.
- 20+ years of IT experience
- Sell free software
- No better place than Red Hat

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What am I going to cover today?

Sales and Adoption part of Optaplanner.

- The business use cases
- The adoption
- Business impact

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Why am I covering this topic

Again; not deep enough in technology to cover anything else. :-)

- Creating awareness - where this technology is being used and what is the impact
- Be a cheerleader and somehow be a part of this team, to propagate this fantastic technology
- Why Sales and Marketing matters.

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Business use cases

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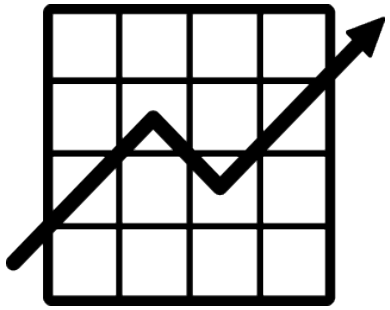
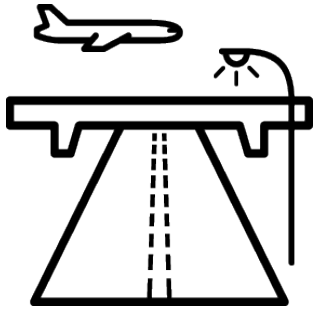
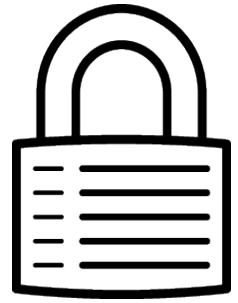
Business Challenge



Optimize **Goals**



With limited **Resources**



Under **Constraints**

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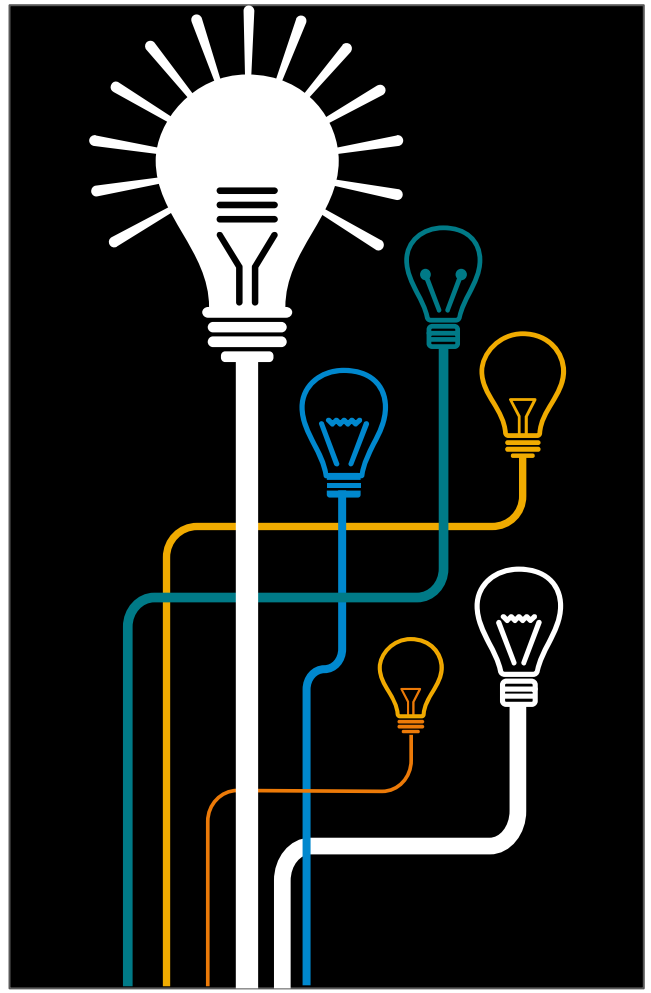
The Business opportunity

By leveraging efficient and affordable resource optimization, business can maximize the return on assets (people and things), improve their profitability, and enhance employee satisfaction.



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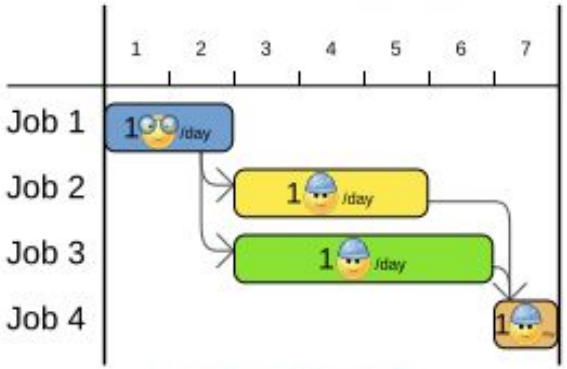
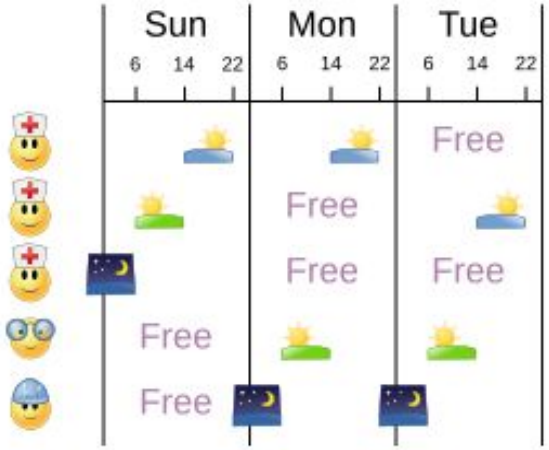
Typical use cases

