

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

**GRADUATE CERTIFICATE  
INTELLIGENT REASONING SYSTEMS**

**Workshop Project Guide (1/5)**

**Subject: Reasoning Systems**

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Singapore 119615



No description, website, or topics provided.

Branch: master New pull request

This branch is 10 commits ahead of telescopeuser:master.

File	Description	Last Commit
telescopeuser Merge pull request #10 from telescopeuser/master	updated S-RS Workshop Guide.pdf	2 days ago
S-RS-Workshop1	updated S-RS Workshop Guide.pdf	2 days ago
S-RS-Workshop2	updated S-RS Workshop Guide.pdf	2 days ago
S-RS-Workshop3	updated S-RS Workshop Guide.pdf	2 days ago
S-RS-Workshop4	updated S-RS Workshop Guide.pdf	2 days ago
S-RS-Workshop5	updated S-RS Workshop Guide.pdf	2 days ago
LICENSE	ISS NUS License	4 months ago
README.md	updated S-RS Workshop Guide.pdf	2 days ago
README.md		

Clone with HTTPS (?)  
Use Git or checkout with SVN using the web URL.  
<https://github.com/IRS-RS/S-RS-Workshop>

Find file Clone or download

Workshops & References <https://github.com/IRS-RS/S-RS-Workshop>



Virtual Machine Workstation <http://bit.ly/iss-vm>

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## 1. Workshop 1 – Search Representation

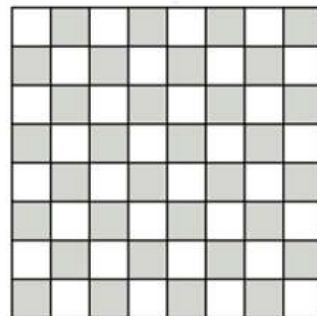
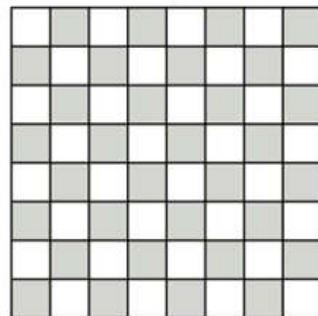
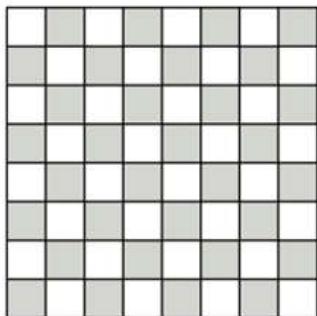
# WORKSHOP SEARCH REPRESENTATION

- **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)

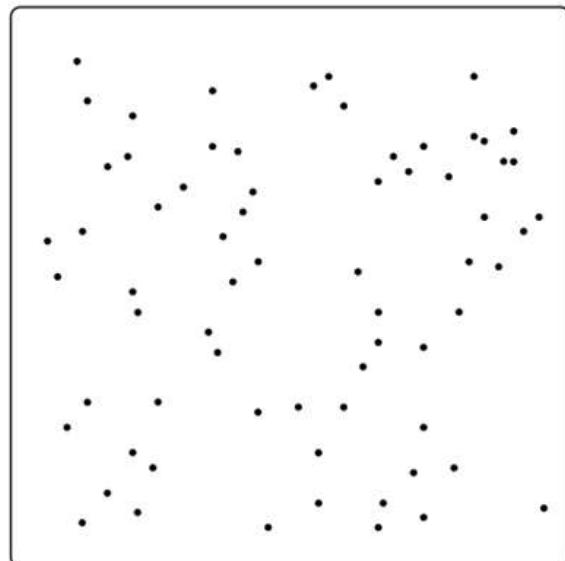
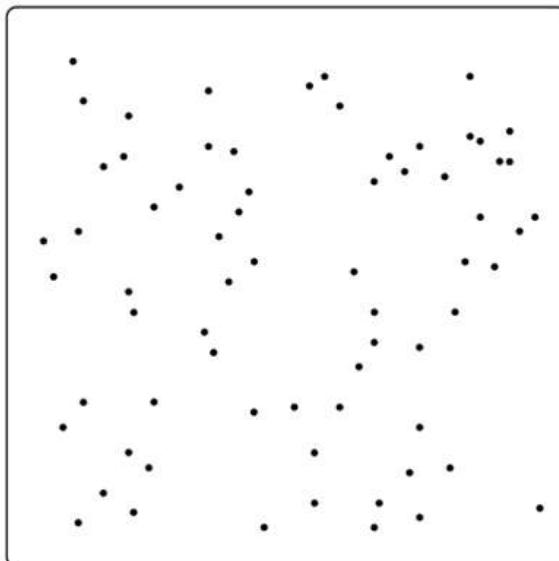
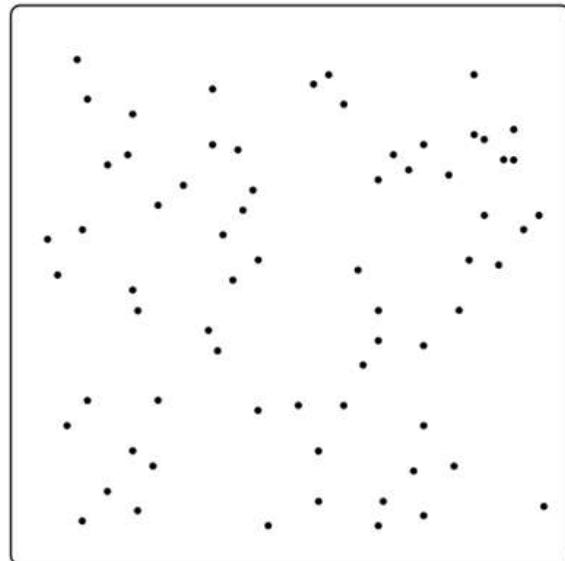
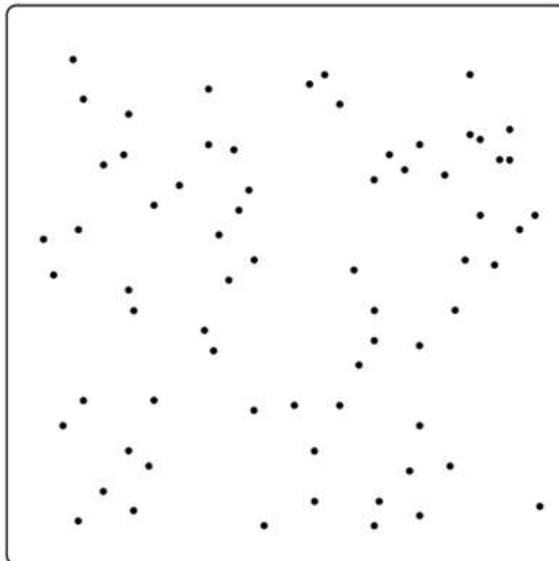
### 1.1. Search Modelling & Representation

#### 1.1.1. Pen & Paper Planning

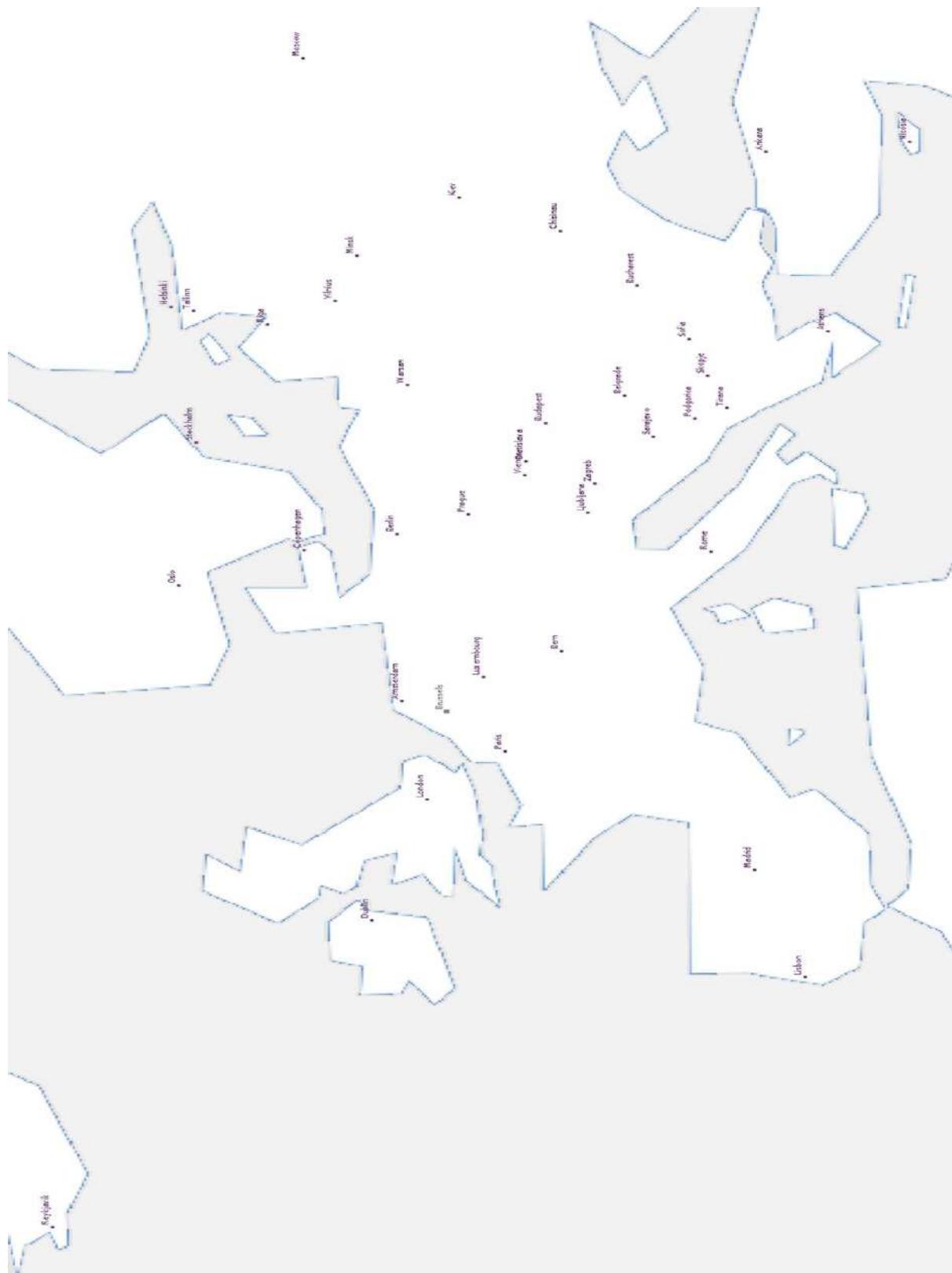
1) Place 8 queens on this chessboard so no 2 queens can attack each other.



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

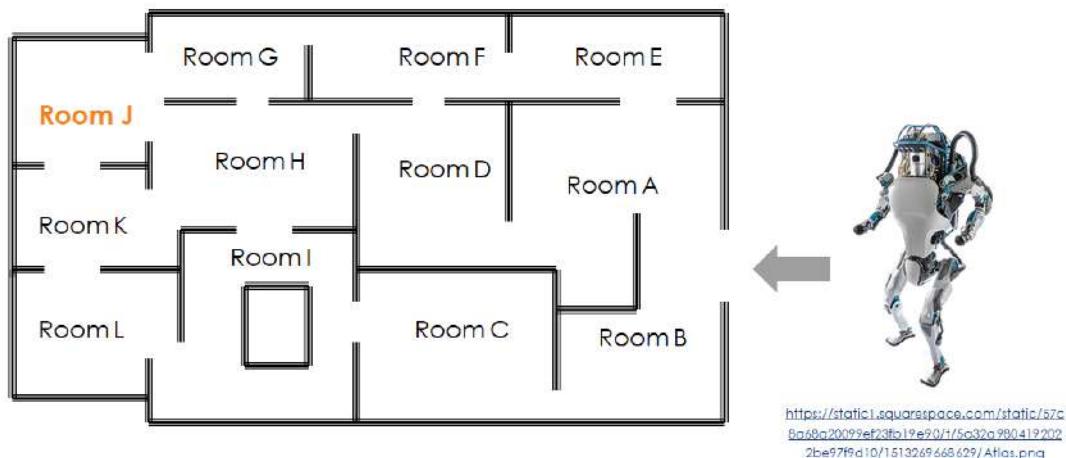


## Plan a Europe round trip (shortest total path preferred)



### 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:**

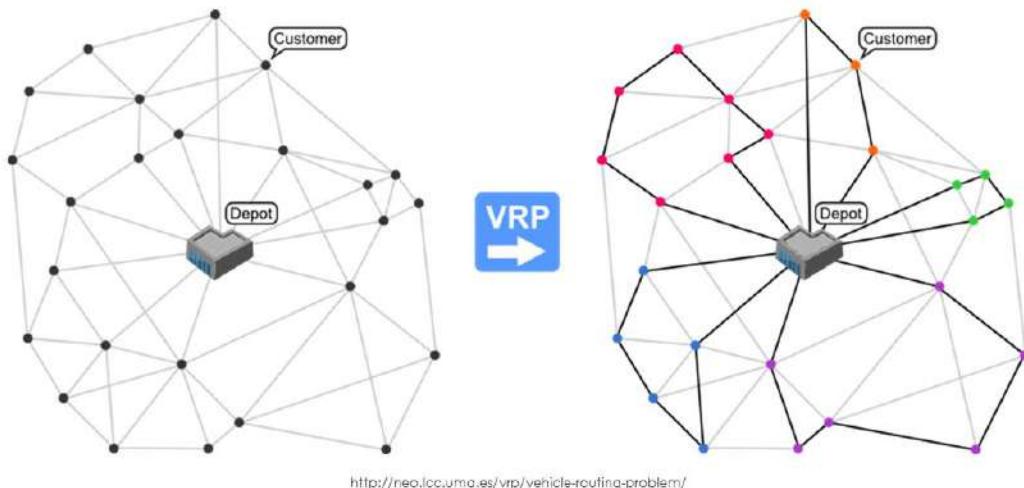
**Write down BFS search order:**

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

### 1.1.3. Vehicle Route Planning (VRP)

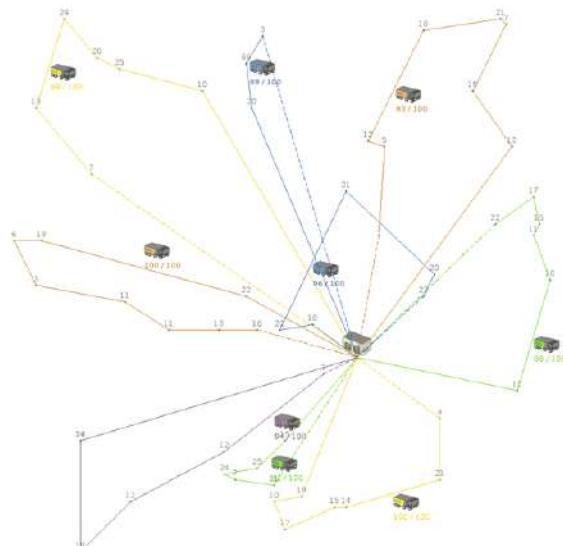
**Form groups: 4-6 learners per group.**

#### 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.



**Try to draw/plan the route for 9 trucks:**



**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 header. It features a logo of a stylized head with orange and blue elements. To the right of the logo, the text "KIE GROUP" is displayed. Below the logo, there are four navigation links: "DROOLS", "OPTAPLANNER", "JBPM", and "APPFORMER". In the top right corner, there is a small "redhat" logo with a dropdown arrow.

**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

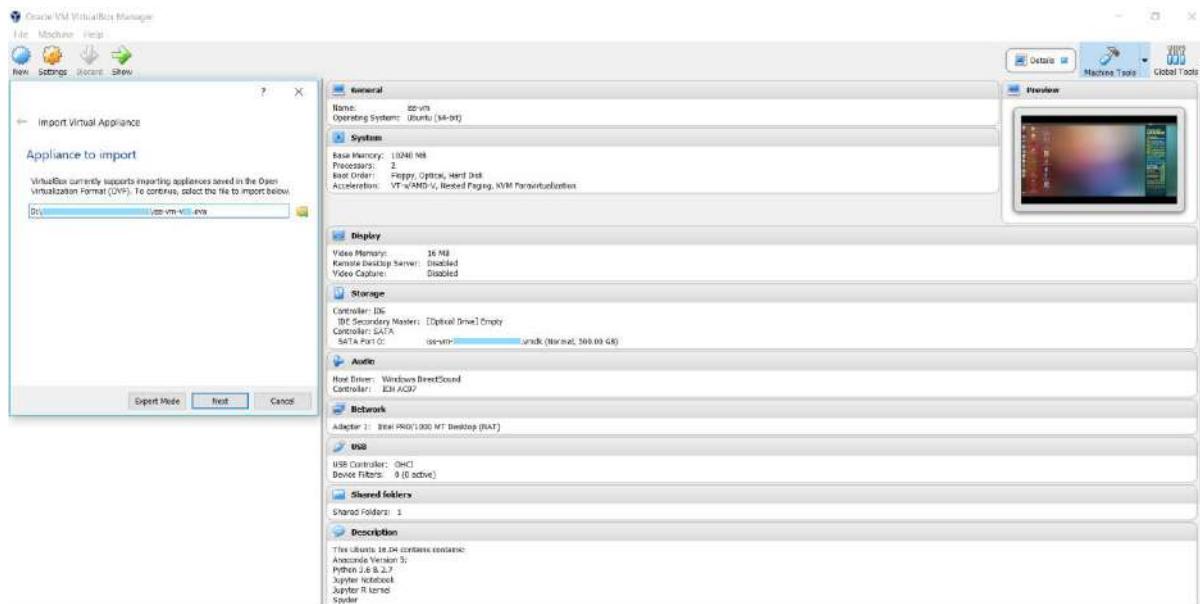
<http://www.kiegroup.org/>

KIE OptaPlanner

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

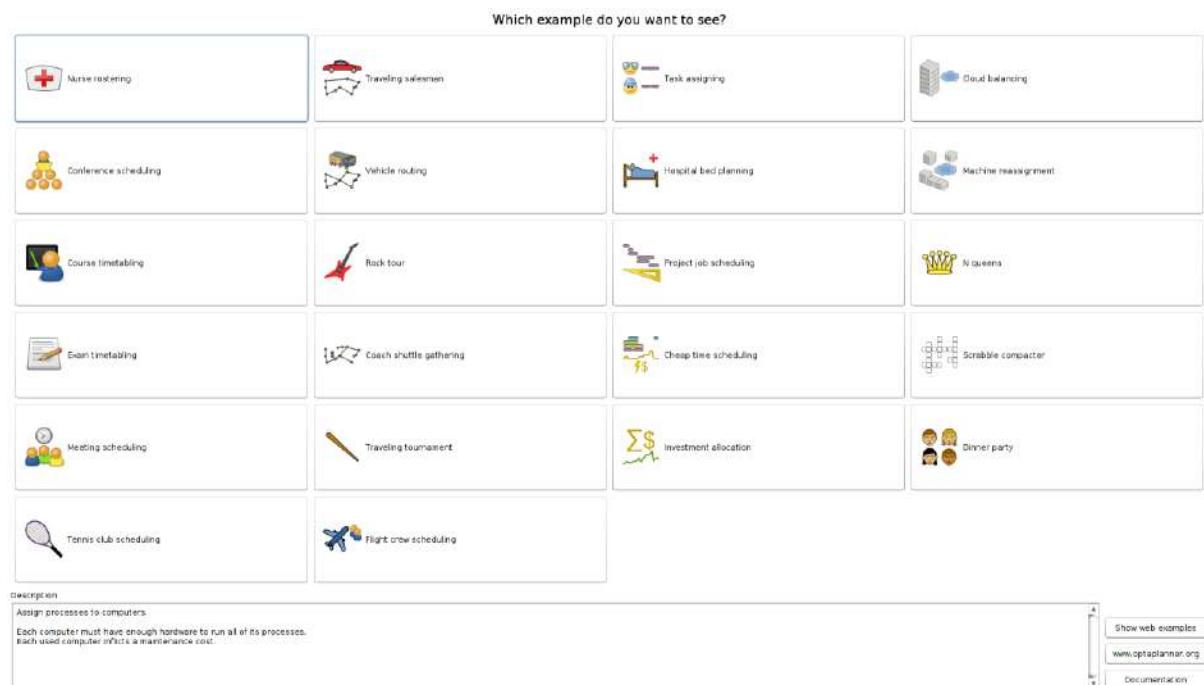
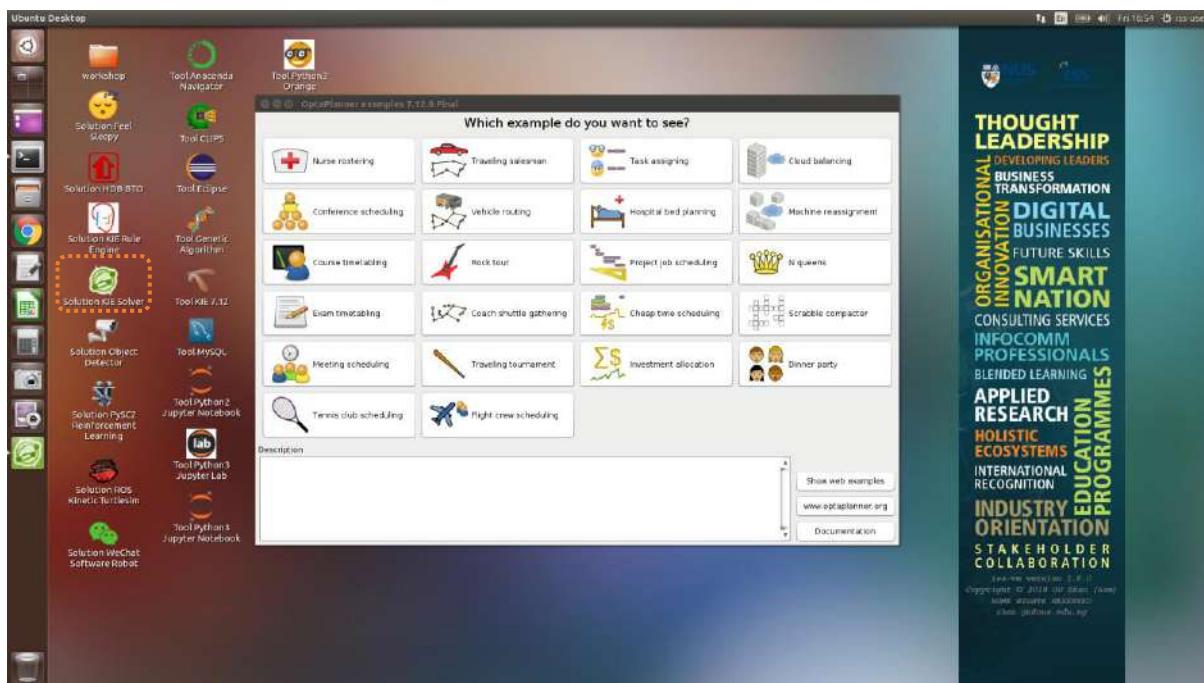
## 1.2.1. OptaPlanner Example Solutions in Graphic User Interface

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



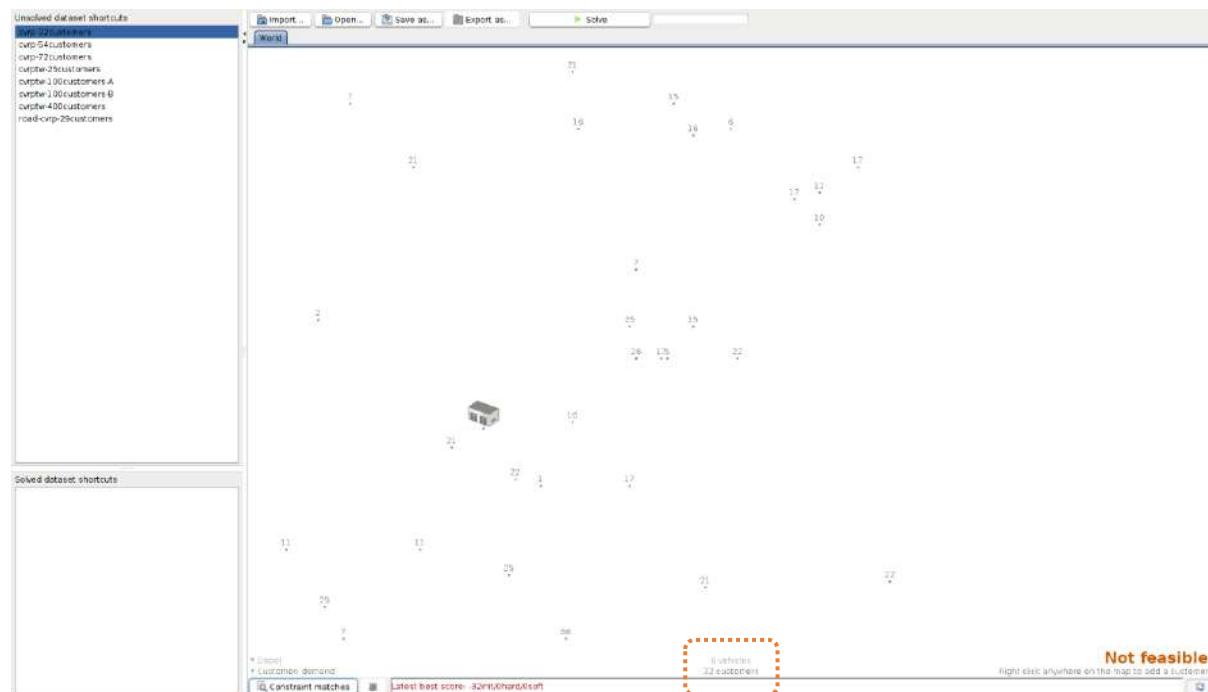
<http://bit.ly/iss-vm>

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

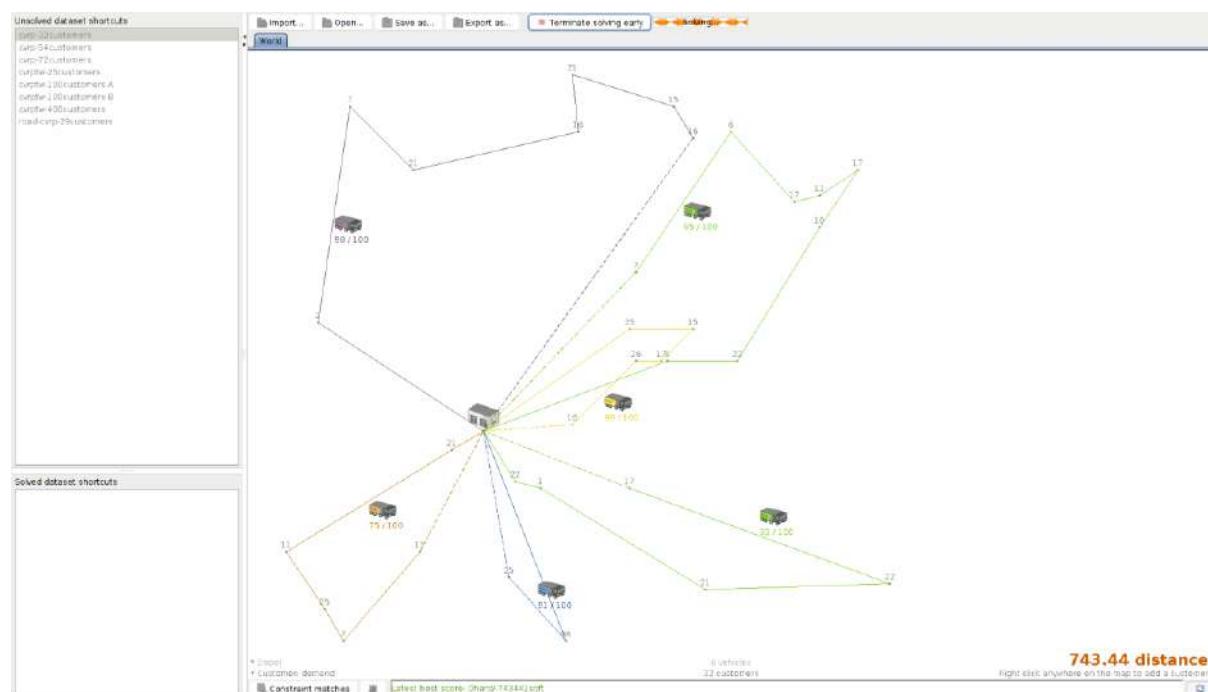


### 3) Start to explore Vehicle routing (VRP).

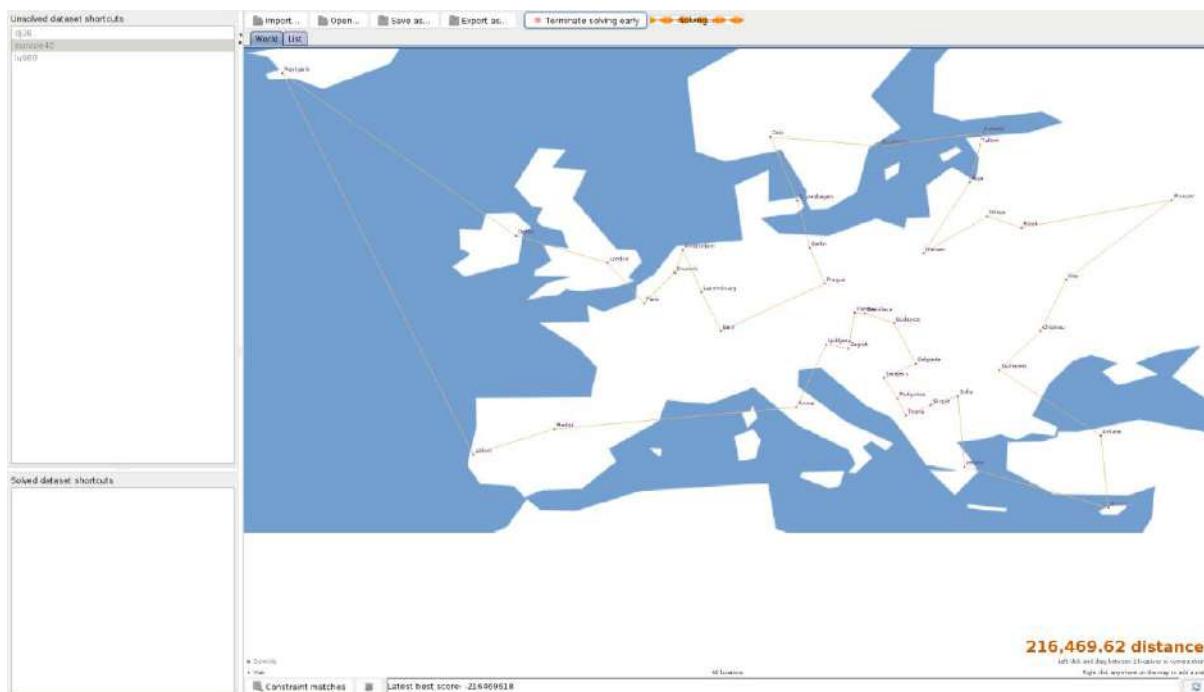
Based on below geospatial map, use pen & paper to plan the **6** trucks' route for **32** customer orders:



