

**Institute of Systems Science
National University of Singapore**

**GRADUATE CERTIFICATE
INTELLIGENT REASONING SYSTEMS**

Workshop Project Guide

Subject: Reasoning Systems

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Singapore 119615



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1. Workshop 1 – Search Representation

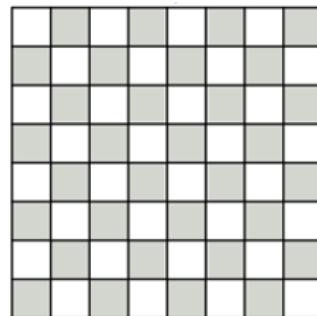
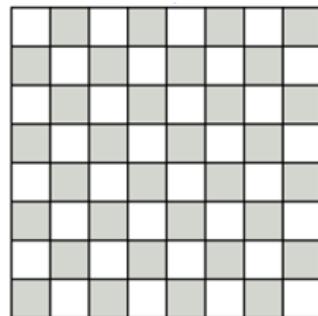
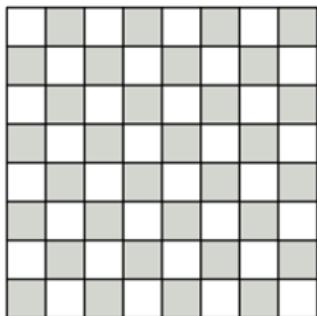
WORKSHOP SEARCH REPRESENTATION

- **Search Modelling & Representation**
 - Pen & Paper Planning
 - Robot Navigation
 - Vehicle Route Planning (VRP)
- **KIE OptaPlanner Tutorial**
 - Optimizing Vehicle Route Planning (VRP)
 - Optimizing Europe Travelling Sales Person (TSP)

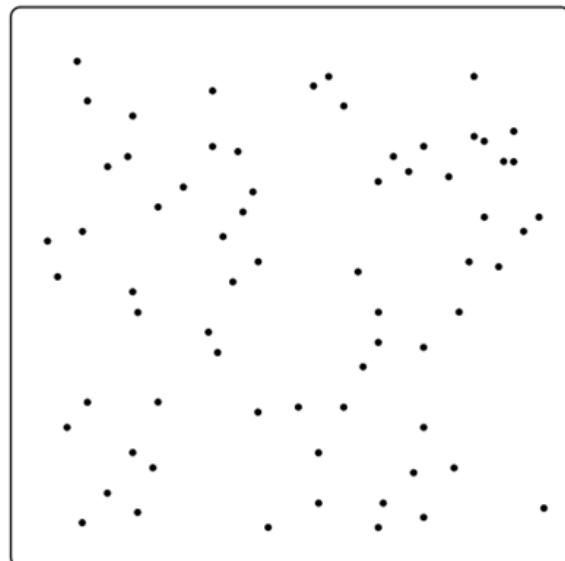
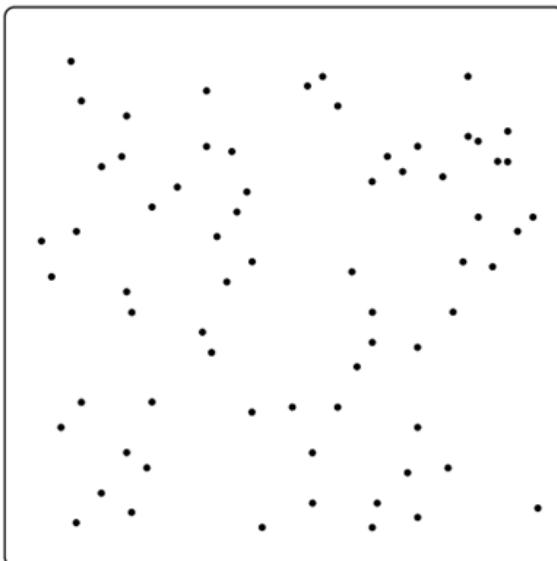
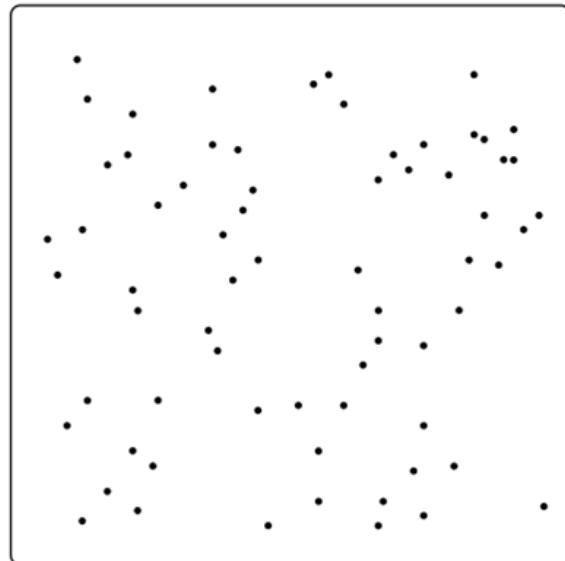
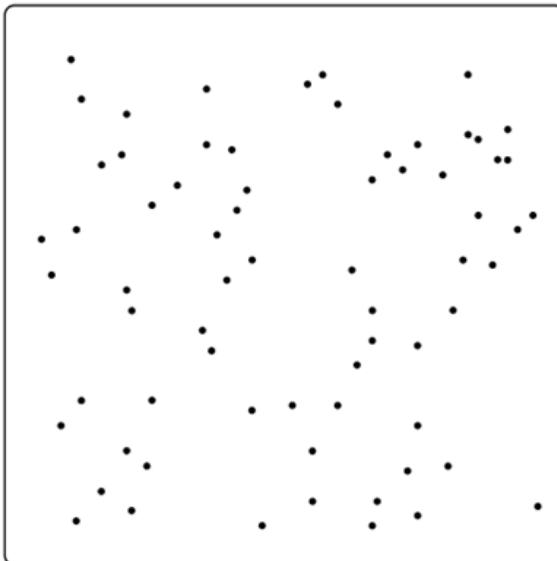
1.1. Search Modelling & Representation

1.1.1. Pen & Paper Planning

1) Place 8 queens on this chessboard so no 2 queens can attack each other.

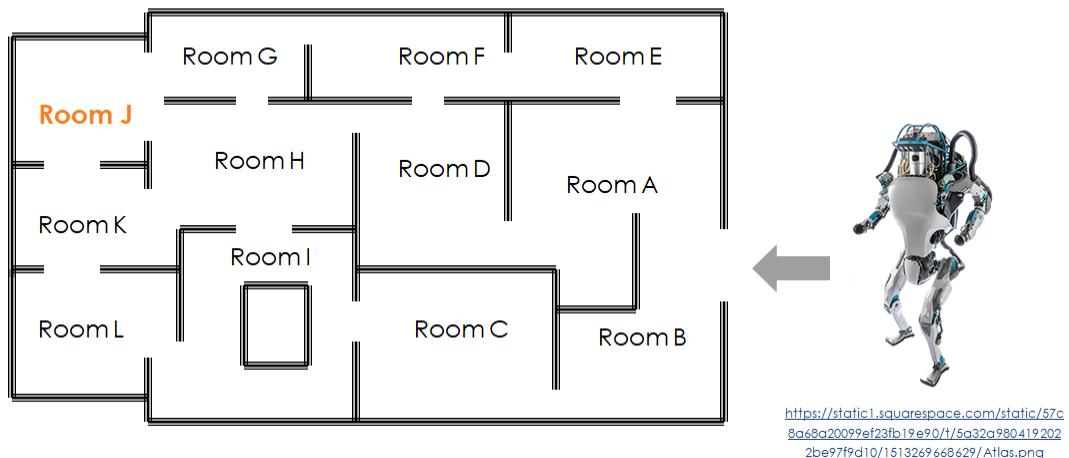


2) Draw the shortest line that connects all dots and returns to its origin.



1.1.2. Robot Navigation

- **Robotics: How to rapidly navigate to Room J ?**



Design and draft robot navigation search representation here:

Write down DFS search order:

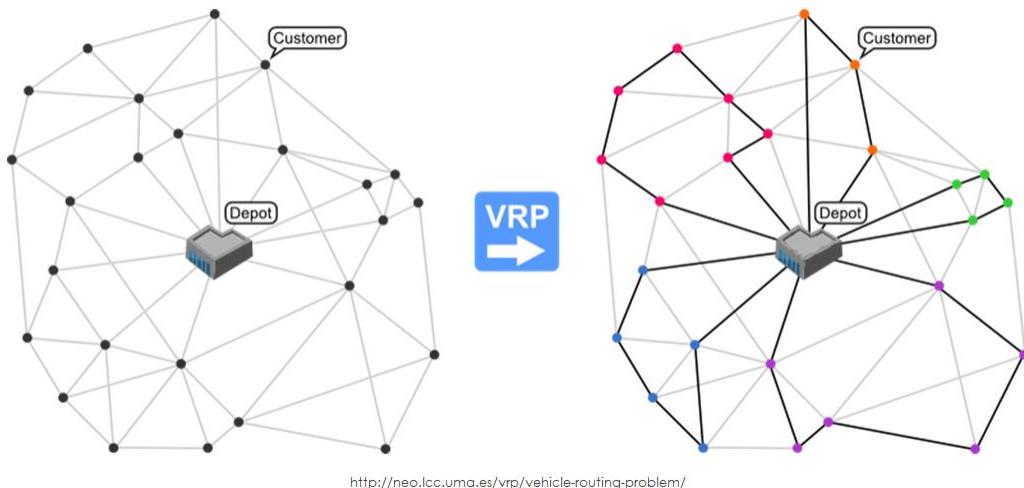
Write down BFS search order:

Construct reasonable heuristics, then design heuristic search strategy to enhance above DFS/BFS brute force search:

1.1.3. Vehicle Route Planning (VRP)

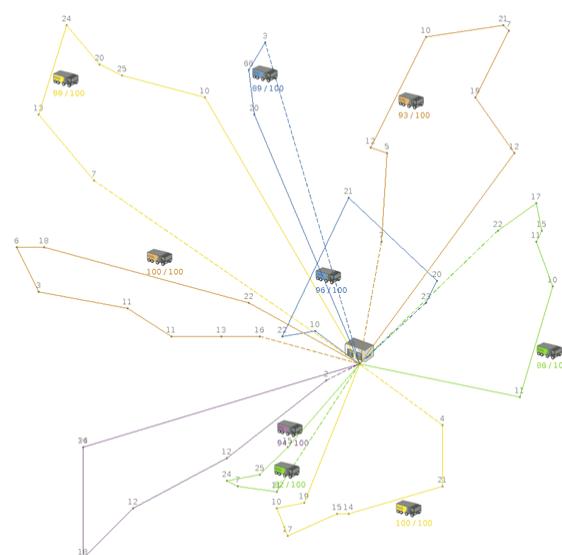
Form groups: 4-6 learners per group.

Vehicle Route Problem



Optimizing Vehicle Route Planning

- We are a logistic company owning a warehouse and 9 delivery trucks. This morning we received 54 customer orders, with different load demand, and different locations. Our truck's maximum load capacity is 100 TVs.
- We want to delivery all customer orders using fewer gasoline. Hence, we'd like to have shortest distance of combined truck delivery routes.



Design and draft VRP search representation here:

Strategy to avoid looping (revisiting same customer):

1.2. KIE OptaPlanner Tutorial

The screenshot shows the KIE Group website's navigation bar at the top. It includes the KIE GROUP logo, followed by links for DROOLS, OPTAPLANNER, JBPM, and APPFORMER. A Red Hat logo is also present. Below the navigation bar is a large red banner featuring a stylized plant or flower graphic. On the left side of the banner, the word "OPTAPLANNER" is written in white capital letters. To the right of the banner, there is a brief description of OptaPlanner.

OPTAPLANNER

OptaPlanner is a lightweight, embeddable planning engine. It enables normal Java™ programmers to solve optimization problems efficiently. It is also compatible with other JVM languages (such as Kotlin and Scala)

DROOLS

Drools is a business rule management system with a forward-chaining and backward-chaining inference based rules engine, allowing fast and reliable evaluation of business rules and complex event processing.

[Read more →](#)

OPTAPLANNER

OptaPlanner is a constraint solver that optimizes use cases such as employee rostering, vehicle routing, task assignment and cloud optimization.

[Read more →](#)

JBPM

jBPM is a flexible Business Process Management suite allowing you to model your business goals by describing the steps that need to be executed to achieve those goals.

[Read more →](#)

APPFORMER

AppFormer is a low code platform to develop modern applications. It's a powerful tool for developers that can easily build applications by mashing up components and connect them to other Red Hat modules and software.

We make building apps looks easy.

[Read more →](#)

KIE / Business Central

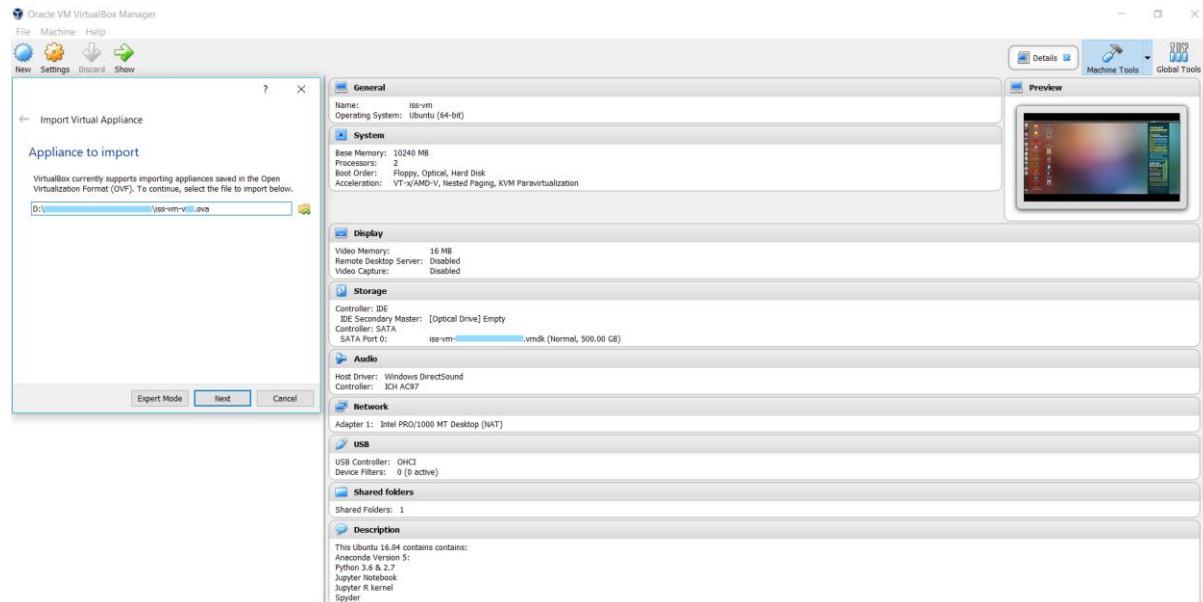
<http://www.kiegroup.org/>

KIE OptaPlanner

<https://www.optaplanner.org/>

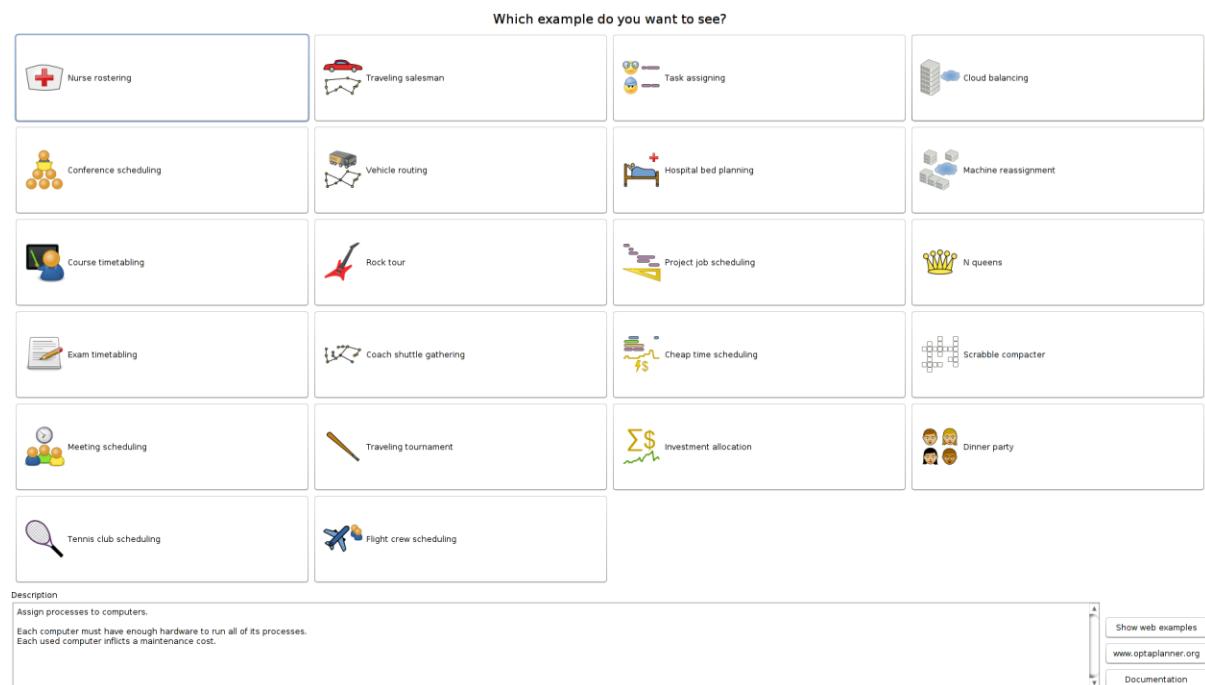
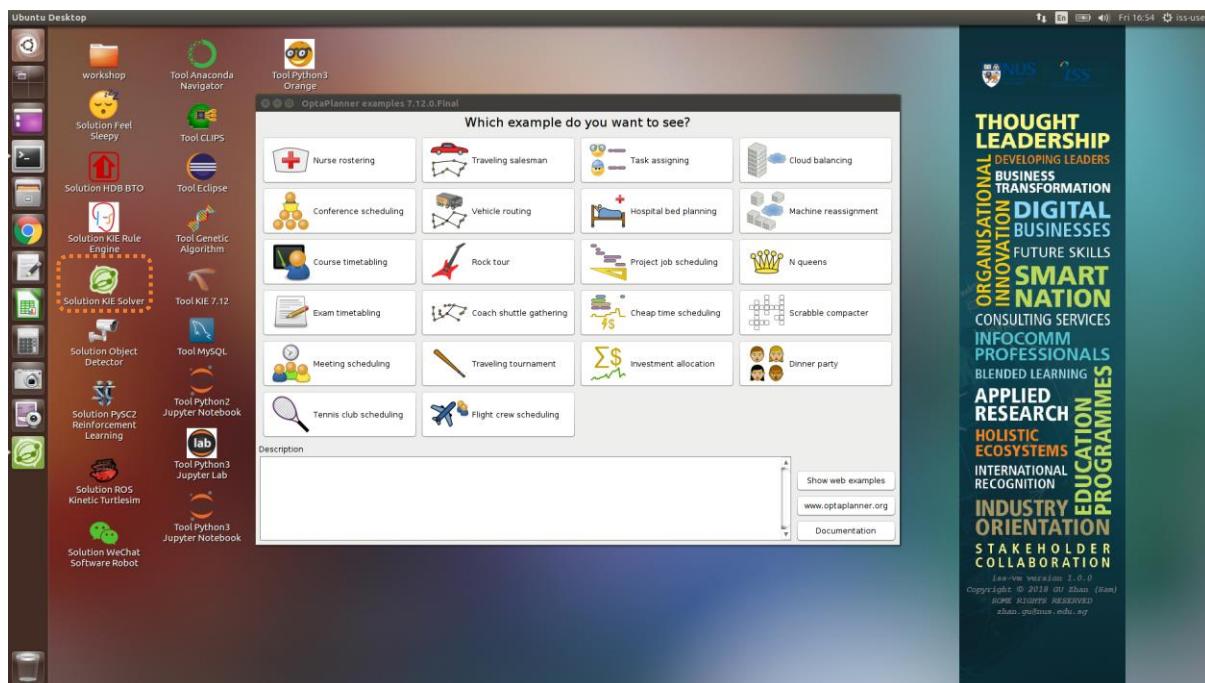
1.2.1. OptaPlanner Example Solutions in Graphic User Interface

- 1) Start computer → Oracle VM Virtual Box → iss-vm virtual machine



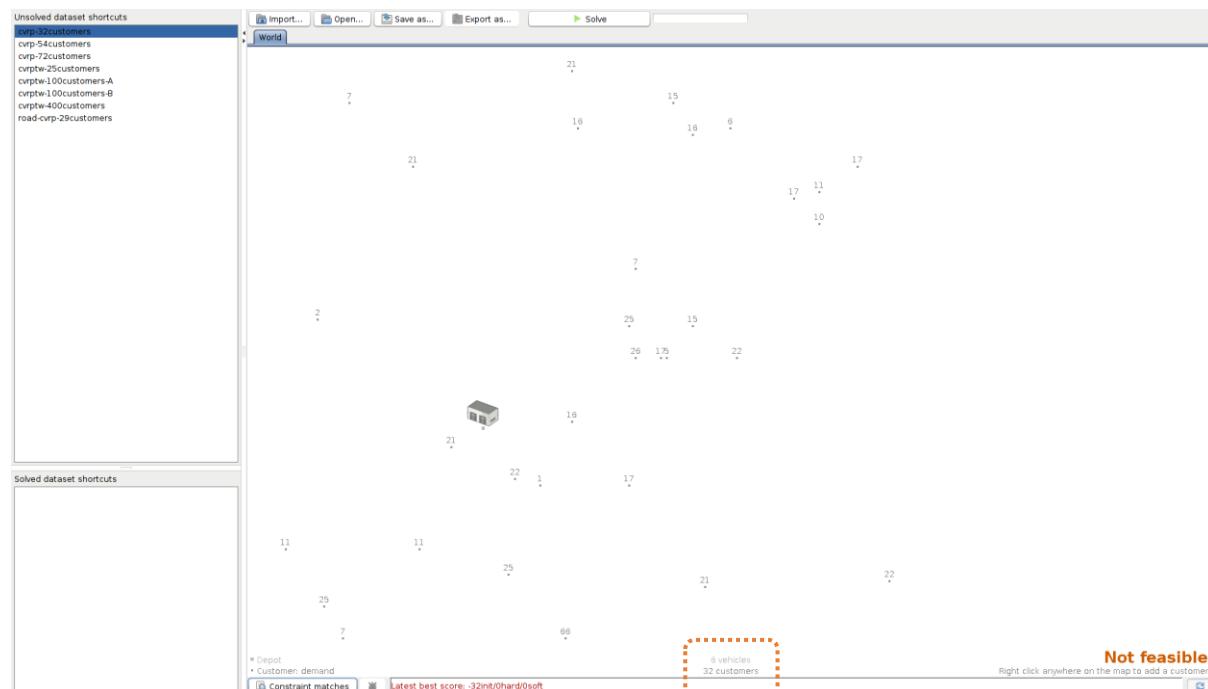
<http://bit.ly/iss-vm>

2) From desktop, start **Solution KIE Solver** (It takes a while to start).

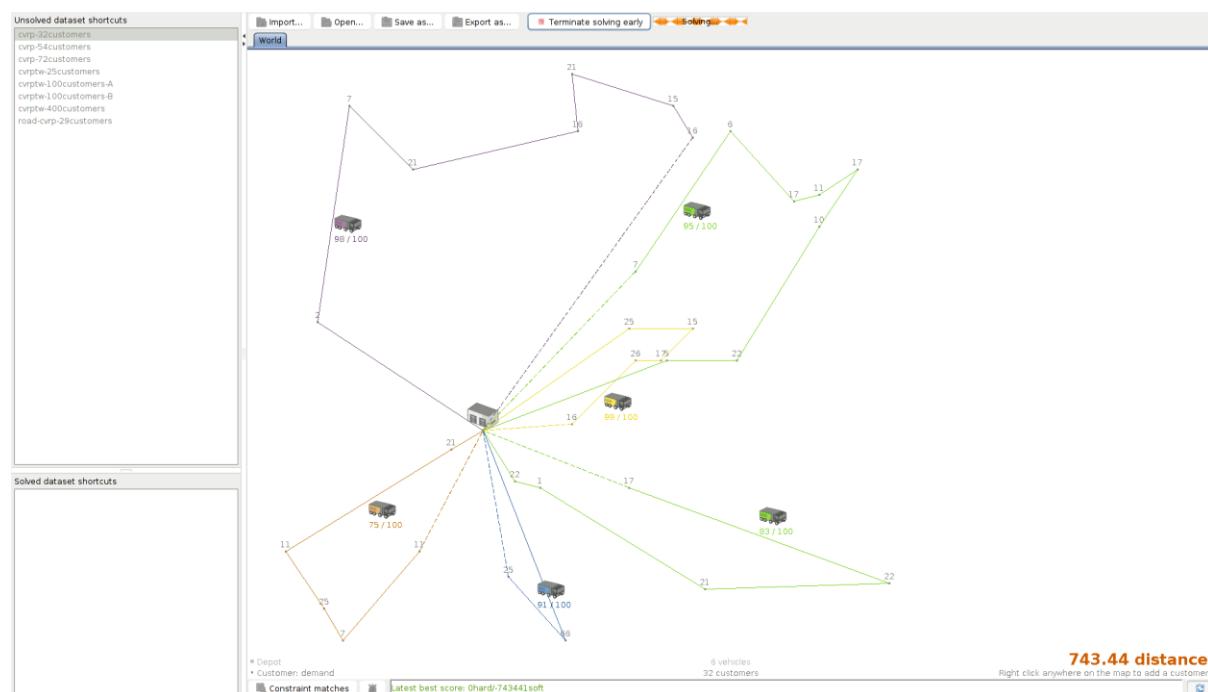


3) Start to explore Vehicle routing (VRP).

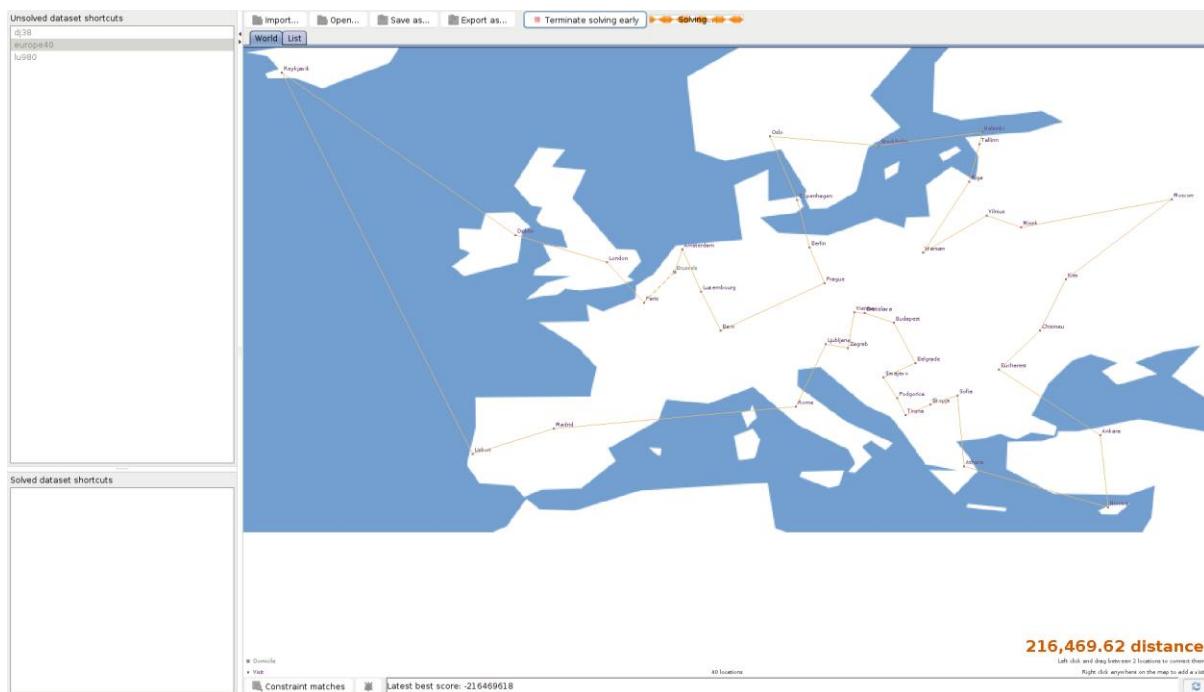
Based on below geospatial map, use pen & paper to plan the **6** trucks' route for **32** customer orders:



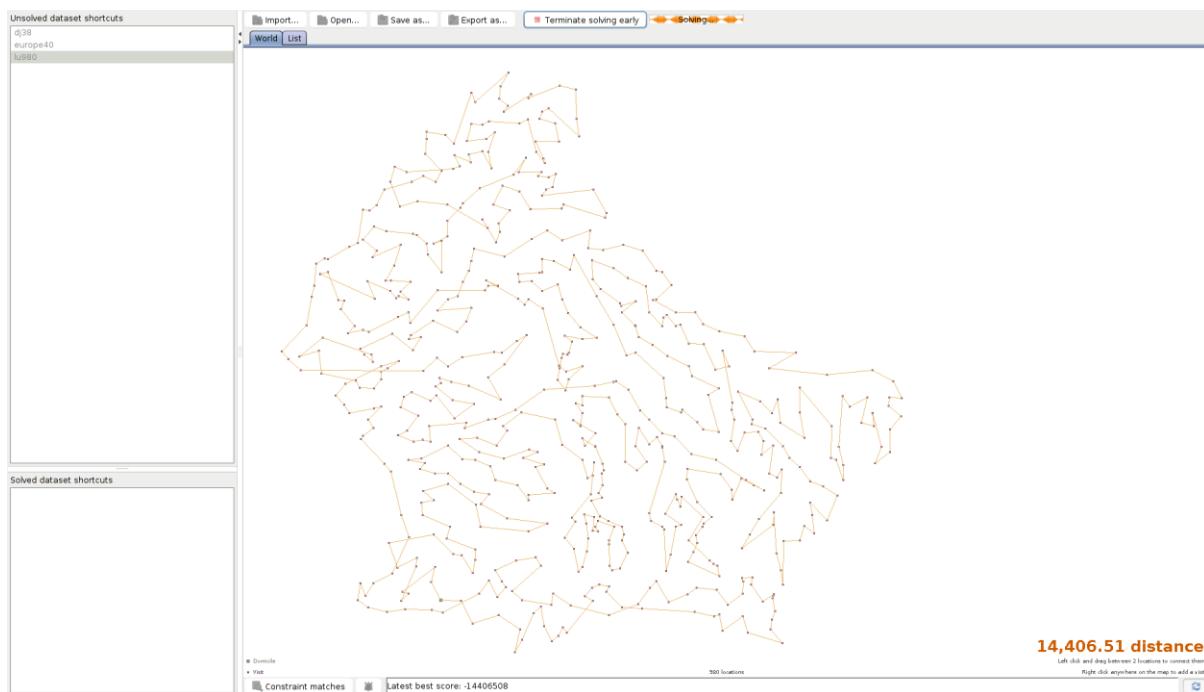
Run the OptaPlanner to view the solution, then compare with above pen & paper solution, which one could be better?



4) Start to explore Travelling salesman (TSP).



Plan a Europe round trip seems enjoyable, but what about visiting more places like below: to find a shortest travel route?



- 5) Explore other example solutions of your interest, e.g. are you inspired to design a course scheduler for NUS ISS courses/classrooms/lecturers/...?