Job shop scheduling



Less makespan

Employee rostering

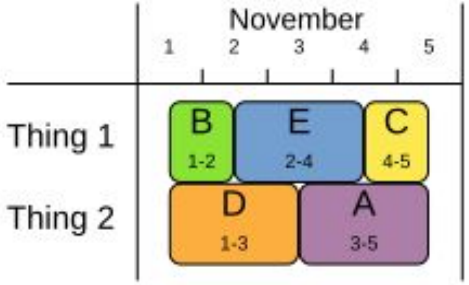


Happier employees

Vehicle routing

Less driving time

Equipment scheduling



Higher utilization

Bin packing

Less fragmentation

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Optimization areas

Scheduling	Routing	Resources Allocation
Jobs to be done, People availability (**time**)	Current **location** Destinations to cover	Resources needed, availability, **capacity**
Time tables - Nurses, Judges, repair person Shift rostering	Planning Technician visits Deliveries	Bin Packing - Filling Containers, Ships, Trucks and storage warehouses with items. Cloud Resource provisioning

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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)	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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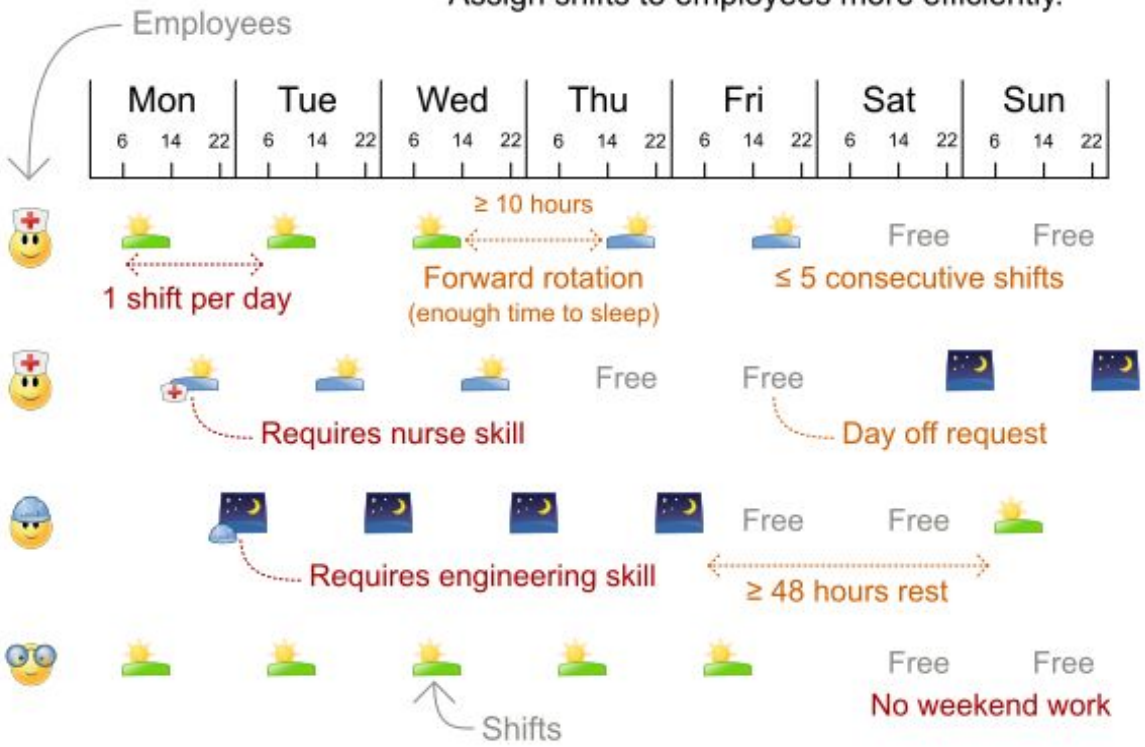
Employee rostering

Assign shifts to employees more efficiently.



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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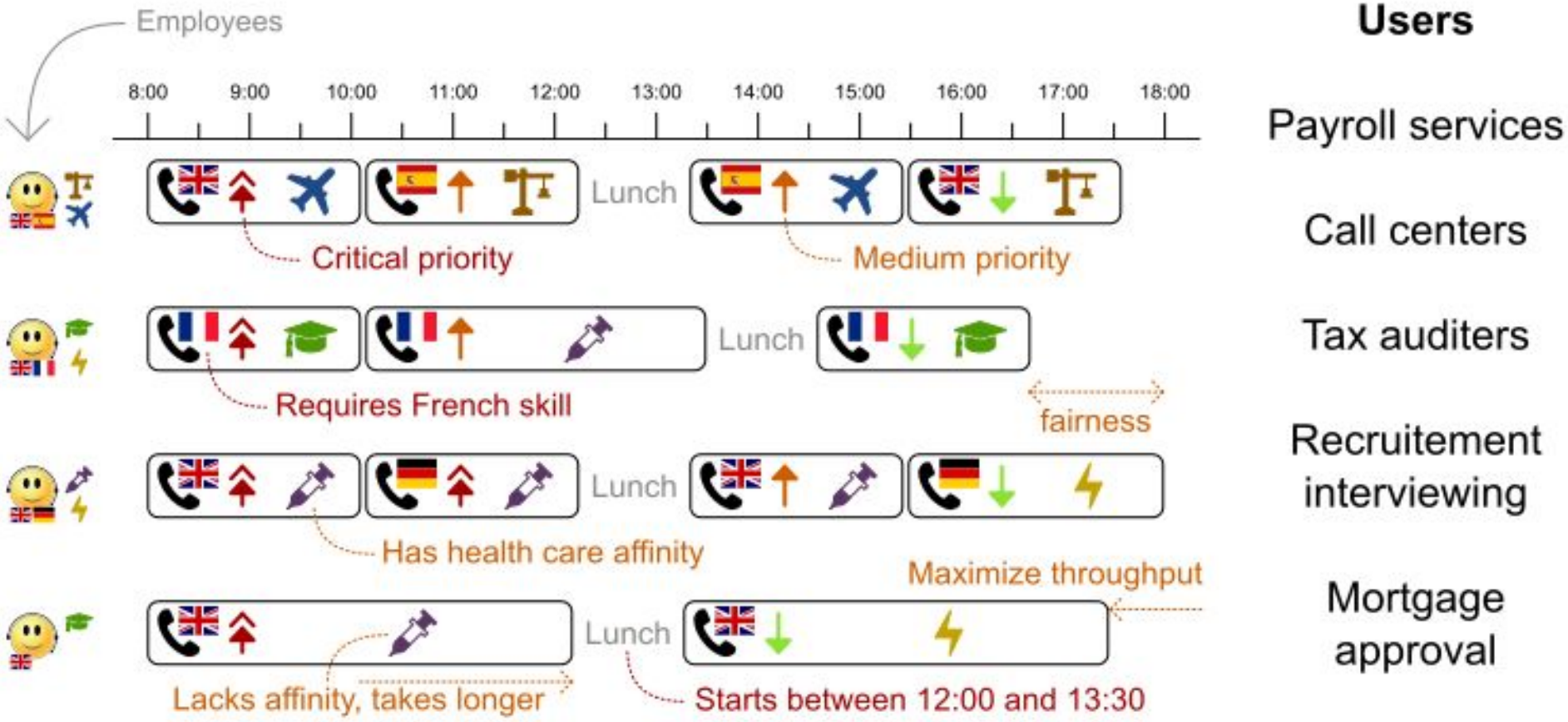
Task assigning

