**Lab Guide**

IBM Decision Manger Open Edition

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Hands-on Guide

DMN Beyond the Basics



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# Introduction

In this guide we go beyond basics of DMN to build real-world DMN.

The following topics are presented:

* **Structuring Input data**
* **Applying patterns for large projects**
* **Hit Policies**
* **Advanced Feel**

By the end, you will be able to apply these real-world tips and techniques to your DMN projects.

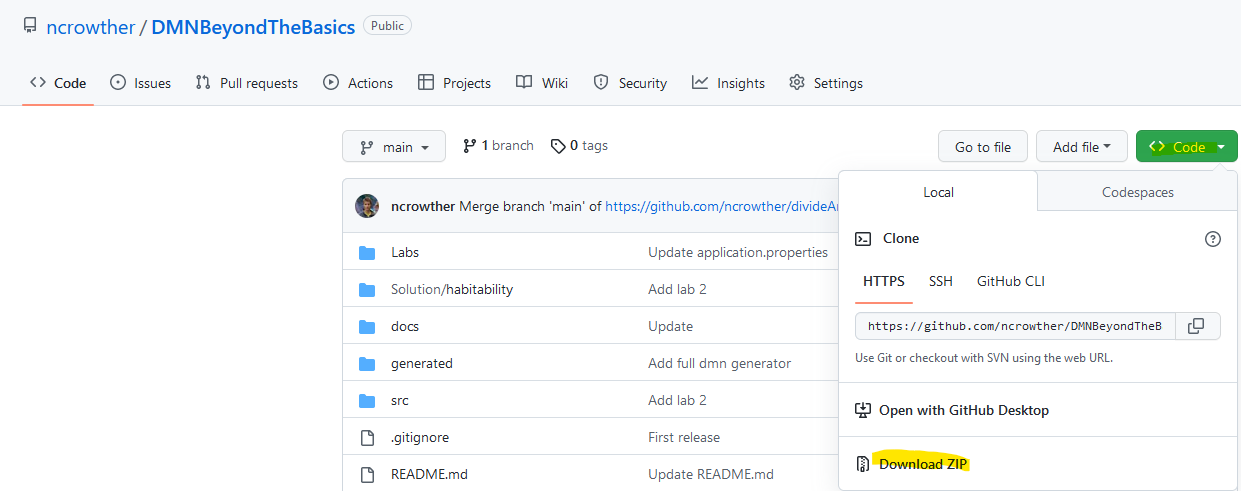
# Prerequisites

For this lab you need **Kie Sandbox** with *Kie Sandbox Extended Services* running. If you have not already done so, download and install the *Kie Sandbox Extended Services*.

You will also need a local copy of the following Git repo.

<https://github.com/ncrowther/DMNBeyondTheBasics>

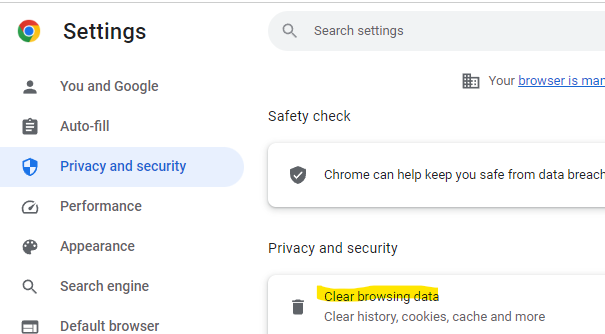
Click on the link above and then click the *Code* button and then *Download ZIP*:



Unpack the zip to a local directory and note the location.

**Clearing Browser Data**

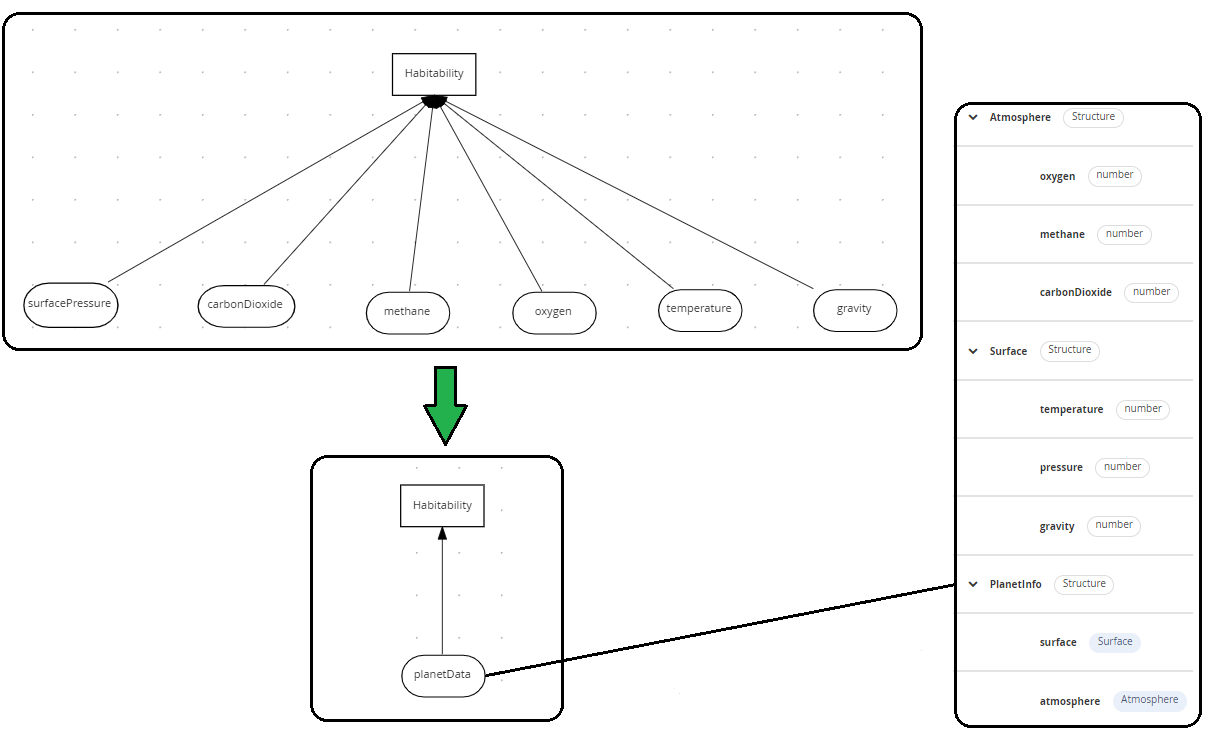
After each lab clear your cache. In Chrome, click then select *Settings*. Select *Privacy and security* and press *Clear browsing data:*



# Lab 1 - Data Types

## Introduction

In this lab you will learn how to simplify DMN diagrams by moving primitive attributes to data structures. See below:

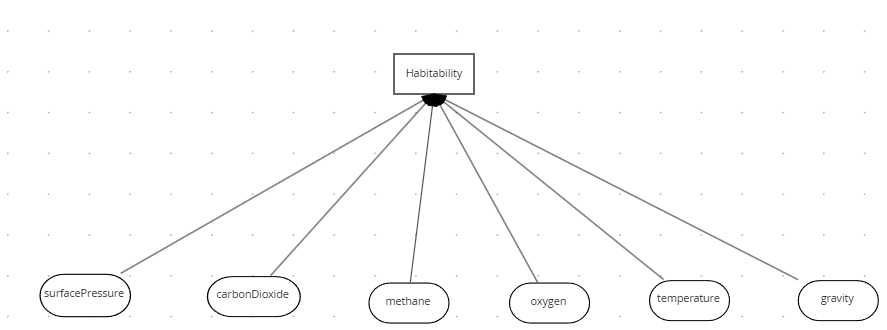


Applying a Data Model to Unstructured Data

## Instructions

1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>  
     
   Graphical user interface, application, website

   Description automatically generated
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Select the file: *lab01*/*HabitabilityStart.dmn*
5. You should see this:

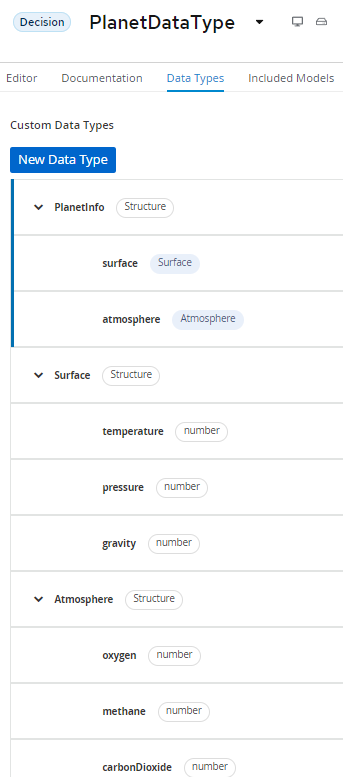


The inputs are simple data types and there are lots of them! This is an antipattern. We will show how to apply a data type to make it more readable.

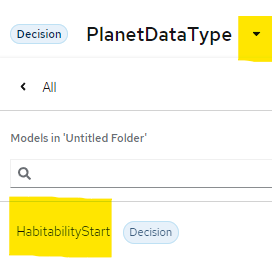
1. Click *New file*  and then Upload…
2. Select the file: *lab01/PlanetDataType.dmn*
3. Click on the *Data Types* tab:



1. You should now see the structure below. This is a data structure containing the attributes from the original diagram. See how it is structured into sub classes of *surface* and *atmosphere*.



