



Corticon Tutorial

Basic Rule Modeling in Corticon Studio

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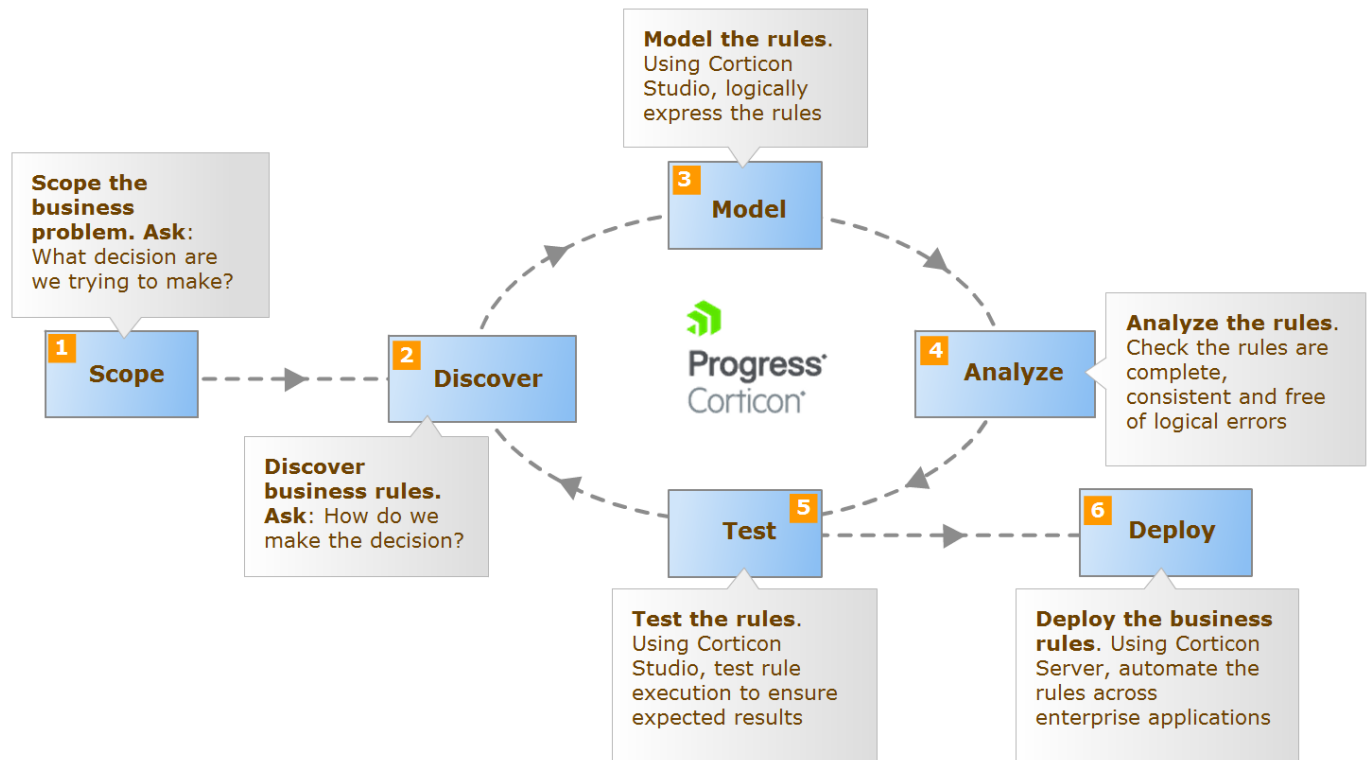
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Tutorial - Basic Rule Modeling in Corticon Studio

The lifecycle of a Decision Service

Corticon provides a simple yet powerful methodology for modeling business rules. The methodology involves the following steps:



This methodology is iterative. You repeat steps 2 to 6 when rules change.

This tutorial provides an introduction to business rule modeling in Corticon Studio. You will learn how to:

- Capture rules from business specifications,
- Model the rules,
- Analyze them for logical errors,
- Test the execution of your rules

In Corticon, you do this without programming.

Your goal in the tutorial is to create a Decision Service, which is a group of rules that captures the logic of a single decision-making step in a business process. You can deploy this Decision Service as an executable, standards-based service that can be made available to other software applications using Java, .NET, or REST messaging, and also as a serverless package for JavaScript deployments.

This tutorial is designed for hands-on so we recommend that you follow along in Corticon Studio, using the provided instructions and illustrations. If you haven't installed Corticon Studio yet, install it now. [Click here](#) to download the Corticon Studio test drive.

This tutorial includes two iterations through the lifecycle, including an initial implementation and a subsequent change cycle.

Note: Deployment is not covered in this tutorial. For information on deploying rule models, refer to the Corticon Deployment topics in the Corticon documentation set.

Scope the business problem

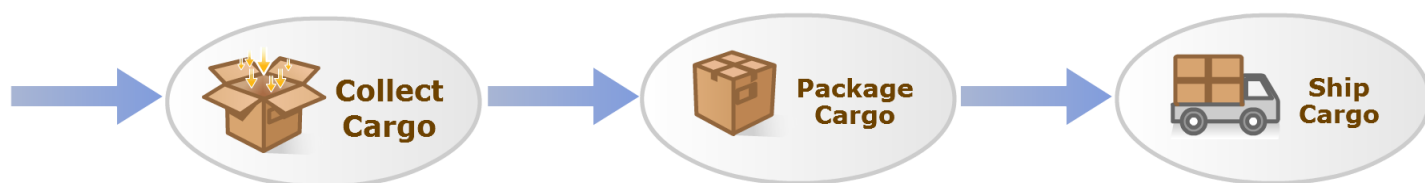
The example used in this tutorial describes a flight planning business problem in which an air cargo company collects cargo of various sizes and weights, loads them into containers, and then places the containers onto its fleet of aircraft prior to shipment.

To operate safely, the company must ensure that an aircraft is never loaded with cargo that exceeds the aircraft's capabilities. Part of the flight planning process involves verifying that no flight violates any safety or operational rule.

The air cargo company wants to improve the quality and efficiency of the flight planning process by modeling and automating business rules using Corticon.

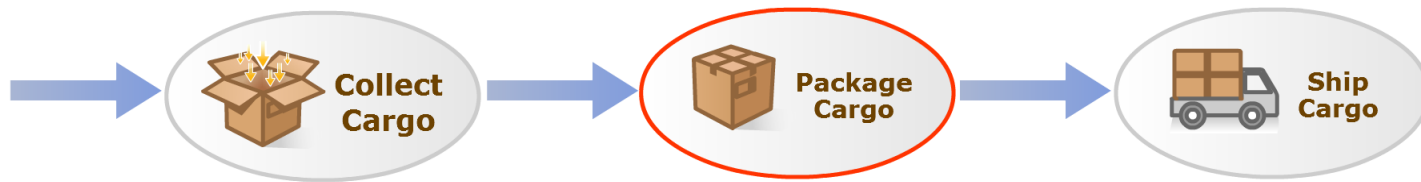
Complex problems such as flight planning are better described in their component parts and the best way to do it is by describing the business process. From a process diagram, you can easily identify the decision-making activities, which in turn are described by business rules.