Unsolved dataset shortcuts

```

200lectures-22periods-10rooms
400lectures-32periods-25rooms
800lectures-32periods-50rooms
comp01
comp01_initialized
comp02
comp03
comp04
comp05
comp06
comp07
comp08
comp09
comp10
comp11
comp12
comp13
comp14
toy01

```

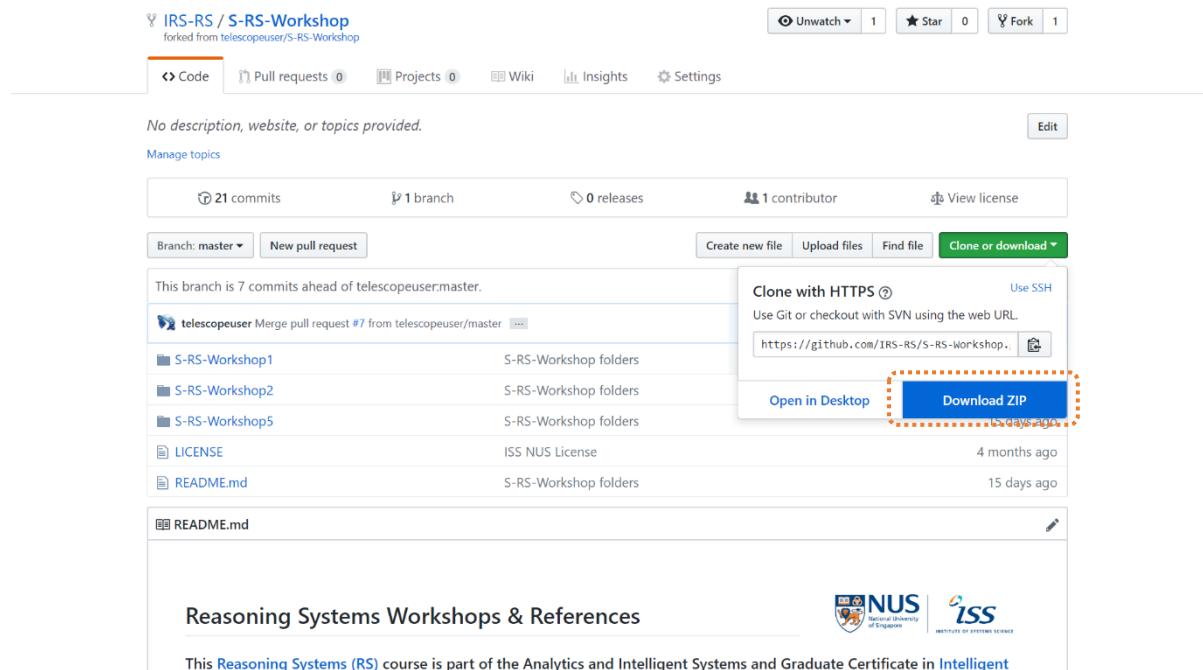
Solved dataset shortcuts

Day	Time	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	Unassigned
Mo	08:00	EnglishB-2	FrenchC-A	MusicC-5	FrenchC-6	MathC-4	Chemistry...	Geograph...	Psycholog...	ICTB-3	MathA-3	ICTA-9		
	09:00	EnglishB-3	MusicA-4	MusicC-4	FrenchC-5	MathC-4	ArtA-3	Geograph...	Psycholog...	ICTB-2	MathA-2	ICTA-2		
	10:00	EnglishB-4	MusicA-3	MusicC-3	FrenchC-4	MathC-3	ArtA-3	Geograph...	Psycholog...	ICTB-1	MathA-1			
	11:00	EnglishB-5	MusicA-2	MusicC-2	FrenchC-3	MathC-2		Geograph...	Psycholog...	ICTB-0	MathA-0	ICTA-3		
	13:00	EnglishB-6	MusicA-3	MusicC-1	FrenchC-2	MathC-1		Geograph...	Psycholog...					
	14:00		MusicB-4	MusicC-0	FrenchC-1	HistoryD-5		Geograph...	Psycholog...					
	15:00	HistoryB-5	EnglishB-1	Economic...	FrenchC-3	MathC-0								
Tu	08:00	GermanB-3	FrenchB-4	Economic...	Geograph...	PhysicsC-5			HistoryA-1					
	09:00	Chemistry...	FrenchB-2	Economic...	FrenchC-0	PhysicsC-4	BiologyB-2			HistoryA-2				
	10:00	Chemistry...	FrenchB-3	Economic...	Geograph...	PhysicsC-3			HistoryA-3					
	11:00	Chemistry...	EnglishB-0	PhysicsC-2	SpanishB-5	HistoryD-4								
	13:00	PhysicsB-5	FrenchB-4	Economic...	Geograph...	PhysicsC-1								
	14:00		MusicA-0	Economic...	Geograph...	PhysicsC-0							FrenchA-0	FrenchA-1
	15:00	HistoryB-4	GermanB-1	Economic...	HistoryC-4	MathB-2	BiologyB-1							
We	08:00	HistoryB-3	Chemistry...	PhysicsA-4		HistoryD-3	FrenchB-3							
	09:00	HistoryB-2	GermanB-3	PhysicsA-3		HistoryD-2	FrenchB-0							
	10:00	HistoryB-1	Chemistry...	PhysicsA-2		HistoryD-1	Economic...							
	11:00	HistoryB-0		PhysicsA-1		HistoryD-0	Economic...							
Th	08:00		Geograph...	SpanishC-4		Psycholog...	BiologyB-0							
	09:00		Geograph...	SpanishC-3		MathD-3								
	10:00		Geograph...	SpanishC-2		MathD-2								
	11:00		Geograph...	SpanishC-1		MathD-1								
	13:00		Geograph...	SpanishC-0		MathD-0								
	14:00		PhysicsB-4	EnglishA-2	PhysicsA-0	BiologyA-1	MusicB-3							
	15:00		PhysicsB-3	EnglishA-1	BiologyA-0	Geograph...	MathB-1							
Fr	08:00	PhysicsB-2	EnglishA-0	Geograph...	FrenchD-2	MathB-0	ArtB-2							
	09:00	GermanB-5	PhysicsB-1	Economic...	SpanishB-4	FrenchD-1	Chemistry...	SpanishA-2						
	10:00	Chemistry...	FrenchB-0	Economic...	SpanishB-3	GermanA-2	ArtB-1							
	11:00	GermanB-4	MusicB-2	HistoryC-0	SpanishB-2	GermanA-3	Chemistry...	SpanishA-1						
	13:00	GermanB-3	PhysicsB-0	HistoryC-1	SpanishB-1	ArtB-0	MusicB-1	Chemistry...						
	14:00	Chemistry...	MusicB-0	HistoryC-2	SpanishB-0	GermanA-3	Chemistry...	SpanishA-0	Chemistry...					
	15:00	GermanB-2	Chemistry...	FrenchB-2	HistoryC-3	GermanA-0	Geograph...							
	Unassigned													

Constraint matches latest best score: -4hard/-18soft

1.2.2. OptaPlanner Example Solutions in Integrated Develop Environment

- 1) Download workshop materials from Github
<https://github.com/telescopeuser/S-RS-Workshop>



The screenshot shows the GitHub repository page for 'IRS-RS / S-RS-Workshop'. The repository was forked from 'telescopeuser/S-RS-Workshop'. It has 21 commits, 1 branch, 0 releases, and 1 contributor. The 'Clone or download' button is highlighted with a red box.

No description, website, or topics provided.

Manage topics

Branch: master | **New pull request** | **Create new file** | **Upload files** | **Find file** | **Clone or download**

This branch is 7 commits ahead of telescopeuser:master.

telescopeuser Merge pull request #7 from telescopeuser/master ...

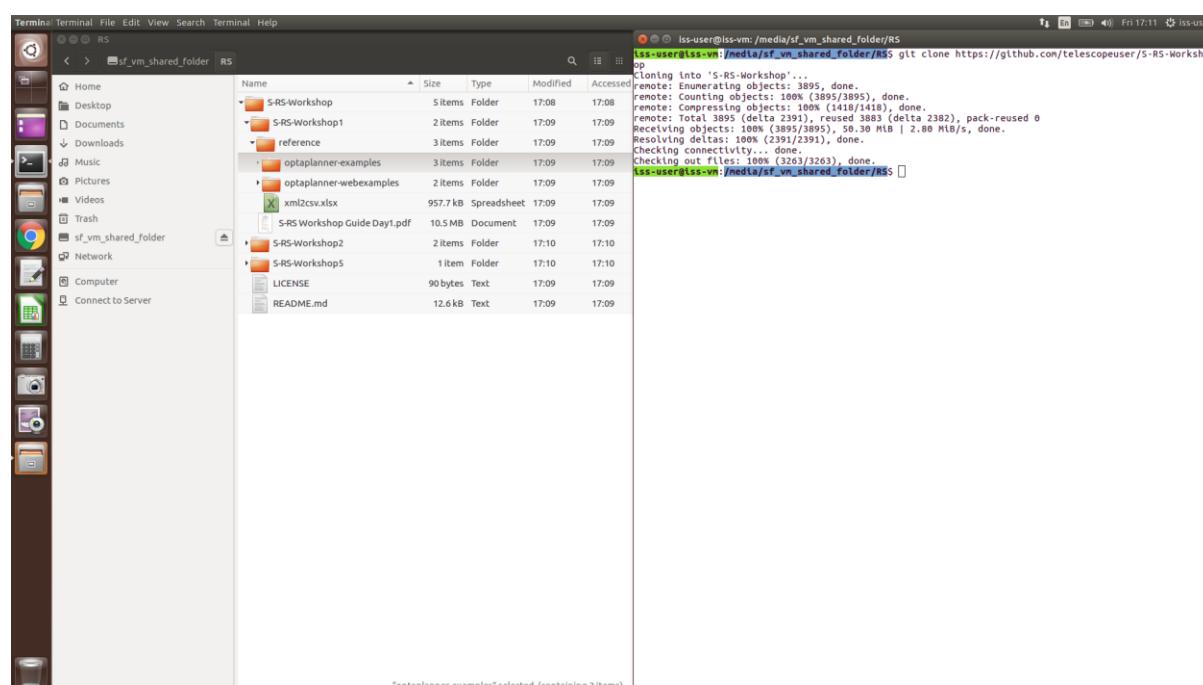
S-RS-Workshop1	S-RS-Workshop folders
S-RS-Workshop2	S-RS-Workshop folders
S-RS-Workshop5	S-RS-Workshop folders
LICENSE	ISS NUS License
README.md	S-RS-Workshop folders

README.md

Reasoning Systems Workshops & References

NUS | ISS

This Reasoning Systems (RS) course is part of the Analytics and Intelligent Systems and Graduate Certificate in Intelligent



The screenshot shows a Linux desktop environment with a terminal window and a file manager window. The terminal window shows the command 'git clone https://github.com/telescopeuser/S-RS-Workshop' being run, and the file manager window shows the cloned repository structure in the 'sf_vm_shared_folder/RS' directory.

Terminal

```
lss-user@lss-vm: /media/sf_vm_shared_folder/RS
lss-user@lss-vm: /media/sf_vm_shared_folder/RS$ git clone https://github.com/telescopeuser/S-RS-Workshop
Cloning into 'S-RS-Workshop'...
remote: Enumerating objects: 3895, done.
remote: Counting objects: 100% (3895/3895), done.
remote: Compressing objects: 100% (1897/1897), done.
remote: Writing objects: 100% (3895/3895), 50.30 MB | 2.80 MB/s, done.
Receiving objects: 100% (3895/3895), 50.30 MB | 2.80 MB/s, done.
Resolving deltas: 100% (2391/2391), done.
Checking connectivity... done.
lss-user@lss-vm: /media/sf_vm_shared_folder/RS$
```

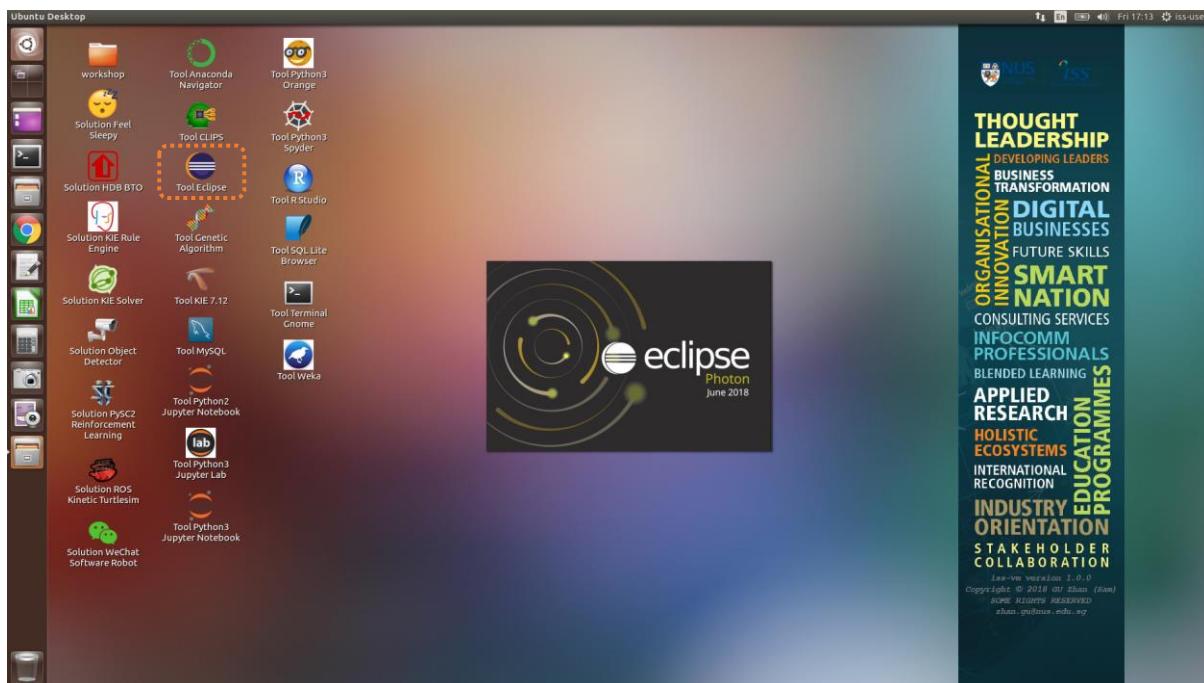
File Manager

The file manager shows the contents of the 'optaplanner-examples' folder:

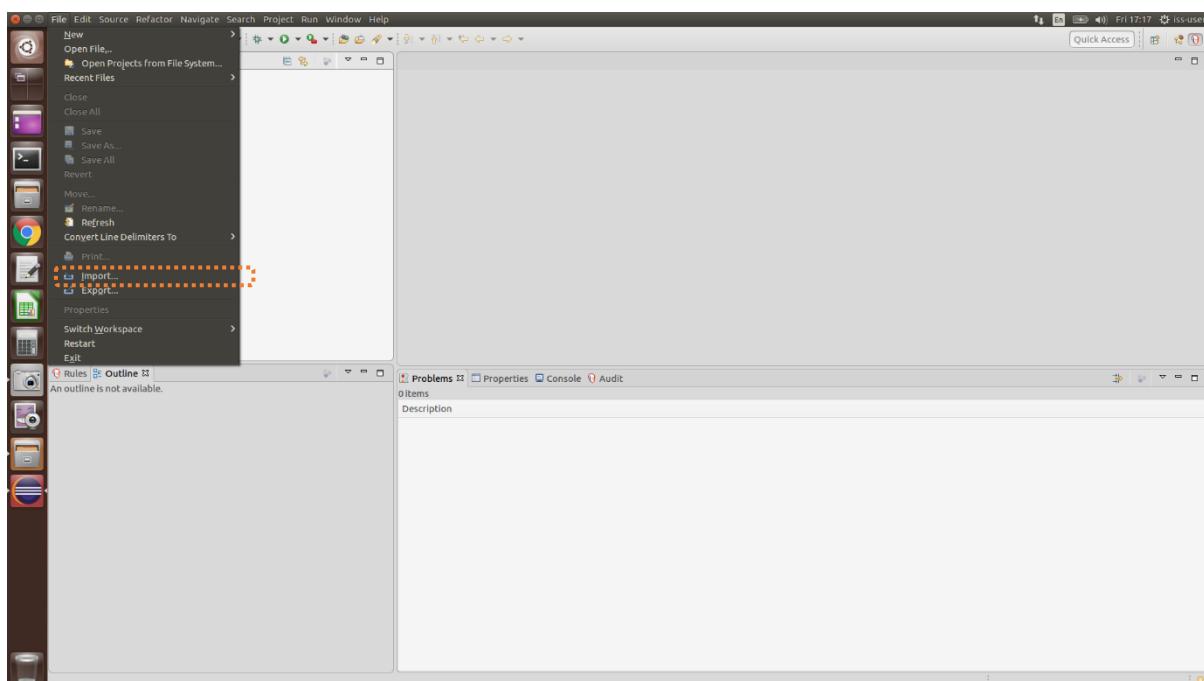
- xml2csv.xlsx
- S-RS Workshop Guide Day1.pdf
- S-RS-Workshop2
- S-RS-Workshop5
- LICENSE
- README.md

"optaplanner-examples" selected (containing 3 items)

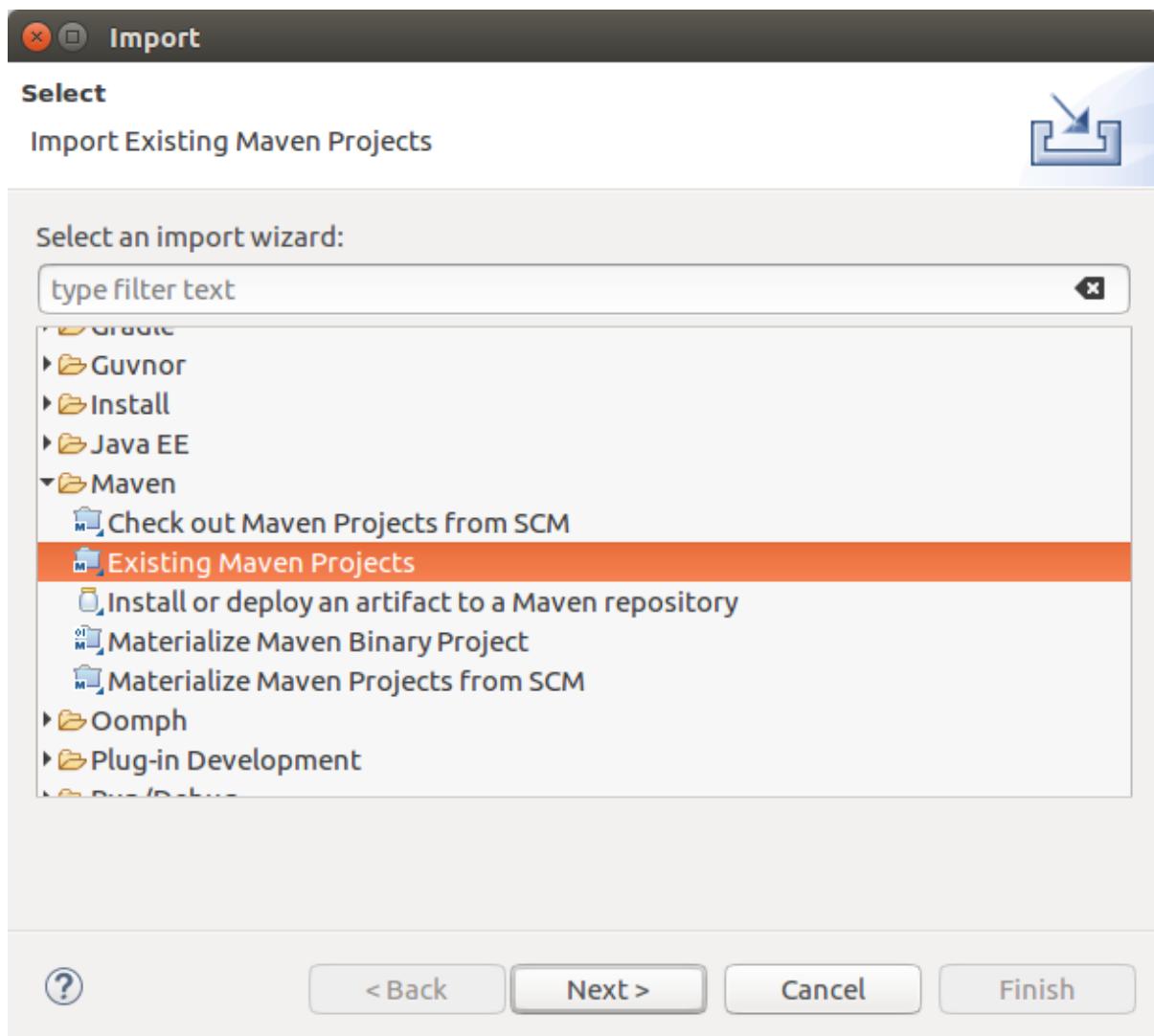
2) From desktop, Start Tool Eclipse.



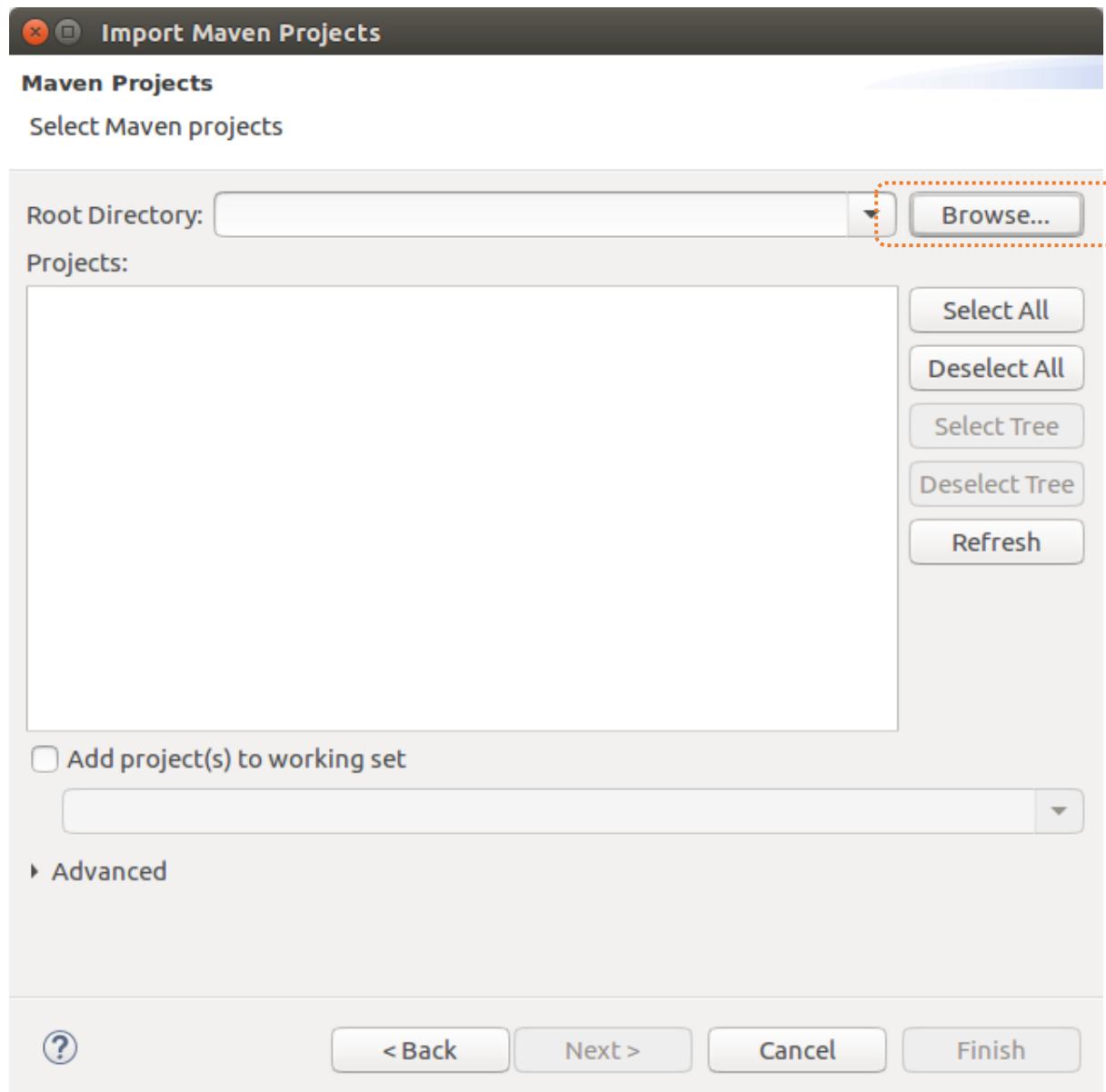
3) Select Import...



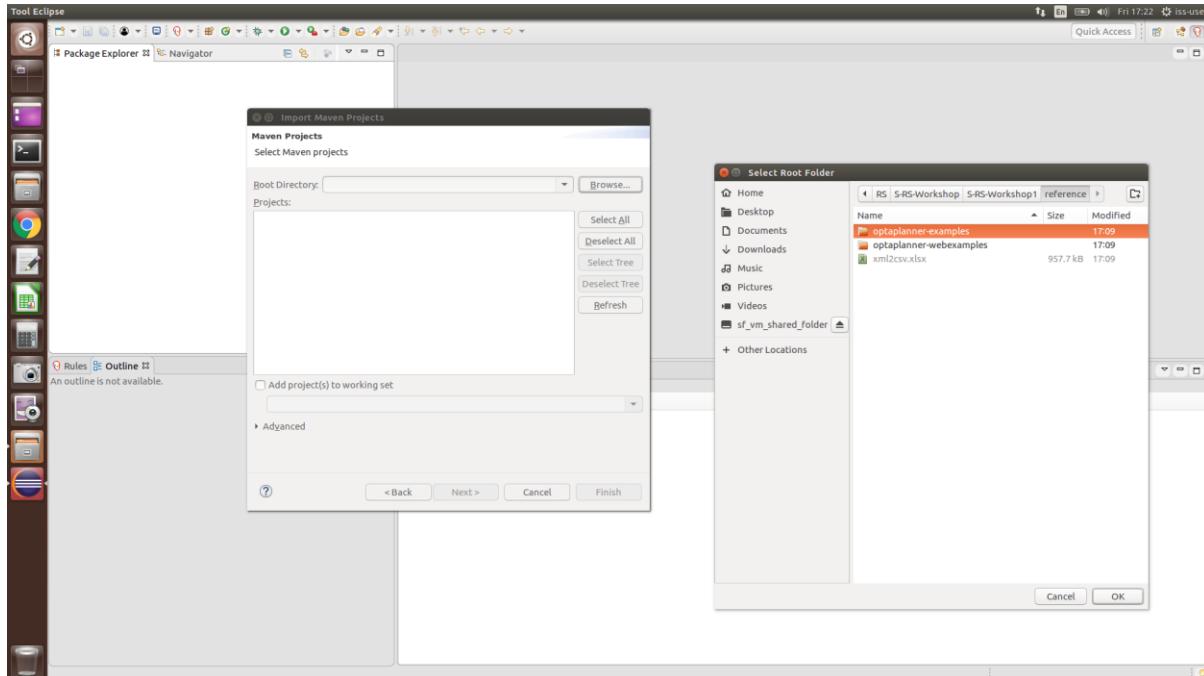
4) Select **Existing Maven Projects**; Click **Next**



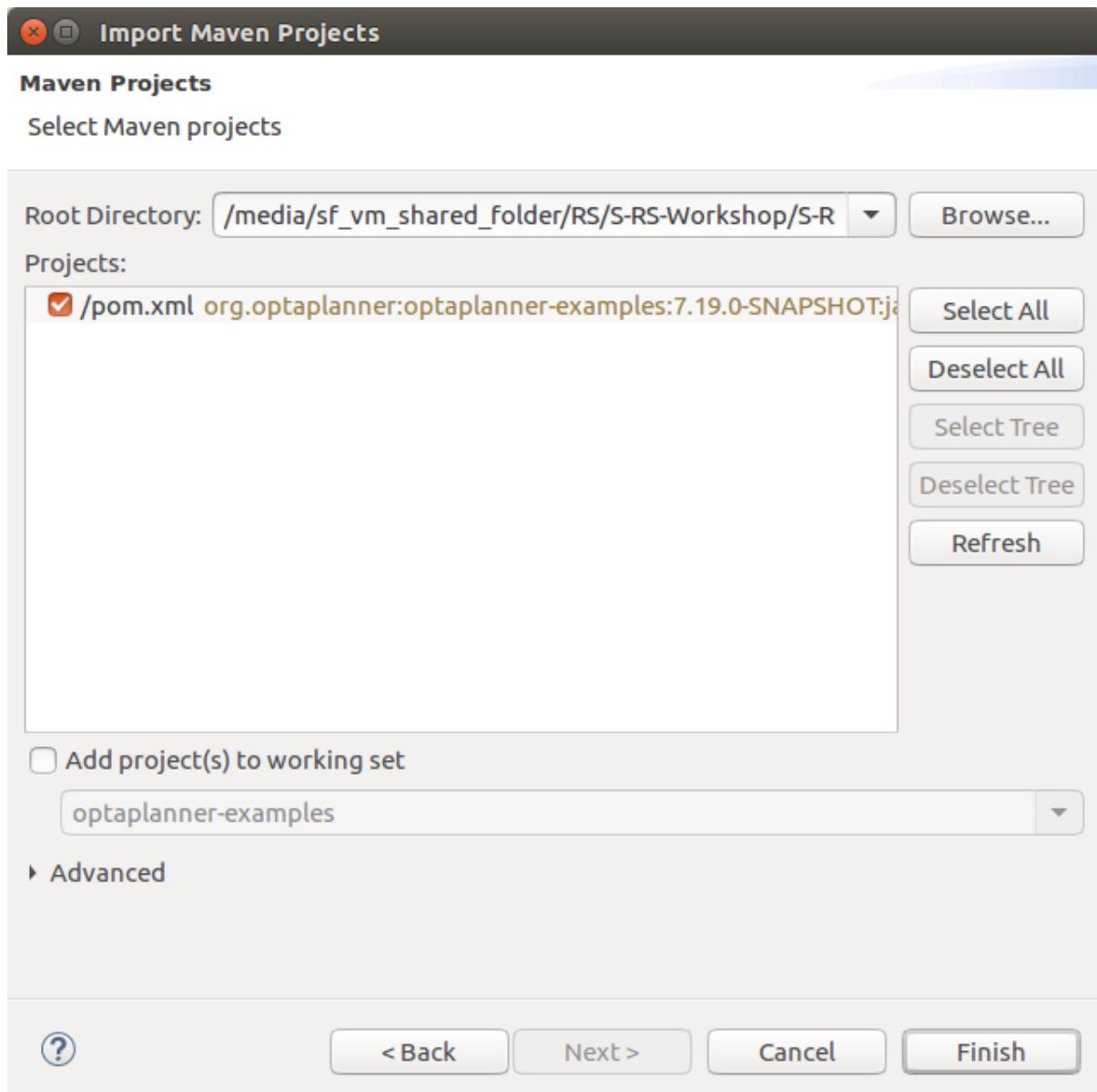
5) Click **Browse...**



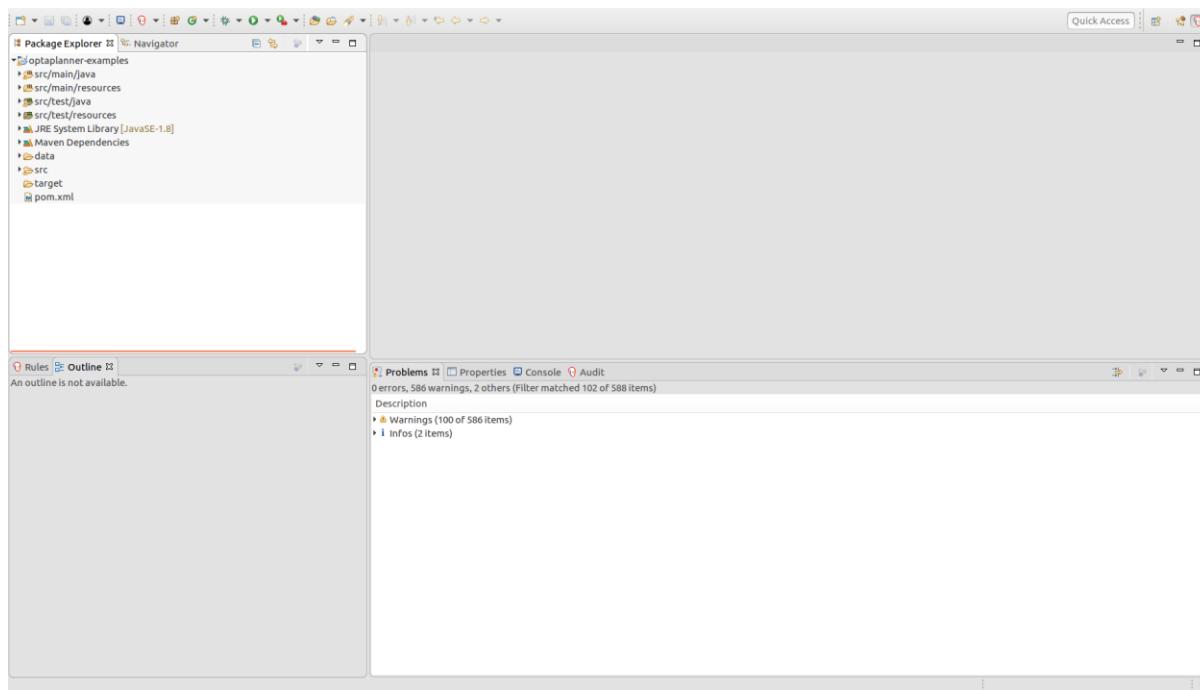
- 6) Browse to locate the **optaplanner-examples** sub-folder from downloaded workshop materials in local computer; Click **OK**
- .../S-RS-Workshop/S-RS-Workshop1/reference/optaplanner-examples**



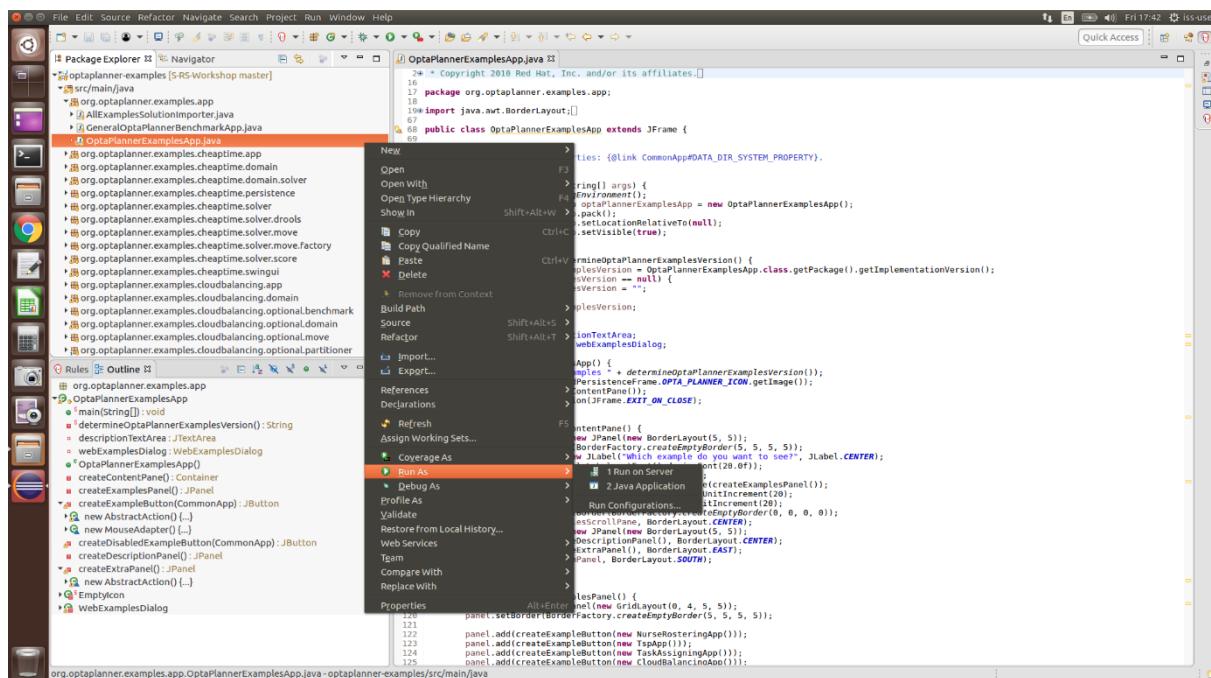
7) Click **Finish**.

