OptaPlanner
WEEK

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Senior Architect

SEPT 2nd 11am EST

"I bet you
I'm better than a human"

RED.HT/OPTAPLANNER-WEEK-EVENT

Agenda

We will level set on what is Business Optimizer followed by a few use cases that are being used today

- What is Business Optimizer?
- Employee Rostering
- Vehicle Routing
- Task Assignment
- Defeating Gerrymandering

Business Optimizer

What is a planning problem

Optimize goals with limited resources under constraints

Optimize goals

With limited resources

Under constraints

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Optimize goals

- Maximise profit
- Minimize ecological footprint
- Maximize happiness of employees / customers
- ...

With limited resources

Under constraints

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With limited resources

- Employees
- Assets (machines, buildings, vehicles, …)
- Time
- Budget

Under constraints

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- Maximise profit
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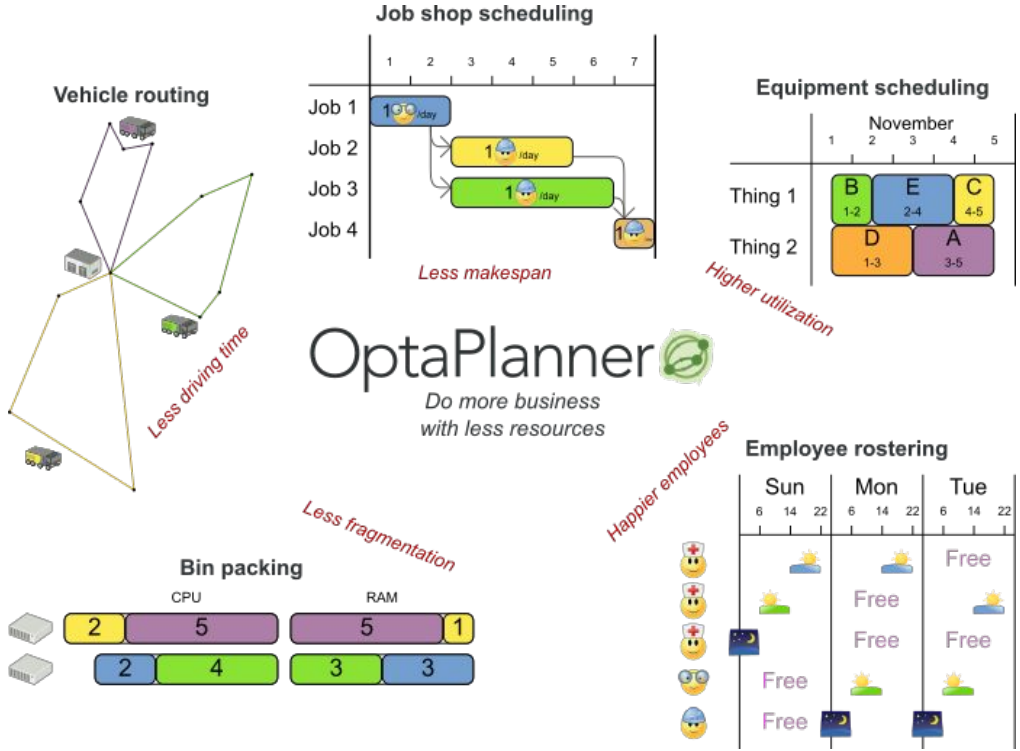
With limited resources

- Employees
- Assets (machines, buildings, vehicles, …)
- Time
- Budget

Under constraints

- vs Working hours
- vs Skills / affinity
- vs Logistical conflicts
- …

Planning problem use cases



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Why are Planning Problems so 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

Positive and negative constraints

Pick the solution which maximizes apples and minimizes fuel usage

Maximize 

Positive and negative constraints

Pick the solution which maximizes apples and minimizes fuel usage

Positive and negative constraints

Pick the solution which maximizes apples and minimizes fuel usage

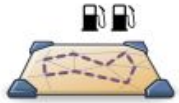
Maximize  ⇒  = 1

<

<

Optimal solution

Minimize 



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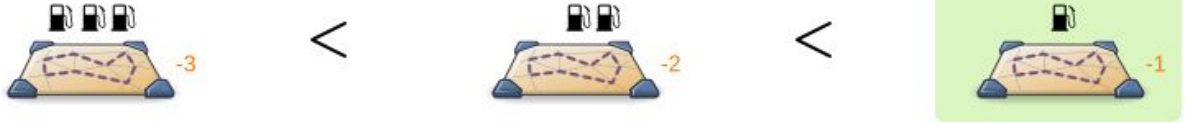
Positive and negative constraints

Pick the solution which maximizes apples and minimizes fuel usage

Maximize 🍏 ⇒ 🍏 = 1

Minimize ⛽ ⇒ ⛽ = -1



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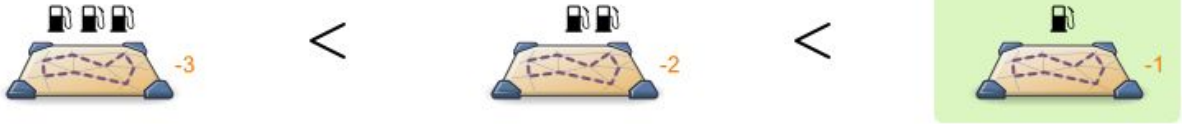