First, define the business process as a sequence of activities or steps:



Next, determine which process steps involve decisions. Any step involving a decision is a candidate for automation using Corticon.

In this process, all three steps involve decisions, in addition to physical labor. The scope of this tutorial is the Package Cargo step, which involves the decision about what container to use for various cargo based upon the cargo's weight and volume.



Currently, the shipping personnel make the packaging decision based upon their experience. The problem is that some people make better decisions than others, which leads to inconsistent practices. Using Corticon will standardize and automate the packaging decision.

Discover business rules

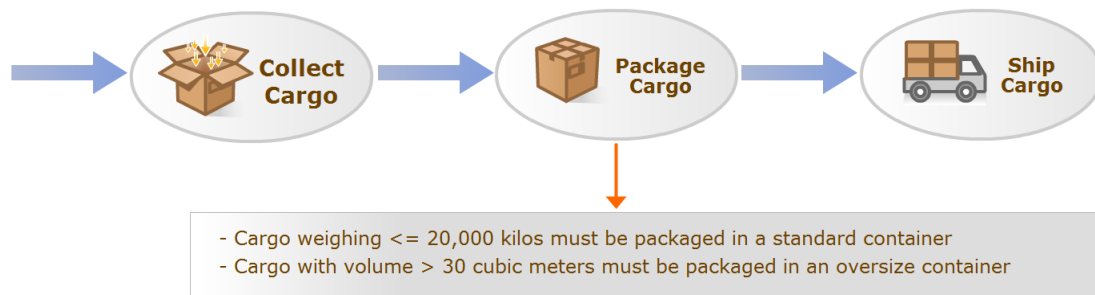
After scoping the problem, you need to discover the business rules.

To discover the business rules, ask the question: “How do we make this decision?”

In the flight planning example, ask “How do we package cargo?”

Ask this question of the people who perform and manage the step in the process. They often provide the answer in the form of a policy or procedure manual, or simply as a set of rules that they follow. Sometimes the rules are embedded in the code of legacy systems. In all cases, you can capture the discovered rules directly into Corticon Studio.

For the packaging decision, assume that you have discovered two rules:



Get started with Rule Modeling

Now that the rules have been discovered, you can model them in Corticon Studio.

To get started:

1. Launch Corticon Studio by selecting **Start > Progress > Corticon Studio**.
2. In the **Workspace Launcher** dialog box, retain the default location and click **OK**.

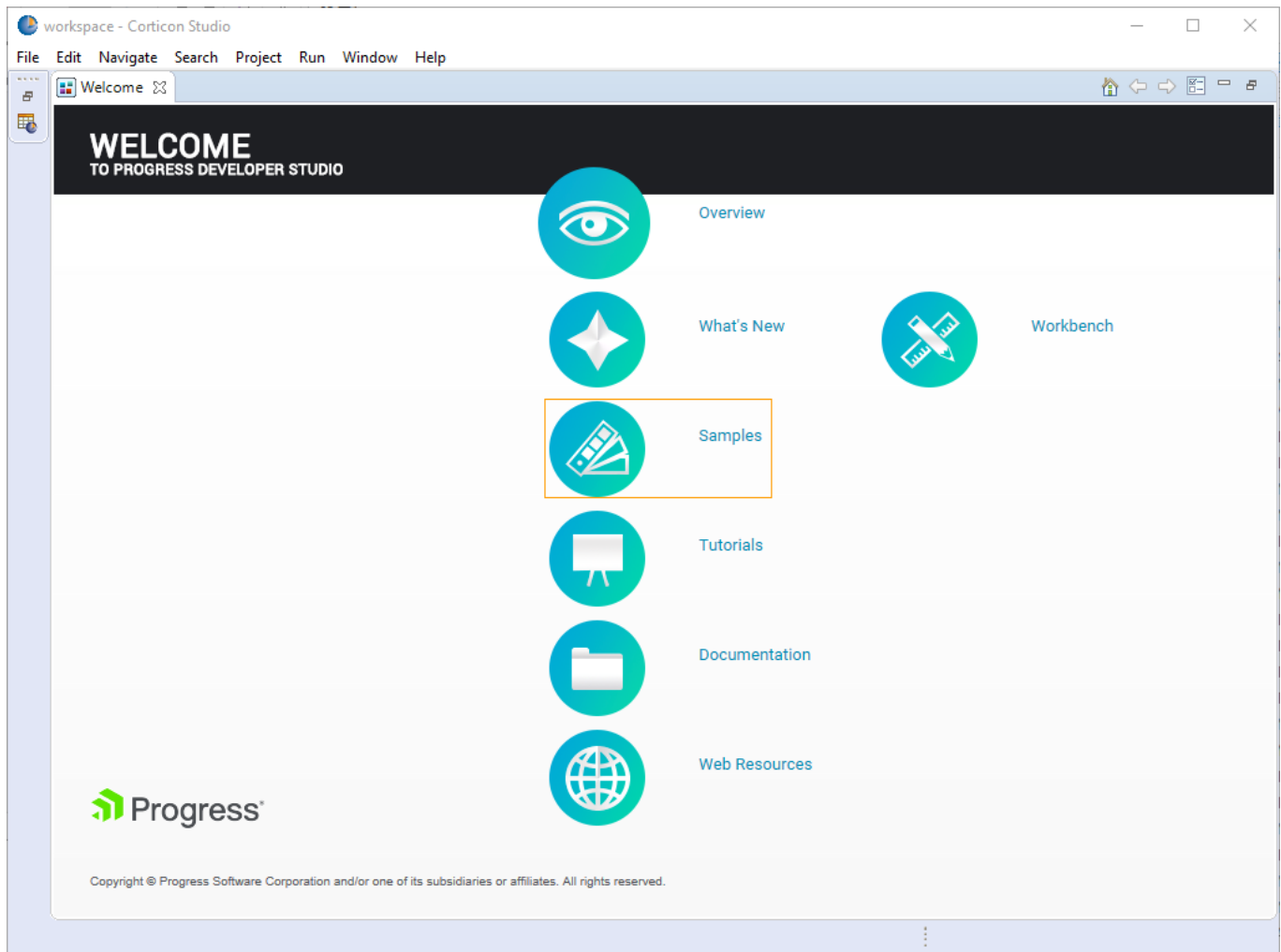
The Corticon Studio opens.