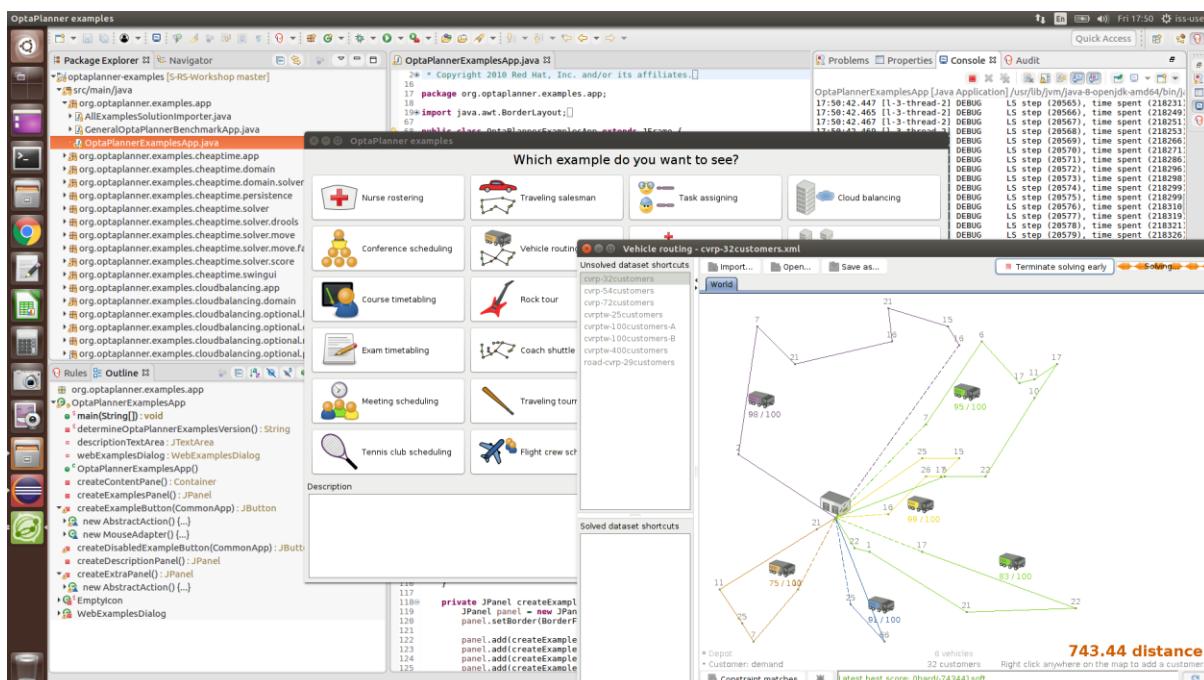
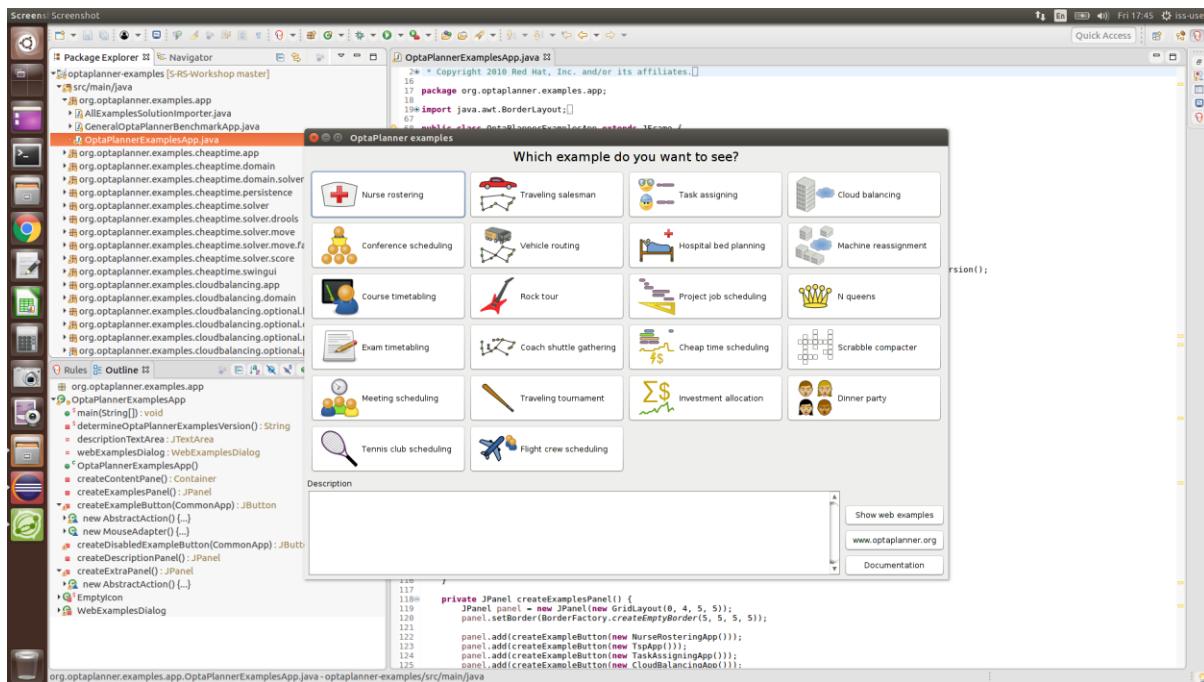


8) Wait for the completion of import;



9) Expand project to **OptaPlannerExampleApp.java**; right click mouse to call menu; Select Run As : 2 Java Application;





Now both **GUI binary version** and **Java source code version** have been running successfully! Thus further enhancements can be made in source code to build customized solutions for business resource optimization.

Congratulations!

You have completed today's challenging workshop!

2. ANNEX

2.1. ANNEX 1 – Workshop Project Candidate

2.1.1. Workshop Project Candidate One

Hybrid Airport Gate Assignment System (HAGAS)

The Airport Gate Assignment Problem: Scheduling Algorithms and Simulation Approach

Ahmed Thanyan AL-Sultan

The rapid development of airlines has made airports busier and more complicated. The assignment of schedule to available gates is a major issue for daily airline operations. We consider the over-constrained airport gate assignment problem (AGAP) where the number of flights exceeds the number of available gates, and where the objectives are to minimize the number of ungated flights and the total walking distance or connection times. The procedures used in this project are to create a mathematical model formulation to identify decision variables to identify, constraints and objective functions. In addition, we will consider in the AGAP the size of each gate in the terminal and also the towing process for the aircraft. We will use a greedy algorithm and a Tabu search meta-heuristic to solve the problem and compare it with other scheduling methods. Actual and forecasted data will be simulated in the experiment. The greedy algorithm minimizes ungated flights while providing initial feasible solutions that allow flexibility in seeking good solutions, especially in case when flight schedules are dense in time. Experiments conduct give good results. The distance a passenger has to walk in any airport to reach various key areas, including departure gates, baggage belts and connecting flights provide for an important performance measure for the quality of any airport. While certain walking distances are fixed, others are dynamic. In particular, the distances traversed by passengers from check-in counters to gates and from gate to gate, in the case of transfer or connecting passengers, change according to how scheduled flights are assigned to gates. This allows for the ground handling agents and airlines, together with airport authorities, to dynamically assign airport gates to scheduled flights so as to minimize walking distances while, consequently, minimizing connection times. Which flight to gate assignment policy to be used so as to achieve such minimum times can be derived at the start of such planning day based on published flights schedules and booked passenger loads. The airport gate assignment problem (AGAP) seeks to find

feasible flight to gate assignments so that total passenger connection times and walking distances is minimized. Distances that are taken into account are those from check-in to gates in the case of embarking or originating passengers, from gates to baggage claim areas (check-out) in the case of disembarking or destination passengers and from gate to gate in the case of transfer or connecting passengers. In the over-constrained case, where the number of aircraft exceeds the number of available gates, we include the distance from the apron or tarmac area to the terminal for aircraft assigned to these areas.

...

Reference

The Airport Gate Assignment Problem: Scheduling Algorithms and Simulation Approach, Ahmed Thanyan AL-Sultan, Graduate School of environmental science, March 2012

http://ousar.lib.okayama-u.ac.jp/files/public/4/48534/20160528091554614463/K0004584_honbun.pdf

2.1.2. Workshop Project Candidate Two

OptaPlanner Application Implementation in KIE Workbench & Server

Objective:

Construct a useful business reasoning system using KIE product suite, incorporating an OptaPlanner solver as an embedded optimization engine/task for automated machine reasoning.

Choose one OptaPlanner example application from below **ONLY**:

- Cloud balancing
- Course timetabling
- Vehicle routing with time windows
- Project job scheduling
- Exam timetabling
- Nurse rostering
- Cheap time scheduling
- Flight crew scheduling

System Requirements:

- Make use of KIE BRMS (Drools) & BPMS (jBPM) capability;
- Define at least one practical business enhancement/requirement based on OptaPlanner example;
- Convert/migrate original Maven/Eclipse OptaPlanner project with enhancements into KIE (jBPM) Workbench project;
- Develop an extensive (web-based) User Interface; Enable configuration of business parameters, e.g. number of cloud computers, number of CPUs per computer, etc.
- Use Restful API between User Interface and KIE Server;
- Deploy the developed system onto KIE Server for use;

2.2. ANNEX 2 – Project Code Export & Import Using KIE Workbench

Example: export KIE project **Mortgage_Process_ISS_MR** from work space **MySpace**

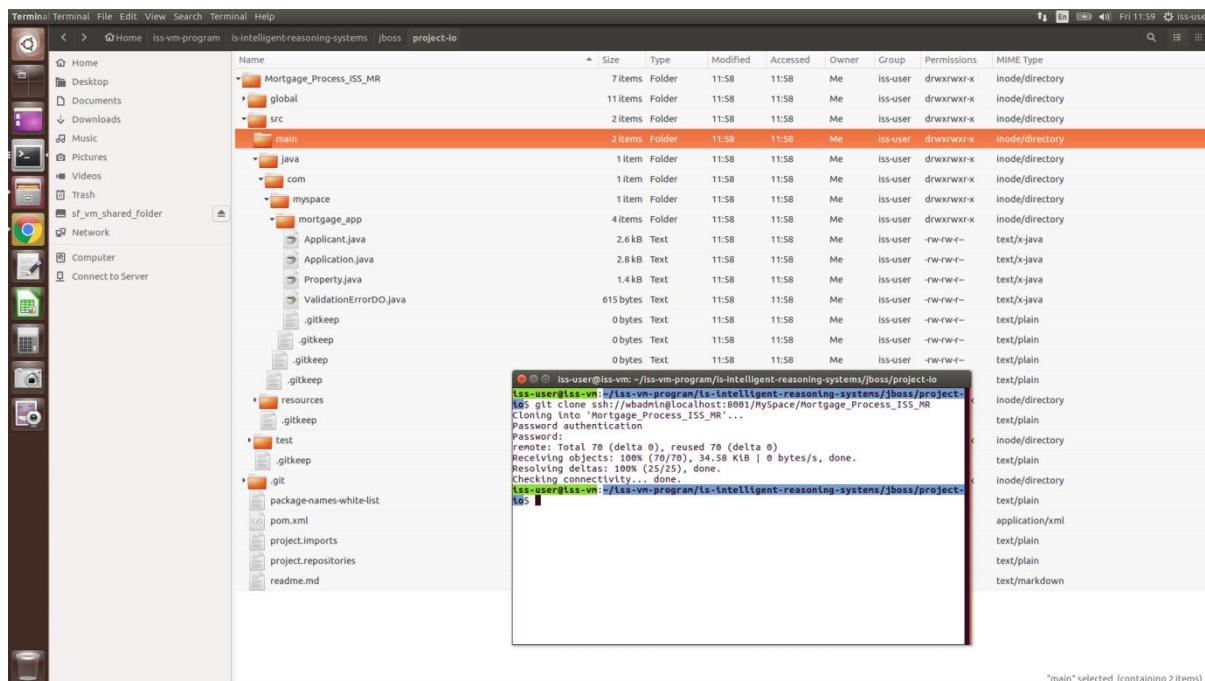
Review project settings to obtain project URL link

The screenshot shows the KIE Workbench interface with the following details:

- Header:** Shows the KIE IDE logo, a yellow circle with 'KIE' and 'IDE' inside, and a 'Menu' dropdown.
- Breadcrumbs:** Spaces > MySpace > Mortgage_Process_ISS_MR > master
- User:** iss-admin
- Buttons:** Build, Deploy, View Alerts, and a refresh icon.
- Left Sidebar:** Assets (18), Contributors (11), Metrics, and Settings (selected). Other options include Dependencies, KIE bases, External Data Objects, Validation, Deployments, and Persistence.
- General Settings:** Sub-section of Settings. Fields include:
 - Name:** Mortgage_Process_ISS_MR
 - Description:** Getting started loan approval process in BPMN2, decision table, business rules, and forms.
 - URL:** ssh v su/localhost:8001/MySpace/Mortgage_Process_ISS_MR
 - Disable GAV conflict check
 - Allow child GAV edition
 - Group ID:** mortgage-process
 - Example: com.myspace.myprojects
 - Artifact ID:** Mortgage_Process_ISS_MR
 - Example: MyProject
 - Version:** 1.0.0-SNAPSHOT
 - Example: 1.0.0
- Buttons:** Save and Reset.

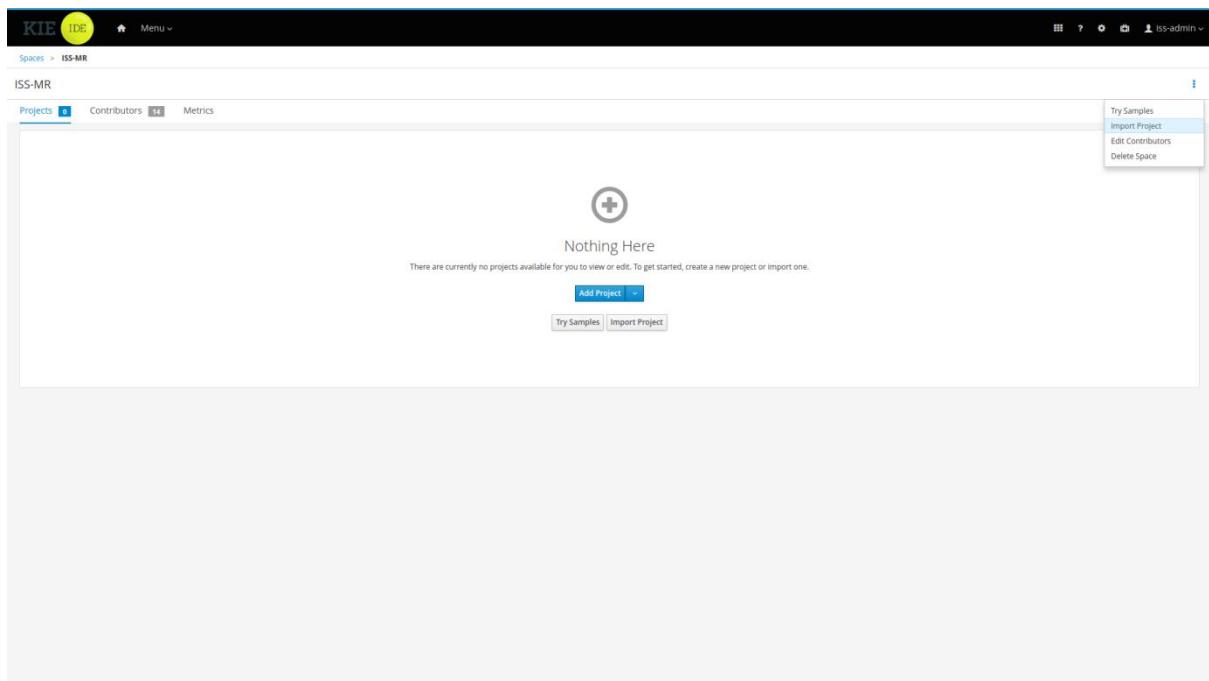
2.2.1. Export project from KIE Workbench

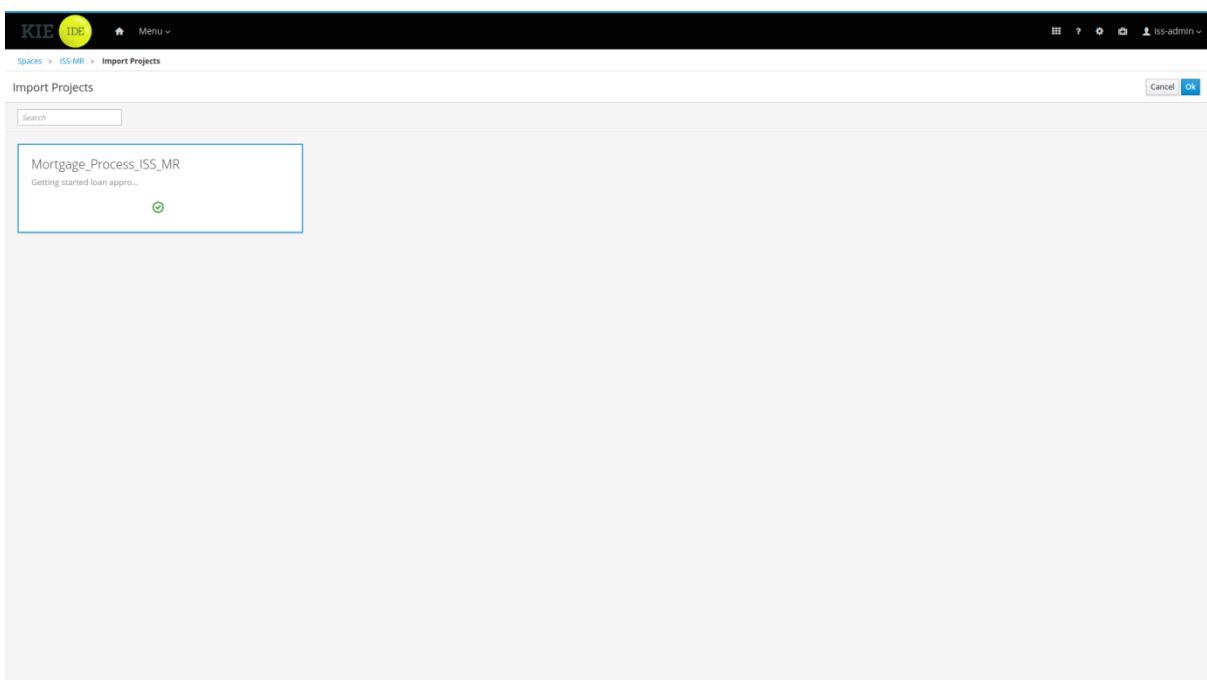
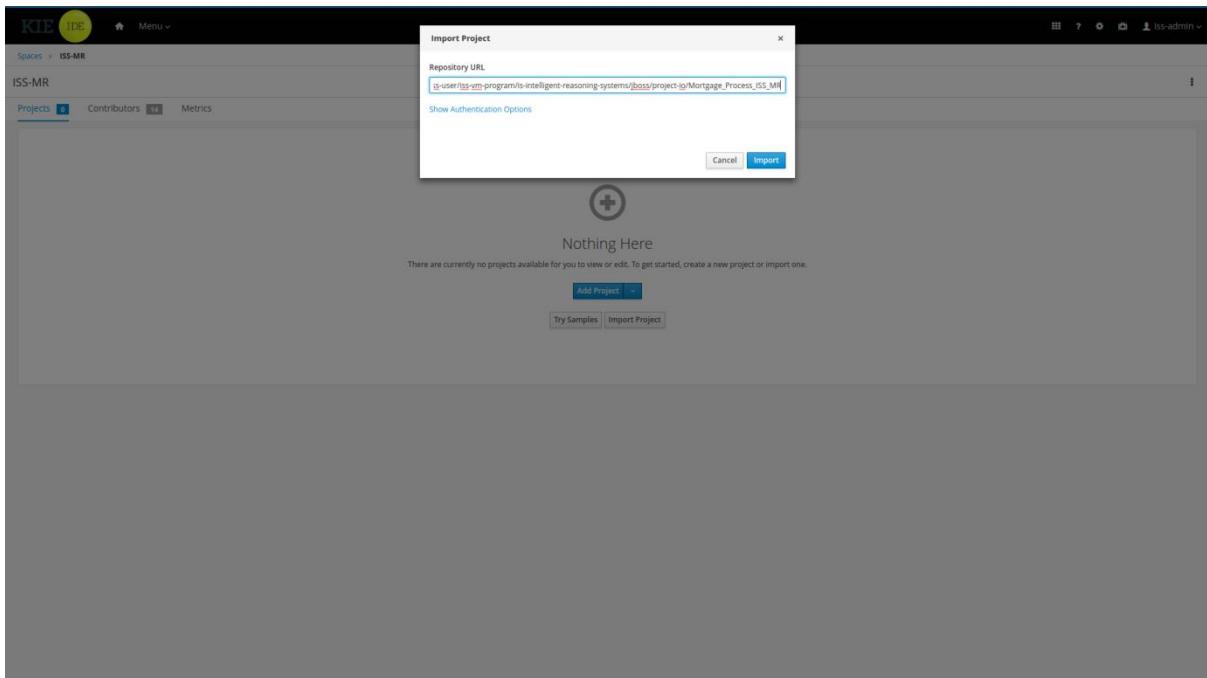
- 1) Select a folder for exporting, example here uses **/home/iss-user/iss-vm-program/is-intelligent-reasoning-systems/jboss/project-io**
- 2) Start a Terminal there, key in command **git clone ssh://wbadmin@localhost:8001/MySpace/Mortgage_Process_ISS_MR**
- 3) Key in password '**wbadmin**' for user wbadmin

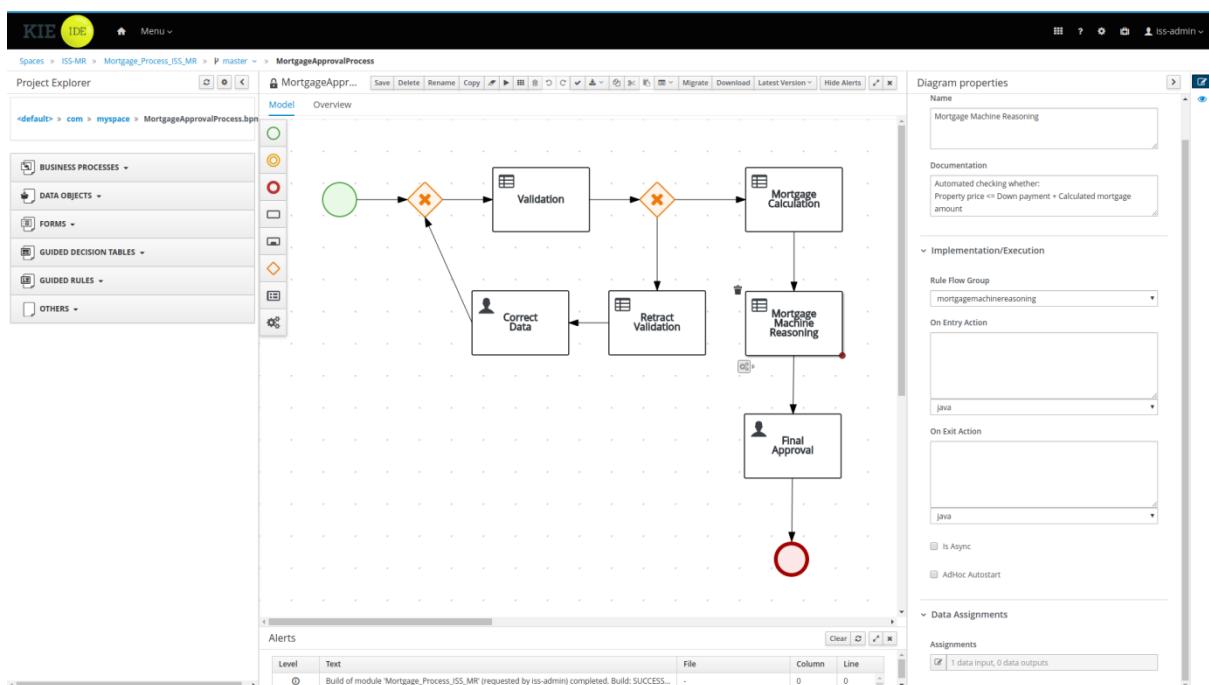
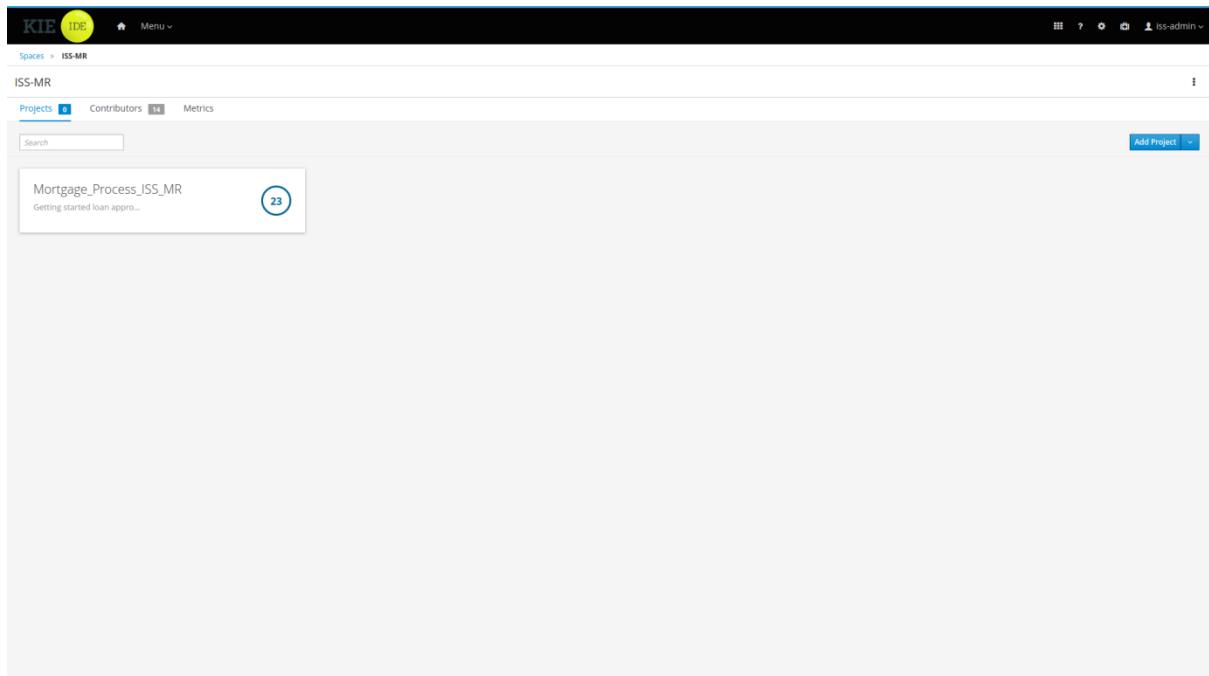


2.2.2. Import project into KIE Workbench

- 1) In KIE workbench, select/create a project Space, example here uses **ISS-MR**
- 2) Click menu function '**Import Project**'
- 3) For Repository URL, key in **file:///home/iss-user/iss-vm-program/is-intelligent-reasoning-systems/jboss/project-io/Mortgage_Process_ISS_MR**







Reference

<https://developer.jboss.org/thread/269991>

<https://developer.jboss.org/thread/237411>

<https://developer.jboss.org/thread/252588>

2.3. ANNEX 3 – Workshop Project Submission

- 1) Create Github repository for project submission;
- 2) Download Github repository as a ZIP file, then upload to NUS LumiNUS;

Reference

<https://github.com/IRS-PM/Workshop-Project-Submission-Template>

IRS-PM / Workshop-Project-Submission-Template
forked from telescopeuser/Workshop-Project-Submission-Template

Code Pull requests 0 Projects 0 Insights

No description, website, or topics provided.

13 commits 1 branch 0 releases 1 contributor

Branch: master New pull request

This branch is 1 commit ahead of telescopeuser:master.

telescopeuser Merge pull request #1 from telescopeuser/master ...

File	Type	Last Commit
Miscellaneous	Initial	43 days ago
ProjectReport	Initial	23 days ago
SystemCode/clips	Initial	23 days ago
UserGuide	Initial	9 days ago
README.md	updated readme	9 days ago

Clone with HTTPS
Use Git or checkout with SVN using the web URL.
<https://github.com/IRS-PM/Workshop-Proje>

Find file Clone or download

Open in Desktop Download ZIP

{ Tips } Workshop Project Submission Template: Github Repository & Zip File

[Naming Convention] CourseCode-StartDate-BatchCode-Group_or_Individual-TeamName_or_PersonName-ProjectName.zip

- [MTech Group Project Naming Example] IRS-MR-2019-01-19-IS1PT-GRP-AwsomeSG-HDB_BTO_Recommender.zip
- [MTech Individual Project Naming Example] IRS-MR-2019-07-01-IS1FT-IND-SamGuZhan-HDB_BTO_Process.zip
- [EEP Group Project Naming Example] IRS-MR-2019-03-13-EEP-GRP-AwsomeSG-HDB_BTO_Recommender.zip
- [EEP Individual Project Naming Example] IRS-MR-2019-08-22-EEP-IND-SamGuZhan-HDB_BTO_Process.zip

2.4. ANNEX 4 – KIE OptaPlanner Examples

Which example do you want to see?

 Nurse rostering	 Traveling salesman	 Task assigning	 Cloud balancing
 Conference scheduling	 Vehicle routing	 Hospital bed planning	 Machine reassignment
 Course timetabling	 Rock tour	 Project job scheduling	 N queens
 Exam timetabling	 Coach shuttle gathering	 Cheap time scheduling	 Scrabble compacter
 Meeting scheduling	 Traveling tournament	 Investment allocation	 Dinner party
 Tennis club scheduling	 Flight crew scheduling		

Description
Assign processes to computers.
Each computer must have enough hardware to run all of its processes.
Each used computer inflicts a maintenance cost.

[Show web examples](#)
www.optaplanner.org
[Documentation](#)

Reference

https://docs.optaplanner.org/latest/optaplanner-docs/html_single/index.html#useCasesAndExamples

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Dinner Party



- **Business Scenario / Problem Description**

- **Miss Manners is throwing another dinner party.**

- This time she invited 144 guests and prepared 12 round tables with 12 seats each.
- Every guest should sit next to someone (left and right) of the opposite gender.
- And that neighbour should have at least one hobby in common with the guest.
- At every table, there should be two politicians, two doctors, two socialites, two coaches, two teachers and two programmers.
- And the two politicians, two doctors, two coaches and two programmers should not be the same kind at a table.