Maximize 🍏 and minimize ⛽

Positive and negative constraints

Pick the solution which maximizes apples and minimizes fuel usage

Maximize 🍏 ⇒ 🍏 = 1

Optimal solution

Minimize ⛽ ⇒ ⛽ = -1

Optimal solution

Maximize 🍏 and minimize ⛽ ⇒ 🍏 = 1 & ⛽ = -1

Optimal solution

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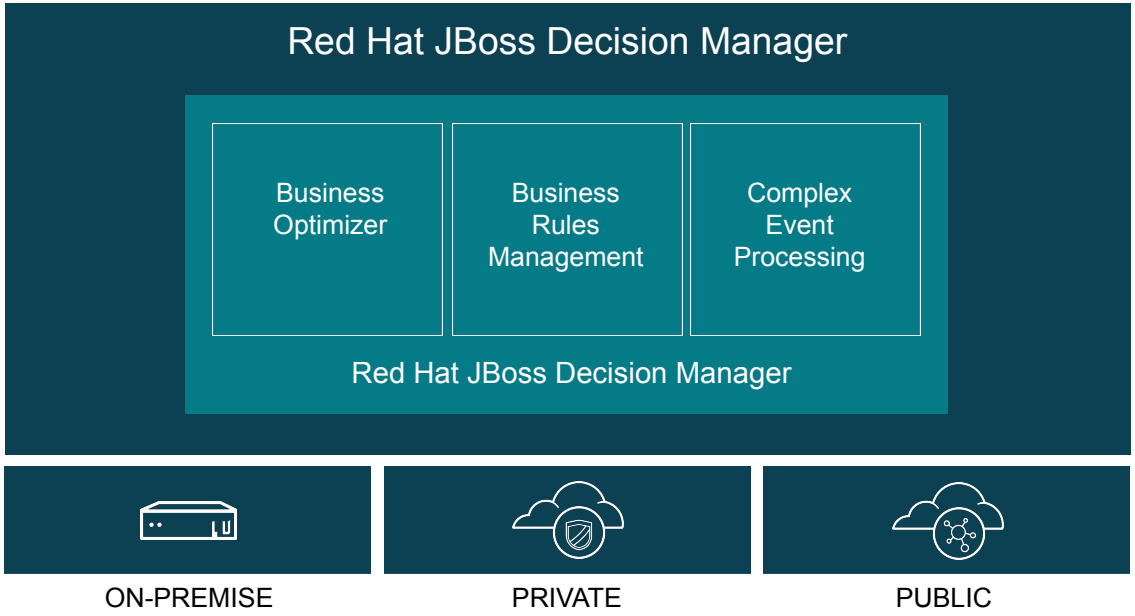
Business Optimizer

Business Optimizer is an “optimization engine” (or “constraint satisfaction solver”) platform that runs on JBoss Decision Manager

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



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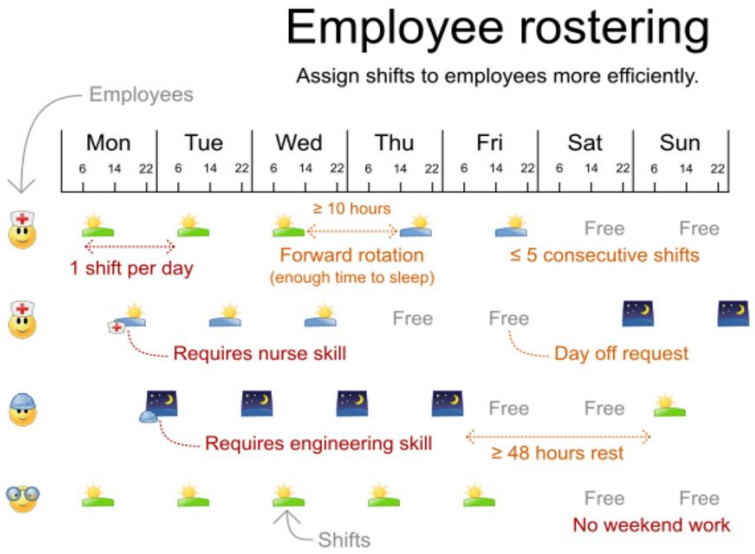
Employee Shift Rostering

Schedule Employee Shifts

Given the domain model below, what is the optimal schedule for shifts to employees?

- Shift
  - Date and Time
  - Skills
  - etc.
- Employee
  - Skills
  - Seniority
  - Days Off
  - etc.



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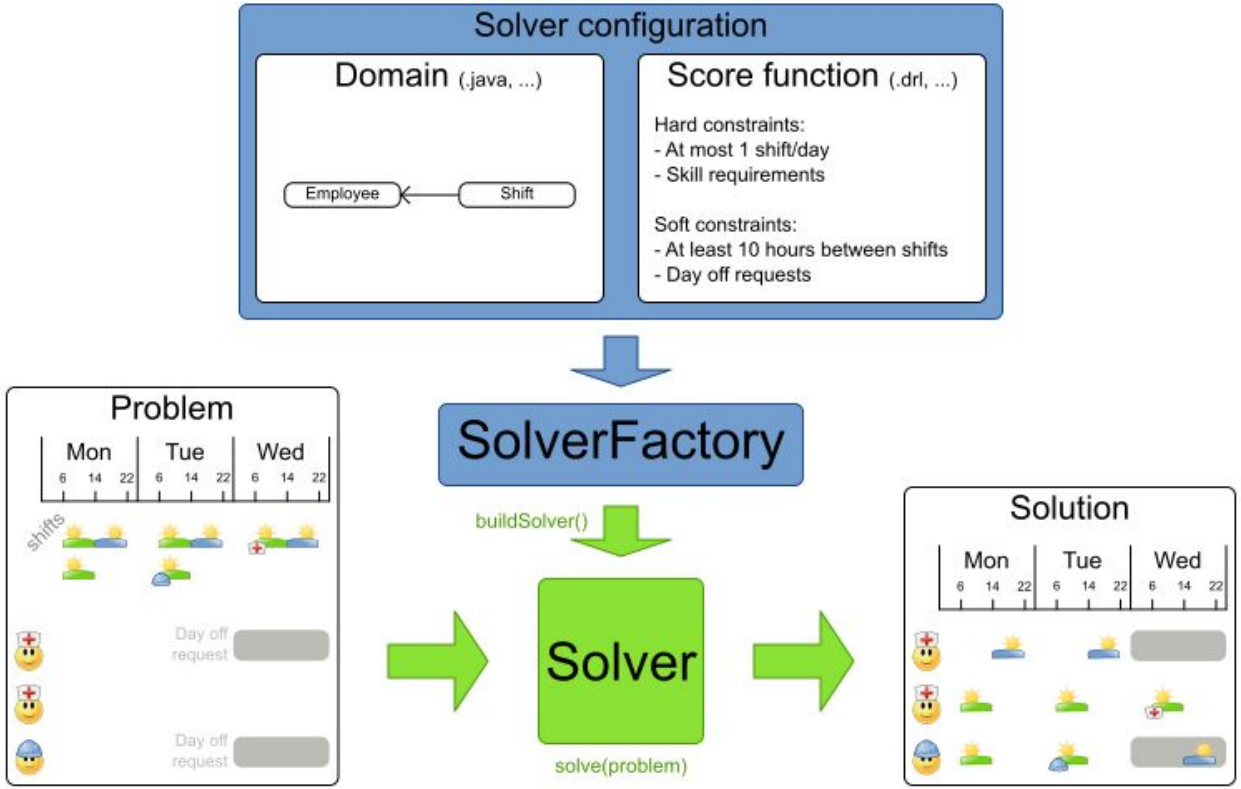
Input/Output overview employee rostering