Note: A workspace is a Windows directory where Corticon Studio rule projects are stored.

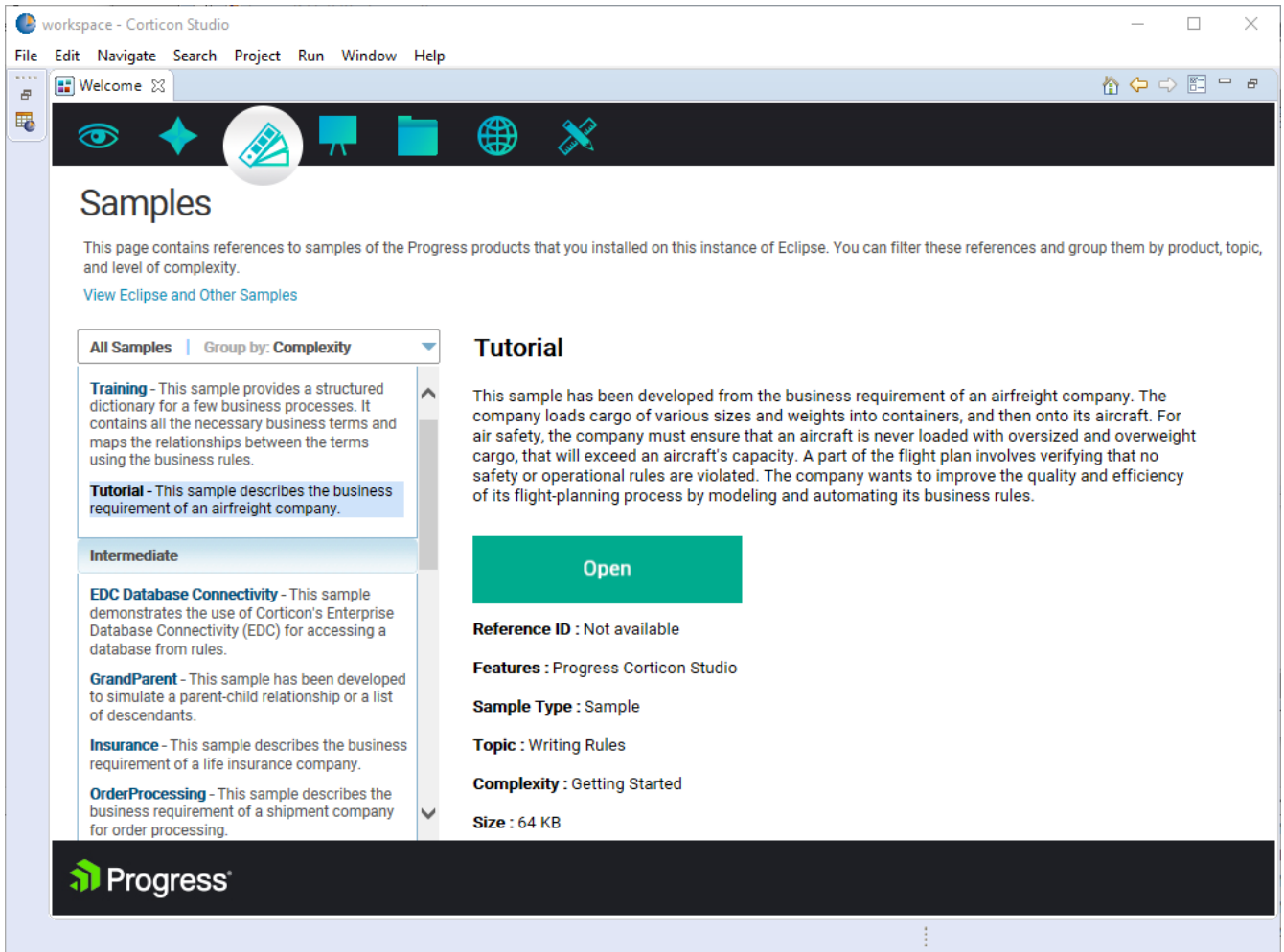
Set up the tutorial rule project

Corticon Studio comes with a built-in sample rule project for this tutorial. To open the sample:

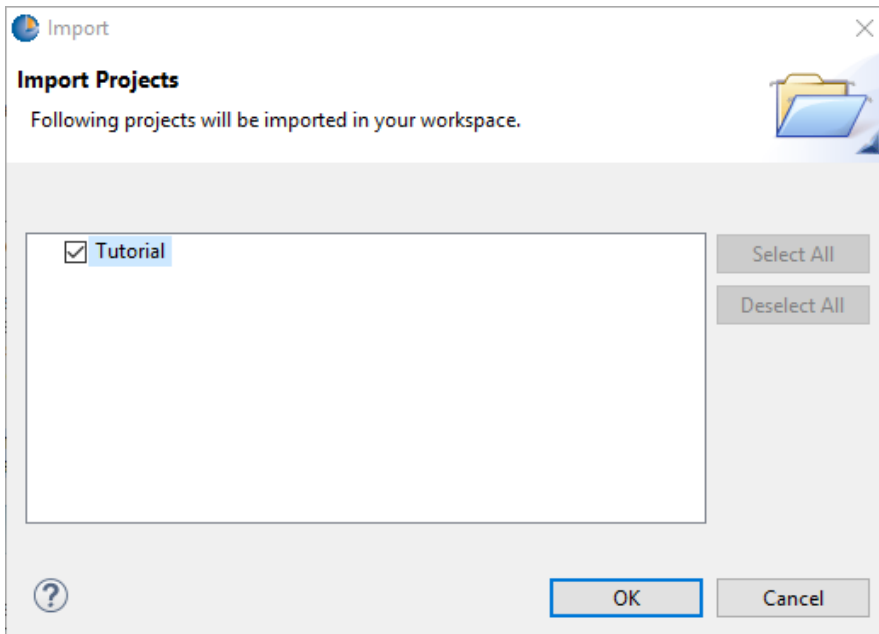
1. On the **Welcome** page, click **Samples**. (If you are not able to see the **Welcome** page right after you launch Corticon Studio, select **Help > Welcome**).