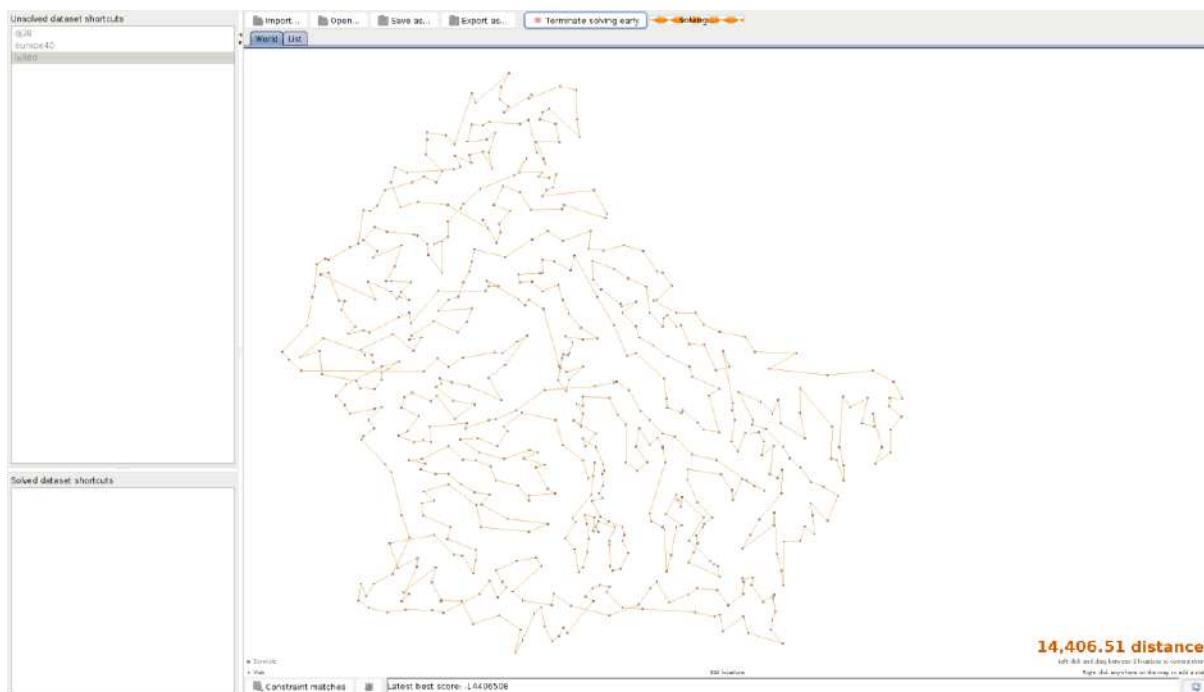
Run the OptaPlanner to view the solution, then compare with above pen & paper solution, which one could be better?



#### 4) Start to explore Travelling salesman (TSP).



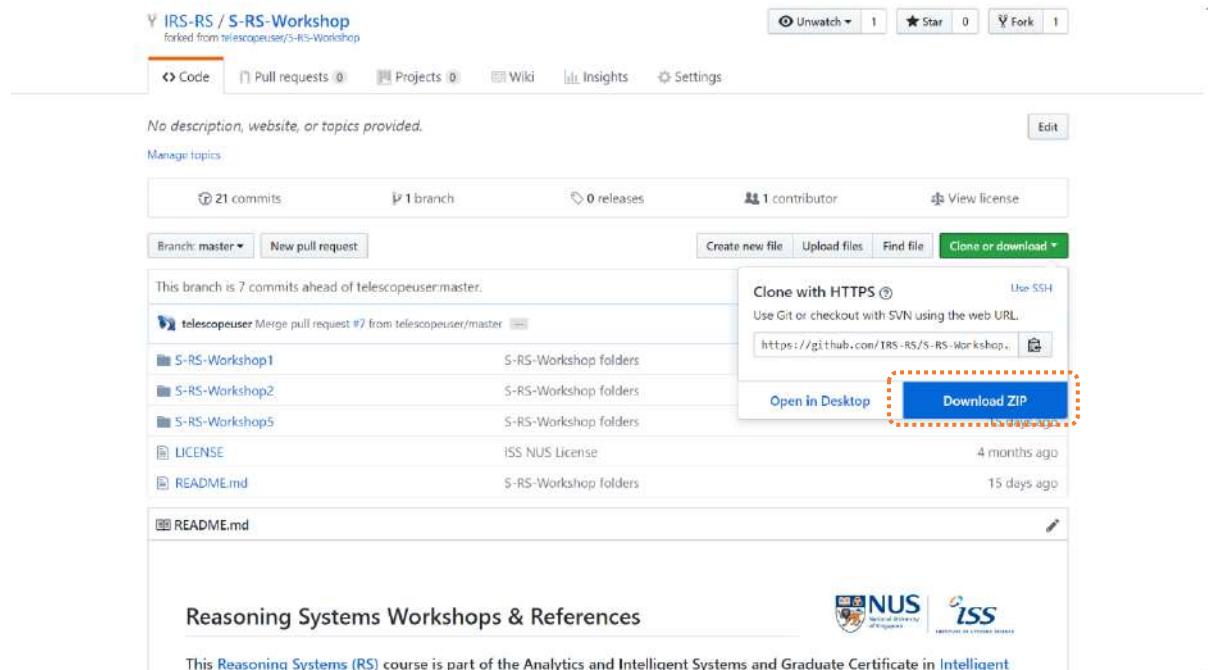
Plan a Europe round trip seems enjoyable, but what about visiting more places like below: to find a shortest travel route?



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

## 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 has 21 commits, 1 branch, 0 releases, and 1 contributor. The 'Clone with HTTPS' section is visible, showing the URL <https://github.com/IRS-RS/S-RS-Workshop>. The 'Download ZIP' button is highlighted with a red box.

**No description, website, or topics provided.**

Manage topics

21 commits 1 branch 0 releases 1 contributor View license

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

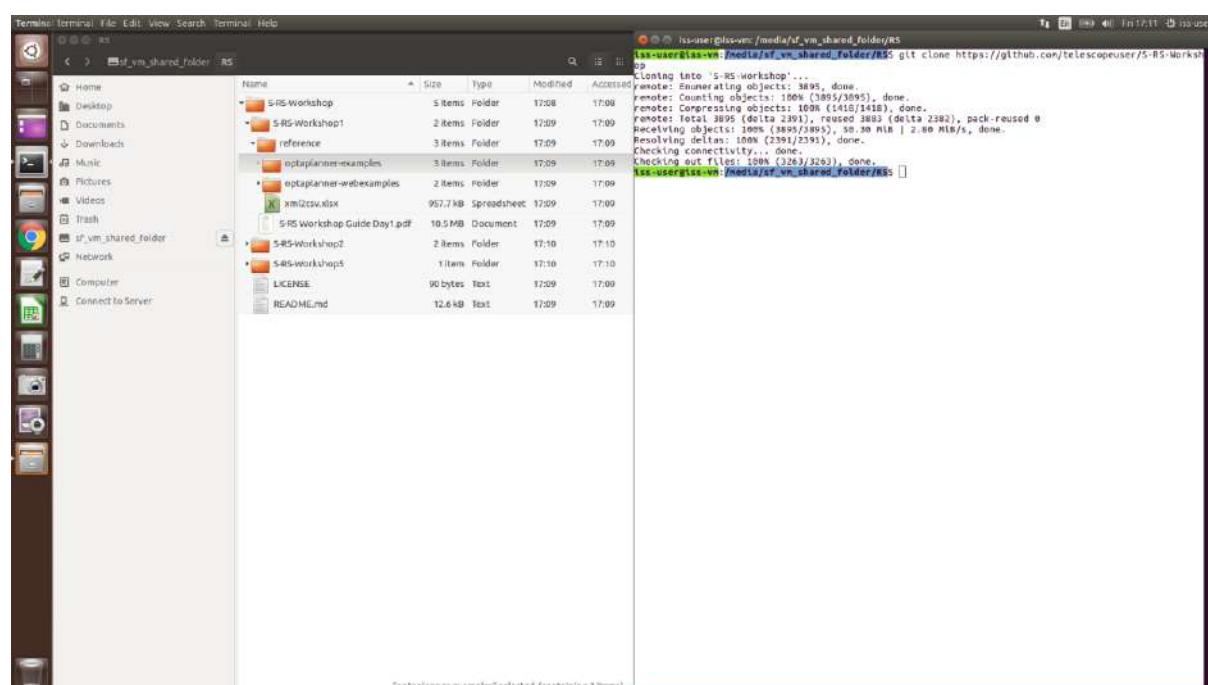
- S-RS-Workshop1 S-RS-Workshop folders
- S-RS-Workshop2 S-RS-Workshop folders
- S-RS-Workshop5 S-RS-Workshop folders
- LICENSE ISS NUS License 4 months ago
- README.md S-RS-Workshop folders 15 days ago

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, with the output indicating the cloning process is complete. The file manager window shows the cloned repository structure in a folder named 'RS'.

Terminal: terminal File Edit View Search Terminal Help

File Manager: sf\_vm\_shared\_folder/RS

Selected: "optaplanner-examples" selected (containing 3 items)

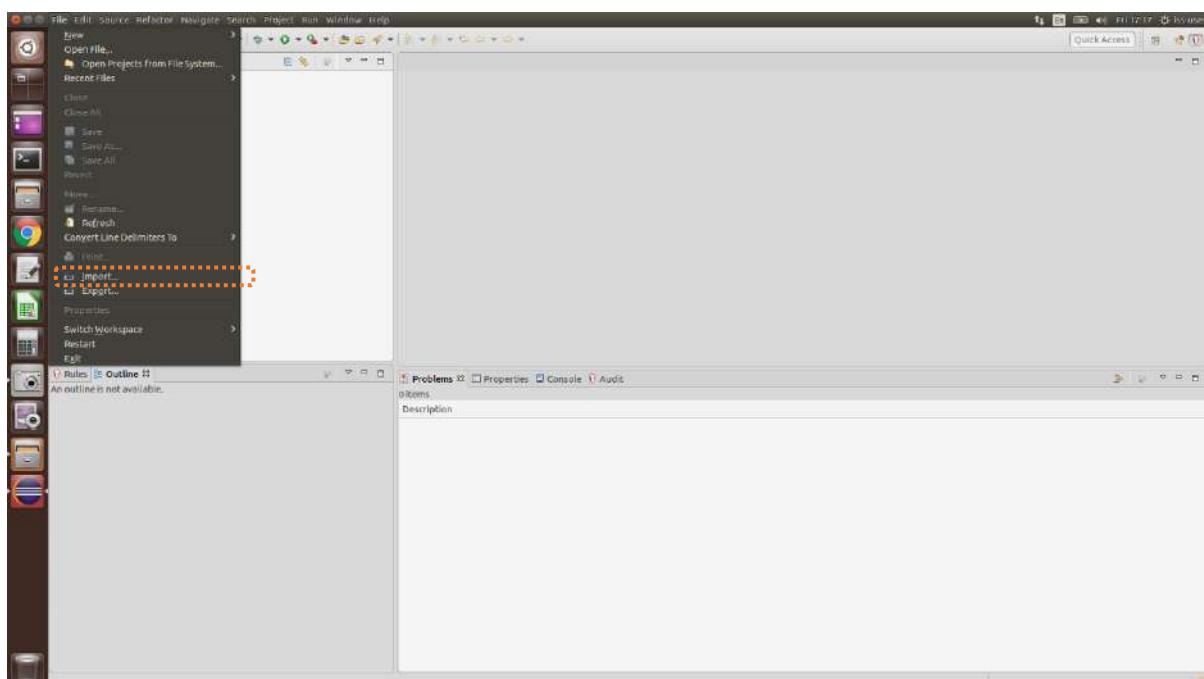
ls-username@sf-vm:~/media/sf\_vm\_shared\_folder/RS\$ git clone https://github.com/telescopeuser/S-RS-Workshop

Cloning into 'S-RS-Workshop'...  
remote: Counting objects: 100% (3895/3895), done.  
remote: Compressing objects: 100% (1418/1418), done.  
remote: Writing objects: 100% (3895/3895), done.  
Receiving objects: 100% (3895/3895), 50.20 MB | 2.88 MB/s, done.  
Resolving deltas: 100% (2391/2391), done.  
Checking connectivity... done.

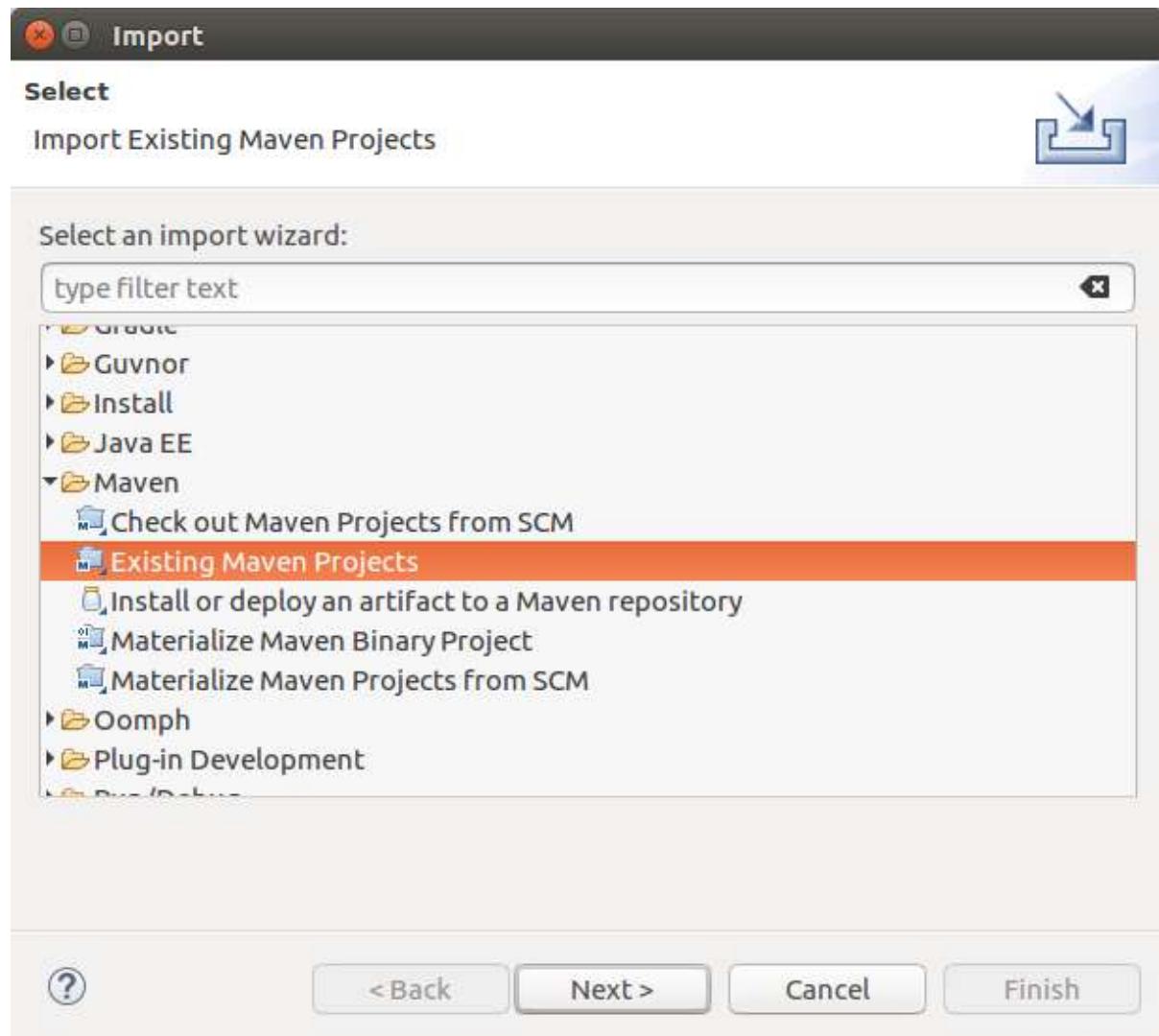
## 2) From desktop, Start Tool Eclipse.



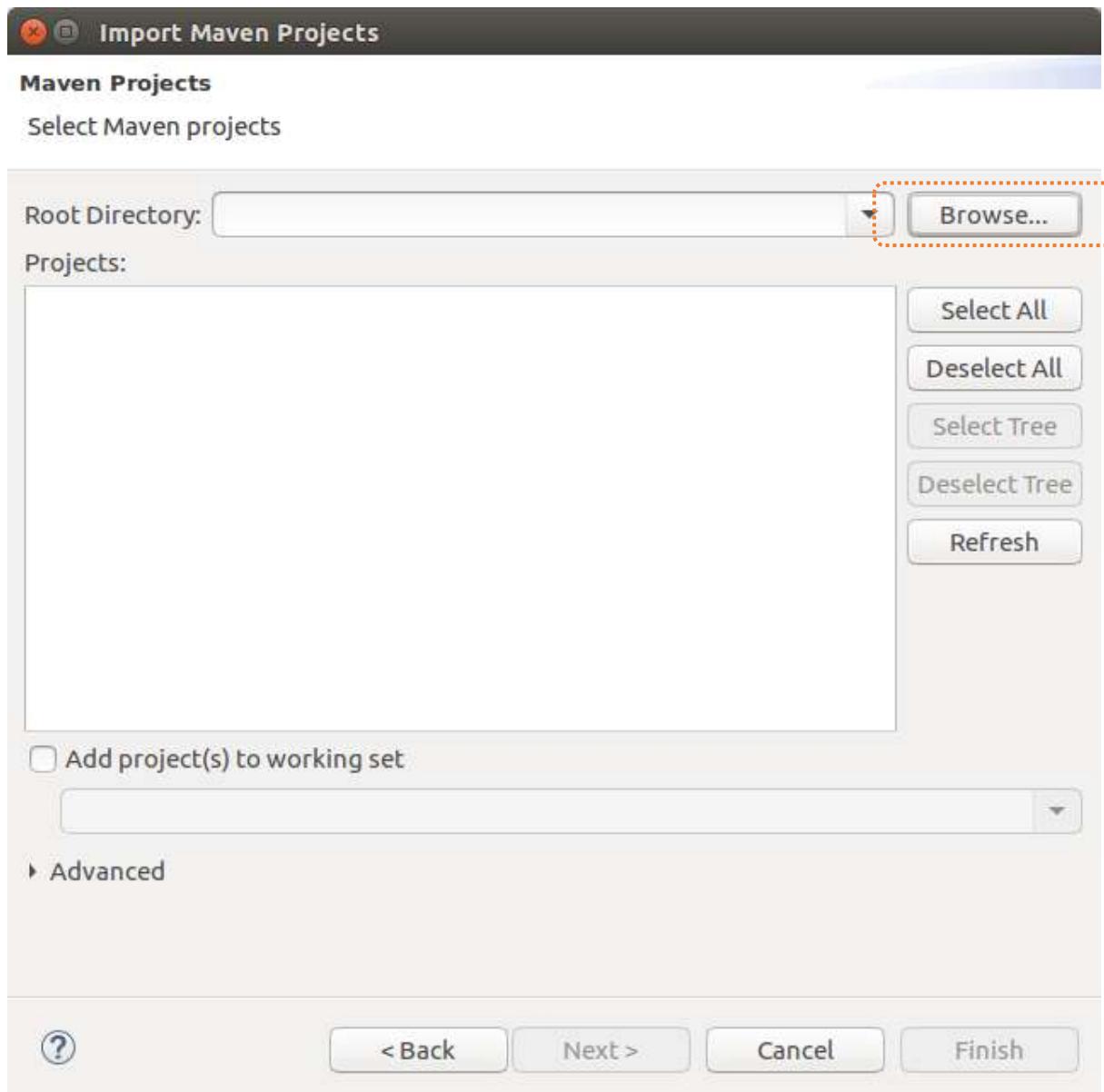
## 3) Select Import...



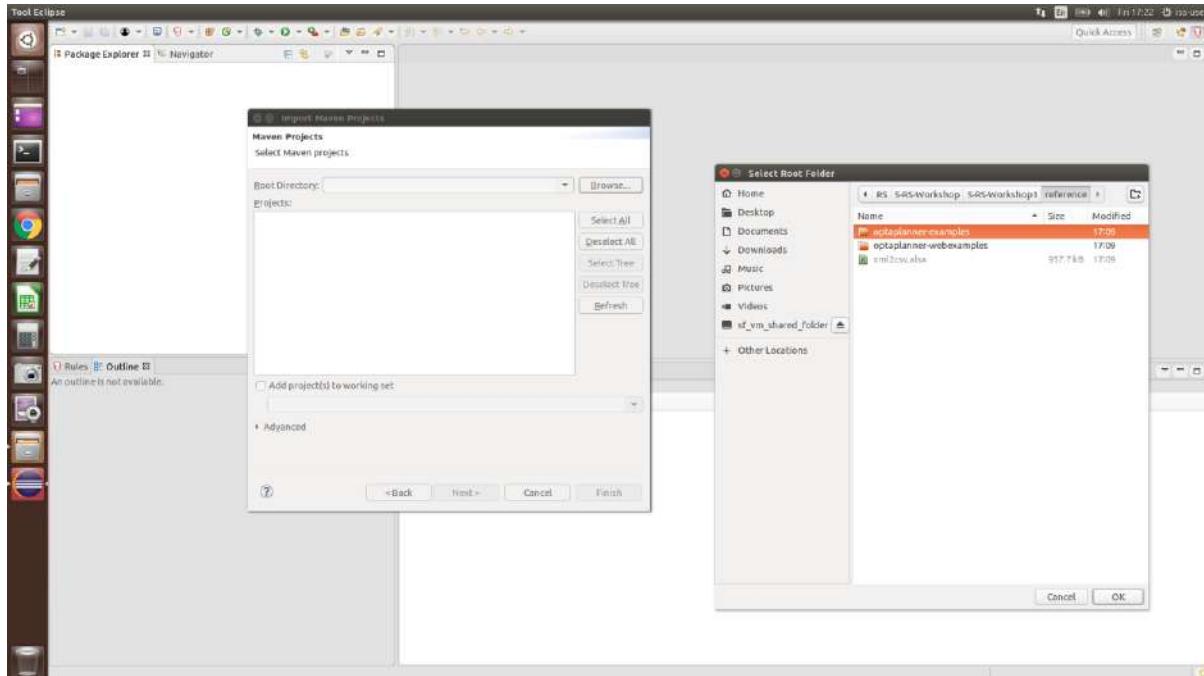
4) Select **Existing Maven Projects**; Click **Next**