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



Users

Payroll services

Call centers

Tax auditers

Recruitement interviewing

Mortgage approval

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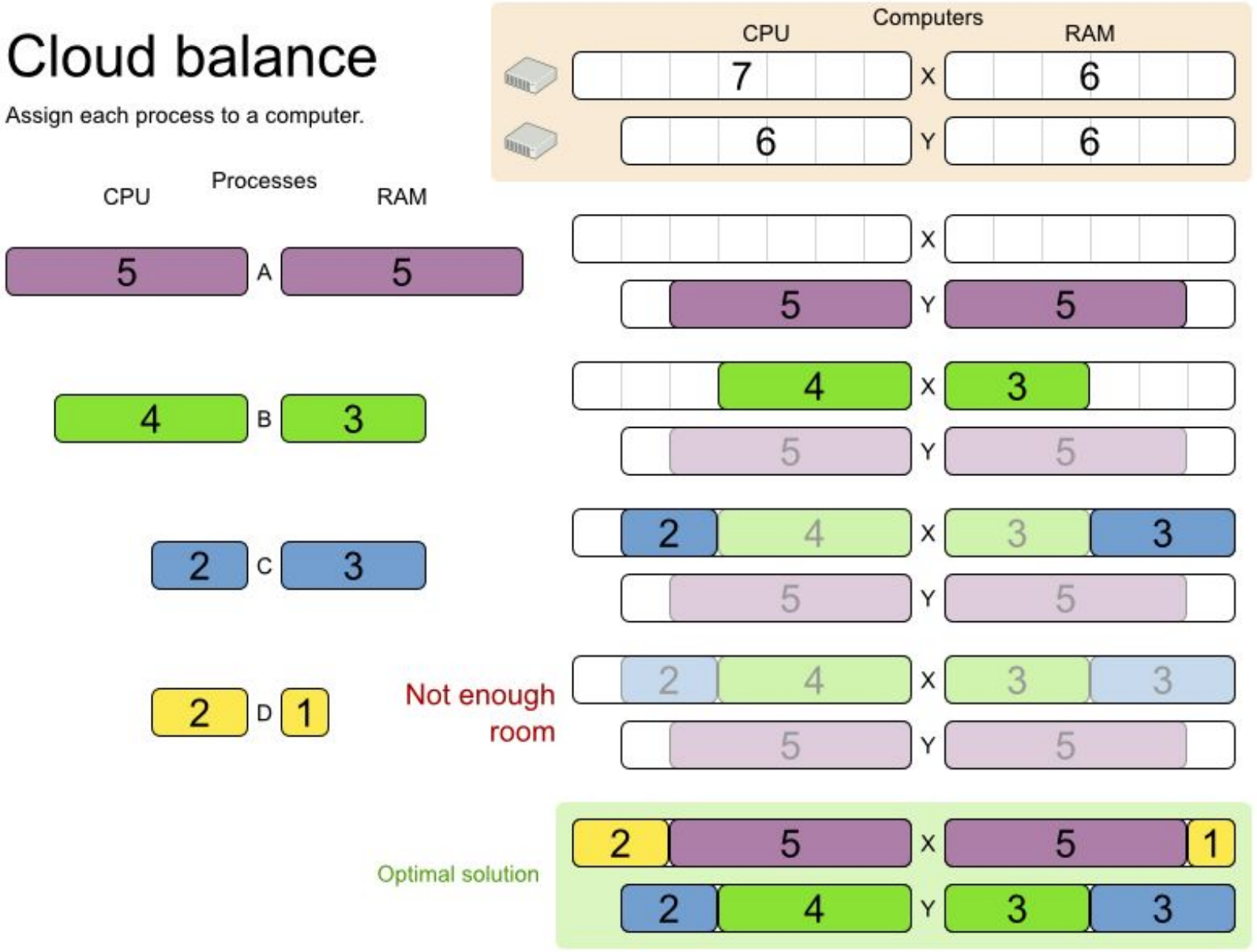
Cloud balance

Assign each process to a computer.