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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram



Unsolved dataset shortcuts: `wedding01`

Solved dataset shortcuts: `wedding1-score20`

Table 0

Zachary	Developer	C	Sophia	Politician	Democrat	Leah	Teacher	English	Matthew	Doctor	Orthopath
Developer	C	Lightbulb	Politician	Democrat	Lightbulb	Teacher	English	Doctor	Orthopath	Developer	Lightbulb
Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb

Table 1

Isabelle	Coach	Football	Emma	Politician	Democrat	Eli	Teacher	Math	Madelyn	Doctor	Pediatrician
Coach	Football	Lightbulb	Politician	Democrat	Lightbulb	Teacher	Math	Doctor	Pediatrician	Developer	Lightbulb
Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Developer	Lightbulb

Table 2

Andrew	Teacher	Math	Ava	Politician	Democrat	Kennedy	Socialite	Republican	Evelyn	Coach	Football
Teacher	Math	Lightbulb	Politician	Democrat	Lightbulb	Socialite	Republican	Coach	Football	Developer	Lightbulb
Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Developer	Lightbulb

Table 4

Caleb	Doctor	Surgeon	Samantha	Socialite	Republican	Brooklyn	Coach	Football	Mia	Politician	Democrat
Doctor	Surgeon	Lightbulb	Socialite	Republican	Lightbulb	Coach	Football	Lightbulb	Politician	Democrat	Lightbulb
Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Developer	Lightbulb

Table 5

Ryan	Doctor	Surgeon	Ella	Doctor	Pediatrician	Grayson	Teacher	Math	Madison	Politician	Republican
Doctor	Surgeon	Lightbulb	Doctor	Pediatrician	Lightbulb	Teacher	Math	Lightbulb	Politician	Republican	Lightbulb
Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Developer	Lightbulb

Table 6

Nicholas	Coach	Baseball	Maria	Developer	Perl	Annabelle	Developer	Java	Jackson	Socialite	Democrat
Coach	Baseball	Lightbulb	Developer	Perl	Lightbulb	Developer	Java	Lightbulb	Socialite	Democrat	Lightbulb
Lightbulb	Developer	Lightbulb									

Table 8

Caleb	Developer	C	Samantha	Socialite	Republican	Brooklyn	Coach	Football	Mia	Politician	Democrat
Developer	C	Lightbulb	Socialite	Republican	Lightbulb	Coach	Football	Lightbulb	Politician	Democrat	Lightbulb
Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Developer	Lightbulb

Table 9

Ryan	Doctor	Surgeon	Ella	Doctor	Pediatrician	Grayson	Teacher	Math	Madison	Politician	Republican
Doctor	Surgeon	Lightbulb	Doctor	Pediatrician	Lightbulb	Teacher	Math	Lightbulb	Politician	Republican	Lightbulb
Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Lightbulb	Developer	Lightbulb

Table 10

Nicholas	Coach	Baseball	Maria	Developer	Perl	Annabelle	Developer	Java	Jackson	Socialite	Democrat
Coach	Baseball	Lightbulb	Developer	Perl	Lightbulb	Developer	Java	Lightbulb	Socialite	Democrat	Lightbulb
Lightbulb	Developer	Lightbulb									

Package Explorer Navigator

```

1 * Copyright 2010 Red Hat, Inc. and/or its affiliates.
16 package org.optaplanner.examples.dinnerparty.domain;
17 import com.thoughtworks.xstream.annotations.XStreamAlias;
24 @PlanningEntity
26 @XStreamAlias("SeatDesignation")
27 public class SeatDesignation extends AbstractPersistable implements Labeled {
28     private Guest guest;
29     private Seat seat;
30     public Guest getGuest() {
31         return guest;
32     }
33     public void setGuest(Guest guest) {
34         this.guest = guest;
35     }
36     @PlanningVariable(valueRangeProviderRefs = {"seatRange"})
37     public Seat getSeat() {
38         return seat;
39     }
40     public void setSeat(Seat seat) {
41         this.seat = seat;
42     }
43     // **** Complex methods ****
44     // **** Complex methods ****
45     public String getGuestName() {
46         return getGuest().getNome();
47     }
48     public Gender getGuestGender() {
49         return getGuest().getGender();
50     }
51     public Job getGuestJob() {
52         return getGuest().getJob();
53     }
54     public JobType getGuestJobType() {
55         return getGuest().getJobType();
56     }
57     public boolean differentKindNeeded(Job otherGuestJob) {
58         JobType jobType = getGuest().getJobType();
59         return jobType == JobType.SOCIALITE || jobType == JobType.TEACHER || guest.getJob() != otherGuestJob;
60     }
61     public Table getSeatTable() {
62         if (seat == null) {
63             return null;
64         }
65         return seat.getTable();
66     }
67     public boolean isRightOf(SeatDesignation leftSeatDesignation) {
68         if (seat == null || leftSeatDesignation.seat == null) {
69             return false;
70         }
71         return seat.getTable() == leftSeatDesignation.seat.getTable();
72     }
73     public boolean isLeftOf(SeatDesignation rightSeatDesignation) {
74         if (seat == null || rightSeatDesignation.seat == null) {
75             return false;
76         }
77         return rightSeatDesignation.seat.getTable() == seat.getTable();
78     }
79 }
80 
```

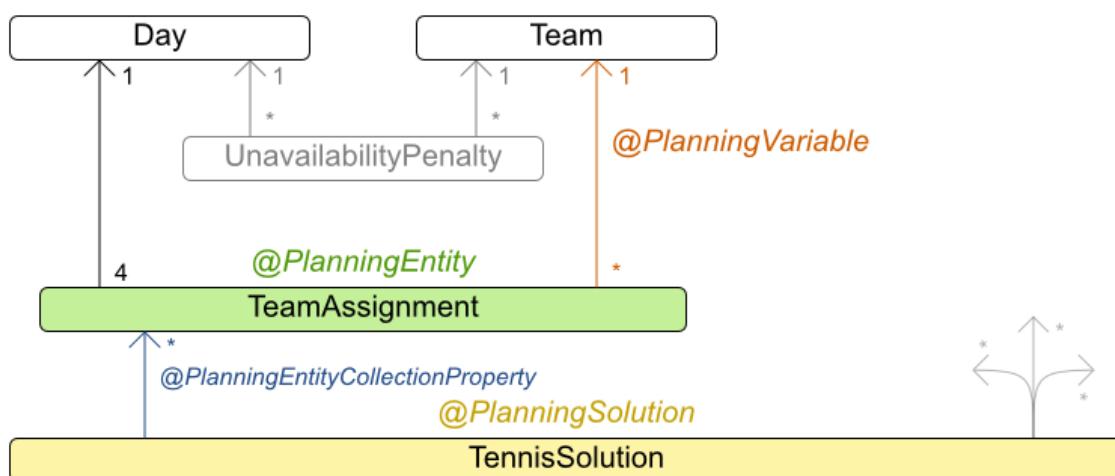
Writable Smart Insert 2:1

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Tennis Club Scheduling

- **Business Scenario / Problem Description**
- Every week the tennis club has four teams playing round robin against each other. Assign those four spots to the teams fairly.
- **Hard constraints:**
 - Conflict: A team can only play once per day.
 - Unavailability: Some teams are unavailable on some dates.
- **Medium constraints:**
 - Fair assignment: All teams should play an (almost) equal number of times.
- **Soft constraints:**
 - Evenly confrontation: Each team should play against every other team an equal number of times.

Tennis class diagram



Unsolved dataset shortcuts

minich-Teams

Team	day 0	day 1	day 2	day 3	day 4	day 5	day 6	day 7	day 8	day 9	day 10	day 11	day 12	day 13	day 14	day 15	day 16	day 17	Day count
Micha	Play	Play		Play	Play		Play		Play	Play		Play	Play	Play	Play	Play	Play	11 days	
Angelika	Play	Play		Play	Play		Play		Play	Play		Play	Play	Play	Play	Play	Play	10 days	
Katrin	Play		Play	Play		Play		Play	Play		Play	11 days							
Susi	Play		Play		Play	Play		Play	Play		Play	10 days							
Irene		Play	Play		Play	Play		Play	Play		Play	10 days							
Kristina		Play	Play	Play		Play		Play		Play	Play	Play	Play	Play	Play	Play	Play	10 days	
Tobias		Play	Play	Play	Play		Play		Play	Play	Play	Play	Play	Play	Play	Play	Play	10 days	
Unassigned																			

Solved dataset shortcuts

Constraint matches

latest best score: Ohard/27239medium/23706soft

Unsolved dataset shortcuts

minich-Teams

	Micha	Angelika	Katrin	Susi	Irene	Kristina	Tobias
Micha	6	6	5	5	5	5	5
Angelika	6	5	5	4	5	5	5
Katrin	6	5	6	6	5	5	5
Susi	5	5	6	4	5	5	5
Irene	6	5	5	4	5	5	5
Kristina	5	4	6	5	5	5	5
Tobias	5	5	5	5	5	5	5

Solved dataset shortcuts

Constraint matches

latest best score: Ohard/27238medium/23706soft

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Meeting Scheduling



- Business Scenario / Problem Description
- Assign each meeting to a starting time and a room. Meetings have different durations.
- Hard constraints:
 - Room conflict: two meetings must not use the same room at the same time.
 - Required attendance: A person cannot have two required meetings at the same time.
 - Required room capacity: A meeting must not be in a room that doesn't fit all of the meeting's attendees.
 - Start and end on same day: A meeting shouldn't be scheduled over multiple days.
- Medium constraints:
 - Preferred attendance: A person cannot have two preferred meetings at the same time, nor a preferred and a required meeting at the same time.
- Soft constraints:
 - Sooner rather than later: Schedule all meetings as soon as possible.
 - A break between meetings: Any two meetings should have at least one time grain break between them.
 - Overlapping meetings: To minimize the number of meetings in parallel so people don't have to choose one meeting over the other.
 - Assign larger rooms first: If a larger room is available any meeting should be assigned to that room in order to accommodate as many people as possible even if they haven't signed up to that meeting.
 - Room stability: If a person has two consecutive meetings with two or less time grains break between them they better be in the same room.

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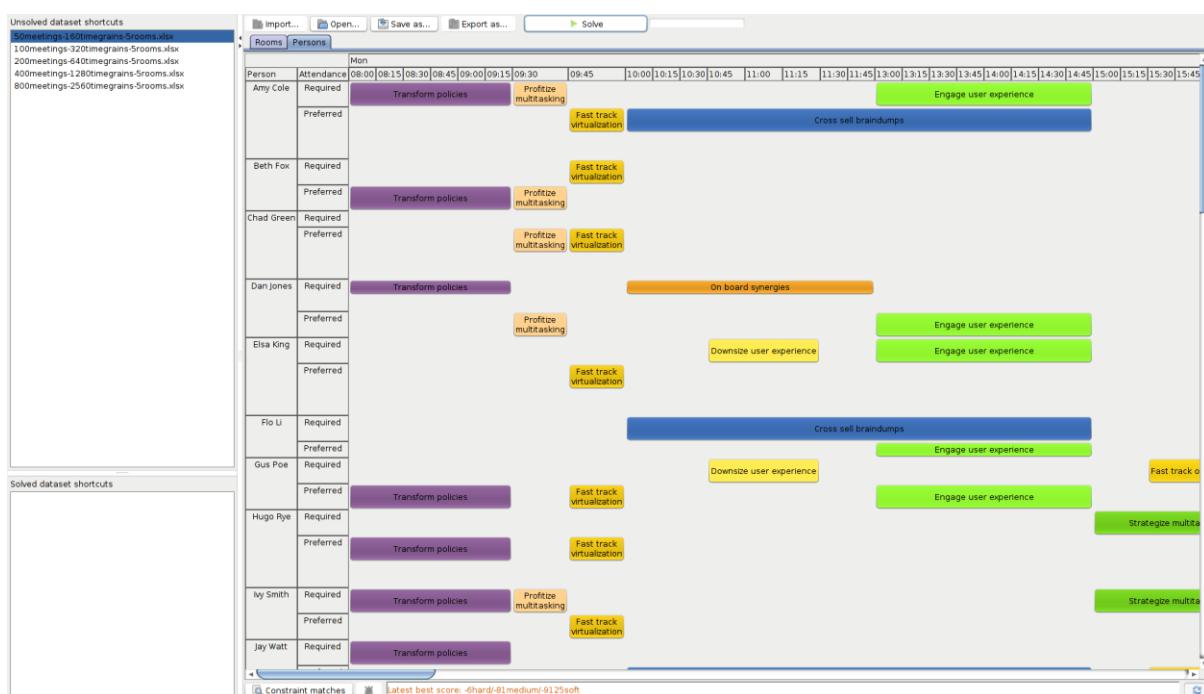
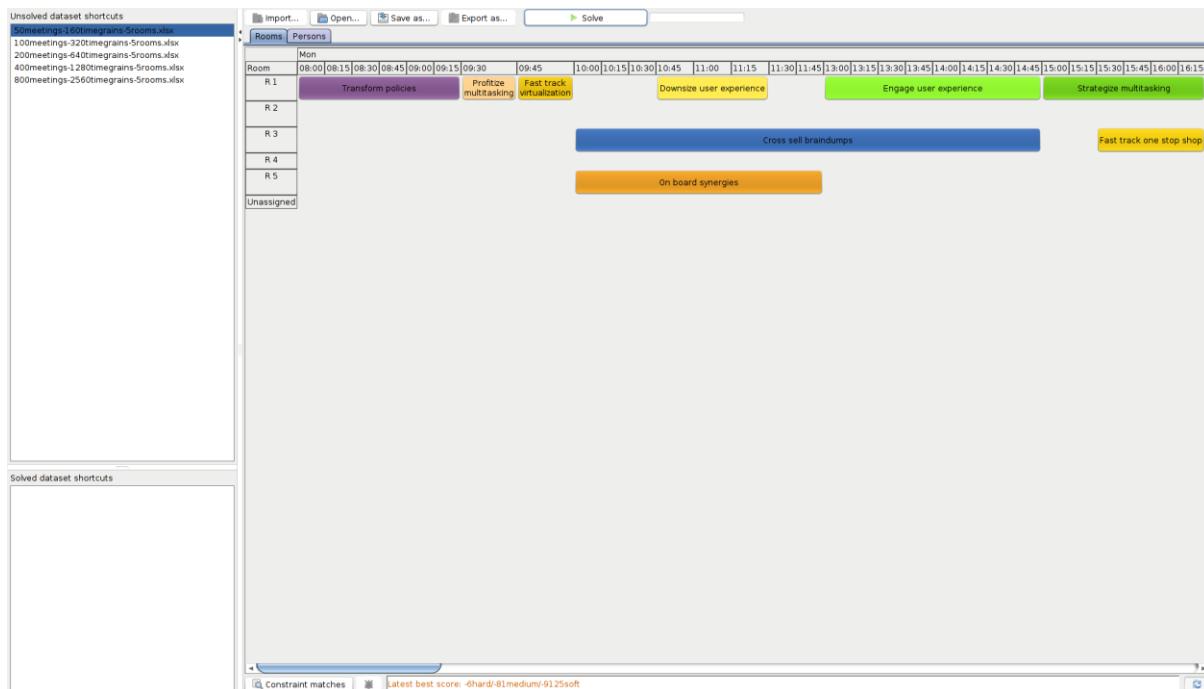
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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram



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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

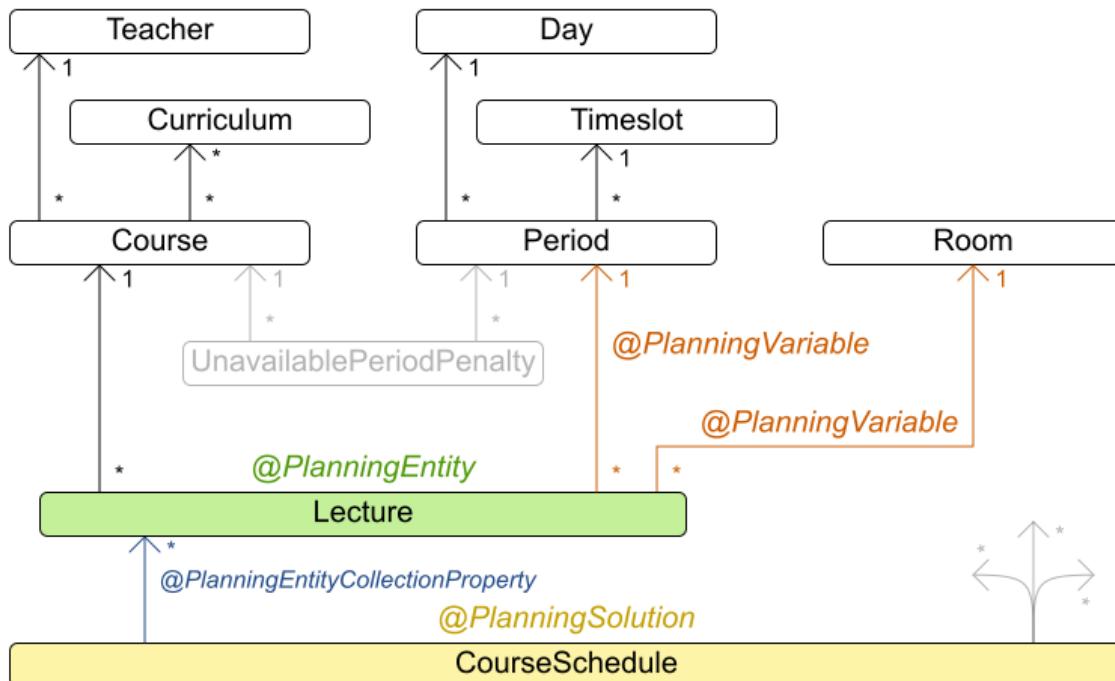
KIE OptaPlanner Deep Dive – Curriculum Course Scheduling

- **Business Scenario / Problem Description**
- **Schedule each lecture into a timeslot and into a room.**
- **Hard constraints:**
 - Teacher conflict: A teacher must not have two lectures in the same period.
 - Curriculum conflict: A curriculum must not have two lectures in the same period.
 - Room occupancy: two lectures must not be in the same room in the same period.
 - Unavailable period (specified per dataset): A specific lecture must not be assigned to a specific period.
- **Soft constraints:**
 - Room capacity: A room's capacity should not be less than the number of students in its lecture.
 - Minimum working days: Lectures of the same course should be spread out into a minimum number of days.
 - Curriculum compactness: Lectures belonging to the same curriculum should be adjacent to each other (so in consecutive periods).
 - Room stability: Lectures of the same course should be assigned to the same room.
- **The problem is defined by [the International Timetabling Competition 2007 track 3](#).**
http://www.cs.qub.ac.uk/itc2007/curriculumcourse/course_curriculum_index.htm

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Curriculum course class diagram



Unsolved dataset shortcuts
200lectures-32periods-12rooms
400lectures-32periods-25rooms
800lectures-32periods-50rooms
comp01
comp01_initialized
comp02
comp03
comp04
comp05
comp06
comp07
comp08
comp09
comp10
comp11
comp12
comp13
comp14
toy01

Day	Time	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	Unassigned
Mo	08:00	GermanB-2		MathB-0		Geograph...		ICTB-0	BiologyA-0	Geograph...	HistoryA-2			
	09:00		Geograph...											
	10:00		ArtB-0	MusicC-3					FrenchD-0					
	11:00			MusicC-2					Psycholog...					
	13:00			MusicC-3										
	14:00	MusicA-4		MusicC-0										
	15:00	Geograph...	ArtB-1	HistoryC-3										
Tu	08:00	GermanB-3	Geograph...											
	09:00	GermanB-6												
	10:00			PhysicsC-3	Chemistry...	GermanA-0			FrenchC-0					
	11:00	Geograph...	GermanB-1						Chemistry...					
	13:00	Geograph...		PhysicsC-1	SpanishA-2				FrenchD-3					
	14:00	Geograph...		PhysicsC-0					PhysicsD-1					
	15:00													
We	08:00			MathB-2					Economic...	FrenchD-4	Chemistry...			
	09:00	GermanB-5	Geograph...		PhysicsA-3	ICTB-1			FrenchE-0					
	10:00			PhysicsA-2	HistoryB-1	GermanA-0			FrenchC-3		HistoryA-1	Economic...		
	11:00			PhysicsA-3	HistoryB-2	FrenchC-4			Chemistry...		HistoryA-2	Economic...		
	13:00			PhysicsA-1	HistoryB-3	MusicB-2			FrenchD-0		HistoryB-0	Geograph...		
	14:00			PhysicsA-0	HistoryB-4	MusicB-3			Chemistry...		HistoryB-5	HistoryB-2		
	15:00													
Th	08:00									Geograph...				
	09:00	SpanischC-4	SpanischC-3							Psycholog...	Psycholog...			
	10:00													
	11:00													
	13:00													
	14:00													
	15:00													
Fr	08:00													
	09:00	SpanischA-4	GermanB-4	MathA-0	MusicC-5	HistoryC-4								
	10:00													
	11:00													
	13:00													
	14:00													
	15:00													
Unassigned														

Constraint matches | X | latest best score: Ohard-26soft

Unsolved dataset shortcuts
200lectures-32periods-12rooms
400lectures-32periods-25rooms
800lectures-32periods-50rooms
comp01
comp01_initialized
comp02
comp03
comp04
comp05
comp06
comp07
comp08
comp09
comp10
comp11
comp12
comp13
comp14
toy01

Day	Time	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	Unassigned
Mo	08:00	GermanB-2		MathB-0		Geograph...		ICTB-0	BiologyA-0	Geograph...	HistoryA-2			
	09:00		Geograph...											
	10:00		ArtB-0	MusicC-3					FrenchD-0					
	11:00			MusicC-2					Psycholog...					
	13:00			MusicC-3										
	14:00	MusicA-4		MusicC-0					MusicB-3					
	15:00	Geograph...	ArtB-1	HistoryC-3										
Tu	08:00	GermanB-3	Geograph...											
	09:00	GermanB-6												
	10:00			PhysicsC-3	Chemistry...	FrenchC-0			FrenchC-3		HistoryA-1	Economic...		
	11:00	Geograph...	GermanB-1						Chemistry...		HistoryA-2	Economic...		
	13:00	Geograph...		PhysicsC-1	SpanishA-2				FrenchD-3		HistoryA-3	Economic...		
	14:00	Geograph...			PhysicsC-0	SpanishA-0			FrenchD-1		Psycholog...	Chemistry...		
	15:00													
We	08:00													
	09:00	GermanB-5	Geograph...		PhysicsA-3	ICTB-1								
	10:00													
	11:00													
	13:00													
	14:00													
	15:00													
Th	08:00													
	09:00	SpanischC-4	SpanischC-3											
	10:00													
	11:00													
	13:00													
	14:00													
	15:00													
Fr	08:00													
	09:00	SpanischA-4	GermanB-4	MathA-0	MusicC-5	HistoryC-4								
	10:00													
	11:00													
	13:00													
	14:00													
	15:00													
Unassigned														

Constraint matches | X | latest best score: Ohard-26soft

Unsolved dataset shortcuts

200lectures-2periods-12rooms
400lectures-3periods-25rooms
800lectures-3periods-50rooms
comp01
comp01_initialized
comp02
comp03
comp04
comp05
comp06
comp07
comp08
comp09
comp10
comp11
comp12
comp13
comp14
toy01

Solved dataset shortcuts

200lectures-2periods-12rooms
400lectures-3periods-25rooms
800lectures-3periods-50rooms
comp01
comp01_initialized
comp02
comp03
comp04
comp05
comp06
comp07
comp08
comp09
comp10
comp11
comp12
comp13
comp14
toy01

Rooms | Teachers | Curricula

Import... Open... Save as... Export as... Solve

Day Time Group A Group B Group C Group D Group E Group F Group G Group H

Mo 08:00 MathB-0 HistoryA-2 HistoryA-2 Geography... German...-2 MathB-0 Geography... French...-0 EnglishB-4 BiologyA-0 BiologyA-0 MusicC-4 MusicC-4 MathC-4 MathC-4 MusicC-4 09:00 French...-0 EnglishB-4 ArtB-0 French...-0 MusicC-3 MusicC-3 MathC-3 MathC-3 MusicC-3 10:00 French...-0 EnglishB-4 EnglishB-4 French...-0 MusicC-2 MusicC-2 MathC-2 MathC-2 MusicC-2 11:00 EnglishB-4 Psychology... Psychology... MusicC-1 MusicC-1 MathC-1 MathC-1 MusicC-1 13:00 French...-0 EnglishB-4 EnglishB-4 MathD-3 MathD-3 MusicC-0 MusicC-0 Biology...-3 14:00 Biology...-3 MathD-0 MathD-0 MusicC-0 MusicC-0 Biology...-3 MusicC-0 15:00 EnglishB-6 ArtB-1 HistoryC-3 HistoryC-3 SpanishA-0 MathC-0 MathC-0

Tu 08:00 French...-0 Economics... HistoryA-1 HistoryA-1 Economics... German...-3 PhysicsC-8 French...-2 EnglishB-2 HistoryD-4 HistoryD-4 PhysicsC-5 SpanishA-1 German...-3 PhysicsC-4 PhysicsC-4 09:00 French...-2 EnglishB-2 HistoryA-3 HistoryA-3 Economics... Chemistry... PhysicsC-3 PhysicsC-3 10:00 French...-2 EnglishB-2 EnglishB-2 HistoryA-3 Economics... Chemistry... PhysicsC-3 PhysicsC-3 11:00 Chemistry... Psychology... Psychology... German...-0 SpanishB-5 German...-1 PhysicsC-2 PhysicsC-2 13:00 French...-0 SpanishA-2 French...-0 SpanishA-2 SpanishA-4 French...-0 French...-1 French...-1 14:00 French...-3 SpanishB-0 HistoryD-0 HistoryD-0 SpanishA-4 Geography... French...-2 French...-2 15:00 MathB-2 Economics... French...-0 HistoryD-4 HistoryD-4 Economics... Chemistry... MathB-2 HistoryB-4

We 08:00 PhysicsA-4 HistoryD-0 HistoryD-0 HistoryD-0 PhysicsC-4 PhysicsC-4 Chemistry... MusicC-4 HistoryB-5 09:00 PhysicsA-4 HistoryD-0 HistoryD-0 HistoryD-0 PhysicsC-3 PhysicsC-3 German...-3 MusicC-0 HistoryB-2 10:00 PhysicsA-2 MathD-2 MathD-2 HistoryD-1 PhysicsC-2 Chemistry... MusicC-2 HistoryB-3 11:00 PhysicsA-1 HistoryD-3 HistoryD-3 HistoryD-3 PhysicsA-1 German...-0 French...-0 HistoryB-3

Th 08:00 Psychology... Psychology... Psychology... SpanishC-4 Geography... Psychology... SpanishC-4 Geography... French...-0 BiologyC-0 WaterD-0 HistoryD-2 SpanishC-3 Geography... Biology...-0 SpanishC-3 Geography... 09:00 BiologyC-0 WaterD-0 HistoryD-2 SpanishC-3 Geography... Biology...-0 SpanishC-3 Geography... 10:00 BiologyC-1 Psychology... Psychology... SpanishC-2 Geography... Biology...-1 SpanishC-2 Geography... 11:00 Psychology... Psychology... Psychology... SpanishC-1 Geography... Psychology... SpanishC-1 Chemistry... 13:00 Chemistry... MathD-3 MathD-3 SpanishC-0 SpanishA-3 Chemistry... SpanishC-0 14:00 PhysicsA-2 Psychology... Psychology... PhysicsC-0 PhysicsA-0 EnglishA-2 MusicC-1 EnglishA-2 15:00 EnglishB-0 HistoryD-2 HistoryD-1 Geography... French...-2 Chemistry... French...-2 Chemistry... French...-0

Fr 08:00 MathB-1 Economics... French...-2 German...-2 Economics... EnglishA-0 MathB-1 EnglishA-0 09:00 Economics... SpanishA-1 French...-3 MusicC-5 MusicC-5 German...-4 Economics... MusicC-5 10:00 Economics... Economics... HistoryD-4 PhysicsC-2 Economics... EnglishA-1 Economics... EnglishA-1 11:00 Biology...-2 Economics... HistoryD-0 HistoryD-0 Economics... Biology...-2 Economics... HistoryB-0 13:00 French...-3 BiologyA-1 BiologyA-1 PhysicsC-4 Geography... MathC-5 MathC-5 Geography... 14:00 EnglishB-3 Economics... HistoryC-2 German...-3 Economics... Chemistry... Economics... Chemistry... 15:00 Chemistry... ArtB-2 HistoryC-3 German...-2 SpanishB-2 Chemistry... French...-1 Chemistry... French...-0

Unassigned

Constraint matches latest best score: 0hard-26soft

Package Explorer Navigator

OptaPlannerExamplesApp.java Lecture.java

```

16 * Copyright 2010 Red Hat, Inc. and/or its affiliates.
17 package org.optaplanner.examples.curriculumcourse.domain;
18
19 import java.util.List;
20
21 @PlanningEntity(difficultyWeightFactoryClass = LectureDifficultyWeightFactory.class)
22 public class Lecture extends AbstractPersistable {
23
24     private Course course;
25     private int lectureIndexInCourse;
26     private boolean pinned;
27
28     // Planning variables: changes during planning, between score calculations.
29     private Period period;
30     private Room room;
31
32     public Course getCourse() {
33         return course;
34     }
35
36     public void setCourse(Course course) {
37         this.course = course;
38     }
39
40     public int getLectureIndexInCourse() {
41         return lectureIndexInCourse;
42     }
43
44     public void setLectureIndexInCourse(int lectureIndexInCourse) {
45         this.lectureIndexInCourse = lectureIndexInCourse;
46     }
47
48     @PlanningPin
49     public boolean isPinned() {
50         return pinned;
51     }
52
53     public void setPinned(boolean pinned) {
54         this.pinned = pinned;
55     }
56
57     @PlanningVariable(valueRangeProviderRefs = {"periodRange"}, strengthWeightFactoryClass = PeriodStrengthWeightFactory.class)
58     public Period getPeriod() {
59         return period;
60     }
61
62     public void setPeriod(Period period) {
63         this.period = period;
64     }
65
66     @PlanningVariable(valueRangeProviderRefs = {"roomRange"}, strengthWeightFactoryClass = RoomStrengthWeightFactory.class)
67     public Room getRoom() {
68         return room;
69     }
70
71     public void setRoom(Room room) {
72         this.room = room;
73     }
74
75     // *****
76 }
```

Rules Outline

org.optaplanner.examples.curriculumcourse.domain

Lecture

- course : Course
- lectureIndexInCourse : int
- pinned : boolean
- period : Period
- room : Room
- getCourse() : Course
- setCourse(Course) : void
- getLectureIndexInCourse() : int
- setLectureIndexInCourse(int) : void
- isPinned() : boolean
- setPinned(boolean) : void
- getPeriod() : Period
- setPeriod(Period) : void
- getRoom() : Room
- setRoom(Room) : void
- getTeacher() : Teacher
- getStudentSize() : int
- getCurriculumList() : List<Curriculum>
- getDay() : Day
- getTimeslotIndex() : int

org.optaplanner.examples.curriculumcourse.domain.Lecture.java - optaplanner-examples/src/main/java

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Machine Reassignment



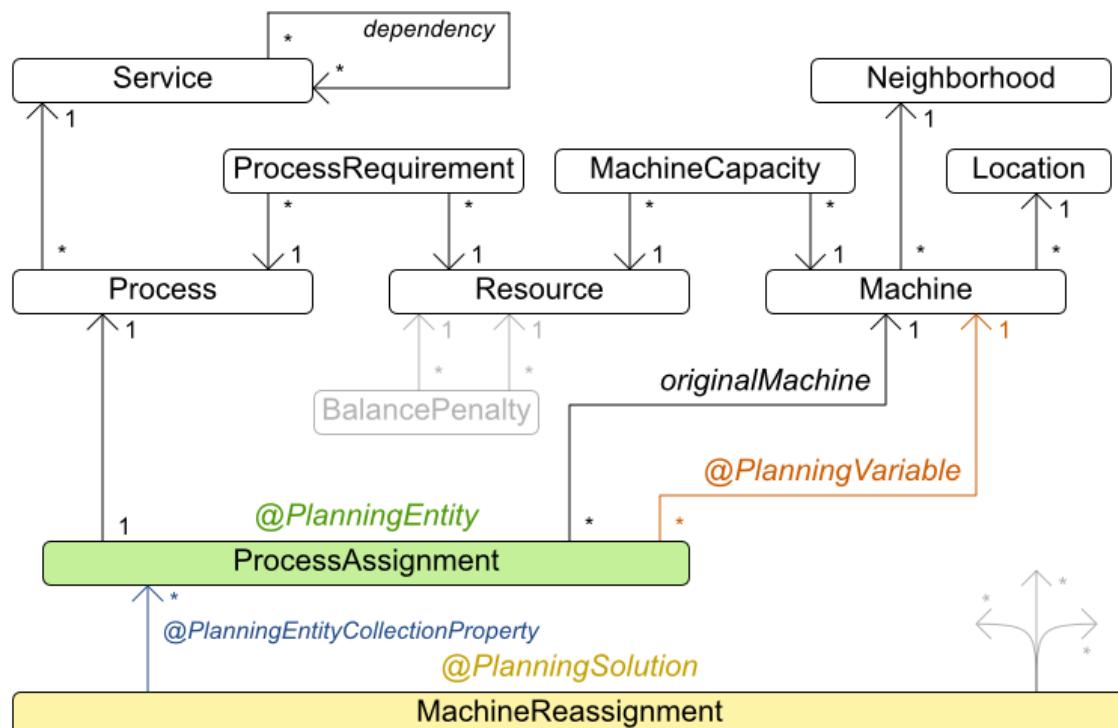
- **Business Scenario / Problem Description**
 - Assign each process to a machine. All processes already have an original (unoptimized) assignment. Each process requires an amount of each resource (such as CPU, RAM, ...). This is a more complex version of the Cloud Balancing example.
 - **Hard constraints:**
 - Maximum capacity: The maximum capacity for each resource for each machine must not be exceeded.
 - Conflict: Processes of the same service must run on distinct machines.
 - Spread: Processes of the same service must be spread out across locations.
 - Dependency: The processes of a service depending on another service must run in the neighborhood of a process of the other service.
 - Transient usage: Some resources are transient and count towards the maximum capacity of both the original machine as the newly assigned machine.
 - **Soft constraints:**
 - Load: The safety capacity for each resource for each machine should not be exceeded.
 - Balance: Leave room for future assignments by balancing the available resources on each machine.
 - Process move cost: A process has a move cost.
 - Service move cost: A service has a move cost.
 - Machine move cost: Moving a process from machine A to machine B has another A-B specific move cost.
 - **The problem is defined by [the Google ROADEF/EURO Challenge 2012](#).**