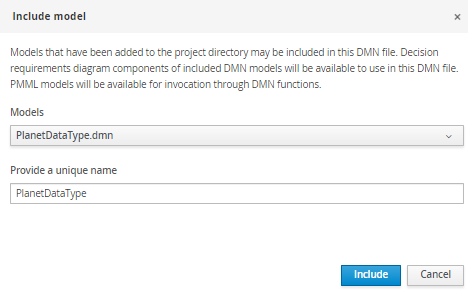
1. Go back to *HabitabilityStart* by clicking the drop-down arrow next to *PlanetDataType*:



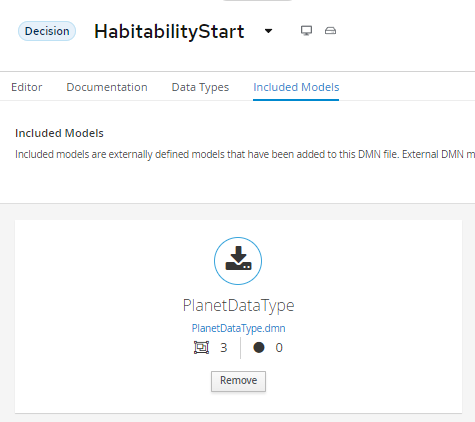
1. Within *HabitabilityStart*, Select **Included Models tab**, and then click **Include Model**



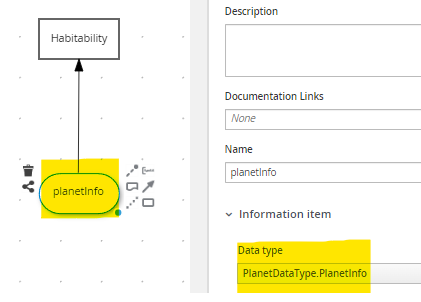
1. Add the *PlanetDataType* model and give it the same name of *PlanetDataType:*



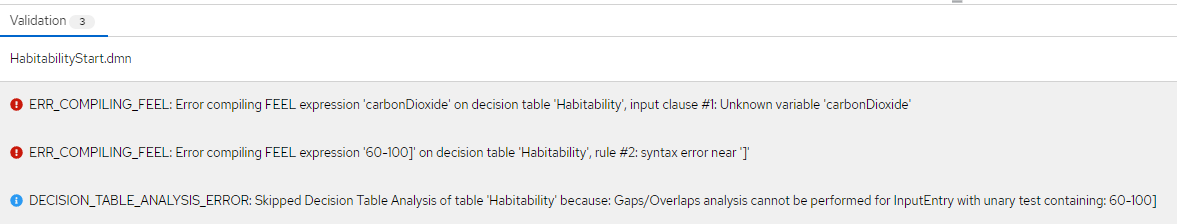
1. Click *Include.* You should see the model has been imported:



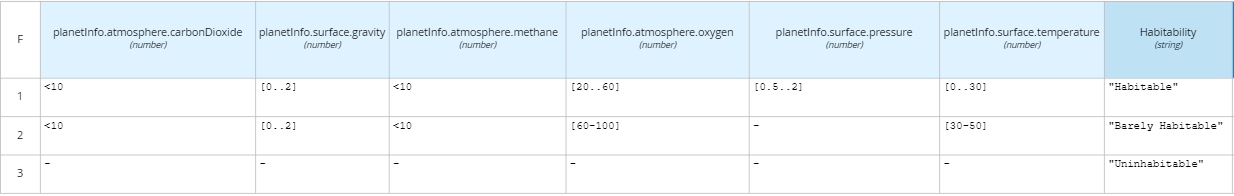
1. Switch to the **Editor** tab.
2. Back in the DMN Diagram, delete all the inputs and replace with one input called *PlanetInfo* assigning it a type of *PlanetDataType.PlanetInfo:*



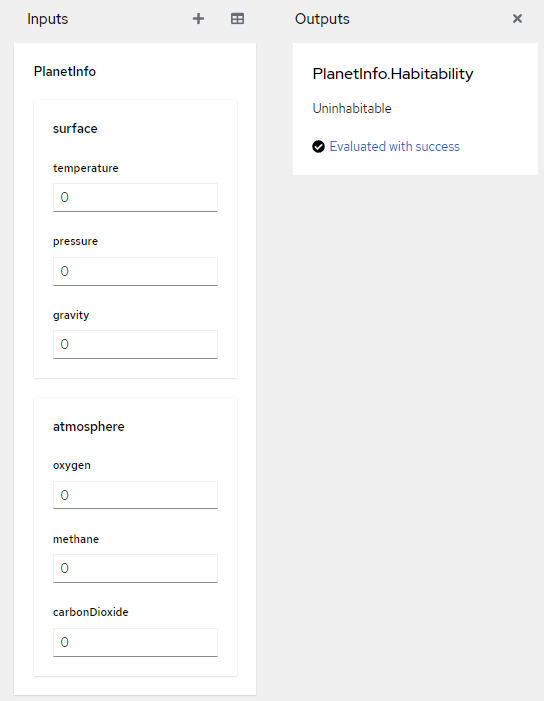
1. Click in the Problems button at the bottom right[[1]](#footnote-2). You should see errors:



The *Habitability* decision table is still referencing the primitive inputs. We need to fix this. Edit the table so that p*lanetInfo* is referenced instead of the primitives. See below:



1. Now there should be no errors and two warnings. We will review the warnings in a later lab. Test the model by pressing *Run*. If you have not installed the *Kie Server Extended Services*, now is the time to do so.
2. Enter zero values for all attributes and the expected result is *Uninhabitable :*



## Conclusion

In this lab we refactored a decision with many inputs into a decision with one input associated to a data structure. Moving primitives to data structures simplifies DMN.

# Lab 2 – The Divide and Conquer Pattern

## Introduction

The decision table in the previous lab will not scale. If all rule combinations were entered the table would be huge. To reduce the size can divide and conquer it into smaller parts.

To do this, we create a decision table for each planet attribute and reduce to an enumerated value: *Optimal, Bearable* or *Deadly.* Then we apply the enumerated values in a decision further up in the model. Using this pattern, we can split a wide table into several smaller manageable tables.

The tables are linked in the DMN diagram shown below:



Divide and Conquer Pattern for Habitability

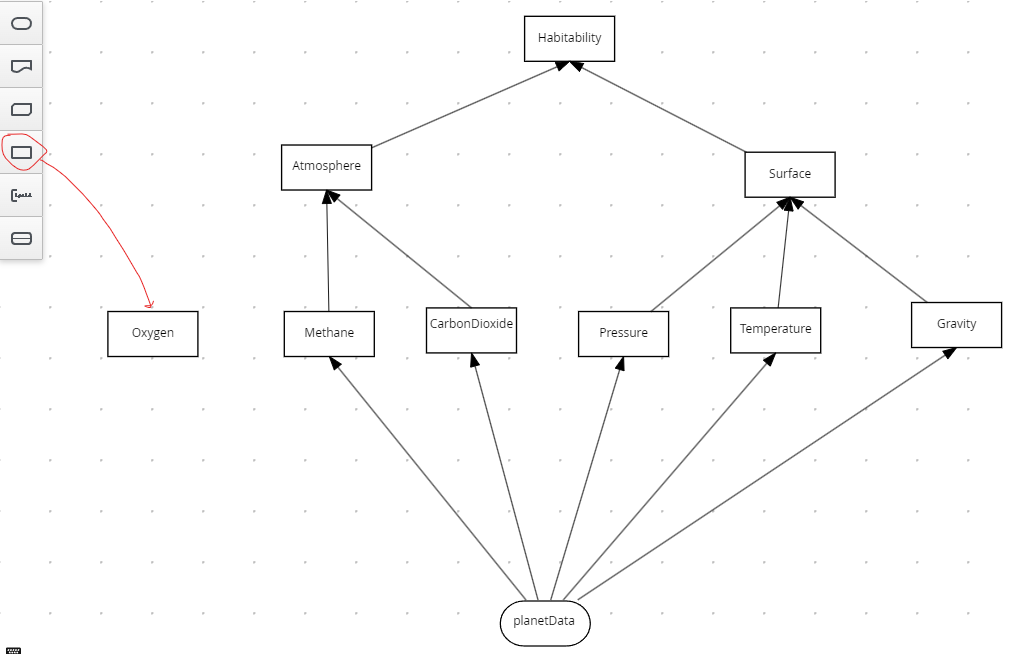
The **habitability** table has the same behavior as the original design, with the benefit that it is easier to maintain. Each attribute has its own table making it easier to change.

## Instructions

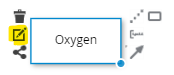
1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Select the file: *lab02*/*HabitabilityStart.dmn*
5. You should see this:



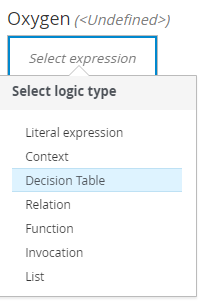
The model is nearly complete but is missing the *oxygen* attribute. Create a new Decision node and call it *Oxygen*.



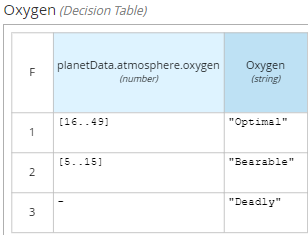
Select the decision and then click the *edit*  button:



Select *Decision Table* as the expression type:



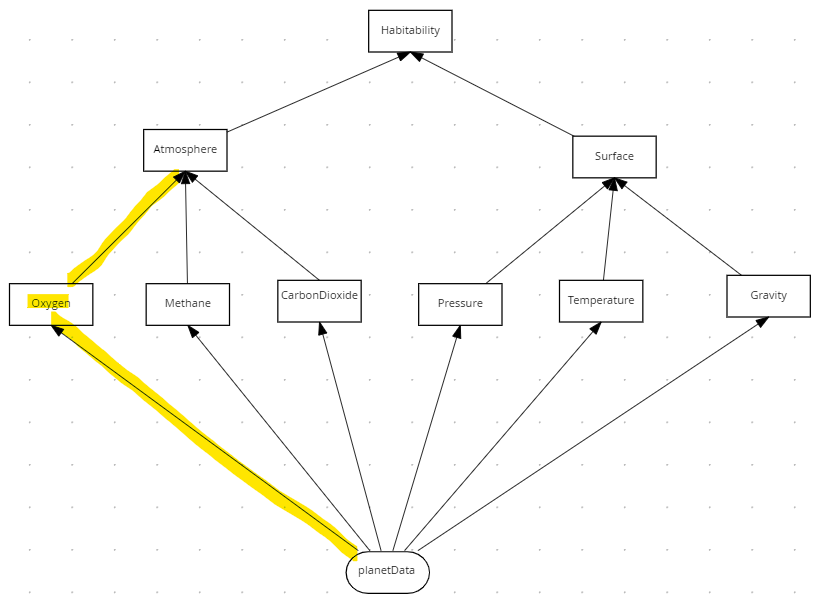
Create the table below.



Verify the following:

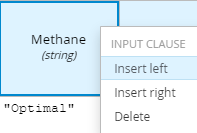
* planetData.atmosphere.oxygen is the condition variable
* Numeric ranges [16..49] and [5..15] are the conditions.
* Enumerated values are in quotes.
* The Hit policy is First (F)

Now plug the *Oxygen* Decision node to the diagram. You should have the following connections:

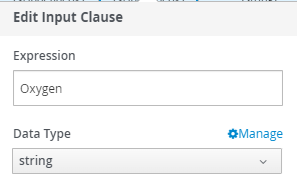


Edit the Atmosphere table so that it handles the Oxygen decision.