Use 1 SolverFactory per application and 1 Solver per dataset.



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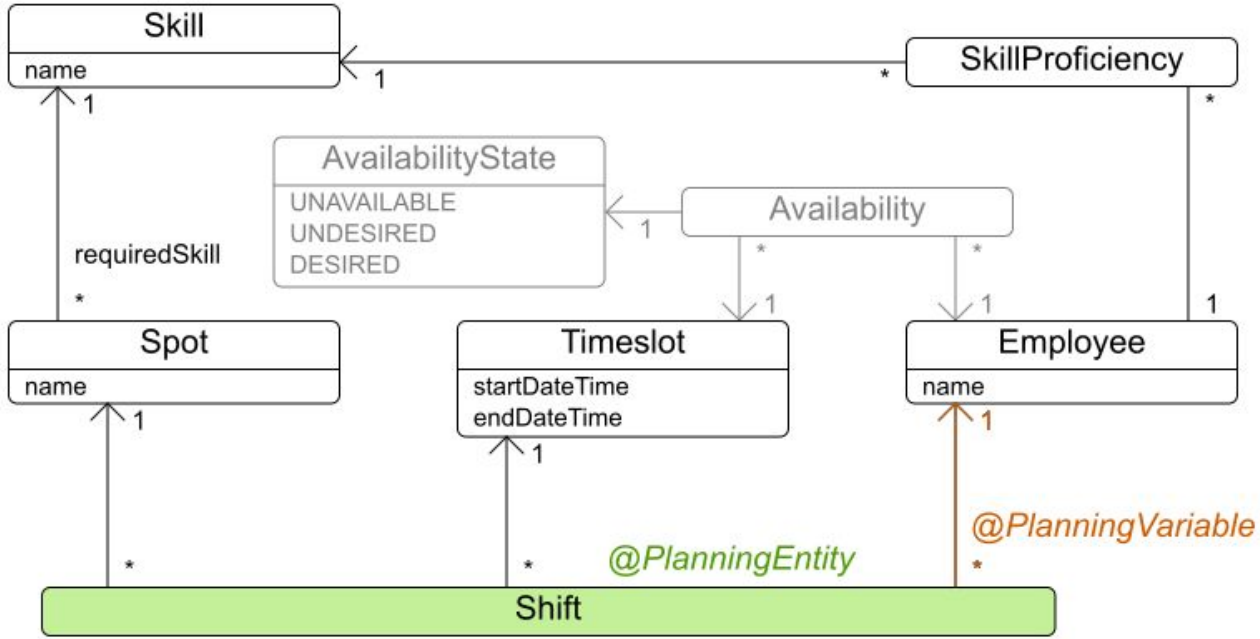
Employee rostering class diagram

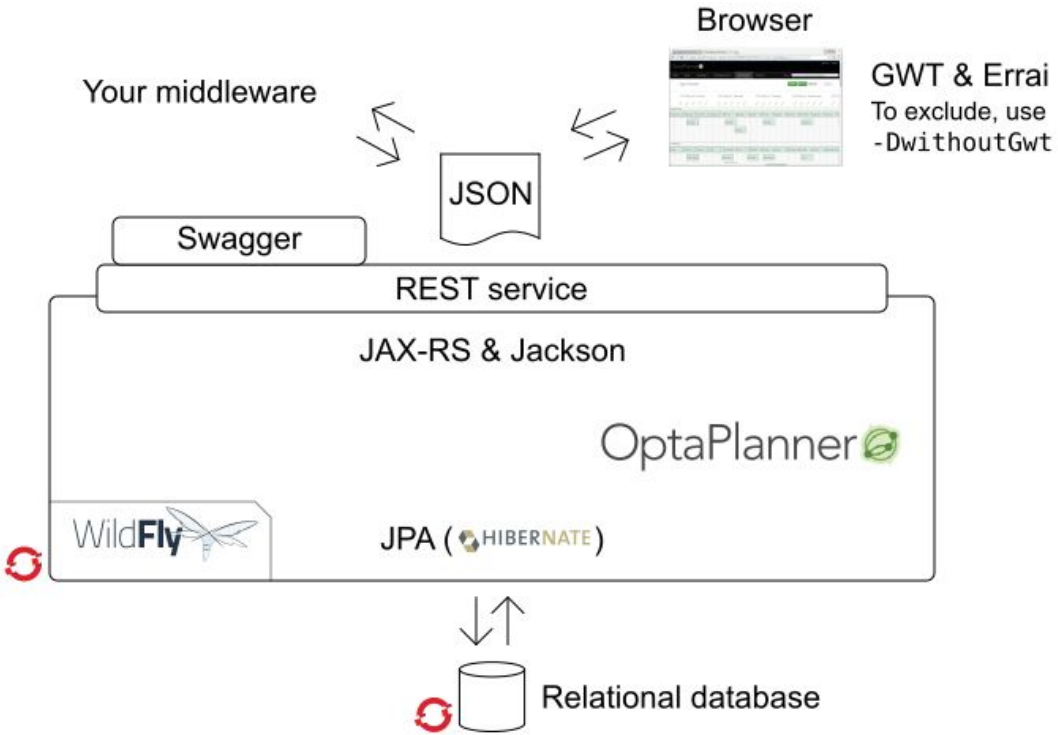


Required skill constraint (DRL)

```
rule "Required skill"
  when
    Shift(
        getEmployee() != null,
        // Employee lacks required skill
        !getEmployee().hasSkill(getSpot().getRequiredSkill()))
  then
    // Lower hard score
    scoreHolder.addHardConstraintMatch(kcontext, -1);
end
```

