The Art of Café Scheduling

with the PlanningAI Timefold in Java

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10.12.2024

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Simon Tiffert

- Founder and CEO of OptaZEN GmbH
- Experience:
  - 20+ years of Java/web eco system
  - 15+ years of international software projects – project lead, dev lead, sw architect, developer
  - 10+ years of optimization projects (Drools Planner, OptaPlanner, Timefold)

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The Problem

Complex planning in a busy café

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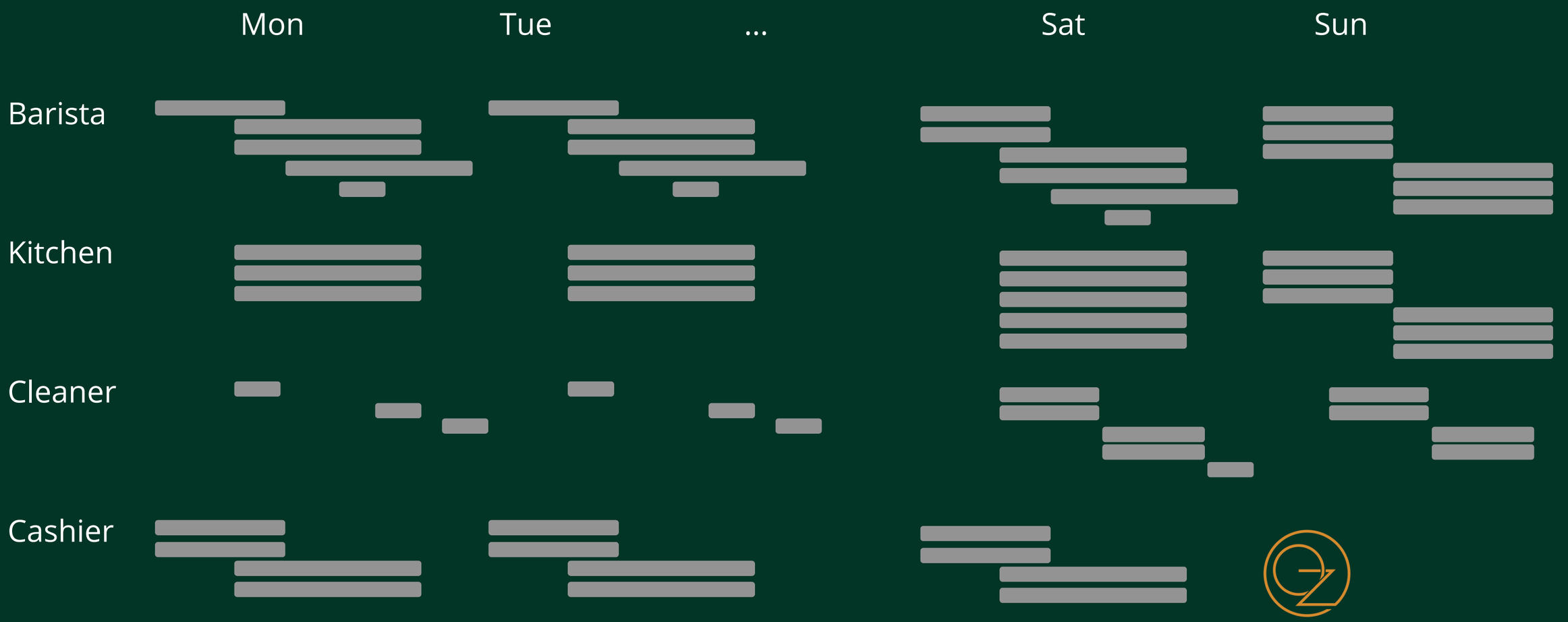
Complex Café Schedules



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Complex Staff Schedules

Free
Non-Preferred
Time Off

Barista: Paul, Mitch, Michelle
Kitchen: Mitch, Michelle
Cleaner: Paul, Mitch, Bernd, Michelle
Cashier: Mitch, Bernd

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Complex Café Schedules

Scheduled Work
Peak Hours
Roles

Traffic
Transportation (multi-site)

Availability
Contracts
Holiday
Rest time
Skills

Sick leave
Sudden unavailability

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Complexity

On the example of the café problem:

- 1 café
- 5 roles needed per shift
- 3 shift times per day
- 7 days
- 10 employees

Possible combinations: ...