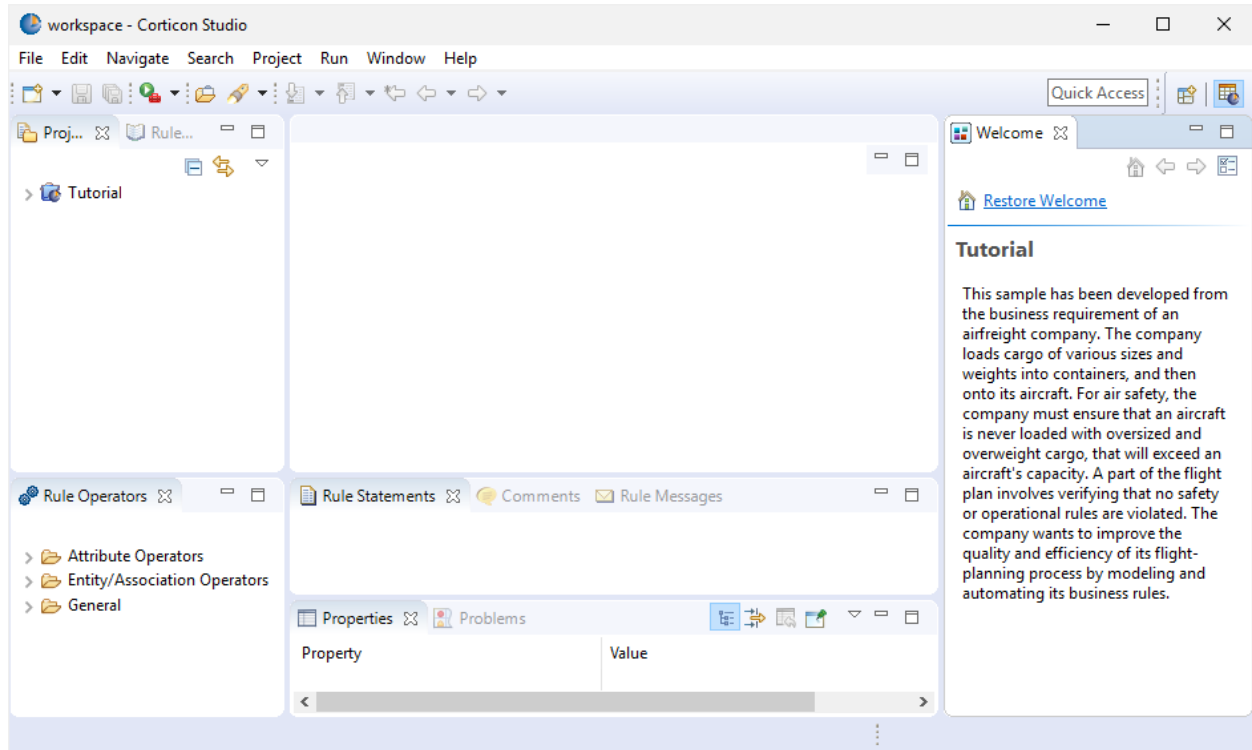
2. On the **Samples** page, select **Tutorial**, and then click **Open**.



3. In the **Import Projects** window, click **OK**.



The sample rule project opens in Corticon Studio.



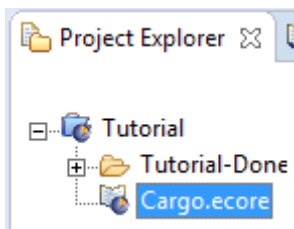
Note: The sample download provides the vocabulary you will use to hands-on create the files and the rules for the project. The accompanying **Tutorial-Done** folder contains all the files that comprise the tutorial exercises (including a slightly modified vocabulary) so that you can prove your work, or—if you just want to audit the tutorial—click your way through the files.

Define the Vocabulary

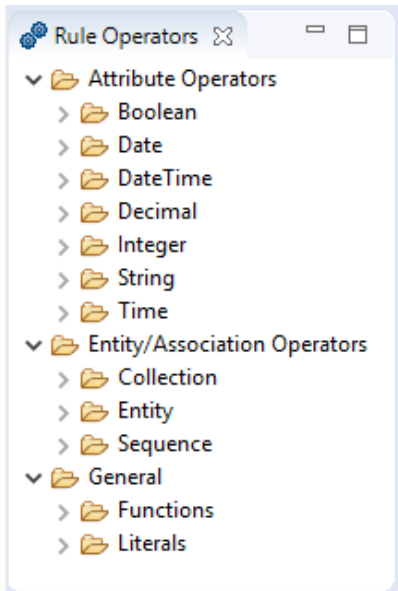
Vocabulary is an important component of all rule modeling projects. It includes the terms, called entities, referenced by the business rules. In this example, the Vocabulary would contain entities such as “Cargo” and “Aircraft.” You can use Corticon Studio to define and edit Vocabularies.

In your project, you may be responsible for defining the Vocabulary or you may simply use an existing Vocabulary that some else defines. In this example, you will use an existing Vocabulary that is part of the Tutorial sample.

1. To open the sample Vocabulary file, expand the **Tutorial Rule Project**, and then double-click **Cargo.ecore**:



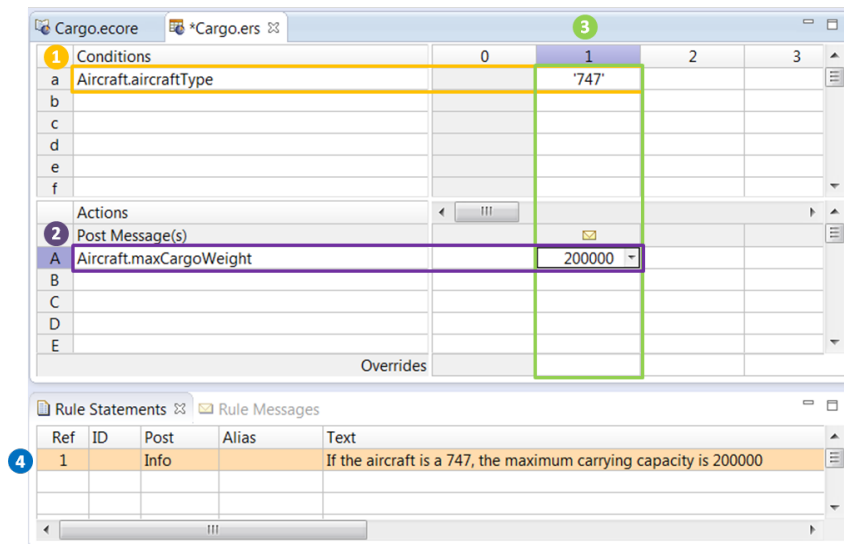
-
3. Explore the Rule Operators pane. Operators act on elements in the Vocabulary (such as cargo, cargo weight, aircraft, aircraft type, and so on because Corticon Studio comes with a rich set of operators for manipulating data (not unlike the Excel function library).