OptaShift Employee Rostering Architecture

Use the powerful REST interface or the user friendly web interface.



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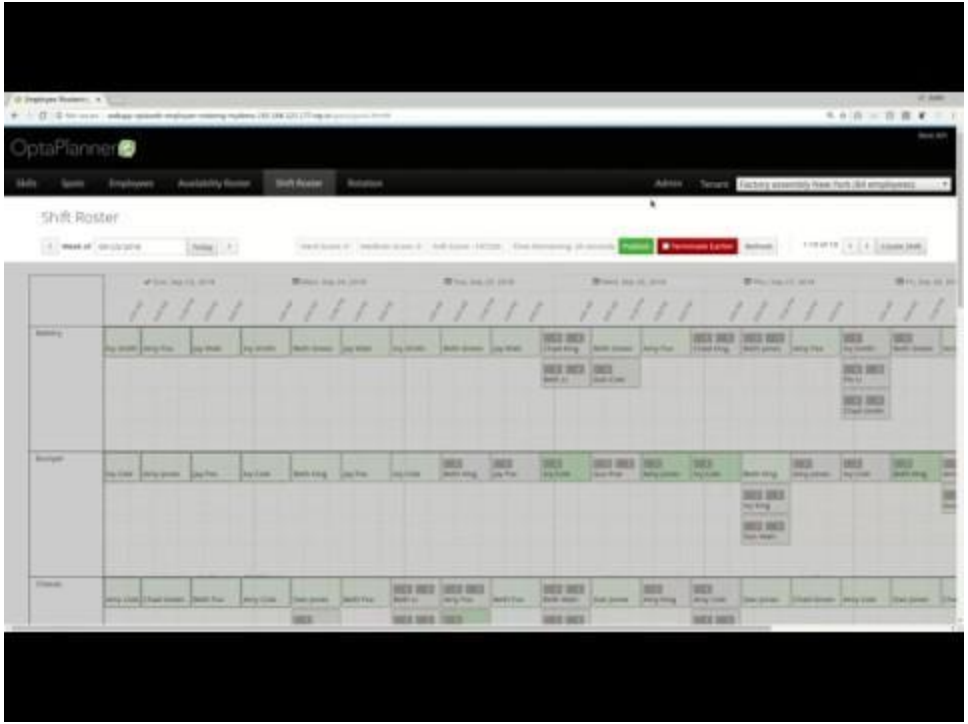

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Continuous planning

Replan at the start of every period (usually a week). Plan 3 periods, but only publish the first period.

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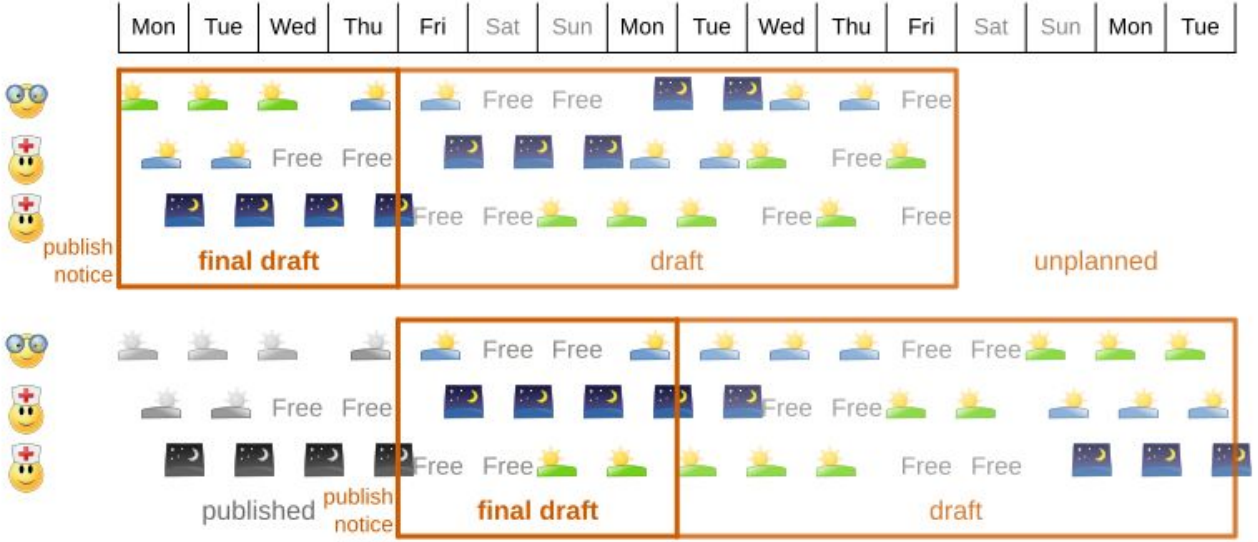