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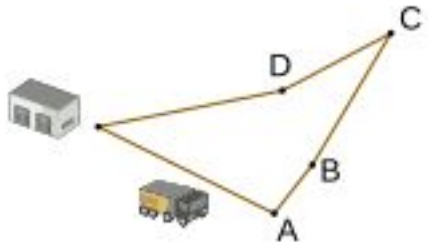
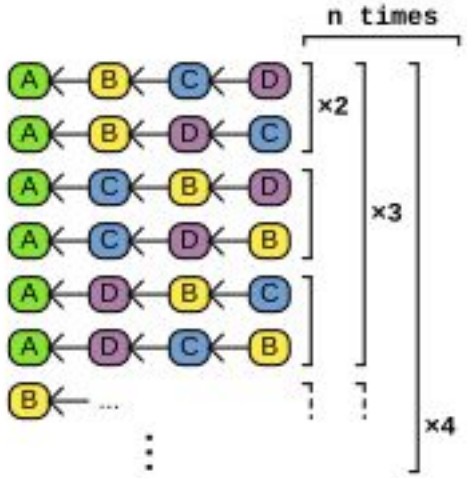
Typical search Space

Traveling salesman (TSP)



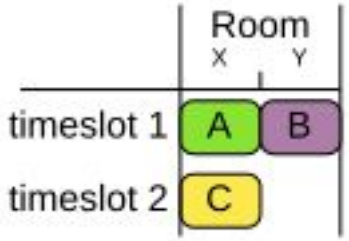
Model: linked list



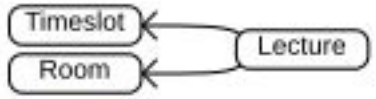
Search space: $n!$

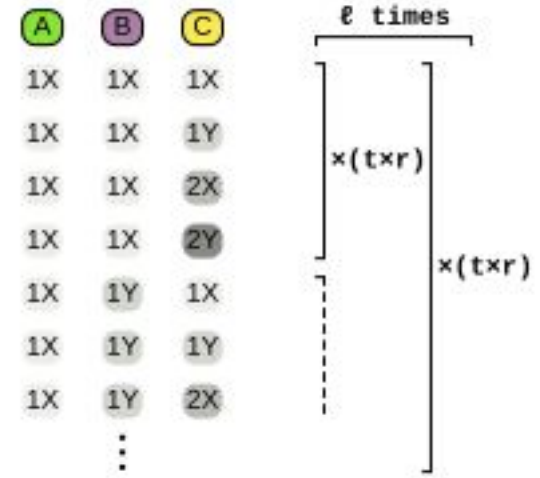
# customers	search space
4	24
100	10^{157}
1000	10^{2567}
10000	10^{35659}

Lesson scheduling



Model:





Search space: $(t \times r)^{\ell}$

# timeslots	# rooms	# lectures	space
2	2	3	64
36	6	100	10^{233}
36	18	400	10^{1124}
36	36	800	10^{2490}

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Closer look at the numbers

Traveling salesman (TSP)

Search space: $n!$

# customers	search space
4	24
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Lesson scheduling

Search space: $(t \times r)^{\ell}$

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*BTW **10^{80}** is the number of atoms in observable universe!!!*

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Algorithms to you rescue

Exact Algorithms

- Brute Force
- Branch and Bound

Construction Heuristics

- First Fit
- First Fit decreasing
- Best Fit
- Best Fit decreasing
- Cheapest Insertion
- Regret Insertion

Metaheuristics

- Local Search
  - Hill Climbing
  - Tabu Search
  - Simulated Annealing
  - Late Acceptance
  - Step Counting Hill Climbing
  - Great Deluge

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Use Case 1 – Field Operations – “Man In a Van”

Lost time behind the wheel between jobs is a huge expense!

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Workforce Planning Challenges – Most notable example

Large Telecom Service Provider – 70,000+ Technicians

"I spend more time driving around than working with our customers, and I often have unrealistic schedules."

FIELD TECHNICIAN

"It's a nightmare to get schedules aligned due to staff churn and demanding customers."

REGIONAL MANAGER

"Selling becomes a difficult task when customers are unhappy with our reliability."

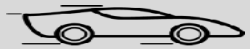
SALES MANAGER

"Our expanding workforce has caused operating costs to skyrocket. We need optimization to drive higher efficiency."

CIO , TRANSPORTATION

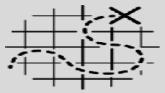
OPERATING COST

A workforce of thousands or tens of thousands of personnel create a high operating cost for the business.



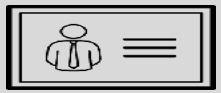
AGILITY

Manual or suboptimal existing scheduling solution makes updates slow and causes lack of consistency.



INEFFICIENCY

Job assignment is manual and challenging, and quality of routing is poor for field technicians.



CUSTOMER SATISFACTION

End customers are unhappy with poor and delayed service and inaccurate scheduling guidance.

WORKSPACE SATISFACTION

Workforce is unhappy due to poor quality of scheduling and skills-job mapping.

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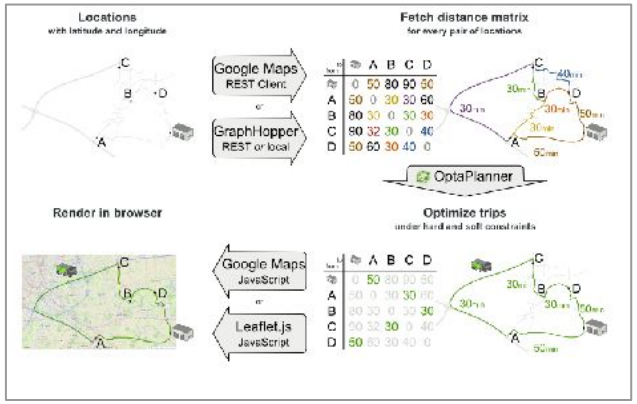
Solution