Complexity

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- 1 café
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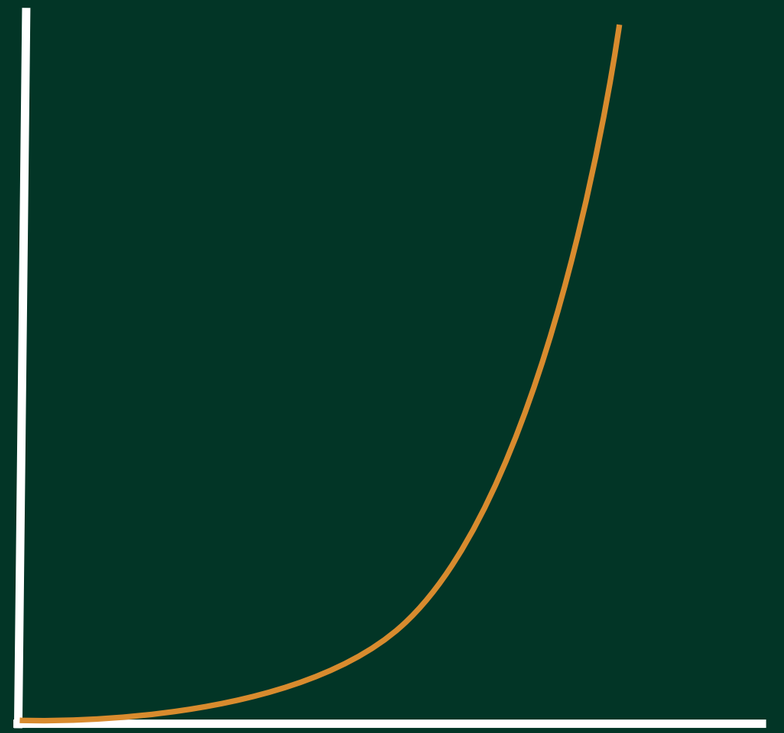
Possible combinations: ... $(10^5)^{3x7} = 10^{105}$



Atoms in the Universum: 10^{89}

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The solution

Optimizing with Timefold

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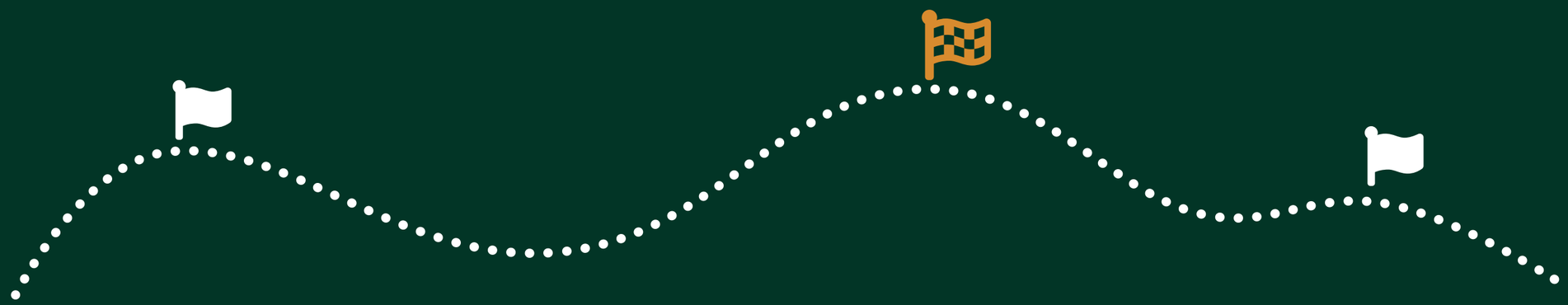
Algorithms

Planning Problems in large scale:

- quick calculation of a single step
- a simple algorithm is not able to find the best result in the search space in reasonable time



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CH- & Meta-Heuristics

Two phases:

- Construction Heuristic
- Local Search

Ready to use algorithms in Timefold:

- Late Acceptance
- Tabu Search
- Simulated Annealing
- ...