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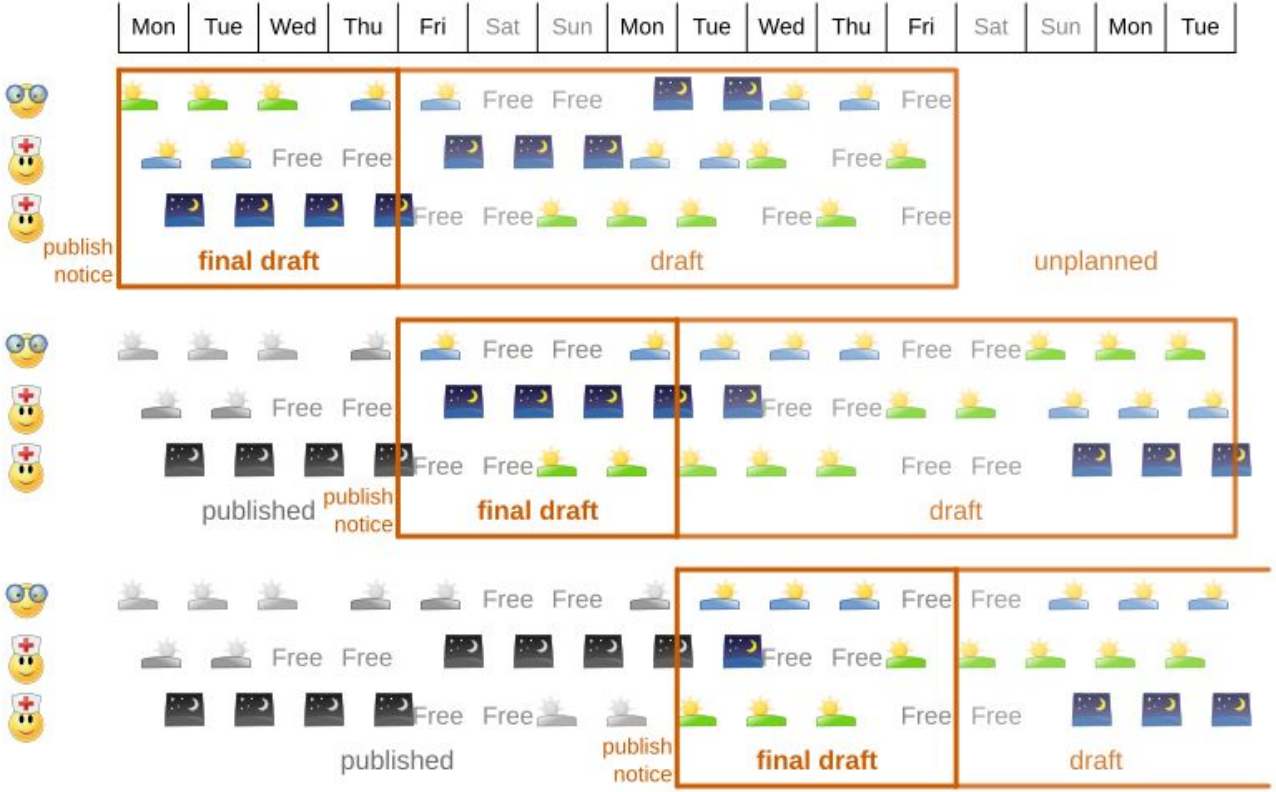

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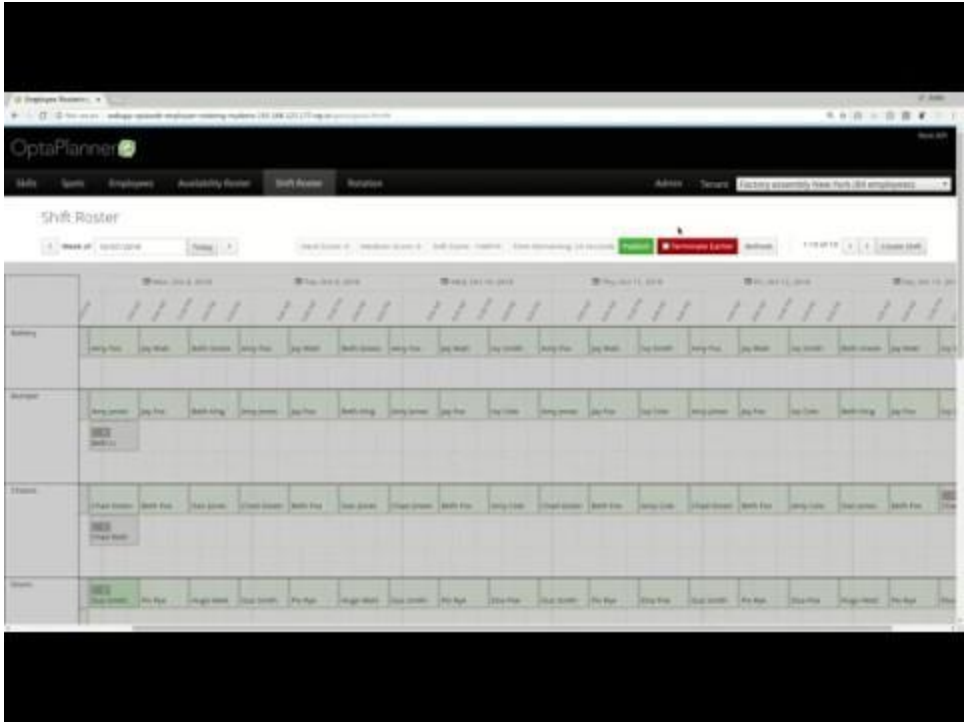