Build a Rulesheet

A Rulesheet is a spreadsheet structure where you enter **Conditions** (IF statements), **Actions** (THEN statements), and values for them that define a rule in each column:

Figure 1: Conditions and Actions define a rule



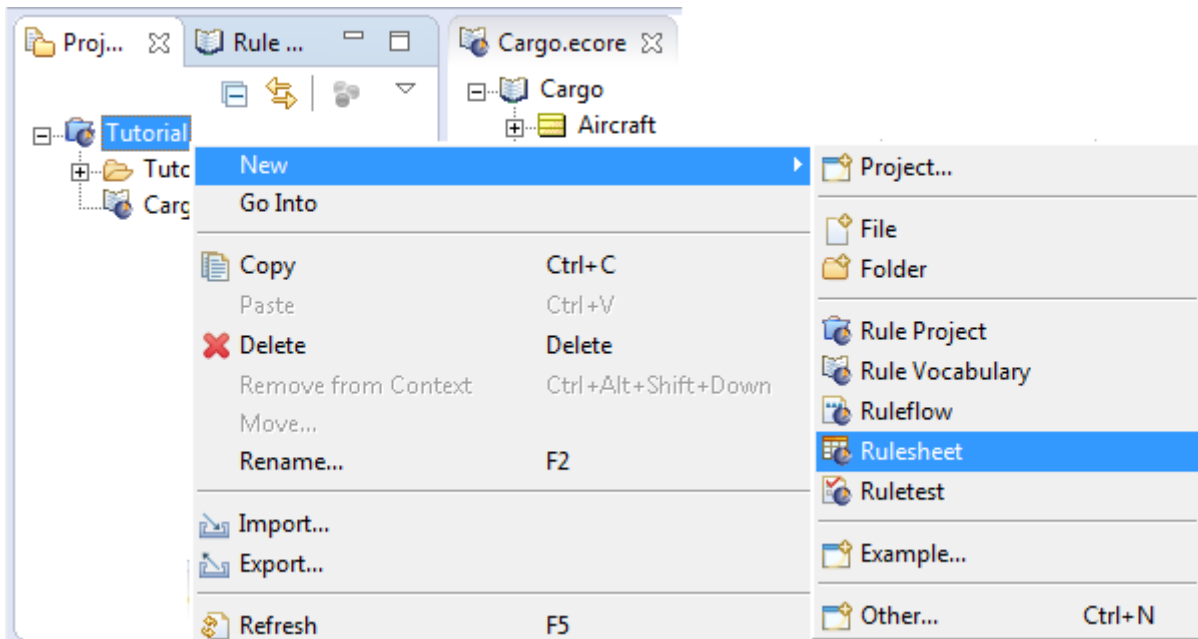
Rulesheets contain sections for specific parts of rules. Sets of **Conditions** 1 and **Actions** 2 that are tied together by vertical columns form rules.

Each column is a rule. For example, the rule in column 1 3 can be read as “if the aircraft is a 747, its maximum cargo weight is 200000”.

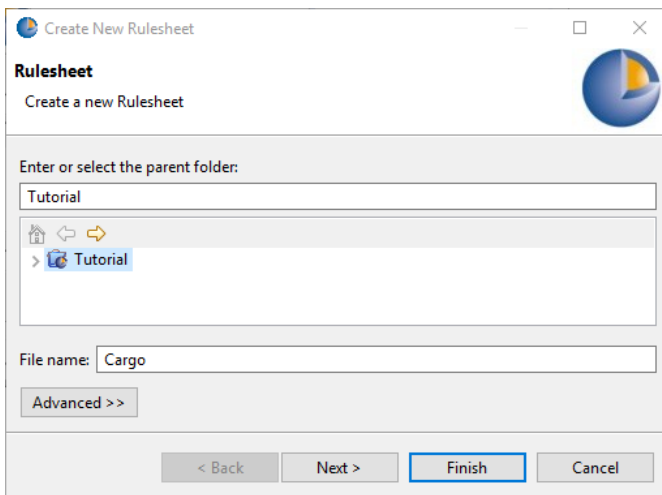
This column provides the model or implementation of the rule statement **4**.

To create some rules using the Vocabulary. To begin, we need to get a new Rulesheet in our project:

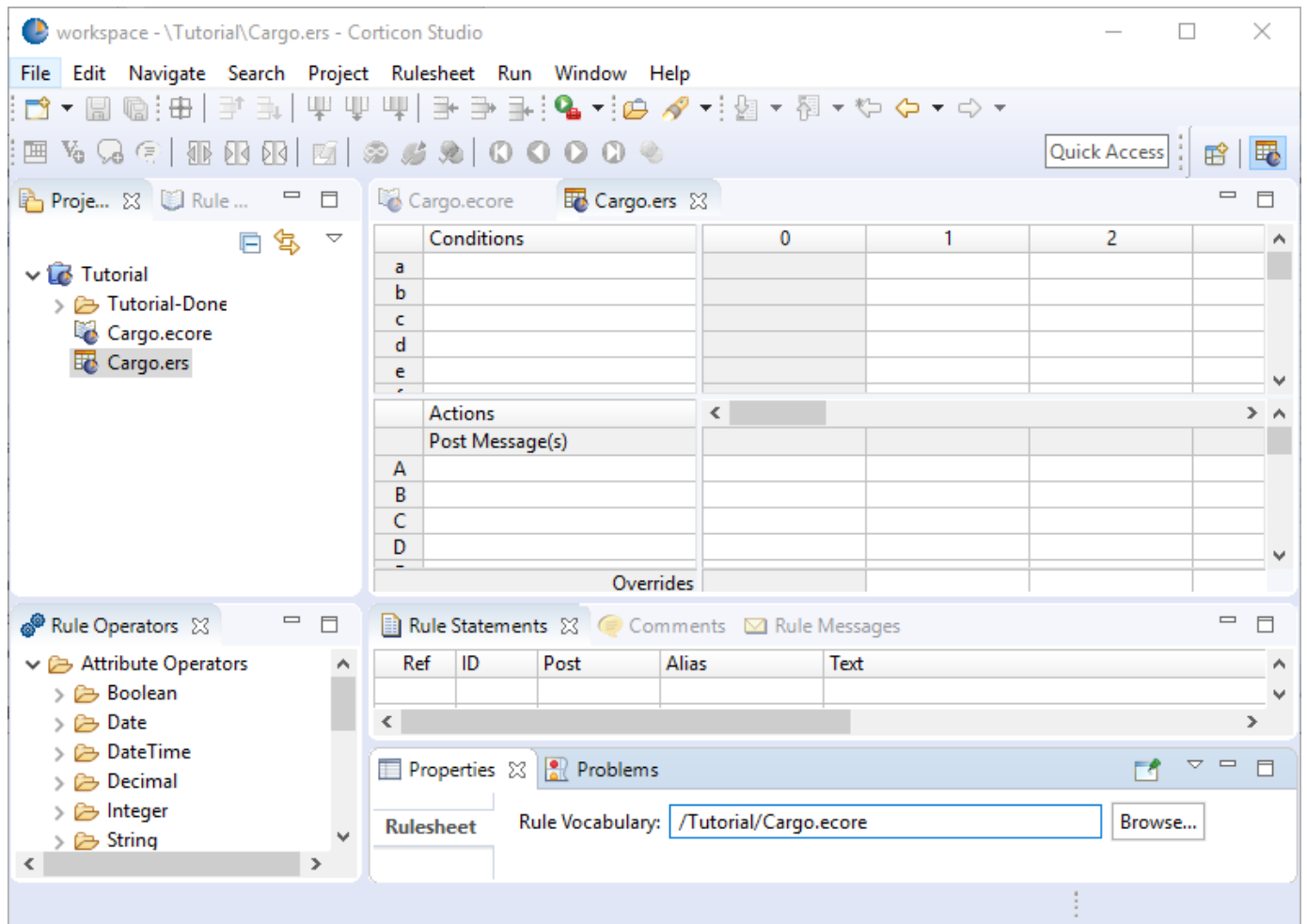
1. In Corticon Studio, right-click **Tutorial** and select **New > Rulesheet**.