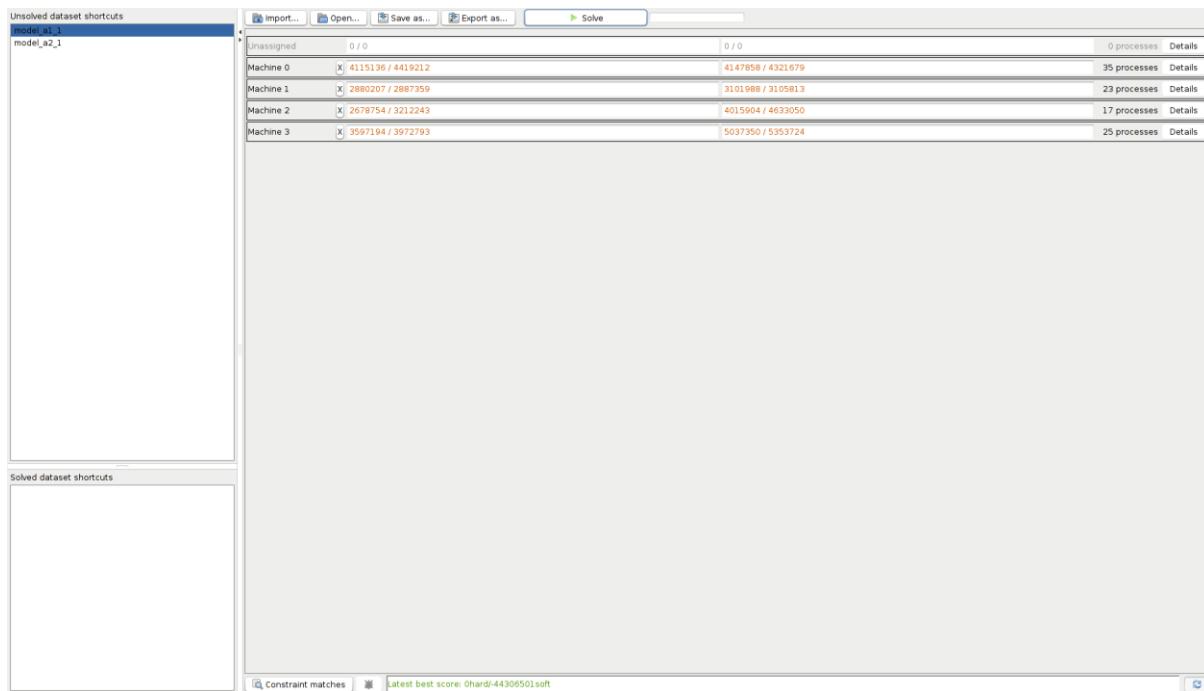
<http://challenge.roadef.org/2012/en/>

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Machine reassignment class diagram





The screenshot shows the Eclipse IDE interface. The left side has 'Package Explorer', 'Navigator', and 'Outline' panes. The 'Outline' pane shows the class structure of MrProcessAssignment. The right side is the code editor with the file 'MrProcessAssignment.java' open. The code is a Java class with annotations like @PlanningEntity, @XStreamAlias, and @PlanningVariable. It contains methods for setting and getting process, machine, and service.

```


/*
 * Copyright 2011 Red Hat, Inc. and/or its affiliates.
 */
package org.optaplanner.examples.machinereassignment.domain;

import java.util.Objects;

import org.optaplanner.examples.machinereassignment.domain.solver.*;
import org.optaplanner.examples.machinereassignment.persistence.*;
import org.optaplanner.examples.machinereassignment.solver.drools.*;
import org.optaplanner.examples.machinereassignment.solver.score.*;
import org.optaplanner.examples.machinereassignment.solver.selector.*;
import org.optaplanner.examples.machinereassignment.solver.solution.initial.*;
import org.optaplanner.examples.machinereassignment.swingui.*;
import org.optaplanner.examples.meetingscheduling.app.*;

import org.antlr.v4.runtime.tree.*;
import org.optaplanner.examples.machinereassignment.domain.*;

public class MrProcessAssignment extends AbstractPersistable {
    private MrProcess process;
    private MrMachine originalMachine;
    private MrMachine machine;
    public MrProcess getProcess() {
        return process;
    }
    public void setProcess(MrProcess process) {
        this.process = process;
    }
    public MrMachine getOriginalMachine() {
        return originalMachine;
    }
    public void setOriginalMachine(MrMachine originalMachine) {
        this.originalMachine = originalMachine;
    }
    @PlanningVariable(valueRangeProviderRefs = {"machineRange"})
    public MrMachine getMachine() {
        return machine;
    }
    public void setMachine(MrMachine machine) {
        this.machine = machine;
    }
    // **** Complex methods ****
    public MrService getService() {
        return process.getService();
    }
    public boolean isMoved() {
        return !Objects.equals(originalMachine, machine);
    }
    public int getProcessMoveCost() {
        return process.getMoveCost();
    }
    public int getMachineMoveCost() {
        return (machine == null || originalMachine == null) ? 0 : originalMachine.getMoveCostTo(machine);
    }
    public MrNeighborhood getNeighborhood() {
        return machine == null ? null : machine.getNeighborhood();
    }
}


```

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

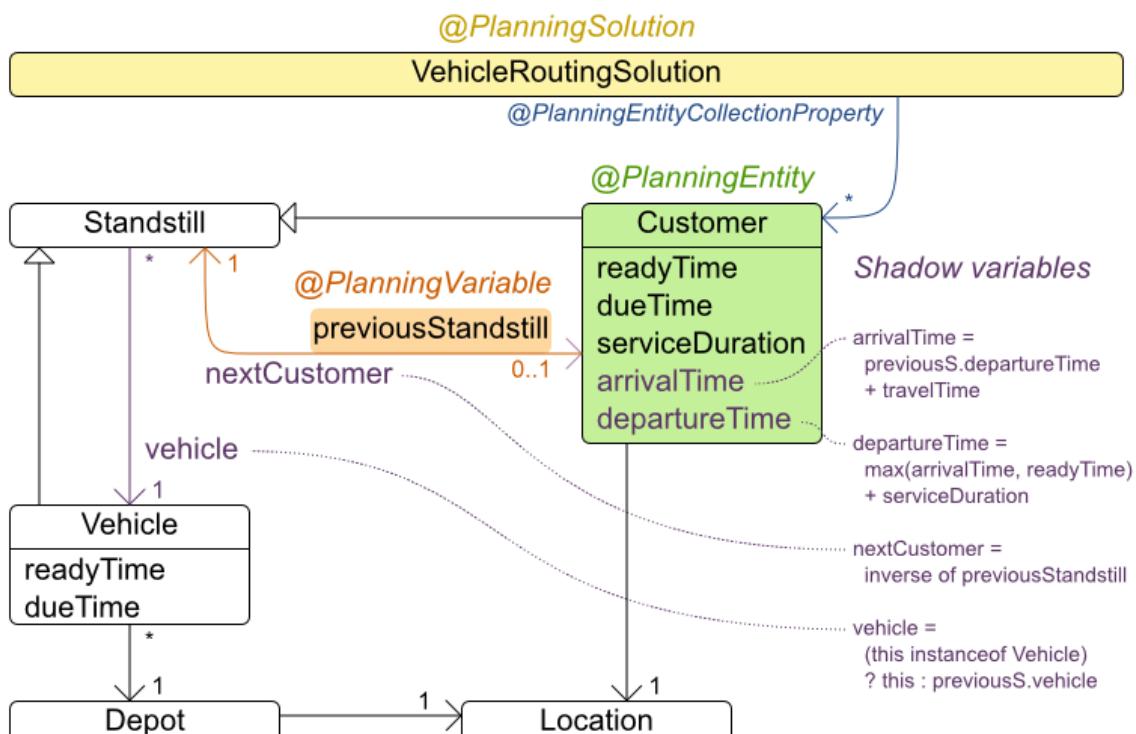
KIE OptaPlanner Deep Dive – Vehicle Routing

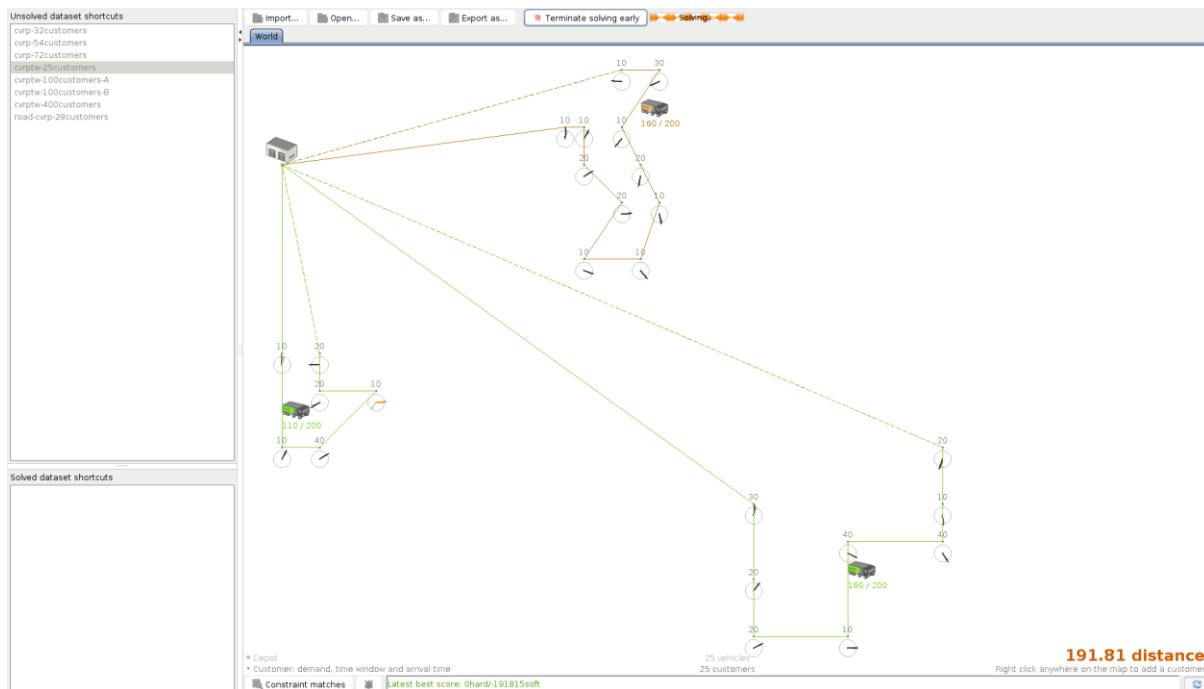
- Business Scenario / Problem Description
- Using a fleet of vehicles, pick up the objects of each customer and bring them to the depot. Each vehicle can service multiple customers, but it has a limited capacity.
- Besides the basic case (CVRP), there is also a variant with time windows (CVRPTW).
- Hard constraints:
 - Vehicle capacity: a vehicle cannot carry more items than its capacity.
 - Time windows (only in CVRPTW):
 - Travel time: Traveling from one location to another takes time.
 - Customer service duration: a vehicle must stay at the customer for the length of the service duration.
 - Customer ready time: a vehicle may arrive before the customer's ready time, but it must wait until the ready time before servicing.
 - Customer due time: a vehicle must arrive on time, before the customer's due time.
- Soft constraints:
 - Total distance: minimize the total distance driven (fuel consumption) of all vehicles.
- The capacitated vehicle routing problem (CVRP) and its time-windowed variant (CVRPTW) are defined by [the VRP web](http://neo.lcc.uma.es/vrp/). <http://neo.lcc.uma.es/vrp/>

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Vehicle routing class diagram





```
Copyright 2012 Red Hat, Inc. and/or its affiliates.  
package org.optaplanner.examples.vehiclerouting.domain;  
import com.thoughtworks.xstream.annotations.XStreamAlias;  
@PlanningEntity(difficultyWeightFactoryClass = DepotAngleCustomerDifficultyWeightFactory.class)  
@XStreamAlias("vrpCustomer")  
@XStreamInclude({  
    TimeIndexedCustomer.class  
})  
public class Customer extends AbstractPersistable implements Standstill {  
    protected Location location;  
    protected int demand;  
    // Planning variables: changes during planning, between score calculations.  
    protected Standstill previousStandstill;  
    // Shadow variables  
    protected Customer nextCustomer;  
    protected Vehicle vehicle;  
    @Override  
    public Location getLocation() {  
        return location;  
    }  
    public void setLocation(Location location) {  
        this.location = location;  
    }  
    public int getDemand() {  
        return demand;  
    }  
    public void setDemand(int demand) {  
        this.demand = demand;  
    }  
    @PlanningVariable(valueRangeProviderRefs = {"vehicleRange", "customerRange"},  
        graphType = PlanningVariableGraphType.CHAINED)  
    public Standstill getPreviousStandstill() {  
        return previousStandstill;  
    }  
    public void setPreviousStandstill(Standstill previousStandstill) {  
        this.previousStandstill = previousStandstill;  
    }  
    @Override  
    public Customer getNextCustomer() {  
        return nextCustomer;  
    }  
    @Override  
    public void setNextCustomer(Customer nextCustomer) {  
        this.nextCustomer = nextCustomer;  
    }  
    @Override  
    @AnchoredVariable(sourceVariableName = "previousStandstill")  
    public Vehicle getVehicle() {  
        return vehicle;  
    }  
}
```

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Project Job Scheduling



- **Business Scenario / Problem Description**
- Schedule all jobs in time and execution mode to minimize project delays. Each job is part of a project. A job can be executed in different ways: each way is an execution mode that implies a different duration but also different resource usages. This is a form of flexible job shop scheduling.
- **Hard constraints:**
 - Job precedence: a job can only start when all its predecessor jobs are finished.
 - Resource capacity: do not use more resources than available.
 - Resources are local (shared between jobs of the same project) or global (shared between all jobs)
 - Resource are renewable (capacity available per day) or nonrenewable (capacity available for all days)
- **Medium constraints:**
 - Total project delay: minimize the duration (makespan) of each project.
- **Soft constraints:**
 - Total makespan: minimize the duration of the whole multi-project schedule.
 - The problem is defined by the MISTA 2013 challenge.
- **The problem is defined by [the MISTA 2013 challenge](http://gent.cs.kuleuven.be/mista2013challenge/).** <http://gent.cs.kuleuven.be/mista2013challenge/>

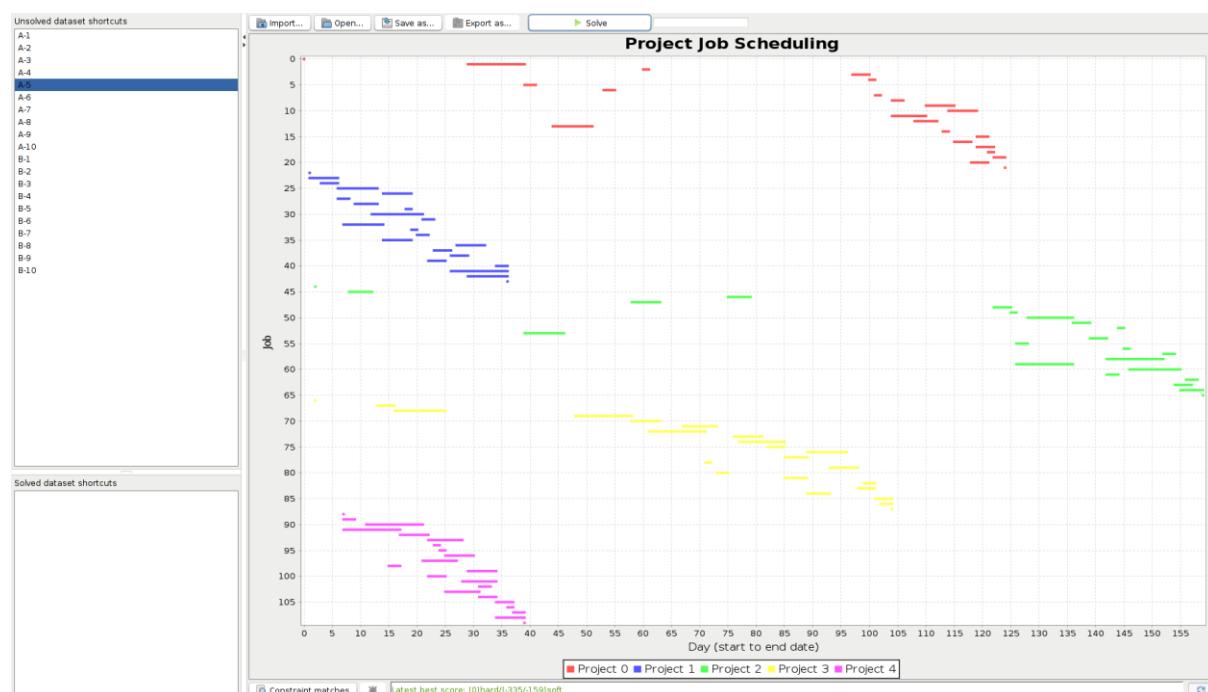
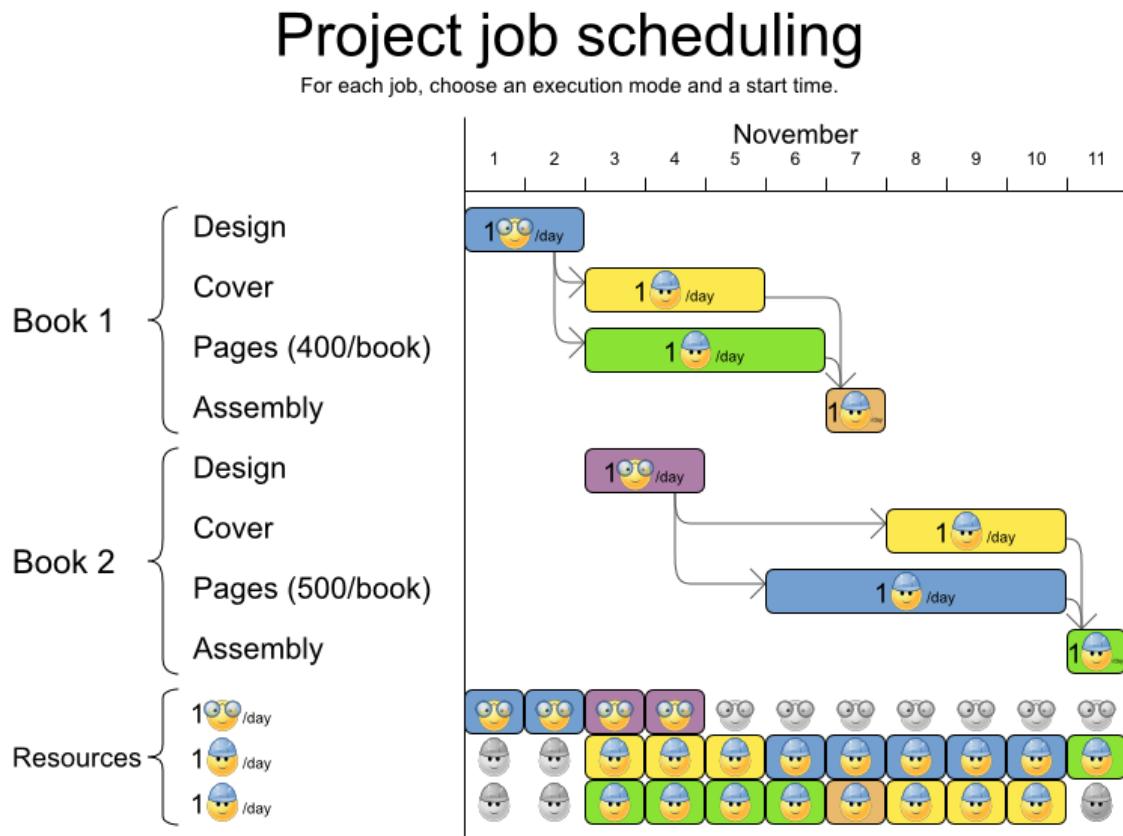
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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram





ANNEX 4 : KIE OPTAPLANNER EXAMPLES

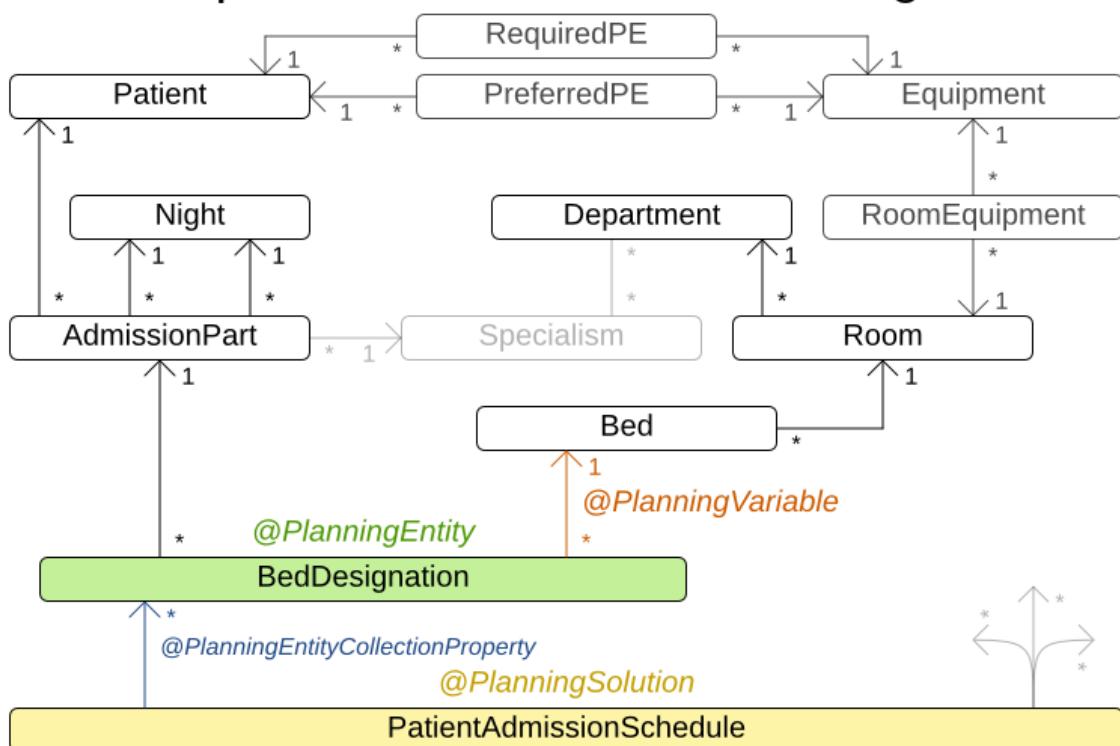
KIE OptaPlanner Deep Dive – Hospital Bed Planning (PAS)



- **Business Scenario / Problem Description**
 - Assign each patient (that will come to the hospital) into a bed for each night that the patient will stay in the hospital. Each bed belongs to a room and each room belongs to a department. The arrival and departure dates of the patients is fixed: only a bed needs to be assigned for each night. This problem features overconstrained datasets.
 - **Hard constraints:**
 - Two patients must not be assigned to the same bed in the same night. Weight: $-1000\text{hard} * \text{conflictNightCount}$.
 - A room can have a gender limitation: only females, only males, the same gender in the same night or no gender limitation at all. Weight: $-50\text{hard} * \text{nightCount}$.
 - A department can have a minimum or maximum age. Weight: $-100\text{hard} * \text{nightCount}$.
 - A patient can require a room with specific equipment(s). Weight: $-50\text{hard} * \text{nightCount}$.
 - **Medium constraints:**
 - Assign every patient to a bed, unless the dataset is over-constrained. Weight: $-1\text{medium} * \text{nightCount}$.
 - **Soft constraints:**
 - A patient can prefer a maximum room size, for example if he/she wants a single room. Weight: $-8\text{soft} * \text{nightCount}$.
 - A patient is best assigned to a department that specializes in his/her problem. Weight: $-10\text{soft} * \text{nightCount}$.
 - A patient is best assigned to a room that specializes in his/her problem. Weight: $-20\text{soft} * \text{nightCount}$.
 - That room speciality should be priority 1. Weight: $-10\text{soft} * (\text{priority} - 1) * \text{nightCount}$.
 - A patient can prefer a room with specific equipment(s). Weight: $-20\text{soft} * \text{nightCount}$.
 - **The problem is a variant on Kaho's Patient Scheduling.** <https://people.cs.kuleuven.be/~wim.vancroonenburg/pas/>

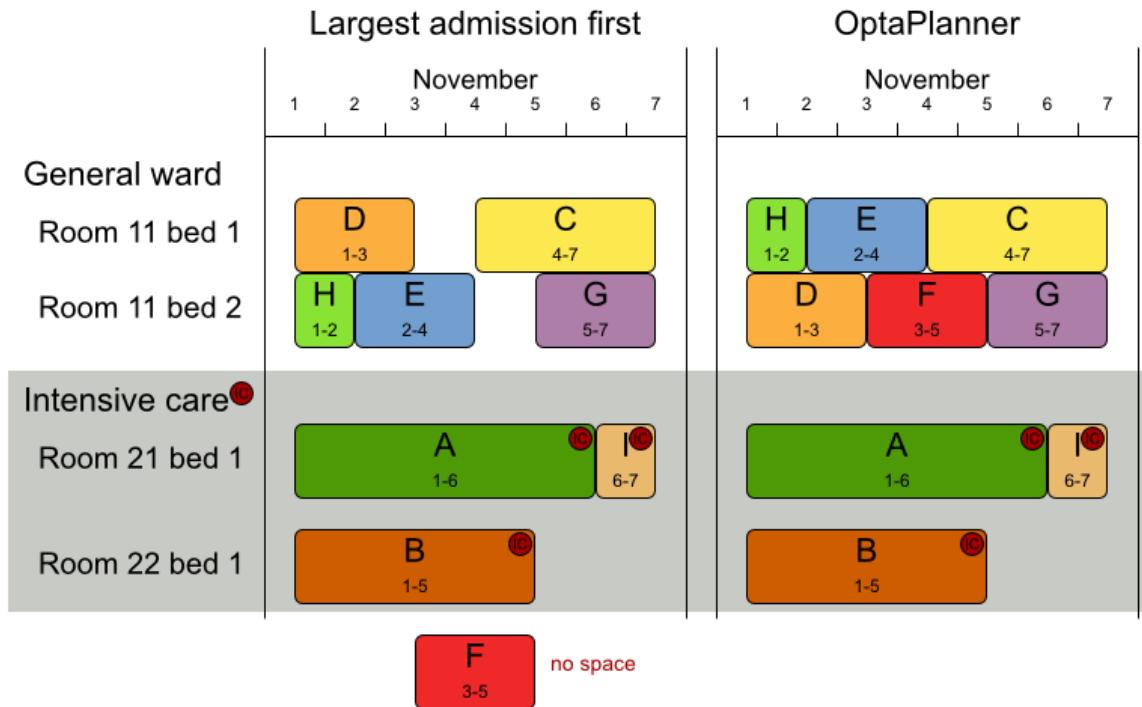
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Hospital bed allocation class diagram



Patient admission schedule

Assign each patient a hospital bed.