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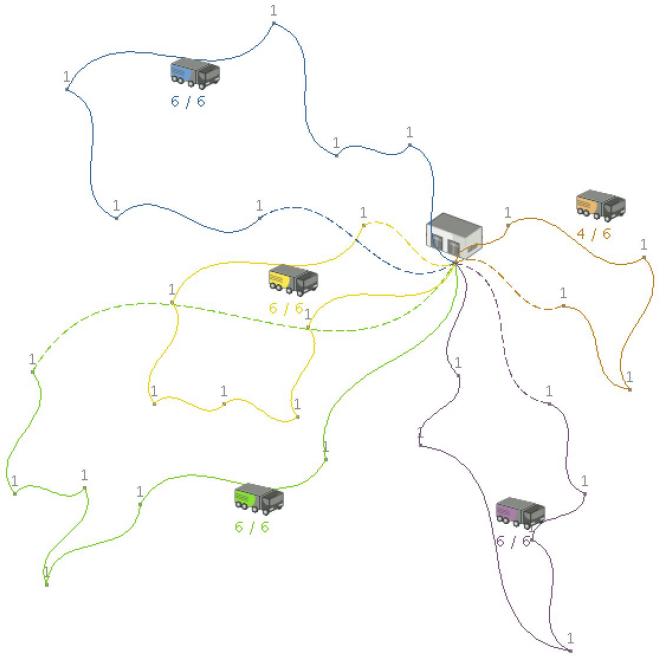
Vehicle Routing with Time Windows

Schedule Jobs to Technicians

Given the domain model below, what is the optimal schedule for jobs to technicians?

- Jobs
  - Time window for job
  - Skills
  - Location
  - etc.
- Technician
  - Skills
  - Working hours/shifts
  - Average job time
  - etc.



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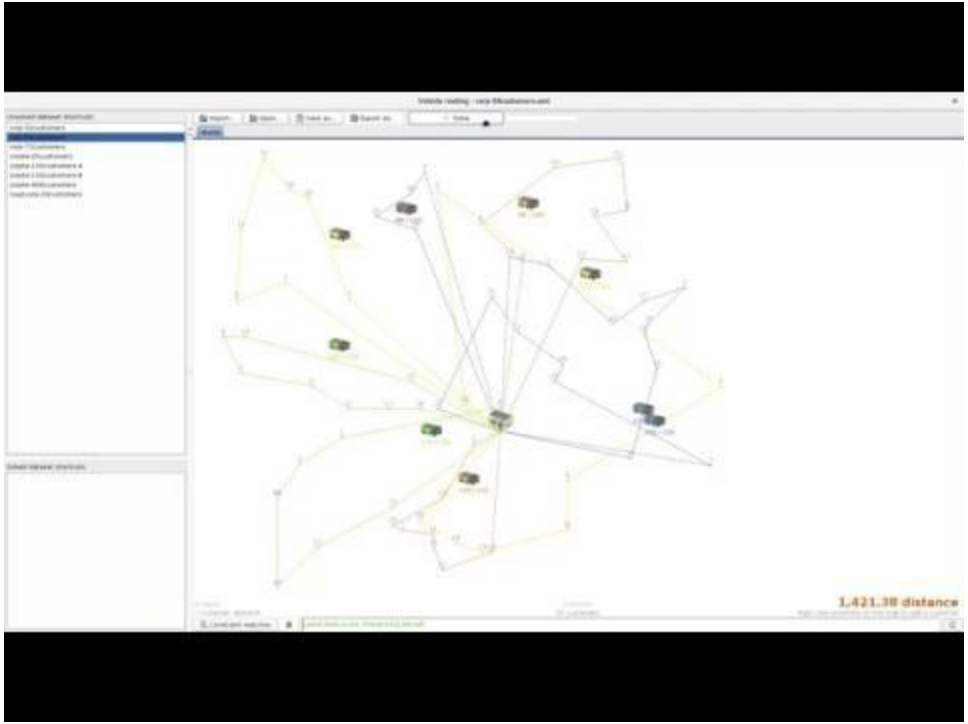
Planning Problem

What conditions are we solving for?

For their planning problem, there were three main objectives.

1. Schedule as many jobs in a day as possible
2. Use the least number of technicians
3. Minimize the miles



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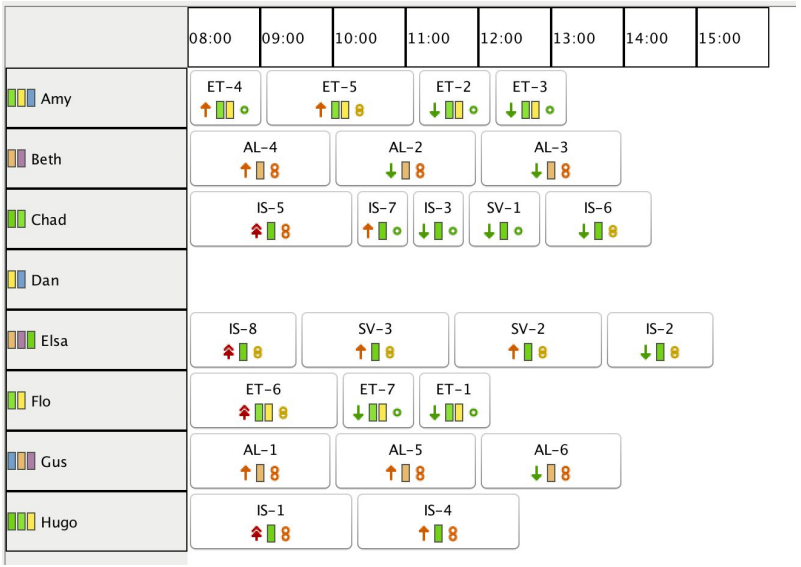
Task Assignment

Assign Tasks to Reviewers

What is the optimal schedule for tasks to reviewers?

- Tasks
  - Task type with skills
  - Various factors created a Priority
  - etc.
- Reviewers
  - Skills
  - Affinity for task type
  - etc.