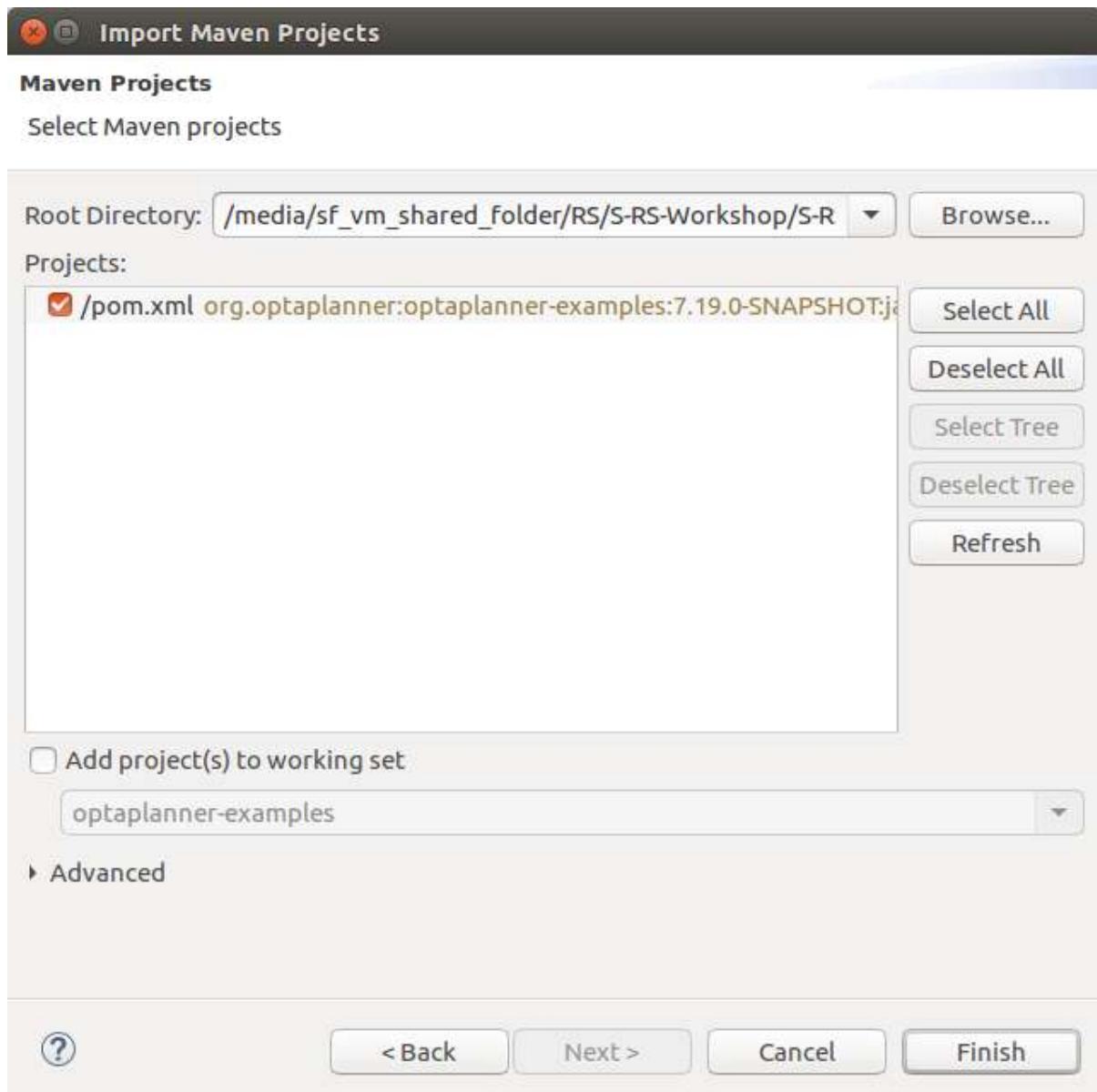
5) Click **Browse...**



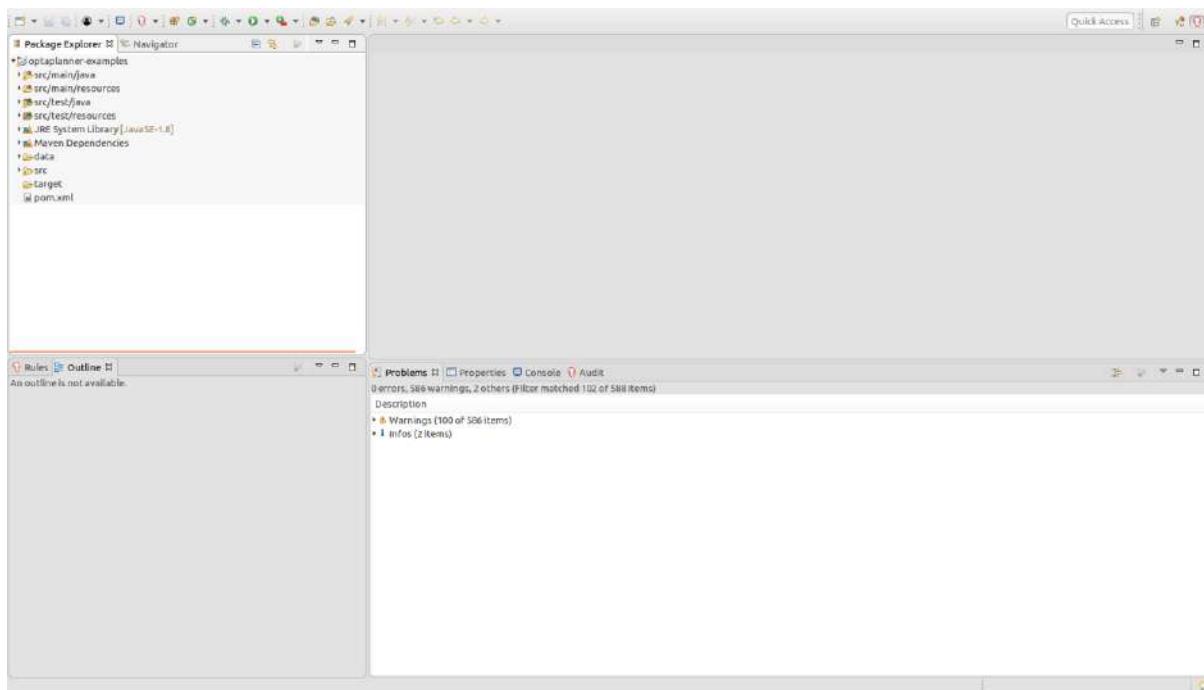
- 6) Browse to locate the **optaplanner-examples** sub-folder from downloaded workshop materials in local computer; Click **OK**  
**.../S-RS-Workshop/S-RS-Workshop1/reference/optaplanner-examples**



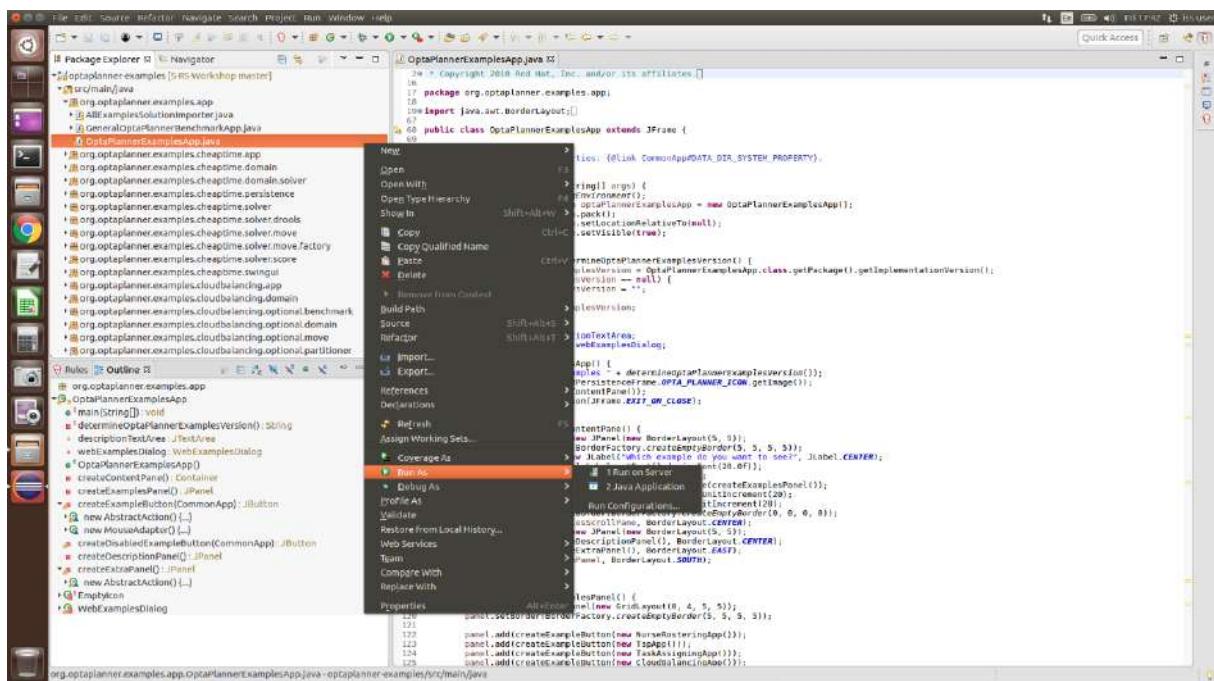
7) Click **Finish**.

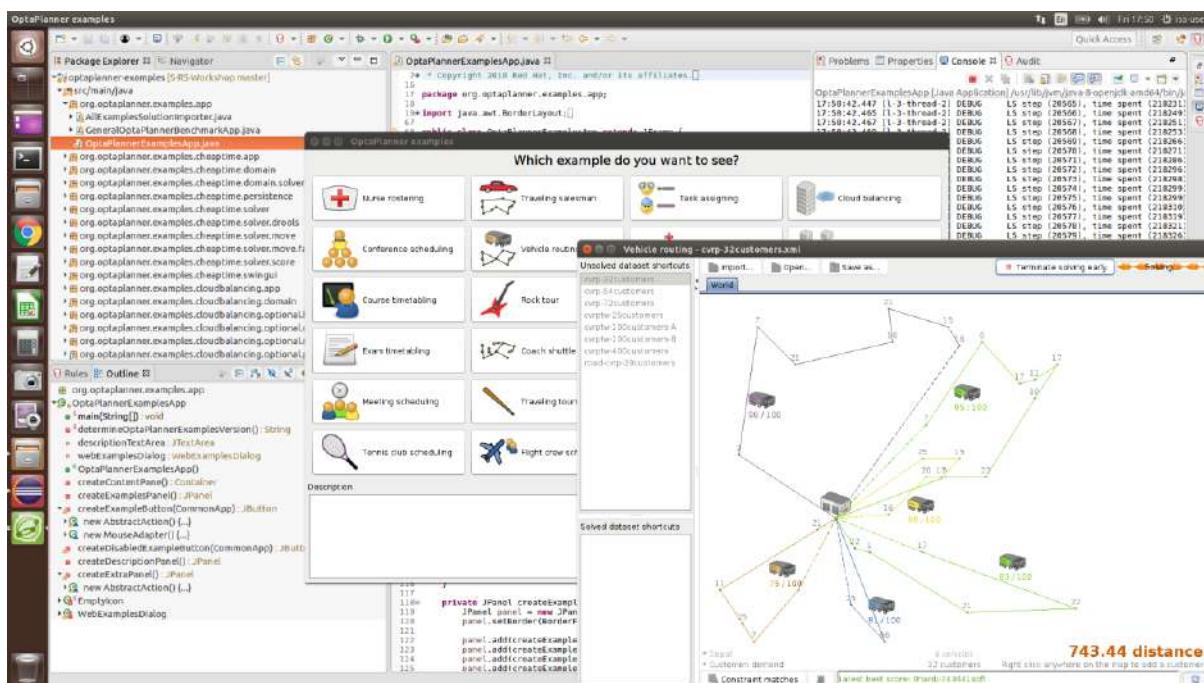
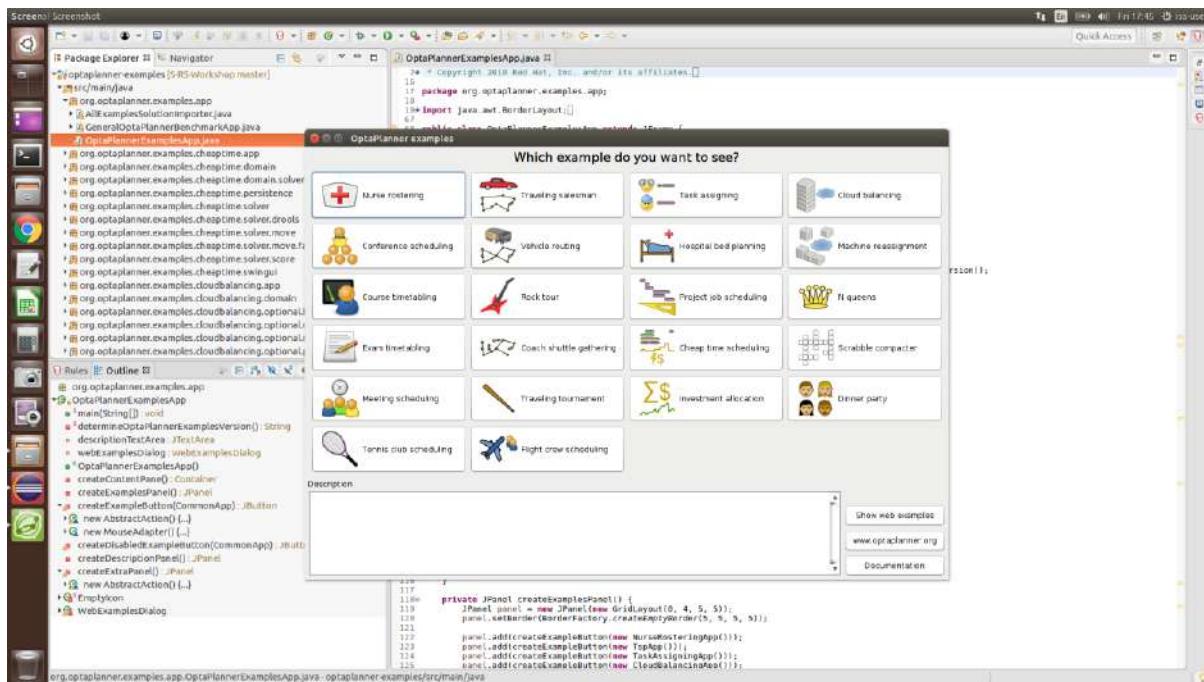


8) Wait for the completion of import;



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](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.

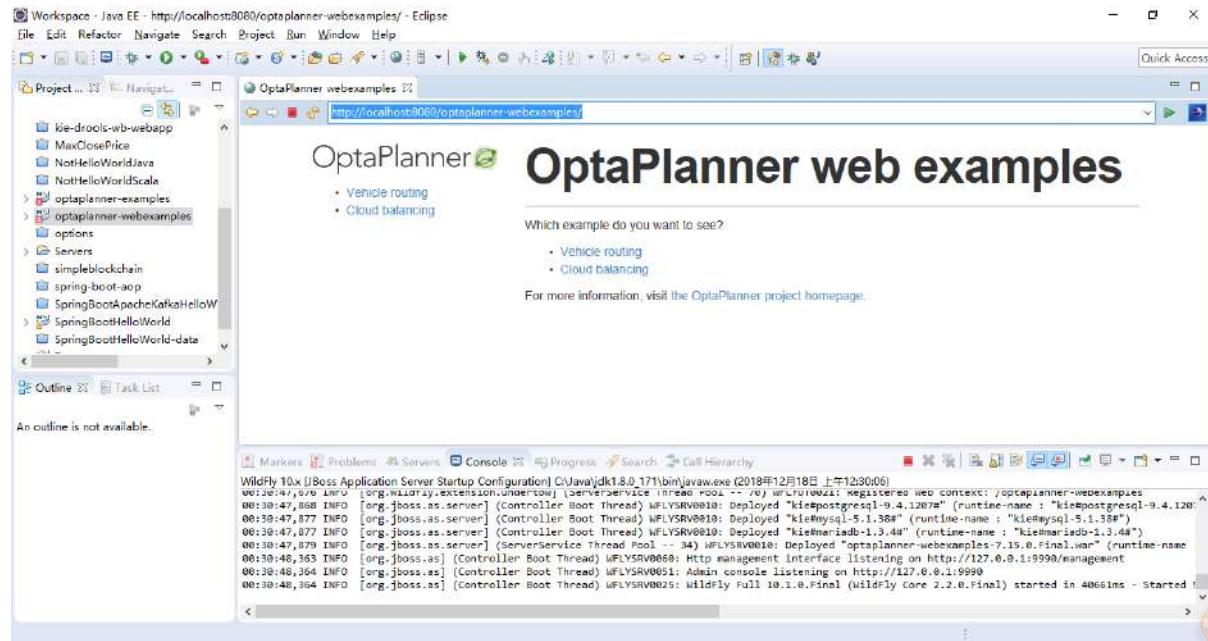
Source new problem **Or** choose one OptaPlanner example application from below:

- 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;

## OptaPlanner web examples



Above: example web applications

## Visualizing Vehicle Routing with Leaflet and Google Maps



```

27 /**
28 * @see DefaultVehicleRoutingRestService
29 */
30 @Path("/vehiclerouting")
31 public interface VehicleRoutingRestService {
32
33     @GET
34     @Path("/solution")
35     @Produces("application/json")
36     JsonVehicleRoutingSolution getSolution();
37
38     @POST
39     @Path("/solution/solve")
40     @Produces("application/json")
41     JsonMessage solve();
42
43     @POST
44     @Path("/solution/terminateEarly")
45     @Produces("application/json")
46     JsonMessage terminateEarly();

```

Above: example KIE server interaction via RESTful API

```

58 };
59
60 loadSolution = function() {
61     $.ajax({
62         url: "<%=application.getContextPath()%>/rest/vehiclerouting/solution",
63         type: "GET",
64         dataType : "json",
65         success: function(solution) {
66             var markers = [];
67             $.each(solution.customerList, function(index, customer) {
68                 var customerIcon = L.divIcon({
69                     iconSize: new L.Point(20, 20),
70                     className: "vehicleRoutingCustomerMarker",
71                     html: "<span>" + customer.demand + "</span>"
72                 });
73                 var marker = L.marker([customer.latitude, customer.longitude], {icon: customerIcon});
74                 marker.addTo(map).bindPopup(customer.locationName + "<br>Deliver " + customer.demand + " items.");
75                 markers.push(marker);
76             });
77             map.fitBounds(L.featureGroup(markers).getBounds());
78         }, error : function(jqXHR, textStatus, errorThrown) {ajaxError(jqXHR, textStatus, errorThrown)}
79     });
80 };

```

Above: example server end point

```

{
  "name": "belgium-road-time-n50-k10", "customerList": [{"locationName": "ANTHISNES", "latitude": 50.4812987, "longitude": 5.5193048, "demand": 15}, {"locationName": "AVE-ET-AUER", "latitude": 50.1086676, "longitude": 5.1426983, "demand": 16}, {"locationName": "BAVINGHOEVE", "latitude": 50.8763581, "longitude": 3.3113744, "demand": 31}, {"locationName": "BERSTILLIES-L'ABRAVE", "latitude": 50.2634945, "longitude": 4.1623037, "demand": 14}, {"locationName": "BLERET", "latitude": 50.6687505, "longitude": 5.2895129, "demand": 33}, {"locationName": "BOURLEERS", "latitude": 50.0262008, "longitude": 4.3408914, "demand": 7}, {"locationName": "BILSKAMP", "latitude": 51.0124457, "longitude": 2.6501345, "demand": 9}, {"locationName": "CHIENNES", "latitude": 50.5661351, "longitude": 3.7853189, "demand": 17}, {"locationName": "DAUNE", "latitude": 51.2356929, "longitude": 3.3400765, "demand": 31}, {"locationName": "DOETELBEEK", "latitude": 50.2849958, "longitude": 4.3116966, "demand": 26}, {"locationName": "ELVERDRIJVE", "latitude": 50.843669, "longitude": 2.8162074, "demand": 18}, {"locationName": "EVELTE", "latitude": 50.41922, "longitude": 5.1737005, "demand": 19}, {"locationName": "FONLAING-L'EVEQUE", "latitude": 50.410698, "longitude": 4.3249526, "demand": 32}, {"locationName": "GELINCOEUR", "latitude": 50.707059, "longitude": 5.2628994, "demand": 26}, {"locationName": "GUINNEES", "latitude": 50.5493608, "longitude": 3.3727315, "demand": 32}, {"locationName": "HAEREN-BRUSSEL", "latitude": 50.891978, "longitude": 4.4182942, "demand": 33}, {"locationName": "HEPPENES", "latitude": 50.4814131, "longitude": 4.493598, "demand": 30}, {"locationName": "HOFSAME-ST-ETIENNE", "latitude": 50.9271045, "longitude": 3.9115699, "demand": 14}, {"locationName": "HOBOKEN", "latitude": 50.8667656, "longitude": 4.3854365, "demand": 16}, {"locationName": "JURHUSE", "latitude": 50.6208191, "longitude": 3.9017076, "demand": 26}, {"locationName": "JOVEN", "latitude": 50.776114, "longitude": 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31}, {"locationName": "VILLERS-VILLE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}], {"depotLocationName": "BLERET", "depotLatitude": 50.6687505, "depotLongitude": 4.4399729, "hexColor": "#f0e68c", "capacity": 129, "demandTotal": 129, "customerList": [{"locationName": "BLERET", "latitude": 50.6687505, "longitude": 5.2895129, "demand": 33}, {"locationName": "VILLERS-EVEQUE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}, {"locationName": "VILLERS-VILLE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}], {"depotLocationName": "BROUSSE", "depotLatitude": 50.8427501, "depotLongitude": 4.3516499, "hexColor": "#ffccbc", "capacity": 125, "demandTotal": 125, "customerList": [{"locationName": "BLERET", "latitude": 50.6687505, "longitude": 5.2895129, "demand": 33}, {"locationName": "VILLERS-EVEQUE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}, {"locationName": "VILLERS-VILLE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}], {"depotLocationName": "VOSSEM", "depotLatitude": 50.8346073, "depotLongitude": 4.95727, "hexColor": "#88e234", "capacity": 125, "demandTotal": 125, "customerList": [{"locationName": "BLERET", "latitude": 50.6687505, "longitude": 5.2895129, "demand": 33}, {"locationName": "VILLERS-EVEQUE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}, {"locationName": "VILLERS-VILLE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}], {"depotLocationName": "WILSELE", "depotLatitude": 50.8427501, "depotLongitude": 4.3516499, "hexColor": "#72cfcf", "capacity": 125, "demandTotal": 125, "customerList": [{"locationName": "BLERET", "latitude": 50.6687505, "longitude": 5.2895129, "demand": 33}, {"locationName": "VILLERS-EVEQUE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}, {"locationName": "VILLERS-VILLE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}], {"depotLocationName": "WILSELE", "depotLatitude": 50.8427501, "depotLongitude": 4.3516499, "hexColor": "#72cfcf", "capacity": 125, "demandTotal": 125, "customerList": [{"locationName": "BLERET", "latitude": 50.6687505, "longitude": 5.2895129, "demand": 33}, {"locationName": "VILLERS-EVEQUE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}, {"locationName": "VILLERS-VILLE", "latitude": 50.7042434, "longitude": 4.4399729, "demand": 31}]}]
}

```

Above: example solution enquiry via RESTful API

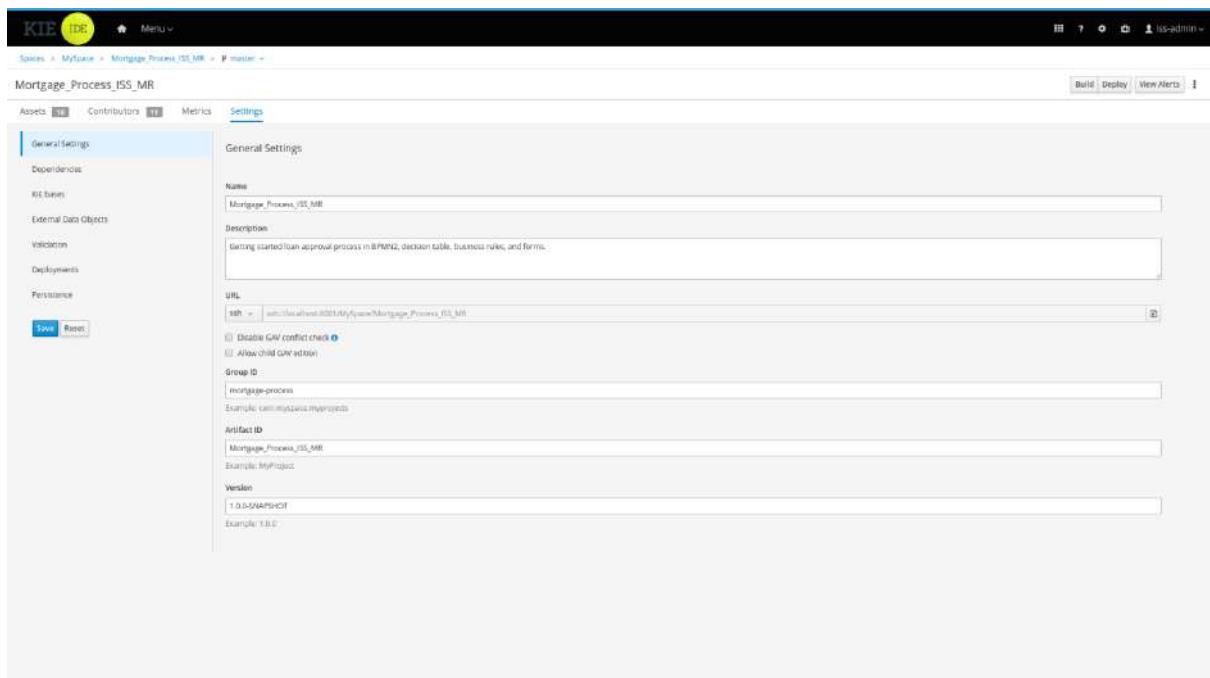
## Reference

- <https://github.com/kiegroup/optaplanner/tree/master/optaplanner-webexamples>
- [https://docs.optaplanner.org/latest/optaplanner-docs/html\\_single/index.html#quickStart](https://docs.optaplanner.org/latest/optaplanner-docs/html_single/index.html#quickStart)

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

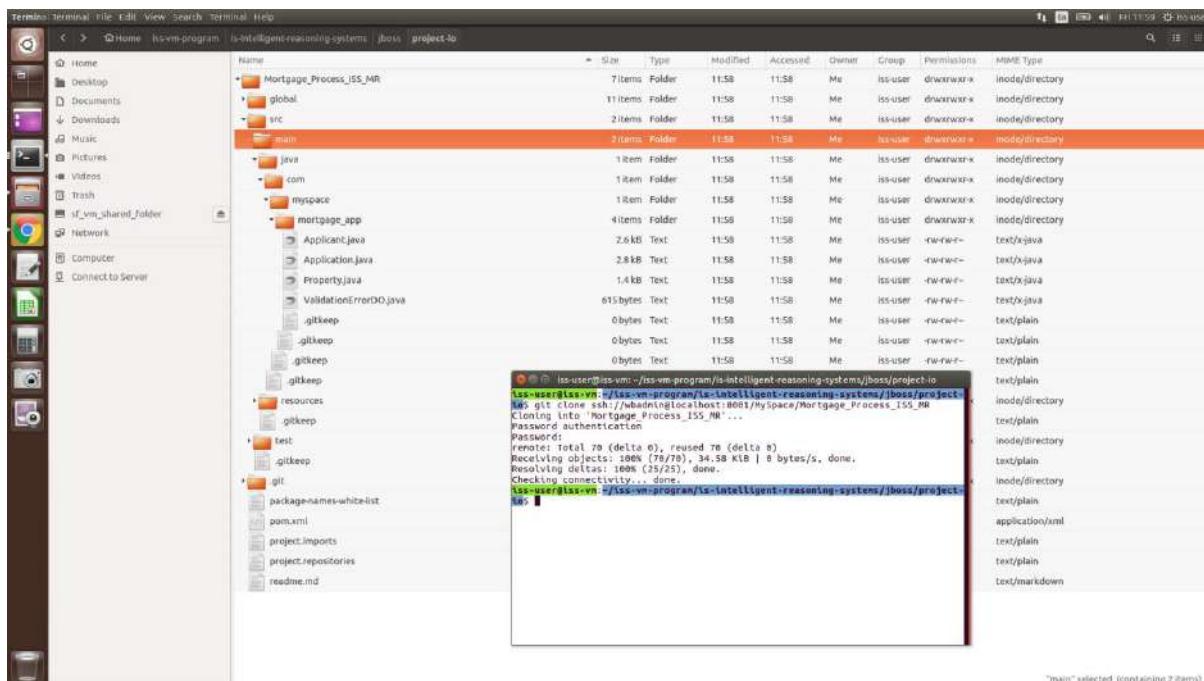
Example: export KIE project **Mortgage\_Process\_ISS\_MR** from work space **MySpace**

Review project settings to obtain project URL link



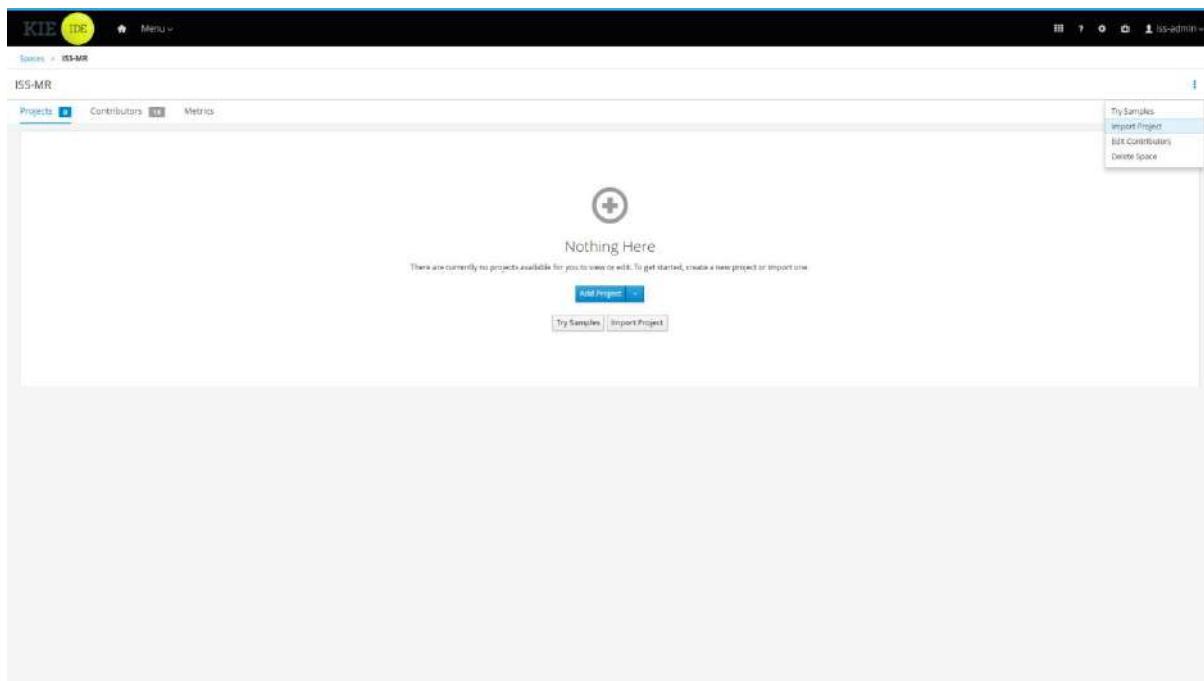
## 2.2.1. Export project from KIE Workbench