Combined with incremental score calculation

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Benefits of Timefold

Open Source

- In active development for over 18 years (Drools Planner, OptaPlanner)
- Or commercial versions
    - ready made models as SAAS
    - Timefold core with advanced features

Java Eco System

- Simple JAR as dependency
- Plain old java objects with annotations
- Java Stream API for constraints

Developer friendly

- Test driven development possible
- Great documentation
- A lot of examples

Timefold works directly from:

- Java / Kotlin
- Python

Timefold integrates seamlessly with:

- Quarkus
- Spring Boot

Timefold runs on:

- JVM based environments
- Kubernetes and OpenShift

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How It Works

Model, constraint, solve

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Model the problem

```
@PlanningEntity
public class Entity {
   @PlanningId
   private int id;

   // Planning variables: changes during planning, between score calculations.
   @PlanningVariable
   private PlanVar pv;

   // ... getters and setters
}

public class PlanVar {
  @PlanningId
  private String name;
}
```

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Add Constraints

```
public class MyConstraintProvider implements ConstraintProvider {

 @Override
      public Constraint[] defineConstraints(ConstraintFactory factory) {
         return new Constraint[] {
                penalizeEveryEntity(factory)
         };
      }

      private Constraint penalizeEveryEntity(ConstraintFactory factory) {
         return factory.forEach(Entity.class)
            .filter(Entity::isTooExpense)
            .penalize(HardSoftScore.ONE_SOFT)
            .asConstraint("Constraint Name");
      }
  }
```

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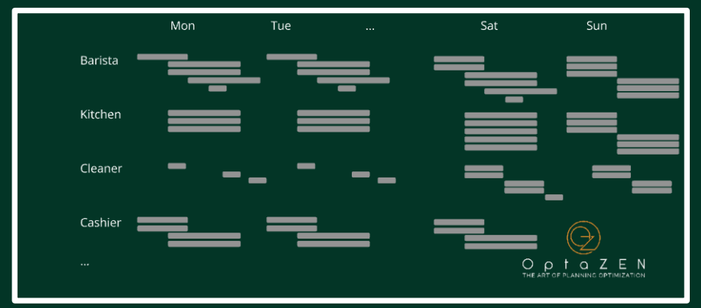
Optimize & Solve

Input

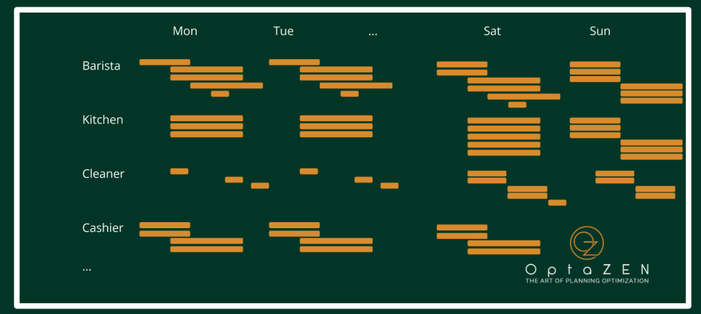


Model

Domain Model

Constraint-Stream

Timefold Solver



Demo Time

Let's solve a café schedule with Timefold & Quarkus

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Insights & Lessons

What I learned about PlanningAI

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Key Challenges

- The right modelling approach
    - Different Domain Models
    - Different Time Modellings
- Customer Expectations
    - Solver needs time: optimal result in the available time 5 sec. vs. 5min
- Problem size
    - Different sizings needs different levels of fine-tuning

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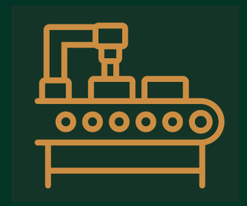
What Worked Well

- Different problem domains
  - Vehicle Routing with Time Windows
  - Maintenance Scheduling
  - Field Service Routing
  - Production (Job Shop) Scheduling
  - and much more
- Integration in existing solutions



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Questions?

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Repository
https://github.com/simontiffert/cafe-scheduling

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