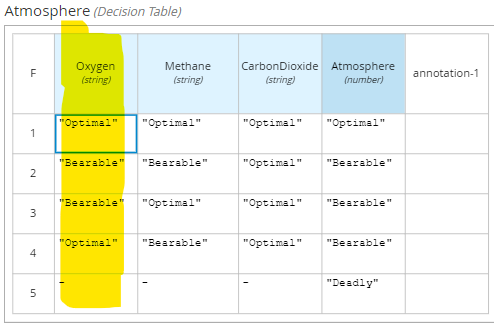
Right-click on the *Methane* column to add a new column to the left:



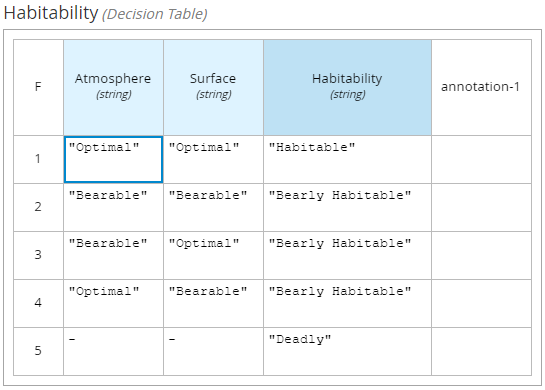
For the new column, set the Expression as *Oxygen* (case important) and the Data type as *string*.



Add four enumerated values (in quotes) as shown below:

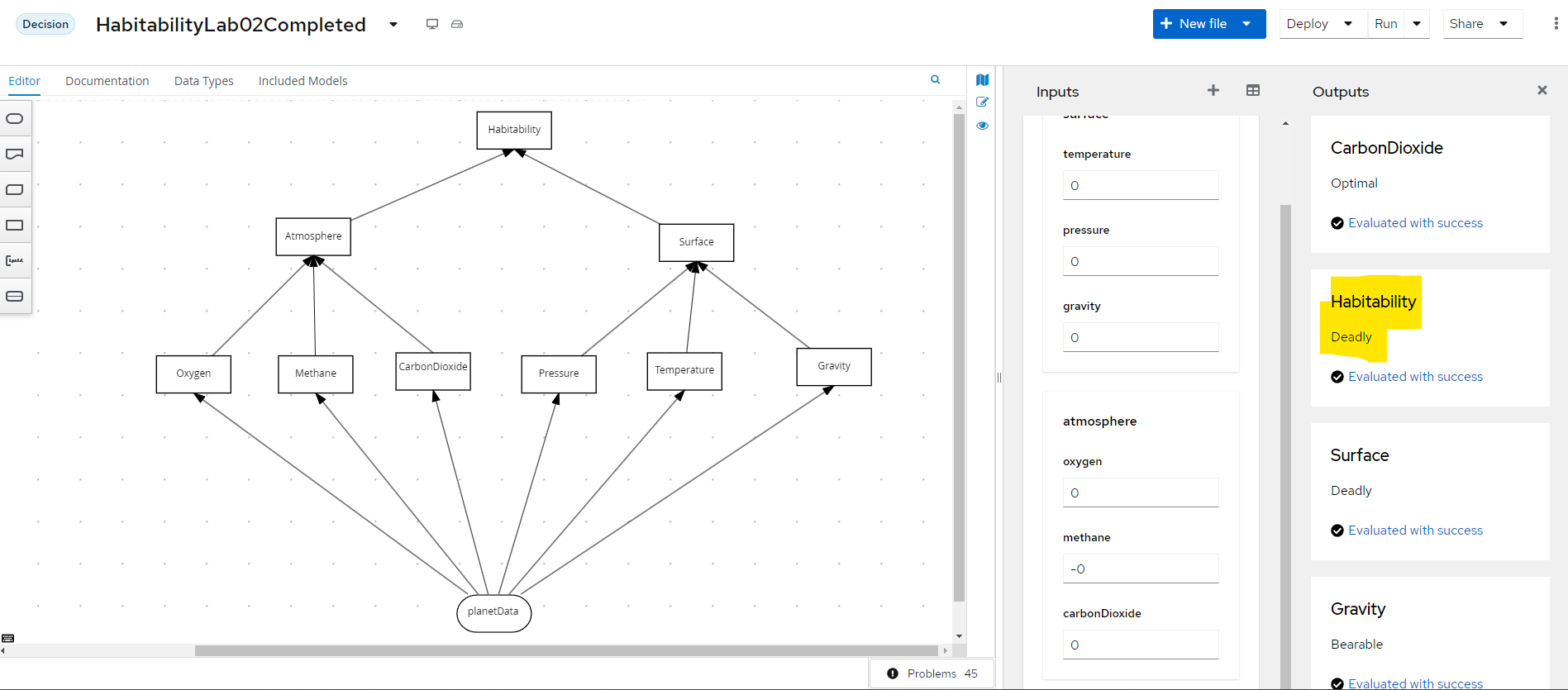


Now look at the root decision node, *Habitablilty*. It combines the decision in the lower tables to make the final decision as to the planet habitability:



We have now implemented the Divide and Conquer pattern by splitting up the wide decision table in lab 01 into several smaller ones! Let’s test the service.

1. Press the *Run* button
2. Enter zero values for all inputs and the expected result is *Deadly*:



## Conclusion

In this lab we refactored the Habitability rules into separate decision services that build up the overall decision. Separating a single decision table in this way helps manage complex decisions with many inputs.

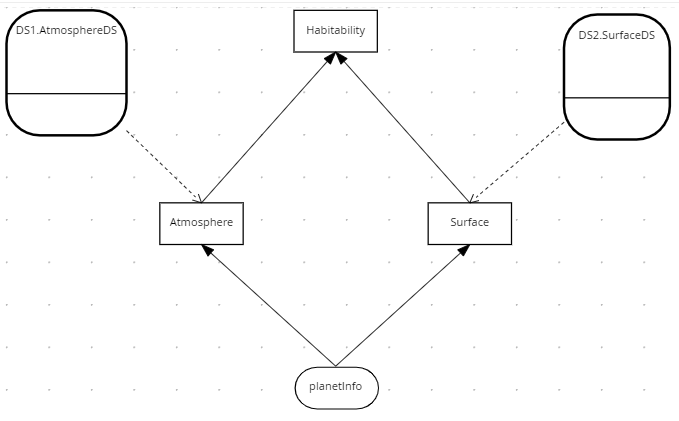
# Lab 3 – The Tiered Service Pattern

## Introduction

The DMN defined in the previous lab is confined to a single file. This is a problem:

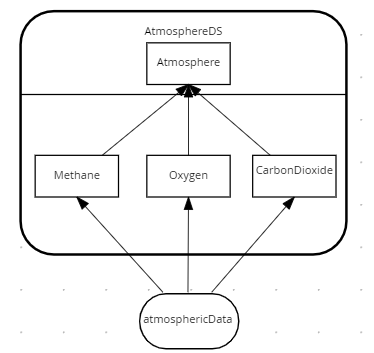
* The DMN cannot be edited simultaneously by separate people
* The DMN cannot be reused in other decisions.

To improve, we move the second-tier decisions into their own decision services and then invoke these decisions from the top tier. See below, where the second-tier decision services are *AtmosphereDS* and *SurfaceDS*:

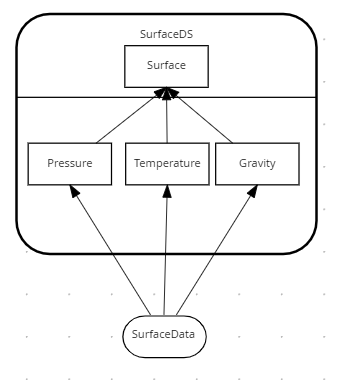


Tiered Service Pattern

The two second tier decision services are *AtmosphereDS* and *SurfaceDS*:



Atmosphere Decision Service



Surface Decision Service

In the Habitability example we have only two tiers – but in practice the pattern could be applied to multiple tiers, with second tier decision services calling third tier services, and so on. The number of tiers depends on project complexity.

## Instructions

1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Select file: *lab03*/*SurfaceDS.dmn*
5. Repeat steps 3 and 4 for a further two files:

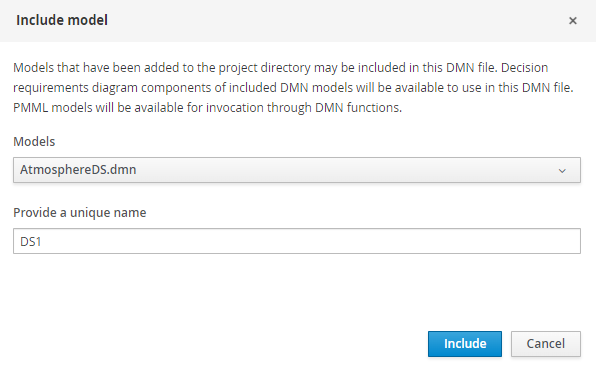
*lab03*/*AtmosphereDS.dmn*

*lab03*/*HabitabilityStart.dmn*

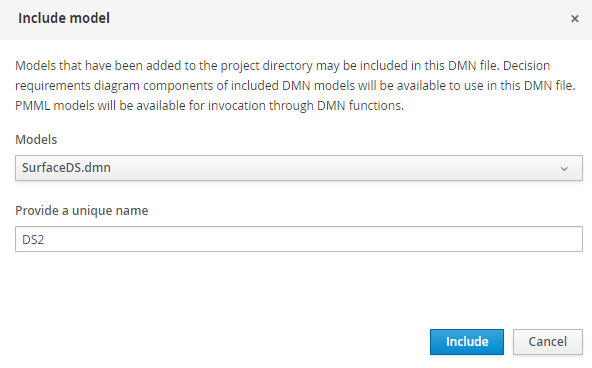
1. Within *HabitabilityStart*, Select **Included Models tab**, and then click **Include Model**