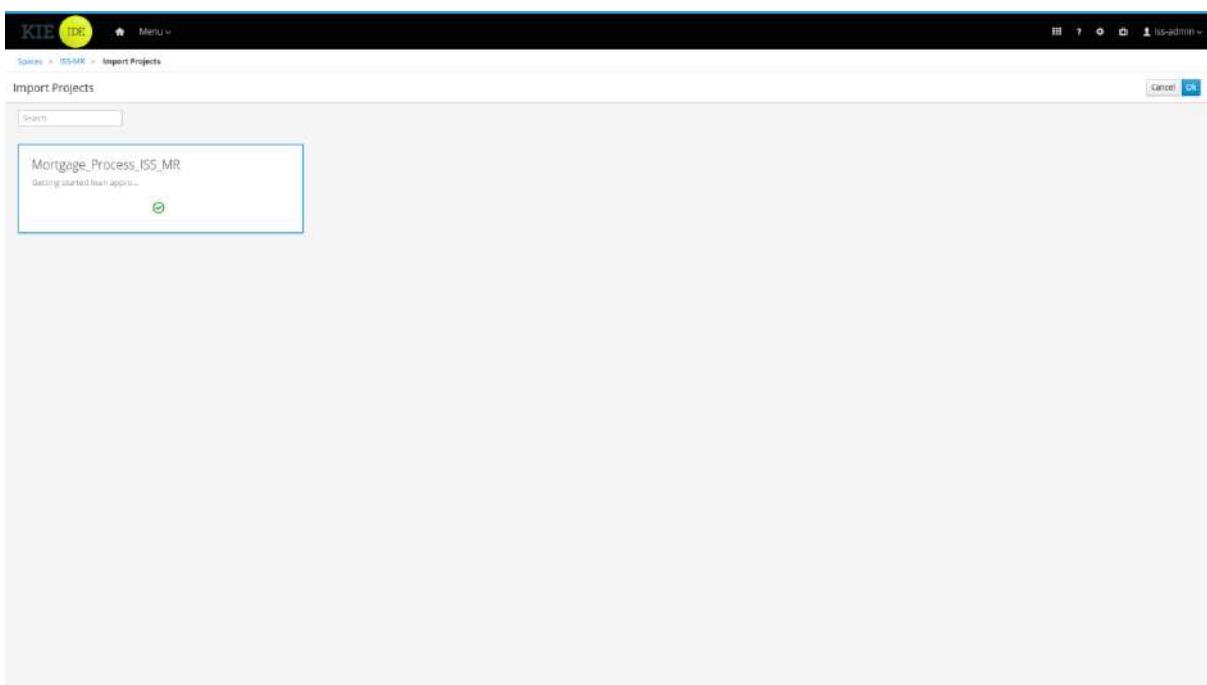
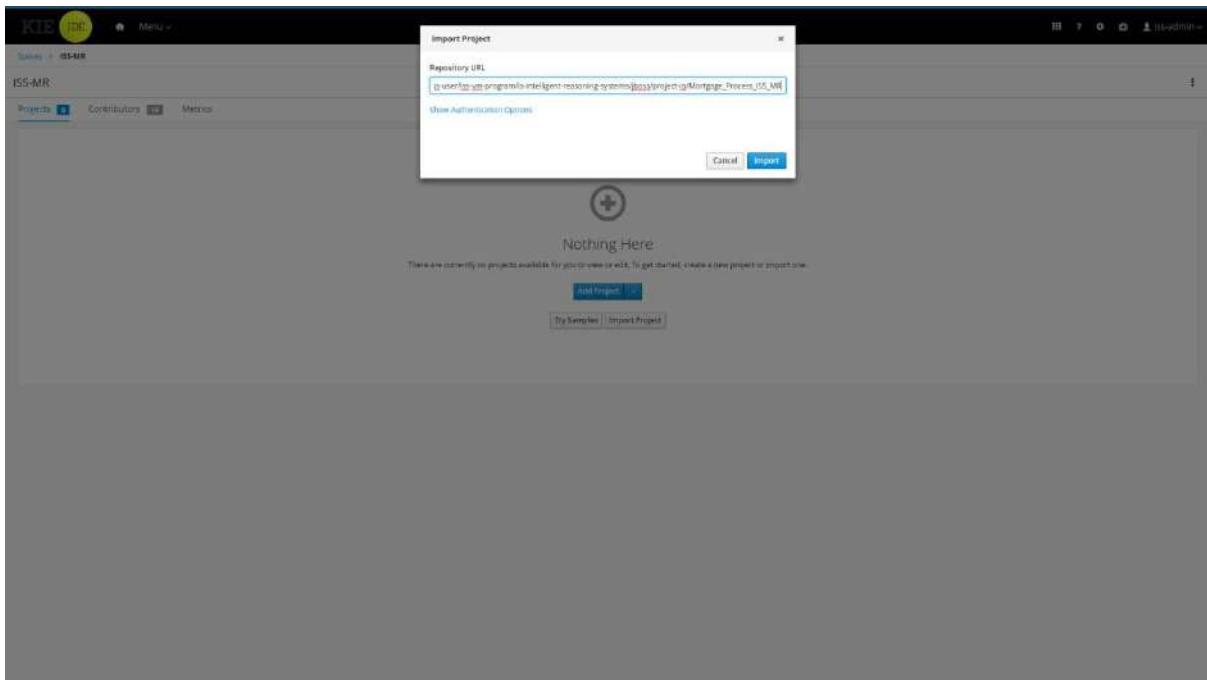
- 1) Select a folder for exporting, example here uses **/home/iss-user/iss-vm-program/is-intelligent-reasoning-systems/jboss/project-io**
- 2) Start a Terminal there, key in command **git clone ssh://wbadmin@localhost:8001/MySpace/Mortgage\_Process\_ISS\_MR**
- 3) Key in password '**wbadmin**' for user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

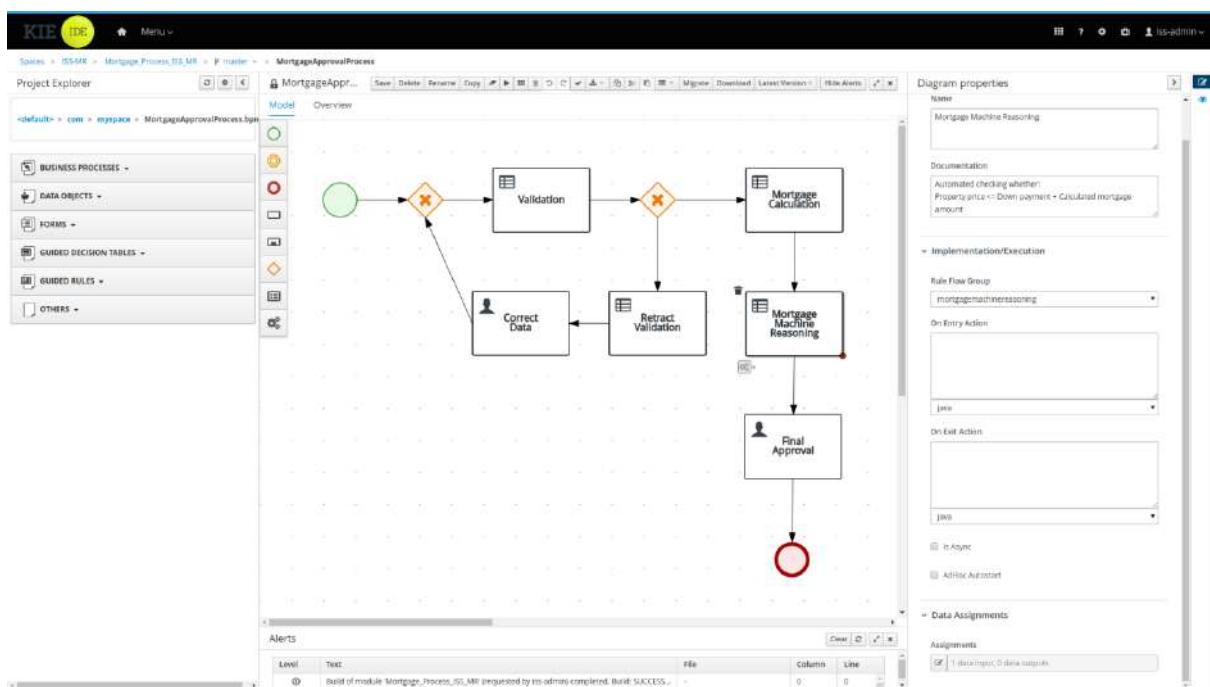
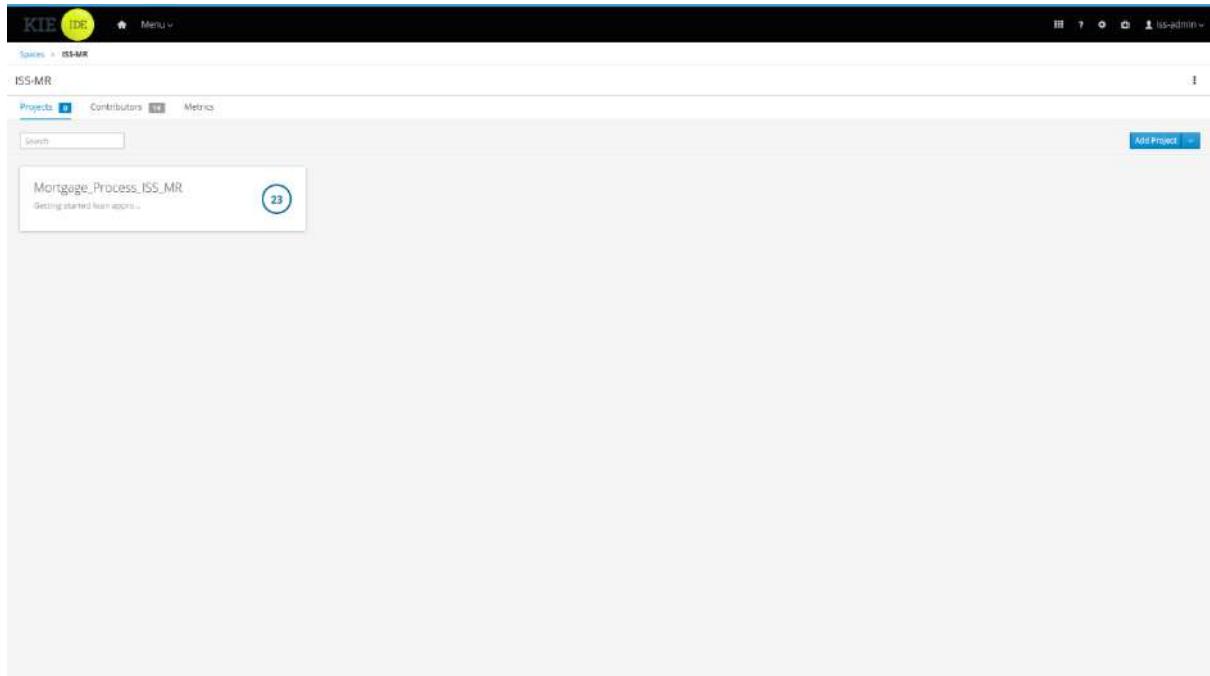


## 2.2.2. Import project into KIE Workbench

- 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>

The screenshot shows a GitHub repository page for 'Workshop-Project-Submission-Template'. At the top, there are buttons for 'Watch' (1), 'Star' (0), and 'Fork' (1). Below the repository name, it says 'forked from telescopeuser/Workshop-Project-Submission-Template'. Under the repository name, there are tabs for 'Code', 'Pull requests (0)', 'Projects (0)', and 'Insights'. A note below says 'No description, website, or topics provided.' Below the stats, there's a 'Branch: master' dropdown and a 'New pull request' button. On the right, there's a 'Clone or download' button (highlighted with a red box) and a 'Clone with HTTPS' section with a URL. The file list shows 'Miscellaneous', 'ProjectReport', 'SystemCode/clips', 'UserGuide', and 'README.md'. The 'Clone with HTTPS' section and the 'Download ZIP' button (highlighted with a red box) are also circled.

{ 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
 Event timetabling	 Coach shuttle gathering	 Cheap time scheduling	 Scrabble computer
 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 incurs a maintenance cost.

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

## Reference

[https://docs.optaplanner.org/latest/optaplanner-docs/html\\_single/index.html#useCasesAndExamples](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  
wedding1-score0

Solved dataset shortcuts  
wedding1-score0

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

Table 0

Zachary Developer	Gopika Politician	Charlie Developer Java	Avery Doctor Surgeon
Leah Teacher English		Mackenzie Coach Football	
Matthew Doctor Surgeon		Emily Politician Journalist	
Alyssa Socialite Democrat	Harley Coach Soccer	Riley Socialite Democrat	Owen Teacher Math

Table 1

Iabelle Coach Football	Emma Politician Journalist	Eli Teacher Math	Madelyn Doctor Researcher
Taylor Socialite Democrat			Joseph Developer Java
Evan Developer Java			Zoe Politician Journalist
Riley Coach Football	Christian Teacher History	Italia Socialite Researcher	Connor Doctor Dentist

Table 2

Andrew Teacher Math	Ava Activist Democrat		
Kennedy Socialite Democrat			
Brynn Coach Football			
Peregrine Socialite Researcher	Isaac Coach Football		

Table 4

Caleb Doctor Surgeon	Samantha Socialite Republican	Brooklyn Coach Football	Nat Politician General
Layla Politician Journalist			Nathan Teacher Math
Hop Teacher English			Ruby Socialite General
Gabriella Developer Java	James Doctor Surgeon	Alyssa Developer Java	Imma Coach Journalist

Table 5

Ryan Doctor Surgeon	Ella Doctor Pediatrician	Grayson Teacher Math	Madison Politician Researcher
Gina Developer Java			Gabriel Coach General
Caitlyn Developer Java			Sabine Socialite General
Eman Socialite Democrat	Dylan Coach Football	Dina Politician Journalist	Wyatt Teacher Science

Table 6

Nicholas Coach Basketball	Menz Developer Inf		
Anabelle Developer Java			
Jackson Politician General			
Carmela Socialite Researcher	Udo Coach Football		

Table 8

Constraint matches   Latest best score: 20

Package Explorer [1] Navigator [2] Search [3] Go To [4] Find [5] Quick Access [6]

OptaplannerExamplesApp [1] SeedDesignation.java [2]

```

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27 * you may not use this file except in compliance with the License.
28 * You may obtain a copy of the License at
29 *
30 *     http://www.apache.org/licenses/LICENSE-2.0
31 *
32 * Unless required by applicable law or agreed to in writing, software
33 * distributed under the License is distributed on an "AS IS" BASIS,
34 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
35 * See the License for the specific language governing permissions and
36 * limitations under the License.
37 */
38 package org.optaplanner.examples.dinnerparty.domain;
39
40 import com.thoughtworks.xstream.annotations.XStreamAlias;
41
42 @PlanningEntity
43 @XStreamAlias("SeatDesignation")
44 public class SeatDesignation extends AbstractPersistable implements Labeled {
45
46     private Guest guest;
47     private Seat seat;
48
49     public Guest getGuest() {
50         return guest;
51     }
52
53     public void setGuest(Guest guest) {
54         this.guest = guest;
55     }
56
57     @PlanningVariable(valueRangeProviderRefs = {"seatRange"})
58     public Seat getSeat() {
59         return seat;
60     }
61
62     public void setSeat(Seat seat) {
63         this.seat = seat;
64     }
65
66     // Complex methods
67     // -----
68
69     public String getGuestName() {
70         return guest().getname();
71     }
72
73     public Gender getGuestGender() {
74         return guest().getgender();
75     }
76
77     public Job getGuestJob() {
78         return guest().getjob();
79     }
80
81     public JobType getGuestJobType() {
82         return guest().getjob().getJobType();
83     }
84
85     public boolean differentKindNeeded(Job otherGuestJob) {
86         JobType jobType = guest().getjob().getJobType();
87         return jobType == JobType.SOCIALIZE || jobType == JobType.FEACHER || guest().getJob() != otherGuestJob;
88     }
89
90     public Table getSeatTable() {
91         if (seat == null) {
92             return null;
93         }
94         return seat.gettable();
95     }
96
97     public boolean isNeighborOf(SeatDesignation leftSeatDesignation) {
98         if (seat == null || leftSeatDesignation.seat == null) {
99             return false;
100        }
101    }
102}

```

Rules [1] Outline [2]

org.optaplanner.examples.dinnerparty.domain

SeatDesignation

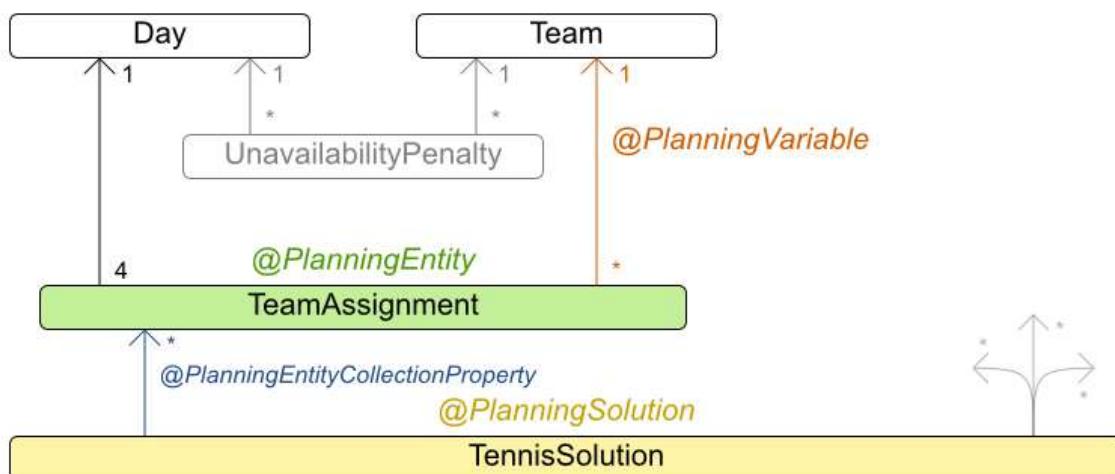
- Guest
- seat
- getGuest(): Guest
- setGuest(Guest): void
- getCount(): int
- setSeat(Seat): void
- getGuestName(): String
- getGuestGender(): Gender
- getGuestJob(): Job
- getGuestJobType(): JobType
- differentKindNeeded(Job): boolean
- getSeatable(): Table
- isLightOff(SeatDesignation): boolean
- isNeighborOf(SeatDesignation): boolean
- getLabel(): String
- toString(): String

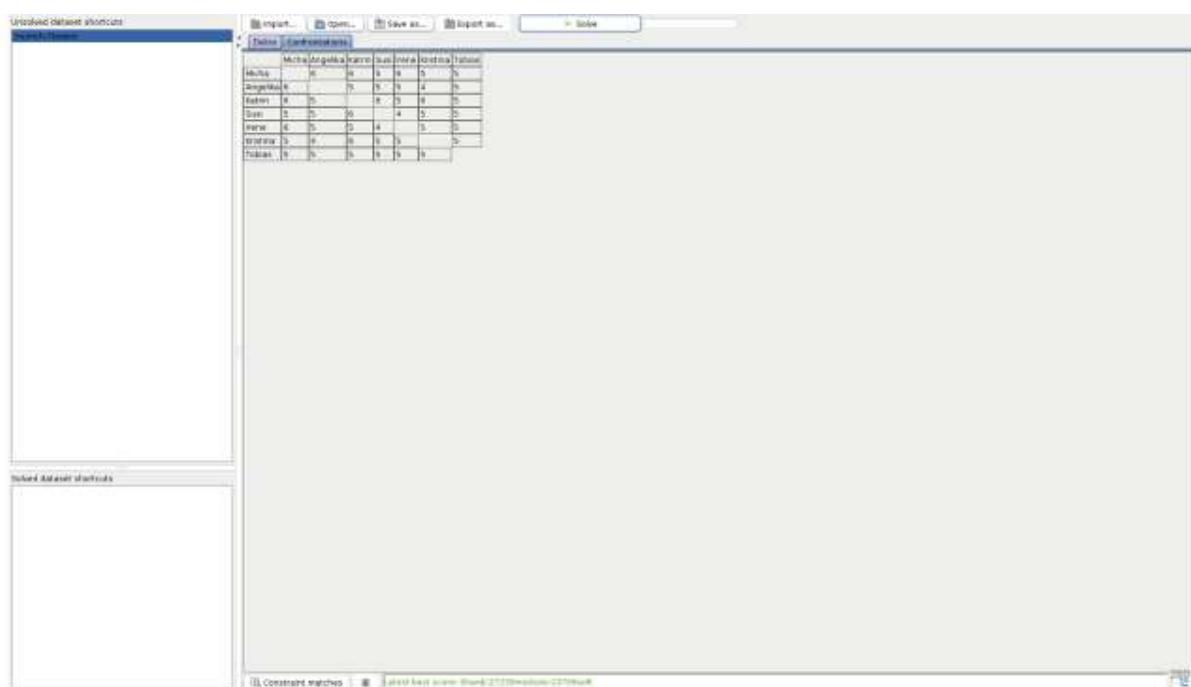
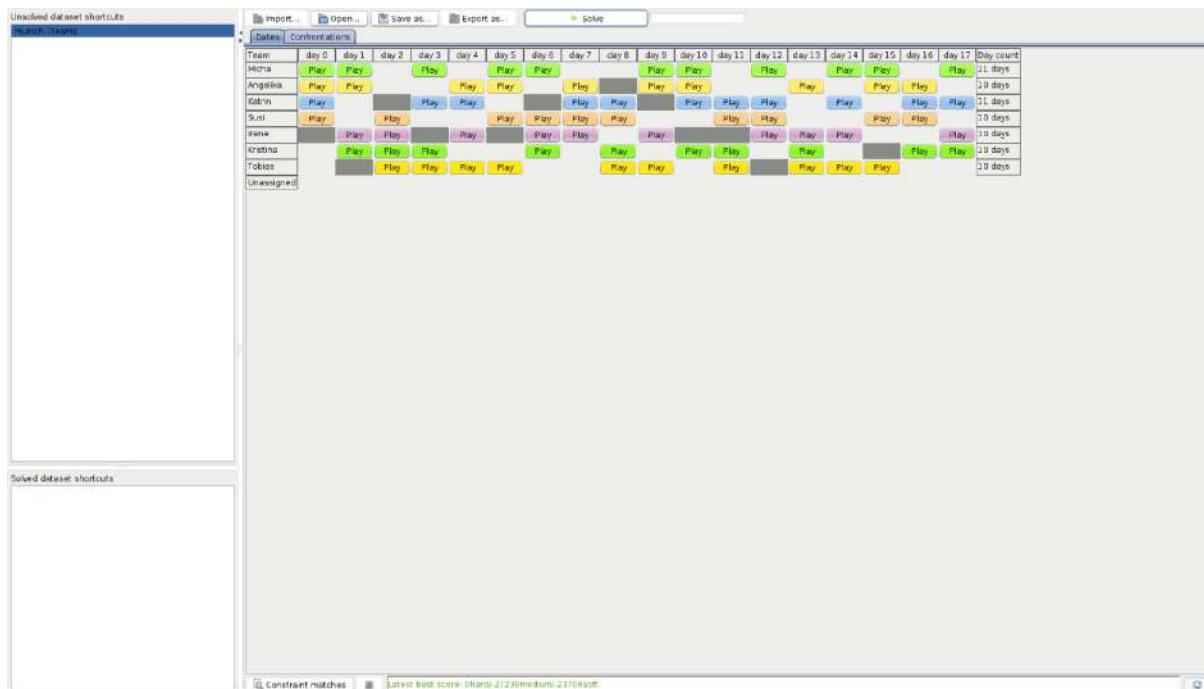
## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

### 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





## 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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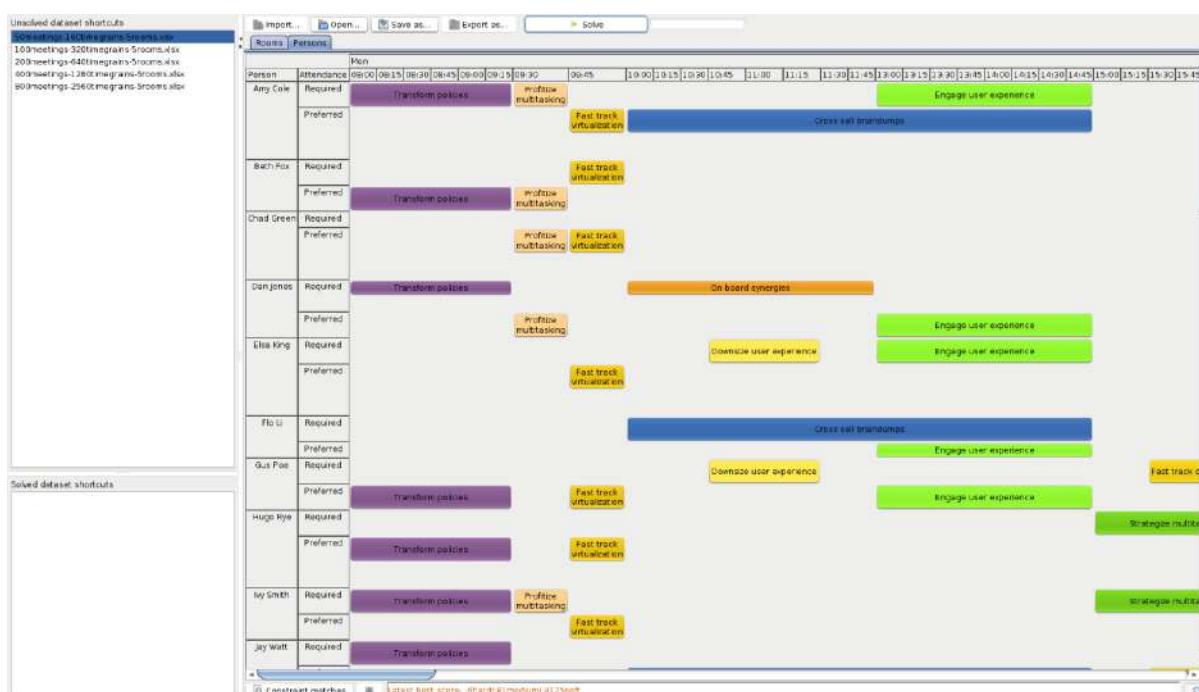
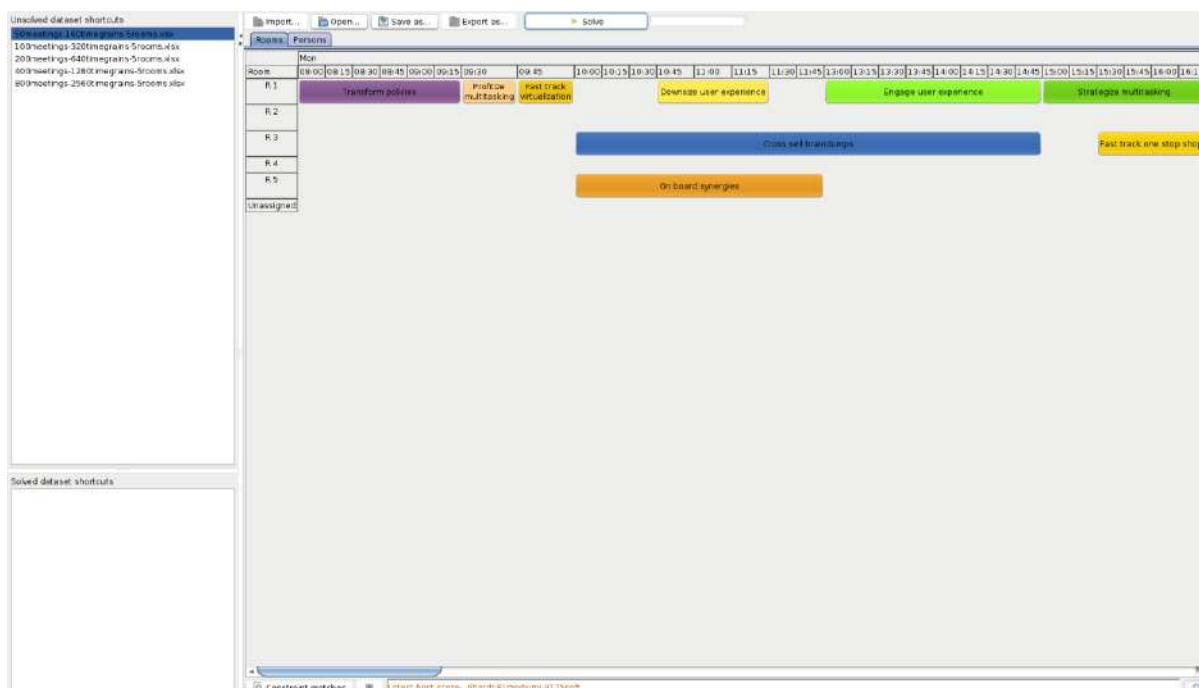
295

## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

### Exercise: Draw Class Diagram



295



## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

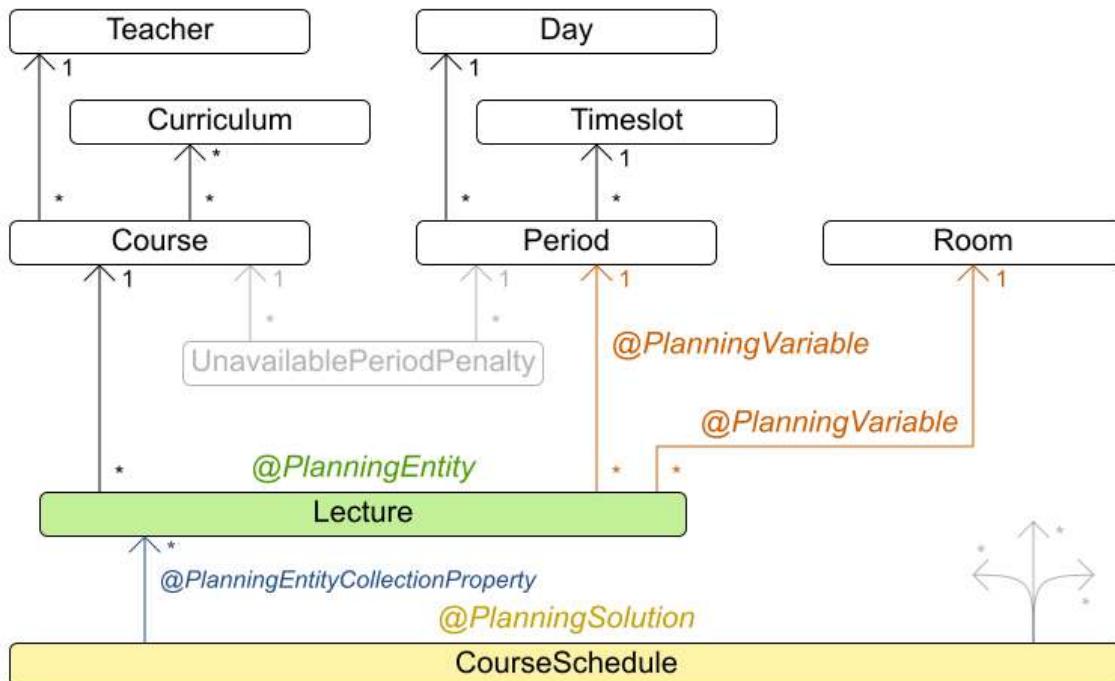
KIE OptaPlanner Deep Dive – Curriculum Course Scheduling

- 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](http://www.cs.qub.ac.uk/itc2007/curriculumcourse/course_curriculum_index.htm)

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## Curriculum course class diagram



Unsolved dataset shortcuts  
209 lectures, 32 periods, 40 rooms  
403 lectures, 32 periods, 50 rooms  
comp01  
comp02\_initialized  
comp03  
comp04  
comp05  
comp06  
comp07  
comp08  
comp09  
comp10  
comp11  
comp12  
comp13  
comp14  
tiny01

Solved dataset shortcuts  
209 lectures, 32 periods, 40 rooms  
403 lectures, 32 periods, 50 rooms  
comp01  
comp02\_initialized  
comp03  
comp04  
comp05  
comp06  
comp07  
comp08  
comp09  
comp10  
comp11  
comp12  
comp13  
comp14  
tiny01

Unsolved dataset shortcuts  
209 lectures, 32 periods, 40 rooms  
403 lectures, 32 periods, 50 rooms  
comp01  
comp02\_initialized  
comp03  
comp04  
comp05  
comp06  
comp07  
comp08  
comp09  
comp10  
comp11  
comp12  
comp13  
comp14  
tiny01

Solved dataset shortcuts  
209 lectures, 32 periods, 40 rooms  
403 lectures, 32 periods, 50 rooms  
comp01  
comp02\_initialized  
comp03  
comp04  
comp05  
comp06  
comp07  
comp08  
comp09  
comp10  
comp11  
comp12  
comp13  
comp14  
tiny01

Unsolved dataset shortcuts

- 2018-09-22-09-45-01-01
- lectures-32periods-25rooms
- lectures-32periods-50rooms

Solved dataset shortcuts

- 2018-09-22-09-45-01-01
- lectures-32periods-25rooms
- lectures-32periods-50rooms

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	Math 8-A		History 2	History 2	Geography	German 2	Math 8	Geograph...
	09:00	English 8-L	Biology 8-D	Biology 8-D	Physics 4	Music 4	Math 4	Math 4	Music 4
	10:00	English 8-K	Math 8-B	French 8-D	Music 3	Music 3	Math 3	Math 3	Music 3
	11:00	English 8-J	Math 8-C	Math 8-C	Physics 2	Music 2	English 2	Math 2	Music 2
	12:00	French 8-J	Math 8-B	Math 8-B	Physics 2	Music 2	English 2	Math 2	Music 2
	13:00	French 8-H	Math 8-D	Math 8-D	Physics 2	Music 2	English 2	Math 2	Music 2
	14:00	Biology 8-G	Math 8-B	Math 8-B	Physics 6	Music 6	Biology 3	Music 3	Music 6
	15:00	English 8-H	Art 8-I	History 3	Science 4	Math 6	Math 6	Math 6	Math 6
Tu	08:00	English 9-J	Math 9-C	History 4	Math 9-C	Math 9-C	Math 9-C	Math 9-C	Math 9-C
	09:00	English 9-J	Math 9-D	History 4	Physics 5	Math 9-A	German 8	Physics 4	Math 9-C
	10:00	French 9-L	Economics	History 3	Math 9-B	Economics	Chemistry	Physics 9	Physics 9
	11:00	Chemistry	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	12:00	French 9-H	Math 9-B	French 9-L	Physics 3	Math 9-B	French 4	Physics 9	Physics 9
	13:00	French 9-H	Math 9-B	Math 9-B	Physics 3	Math 9-B	French 4	Physics 9	Physics 9
	14:00	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	15:00	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
We	08:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	09:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	10:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	11:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	12:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	13:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	14:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	15:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
Th	08:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	09:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	10:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	11:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	12:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	13:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	14:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
	15:00	Physics 9-L	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B	Math 9-B
Fr	08:00	Math 9-B	Economics	French 9-D	German 9-A	Korean 9-C	English 9-B	Math 9-B	English 9-A
	09:00	Economics	Math 9-B	French 9-D	Math 9-B	Math 9-B	German 9-C	Economics	Math 9-B
	10:00	Economics	Math 9-B	French 9-D	Math 9-B	Math 9-B	German 9-C	Economics	Math 9-B
	11:00	Math 9-B	Economics	French 9-D	Math 9-B	Math 9-B	German 9-C	Economics	Math 9-B
	12:00	French 9-H	Biology 9-L	Biology 9-L	Physics 4	Geography	Math 9-B	French 9-L	Geography
	13:00	French 9-H	Biology 9-L	Biology 9-L	Physics 4	Geography	Math 9-B	French 9-L	Geography
	14:00	French 9-H	Economics	History 9-C	German 9-A	Economics	Chemistry	Economics	Chemistry
	15:00	Chemistry	Math 9-B	History 9-C	German 9-A	Economics	Chemistry	Economics	Chemistry
Unassigned									

Constraint matches X latest best score: rhann Session

Package Explorer Navigator Quick Access

```

src/main/java/org/optaplanner/examples/curriculumcourse/domain/Lecture.java
1 * Copyright 2018 Red Hat, Inc. and/or its affiliates.
2 *
3 package org.optaplanner.examples.curriculumcourse.domain;
4
5 import java.util.List;
6
7 import org.optaplanner.examples.curriculumcourse.domain.solver.*;
8 import org.optaplanner.examples.curriculumcourse.persistence.*;
9 import org.optaplanner.examples.curriculumcourse.swingui.*;
10 import org.optaplanner.examples.clinerparty.app.*;
11 import org.optaplanner.examples.clinerparty.domain.*;
12 import org.optaplanner.examples.clinerparty.persistence.*;
13 import org.optaplanner.examples.clinerparty.solver.*;
14 import org.optaplanner.examples.clinerparty.solver.solution.initializer.*;
15 import org.optaplanner.examples.clinerparty.swngui.*;

Rules Outline
src/main/java/org/optaplanner/examples/curriculumcourse/domain/Lecture.java
1 package org.optaplanner.examples.curriculumcourse.domain;
2
3 import org.optaplanner.examples.curriculumcourse.domain.Course;
4 import org.optaplanner.examples.curriculumcourse.domain.Period;
5 import org.optaplanner.examples.curriculumcourse.domain.Room;
6 import org.optaplanner.examples.curriculumcourse.domain.Teacher;
7 import org.optaplanner.examples.curriculumcourse.domain.Student;
8 import org.optaplanner.examples.curriculumcourse.domain.Lecture;
9
10 import org.optaplanner.examples.curriculumcourse.domain.solver.*;
11 import org.optaplanner.examples.curriculumcourse.persistence.*;
12 import org.optaplanner.examples.curriculumcourse.swingui.*;
13 import org.optaplanner.examples.clinerparty.app.*;
14 import org.optaplanner.examples.clinerparty.domain.*;
15 import org.optaplanner.examples.clinerparty.persistence.*;
16 import org.optaplanner.examples.clinerparty.solver.*;
17 import org.optaplanner.examples.clinerparty.solver.solution.initializer.*;
18 import org.optaplanner.examples.clinerparty.swngui.*;

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

```

## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

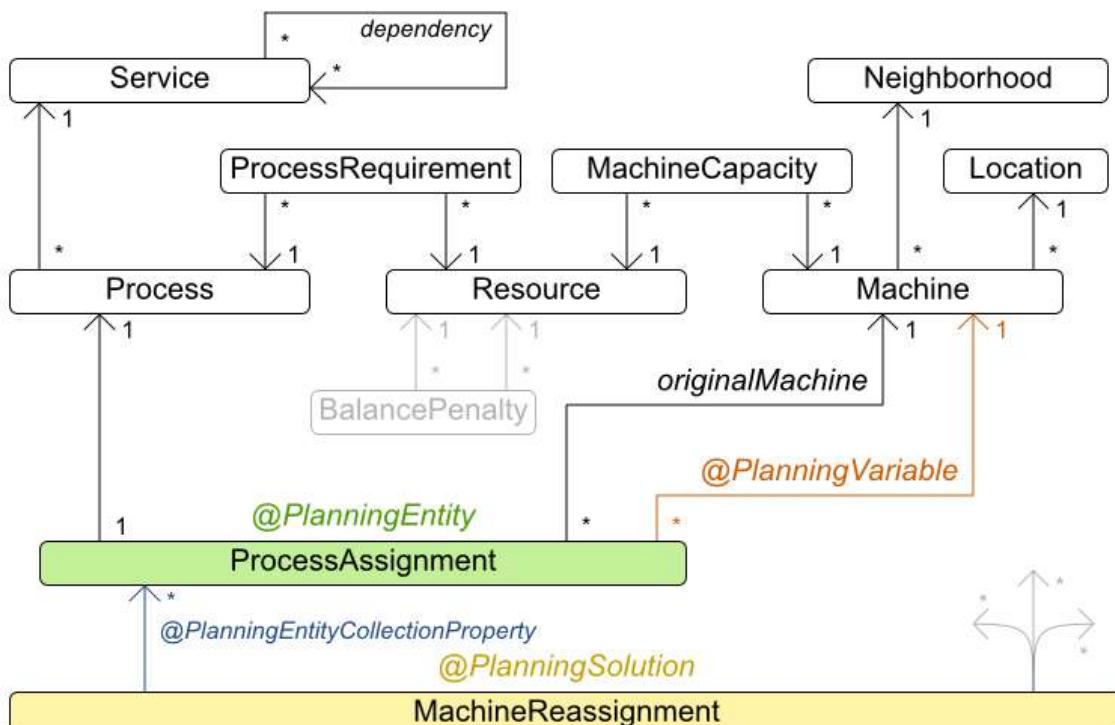
### KIE OptaPlanner Deep Dive – Machine Reassignment

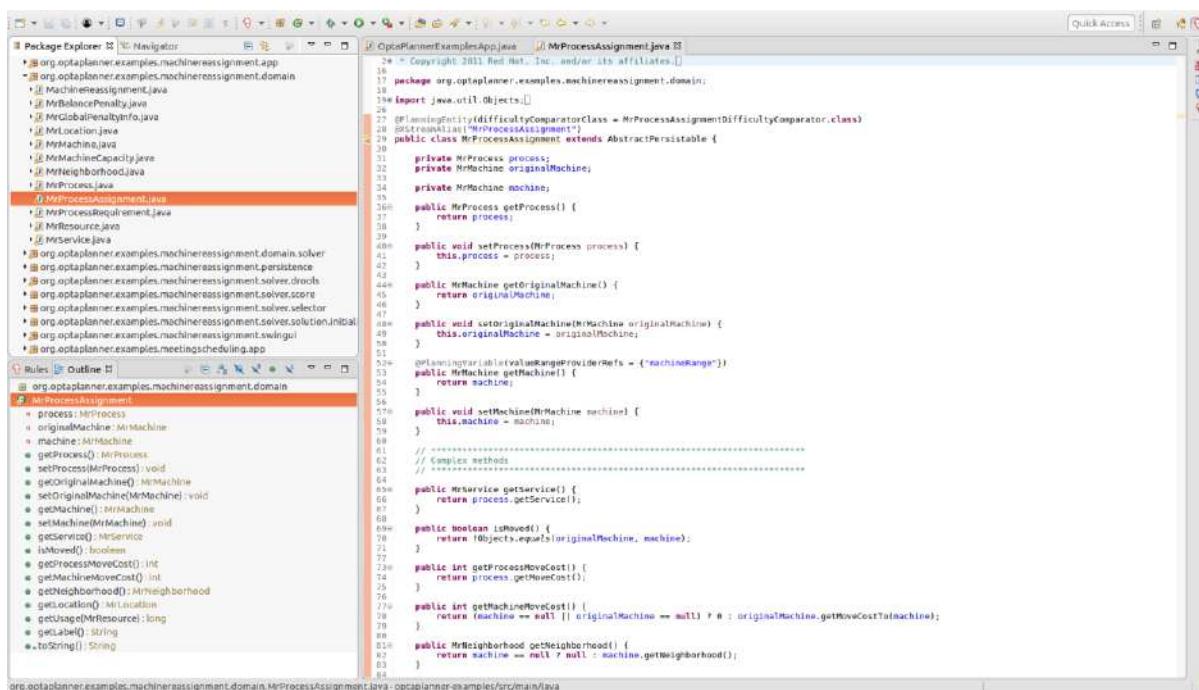
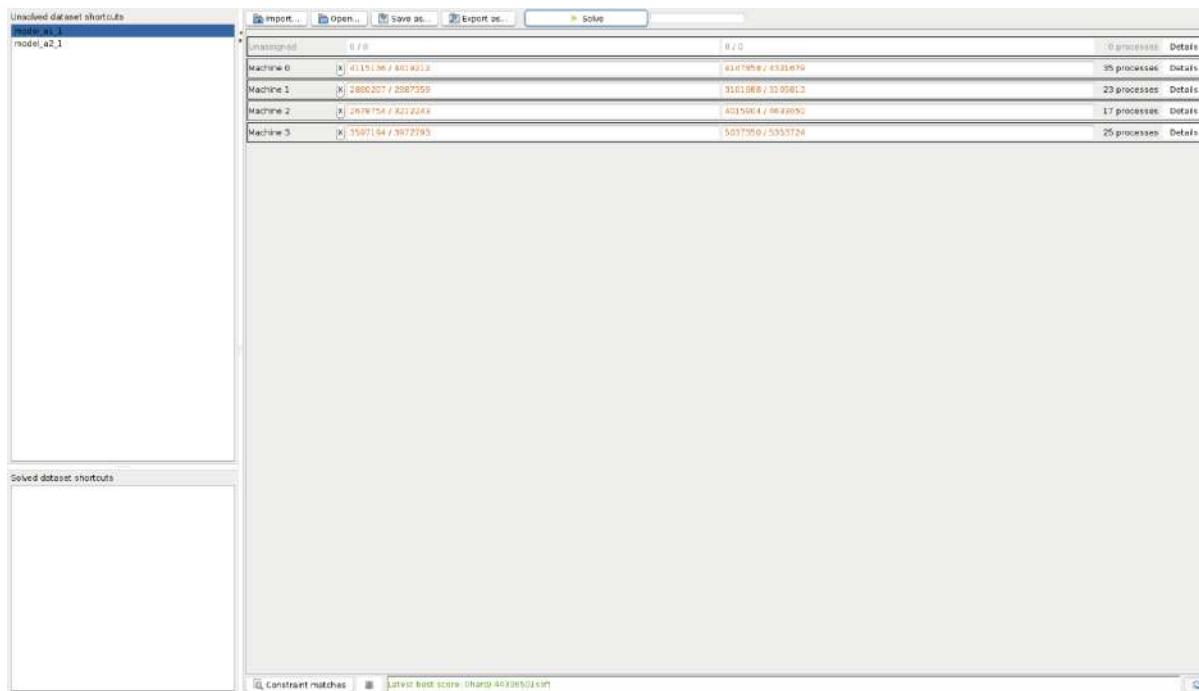
- **Business Scenario / Problem Description**
- Assign each process to a machine. All processes already have an original (unoptimized) assignment. Each process requires an amount of each resource (such as CPU, RAM, ...). This is a more complex version of the Cloud Balancing example.
- **Hard constraints:**
  - 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





## 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

@PlanningSolution

VehicleRoutingSolution

@PlanningEntityCollectionProperty

@PlanningEntity

Customer

readyTime  
dueTime  
serviceDuration  
arrivalTime  
departureTime

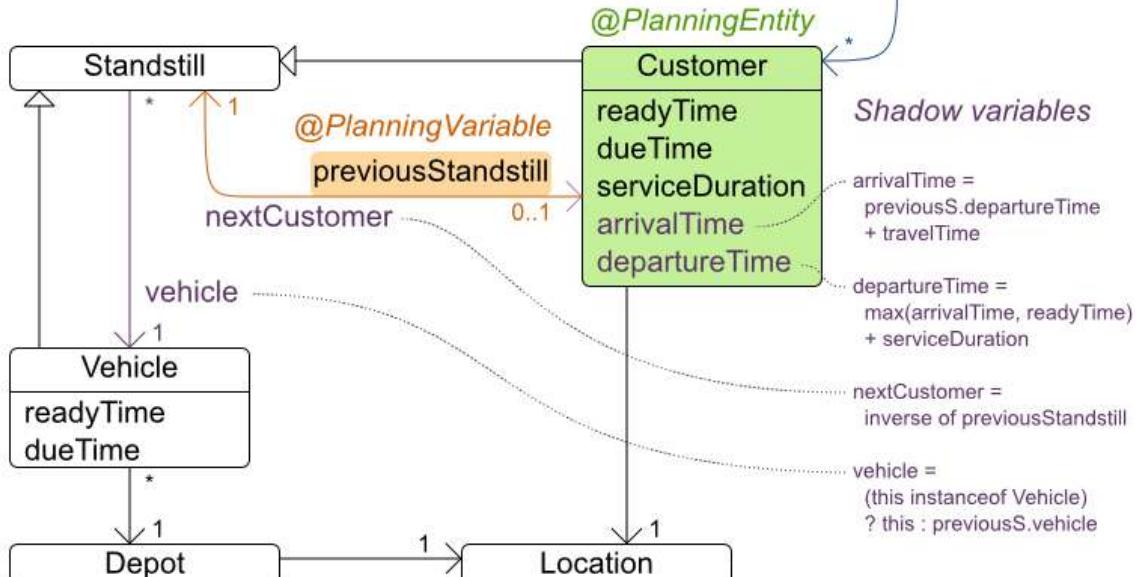
Shadow variables

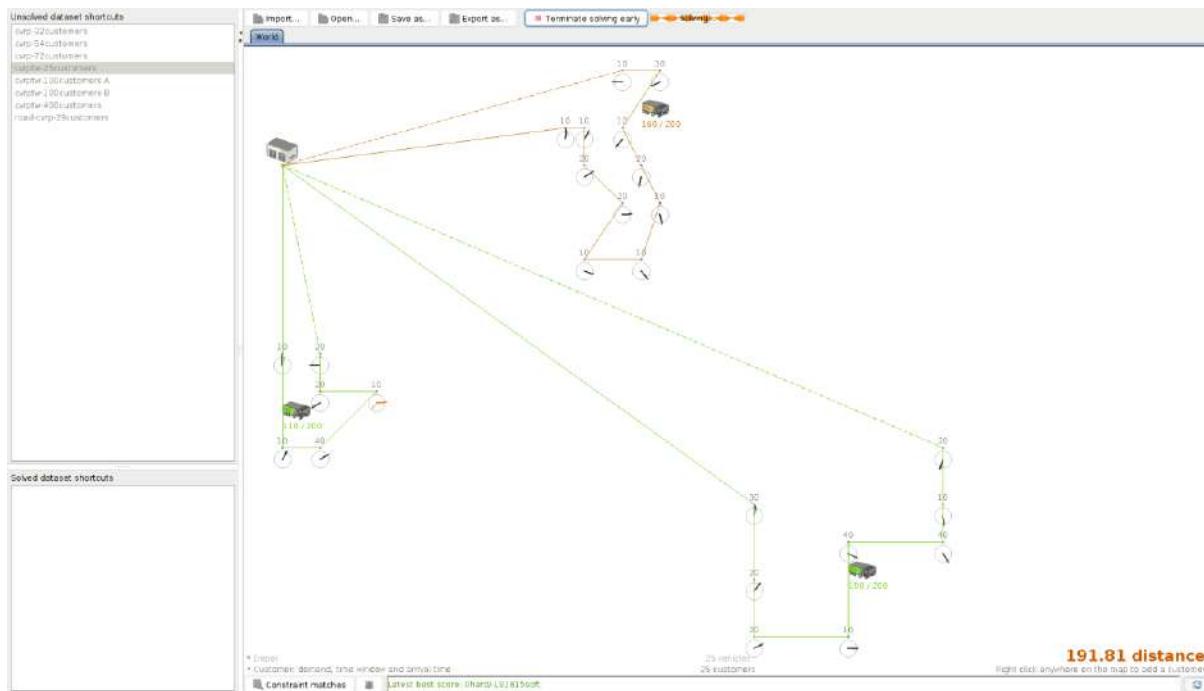
arrivalTime =  
previousS.departureTime  
+ travelTime

departureTime =  
max(arrivalTime, readyTime)  
+ serviceDuration

nextCustomer =  
inverse of previousStandstill

vehicle =  
(this instanceof Vehicle)  
? this : previousS.vehicle





```

Customer.java
1 package org.optaplanner.examples.vrp.persistence;
2 import org.optaplanner.examples.tsp.persistence.*;
3 import org.optaplanner.examples.tsp.solver.Score;
4 import org.optaplanner.examples.tsp.swing.gui.*;
5 import org.optaplanner.examples.vehicleRouting.app.*;
6 import org.optaplanner.examples.vehicleRouting.domain.*;
7
8 public class Customer extends AbstractPersistable implements Standstill {
9     protected Location location;
10    protected int demand;
11    // Planning variables: changes during planning, between score calculations.
12    protected Standstill previousStandstill;
13    // Shadow variables
14    protected Customer nextCustomer;
15    protected Vehicle vehicle;
16
17    @Override
18    public Location getLocation() {
19        return location;
20    }
21
22    public void setLocation(Location location) {
23        this.location = location;
24    }
25
26    public int getDemand() {
27        return demand;
28    }
29
30    public void setDemand(int demand) {
31        this.demand = demand;
32    }
33
34    @PlanningVariable(valuesRangeProviderRefs = {"vehicleRange", "customerRange"}, graphType = PlanningVariableGraphType.CHAINED)
35    public Standstill getPreviousStandstill() {
36        return previousStandstill;
37    }
38
39    @Override
40    public void setPreviousStandstill(Standstill previousStandstill) {
41        this.previousStandstill = previousStandstill;
42    }
43
44    @Override
45    public Customer getNextCustomer() {
46        return nextCustomer;
47    }
48
49    @Override
50    public void setNextCustomer(Customer nextCustomer) {
51        this.nextCustomer = nextCustomer;
52    }
53
54    @Override
55    public Vehicle getVehicle() {
56        return vehicle;
57    }
58
59    @Override
60    public void setVehicle(Vehicle vehicle) {
61        this.vehicle = vehicle;
62    }
63
64    @Override
65    public long getDistanceFromPreviousStandstill() {
66        return getDistanceFromStandstill();
67    }
68
69    @Override
70    public long getDistanceFromStandstill() {
71        return getDistanceToStandstill();
72    }
73
74    @Override
75    public Customer getNextCustomer() {
76        return nextCustomer;
77    }
78
79    @Override
80    public void setNextCustomer(Customer nextCustomer) {
81        this.nextCustomer = nextCustomer;
82    }
83
84    @Override
85    public Vehicle getVehicle() {
86        return vehicle;
87    }
88}