Unsolved dataset shortcuts

testdata01	testdata02	testdata03	testdata04	testdata05	testdata06	testdata07	testdata08	testdata09	testdata10	testdata11	testdata12	testdata13				
Department	Room	Bed	1-JAN	2-JAN	3-JAN	4-JAN	5-JAN	6-JAN	7-JAN	8-JAN	9-JAN	10-JAN	11-JAN	12-JAN	13-JAN	14-JAN
Unassigned																
Patient1	Patient2	Patient3	Patient4	Patient5	Patient6	Patient7	Patient8	Patient9	Patient10	Patient11	Patient12	Patient13	Patient14	Patient15	Patient16	Patient17
Patient18	Patient19	Patient20	Patient21	Patient22	Patient23	Patient24	Patient25	Patient26	Patient27	Patient28	Patient29	Patient30	Patient31	Patient32	Patient33	Patient34
Patient35	Patient36	Patient37	Patient38	Patient39	Patient40	Patient41	Patient42	Patient43	Patient44	Patient45	Patient46	Patient47	Patient48	Patient49	Patient50	Patient51
Patient52	Patient53	Patient54	Patient55	Patient56	Patient57	Patient58	Patient59	Patient60	Patient61	Patient62	Patient63	Patient64	Patient65	Patient66	Patient67	Patient68
Patient69	Patient70	Patient71	Patient72	Patient73	Patient74	Patient75	Patient76	Patient77	Patient78	Patient79	Patient80	Patient81	Patient82	Patient83	Patient84	Patient85
Patient86	Patient87	Patient88	Patient89	Patient90	Patient91	Patient92	Patient93	Patient94	Patient95	Patient96	Patient97	Patient98	Patient99	Patient100	Patient101	Patient102
Patient103	Patient104	Patient105	Patient106	Patient107	Patient108	Patient109	Patient110	Patient111	Patient112	Patient113	Patient114	Patient115	Patient116	Patient117	Patient118	Patient119
Patient120	Patient121	Patient122	Patient123	Patient124	Patient125	Patient126	Patient127	Patient128	Patient129	Patient130	Patient131	Patient132	Patient133	Patient134	Patient135	Patient136
Patient137	Patient138	Patient139	Patient140	Patient141	Patient142	Patient143	Patient144	Patient145	Patient146	Patient147	Patient148	Patient149	Patient150	Patient151	Patient152	Patient153
Patient154	Patient155	Patient156	Patient157	Patient158	Patient159	Patient160	Patient161	Patient162	Patient163	Patient164	Patient165	Patient166	Patient167	Patient168	Patient169	Patient170
Patient171	Patient172	Patient173	Patient174	Patient175	Patient176	Patient177	Patient178	Patient179	Patient180	Patient181	Patient182	Patient183	Patient184	Patient185	Patient186	Patient187
Patient188	Patient189	Patient190	Patient191	Patient192	Patient193	Patient194	Patient195	Patient196	Patient197	Patient198	Patient199	Patient200	Patient201	Patient202	Patient203	Patient204
Patient205	Patient206	Patient207	Patient208	Patient209	Patient210	Patient211	Patient212	Patient213	Patient214	Patient215	Patient216	Patient217	Patient218	Patient219	Patient220	Patient221
Patient222	Patient223	Patient224	Patient225	Patient226	Patient227	Patient228	Patient229	Patient230	Patient231	Patient232	Patient233	Patient234	Patient235	Patient236	Patient237	Patient238
Patient239	Patient240	Patient241	Patient242	Patient243	Patient244	Patient245	Patient246	Patient247	Patient248	Patient249	Patient250	Patient251	Patient252	Patient253	Patient254	Patient255
Patient256	Patient257	Patient258	Patient259	Patient260	Patient261	Patient262	Patient263	Patient264	Patient265	Patient266	Patient267	Patient268	Patient269	Patient270	Patient271	Patient272
Patient273	Patient274	Patient275	Patient276	Patient277	Patient278	Patient279	Patient280	Patient281	Patient282	Patient283	Patient284	Patient285	Patient286	Patient287	Patient288	Patient289
Patient290	Patient291	Patient292	Patient293	Patient294	Patient295	Patient296	Patient297	Patient298	Patient299	Patient300	Patient301	Patient302	Patient303	Patient304	Patient305	Patient306
Patient307	Patient308	Patient309	Patient310	Patient311	Patient312	Patient313	Patient314	Patient315	Patient316	Patient317	Patient318	Patient319	Patient320	Patient321	Patient322	Patient323
Patient324	Patient325	Patient326	Patient327	Patient328	Patient329	Patient330	Patient331	Patient332	Patient333	Patient334	Patient335	Patient336	Patient337	Patient338	Patient339	Patient340
Patient341	Patient342	Patient343	Patient344	Patient345	Patient346	Patient347	Patient348	Patient349	Patient350	Patient351	Patient352	Patient353	Patient354	Patient355	Patient356	Patient357
Patient358	Patient359	Patient360	Patient361	Patient362	Patient363	Patient364	Patient365	Patient366	Patient367	Patient368	Patient369	Patient370	Patient371	Patient372	Patient373	Patient374
Patient375	Patient376	Patient377	Patient378	Patient379	Patient380	Patient381	Patient382	Patient383	Patient384	Patient385	Patient386	Patient387	Patient388	Patient389	Patient390	Patient391
Patient392	Patient393	Patient394	Patient395	Patient396	Patient397	Patient398	Patient399	Patient400	Patient401	Patient402	Patient403	Patient404	Patient405	Patient406	Patient407	Patient408
Patient409	Patient410	Patient411	Patient412	Patient413	Patient414	Patient415	Patient416	Patient417	Patient418	Patient419	Patient420	Patient421	Patient422	Patient423	Patient424	Patient425
Patient426	Patient427	Patient428	Patient429	Patient430	Patient431	Patient432	Patient433	Patient434	Patient435	Patient436	Patient437	Patient438	Patient439	Patient440	Patient441	Patient442
Patient443	Patient444	Patient445	Patient446	Patient447	Patient448	Patient449	Patient450	Patient451	Patient452	Patient453	Patient454	Patient455	Patient456	Patient457	Patient458	Patient459
Patient460	Patient461	Patient462	Patient463	Patient464	Patient465	Patient466	Patient467	Patient468	Patient469	Patient470	Patient471	Patient472	Patient473	Patient474	Patient475	Patient476
Patient477	Patient478	Patient479	Patient480	Patient481	Patient482	Patient483	Patient484	Patient485	Patient486	Patient487	Patient488	Patient489	Patient490	Patient491	Patient492	Patient493
Patient494	Patient495	Patient496	Patient497	Patient498	Patient499	Patient500	Patient501	Patient502	Patient503	Patient504	Patient505	Patient506	Patient507	Patient508	Patient509	Patient510
Patient511	Patient512	Patient513	Patient514	Patient515	Patient516	Patient517	Patient518	Patient519	Patient520	Patient521	Patient522	Patient523	Patient524	Patient525	Patient526	Patient527
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Patient545	Patient546	Patient547	Patient548	Patient549	Patient550	Patient551	Patient552	Patient553	Patient554	Patient555	Patient556	Patient557	Patient558	Patient559	Patient560	Patient561
Patient562	Patient563	Patient564	Patient565	Patient566	Patient567	Patient568	Patient569	Patient570	Patient571	Patient572	Patient573	Patient574	Patient575	Patient576	Patient577	Patient578
Patient579	Patient580	Patient581	Patient582	Patient583	Patient584	Patient585	Patient586	Patient587	Patient588	Patient589	Patient590	Patient591	Patient592	Patient593	Patient594	Patient595
Patient596	Patient597	Patient598	Patient599	Patient600	Patient601	Patient602	Patient603	Patient604	Patient605	Patient606	Patient607	Patient608	Patient609	Patient610	Patient611	Patient612
Patient613	Patient614	Patient615	Patient616	Patient617	Patient618	Patient619	Patient620	Patient621	Patient622	Patient623	Patient624	Patient625	Patient626	Patient627	Patient628	Patient629
Patient630	Patient631	Patient632	Patient633	Patient634	Patient635	Patient636	Patient637	Patient638	Patient639	Patient640	Patient641	Patient642	Patient643	Patient644	Patient645	Patient646
Patient647	Patient648	Patient649	Patient650	Patient651	Patient652	Patient653	Patient654	Patient655	Patient656	Patient657	Patient658	Patient659	Patient660	Patient661	Patient662	Patient663
Patient664	Patient665	Patient666	Patient667	Patient668	Patient669	Patient670	Patient671	Patient672	Patient673	Patient674	Patient675	Patient676	Patient677	Patient678	Patient679	Patient680
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Patient732	Patient733	Patient734	Patient735	Patient736	Patient737	Patient738	Patient739	Patient740	Patient741	Patient742	Patient743	Patient744	Patient745	Patient746	Patient747	Patient748
Patient749	Patient750	Patient751	Patient752	Patient753	Patient754	Patient755	Patient756	Patient757	Patient758	Patient759	Patient760	Patient761	Patient762	Patient763	Patient764	Patient765
Patient766	Patient767	Patient768	Patient769	Patient770	Patient771	Patient772	Patient773	Patient774	Patient775	Patient776	Patient777	Patient778	Patient779	Patient780	Patient781	Patient782
Patient783	Patient784	Patient785	Patient786	Patient787	Patient788	Patient789	Patient790	Patient791	Patient792	Patient793	Patient794	Patient795	Patient796	Patient797	Patient798	Patient799
Patient800	Patient801	Patient802	Patient803	Patient804	Patient805	Patient806	Patient807	Patient808	Patient809	Patient810	Patient811	Patient812	Patient813	Patient814	Patient815	Patient816
Patient817	Patient818	Patient819	Patient820	Patient821	Patient822	Patient823	Patient824	Patient825	Patient826	Patient827	Patient828	Patient829	Patient830	Patient831	Patient832	Patient833
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Patient868	Patient869	Patient870	Patient871	Patient872	Patient873	Patient874	Patient875	Patient876	Patient877	Patient878	Patient879	Patient880	Patient881	Patient882	Patient883	Patient884
Patient885	Patient886	Patient887	Patient888	Patient889	Patient890	Patient891	Patient892	Patient893	Patient894	Patient895	Patient896	Patient897	Patient898	Patient899	Patient900	Patient901
Patient902	Patient903	Patient904	Patient905	Patient906	Patient907	Patient908	Patient909	Patient910	Patient911	Patient912	Patient913	Patient914	Patient915	Patient916	Patient917	Patient918
Patient919	Patient920	Patient921	Patient922	Patient923	Patient924	Patient925	Patient926	Patient927	Patient928	Patient929	Patient930	Patient931	Patient932	Patient933	Patient934	Patient935
Patient936	Patient937	Patient938	Patient939	Patient940	Patient941	Patient942	Patient943	Patient944	Patient945	Patient946	Patient947	Patient948	Patient949	Patient950	Patient951	Patient952
Patient953	Patient954	Patient955	Patient956	Patient957	Patient958	Patient959	Patient960	Patient961	Patient962	Patient963	Patient964	Patient965	Patient966	Patient967	Patient968	Patient969
Patient970	Patient971	Patient972	Patient973	Patient974	Patient975	Patient976	Patient977	Patient978	Patient979	Patient980	Patient981	Patient982	Patient983	Patient984	Patient985	Patient986
Patient987	Patient988	Patient989	Patient990	Patient991	Patient992	Patient993	Patient994	Patient995	Patient996	Patient997	Patient998	Patient999	Patient1000	Patient1001	Patient1002	Patient1003

Solved dataset shortcuts

Constraint matches

Latest best score: 0hard/1353medium/34754soft

Patient: Patient318
Gender: M (see icon)
Age: 30
Preferred maximum room capacity: 1
Requires 2 equipments (shown as rectangles)
Prefers 1 equipments

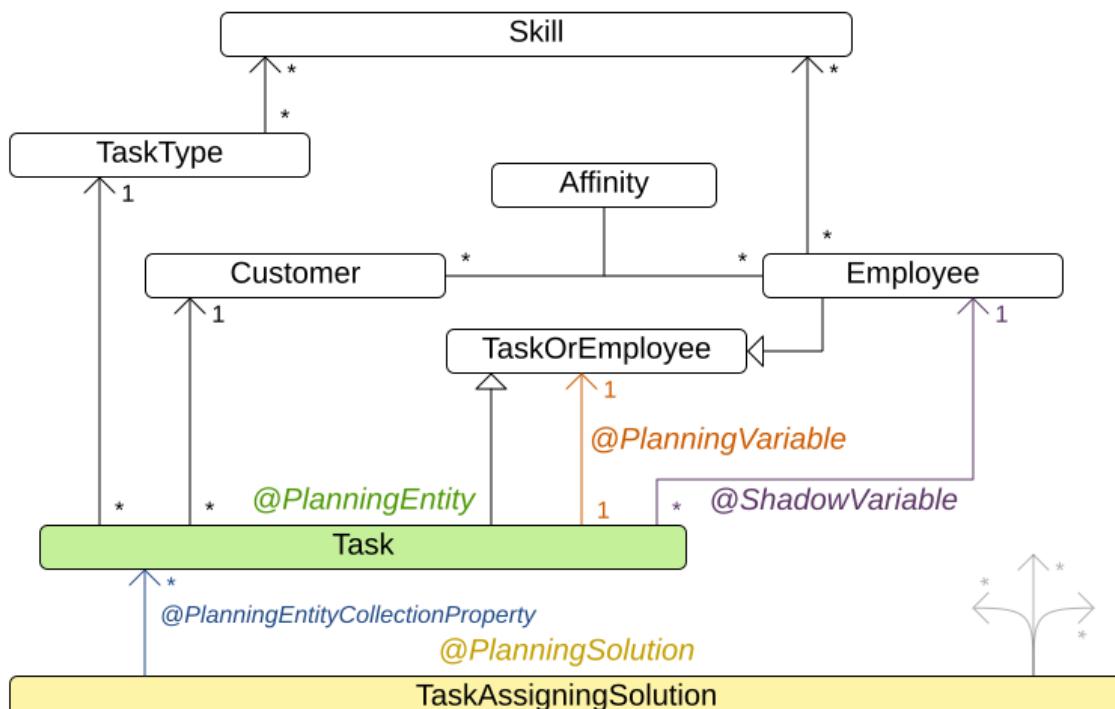
ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Task assigning

- Business Scenario / Problem Description
- Assign each task to a spot in an employee's queue. Each task has a duration which is affected by the employee's affinity level with the task's customer.
- Hard constraints:
 - Skill: Each task requires one or more skills. The employee must possess all these skills.
- Soft level 0 constraints:
 - Critical tasks: Complete critical tasks first, sooner than major and minor tasks.
- Soft level 1 constraints:
 - Minimize makespan: Reduce the time to complete all tasks.
 - Start with the longest working employee first, then the second longest working employee and so forth, to create fairness and load balancing.
- Soft level 2 constraints:
 - Major tasks: Complete major tasks as soon as possible, sooner than minor tasks.
- Soft level 3 constraints:
 - Minor tasks: Complete minor tasks as soon as possible.

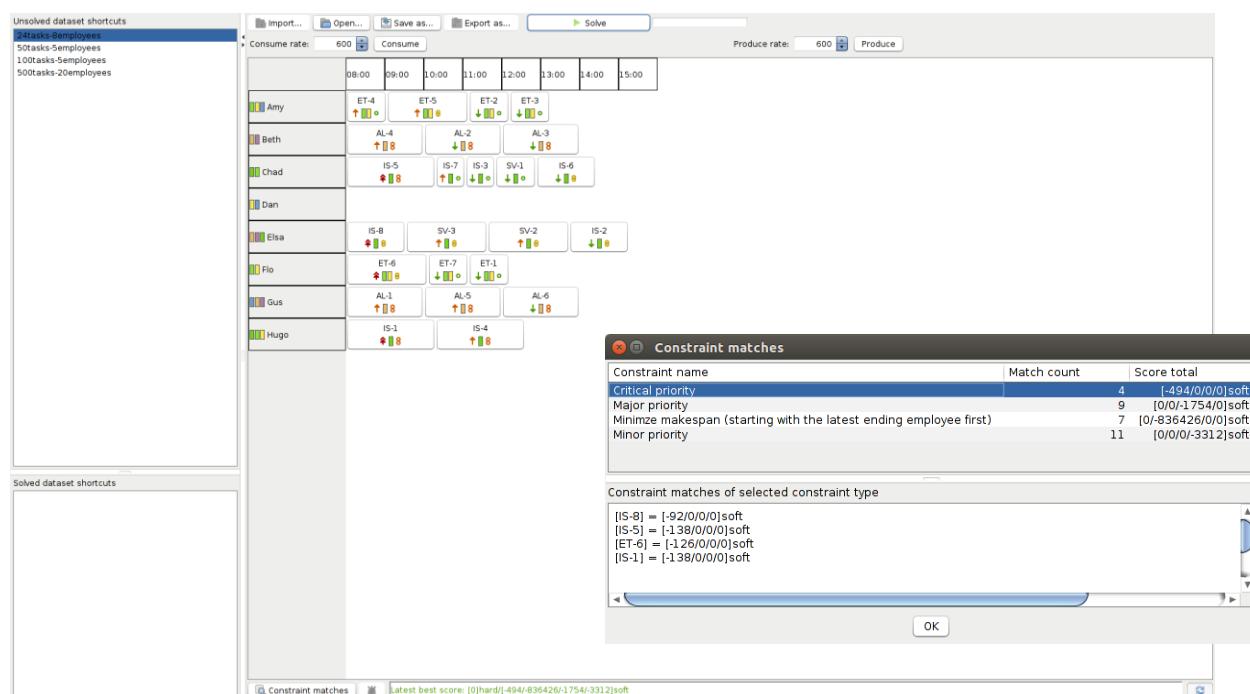
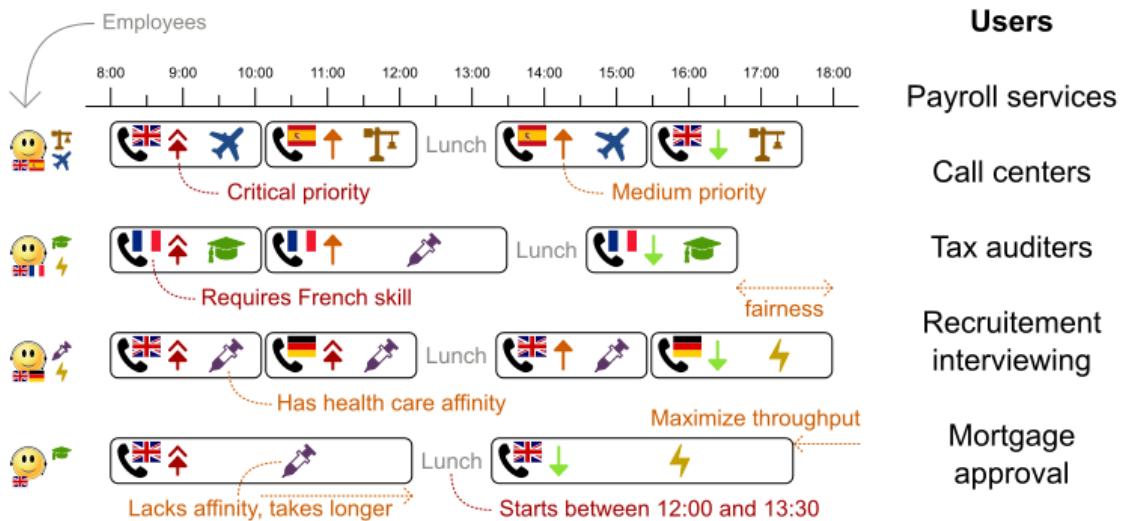
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Task assigning class diagram



Task assigning

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



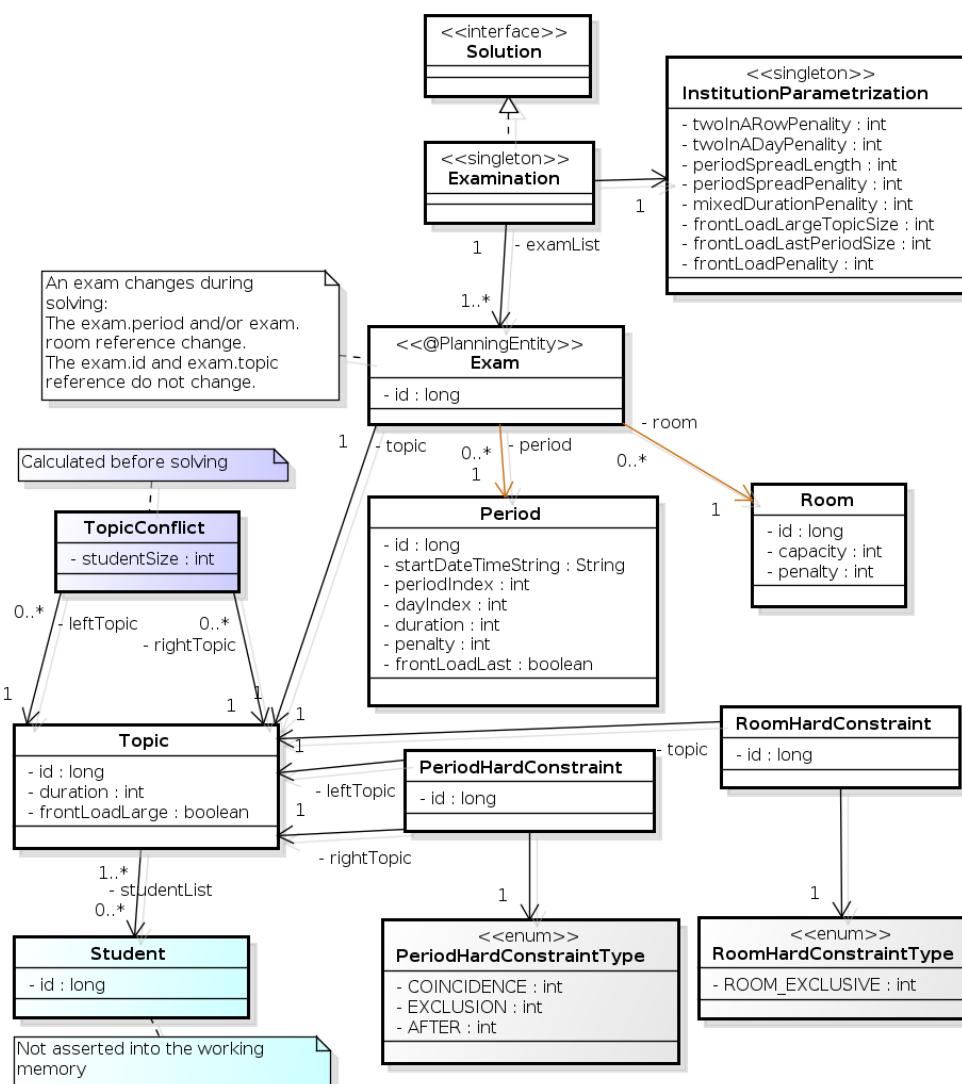
ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Exam Timetabling

- Business Scenario / Problem Description
- Schedule each exam into a period and into a room. Multiple exams can share the same room during the same period.
- Hard constraints:
 - Exam conflict: two exams that share students must not occur in the same period.
 - Room capacity: A room's seating capacity must suffice at all times.
 - Period duration: A period's duration must suffice for all of its exams.
 - Period related hard constraints [specified per dataset]:
 - Coincidence: two specified exams must use the same period (but possibly another room).
 - Exclusion: two specified exams must not use the same period.
 - After: A specified exam must occur in a period after another specified exam's period.
 - Room related hard constraints [specified per dataset]:
 - Exclusive: one specified exam should not have to share its room with any other exam.
- Soft constraints (each of which has a parametrized penalty):
 - The same student should not have two exams in a row.
 - The same student should not have two exams on the same day.
 - Period spread: two exams that share students should be a number of periods apart.
 - Mixed durations: two exams that share a room should not have different durations.
 - Front load: Large exams should be scheduled earlier in the schedule.
 - Period penalty [specified per dataset]: Some periods have a penalty when used.
 - Room penalty [specified per dataset]: Some rooms have a penalty when used.
 - It uses large test data sets of real-life universities.
- The problem is defined by [the International Timetabling Competition 2007 track 1](#).

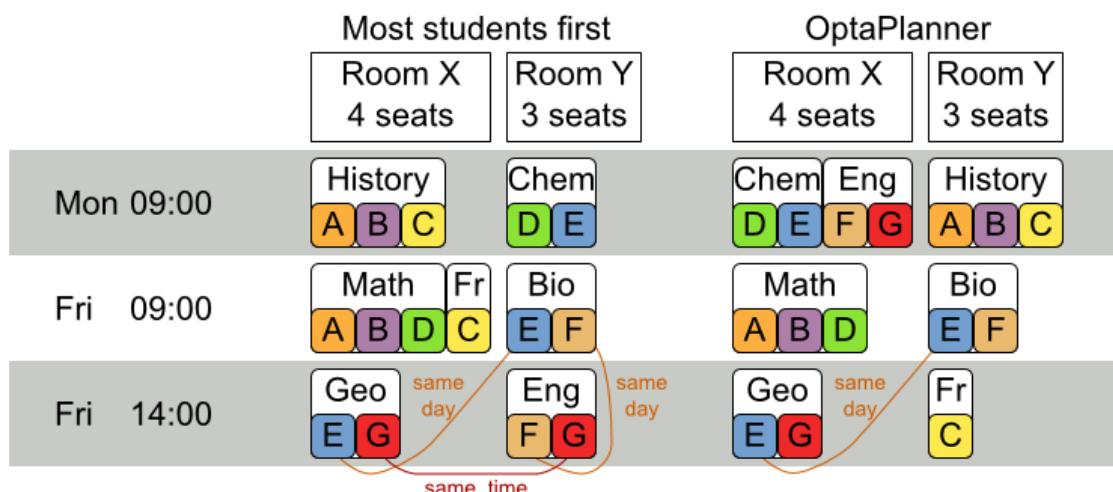
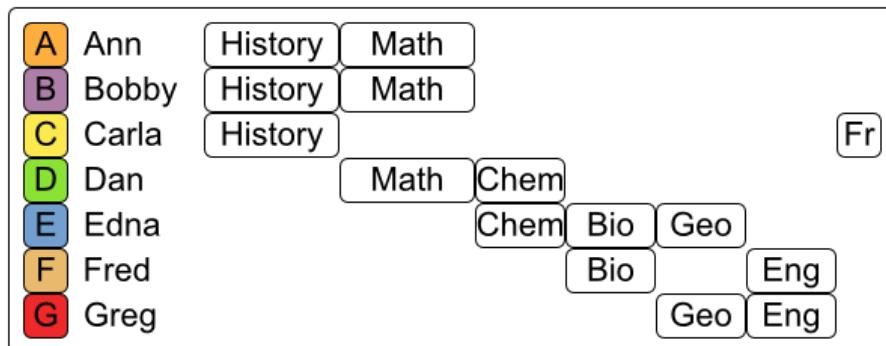
http://www.cs.qub.ac.uk/itc2007/examtrack/exam_track_index.htm

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Examination timetabling

Assign each exam a period and a room.



Parameter	Value
2 exams in a row penalty	15
2 exams in a day penalty	5
Period spread length	1
Period spread penalty	1
Exams of mixed duration penalty	25
Front load: large exam size	250
Front load: last period size	30
Front load: penalty	5

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

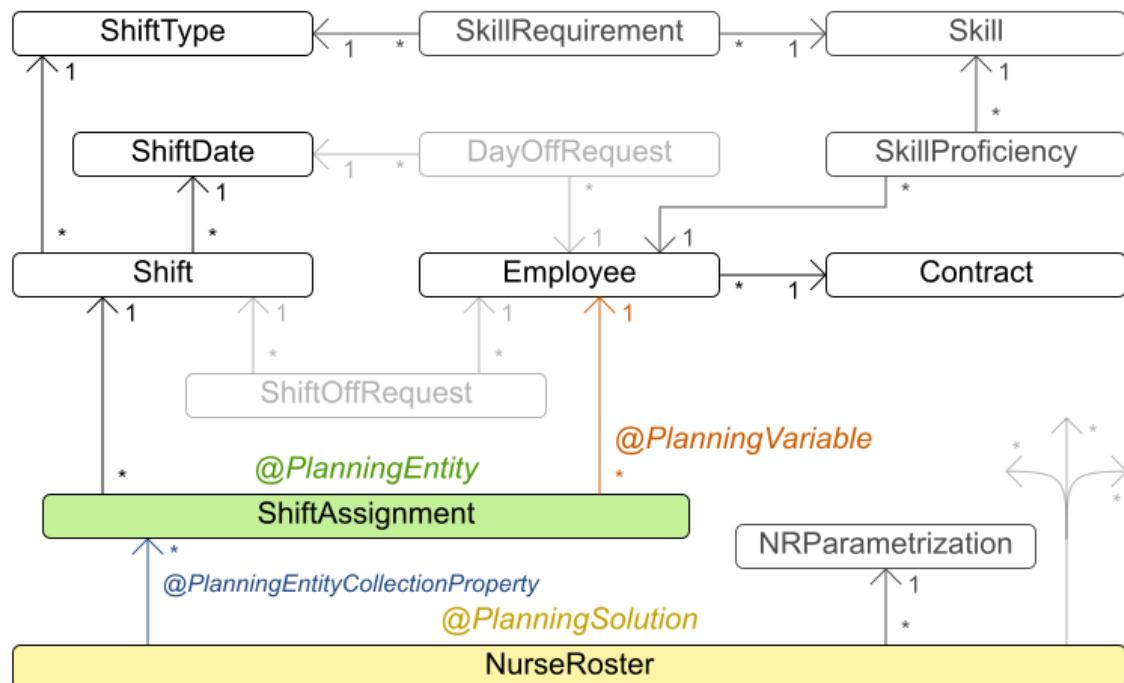
KIE OptaPlanner Deep Dive – Employee Rostering



- **Business Scenario / Problem Description**
 - **For each shift, assign a nurse to work that shift.**
 - **Hard constraints:**
 - No unassigned shifts (built-in): Every shift needs to be assigned to an employee.
 - Shift conflict: An employee can have only one shift per day.
 - **Soft constraints:**
 - Contract obligations: The business frequently violates these, so they decided to define these as soft constraints instead of hard constraints.
 - Minimum and maximum assignments: Each employee needs to work more than x shifts and less than y shifts (depending on their contract).
 - Minimum and maximum consecutive working days: Each employee needs to work between x and y days in a row (depending on their contract).
 - Minimum and maximum consecutive free days: Each employee needs to be free between x and y days in a row (depending on their contract).
 - Minimum and maximum consecutive working weekends: Each employee needs to work between x and y weekends in a row (depending on their contract).
 - Complete weekends: Each employee needs to work every day in a weekend or not at all.
 - Identical shift types during weekend: Each weekend shift for the same weekend of the same employee must be the same shift type.
 - Unwanted patterns: A combination of unwanted shift types in a row. For example: a late shift followed by an early shift followed by a late shift.
 - **Employee wishes:**
 - Day on request: An employee wants to work on a specific day.
 - Day off request: An employee does not want to work on a specific day.
 - Shift on request: An employee wants to be assigned to a specific shift.
 - Shift off request: An employee does not want to be assigned to a specific shift.
 - **Alternative skill: An employee assigned to a skill should have a proficiency in every skill required by that shift.**
 - **The problem is defined by the International Nurse Rostering Competition 2010: <http://www.kuleuven-kortrijk.be/nrpcompetition>**

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Nurse rostering class diagram



Employee shift rostering

Populate each work shift with a nurse.

	Maternity nurses			Emergency nurses			Basic nurses		
	A Ann	B Beth	C Cory	D Dan	E Elin	G Greg	H Hue	I Ilse	
Largest staff first									
Maternity nurses	1 C A	2 B		1 C A	1 B	2 A C	1 C A	2 B	1 C A
Emergency nurses	2 D G	1 E		2 D G	1 E	1 D E	2 D G	2 D G	1 D G
Any nurses	1 H I	1 H I	1 H I	1 H I	1 H I	1 H I	1 H I	1 H I	1 H I
OptaPlanner									
Maternity nurses	1 C A	2 B		1 C A	1 B	2 A C	1 C A	2 B	1 C A
Emergency nurses	2 D G	1 E		2 D G	1 E	1 D E	2 D G	2 D G	1 D G
Any nurses	1 H I	1 H I	1 H I	1 H I	1 H I	1 H I	1 H I	1 H I	1 H I

Unsolved dataset shortcuts

```
longQ1
longQ2
longHint01
longHint02
medium01
medium02
medium03
medium04
medium05
mediumHint01
mediumHint02
mediumHint03
mediumLate01
mediumLate01_initialized
mediumLate02
mediumLate03
mediumLate04
mediumLate05
mediumLate06
sprint01
sprint02
sprintHint01
sprintHint02
```

Solved dataset shortcuts

Planning window start: Fri 1 Jan Advance 1 day into the future E = Early shift, L = Late shift...

	Fri 1 Jan	Sat 2 Jan	Sun 3 Jan	Mon 4 Jan	Tue 5 Jan	Wed 6 Jan	Thu 7 Jan	Fri 8 Jan	Sat 9 Jan	Sun 10 Jan	Mon 11 Jan	Tue 12 Jan	Wed 13 Jan	Thu 14 Jan	Fri 15 Jan	Sat 16 Jan
Employee 0	X															N
Employee 1	X	E	E	E	D										L	L
Employee 2	X														N	D
Employee 3	X		N	L	L	E	L							L	E	
Employee 4	X	L	N	N	L									D	L	E
Employee 5	X	D	D	D		N	L	E	L					L	E	E
Employee 6	X					D	L							D	E	L
Employee 7	X					L	E	L						N		D
Employee 8	X	L					E									
Employee 9	X	E						E	N					D	L	

Constraint matches

Constraint name	Match count	Score total
Minimum and maximum number of assignments	10	-30soft
dayOffRequest	27	-27soft

Constraint matches of selected constraint type

```
[2010-01-08/D, 2010-01-08_OFF_0] = -1soft
[2010-01-07/D, 2010-01-07_OFF_0] = -1soft
[2010-01-27/E, 2010-01-27_OFF_0] = -1soft
[2010-01-15/L, 2010-01-15_OFF_1] = -1soft
[2010-01-18/E, 2010-01-18_OFF_1] = -1soft
[2010-01-17/L, 2010-01-17_OFF_1] = -1soft
[2010-01-04/E, 2010-01-04_OFF_1] = -1soft
```

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Traveling Tournament Problem (TTP)



- **Business Scenario / Problem Description**

- **Schedule matches between n teams.**

- **Hard constraints:**

- Each team plays twice against every other team: once home and once away.
- Each team has exactly one match on each timeslot.
- No team must have more than three consecutive home or three consecutive away matches.
- No repeaters: no two consecutive matches of the same two opposing teams.

- **Soft constraints:**

- Minimize the total distance traveled by all teams.