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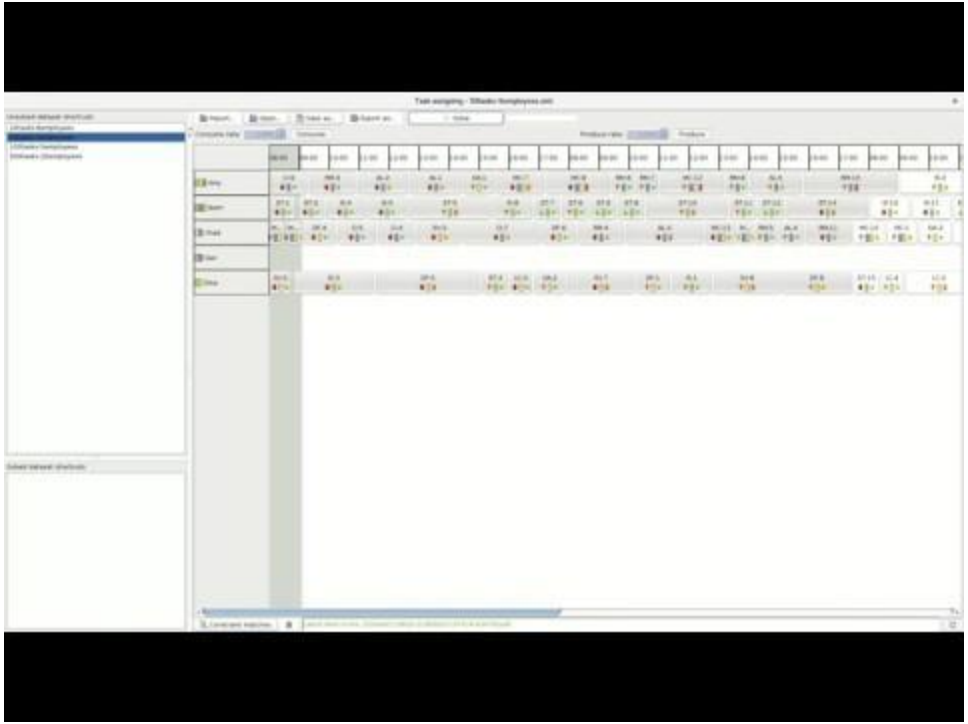
Planning Problem

What conditions are we solving for?

For their planning problem, there were three main objectives.

1. Dollar value for the claim
2. Date added
3. Customer Status (Premium, Gold, Silver, etc.)



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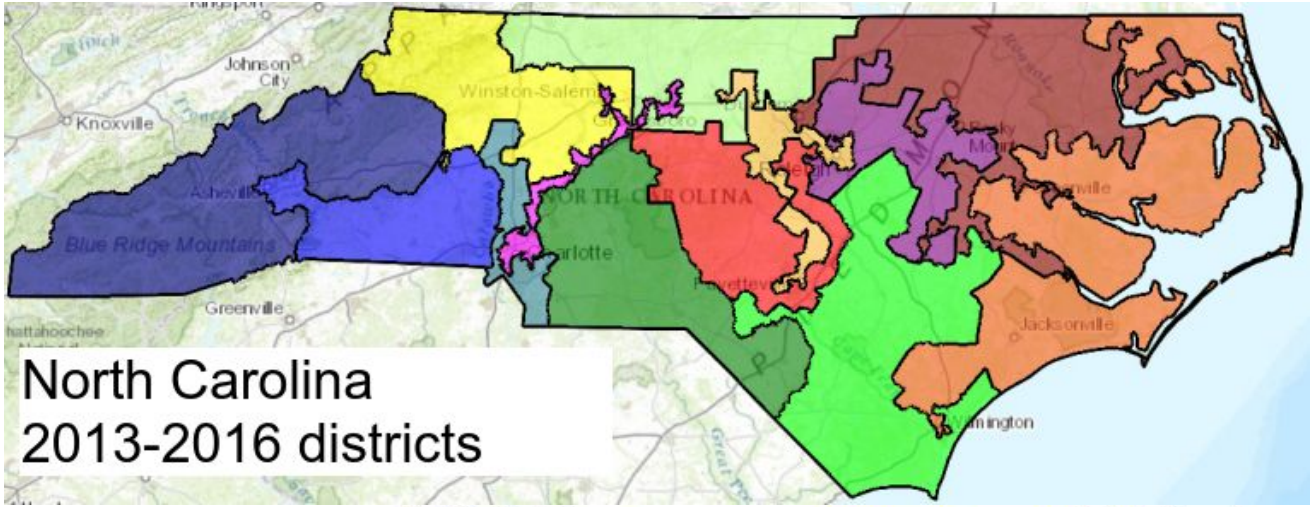
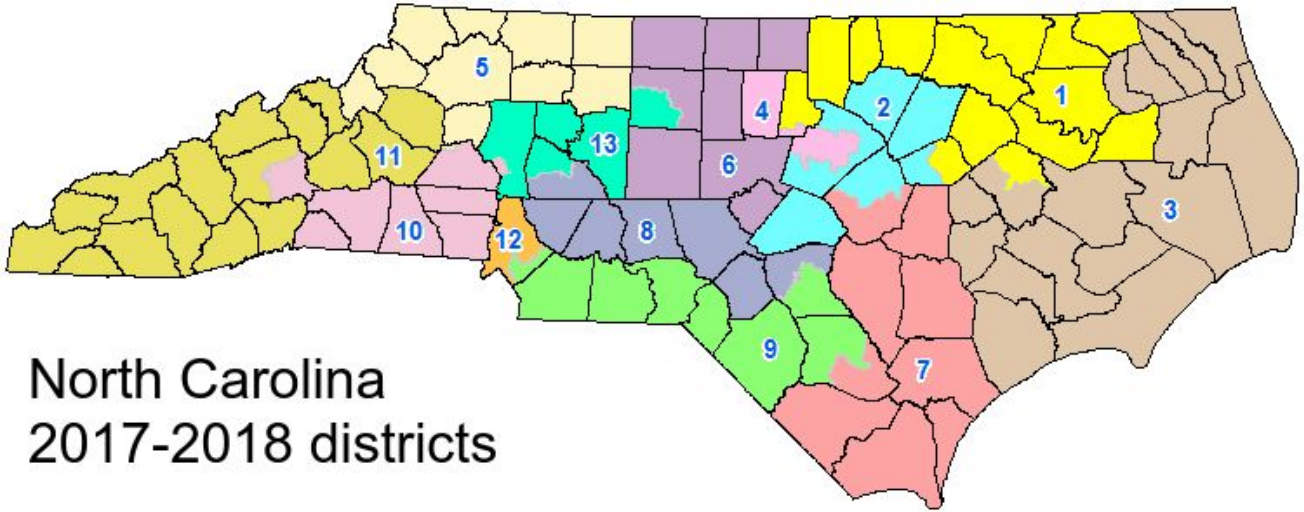
Gerrymandering