2. In the **Create New Rulesheet** wizard, in the **File Name** field type `Cargo`, and click **Next**.
3. Ensure that `Cargo.ecore` (under **Tutorial**) is selected as the Vocabulary to associate with your new Rulesheet, and then click **Finish**.



The Rulesheet opens in Corticon Studio.



A Rulesheet is like a decision table or spreadsheet. You can extend Rulesheets to model any kind of business logic—from simple to complex.

Model the first rule

Model the first rule: **Cargo weighing <= 20000 kilos must be packaged in a standard container.**

Step 1—Defining the rule statement

Enter the plain-language business rule into the Rule Statements section of the Rulesheet as shown.

The screenshot displays the Corticon Studio interface for modeling a rule. The main window is titled 'Cargo.ecore' and contains a 'Rulesheet' for '*Cargo.ers'. The Rulesheet is divided into several sections:

- Conditions:** A table with 6 rows (a-f) and 4 columns (0-3).
- Actions:** A table with 5 rows (A-E) and 4 columns (0-3).
- Post Message(s):** A table with 5 rows (A-E) and 4 columns (0-3).
- Overrides:** A table with 1 row and 4 columns (0-3).
- Rule Statements:** A table with 5 columns: Ref, ID, Post, Alias, and Text. The Text column contains the rule statement: "Cargo weighing <= 20000 kilos must be packaged in a standard container".
- Rule Messages:** A table with 5 columns: Ref, ID, Post, Alias, and Text.

The 'Rule Statements' table is highlighted, and the rule statement is entered in the 'Text' column.

Ref	ID	Post	Alias	Text
				Cargo weighing <= 20000 kilos must be packaged in a standard container

Step 2—Define rule conditions

Model the condition of the first rule—**Cargo weighing <= 20,000**. You can represent this as **Cargo.weight <= 20000**.

1. Click the **Rule Vocabulary** tab, expand the **Cargo** entity, and then drag **weight** from the Vocabulary and drop it in Row a of the Conditions pane.

The screenshot shows the Corticon Studio interface. On the left, the 'Rule Vocabulary' pane is expanded to show the 'Cargo' entity, with the 'weight' attribute selected. The main workspace displays a 'Conditions' table with row 'a' containing 'Cargo.weight'. Below it is an 'Actions' table with 'Post Message(s)' and rows A-E. At the bottom, the 'Rule Statements' pane shows a rule text: 'Cargo weighing <= 20000 kilos must be packaged in a standard container'.

2. Specify a value expression for cargo weight in cell 1a (row a, column 1). Enter **<= 20000** in the cell.

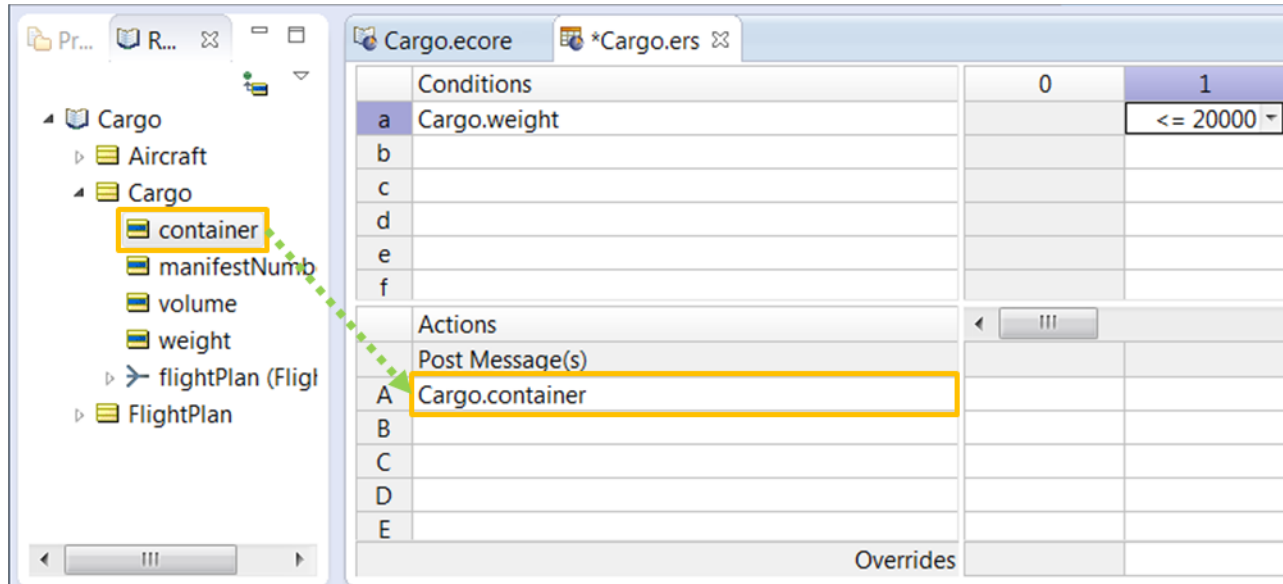
Note: Do not use commas in value expressions because commas are used to indicate multiple values in Corticon rule modeling.

The screenshot shows the 'Conditions' table with the value '<= 20000' entered in cell 1a (row a, column 1). The table has columns 0, 1, 2, and 3, and rows a, b, c, d, e, and f. The 'Actions' table below it is empty.