- **The problem is defined on [Michael Trick's website](#).**

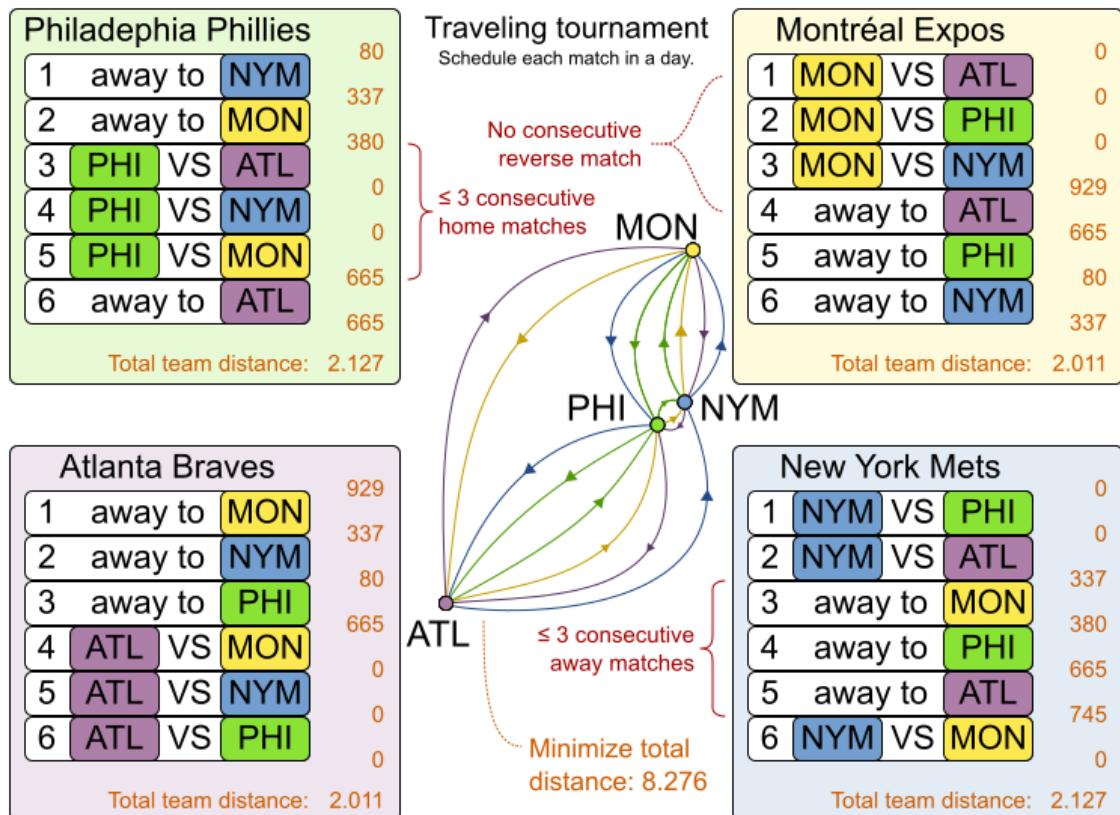
<http://mat.tepper.cmu.edu/TOURN/>

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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram





Unsolved dataset shortcuts

1-r06
1-r08
1-r10
1-r12
1-r14
1-r16
2-r02
2-r04
3-r05
3-r08
3-r10
3-r12
3-r14
3-r16
3-r18
3-r20
3-r22
3-r24
3-r26
3-r28
3-r30
3-r32
4-super0
4-super04
4-super06
4-super08
4-super10
4-super12
4-super14

Solved dataset shortcuts

Teams

Day	ATL	NYM	PHI	MON	Unassigned
0	MON	PHI	NYM	ATL	
1		NYM	ATL	MON	PHI
2		PHI	MON	ATL	NYM
3	MON	PHI	NYM	ATL	
4	NYM	ATL	MON	PHI	
5	PHI	MON	ATL	NYM	
Unassigned					

Constraint matches

Constraint name	Match count	Score total
awayToAwayHop	7	-2544soft
awayToEndHop	2	-1002soft
awayToHomeHop	3	-1790soft
homeToAwayHop	3	-1931soft
startToAwayHop	2	-1009soft

Constraint matches of selected constraint type

```
[PHI+MON, ATL+MON] = -665soft
[PHI+ATL, NYM+ATL] = -80soft
[MON+PHI, NYM+PHI] = -337soft
[ATL+NYM, PHI+NYM] = -665soft
[NYM+MON, PHI+MON] = -80soft
[NYM+ATL, MON+ATL] = -337soft
[PHI+NYM, MON+NYM] = -380soft
```

OK

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Cheap Time Scheduling



- **Business Scenario / Problem Description**
- **Schedule all tasks in time and on a machine to minimize power cost. Power prices differs in time.** This is a form of job shop scheduling.
- **Hard constraints:**
 - Start time limits: each task must start between its earliest start and latest start limit.
 - Maximum capacity: the maximum capacity for each resource for each machine must not be exceeded.
 - Startup and shutdown: each machine must be active in the periods during which it has assigned tasks. Between tasks it is allowed to be idle to avoid startup and shutdown costs.
- **Medium constraints:**
 - Power cost: minimize the total power cost of the whole schedule.
 - Machine power cost: Each active or idle machine consumes power, which infers a power cost (depending on the power price during that time).
 - Task power cost: Each task consumes power too, which infers a power cost (depending on the power price during its time).
 - Machine startup and shutdown cost: Every time a machine starts up or shuts down, an extra cost is inflicted.
- **Soft constraints (addendum to the original problem definition):**
 - Start early: prefer starting a task sooner rather than later.

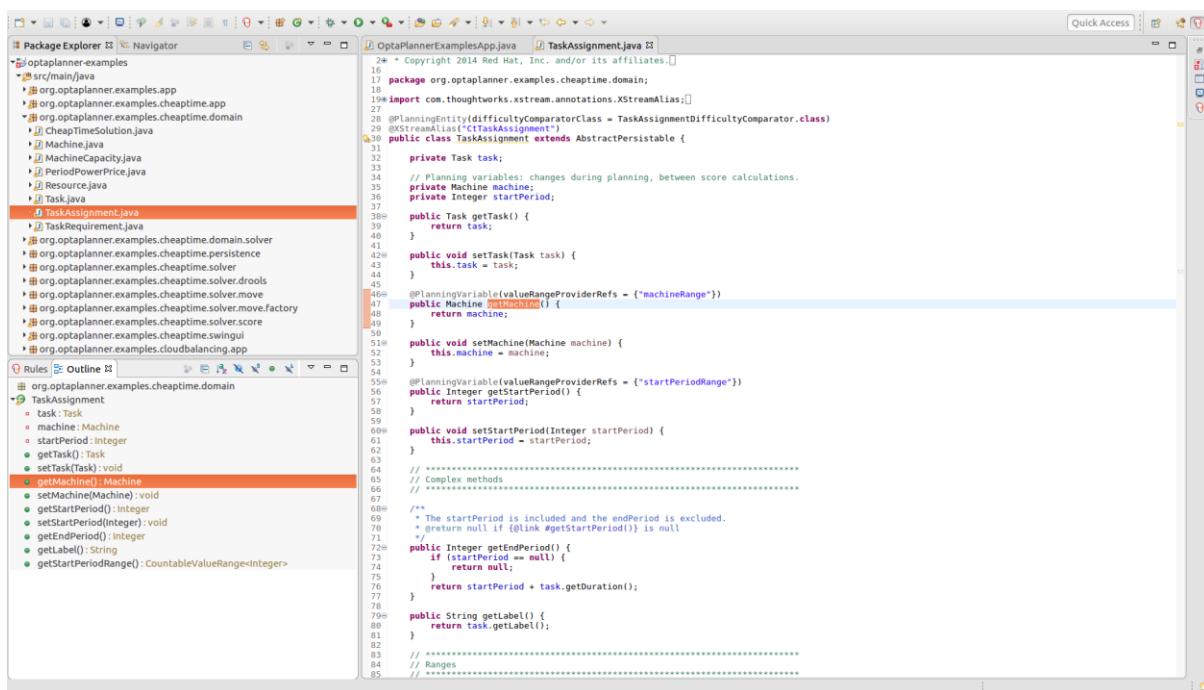
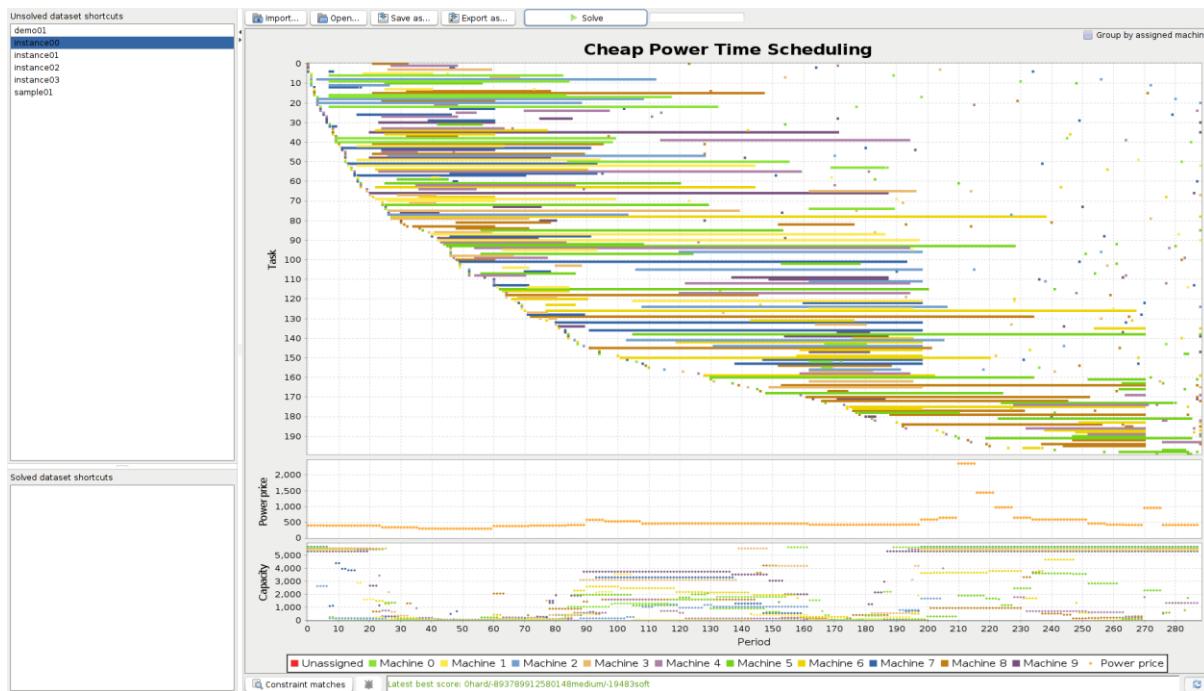
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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram



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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Investment Asset Class Allocation



- **Business Scenario / Problem Description**

- Decide the relative quantity to invest in each asset class.

- **Hard constraints:**

- Risk maximum: the total standard deviation must not be higher than the standard deviation maximum.
- Total standard deviation calculation takes asset class correlations into account by applying Markowitz Portfolio Theory.
- Region maximum: Each region has a quantity maximum.
- Sector maximum: Each sector has a quantity maximum.

- **Soft constraints:**

- Maximize expected return.

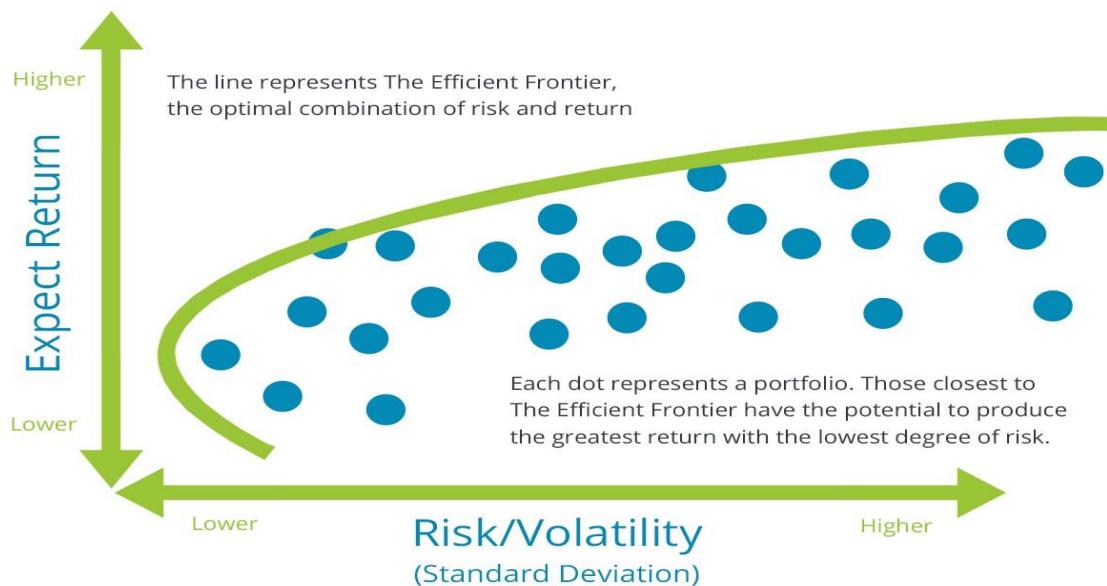
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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram



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[Link](https://www.guidedchoice.com/video/dr-harry-markowitz-father-of-modern-portfolio-theory/) <https://www.guidedchoice.com/video/dr-harry-markowitz-father-of-modern-portfolio-theory/>

Unsolved dataset shortcuts

ds_alpha_1
irnnk1

Import... Open... Save as... Export... Solve... Standard deviation maximum 15.0%

Asset class	Region	Sector	Expected return	Standard deviation risk	Quantity	Red Hat...	Google L...	Oracle C...	Apple Inc.	Microsof...	Tesla Mo...	Ford Mot...	Toyota M...	General ...	Starbuck...	McDonal...
Red Hat, Inc.	Global	Tech	13.6%	29.1%	0.0%	0.000	0.050	0.600	0.130	0.140	0.230	0.210	0.080	0.320	0.330	0.000
Google Inc.	Global	Tech	15.6%	21.5%	8.3%	0.050	0.000	0.050	0.260	0.180	0.100	0.080	0.200	0.210	0.210	0.210
Oracle Corporation	Global	Tech	12.3%	21.7%	1.8%	0.600	0.050	0.000	0.190	0.330	0.140	0.420	0.190	0.500	0.170	-0.010
Apple Inc.	Global	Tech	28.8%	24.1%	29.6%	0.130	0.260	0.190	0.000	0.270	0.010	0.150	0.180	0.250	0.230	0.030
Microsoft Corporation	Global	Tech	17.9%	20.7%	10.3%	0.140	0.180	0.330	0.270	0.000	0.180	0.290	0.250	0.320	0.170	0.160
Tesla Motors, Inc.	Global	Cars	54.7%	53.9%	13.1%	0.230	0.100	0.140	0.010	0.180	0.000	0.320	0.160	0.230	0.240	-0.050
Ford Motor Company	Global	Cars	1.0%	25.9%	0.0%	0.210	0.980	0.420	0.150	0.290	0.320	0.000	0.240	0.830	0.360	0.100
Toyota Motor Corp Ltd Ord	Global	Cars	13.6%	19.2%	16.9%	0.080	0.200	0.190	0.180	0.250	0.160	0.240	0.000	0.360	0.320	0.100
General Motors Company	Global	Cars	2.1%	29.5%	0.0%	0.320	0.210	0.500	0.250	0.320	0.230	0.830	0.360	0.000	0.300	0.090
Starbucks Corporation	Global	Food	33.2%	19.7%	20.0%	0.330	0.210	0.170	0.230	0.170	0.240	0.360	0.320	0.300	0.000	0.310
McDonald's Corporation	Global	Food	8.0%	11.3%	0.0%	0.210	-0.010	0.030	0.160	-0.050	0.100	0.090	0.310	0.000	-0.000	-0.000
Total			28.0%	15.0%	100.0%											

Constraint matches

Constraint name	Match count	Score total
Maximize expected return	11	279888soft

Constraint matches of selected constraint type

```
[11-McDonald's Corporation] = 0
[10-Starbucks Corporation] = 66400soft
[9-General Motors Company] = 0
[8-Toyota Motor Corp Ltd Ord] = 22984soft
[7-Ford Motor Company] = 0
[6-Tesla Motors, Inc.] = 71657soft
[5-Microsoft Corporation] = 18437soft
[4-Apple Inc.] = 85248soft
[3-Oracle Corporation] = 2214soft
[2-Google Inc.] = 12948soft
[1-Red Hat, Inc.] = 0
```

OK

Constraint matches latest best score: 0hard/279888soft

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Conference Scheduling

- **Business Scenario / Problem Description**
- **Assign each conference talk to a timeslot and a room, after the talks have been accepted.**
- **Hard constraints (unless configured otherwise):**
 - Talk type of timeslot: The type of a talk must match the timeslot's talk type.
 - Room unavailable timeslots: A talk's room must be available during the talk's timeslot.
 - Room conflict: Two talks can't use the same room during overlapping timeslots.
 - Speaker unavailable timeslots: Every talk's speaker must be available during the talk's timeslot.
 - Speaker conflict: Two talks can't share a speaker during overlapping timeslots.
 - Generic purpose timeslot and room tags
 - Speaker required timeslot tags: If a speaker has a required timeslot tag, then all his/her talks must be assigned to a timeslot with that tag.
 - Speaker prohibited timeslot tags: If a speaker has a prohibited timeslot tag, then all his/her talks cannot be assigned to a timeslot with that tag.
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 - Speaker prohibited room tags: If a speaker has a prohibited room tag, then all his/her talks cannot be assigned to a room with that tag.
 - Talk required room tags: If a talk has a required room tag, then it must be assigned to a room with that tag.
 - Talk prohibited room tags: If a talk has a prohibited room tag, then it cannot be assigned to a room with that tag.
 - Talk prerequisite talks: A talk must be scheduled after all its prerequisite talks.
 - Consecutive talks pause: A speaker who has more than one talk must have a break between them.
 - Talk mutually-exclusive-talks tags: Talks that share such tags must not be scheduled in overlapping timeslots.
- **Medium constraints (unless configured otherwise):**
 - Published timeslot: A published talk must not be scheduled at a different timeslot than currently published. If a hard constraint's input data changes after publishing (such as speaker unavailability), then this medium constraint will be minimally broken to attain a new feasible solution.

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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

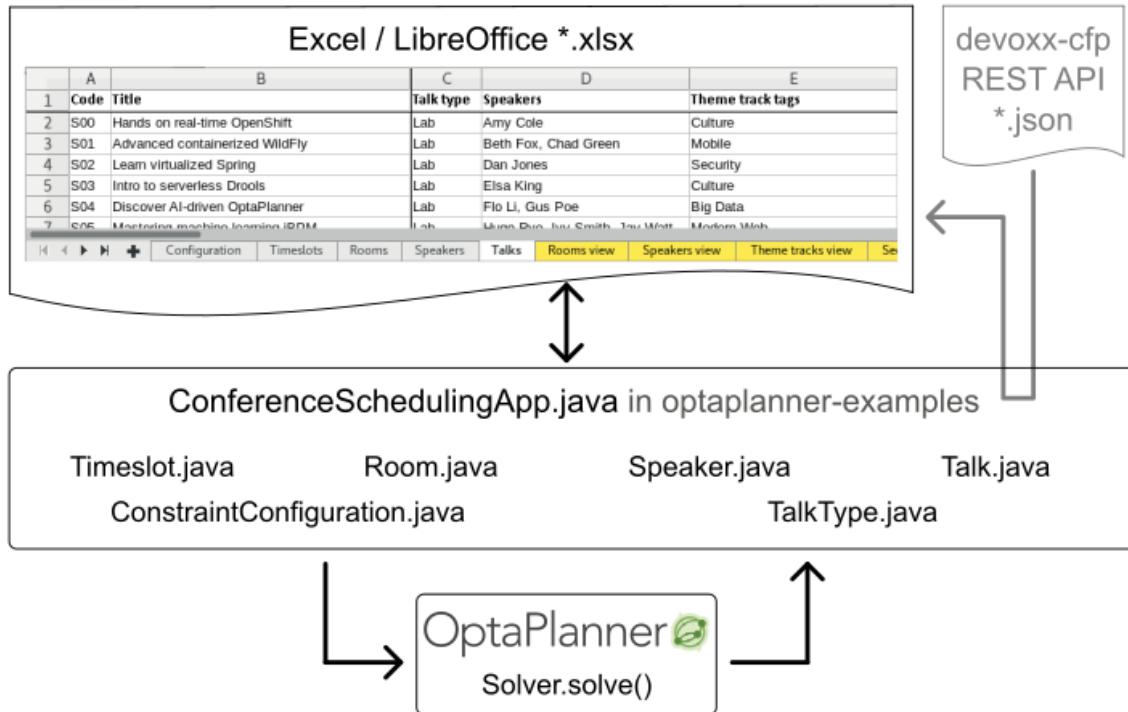
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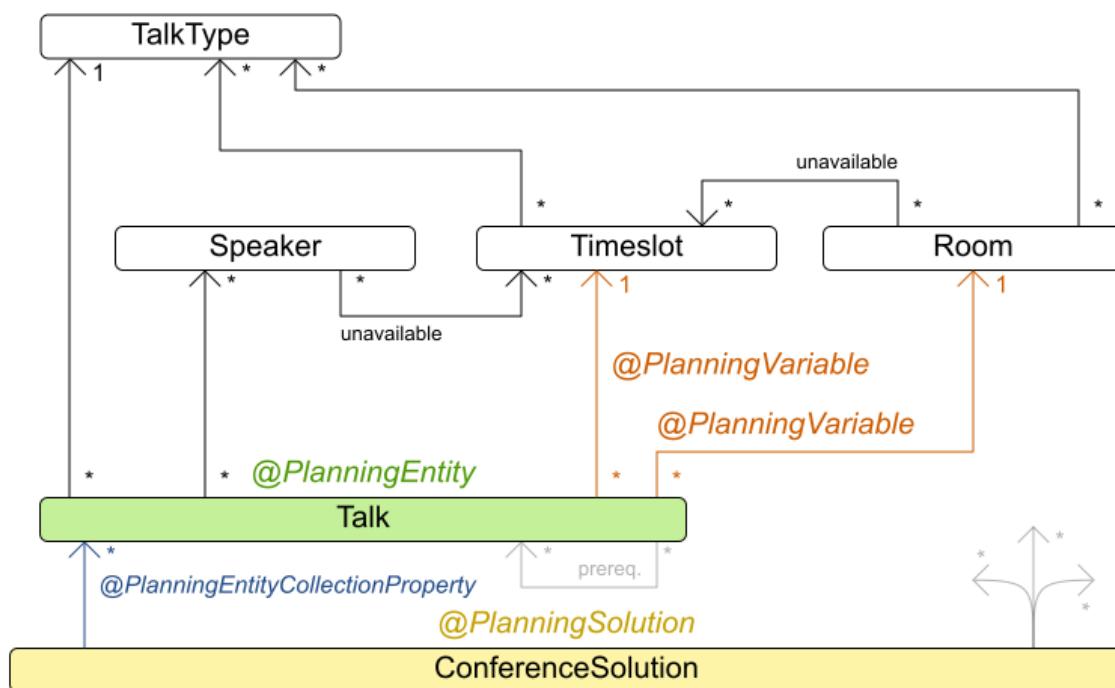
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Conference scheduling architecture

Planner works with plain Java objects that are read/written to *.xlsx

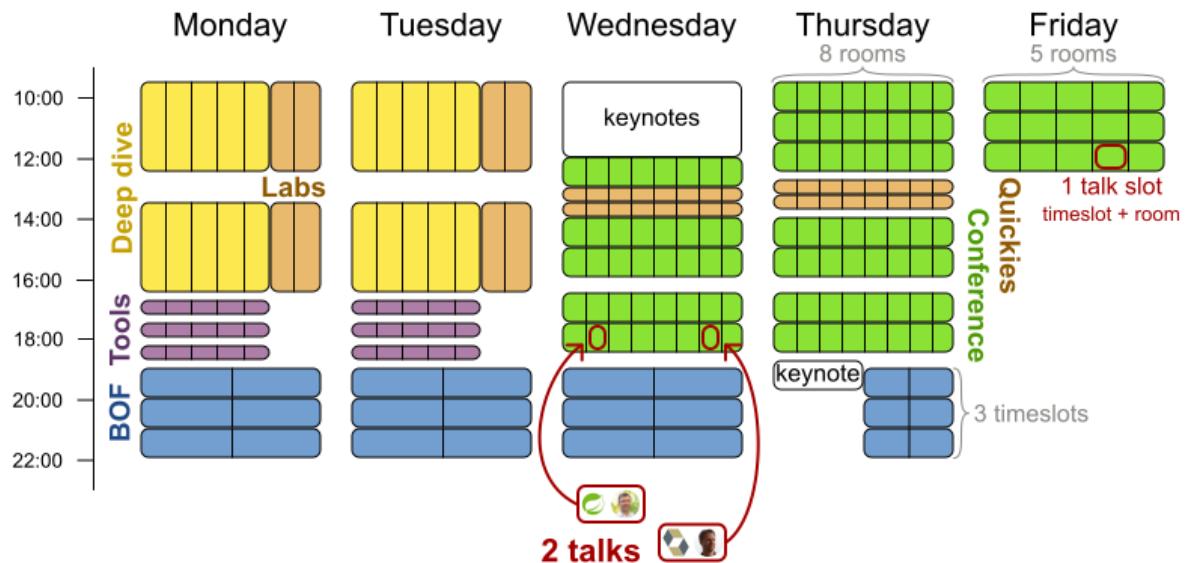


Conference scheduling class diagram



Conference scheduling problem

Assign each talk to a timeslot and a room.



Devoxx Belgium assigns 214 talks to 40 timeslots and 10 rooms for 3500 attendees.

Constraint name	Match count	Score total
Audience level diversity	15	15soft
Audience type diversity	13	13soft
Crowd control	13	-130soft
Popular talks	22	-220soft
Room stability	17	-170soft
Speaker unavailable timeslot	1	-1hard
Theme track conflict	3	-30soft

Constraint matches of selected constraint type
[S11, ConferenceParametrization-0] = -1hard

A	B	C
1 Conference name	Javoxx 2021	
2		
3 Constraint		
4 Theme track conflict		10 Soft penalty per common theme track of 2 talks that have an overlapping timeslot
5 Sector conflict		10 Soft penalty per common sector of 2 talks that have an overlapping timeslot
6 Audience type diversity		10 Soft penalty per 2 talks that have different audience types
7 Audience type theme track conflict		10 Soft penalty per 2 talks that have a common audience type, have a common theme track and have an overlapping timeslot
8 Audience level diversity		10 Soft penalty per common content of 2 talks with a different audience level for which the easier talk isn't scheduled earlier than the other talk
9 Audience level flow per content violation		10 Soft penalty per common content of 2 talks that have an overlapping timeslot
10 Content conflict		10 Soft reward per 2 talks that have the same timeslot and a different language
11 Language diversity		10 Soft penalty per missing preferred tag in a talk's timeslot
12 Speaker preferred timeslot tags		20 Soft penalty per undesired tag in a talk's timeslot
13 Speaker undesired timeslot tags		20 Soft penalty per missing preferred tag in a talk's timeslot
14 Talk preferred timeslot tags		20 Soft penalty per undesired tag in a talk's timeslot
15 Talk undesired timeslot tags		20 Soft penalty per missing preferred tag in a talk's room
16 Speaker preferred room tags		20 Soft penalty per undesired tag in a talk's room
17 Speaker undesired room tags		20 Soft penalty per missing preferred tag in a talk's room
18 Talk preferred room tags		20 Soft penalty per undesired tag in a talk's room
19 Talk undesired room tags		20 Soft penalty per missing preferred tag in a talk's room
20 Same day talks		20 Soft penalty per 2 talks that share the same day
21 Popular talks		10 Soft penalty per 2 talks where the less popular one (has lower favorite count) is assigned a larger room than the more popular talk
22 Crowd control		10 Soft penalty per talk with crowd control risk greater than zero that are not in pairs
23 Published room		10 Soft penalty per talk scheduled at a different room than its published one
24 Room stability		10 Soft penalty per two talks with the same track scheduled in the same day but at different rooms
25		
26 Talk mutually-exclusive-talks tags		1 Medium penalty per two talks that share the same mutually exclusive talks tag that are scheduled in overlapping timeslots
27 Published timeslot		10 Medium penalty per talk scheduled at a different timeslot than its published one
28		
29 Talk type of timeslot		10000 Hard penalty per talk in a timeslot with another talk type
30 Talk type of room		10000 Hard penalty per talk in a room with another talk type
31 Room unavailable timeslot		10000 Hard penalty per talk with an unavailable room at its timeslot
32 Room conflict		10000 Hard penalty per pair of talks in the same room in overlapping timeslots
33 Speaker unavailable timeslot		10000 Hard penalty per talk with an unavailable speaker at its timeslot
34 Speaker conflict		10000 Hard penalty per pair of talks with the same speaker in overlapping timeslots
35 Speaker required timeslot tags		1 Hard penalty per missing required tag in a talk's timeslot
36 Speaker prohibited timeslot tags		1 Hard penalty per prohibited tag in a talk's timeslot
37 Talk required timeslot tags		1 Hard penalty per missing required tag in a talk's timeslot
38 Talk prohibited timeslot tags		1 Hard penalty per prohibited tag in a talk's timeslot
39 Speaker required room tags		1 Hard penalty per missing required tag in a talk's room
40 Speaker prohibited room tags		1 Hard penalty per prohibited tag in a talk's room
41 Talk required room tags		1 Hard penalty per missing required tag in a talk's room
42 Talk prohibited room tags		1 Hard penalty per prohibited tag in a talk's room
43 Talk prerequisite talks		1 Hard penalty per talk that is scheduled before any of its prerequisite talks

A	B	C	D	E	F	G
1	Mon 2018-10-01	10:15-11:00	11:30-12:15	13:00-15:00	15:30-16:15	16:30-17:15
2 Room	10:15-12:15	S10: Prepare for streaming GWT Dan Jones	S13: Grok distributed Weld Hugo Rye		S09: Debug enterprise Hibermate Chad Green	S08: Securing scalable Docker Beth Fox
3 R 1					S04: Discover AI-driven OptaPlanner Gus Poe, Hugo Rye	S14: Troubleshooting reliable RestEasy Ivy Smith
4 R 2		S16: Deliver stable Tensorflow Amy Fox	S17: Implement platform-independent VertX Beth Green		S03: Intro to serverless Drools Flo Li	S07: Building deep learning XStream Amy Fox, Beth Green, Amy Cole
5 R 3		S05: Mastering machine learning jBPM Ivy Smith	S11: Understand mobile Errai Elsa King, Flo Li		S02: Learn virtualized Spring Elsa King	S06: Tuning IOT-driven Camel Jay Watt
6 R 4		S12: Applying modern Angular Gus Poe	S15: Using secure Android Jay Watt			
7 R 5	S00: Hands on real-time OpenShift Amy Cole, Beth Fox		S01: Advanced containerized WildFly Chad Green, Dan Jones			
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ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Rock Tour



- **Business Scenario / Problem Description**
- **Drive the rock bus from rock-show to rock-show, but schedule rock-shows only on available days.**
- **Hard constraints:**
 - Schedule every required show.
 - Schedule as many shows as possible.
- **Medium constraints:**
 - Maximize revenue opportunity.
 - Minimize driving time.
 - Visit sooner than later.
- **Soft constraints:**
 - Avoid long driving times.