```

## 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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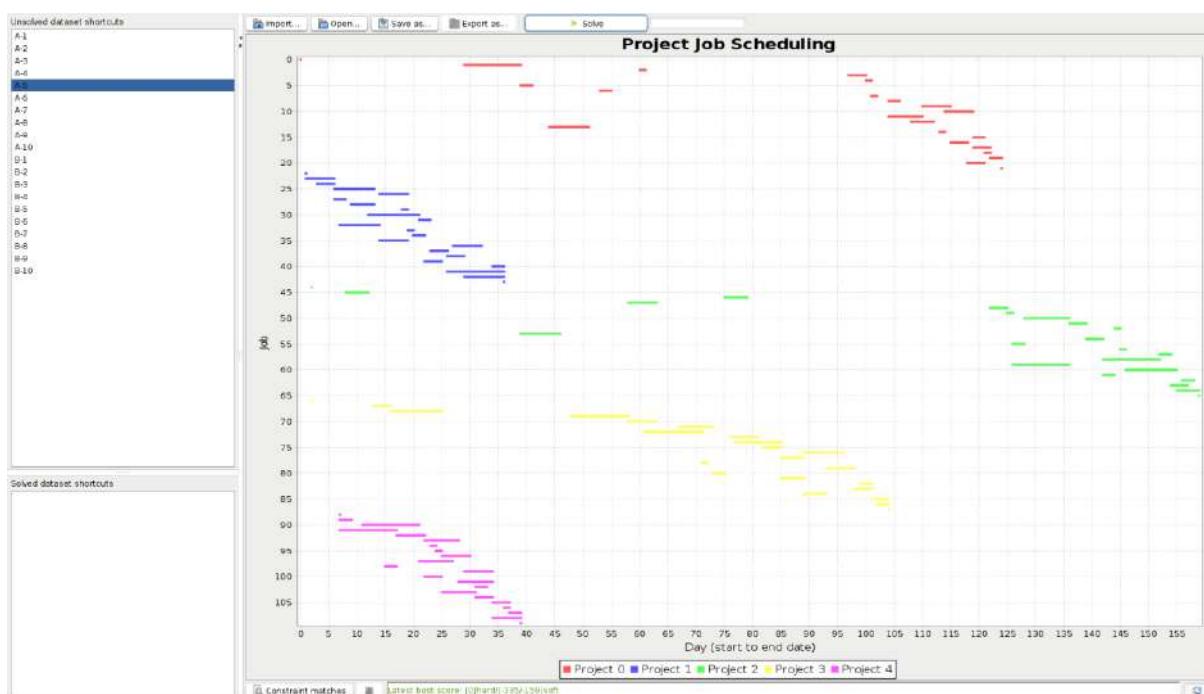
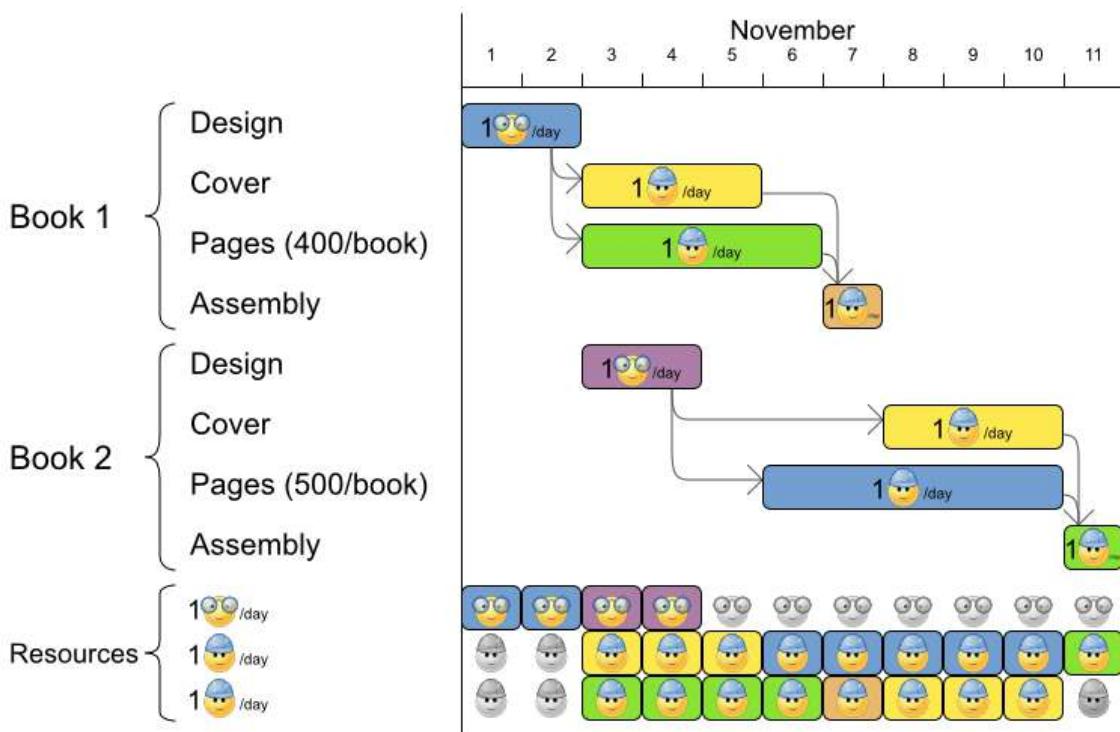
## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

### Exercise: Draw Class Diagram



# Project job scheduling

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



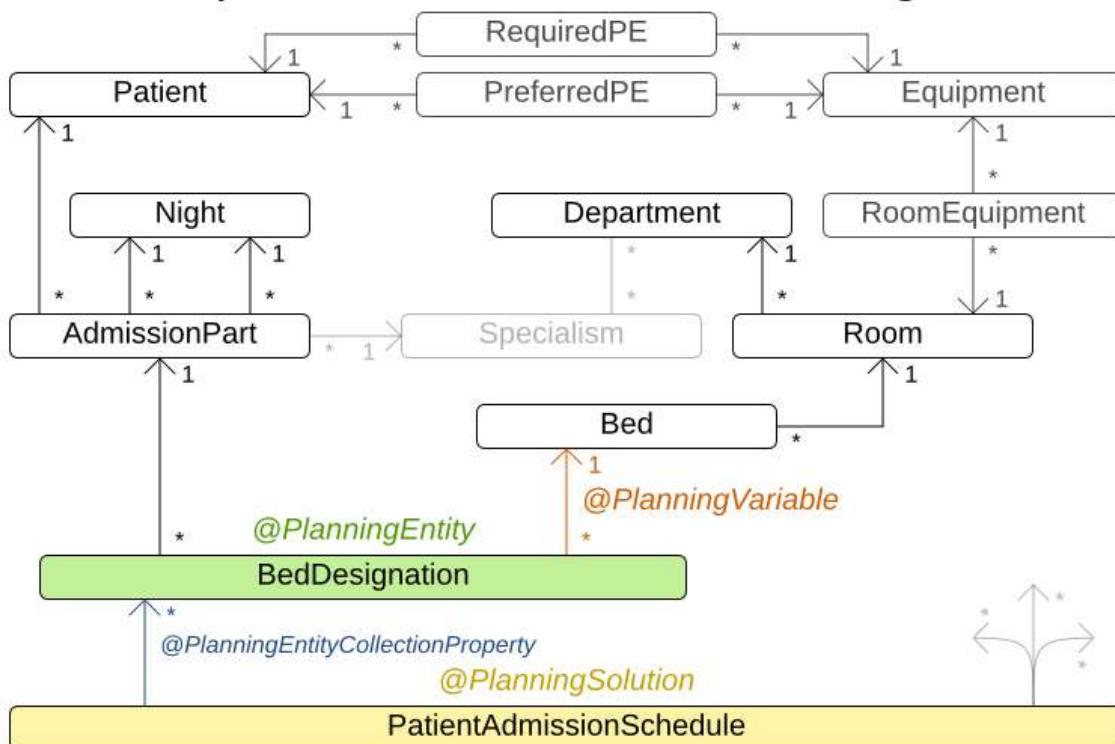
## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

### 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 specialty 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/). <https://people.cs.kuleuven.be/~wim.vancroonenburg/pas/>

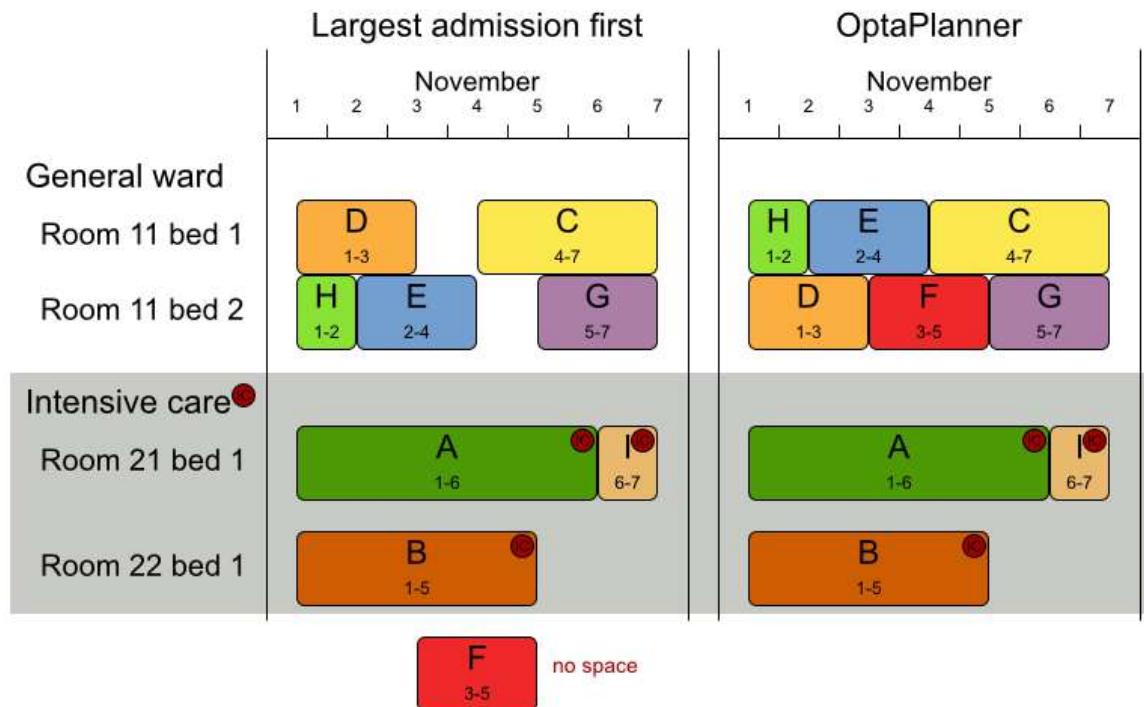
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## Hospital bed allocation class diagram



# Patient admission schedule

Assign each patient a hospital bed.



The screenshot shows the OptaPlanner software interface with a patient admission schedule grid. The grid has columns for Department, Room, Bed, and time slots from 1-AM to 14-AM. The grid is divided into General ward (white) and Intensive care (grey) sections. Patients are represented by colored rectangles with their names and admission times. A tooltip provides details for Patient 318:

Patient 318  
General M (see icon)  
Age: 79  
Preferred maximum room capacity: 1  
Requires 2 equipments (shown as rectangles)  
Requires 1 equipment

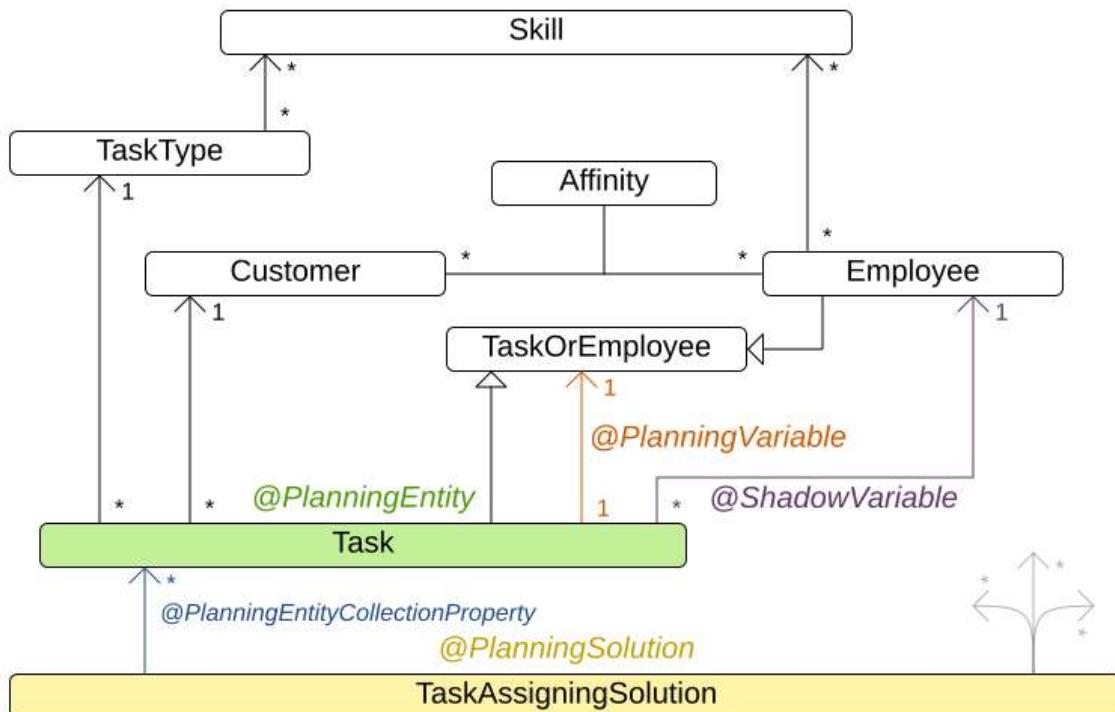
## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

### 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 creates 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.

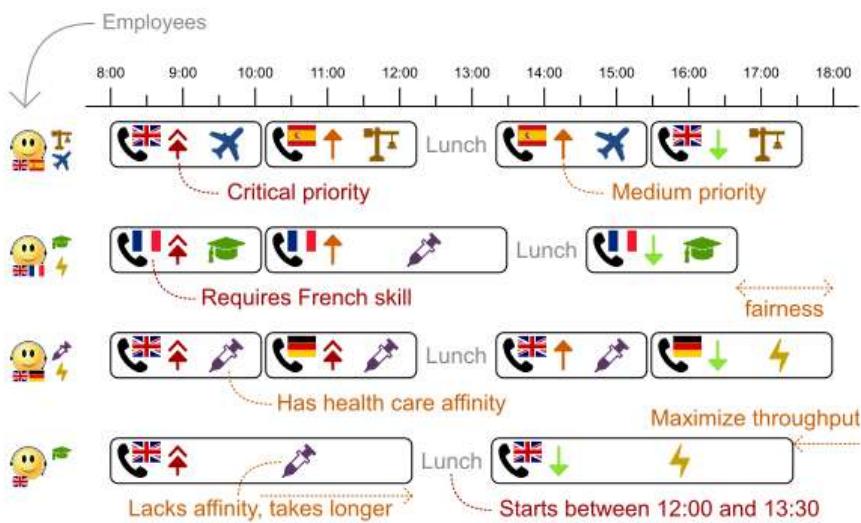
337

## Task assigning class diagram

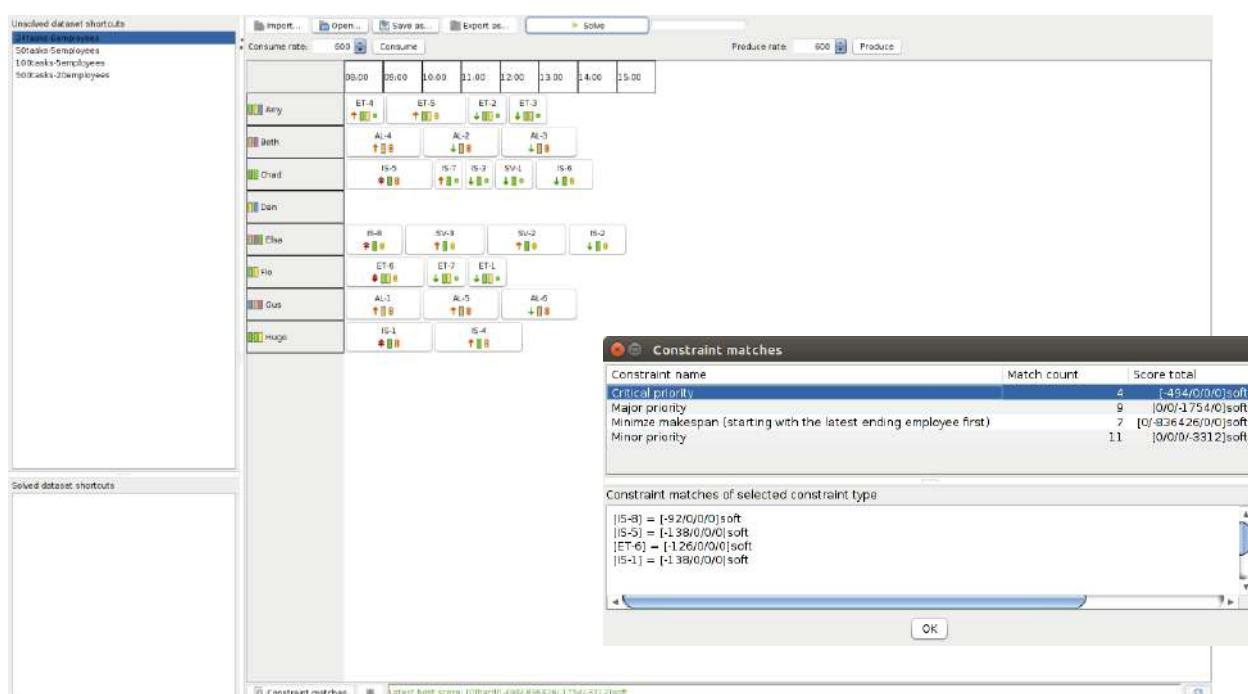


# Task assigning

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



- Payroll services
- Call centers
- Tax auditors
- Recruitment interviewing
- Mortgage approval



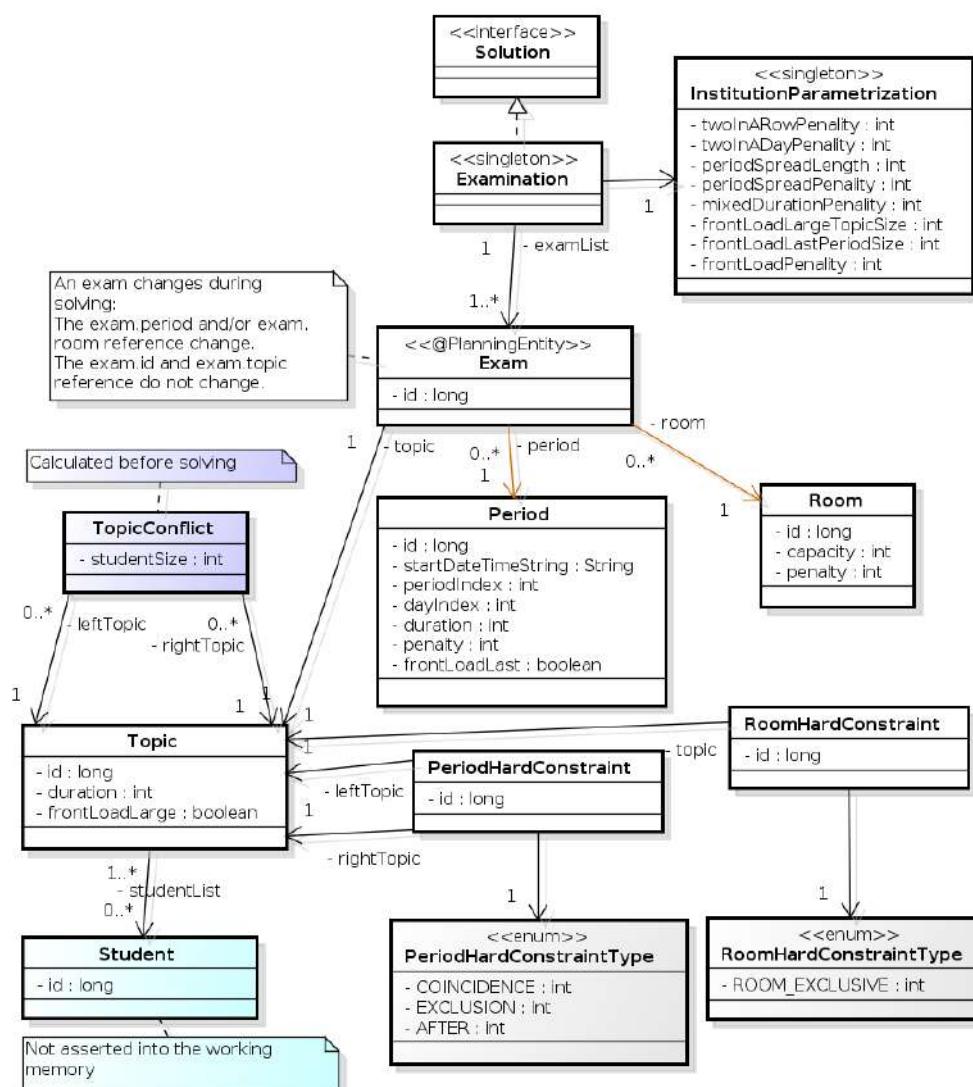
## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

### 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](#).

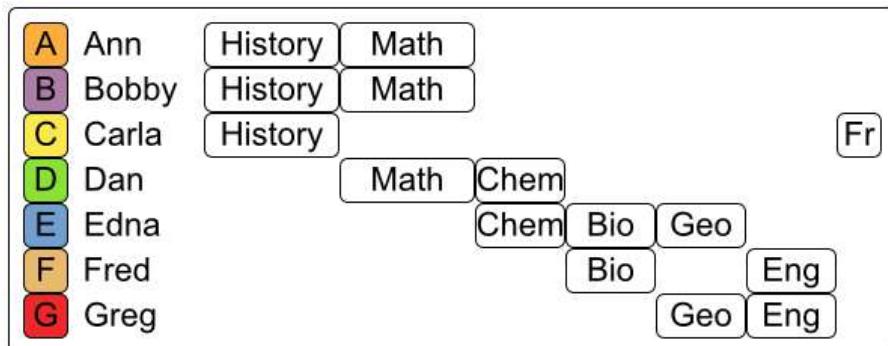
[http://www.cs.qub.ac.uk/ittc2007/examtrack/exam\\_track\\_index.htm](http://www.cs.qub.ac.uk/ittc2007/examtrack/exam_track_index.htm)

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## Examination timetabling

Assign each exam a period and a room.



Most students first

	Room X 4 seats	Room Y 3 seats
--	-------------------	-------------------

OptaPlanner

	Room X 4 seats	Room Y 3 seats
--	-------------------	-------------------

Mon 09:00

History	Chem	Chem	Eng	History
A B C	D E	D E F G	A B C	

Fri 09:00

Math	Fr	Bio	Math	Bio
A B D C		E F	A B D	E F

Fri 14:00

Geo	Eng	Geo	Fr
E G	F G	E G	C

same time

same day

same day

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
03-05-2005 09:00:00	120	144	136	126	109	167	176	154	161	168	148	160	158	165	159	164	
03-05-2005 13:30:00	880	142	174	149	155	129	154	140	160	157	125	115	165	159	166	164	
03-05-2005 16:30:00	140	245	166	169	108	105	106	169	153	157	137	174	154	164	155	156	
04-05-2005 09:30:00	138	166	159	111	115	131	129	157	166	156	141	147	148	149	151	152	
04-05-2005 13:30:00	138	166	159	111	115	131	129	157	166	156	141	147	148	149	151	152	
04-05-2005 16:30:00	138	166	159	111	115	131	129	157	166	156	141	147	148	149	151	152	
05-05-2005 09:30:00	429	566	142	105	152	104	154	155	156	157	158	159	160	161	162	163	
05-05-2005 13:30:00	429	566	142	105	152	104	154	155	156	157	158	159	160	161	162	163	
05-05-2005 16:30:00	429	566	142	105	152	104	154	155	156	157	158	159	160	161	162	163	

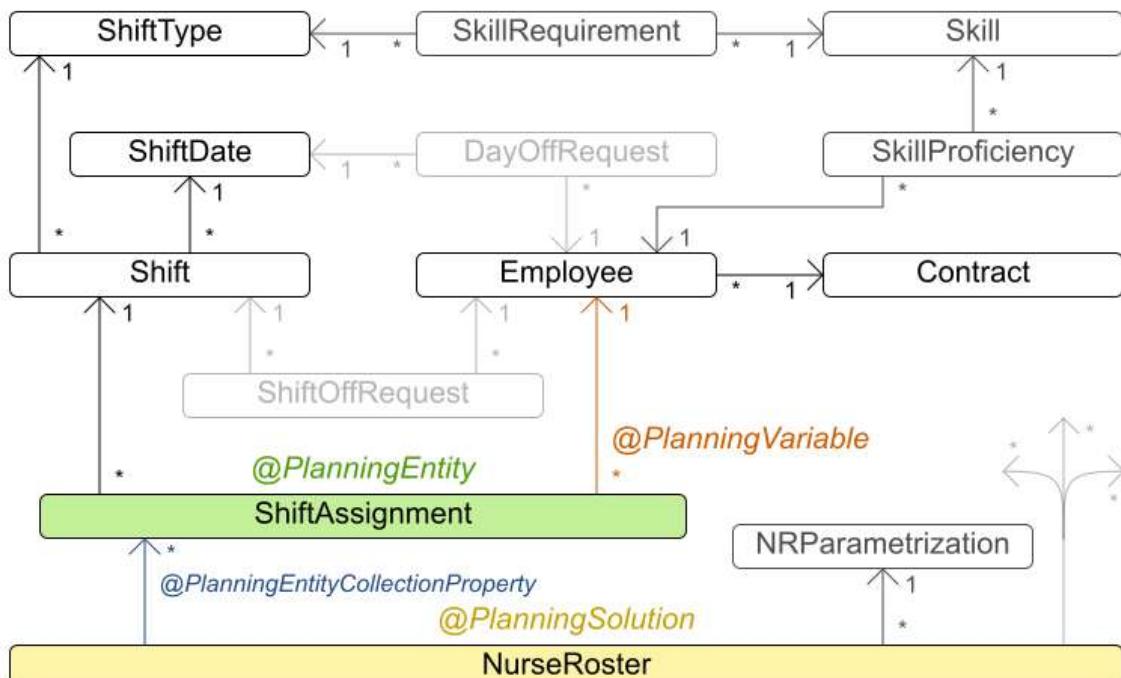
## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

### 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 need 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).
    - 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) <http://www.kuleuven-kortrijk.be/nrpcompetition>

35E

## 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			OptaPlanner		
	Sat	Sun	Mon	Sat	Sun	Mon
	6	14	22	6	14	22
Maternity nurses	1 2 C A B	1 1 C A B	2 1 A C B	1 2 C A B	1 1 C A B	2 1 C A B
Emergency nurses	2 1 D G E	2 1 D G E	1 1 D E	2 1 D G E	2 1 D G E	1 1 D G
Any nurses	1 1 H I	1 1 H I G H I	1 1 1 1 1 H I E H I	1 1 H I	1 1 1 1 1 H I E H I	1 1 1 1 1 H I E H I

The screenshot shows the OptaPlanner interface for a shift rostering problem. The main area displays a grid of 10 employees (Employee 1 to Employee 10) over 16 days (Jan 1 to Jan 16). The grid uses color-coded squares to represent shifts: blue for day shifts, orange for night shifts, and grey for off-duty. Some squares contain numbers (e.g., 1, 2, 3) and letters (e.g., A, B, C, D, E, G, H, I, N, L, U) indicating specific assignments or constraints. Red arrows and text 'too early' highlight certain conflicts in the initial solution.