Maximize task throughput Fairness among employees	Employees (affinity, skills)	Critical priority tasks first Tasks require skills
Goals	**Resources**	**Constraints**
Minimize fuel consumption, driving time, required vehicles	Vehicles (capacity, fuel) Deliveries (location, packages)	Max 8 hrs consecutive driving Arrive before due time

Task Assignment



Vehicle Routing

Red Hat Decision Manager

Complex event processing

Business rules

Business optimization

OptaPlanner

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Success Story

Challenges

- Nx10,000 + Technicians/Vehicles - high cost
- Very old and suboptimal planning solution
- Poor Job Assignment and quality of routing
- Customers unhappy with poor & delayed service.
- Technicians unhappy due to poor quality of scheduling and skills-job mapping

Optimization Concerns

Find the optimal schedule and route for technician, based on:

- Location
- Skills
- Availability
- Job windows
- Other preferences: regional affinity, regulatory aspects, etc.

Benefits

- **200M+ USD Savings**
- More jobs completed
  - Productivity increase
  - Expedited service activations
- Reduced Operating Cost
  - Less Fuel
    - Carbon Credits
  - Vehicle maintenance reduced
- Happy Customer
  - Issues resolved sooner
- Happy Technician
  - Reasonable job assignment,
  - Less driving

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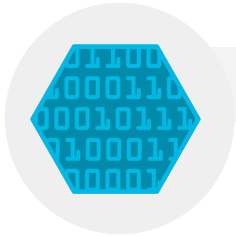
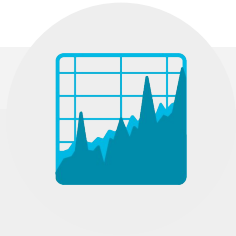
What worked?



Superior Technology

Beat the competition in 6 evaluation rounds



Focus on Business Outcomes

Outcomes-based solutioning

Support

Strong support from Customer Team

Savings

$230M Savings

Customer Experience

Improved customer retention

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What had to be done?

- Work with the business. Decisions aren't made at the technology level
- Deep engagement with Data Scientists, Developers, Business folks.
- Need to Collaborate (Practice Architects, Tiger Team, Consulting, Founder)
- Tiered Solution approach: - start simple, incrementally add complexity.
- Constantly engaging over the 2 year period

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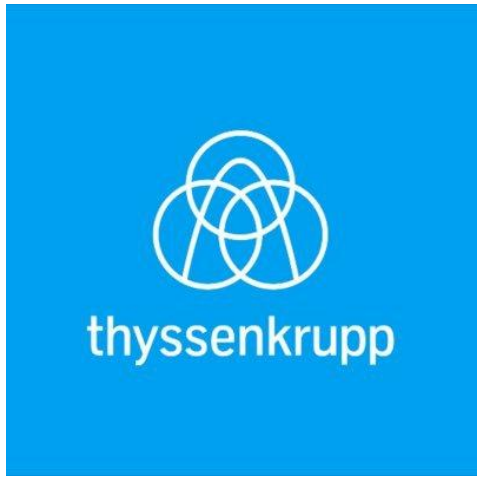
Use Case 2 – thyssenkrupp Elevator



Business Challenge
Escalating losses due to missed service level agreements tied to an obsolete Microsoft Silverlight solution for field services management; **lacking automation, flexibility, key management features, and vendor support**.

Geo
North America

Industry
Integrated Materials and Technology Company

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COMPANY OVERVIEW

Integrated Materials and Technology Company
156,000 employees in 80 countries
€40 billion order intake

Component Technology	Elevator Technology	Industrial Solutions	Material Services	Steel Europe	Steel Americas

Service	Repairs	New Installation & Mod	New Construction

thyssenkrupp Elevator Worldwide

- 50,000 employees
- 20 plants, > 900 branches in 70 Countries
- 1.1 m units under maintenance contract
- 24,000 technicians
- €6 BILLION ORDER INTAKE

thyssenkrupp Elevator US

- 8,600 employees
- 115 branches
- ~220,000 units under maintenance contract
- 5,000 technicians
- $2 BILLION ORDER INTAKE

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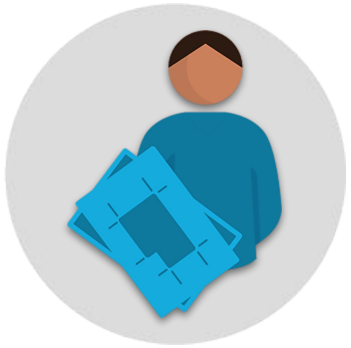
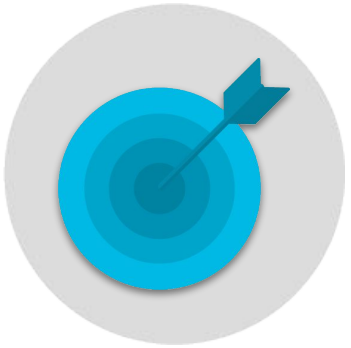
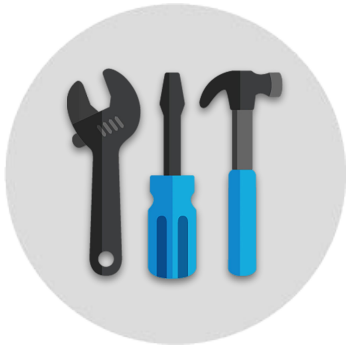
The Four “Rights” to Target Outcomes