Step 3—Define rule actions

To define the second part of the rule (Cargo weighing <= 20,000 kilos must be packaged in a standard container), define the rule action:

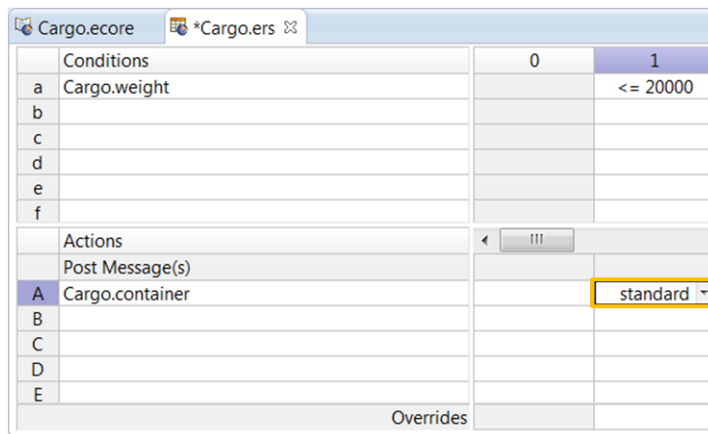
1. Drag **Cargo** attribute **container** from the Vocabulary and drop it in Row A of the Actions



2. Specify a value expression for cargo container in cell 1A (row A, column 1). Select **standard** in the drop-down list.

Note: The drop-down menu options were defined in the Vocabulary, which we will edit later.

This action assigns the value of **standard** to **Cargo.container**.



Step 4—Link the rule statement to the rule

Link a rule statement to the rule that will be used when the rule is executed. If the conditions in the rule are met, the rule fires, triggering the rule action and sending the rule statement as a message to the application that uses the rule.

To link the rule statement to the rule, enter the Rule Statement's Reference number, connecting the Rule Statement to the corresponding rule column in the Rulesheet. In this example, the rule is defined in column 1, so enter **1** in the **Reference** column of the rule statement.

The screenshot shows two windows from the Corticon Studio interface. The top window, titled 'Cargo.ers', contains a table for defining rules. It has columns for conditions (a-f) and actions (A-E), and a grid with columns 0, 1, 2, and 3. The '1' column is highlighted in orange. In the conditions section, row 'a' has the value '<= 20000' in column 1. In the actions section, row 'A' has the value 'standard' in column 1. The bottom window, titled 'Rule Statements', shows a table with columns 'Ref', 'ID', 'Post', 'Alias', and 'Text'. The first row has '1' in the 'Ref' column and 'Cargo weighing <= 20000 kilos must be packaged in a standard container' in the 'Text' column. The '1' in the 'Ref' column is also highlighted in orange.

Conditions	0	1	2	3
a		<= 20000		
b				
c				
d				
e				
f				
Actions	0	1	2	3
Post Message(s)				
A		standard		
B				
C				
D				
E				

Ref	ID	Post	Alias	Text
1				Cargo weighing <= 20000 kilos must be packaged in a standard container

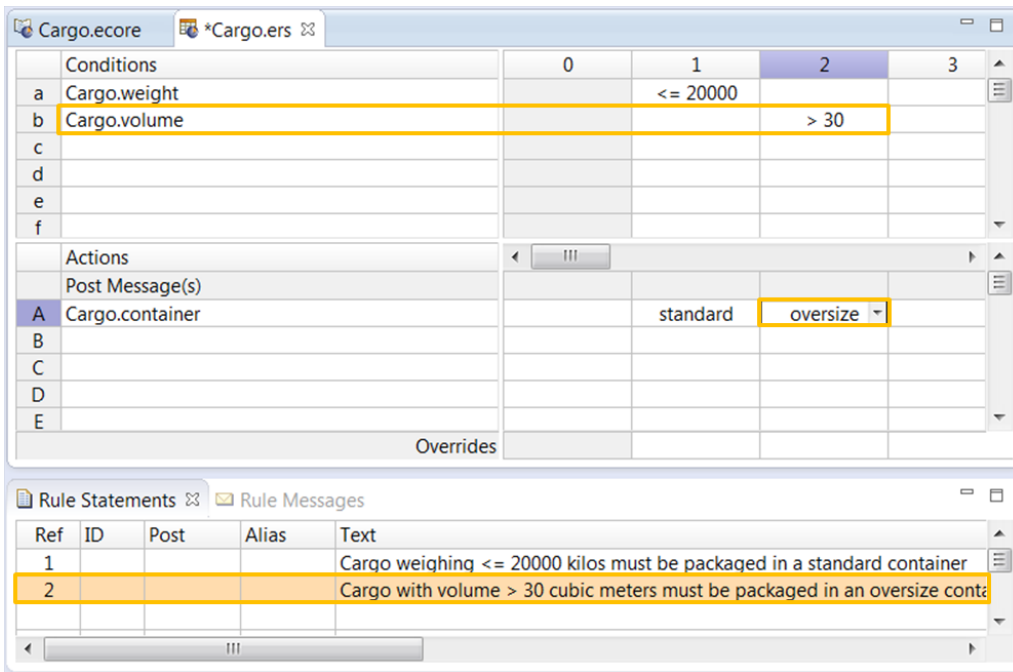
The rule column is highlighted in orange, indicating that the rule is linked to the rule statement.

Model the second rule

Now that the first rule is defined, define the second rule—**Cargo with volume > 30 cubic meters must be packaged in an oversize container**—in the same way.