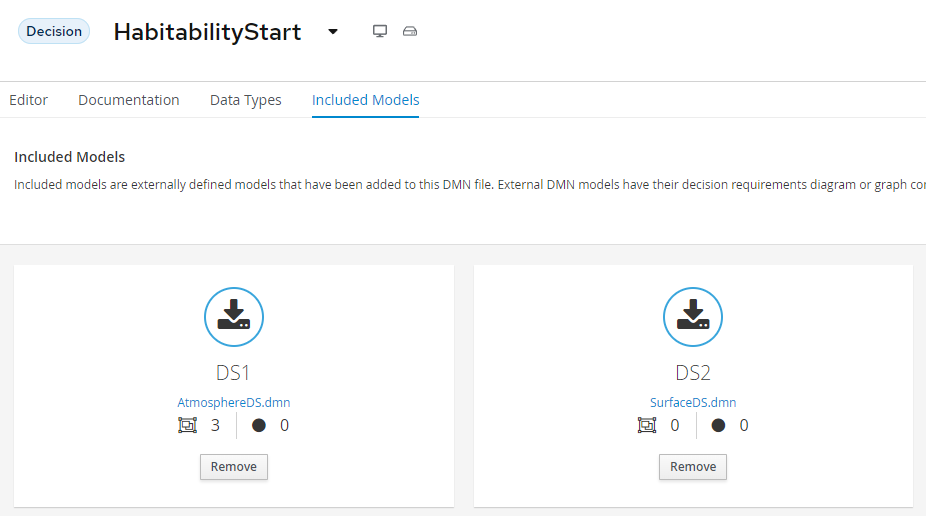
1. Add the *AtomosphereDS.dmn* and give it the name of *DS1:*



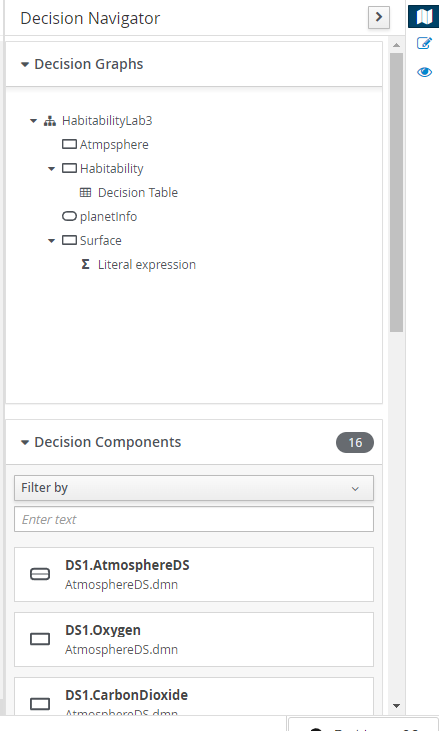
1. Click *Include.*
2. Click *Include Model* againand import *SurfaceDS.dmn.* Give it a name of *DS2:*

**

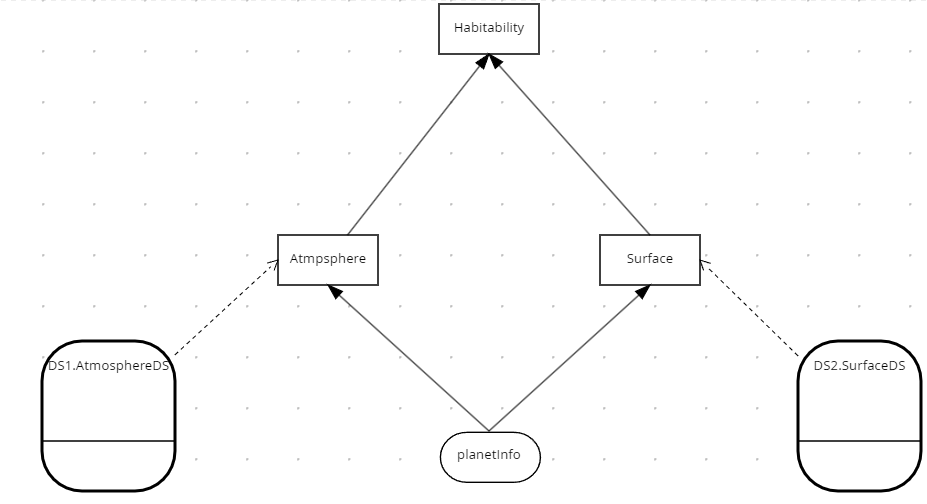
1. You should see both decision services have been imported:



1. Select the *Editor tab.*
2. Select the Decision Navigator button on the far right . You should see the following:

**

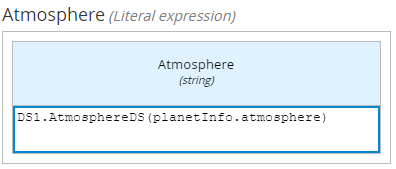
1. Drag and drop *DS1.AtmosphereDS* and *DS2.SurfaceDS* to the diagram
2. Using the arrow connector, connect *DS1.AtmosphereDS* to *Atmosphere* and *DS2.SurfaceDS* to *Surface*. You should now see the following:



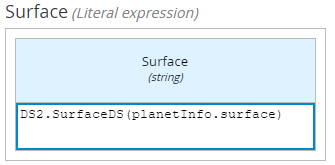
1. Edit the Atmosphere Decision Node. Create a Literal Expression and the FEEL expression:

DS1.AtmosphereDS(planetInfo.atmosphere)

1. Set the return type of *Atmosphere* to *string*. You should see this.



1. Edit *Surface* Decision. You should see it has been predefined to call the *DS2.SurfaceDS* decision service:



1. Press the *Run* button
2. Enter zero values for all inputs and the expected result is *Deadly*

## Conclusion

In this lab we refactored the Habitability rules to call separate decision services. Separating a single decision into multiple services helps scale your DMN projects.

# Lab 4 – The Index Pattern

## Introduction

The Divide and Conquer Pattern does not work with many rules and few conditions. Instead, we can apply the Index Pattern. An example is SWIFT interchange rules. A simplified SWIFT message is:

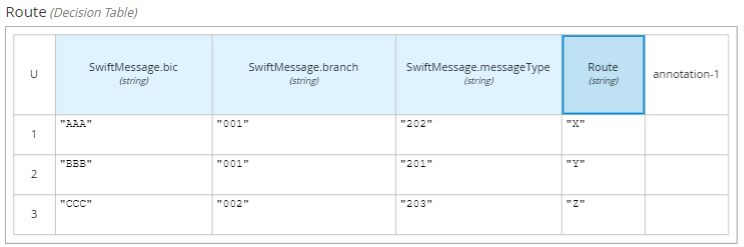
**BIC** – A Bank Identifier Code

**Receiving Branch** – The bank branch

**Message type** – The type of payment

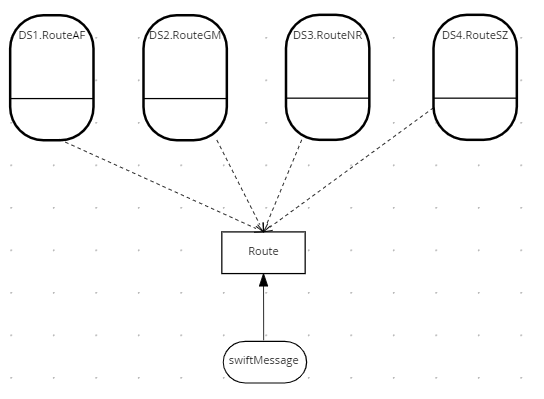
**Route** – The route the message is sent

The rules below decide where to route a SWIFT message within the banking network:



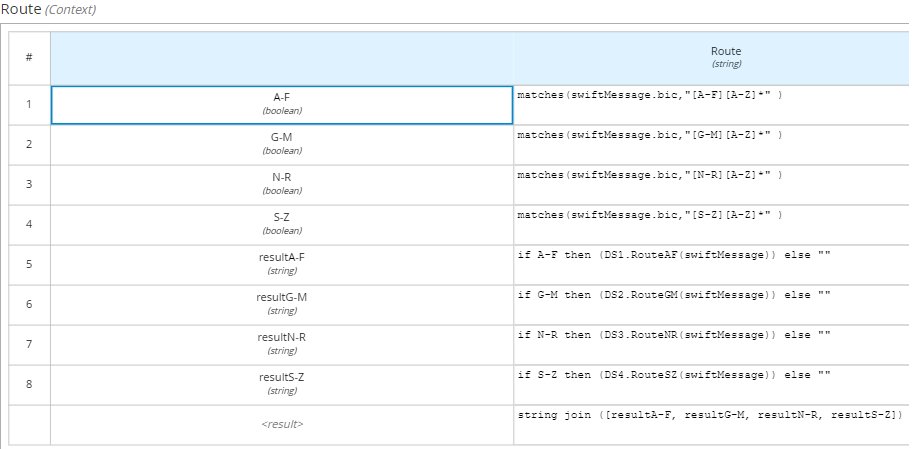
There could be thousands of these rules based on combinations of *Bic, Branch* and *Message Type*.

In DMN this we could model the decision using the Index pattern:

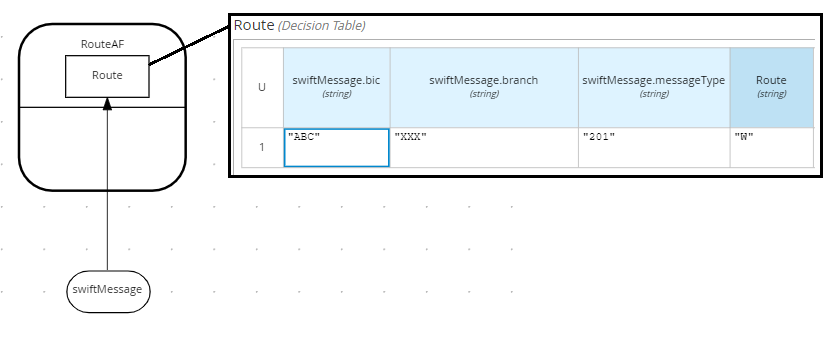


The key logic is the *Route* decision. It routes the message to an indexed decision service based on the first letter of the BIC. This splits the table into four smaller tables, each alphabetically indexed. There could be further indexing within each of these decision services to split the decision table further

Here is the logic for the Route decision:



The indexed decision service caters for each part of allocated the alphabet. The service handling BICs starting A-F is shown below.



The decision services handling BICs G-M, N-R and S-Z follow the same pattern.