Right Mechanic



Right Unit



Right Maintenance

Right Time

Decrease Missed Maintenance | Increase Customer Satisfaction | Decrease Waste

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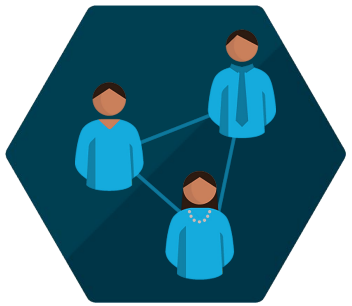
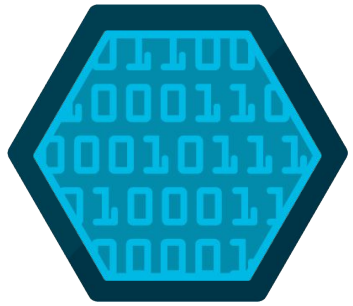
What worked



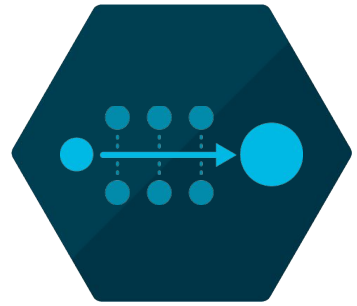
Relationships

Successful Services Engagements

Earned Trusted Advisor Status



Technology



Approach

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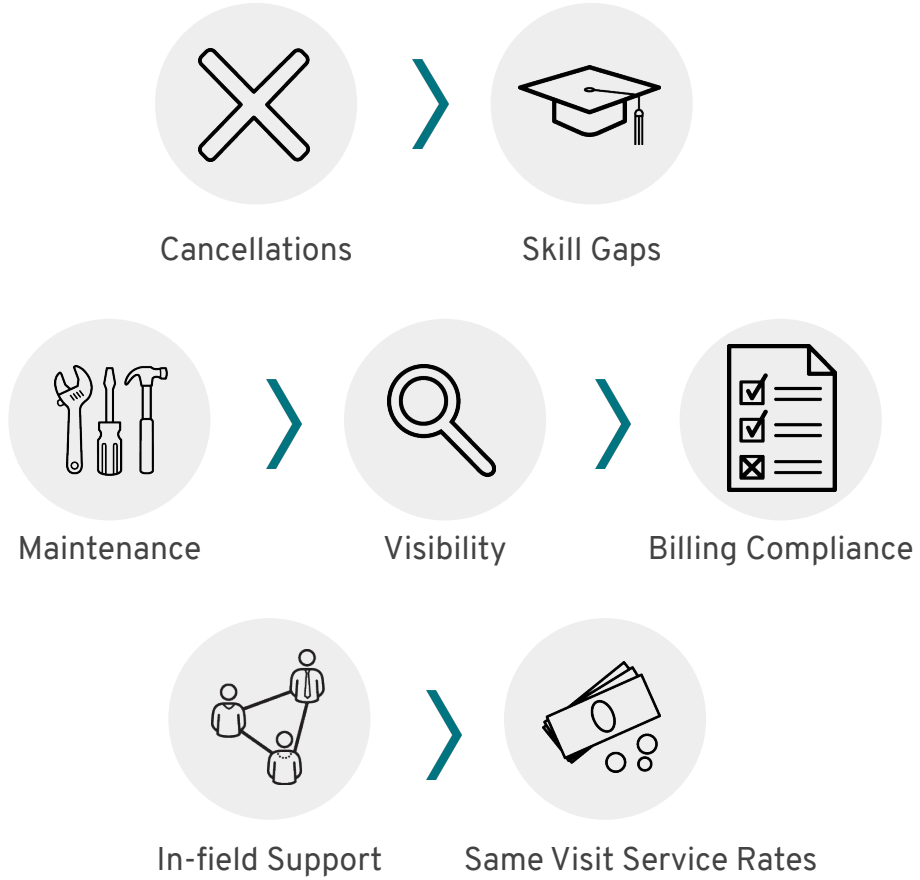
Benefits



- Increased percentage of completed maintenance from 50% to 75% in six months (Goal of 100% within the year)
- Eliminated skills gaps from the infrastructure side, reduced capex and HW costs by utilizing managed cloud offerings
- Enhanced in field support for mechanics with meaningful pictures, diagrams, and historical information
- Improved same visit service rates using database of fault codes and common resolutions, enable preventative maintenance

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Other notable use cases

- Agenda scheduling: doctor appointments, court hearings, maintenance jobs, TV advertisements, ...
- Educational timetabling: lectures, exams, conference presentations, ...
- Task assignment: affinity/skill matchmaking for tax audits, wage calc, ...
- Employee shift rostering: nurses, repairmen, help desk, firemen, ...
- Vehicle routing: route trucks, buses, trains, boats, airplanes, ...
- Bin packing: fill containers, trucks, ships, storage warehouses, cloud computers nodes, prisons, hospitals, ...
- Cutting stock: minimize waste while cutting paper, steel, carpet, ...
- Sport scheduling: football/baseball league, tennis court utilization, ...
- Financial optimization: investment portfolio balance, risk spreading, ...

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5G Equipment installation – Site Planning

Candidate List	Shortlist	Simulation	Prediction Plot
Get List from MLA Partners	Height	Automatic Cell Planning	RSRP
	Long/Lat	Run Diff Scenarios	SINR
	Structure Availability	Determine Coverage & Quality	Acquire
	Quality - SINR	95% Criteria Met	
	RSRP		
	Area		
	Rank/Cost		

- Spectrum - micro/Macro
- How many towers
- GPS Coordinates
- Interference
- ROI

