Workforce Optimization With Business Resource Planner and OpenShift

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Agenda

● Problem Space
● Thyssenkrupp Elevator Use Case
● Business Resource Planner
● Openshift
● Demo
● Q&A
Planning planning problem 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, ...
- **Job shop scheduling**: assembly lines for cars, furniture, books, ...
- **Cutting stock**: minimize waste while cutting paper, steel, carpet, ...
- **Sport scheduling**: football/baseball league, tennis court utilization, ...
- **Financial optimization**: investment portfolio balance, risk spreading, ...
What is a planning problem

- Optimize goals with limited resources under constraints

<table>
<thead>
<tr>
<th>Optimize goals</th>
<th>Maximize profit</th>
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<tbody>
<tr>
<td></td>
<td>Minimize ecological footprint</td>
</tr>
<tr>
<td></td>
<td>Maximize happiness of employees / customers</td>
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<td>...</td>
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<thead>
<tr>
<th>With limited resources</th>
<th>Employees</th>
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<tbody>
<tr>
<td></td>
<td>Assets (machines, buildings, vehicles, ...)</td>
</tr>
<tr>
<td></td>
<td>Time</td>
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<td>Budget</td>
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<th>Under constraints</th>
<th>Working hours</th>
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<tr>
<td></td>
<td>Skills / affinity</td>
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<td>Logistic conflicts</td>
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Why are planning problems hard

- No known solution to solve in polynomial time
- Traveling Salesman
  - Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city exactly once and returns to the origin city
  - $O(n!)$
  - Just 10 cities would be 3628800 combinations
  - 25 cities is $1.551121e+25$
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Company Overview

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

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

thyssenkrupp elevator US
- 8,600 employees
- 115 branches
- ~220,000 units under maintenance
- 5,000 technicians
- $2 BILLION ORDER INTAKE
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Maintenance Overview

- Field service organization of 2500+
- Install base of 220K +

- Various Service Levels
  - Contractual maintenance (Planned)
  - Break-fix (Unplanned)

- Planning Model
  - Routes
  - Location
  - Frequency, Durations
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Measuring Maintenance

Objectives
- Reduce/eliminate missed maintenance
- Reduce break fix
- Increase customer service
- Increase service efficiencies

Measuring Success
- Increased % Mechanic total productive time
- Reduction % in NB CB OT hours
- Reduction % in missed maintenance
- Increase % in contract renewals
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Future of Maintenance Planning

Plan
● Install base clean up
● SLA integration
● Resource availability
● Location grouping
● Unit scoring
● Service levels
● Schedule and balance routes

Future
● IOT
● Repairs
● Safety
Business Resource Planner

Vehicle routing

Less driving time

Less makespan

OptaPlanner

Do more business with less resources

Bin packing

CPU

2  5

5  1

RAM

2  4

3  3

Job shop scheduling

Job 1

Job 2

Job 3

Job 4

Less fragmentation

Equipment scheduling

November

Thing 1

Thing 2

Equipment

B <2

E  2-4

C  4-6

A  3-5

Employee rostering

Happier employees

Sun

Free

Free

Mon

Free

Free

Free

Tue

Free

Free

Free
Business Resource Planner

Business Resource Planner is an “optimization engine” (or “constraint satisfaction solver”) platform that runs on JBoss BRMS.

It enables regular Java developers to create solvers for complex planning problems using a variety of out-of-the-box provided algorithms.
Types of constraints

*Hard Constraints* must be satisfied by any solution (for it to be a feasible solution)

- Crew must not exceed 8 hours in 24
- Truck must not be overloaded
- Every shift must have a full complement of nurses
- PM visit should be before safety inspection in a year

*Soft Constraints* should be satisfied as much as possible (better solutions satisfy more soft constraints)

- Crews should return home every 5 days
- A nurse’s time preference should be honored
- A mechanic should have about an equal amount of work each week
Openshift Jobs

- Jobs are Pods that run to completion
- Jobs are a Kubernetes object
  - Creates one or more pods and ensures they complete successfully

```yaml
apiVersion: batch/v1
kind: Job
metadata:
  name: planner-job
spec:
  parallelism: 2
  template:
    metadata:
      name: planner-job
    spec:
      containers:
      - name: planner-job
        image: 172.30.1.1:5000/test/test:latest
        volumeMounts:
        - name: sample-data
          mountPath: /etc/sample-data
        - name: report-data
          mountPath: /etc/report-data
      resources:
        limits:
          cpu: "1"
        requests:
          cpu: "1"
      env:
      - name: JAVA_MAIN_CLASS
        value: com.rhc.planner.app.PlannerRunner
```

#redhat #rhsummit
Partitioned Jobs

1) Partition
   Divide into n pieces

2) Map
   Solve each piece

3) Reduce
   Merge piece solutions (not always possible)

4) Result
   Not (near) optimal
   Worse when scaling

-706

Optimal solution

-674
Demo Architecture
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THANK YOU

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