## Instructions

1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Perform a multiple select on the Lab04 files:

*lab04*/*SwiftDataStructure.dmn*

*lab04*/*RouteAF.dmn*

*lab04*/*RouteGM.dmn*

*lab04*/*RouteNR.dmn*

*lab04*/*RouteSZ.dmn*

*lab04*/*SwiftRoutingRules.dmn*

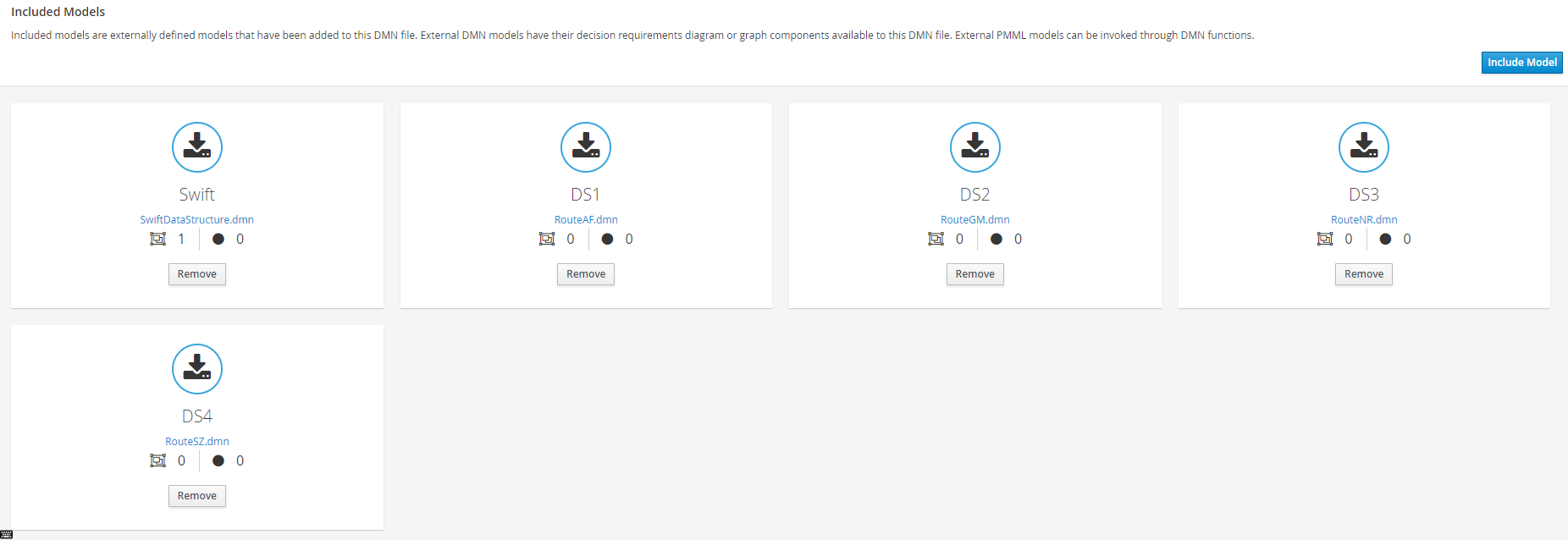
1. Within *SwiftRoutingRulesStart*, select **Included Models tab**, and then click **Include Model**



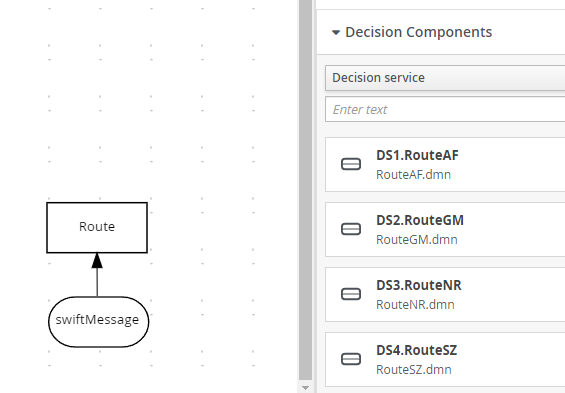
1. Include the following DMN Files as model:

|  |  |
| --- | --- |
| DMN File | Name |
| SwiftDataStructure.dmn | **Swift** |
| *RouteAF.dmn* | **DS1** |
| *RouteGM.dmn* | **DS2** |
| *RouteNR.dmn* | **DS3** |
| *RouteSZ.dmn* | **DS4** |

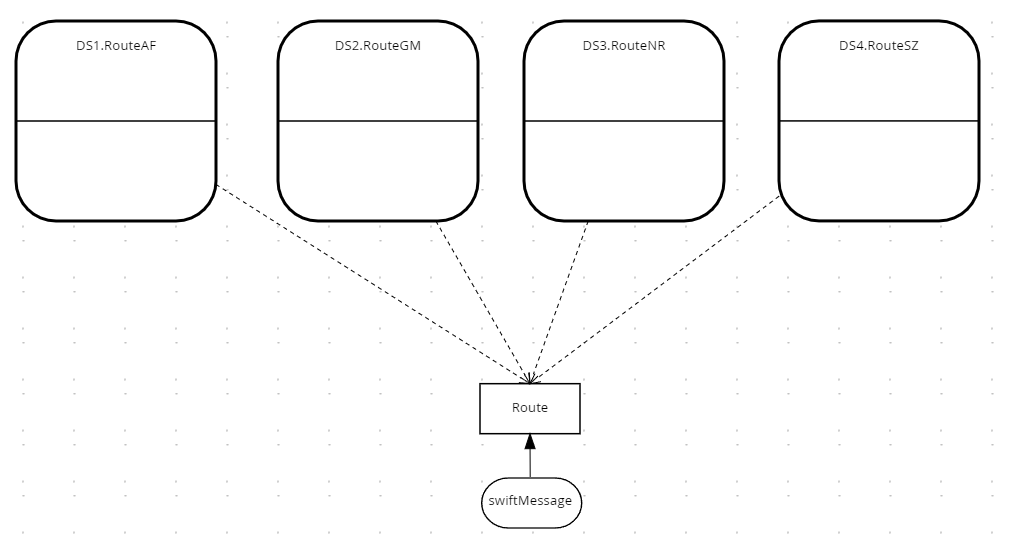
1. Once you have done this, you should see the following models included:



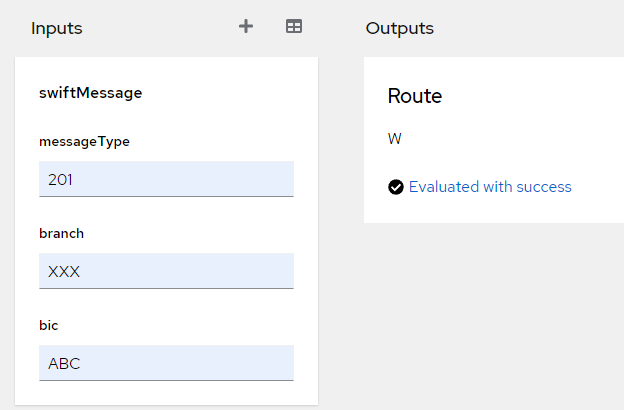
1. Select the *Editor tab.*
2. Select the Decision Navigator button on the far right .
3. Filter by Decision Service. You should see the following:

**

1. Drag and drop all four decision services to the diagram
2. Using the arrow connector, connect *the decision services to Route*. You should see the following:

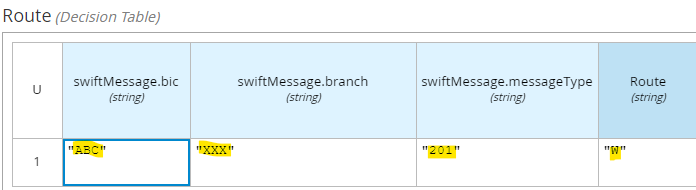


1. Test the decision service by pressing *Run*.
2. Enter the following values:



The output should be W. The Route decision determined the BIC started with ‘A’ and routed it to RoutAF. This decision service determines that a Swift message of ABC/XXX/201 is routed to W.

Verify this by selecting the RouteAF decision service and viewing the decision table.



Now test the following Swift messages:

|  |  |
| --- | --- |
| Swift Message | Route |
| GBC/XXX/201 | **X** |
| NBC/XXX/201 | **Y** |
| SBC/XXX/201 | **Z** |

You should see that each message is routed to a different decision service.

Now add a new message: **ZBC/XXX/201** with route **Z1**. Where would you put this rule?

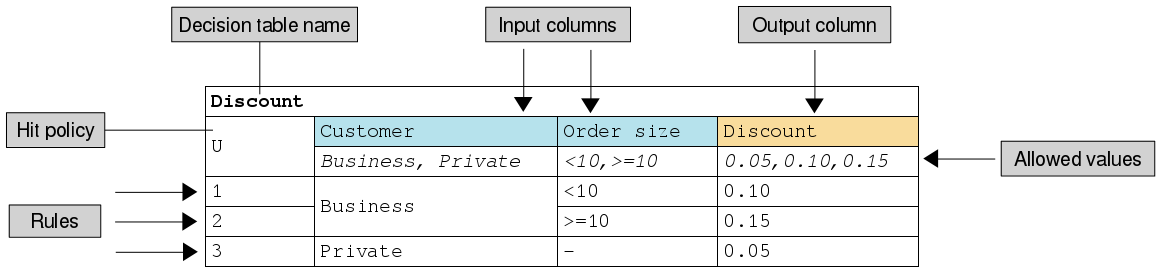
## Conclusion

In this lab we split a tall narrow decision table into more manageable chunks using the Index Pattern.

# Lab 5 - Hit Policies

## Introduction

Not all decision tables require the same reasoning. Some tables count outcomes, some are go / no go decisions and others require precise reasoning. A different hit policy is required for each of these. In DMN the hit policy is specified in the top left of the decision table. See below:



Hit policies change the way of reasoning over a decision table. It is important to select the appropriate hit policy for your application.