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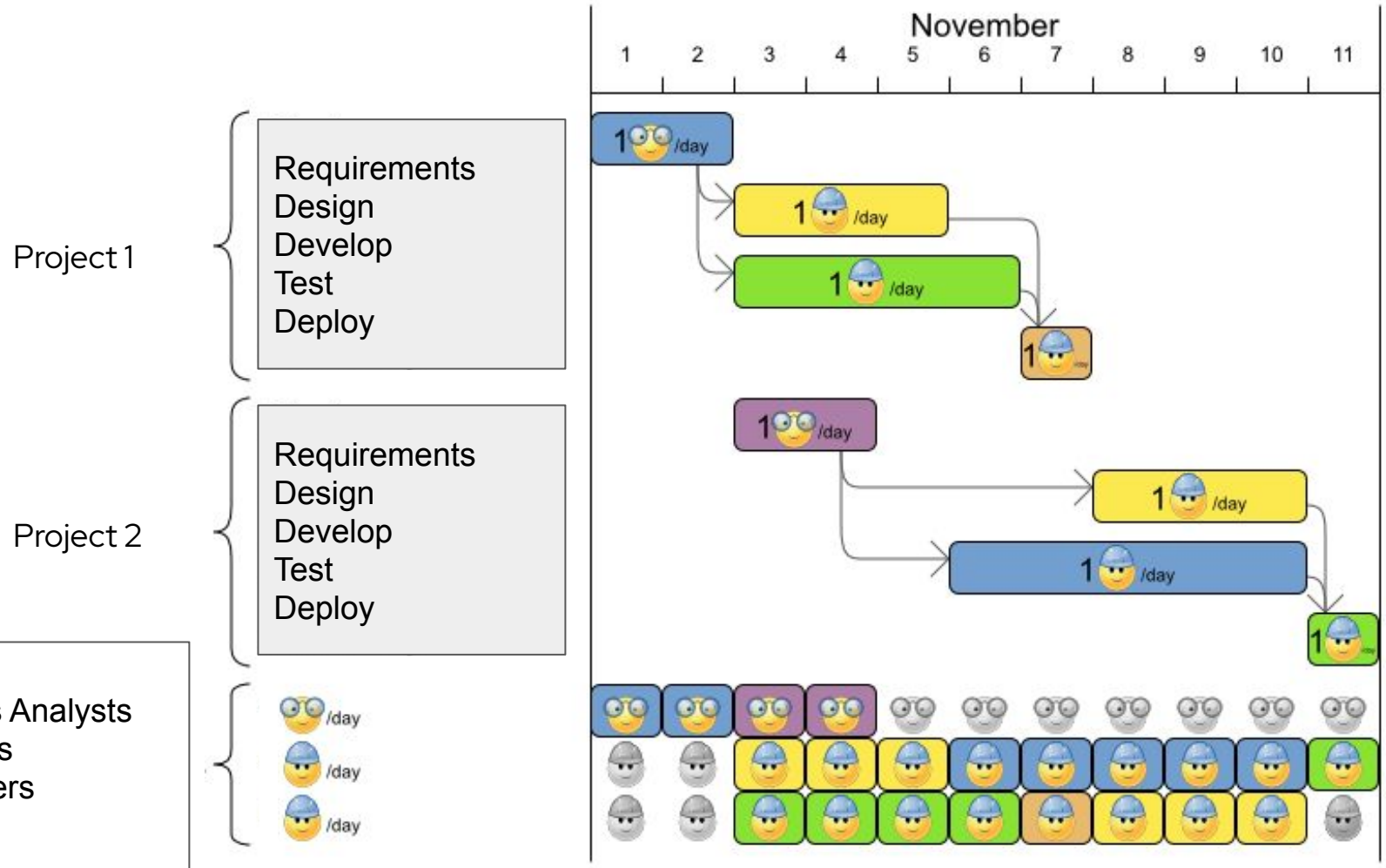
Project job scheduling

For each job, choose an execution mode and a start time.



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Why Red Hat

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Understanding Project and Enterprise Product

Projects

- Frequent release cycles
- Focus on features
- Help through forums
- No SLA
- Functional requirements prioritized.
- Non-functional requirements may not be prioritized. E.x. Security, IDE integration, etc.

Enterprise Products

- Planned release cycles
- Focus on features, as well as stability
- Professional, SLA based support from experts
- A comprehensive ecosystem of dedicated teams and co-ordination with partners/agencies to handle security vulnerabilities.

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Hidden cost of unsupported software

- $7.15M value on average/year
- 33% more new apps/year
- 70% more new features/year
- 26% more efficient mgmt
- 49% more efficient support
- Meeting regulatory compliance

Red Hat JBoss Middleware Software and the Hidden Costs of Unsupported Software

An IDC InfoBrief, sponsored by Red Hat | May 2017

IDC
Analyze the Future

This example is for JBoss EAP.