North Carolina
2013-2016 districts



North Carolina
2017-2018 districts

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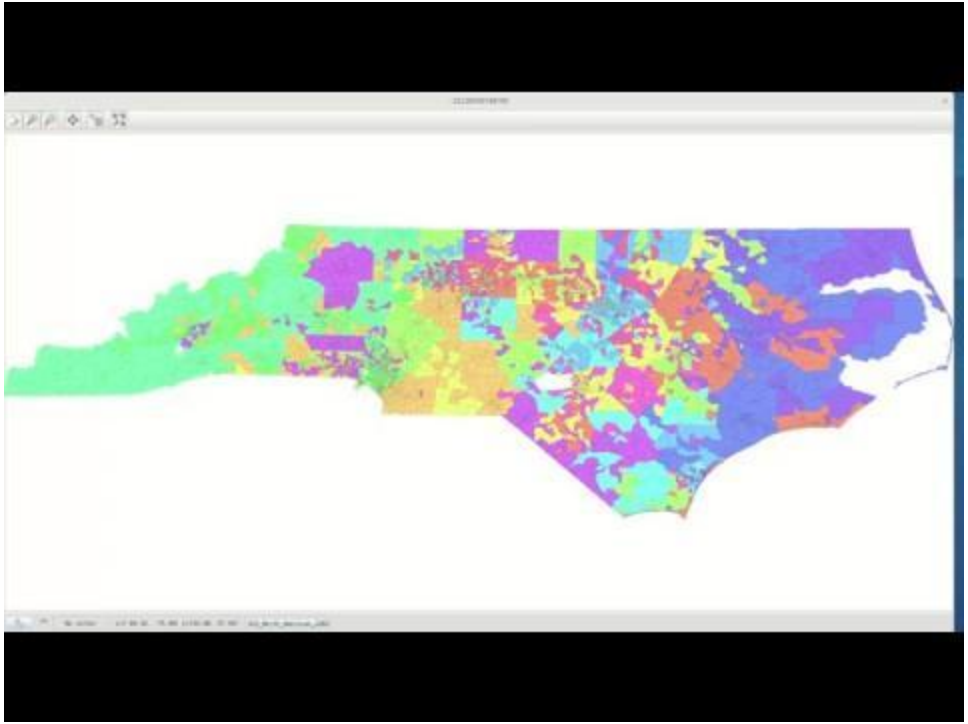
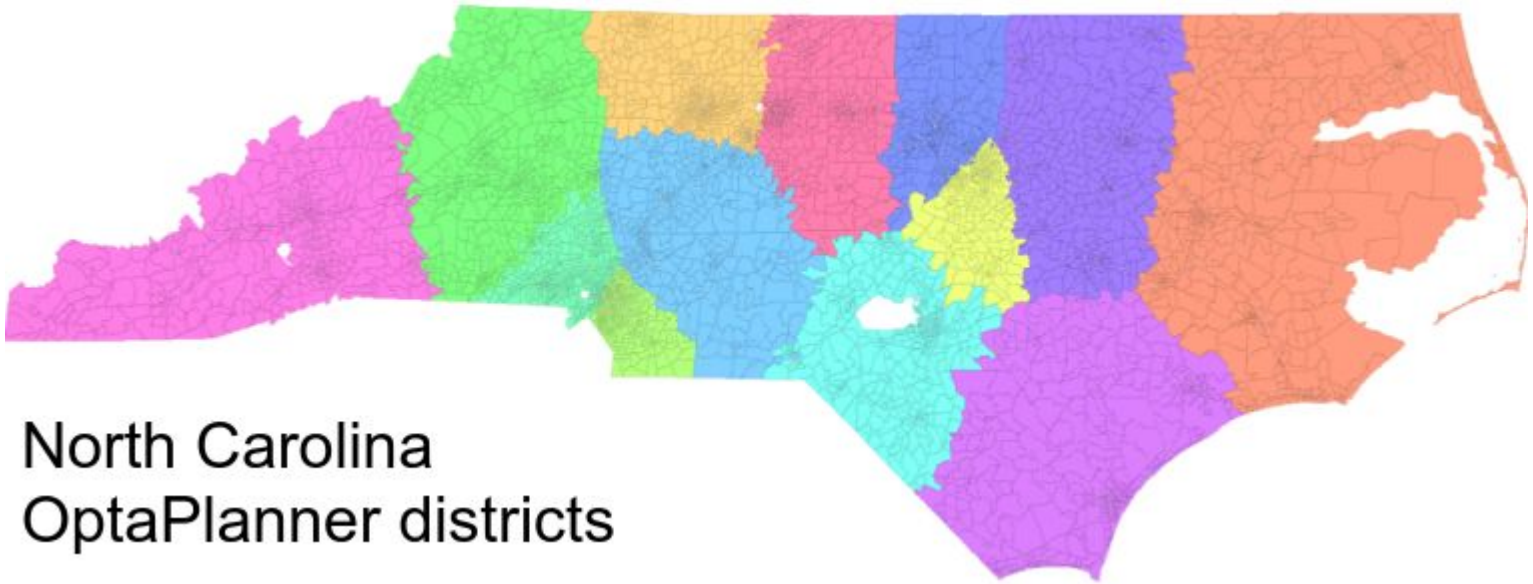


How to defeat gerrymandering and create fair elections



Questions

Gerrymandering Blog:
http://www.optaplanner.org/blog/2018/07/25/HowToDefeatGerrymanderingAndCreateFairElections.html

OptaShift Employee Rostering:

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