The commonly used hit policies are:

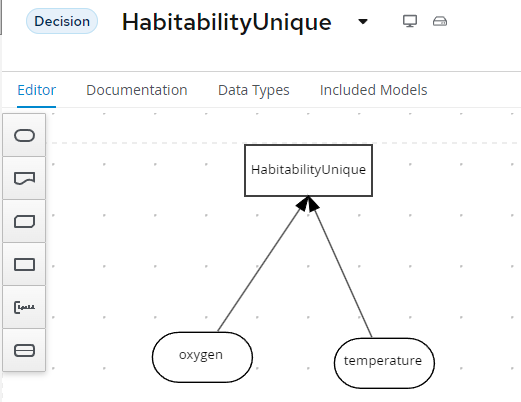
|  |  |  |
| --- | --- | --- |
| Hit Policy | Description | When to use |
| ****Unique (U)**** | Permits only one rule to match. Any overlap raises an error. | For detailed reasoning. Ensures your rules cover all cases and are complete |
| Any (A) | Permits only one rule to match. But allows overlaps. | As above but less strict enforcement of overlaps |
| First (F) | Rules are evaluated from top to bottom. Rules may overlap, but only the first match counts. | For concise decision tables where a simple go / no go decision is needed rather than complete reasoning. |
| ****Collect (C)**** | Aggregates values in an arbitrary list. | For multiple row matches.  **String** aggregator:   * <None> - matching instances returned as list * Count – Matching instances counted   **Number** aggregator:   * SUM – matching instances added * Count – matching instances counted * Min – minimum value * Max – maximum value |

Hit policies not covered in this lab are **Priority** which behaves like **Any**, and **Rule Order** and **Output Order** which behave like **Collect.**

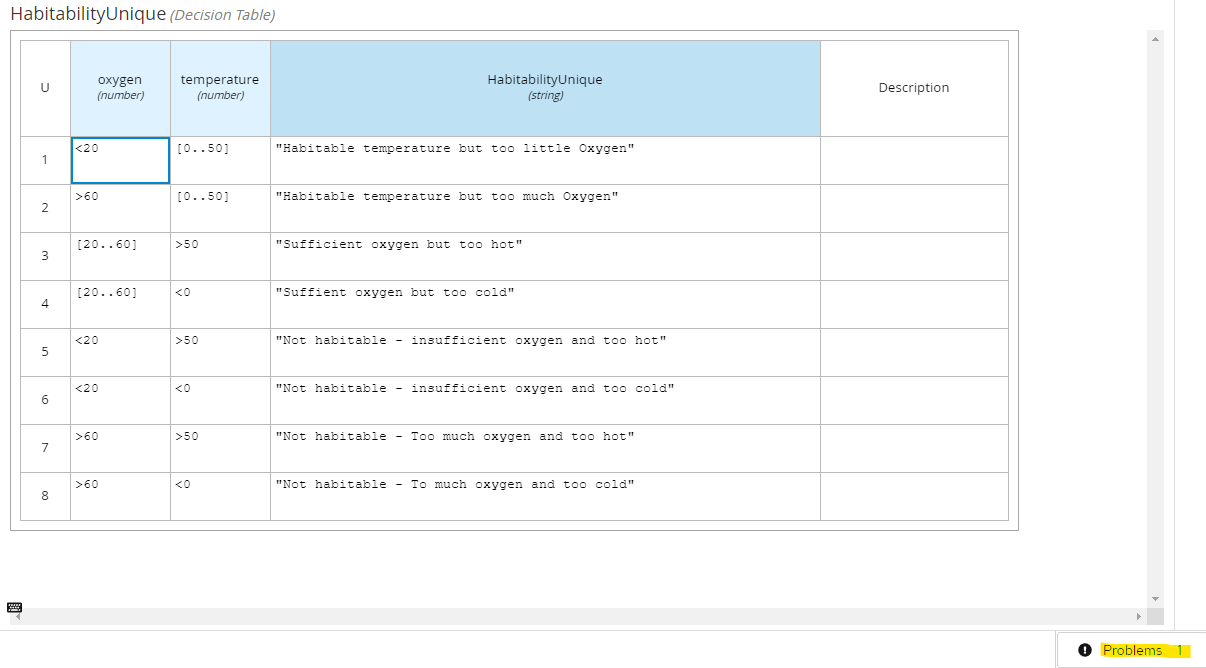
## Instructions

### Unique Policy

1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Select the file: *lab05/HabitabilityUnique.dmn*. You should see this:



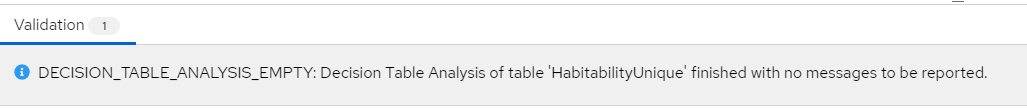
1. Edit the *HabitabilityUnique* decision by clicking it and selecting Edit .
2. Delete the first row by right clicking row 1 and select *Delete*.
3. After deleting the first row you should see this:



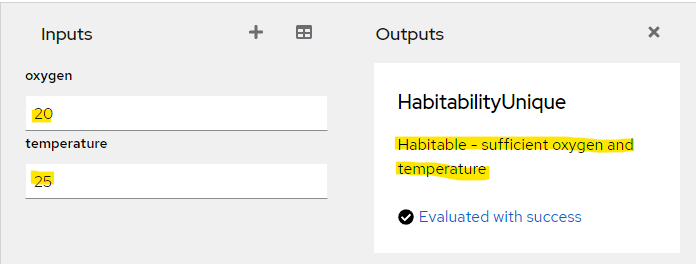
1. Click in the *Problems* button in the bottom right. There is a gap warning:



1. The gap created from the deleted row has been detected.
2. Fix this error by hitting **Ctrl-Z** to undo the change. The deleted row should reappear, and the analysis warning should disappear. You should see:



1. Test by pressing R*un*. Enter Oxygen *20* and Temperature *25*:



1. The decision correctly evaluates to “*Habitable - sufficient oxygen and temperature*".

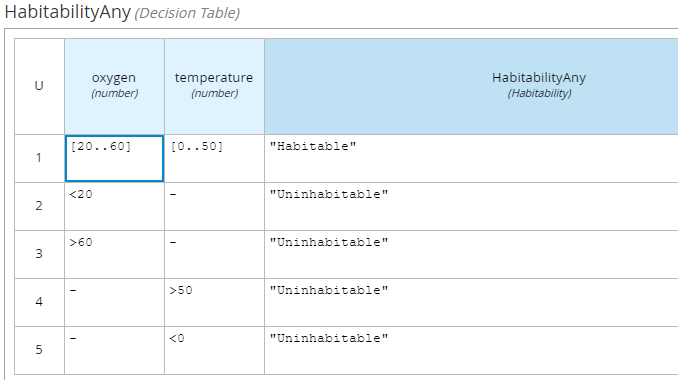
**Conclusion**

The *Unique* policy reasons over every possible input. This is useful for decisions requiring traceability. For example, an applicant my want to know the decision behind their rejected mortgage application. A second advantage of the Unique policy is that you can order rows in any order to get the same result.

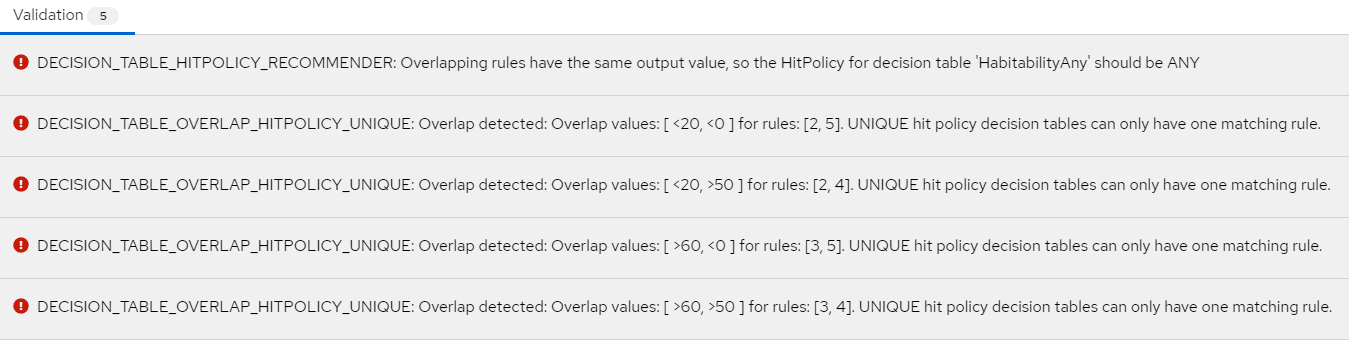
The disadvantage of the Unique policy is that it can force the table to be more verbose than it needs to be.

### Any Policy

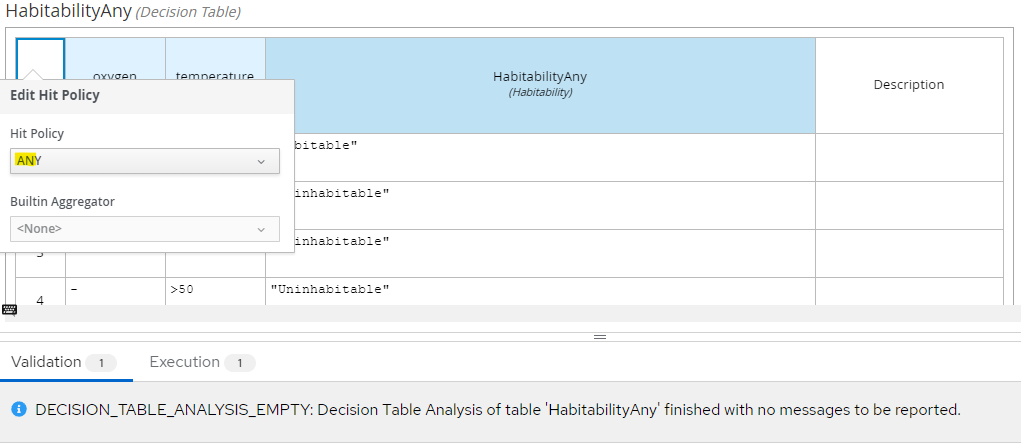
1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Select the file: lab05/*HabitabilityAny*.*dmn*
5. Edit the *HabitabilityAny* decision by clicking it and selecting Edit .
6. You should see this:



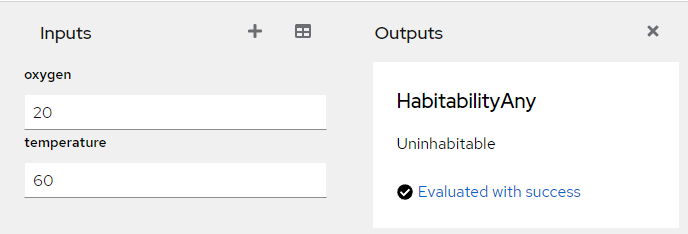
1. Click in the *Problems* button in the bottom right. There are several gap warnings:



1. These errors a due to the Hit policy being **Unique** and there are overlapping rows. Fix these errors by changing the Hit Policy to **Any**. You should see the policy symbol change to **A** and all errors disappear:



1. Test by pressing R*un*. Enter Oxygen *20* and Temperature *60*:



1. This tests row 4 of the decision table.

**Conclusion**

The advantage of the **Any** policy is you can create overlapping rules using “don’t care” (-) values to make it more compact.

This advantage is also a disadvantage of imprecision; row 4 is hit whether oxygen is *habitable* or *uninhabitable*. This may be a problem if you need to know the exact reason as to why this planet is uninhabitable.