The bottom right window, titled 'Constraint matches', lists the following information:

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

Below this, the 'Constraint matches of selected constraint type' section lists several constraints:

- [2010-01-06/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
- [2010-01-16/E, 2010-01-16\_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/>

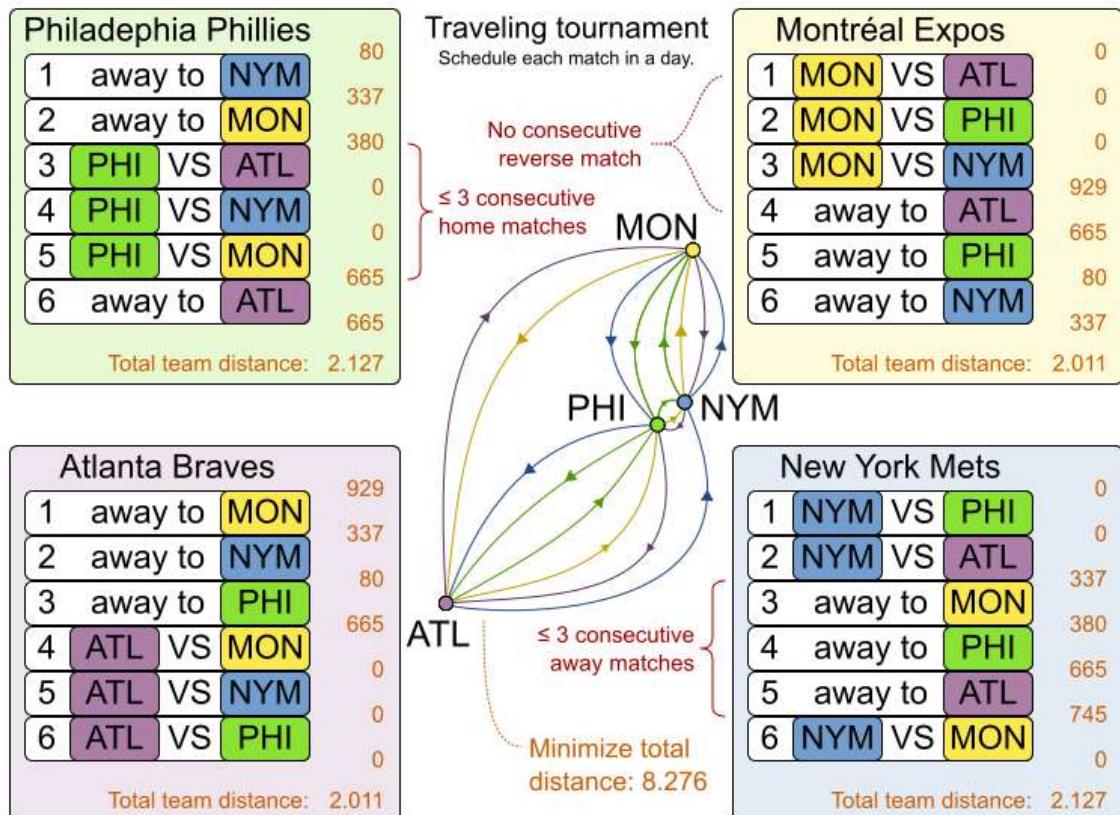
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## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram



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Unsolved dataset shortcuts

Solved dataset shortcuts

Teams

Day	ATL	NYM	PHL	MON	Unassigned
0	X MON	PHL	X NYM	ATL	
1	X NYM	ATL	X PHL	MON	
2	X PHL	X MON	ATL	NYM	
3	MON	X PHL	NYM	X ATL	
4	NYM	X ATL	MON	X PHL	
5	PHL	MON	X ATL	X NYM	
6					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

Constraint matches      Latest best score: 0.271000

## 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.

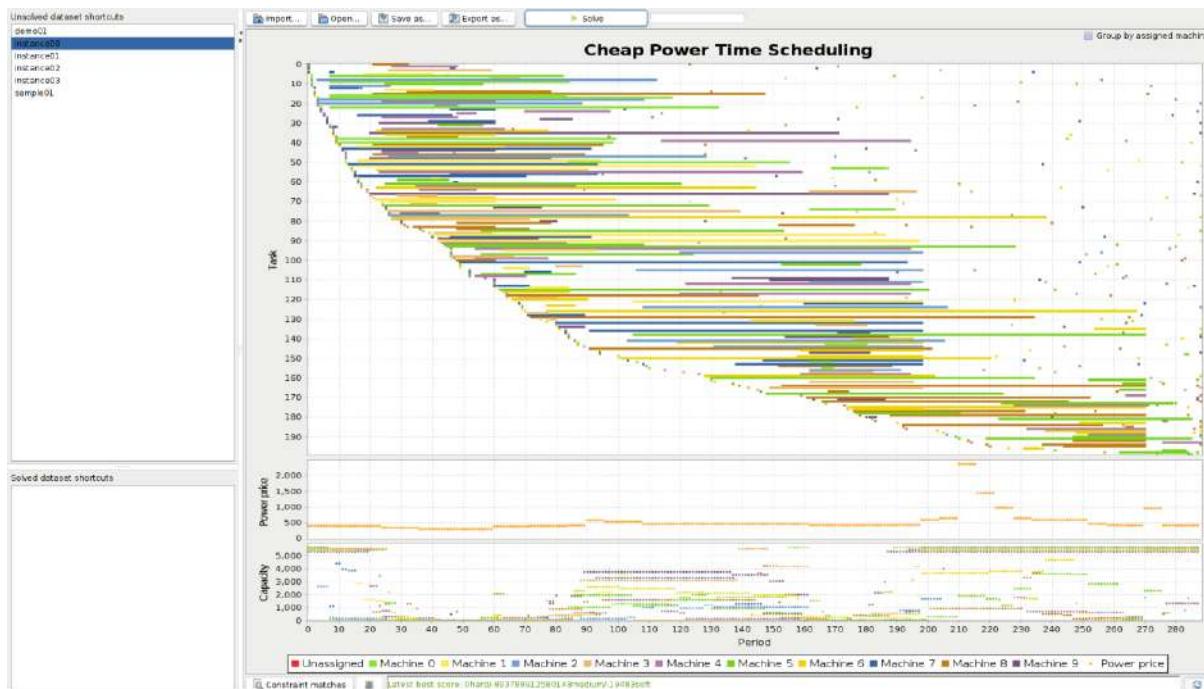
375

## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

### Exercise: Draw Class Diagram



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Screenshot of an IDE (Eclipse) showing the code for `TaskAssignment.java`. The code implements a `TaskAssignment` class that extends `AbstractPersistable`. It includes methods for setting a task, machine, start period, and end period. The code also contains annotations like `@PlanningVariable` and `@TaskRequirement`.

```

24 * Copyright 2014 Optaplanner, Inc. and/or its affiliates.
25 *
26 package org.optaplanner.examples.cheptime.domain;
27
28 import com.thoughtworks.xstream.annotations.XStreamAlias;
29
30 @PlanningEntity(difficultyComparatorClass = TaskAssignmentDifficultyComparator.class)
31 @XStreamAlias("TaskAssignment")
32 public class TaskAssignment extends AbstractPersistable {
33
34     private Task task;
35
36     // Planning variables: changes during planning, between score calculations...
37     private Machine machine;
38     private Integer startPeriod;
39
40     public Task getTask() {
41         return task;
42     }
43
44     public void setTask(Task task) {
45         this.task = task;
46     }
47
48     @PlanningVariable(valueRangeProviderRefs = {"machineRange"})
49     public Machine getMachine() {
50         return machine;
51     }
52
53     public void setMachine(Machine machine) {
54         this.machine = machine;
55     }
56
57     @PlanningVariable(valueRangeProviderRefs = {"startPeriodRange"})
58     public Integer getStartPeriod() {
59         return startPeriod;
60     }
61
62     public void setStartPeriod(Integer startPeriod) {
63         this.startPeriod = startPeriod;
64     }
65
66     // Complex methods
67     // *****
68
69     /**
70      * The startPeriod is included and the endPeriod is excluded.
71      * > return null if @link{getStartPeriod()} is null.
72      */
73     public Integer getEndPeriod() {
74         if (startPeriod == null) {
75             return null;
76         }
77         return startPeriod + task.getDuration();
78     }
79
80     public String getLabel() {
81         return task.getLabel();
82     }
83
84     // *****
85     // Range
86 }

```

## 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.

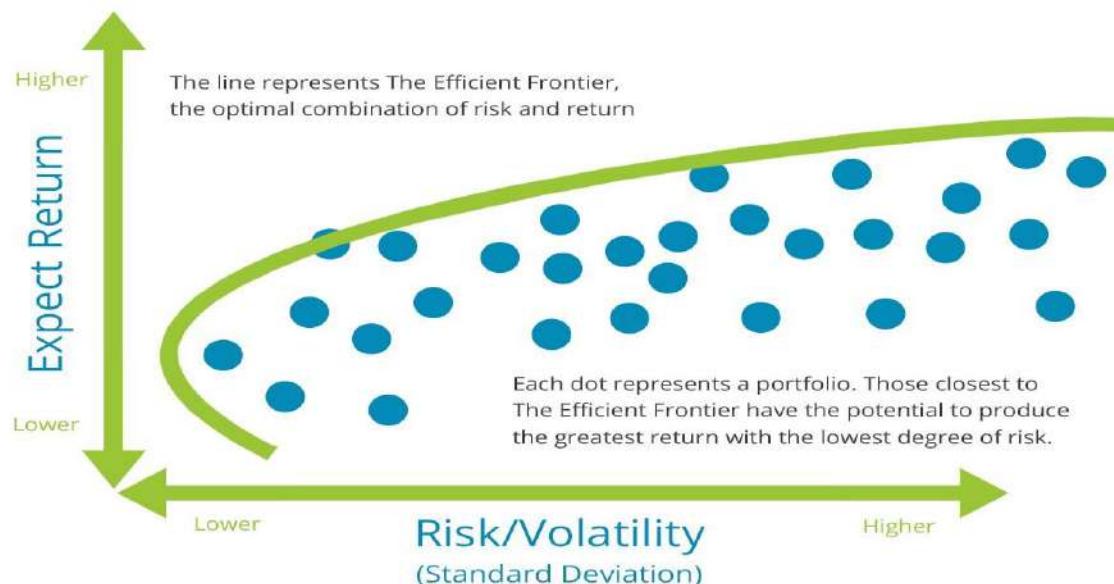
384

## 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/>

Asset class	Region	Sector	Expected return	Standard deviation risk	Quoted	Red Hat...	Google L...	Oracle C...	Apple Inc...	Microsoft...	Tata Me...	Ford Mot...	Toyota M...	General ...	Starbuck...	McDonald...
Red Hat, Inc.	Global	Tech	15.0%	29.1%	0.0%	0.000	0.050	0.000	0.130	0.140	0.230	0.210	0.080	0.320	0.330	0.060
Google Inc.	Global	Tech	15.0%	21.5%	0.0%	0.050	0.000	0.050	0.260	0.180	0.100	0.000	0.200	0.210	0.210	0.210
Oracle Corporation	Global	Tech	12.3%	21.7%	1.8%	0.000	0.050	0.000	0.190	0.330	0.140	0.420	0.190	0.500	0.170	-0.010
Apple Inc.	Global	Tech	20.0%	24.1%	20.0%	0.130	0.260	0.190	0.000	0.270	0.610	0.150	0.180	0.250	0.230	0.020
Microsoft Corporation	Global	Tech	17.9%	20.7%	10.3%	0.140	0.180	0.330	0.270	0.000	0.180	0.260	0.350	0.320	0.170	0.160
Tesla Motors, Inc.	Global	Cars	54.7%	53.9%	13.1%	0.230	0.100	0.140	0.610	0.180	0.000	0.320	0.160	0.230	0.240	-0.050
Ford Motor Company	Global	Cars	1.0%	25.8%	0.0%	0.210	0.040	0.420	0.150	0.290	0.370	0.000	0.240	0.380	0.100	0.100
Toyota Motor Corp Ltd Ord	Global	Cars	13.0%	19.2%	16.0%	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	0.080
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%	0.000	0.210	-0.010	0.030	0.180	-0.050	0.100	0.050	0.310	0.000	0.000
Total			28.0%	35.0%	16.0%											