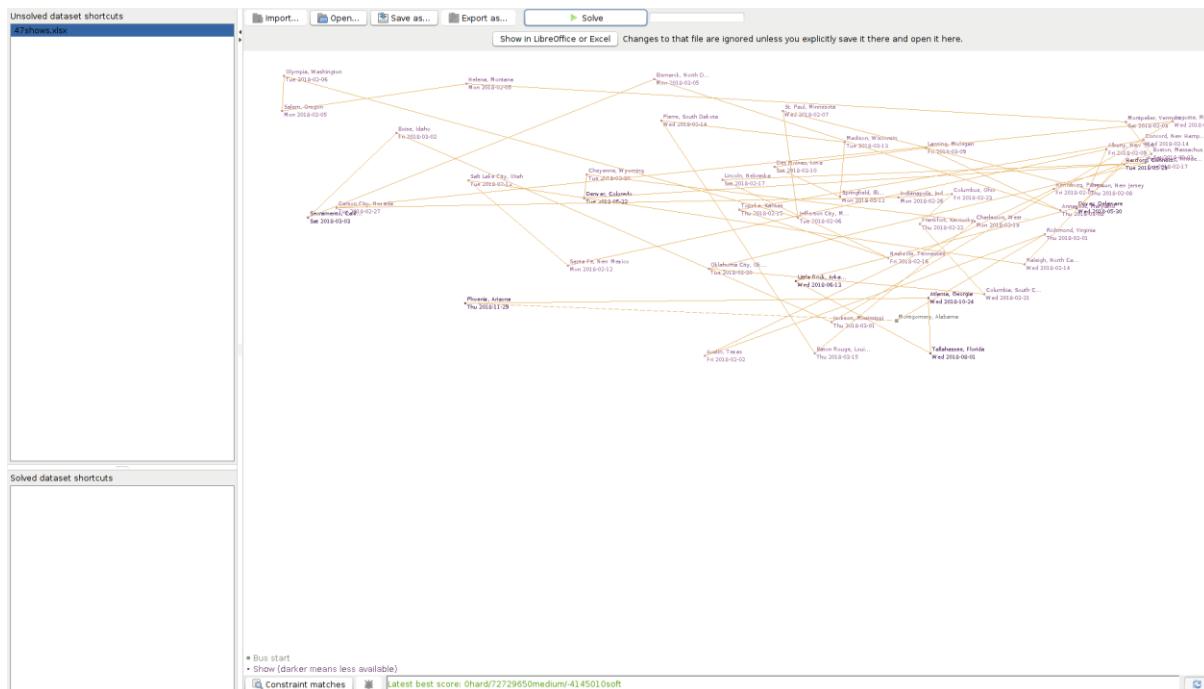
409

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram



410



	Date	Venue name	City name	Driving time	Driving time per week	Latitude	Longitude	Duration (in days)	Revenue opportunity	Required	Available dates size
2	Thu 2018-02-01	Richmond, Virginia	Richmond, Virginia	0 hours 6 minutes		37.538857	-77.43364	0.5	2400000	0	224
3	Fri 2018-02-02	Austin, Texas	Austin, Texas	0 hours 2 minutes		30.27467	-97.740349	0.5	200000	0	256
4		Harrisburg, Pennsylvania	Harrisburg, Pennsylvania	0 hours 0 minutes		40.264378	-76.883598	0.5	100000	0	252
5	Sat 2018-02-03	Boston, Massachusetts	Boston, Massachusetts	0 hours 1 minutes		42.358162	-71.063698	0.5	600000	0	225
6		Montpelier, Vermont	Montpelier, Vermont	0 hours 0 minutes		44.262436	-72.580536	0.5	100000	0	209
7	Sun 2018-02-04				0 hours 12 minutes						
8	Mon 2018-02-05	Helena, Montana	Helena, Montana	0 hours 1 minutes		46.585709	-112.018417	0.5	1300000	0	215
9		Salem, Oregon	Salem, Oregon	0 hours 0 minutes		44.938461	-123.030403	0.5	1200000	0	231
10	Tue 2018-02-06	Olympia, Washington	Olympia, Washington	0 hours 0 minutes		47.035805	-122.905014	0.5	1800000	0	222
11		Jefferson City, Missouri	Jefferson City, Missouri	0 hours 3 minutes		38.579201	-92.172935	0.5	1800000	0	235
12	Wed 2018-02-07	St. Paul, Minnesota	St. Paul, Minnesota	0 hours 1 minutes		44.955097	-93.102211	1	600000	0	248
13	Thu 2018-02-08	Trenton, New Jersey	Trenton, New Jersey	0 hours 3 minutes		40.220596	-74.769913	0.5	1100000	0	227
	Fri 2018-	Albany, New York	Albany, New York	0 hours 0 minutes							

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

KIE OptaPlanner Deep Dive – Flight Crew Scheduling



- **Business Scenario / Problem Description**
- **Assign flights to pilots and flight attendants.**
- **Hard constraints:**
 - Required skill: each flight assignment has a required skill. For example, flight AB0001 requires 2 pilots and 3 flight attendants.
 - Flight conflict: each employee can only attend one flight at the same time
 - Transfer between two flights: between two flights, an employee must be able to transfer from the arrival airport to the departure airport. For example, Ann arrives in Brussels at 10:00 and departs in Amsterdam at 15:00.
 - Employee unavailability: the employee must be available on the day of the flight. For example, Ann is on PTO on 1-Feb.
- **Soft constraints:**
 - First assignment departing from home
 - Last assignment arriving at home
 - Load balance flight duration total per employee

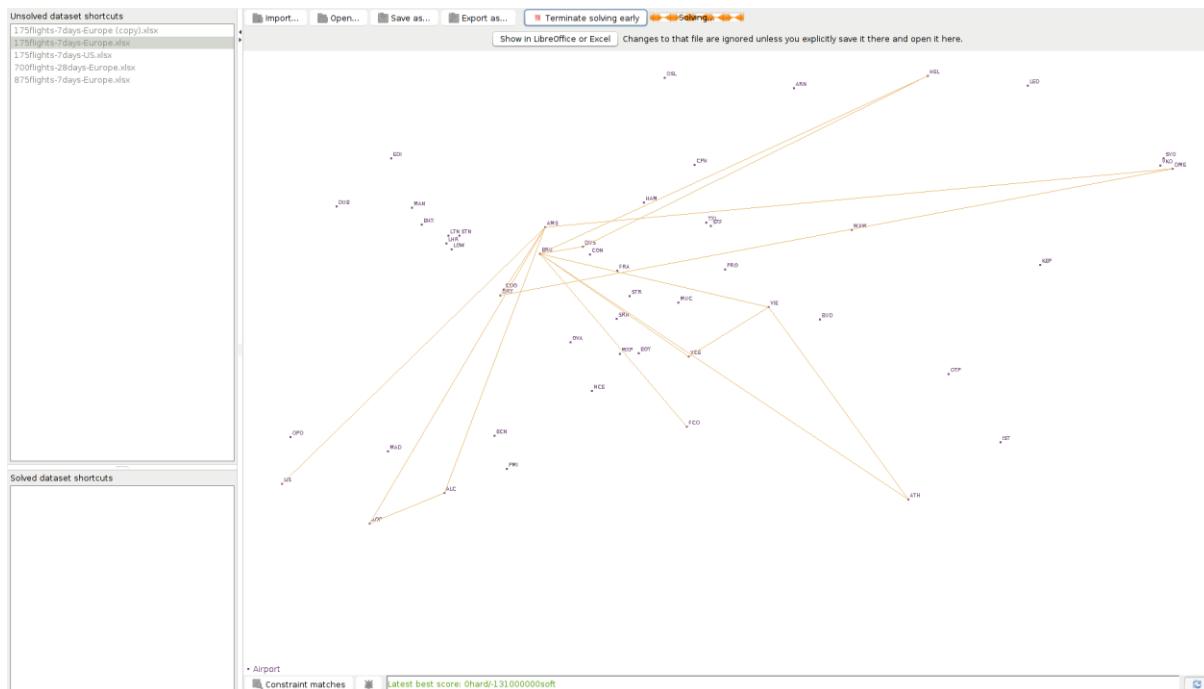
420

ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram

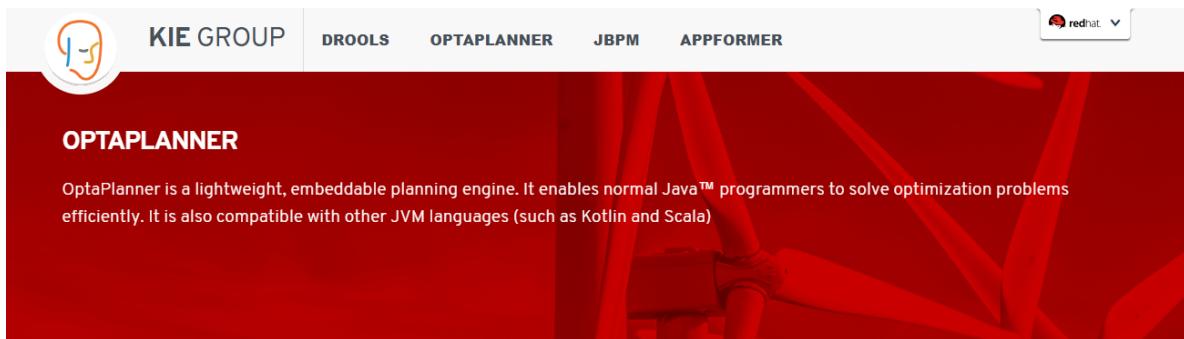


421



A	B	C	D	E	F	G	H
Flight number	Departure airport code	Departure UTC date time	Arrival airport code	Arrival UTC date time	Employee skill requirements	Employee assignments	
2 AB003	BRU	2018-01-01 07:08	ATH	2018-01-01 10:44	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Amy O. Cole, Flo T. Li, Chad Q. Green, Dan R. Jones, Elsa S. Li	
3 AB008	BRU	2018-01-01 09:01	VIE	2018-01-01 11:26	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Poe, Amy O. Fox, Jay X. Cole, Chad Q. King, Dan R. Li	
4 AB021	BRU	2018-01-01 13:36	FCO	2018-01-01 13:19	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Poe, Amy O. Fox, Jay X. Cole, Chad Q. King, Dan R. Li	
5 AB018	BRU	2018-01-01 11:05	DUK	2018-01-01 18:47	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Poe, Amy O. Fox, Jay X. Cole, Chad Q. King, Dan R. Li	
6 AB006	BRU	2018-01-01 16:27	VCE	2018-01-01 18:47	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Li, Flo T. Watt, Dan R. Rye, Elsa S. Smith, Hugo V. Fox	
7 AB001	AMS	2018-01-01 06:39	AGP	2018-01-01 10:02	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Fox, Beth P. Green, Elsa S. King, Hugo V. Rye, Jay X. Watt	
8 AB023	AMS	2018-01-01 06:55	AGP	2018-01-01 10:18	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Flo T. Poe, Beth P. Jones, Chad Q. Jones, Dan R. King, Hugo V. Smith	
9 AB011	AMS	2018-01-01 07:02	LIS	2018-01-01 10:22	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Flo T. Rye, Amy O. Jones, Elsa S. Poe, Dan R. Poe, Hugo V. Cole	
10 AB015	AMS	2018-01-01 11:22	DME	2018-01-01 15:02	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. King, Gus U. Watt, Jay X. Green, Chad Q. Rye, Elsa S. Watt	
11 AB013	AMS	2018-01-01 13:54	DME	2018-01-01 17:34	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Amy O. King, Flo T. Cole, Ivy W. Jones, Hugo V. Jones, Chad Q. Watt	
12 AB022	FCO	2018-01-01 17:16	BRU	2018-01-01 19:56	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Fox, Amy O. Green, Hugo V. Watt, Ivy W. Cole, Jay X. Fox	
13 AB007	ORY	2018-01-01 16:50	AMS	2018-01-01 18:45	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Fox, Amy O. Poe, Dan R. Cole, Elsa S. Fox, Hugo V. King	
14 AB017	DME	2018-01-01 10:57	AMS	2018-01-01 14:37	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Rye, Flo U. Watt, Ivy W. Li, Chad Q. Cole, Ivy W. Poe	
15 AB014	DME	2018-01-01 13:56	ORY	2018-01-01 17:56	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Cole, Amy O. Li, Ivy W. Green, Jay X. Jones, Dan R. Smith	
16 AB012	IUS	2018-01-01 09:12	AMS	2018-01-01 12:32	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Amy O. King, Flo T. Cole, Ivy W. Jones, Hugo V. Jones, Chad Q. Watt	
17 AB019	DUS	2018-01-01 14:45	HEL	2018-01-01 18:45	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Fox, Amy O. Poe, Dan R. Cole, Elsa S. Fox, Hugo V. King	
18 AB009	VIE	2018-01-01 06:45	VCE	2018-01-01 08:12	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Fox, Amy O. Green, Hugo V. Watt, Jay X. King, Dan R. Watt	
19 AB005	VIE	2018-01-01 12:53	BRU	2018-01-01 15:18	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Poe, Amy O. Fox, Dan R. Li, Chad Q. King, Jay X. Cole	
20 AB004	ATH	2018-01-01 07:26	VIE	2018-01-01 10:12	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Rye, Beth P. Smith, Elsa S. Cole, Ivy W. King, Jay X. Li	
21 AB020	HEL	2018-01-01 10:55	BRU	2018-01-01 14:03	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Li, Flo U. Poe, Hugo V. Li, Elsa S. Smith, Hugo V. Fox	
22 AB002	AGP	2018-01-01 08:49	AMS	2018-01-01 12:12	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Watt, Gus U. King, Chad R. Rye, Ivy W. Rye, Hugo V. Jones	
23 AB004	AGP	2018-01-01 17:44	ALC	2018-01-01 19:37	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Fox, Amy T. Cole, Elsa S. King, Hugo V. Rye, Jay X. Watt	
24 AB025	ALC	2018-01-01 14:44	AMS	2018-01-01 19:50	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Amy P. Fox, Amy P. Li, Elsa T. Li, Chad R. King, Elsa T. Poe	
25 AB007	VCE	2018-01-01 07:14	BRU	2018-01-01 09:34	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Rye, Amy O. Green, Hugo V. Watt, Hugo V. Smith, Jay X. Fox	
26 AB010	VCE	2018-01-01 16:05	BRU	2018-01-01 18:25	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Gus U. Green, Hugo V. Green, Jay X. King, Dan R. Watt	
27 AB003	BRU	2018-01-02 07:08	ATH	2018-01-02 10:44	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Green, Gus U. Poe, Ivy W. Watt, Jay X. Cole, Chad Q. King	
28 AB005	BRU	2018-01-02 09:01	VIE	2018-01-02 11:26	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Amy O. Fox, Gus U. Rye, Dan R. Li, Hugo V. Watt, Ivy W. Cole	
29 AB021	BRU	2018-01-02 09:36	FCO	2018-01-02 12:16	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Amy O. Green, Beth P. Poe, Jay X. Fox, Hugo V. Green, Jay X. King	
30 AB018	BRU	2018-01-02 13:40	DUS	2018-01-02 13:38	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Flo T. Cole, Gus U. Jones, Chad Q. Smith, Dan R. Watt, Jay X. Poe	
31 AB006	BRU	2018-01-02 16:27	VCE	2018-01-02 18:47	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Fox, Amy O. Green, Hugo V. Watt, Jay X. King, Dan R. Watt	
32 AB001	AMS	2018-01-02 06:45	AGP	2018-01-02 10:02	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Fox, Amy O. Poe, Ivy W. Smith, Chad Q. King, Dan R. Cole	
33 AB023	AMS	2018-01-02 06:55	AGP	2018-01-02 10:18	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Rye, Flo T. Fox, Elsa S. Fox, Hugo V. King, Ivy W. Li	
34 AB011	AMS	2018-01-02 07:02	LIS	2018-01-02 10:22	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Watt, Gus U. King, Chad Q. Cole, Ivy W. Poe, Jay X. Rye	
35 AB016	AMS	2018-01-02 11:22	DME	2018-01-02 15:02	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Amy O. Watt, Beth P. Cole, Ivy W. Rye, Dan S. King, Elsa T. Li	
36 AB013	AMS	2018-01-02 13:54	DME	2018-01-02 17:34	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Flo T. King, Amy P. Fox, Chad R. King, Elsa T. Poe, Jay O. Fox	
37 AB022	FCO	2018-01-02 17:16	BRU	2018-01-02 19:56	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Amy O. Green, Beth P. Poe, Jay X. Fox, Hugo V. Green, Jay X. King	
38 AB008	ORY	2018-01-02 16:50	AMS	2018-01-02 18:45	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Cole, Beth P. Green, Jay X. Jones, Ivy W. Green, Dan R. Smith	
39 AB017	DME	2018-01-02 10:57	AMS	2018-01-02 14:37	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. King, Gus U. Watt, Jay X. Green, Elsa S. Watt, Ivy W. Jones	
40 AB014	DME	2018-01-02 13:56	ORY	2018-01-02 17:56	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Amy O. King, Flo T. Cole, Hugo V. Jones, Chad Q. Watt, Dan R. Green	
41 AB012	IUS	2018-01-02 09:12	AMS	2018-01-02 12:32	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Flo T. Rye, Amy O. Jones, Elsa S. Poe, Dan R. Poe, Hugo V. Cole	
42 AB019	IUS	2018-01-02 14:45	HEL	2018-01-02 17:45	Pilot, Pilot, Flight attendant, Flight attendant, Flight attendant	Flo T. Green, Gus U. Jones, Chad Q. Smith, Dan R. Watt, Jay X. Poe	

2.5. ANNEX 5 – KIE OptaPlanner Installation



DROOLS

Drools is a business rule management system with a forward-chaining and backward-chaining inference based rules engine, allowing fast and reliable evaluation of business rules and complex event processing.

[Read more →](#)

OPTAPLANNER

OptaPlanner is a constraint solver that optimizes use cases such as employee rostering, vehicle routing, task assignment and cloud optimization.

[Read more →](#)

JBPM

JBPM is a flexible Business Process Management suite allowing you to model your business goals by describing the steps that need to be executed to achieve those goals.

[Read more →](#)

APPFORMER

AppFormer is a low code platform to develop modern applications. It's a powerful tool for developers that can easily build applications by mashing up components and connect them to other Red Hat modules and software.

We make building apps looks easy.

[Read more →](#)

Above: OptaPlanner Installation

<https://www.optaplanner.org/>

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 Eclipse IDE for Java EE Developers 339 MB 374,239 DOWNLOADS Tools for Java developers creating Java EE and Web applications, including a Java IDE, tools for Java EE, JPA, JSF, Mylyn, EGit and others.	 Windows 32-bit 64-bit Mac Cocoa 64-bit Linux 32-bit 64-bit	
Eclipse Modeling Tools 437 MB 8,208 DOWNLOADS		

Above: Install Eclipse IDE

<https://www.eclipse.org/downloads/packages/>

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509 (Edit 2016-10-12: Many Eclipse downloads from <https://eclipse.org/downloads/eclipse-packages/> have M2Eclipse included already. As of Neon both the Java and the Java EE packages do - look for "Maven support")

Maven Eclipse plugin installation step by step:

1. Open Eclipse IDE
2. Click Help -> Install New Software...
3. Click Add button at top right corner
4. At pop up: fill up Name as "M2Eclipse" and Location as "<http://download.eclipse.org/technology/m2e/releases>" or <http://download.eclipse.org/technology/m2e/milestones/1.0>
5. Now click OK

After that installation would be started.

Another way to install Maven plug-in for Eclipse:

1. Open Eclipse
2. Go to Help -> Eclipse Marketplace
3. Search by Maven
4. Click "Install" button at "Maven Integration for Eclipse" section
5. Follow the instruction step by step

After successful installation do the followings in Eclipse:

1. Go to Window -> Preferences
2. Observe, Maven is enlisted at left panel

Finally,

1. Click on an existing project
2. Select Configure -> Convert to Maven Project

share improve this answer edited Oct 12 '16 at 9:05 Thorbjørn Ravn Andersen 56.8k ● 23 ● 142 ● 286 answered Nov 30 '12 at 6:26 Ripon Al Wasim 25.3k ● 30 ● 123 ● 149

4 I have tired these steps but not install, I got some error which detail below.....Cannot complete the install because one or more required items could not be found. Software being installed: m2e - Maven Integration for Eclipse (includes incubating components) 1.5.0.20140606-0033 (org.eclipse.m2e.feature.feature.group 1.5.0.20140606-0033) – Krunal Patel Oct 6 '14 at 6:31 ✓ @Krunal Patel: have you tried from Marketplace? – Ripon Al Wasim Oct 13 '14 at 6:21

I have the same Cannot complete the install because one or more required items could not be found. Software being installed: m2e - slf4j over logback logging (Optional) 1.5.0.20140606-0033 (org.eclipse.m2e.logback.feature.feature.group 1.5.0.20140606-0033) - didn't see the marketplace option under help. – Diego Oct 21 '14 at 0:44

4 Eclipse juno doesnt support maven 1.5..still they have not added capability of 1.5 so try 1.4 or 1.3 download.eclipse.org/technology/m2e/releases/1.3 download.eclipse.org/technology/m2e/releases/1.4 – Alvin Mar 3 '15 at 6:47

Thanks for such a great description but I am not able to install maven either way. Error saying that "Cannot satisfy dependency:" and "annot complete the install because one or more required items could not be found.". I am not sure what's the issue. Please help. – Kushal Jayswal Nov 19 '15 at 12:19

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Above: Install Maven in Eclipse

<https://stackoverflow.com/questions/8620127/maven-in-eclipse-step-by-step-installation>

Name	Description	Download
Drools Engine	Drools Expert is the rule engine and Drools Fusion does complex event processing (CEP). Distribution zip contains binaries, examples, sources and javadocs.	Distribution ZIP
Drools and jBPM integration	Drools and jBPM integration with third party project like Spring. Distribution zip contains binaries, examples and sources.	Distribution ZIP
Drools Workbench	Drools Workbench is the web application and repository to govern Drools and jBPM assets. See documentation for details about installation.	WildFly 14 WAR EAP 7 WAR
Drools and jBPM tools	Eclipse plugins and support for Drools, jBPM and Guvnor functionality. Distribution zip contains binaries and sources.	Distribution ZIP
KIE Execution Server	Standalone execution server that can be used to remotely execute rules using REST, JMS or Java interface. Distribution zip contains WAR files for all supported containers.	Distribution ZIP

Above: Install KIE plug-in for Eclipse

<https://www.drools.org/download/download.html>

kiegroup / optaplanner

Code Pull requests 9 Insights

Branch: master [optaplanner / optaplanner-examples /](#)

geoffrey add breadcrumbs for other conferences to get the import working Latest commit cc1751b 2 days ago

..

data conf scheduling: reorder constraints more logically - crowd control 11 days ago

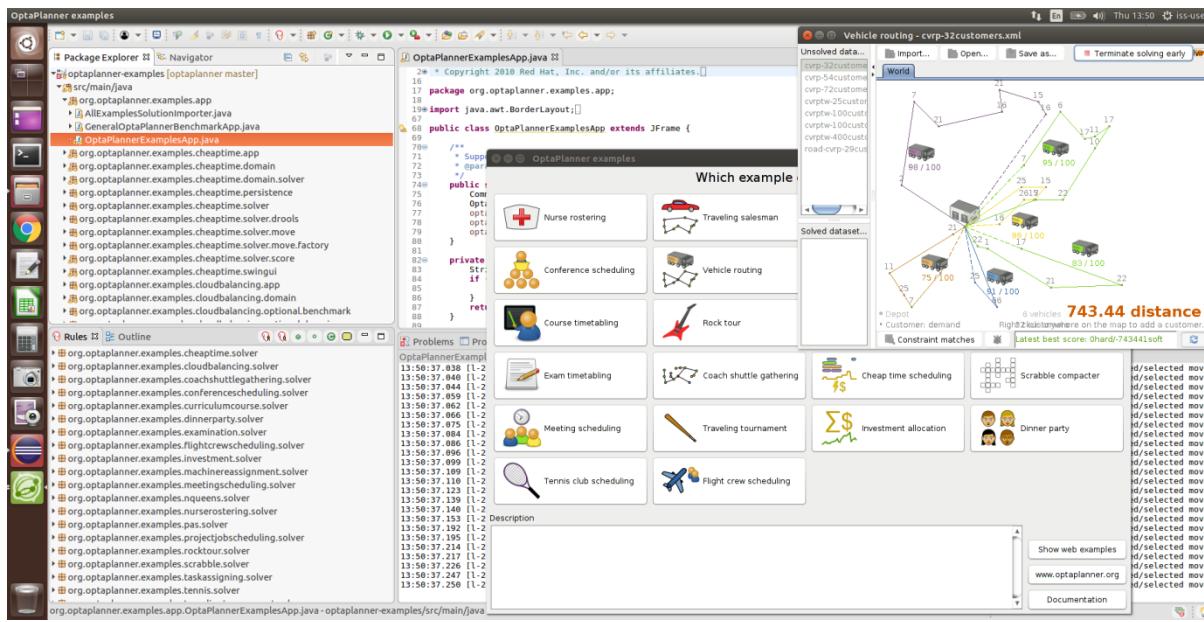
src add breadcrumbs for other conferences to get the import working 18 hours ago

.gitignore Rename drools-planner to optaplanner: rename module directories 6 years ago

pom.xml bumped up to 7.15.0-SNAPSHOT version 15 days ago

Above: Download OptaPlanner source code and example cases

<https://github.com/kiegroup/optaplanner>

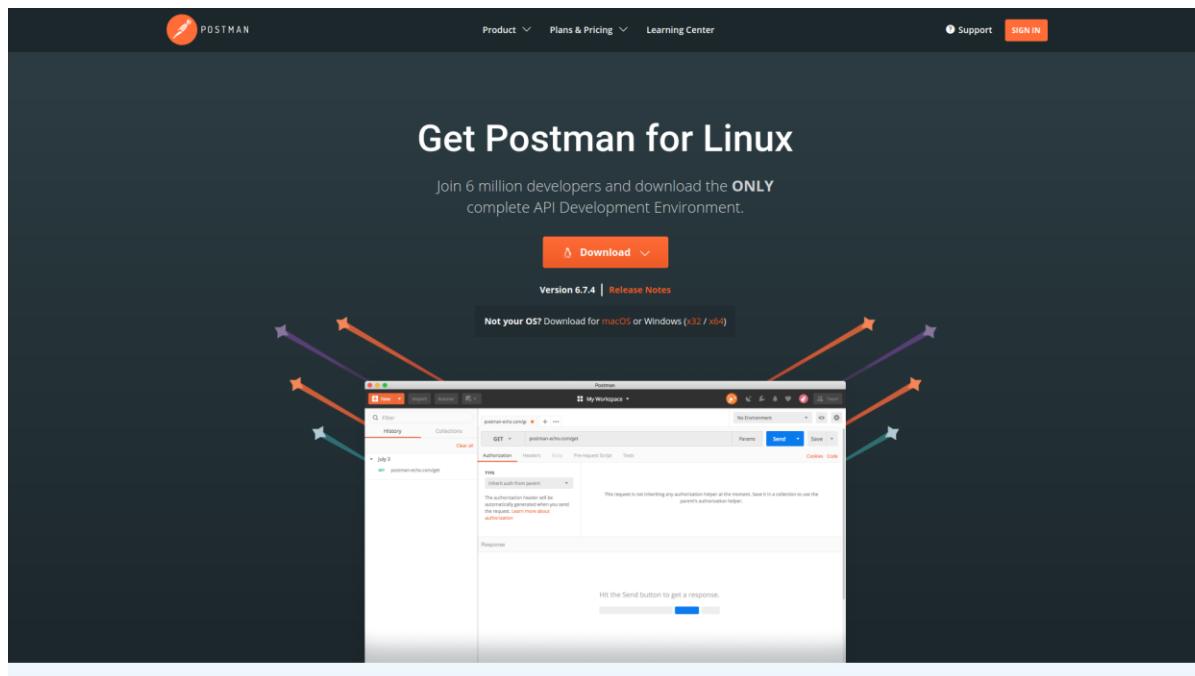


Above: Import OptaPlanner example cases as Maven project in Eclipse

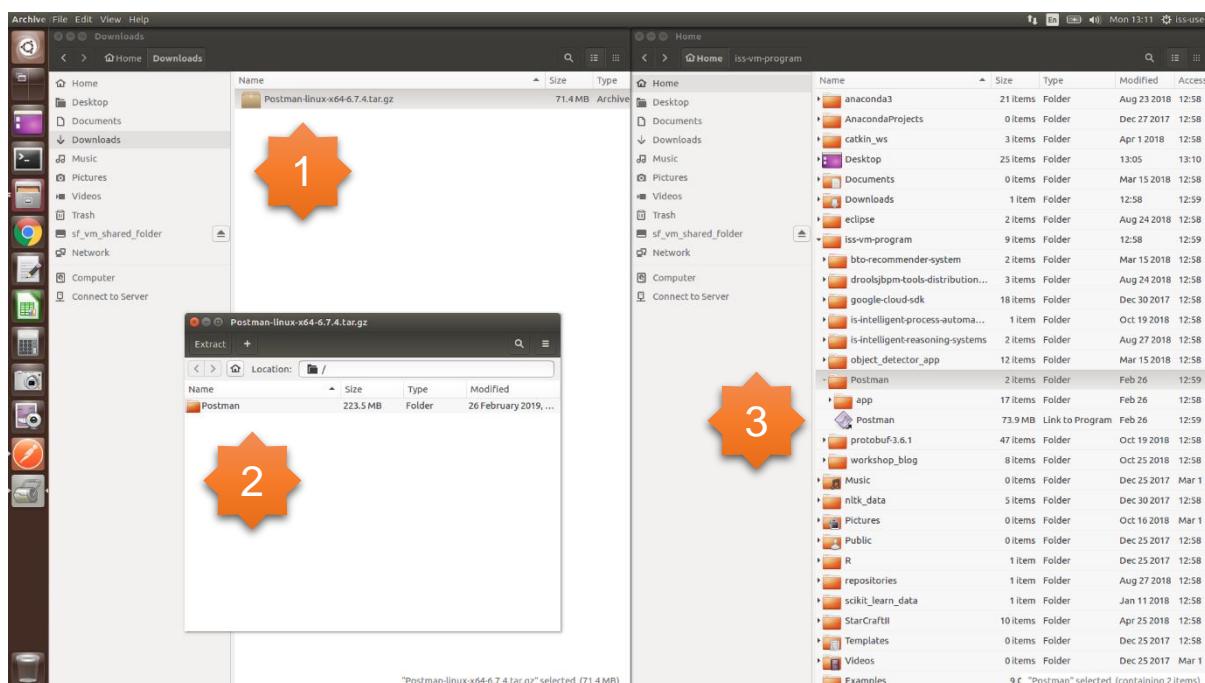
Above: Standalone OptaPlanner

<https://www.optaplanner.org/>

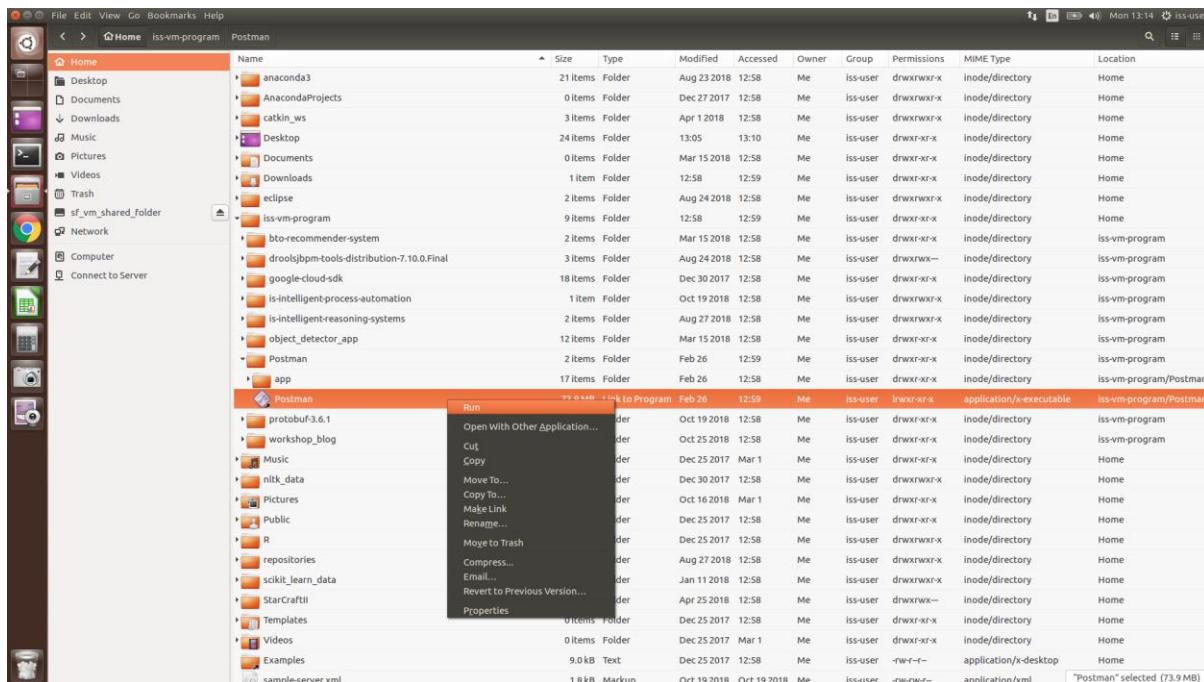
2.6. ANNEX 6 – Postman Installation



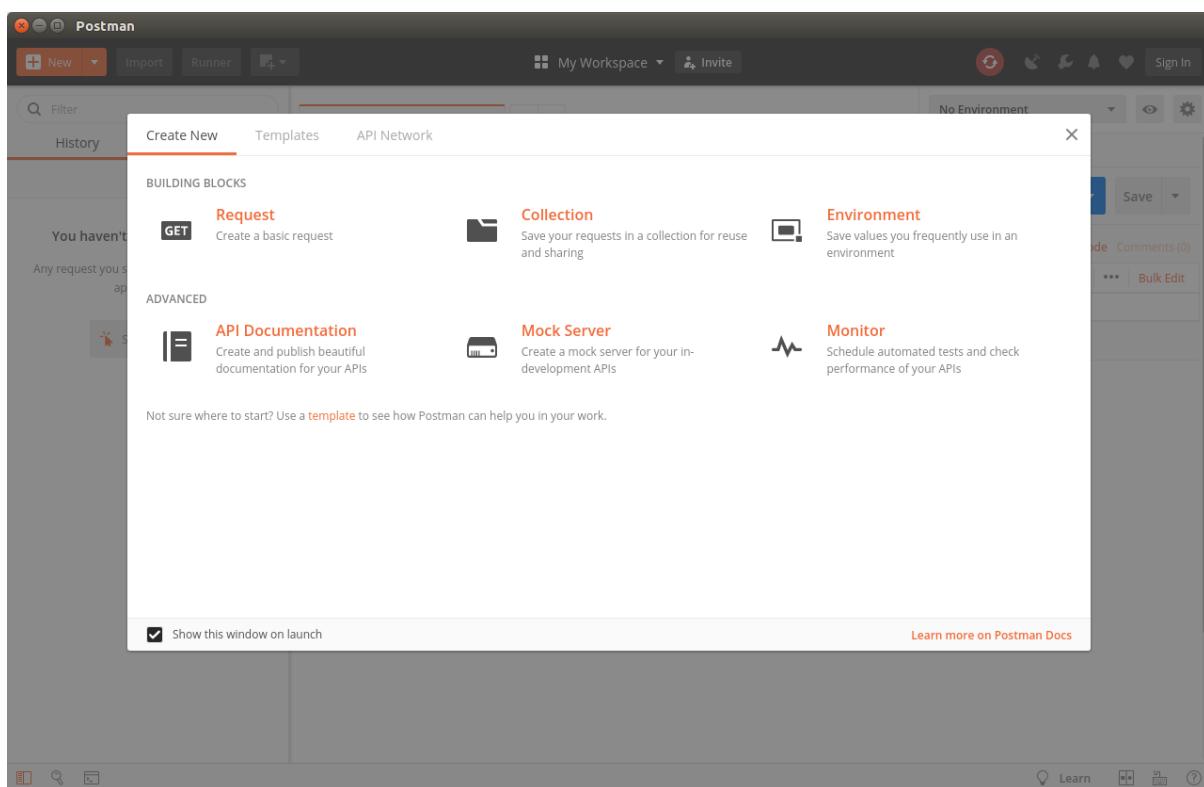
<https://www.getpostman.com/downloads/>



Open/Up-compress downloaded file xxx.tar.gz; Copy folder **Postman** to **/home/iss-user/iss-vm-program/**



Test: Start Postman; Click skip sign up/in at the bottom



Test: Close the welcome window

The End of Workshop Project Guide