### First Policy

1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Select the file: lab05/*HabitabilityFirst*.*dmn*
5. Edit the *HabitabilityFirst* decision by clicking it and selecting Edit 
6. You should see this:



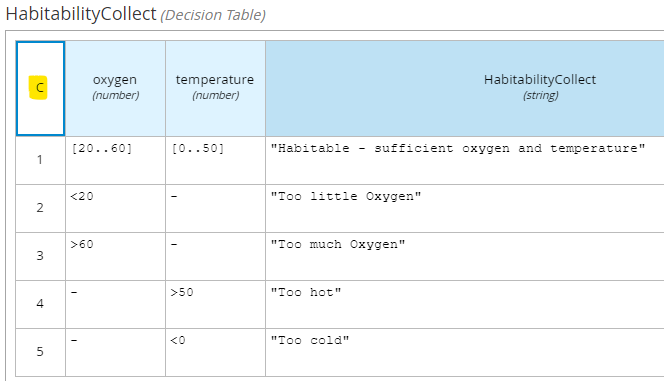
Test the decision by pressing *run*. Enter Oxygen *20* and Temperature *25* to check that row 1 fires.

**Conclusion**

Using the **First** hit policy you get the same result as the *Unique* and *Any* Policies, but with fewer rows. There are just two rows, one for a habitable planet, and another for an uninhabitable planet. The advantage is conciseness, but there are disadvantages. The first is that order matters – you cannot move row 2 to row 1. The **First** policy also has similar problems as the **Any** policy in that the decision has no detailed reasoning. Finally, the policy is the least strict, allowing overlaps and missing rows which could cause problems at run time.

### String Collection policy

1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Select the file: lab05/*HabitabilityStringCollect*.*dmn*
5. Edit the *HabitabilityCollect* decision. You should see this:

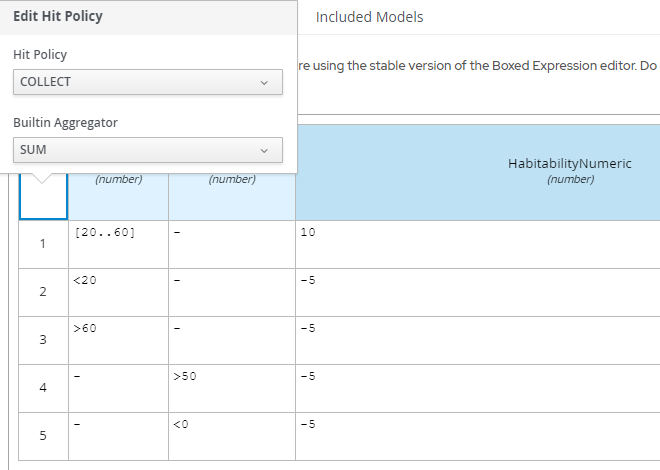


Test the decision by pressing *run*. Enter Oxygen *0* and Temperature *-1*. This time two rows are fired: row 2 and row 5.

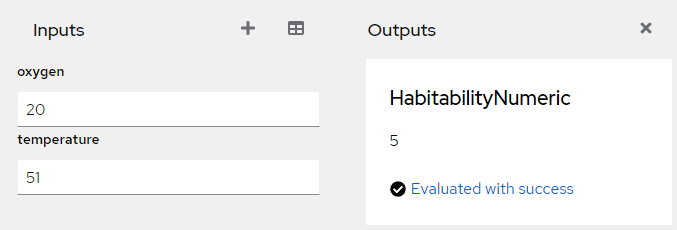
The advantages of the Collection policy are that you can combine rows to make more detailed decisions. In this example the decision tells us that the oxygen is too low and the temperature too cold. This is performing the same inference as the Unique policy, but with fewer rows.

### Numeric Collection policy

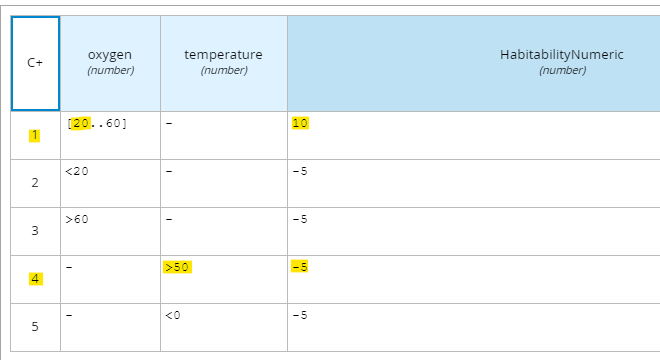
1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Select the file: lab05/*HabitabilityNumericCollect*.*dmn*
5. Edit the *HabitabilityNumeric* decision, and in the top left select the hit policy. Click the *C+* symbol in the top right of the decision table. This expands to show the Hit Policy called *Collect SUM*:



The *Collect SUM* hit Policy collects all the rows satisfying the input conditions and sums them together. Let’s test this. Press *Run*. Enter Oxygen *20* and Temperature *51*:



The *collect sum hit policy* collects rows 1 and 4 and then adds them together resulting in 5. See workings highlighted below:



Now change the hit policy to each of the following and run with the same test inputs:

|  |  |  |
| --- | --- | --- |
| Symbol | Hit Policy / Aggregator | Result |
| C# | Collect/Count | **2** |
| C< | Collect/Min | **-5** |
| C> | Collect/Max | **10** |

See the test results change for each aggregator. What are the uses for each aggregator?

## Conclusion

In this lab we looked at hit policies. The choice of hit policy depends on whether you need a simple *go/no go* table, or a comprehensive table covering all rule conditions

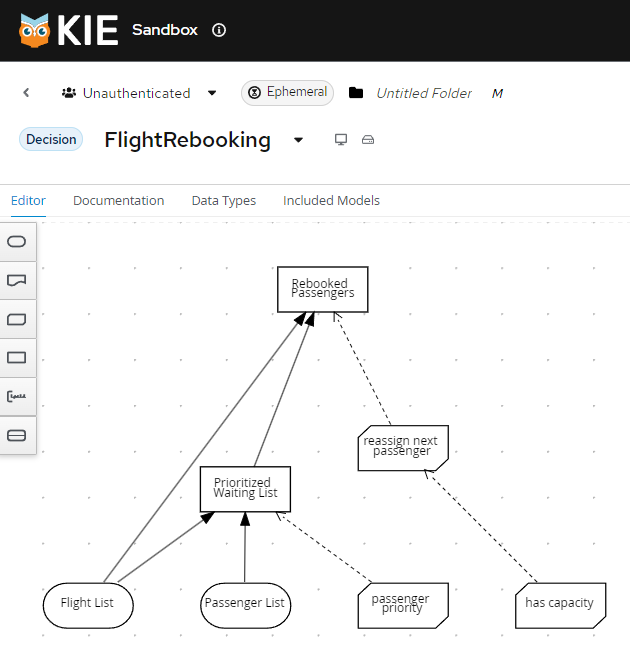
# Lab 6 - Advanced FEEL

## Introduction

Basic DMN focuses on Decision Requirements Diagrams and Decision Tables, since it is something every business user can understand. The problem is that it is difficult to do anything useful except to provide requirements to developers. The real power of DMN comes with FEEL (Friendly Enough Expression Language) and boxed expression. In this lab we will explore this.

## Instructions

1. In browsers Chrome or Safari open the web site <https://sandbox.kie.org/>
2. Click on **New Decision**.
3. An empty canvas opens. Click *New file*  and then U*pload…*
4. Select the file: lab06/FlightBooking.*dmn*
5. You should see the following:

­

Passenger Rebooking Service

### Understanding the service

The DMN has the following components:

**Data Types**

A list of flights

A list of passengers

**Decisions**

Prioritizing the passengers who will get seats on a new flight

Determining which flights those passengers will be offered

**Business knowledge models**

The company process for determining passenger priority

Any flights that have space available

Company rules for determining how best to reassign inconvenienced customers

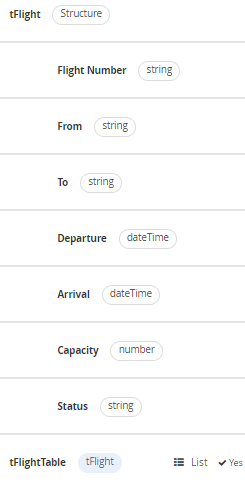
Then, the airline uses the DMN standard to model its decision process in a decision requirements diagram (DRD), and creates the following diagram for determining the best rebooking solution:

**Feel Functions**

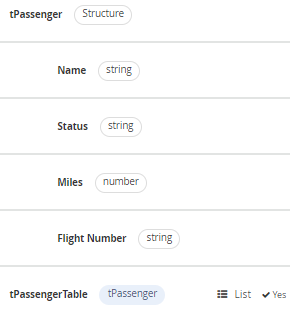
* Sort
* List contains

Let’s examine each of these components in detail, starting with data types.