Constraint matches

Constraint name	Match count	Score total
Maximize expected return	11	27989soft

Constraint matches of selected constraint type

```
[11-McDonald's Corporation] = 0
[10-Starbucks Corporation] = 66400soft
[9-General Motors Company] = 0
[8-Bayer 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

## 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 tag: 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 tag: If a speaker has a prohibited timeslot tag, then all his/her talks cannot be assigned to a timeslot with that tag.
    - Talk required timeslot tag: If a talk has a required timeslot tag, then it must be assigned to a timeslot with that tag.
    - Talk prohibited timeslot tag: If a talk has a prohibited timeslot tag, then it cannot be assigned to a timeslot with that tag.
    - Speaker required room tag: If a speaker has a required room tag, then all his/her talks must be assigned to a room with that tag.
    - Speaker prohibited room tag: 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 tag: If a talk has a required room tag, then it must be assigned to a room with that tag.
    - Talk prohibited room tag: 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

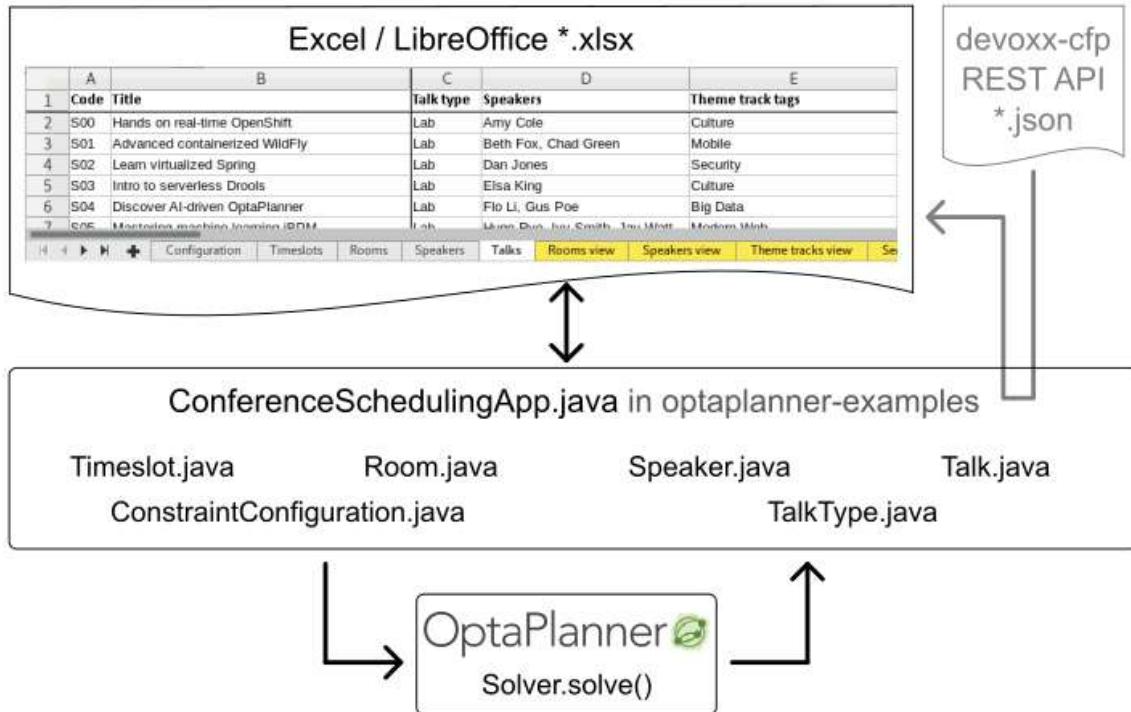
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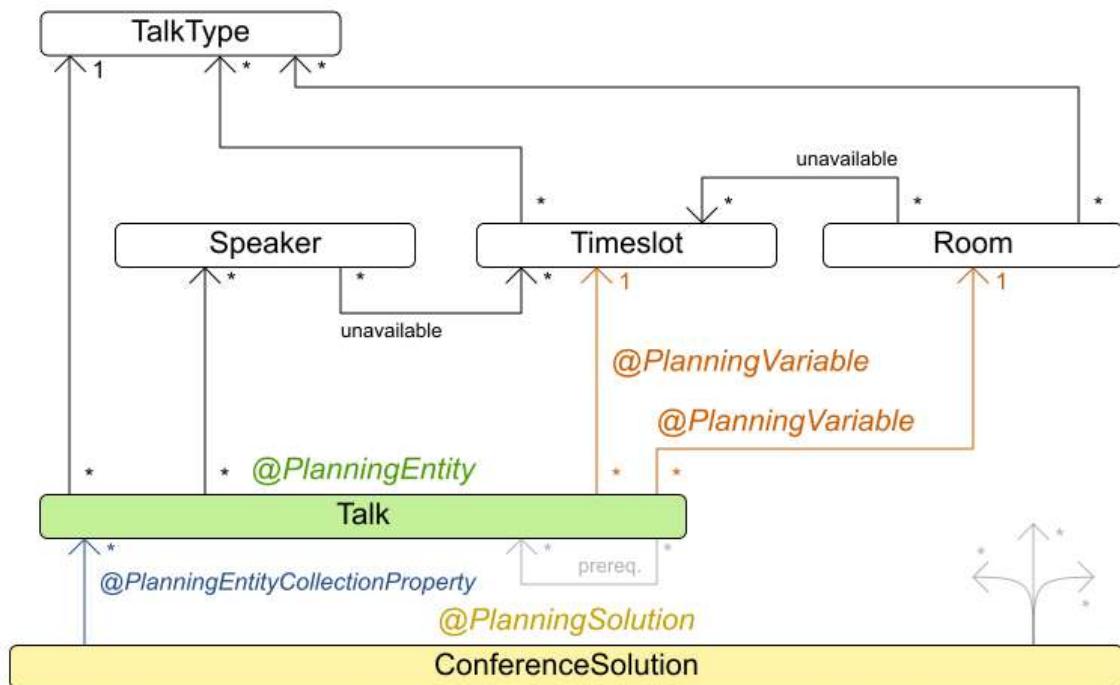
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# Conference scheduling architecture

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

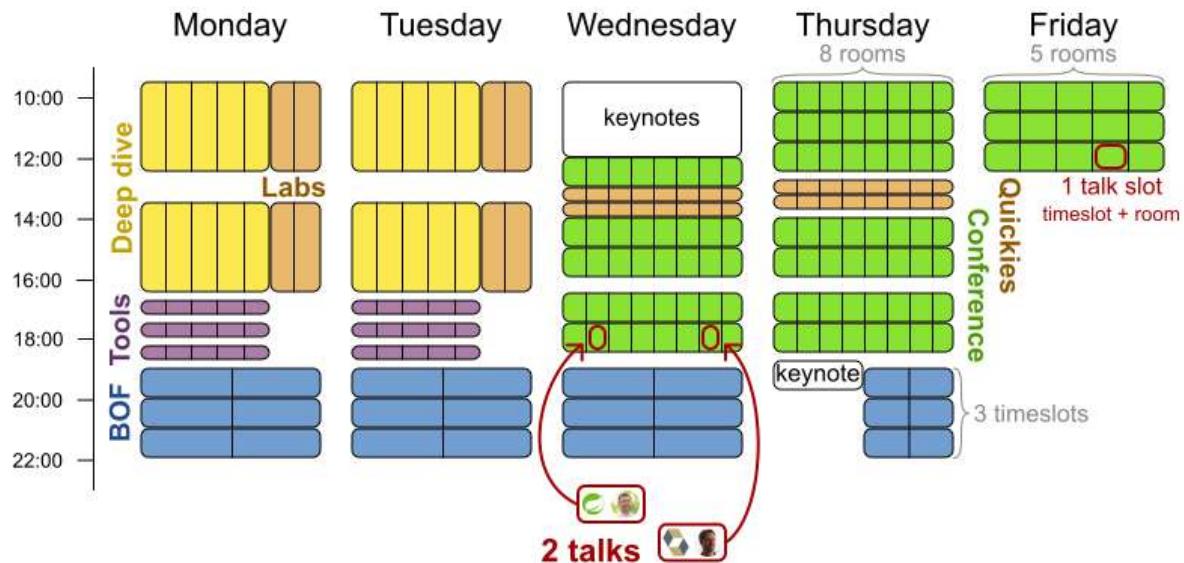


## Conference scheduling class diagram



# 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
<b>Speaker unavailable timeslot</b>	1	-1hard
Theme track conflict	3	-30soft

A1	B	C
1 Conference name	Javexx 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	15: Soft reward per 2 talks that have the same timeslot and a different audience type	
7 Audience topic theme track conflict	15: 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	15: Soft reward per 2 talks that have the same timeslot and a different audience level	
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 penalty per common content of 2 talks that have an overlapping timeslot	
11 Language diversity	15: Soft reward per 2 talks that have the same timeslot and a different language	
12 Speaker preferred timeslot tags	20: Soft penalty per missing preferred tag in a talk's timeslot	
13 Speaker undesired timeslot tags	20: Soft penalty per undesired tag in a talk's timeslot	
14 Talk preferred timeslot tags	20: Soft penalty per missing preferred tag in a talk's timeslot	
15 Talk undesired timeslot tags	20: Soft penalty per undesired tag in a talk's timeslot	
16 Speaker preferred room tags	20: Soft penalty per missing preferred tag in a talk's room	
17 Speaker undesired room tags	20: Soft penalty per undesired tag in a talk's room	
18 Talk preferred room tags	20: Soft penalty per missing preferred tag in a talk's room	
19 Talk undesired room tags	20: Soft penalty per undesired tag in a talk's room	
20 Same room talks	15: Soft penalty per talk with common room if both talks are scheduled on different days	
21 Popular talks	10: Hard penalty for 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 talks 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	30000: Hard penalty per talk in a timeslot with another talk type	
30 Talk type of room	30000: Hard penalty per talk in a room with another talk type	
31 Room unavailable timeslot	30000: Hard penalty per talk with an unavailable room at its timeslot	
32 Room conflict	10: Hard penalty per pair of talks in the same room in overlapping timeslots	
33 Speaker unavailable timeslot	10: Hard penalty per talk in an unavailable room at its timeslot	
34 Speaker conflict	10: 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 tags	1: Hard penalty per talk that is scheduled before any of its prerequisite talks	

A1	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				
3	R 1	S10: Prepare for streaming GWT Dan Jones	S13: Grok distributed Weld Hugo Rye		S09: Debug enterprise Hibenate Chad Green	S08: Securing scalable Docker Beth Fox
4	R 2	S16: Deliver stable Tensorflow Amy Fox	S17: Implement platform-independent VertX Beth Green		S04: Discover AI-driven OptaPlanner Gus Poe, Hugo Rye	S14: Troubleshooting reliable RestEasy Ivy Smith
5	R 3	S05: Mastering machine learning BPM Ivy Smith	S11: Understand mobile Elm Elsa King, Flo Li		S03: Intro to serverless Drools Flo Li	S07: Building deep learning XStream Amy Fox, Beth Green, Amy Cole
6	R 4	S12: Applying modern Angular Gus Poe	S15: Using secure Android Jay Watt		S02: Learn virtualized Spring Elsa King	S06: Tuning IOT-driven Camel Jay Watt
7	R 5	S00: Hands on real-time OpenShift Amy Cole, Beth Fox	S01: Advanced containerized WildFly Chad Green, Dan Jones			
8						
9						
10						
11						
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14						
15						
16						
17						
18						
19						
20						
21						

## 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.

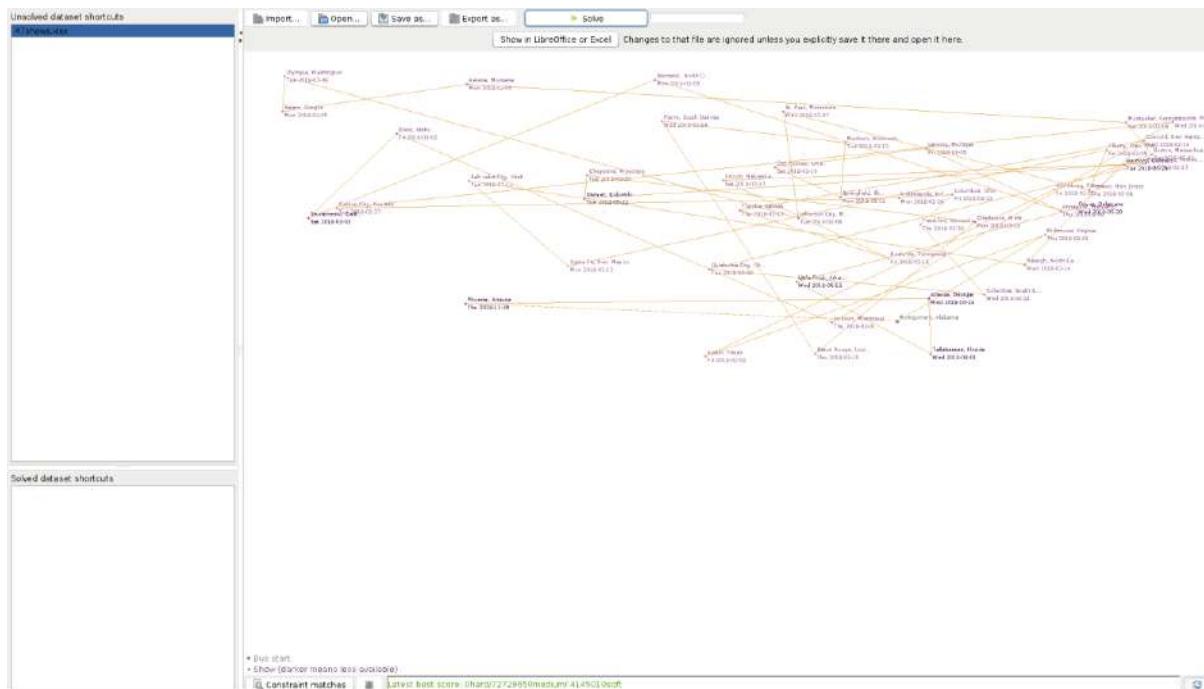
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## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram



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	Date	Venue name	City name	Driving time per week	Latitude	Longitude	Duration (in days)	Revenue opportunity	Required	Available dates size
1	<b>Thu 2018-02-01</b>	Richmond, Virginia	Richmond, Virginia	0 hours 6 minutes	37.538857	-77.43364	0.5	240000	0	224
2	<b>Fri 2018-02-02</b>	Austin, Texas	Austin, Texas	0 hours 2 minutes	30.27467	-97.740349	0.5	200000	0	256
3	<b>Sat 2018-02-03</b>	Harrisburg, Pennsylvania	Harrisburg, Pennsylvania	0 hours 0 minutes	40.264378	-76.883598	0.5	100000	0	252
4	<b>Boston, Massachusetts</b>	Boston, Massachusetts	Boston, Massachusetts	0 hours 1 minutes	42.358162	-71.063698	0.5	600000	0	225
5	<b>Montpelier, Vermont</b>	Montpelier, Vermont	Montpelier, Vermont	0 hours 0 minutes	44.262436	-72.580536	0.5	100000	0	209
6	<b>Sun 2018-02-04</b>			0 hours 12 minutes						
7	<b>Mon 2018-02-05</b>	Helena, Montana	Helena, Montana	0 hours 1 minutes	46.585709	-112.018417	0.5	1300000	0	215
8	<b>Salem, Oregon</b>	Salem, Oregon	Salem, Oregon	0 hours 0 minutes	44.938461	-123.030403	0.5	1200000	0	231
9	<b>Tue 2018-02-06</b>	Olympia, Washington	Olympia, Washington	0 hours 0 minutes	47.035805	-122.905014	0.5	1800000	0	222
10	<b>Jefferson City, Missouri</b>	Jefferson City, Missouri	Jefferson City, Missouri	0 hours 3 minutes	38.579201	-92.172935	0.5	1800000	0	235
11	<b>Wed 2018-02-07</b>	St. Paul, Minnesota	St. Paul, Minnesota	0 hours 1 minutes	44.955097	-93.102211	1	600000	0	248
12	<b>Thu 2018-02-08</b>	Trenton, New Jersey	Trenton, New Jersey	0 hours 3 minutes	40.220596	-74.769913	0.5	1100000	0	227
13	<b>Fri 2018-</b>	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

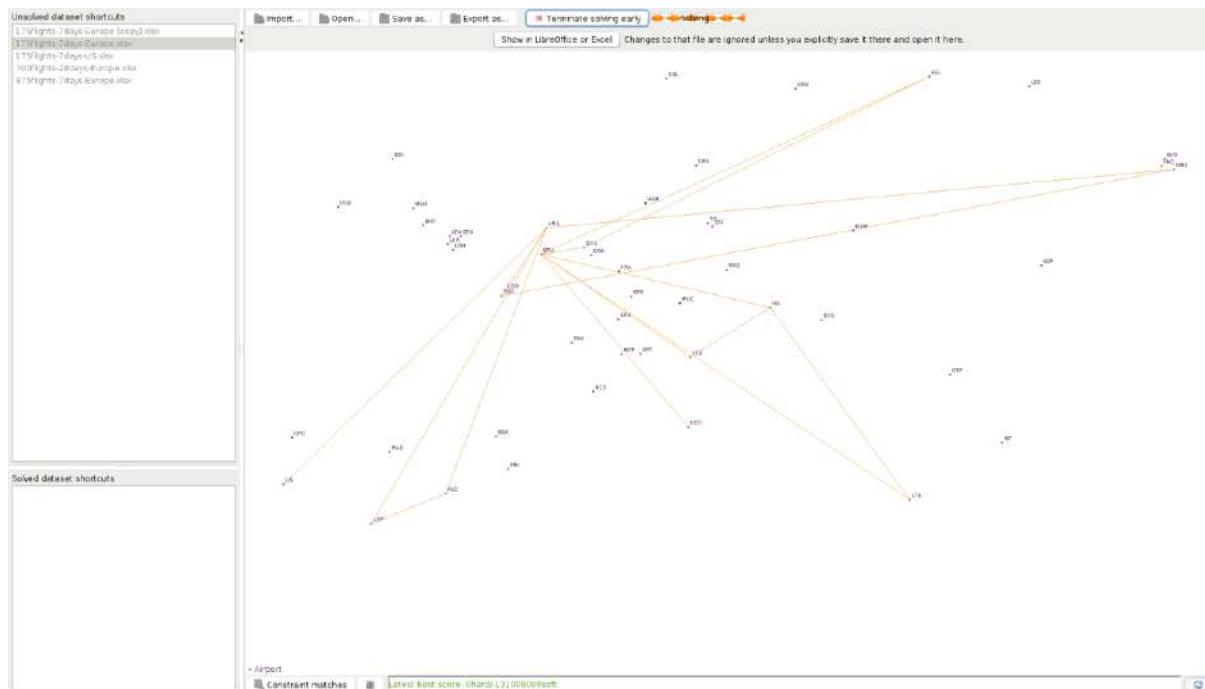
420

## ANNEX 4 : KIE OPTAPLANNER EXAMPLES

Exercise: Draw Class Diagram



421



Flight number

Flight number	Departure airport code	Departure UTC date time	Arrival airport code	Arrival UTC date time	Employee skill requirements	Employee assignments
2. ABD03	BRU	2019-01-01 07:05	ATH	2019-01-01 10:44	Pilot, Flight attendant, Flight attendant, Flight attendant	Amy O. Cole, Flo T. Li, Chad Q. Green, Dan R. Jones, Elsa S. Li Beth P. Poe, Amy O. Fox, Chad Q. King, Dan R. Li
3. ABD08	BRU	2019-01-01 06:01	VIE	2019-01-01 11:25	Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Rye, Amy O. Green, Hugo V. Watt, Ivy W. Cole, Joy X. Fox Beth P. Poe, Amy O. Fox, Chad Q. King, Dan R. Li
4. ABD01	BRU	2019-01-01 10:36	FCO	2019-01-01 13:19	Pilot, Flight attendant, Flight attendant, Flight attendant	Dan R. Li, Amy O. Cole, Elsa S. Poole, Flo T. Li, Joy X. Fox Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole
5. ABD09	BRU	2019-01-01 11:05	DUS	2019-01-01 14:27	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Li, Flo T. Watt, Dan R. Rye, Elsa S. Smith, Hugo V. Cole Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole
7. ABD01	AMS	2019-01-01 06:39	AGP	2019-01-01 10:02	Pilot, Flight attendant, Flight attendant, Flight attendant	Troy T. Cole, Amy O. Jones, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole
8. ABD23	AMS	2019-01-01 08:25	AOP	2019-01-01 10:18	Pilot, Flight attendant, Flight attendant, Flight attendant	Flo T. Cole, Amy O. Jones, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole
9. ABD11	AMS	2019-01-01 07:02	LIS	2019-01-01 10:22	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. King, Chad Q. Watt, Joy X. Green, Hugo V. Watt, Elsa S. Watt Amy O. King, Flo T. Cole, Ivy W. Jones, Hugo V. Jones, Chad Q. Watt
10. ABD18	AMS	2019-01-01 11:22	DME	2019-01-01 15:02	Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Rye, Amy O. Green, Hugo V. Watt, Ivy W. Cole, Joy X. Fox Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole
11. ABD13	AMS	2019-01-01 13:54	DME	2019-01-01 17:34	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole
12. ABD02	FCO	2019-01-01 17:15	BRU	2019-01-01 19:58	Pilot, Flight attendant, Flight attendant, Flight attendant	Dan R. Li, Amy O. Cole, Elsa S. Poole, Flo T. Li, Joy X. Fox Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole, Joy X. Fox
13. ABD15	DYR	2019-01-01 10:00	AMS	2019-01-01 18:45	Pilot, Flight attendant, Flight attendant, Flight attendant	Dan R. Li, Amy O. Cole, Elsa S. Poole, Flo T. Li, Joy X. Fox Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
14. ABD17	DME	2019-01-01 10:17	AMS	2019-01-01 13:37	Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Rye, Amy O. Green, Hugo V. Watt, Ivy W. Cole, Joy X. Fox Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole
15. ABD14	DME	2019-01-01 12:56	ORY	2019-01-01 17:56	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. King, Chad Q. Watt, Joy X. Green, Hugo V. Watt, Elsa S. Watt Amy O. King, Flo T. Cole, Ivy W. Jones, Hugo V. Jones, Chad Q. Watt
16. ABD12	LIS	2019-01-01 09:12	AMS	2019-01-01 12:37	Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Rye, Amy O. Green, Hugo V. Watt, Ivy W. Cole, Joy X. Fox Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole
17. ABD19	DUS	2019-01-01 14:45	HEL	2019-01-01 01:05	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
18. ABD09	VIE	2019-01-01 12:17	VCE	2019-01-01 06:45	Pilot, Flight attendant, Flight attendant, Flight attendant	Gus U. Rye, Amy O. Green, Hugo V. Watt, Ivy W. Cole, Joy X. Fox Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole
19. ABD05	VIE	2019-01-01 12:37	BRU	2019-01-01 15:18	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
20. ABD04	ATH	2019-01-01 07:26	VIE	2019-01-01 10:12	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
21. ABD09	HEL	2019-01-01 10:05	BIR	2019-01-01 14:05	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
22. ABD03	AGR	2019-01-01 08:39	AMS	2019-01-01 12:12	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
23. ABD04	AGR	2019-01-01 17:44	AUC	2019-01-01 19:27	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
24. ABD25	AUC	2019-01-01 14:44	AMS	2019-01-01 19:57	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
25. ABD07	VCE	2019-01-01 07:14	BRU	2019-01-01 09:34	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
26. ABD10	VCE	2019-01-01 10:05	BRU	2019-01-01 18:25	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
27. ABD03	BRU	2019-01-02 07:08	ATH	2019-01-02 10:44	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
28. ABD08	BRU	2019-01-02 09:01	VIE	2019-01-02 11:26	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
29. ABD21	BRU	2019-01-02 09:35	FCO	2019-01-02 12:15	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
30. ABD18	BRU	2019-01-02 11:40	DUS	2019-01-02 13:19	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
31. ABD06	BRU	2019-01-02 13:27	VCE	2019-01-02 16:45	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
32. ABD01	AMS	2019-01-02 09:39	AOP	2019-01-02 10:09	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
33. ABD23	AMS	2019-01-02 09:39	AGP	2019-01-02 10:18	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
34. ABD11	AMS	2019-01-02 07:29	LIS	2019-01-02 10:22	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
35. ABD16	AMS	2019-01-02 11:22	DME	2019-01-02 15:02	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
36. ABD13	AMS	2019-01-02 12:54	DME	2019-01-02 17:34	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
37. ABD22	FCO	2019-01-02 17:16	BRU	2019-01-02 19:55	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
38. ABD15	ORY	2019-01-02 10:50	AMS	2019-01-02 18:35	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
39. ABD17	DME	2019-01-02 10:37	AMS	2019-01-02 14:37	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
40. ABD14	DME	2019-01-02 13:55	ORY	2019-01-02 17:50	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
41. ABD12	IUS	2019-01-02 09:12	AMS	2019-01-02 12:32	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole
42. ABD19	IUS	2019-01-02 14:45	HEL	2019-01-02 17:45	Pilot, Flight attendant, Flight attendant, Flight attendant	Beth P. Poe, Beth P. Green, Elsa S. Poole, Dan R. Lee, Hugo V. Cole Beth P. Poe, Amy O. Fox, Dan R. Lee, Hugo V. Watt, Ivy W. Cole

## 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 2018-09 R Packages

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 <b>Eclipse IDE for Eclipse Committers</b> 311 MB   17,7028 DOWNLOADS Package suited for development of Eclipse itself at Eclipse.org: based on the Eclipse Platform adding PDE, Git, Marketplace Client, source code and developer documentation.  Click here to file a bug against Eclipse Platform. Click here to file a bug against Eclipse Git team provider.	<a href="#"></a>	Windows 32-bit 64-bit Mac Cocoa 64-bit Linux 32-bit 64-bit
 <b>Eclipse IDE for C/C++ Developers</b> 223 MB   125,264 DOWNLOADS An IDE for C/C++ developers with Mylyn integration.	<a href="#"></a>	Windows 32-bit 64-bit Mac Cocoa 64-bit Linux 32-bit 64-bit
 <b>Eclipse IDE for Java and DSL Developers</b> 338 MB   88,054 DOWNLOADS The essential tools for Java and DSL developers, including a Java & Xtend IDE, a DSL Framework (Xtext), a Git client, XML Editor, and Maven integration.	<a href="#"></a>	Windows 32-bit 64-bit Mac Cocoa 64-bit Linux 32-bit 64-bit
 <b>Eclipse IDE for Java Developers</b> 189 MB   352,300 DOWNLOADS The essential tools for any Java developer, including a Java IDE, a Git client, XML Editor, Mylyn, Maven and Gradle integration	<a href="#"></a>	Windows 32-bit 64-bit Mac Cocoa 64-bit Linux 32-bit 64-bit
 <b>Eclipse IDE for JavaScript and Web Developers</b> 172 MB   20,311 DOWNLOADS The essential tools for any JavaScript developer, including JavaScript, HTML, CSS, XML languages support, Git client, and Mylyn.	<a href="#"></a>	Windows 32-bit 64-bit Mac Cocoa 64-bit Linux 32-bit 64-bit
 <b>Eclipse IDE for Java EE Developers</b> 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.	<a href="#"></a>	Windows 32-bit 64-bit Mac Cocoa 64-bit Linux 32-bit 64-bit
<b>Eclipse Modeling Tools</b> 437 MB   8,208 DOWNLOADS		

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- Updating Eclipse
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- Eclipse Photon (4.8)
- Eclipse Oxygen (4.7)
- Eclipse Neon (4.6)
- Eclipse Mars (4.5)
- Eclipse Luna (4.4)
- Eclipse Kepler (4.3)
- Older Versions

**HINT**  
You will need a Java runtime environment (JRE) to use Eclipse.

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](http://download.eclipse.org/technology/m2e/releases/1.3) [download.eclipse.org/technology/m2e/releases/1.4](http://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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2 Exception in java.lang.N 1 How do I in Java file if I my project Path? 4 java applica eclipse 0 How To Cre 1 creating a s in eclipse 1 No suitable driver 1 How to use with an Ecli dependenc see more linked que

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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.	<a href="#">Distribution ZIP</a>
Drools and jBPM integration	Drools and jBPM integration with third party project like Spring. Distribution zip contains binaries, examples and sources.	<a href="#">Distribution ZIP</a>
Drools Workbench	Drools Workbench is the web application and repository to govern Drools and jBPM assets. See <a href="#">documentation</a> for details about installation.	<a href="#">WildFly 14 WAR</a> <a href="#">EAP 7 WAR</a>
Drools and jBPM tools	Eclipse plugins and support for Drools, jBPM and Guvnor functionality. Distribution zip contains binaries and sources.	<a href="#">Distribution ZIP</a>
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.	<a href="#">Distribution ZIP</a>

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 /](#)    Create new file Find file History

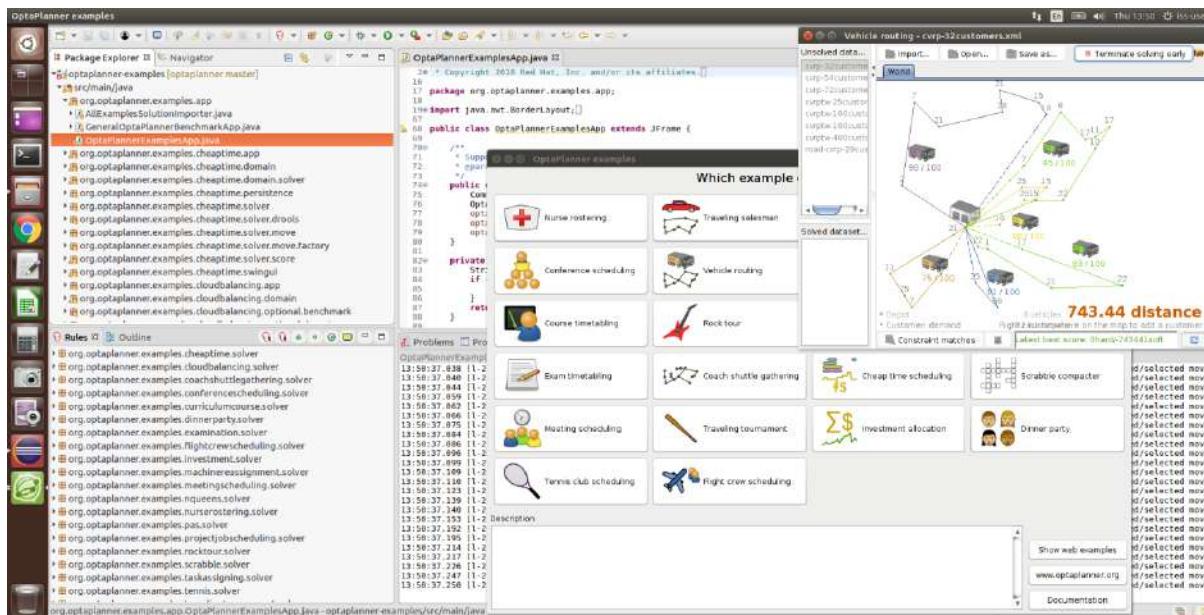
geOffrey add breadcrumbs for other conferences to get the import working    Latest commit `cc1751b` 2 days ago

..

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

**What is OptaPlanner?**

OptaPlanner is a **constraint solver**. It optimizes business resource planning use cases, such as **Vehicle Routing**, **Employee Rostering**, **Cloud Optimization**, **Task Assignment**, **Conference Scheduling**, **Job Scheduling**, **Bin Packing** and many more. Every organization faces such scheduling puzzles: assign a limited set of *constrained* resources (employees, assets, time and money) to provide products or services. OptaPlanner delivers more efficient plans to improve service quality and reduce costs.

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). Constraints apply on plain domain objects and can reuse existing code. There's no need to input them as mathematical equations. Under the hood, OptaPlanner combines sophisticated optimization heuristics and metaheuristics (such as Tabu Search, Simulated Annealing and Late Acceptance) with very efficient score calculation.

OptaPlanner is **open source software**, released under the Apache Software License. It is written in 100% pure Java™, runs on any JVM and is available in the Maven Central repository too.

**Download OptaPlanner 7.14.0.Final**

Try the examples now:

1. Download the zip and unzip it
2. On Linux/Mac, run `examples/runExamples.sh`  
On Windows, run `examples/runExamples.bat`

Requires Java™ to run.

**Read documentation 7.14.0.Final**

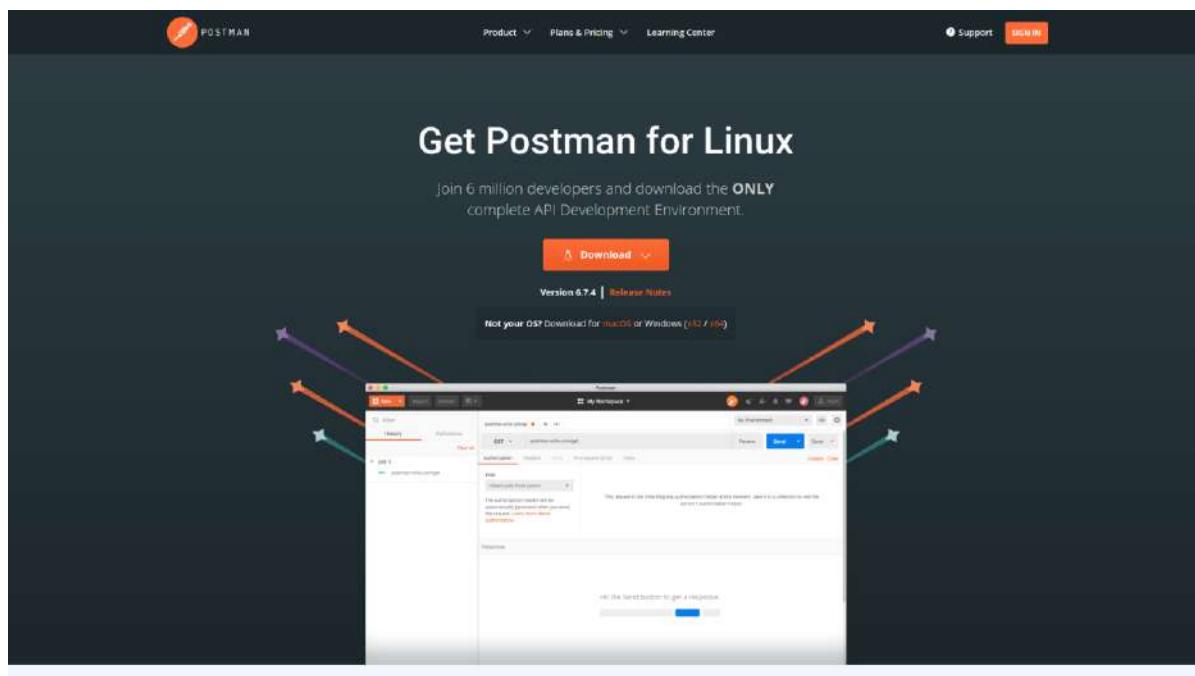
Read the Quick Start chapter.

Video      Use cases      Usage      Integration      Compatibility      Scalability

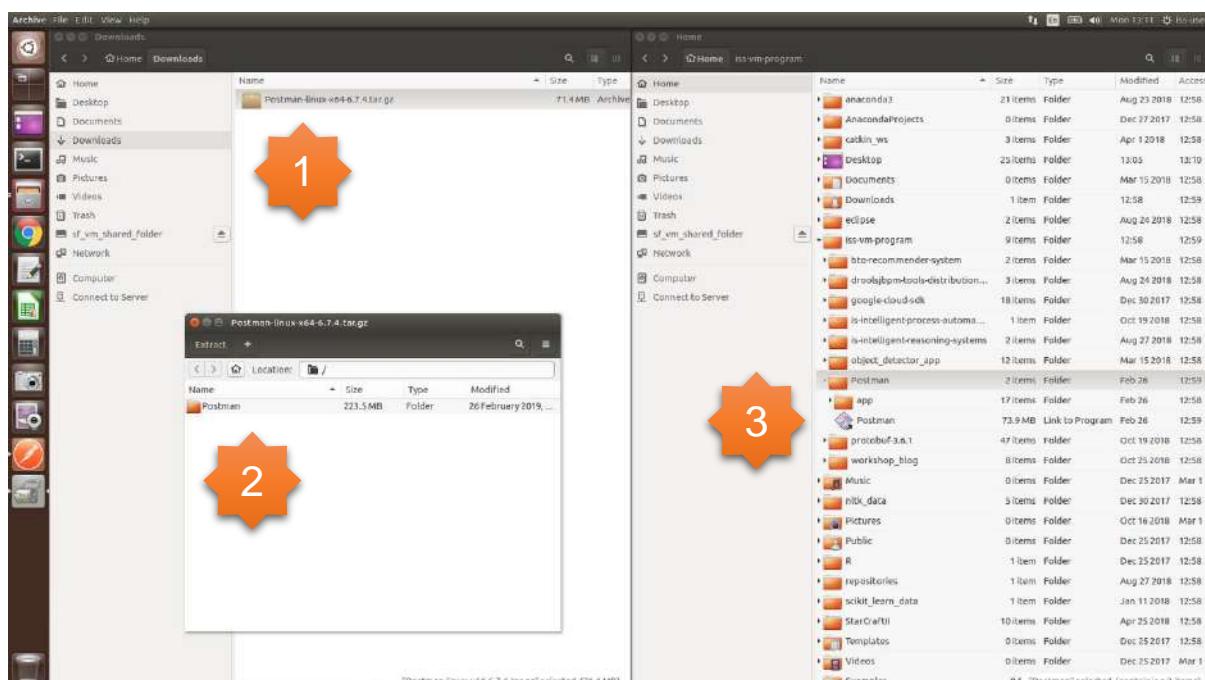
Above: Standalone OptaPlanner

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

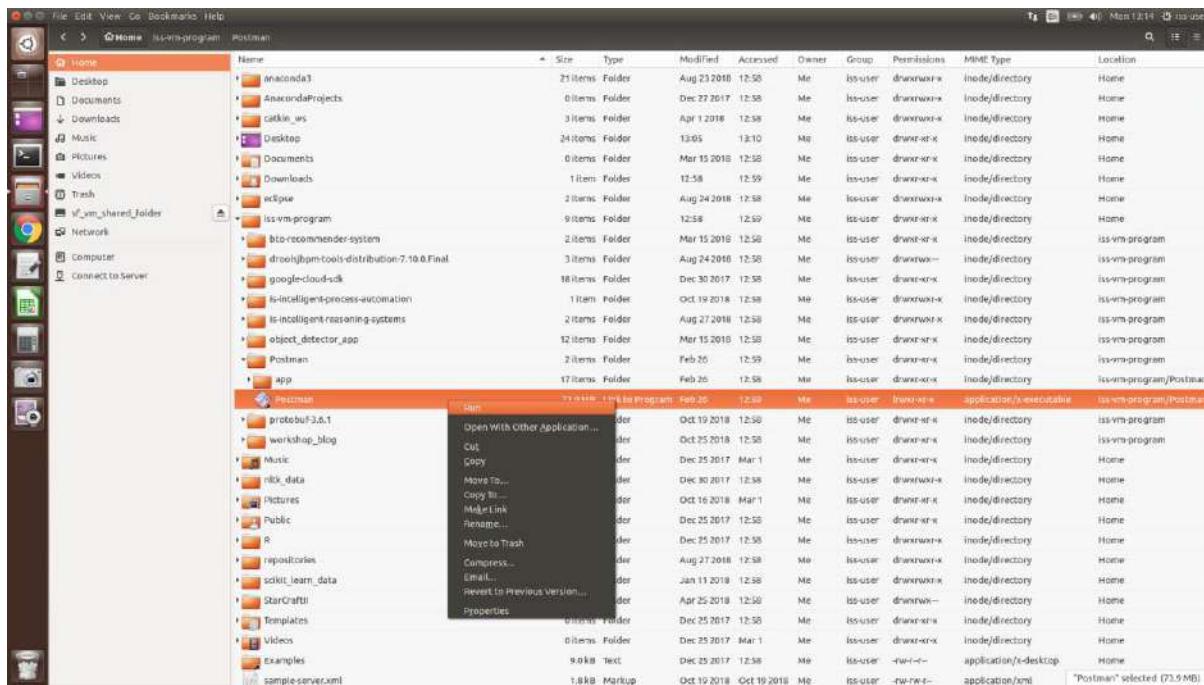
## 2.6. ANNEX 6 – Postman Installation



<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 signing in at the bottom



# POSTMAN

## WHY SIGN UP?

- Organize all your API development within Postman Workspaces
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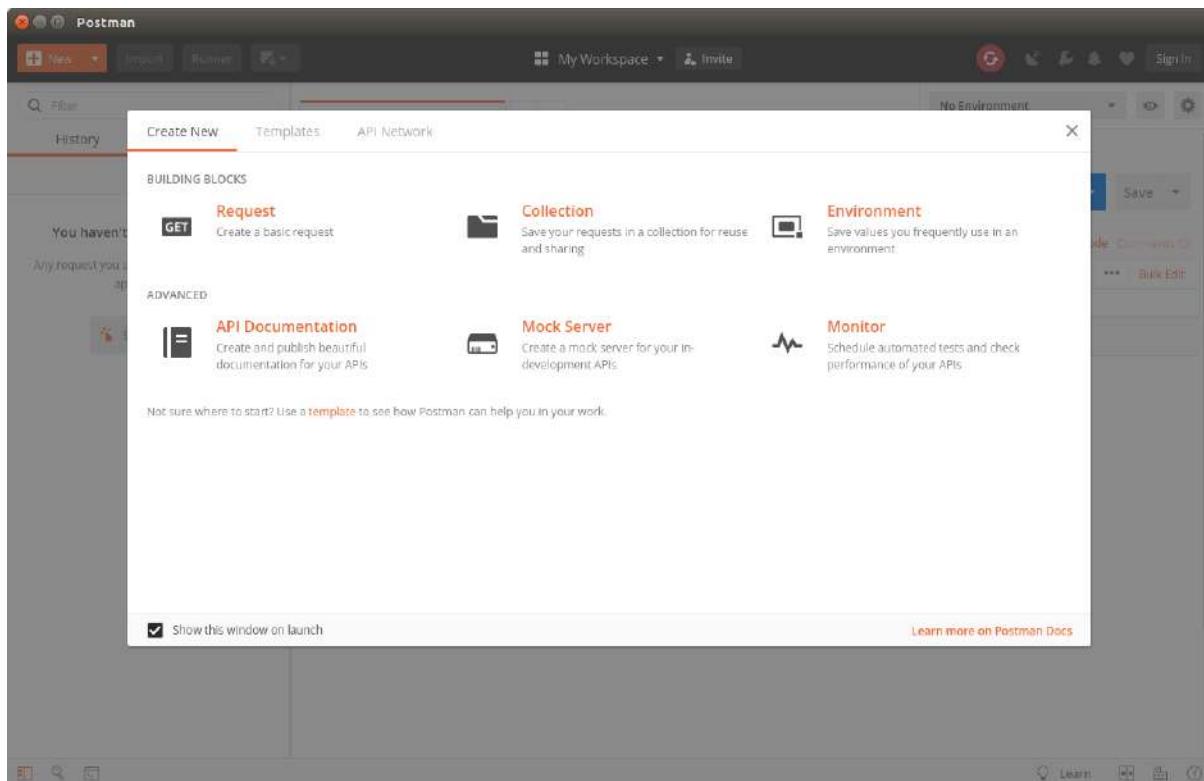
**Create free account**

OR

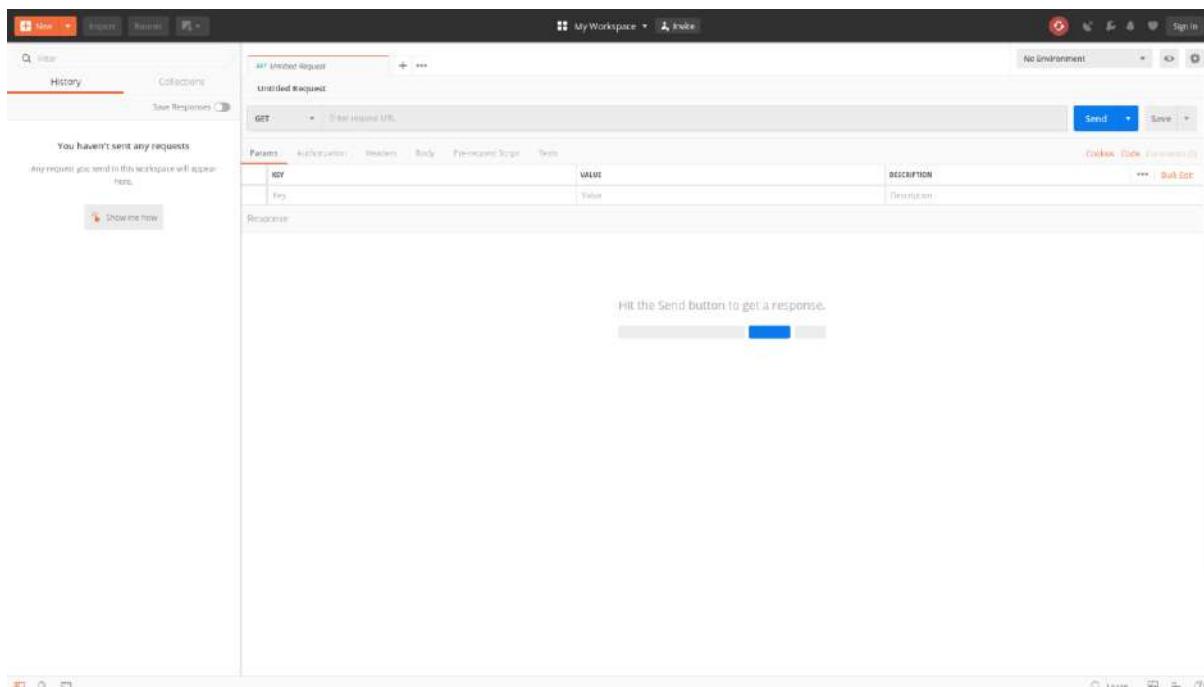
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### Test: Close the welcome window



## The End of Workshop Project Guide