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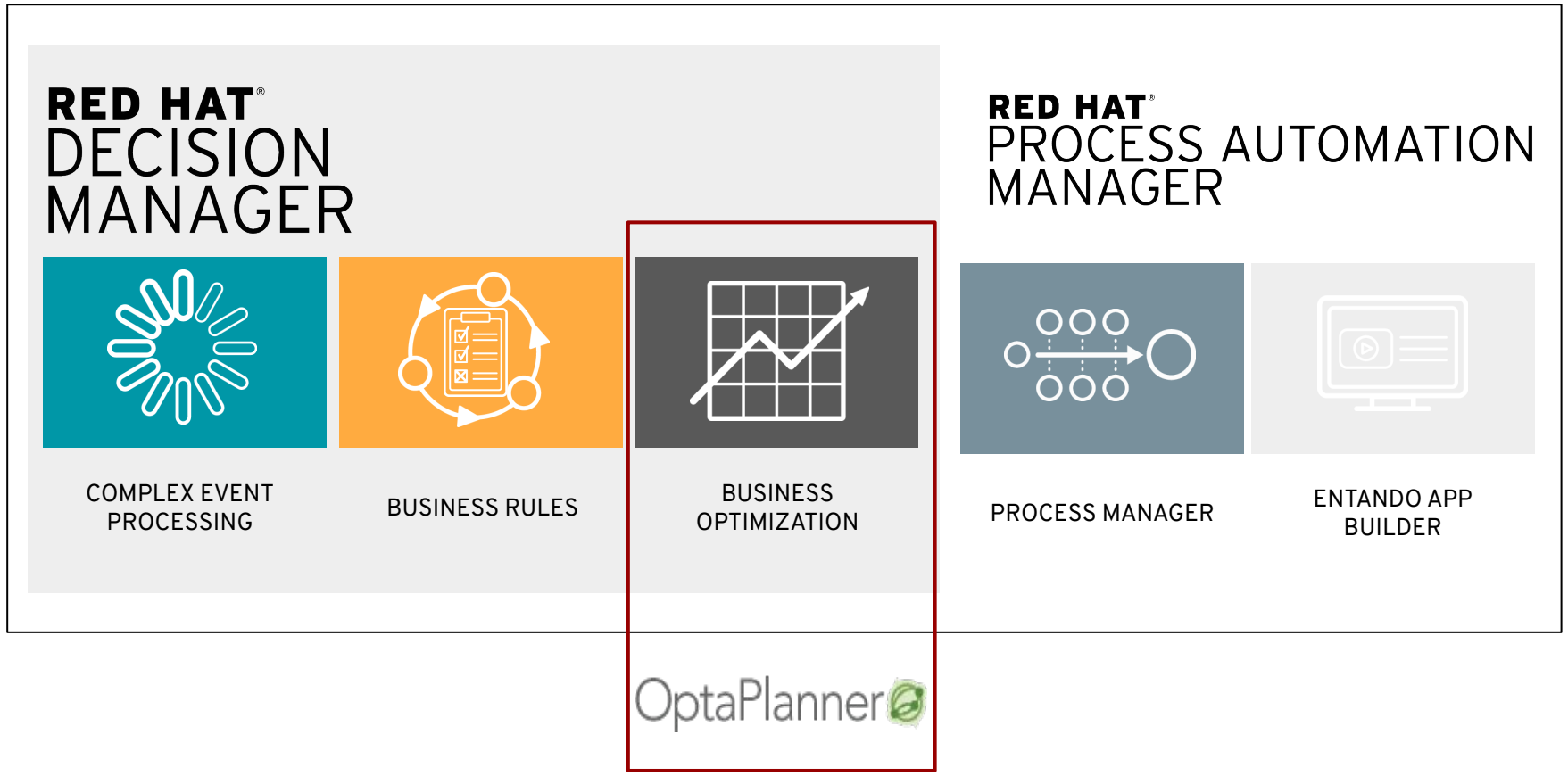
Productized Optaplanner



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Closing thoughts

Technology which truly is close to AI.

Tremendous business value

Solves the seemingly unsolvable problem space

Rock Solid technology

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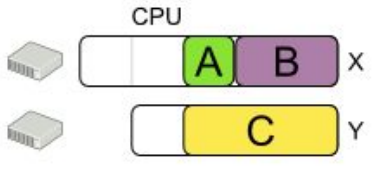
Search Space

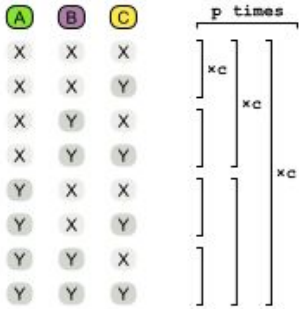
Calculate the size of the search space

Given a Solution model, how many different combinations can it represent?

Cloud balancing



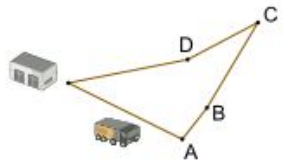
Model: Computer — Process



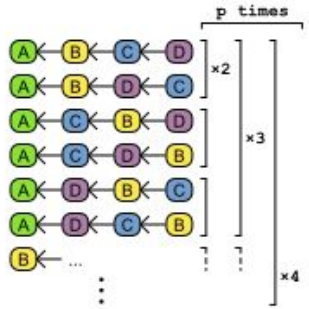
Search space: c^p

# computers	# processes	search space
2	3	8
100	300	10^{600}
200	600	10^{1380}
400	1200	10^{6967}

Traveling salesman (TSP)



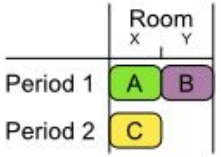
Model: linked list



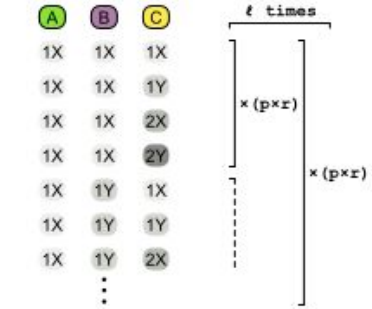
Search space: $n!$

# customers	search space
4	24
100	10^{157}
1000	10^{2567}
10000	10^{35659}

Course scheduling



Model: Period, Room — Lecture



Search space: $(p \times r)^{\ell}$

# periods	# rooms	# lectures	space
2	2	3	64
36	6	100	10^{233}
36	18	400	10^{1124}
36	36	800	10^{2490}

Search space: c^p

# computers	# processes	search space
2	3	8
100	300	10^{600}
200	600	10^{1380}
400	1200	10^{6967}

Search space: $n!$

# customers	search space
4	24
100	10^{157}
1000	10^{2567}
10000	10^{35659}

Search space: $(p \times r)^{\ell}$

# periods	# rooms	# lectures	space
2	2	3	64
36	6	100	10^{233}
36	18	400	10^{1124}
36	36	800	10^{2490}

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“IF I HAD ASKED PEOPLE WHAT THEY WANTED, THEY WOULD HAVE SAID FASTER HORSES.”
Henry Ford

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Thank you

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