### Data Types

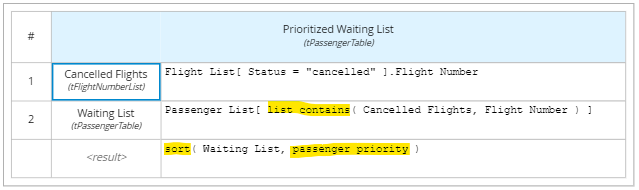


Flight

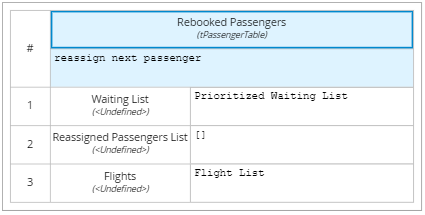


Passenger

### Decisions

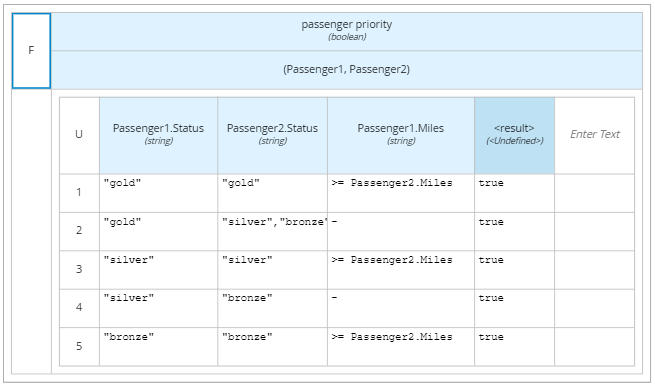


Prioritized Waiting List

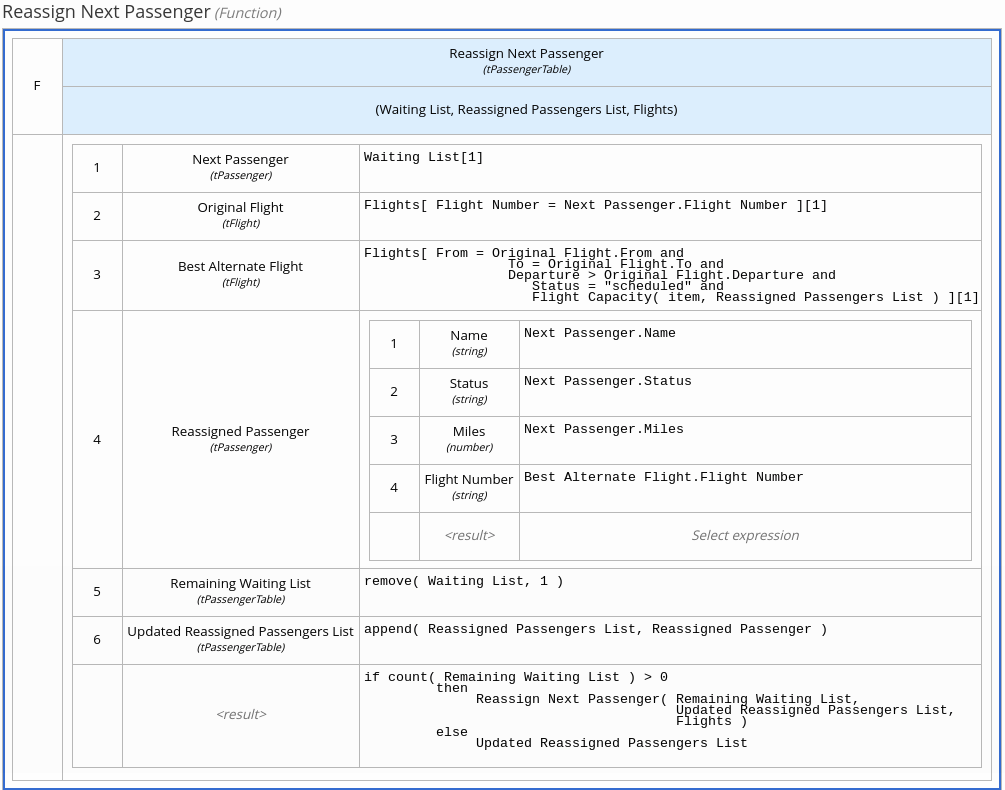


Rebooked Passengers

### Functions



Passenger Priority Function



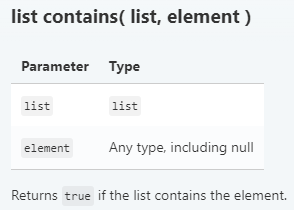
Reassign Next Passenger Function



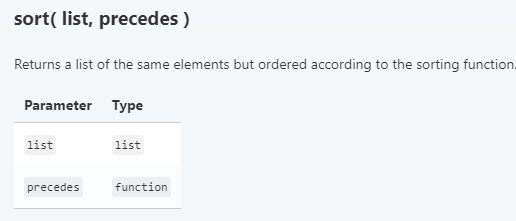
Has Capacity Function

### Feel Functions

<https://kiegroup.github.io/dmn-feel-handbook/#sort-functions>



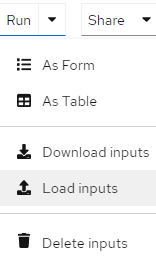
List Contains Function



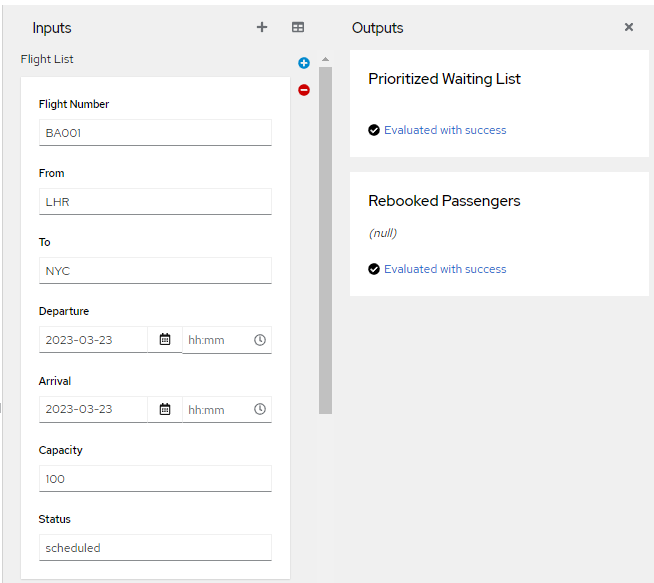
Sort Function

### Run the service

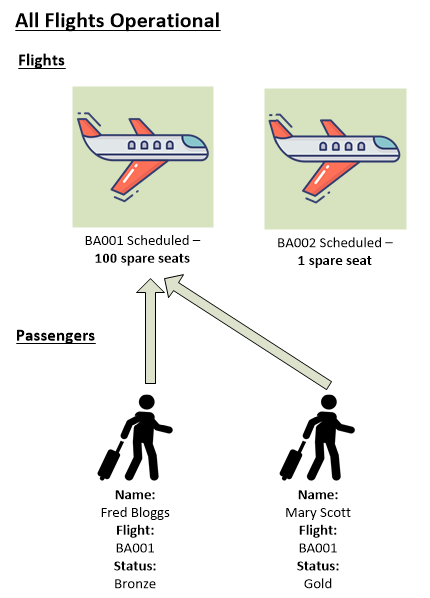
1. Now add some test data. Click *Run->Load Inputs*



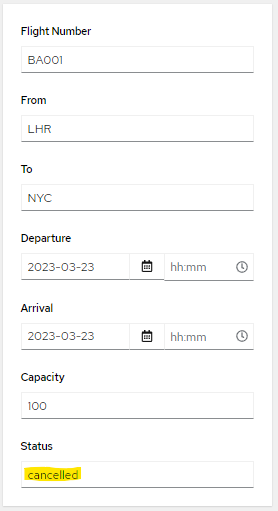
1. Open */Labs/Lab00/src/test/resources/FlightRebooking.json*
2. Click 
3. The service will run using the test data. You should see the test data in the *Inputs* panel and the results in the *Outputs* panel:



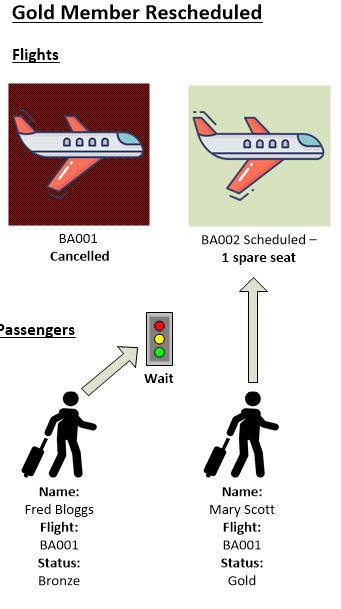
The output contains no waiting list or rebooked passengers all flights are operational. This is represented by the diagram below:



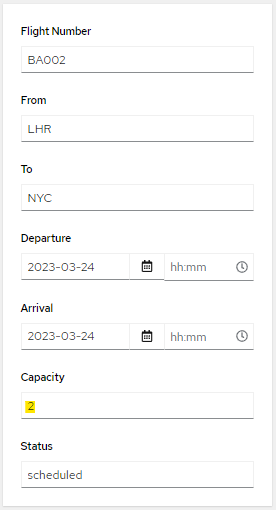
Now change the status of flight BA001 to *cancelled* (all lower case):



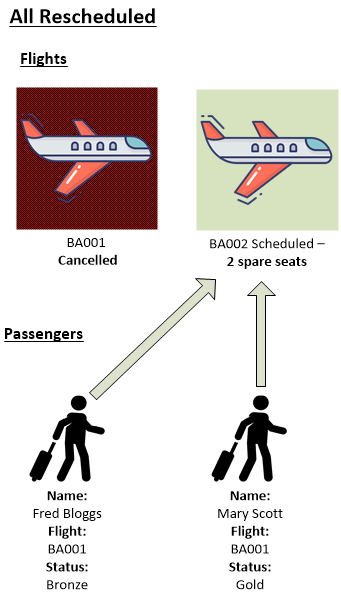
Check that *Mary Scott* is rebooked onto flight *BA002*. *Fred Bloggs* must wait as there is only one spare seat and Mary is a gold member.



Now change the spare seat capacity on flight *BA002* to *2*:



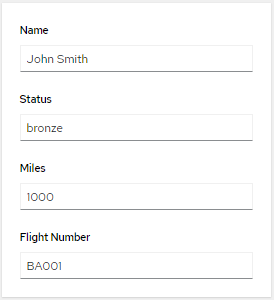
You should see that both Mary and Fred are scheduled to fly on *BA002*:



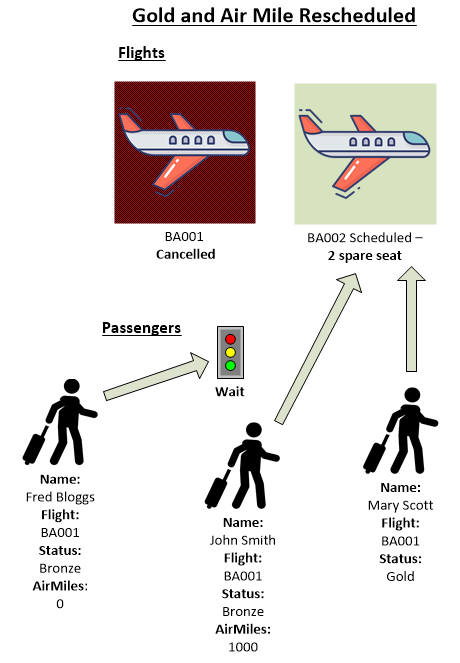
Add another passenger, *John Smith*. To do this, click on the plus button next to *Passenger List* in the *Inputs* Panel:



Add the following data:



After you enter the data, the test should automatically run. Verify that *Fred Bloggs* is put on hold again as *John Smith* has 1000 air miles and *Fred* Bloggs has 0



### Extend the diagram

Modify the DRG so that is formatted as shown in Figure 1. (to be expanded)

Modify the service (to be expanded)

# Conclusion

In this lab we went beyond the basics of DMN to give ideas and techniques for building real world DMN projects.

1. You will need *Kie Sandbox Extended Services* installed. Hit the *Run* button and follow the instructions. [↑](#footnote-ref-2)