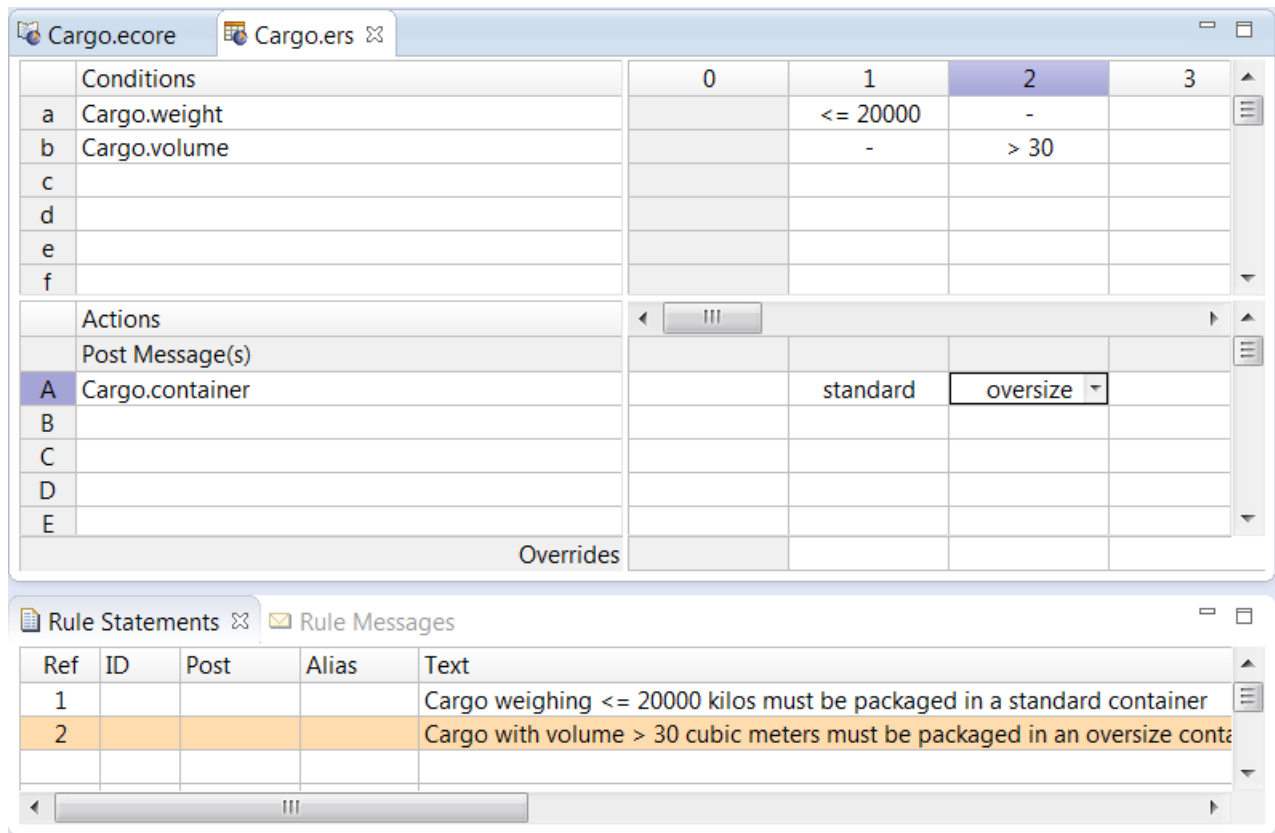
1. Enter the rule in plain language in the **Rule Statements** section.
2. Drag **volume** from the Vocabulary to row **b** in the **Conditions** pane.
3. Specify the value expression for cargo volume in cell 2b (**row b, column 2**). Enter **> 30** in the cell.
4. Define the action. Select **oversize** from the drop-down in cell 2A (**row A, column 2**).
5. Link the rule statement with the rule.

The final result should look like this:



6. Save your Rulesheet by selecting **File > Save** from the Corticon Studio menu bar.

When saved, Corticon Studio places a dash in the empty cells, meaning that the condition is ignored. The conditions and actions in a column are combined by an AND operator. For example, the logic in Rule 1 is modified to: “Cargo weighing <= 20,000 kilos, *regardless of volume*, must be packaged in a standard container.”



Post rule statements

Finally, you should post rule statements to a Vocabulary entity to provide an audit trail during rule execution (seen later during rule testing). In this example, post the rule statements to the **Cargo** entity.

To post, first select the appropriate severity level from the drop-down in each rule statement's Post column. In this case, select **Info**. Next, select an **Alias** for each rule statement. The **Alias** defines the entity to which the rule statement is posted. In this case, select **Cargo**, which is the only option, because the rule conditions and actions only use **Cargo**.

When you post a rule statement, an icon appears in the **Post Message(s)** row of the linked rule column.

The screenshot displays the Corticon Studio interface for a rule named 'Cargo'. It is divided into two main sections: 'Conditions' and 'Actions'.

Conditions Section:

Conditions	0	1	2	3
a Cargo.weight		<= 20000	-	
b Cargo.volume		-	> 30	
c				
d				
e				
f				

Actions Section:

Post Message(s)	0	1	2	3
A Cargo.container		standard	oversize	
B				
C				
D				
E				

Rule Statements Section:

Ref	ID	Post	Alias	Text
1		Info	Cargo	Cargo weighing <= 20000 kilos must be packaged in a standard container
2		Info	Cargo	Cargo with volume > 30 cubic meters must be packaged in an oversize container

Analyze rules

When you have finished modeling rules, analyze the rules for logical errors. Often, initial business rule specifications are:

- **Ambiguous**—The rules conflict under certain scenarios.
- **Incomplete**—The rules fail to address all possible scenarios.
- **Looping**—The rules form circular logic or loops.

Before automating the rules, it is critical to eliminate logical errors to ensure that the decision service provides correct and consistent results. Corticon Studio provides unique and powerful features to help you ensure that rules are complete and consistent.

✦ **Corticon AI Assistant** **Discover Ways to Improve Your Rules**

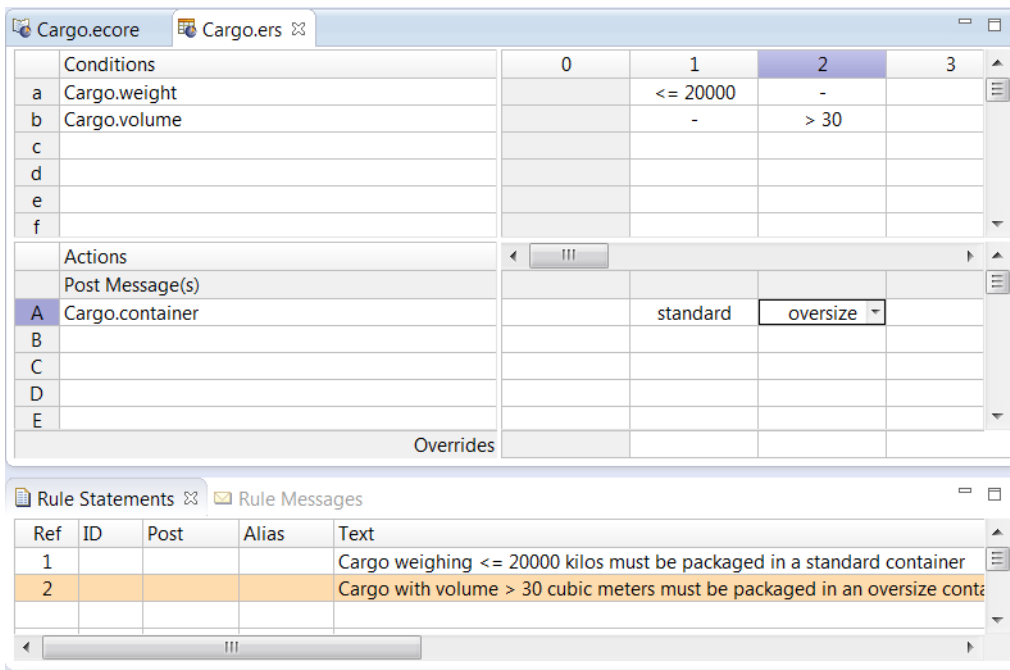
The AI Assistant can help identify potential improvements in your rulesheets, such as redundancies or inefficiencies. Try prompts like:

- “How could this rulesheet be improved?”
- “What other conditions might this rulesheet need to cover?”

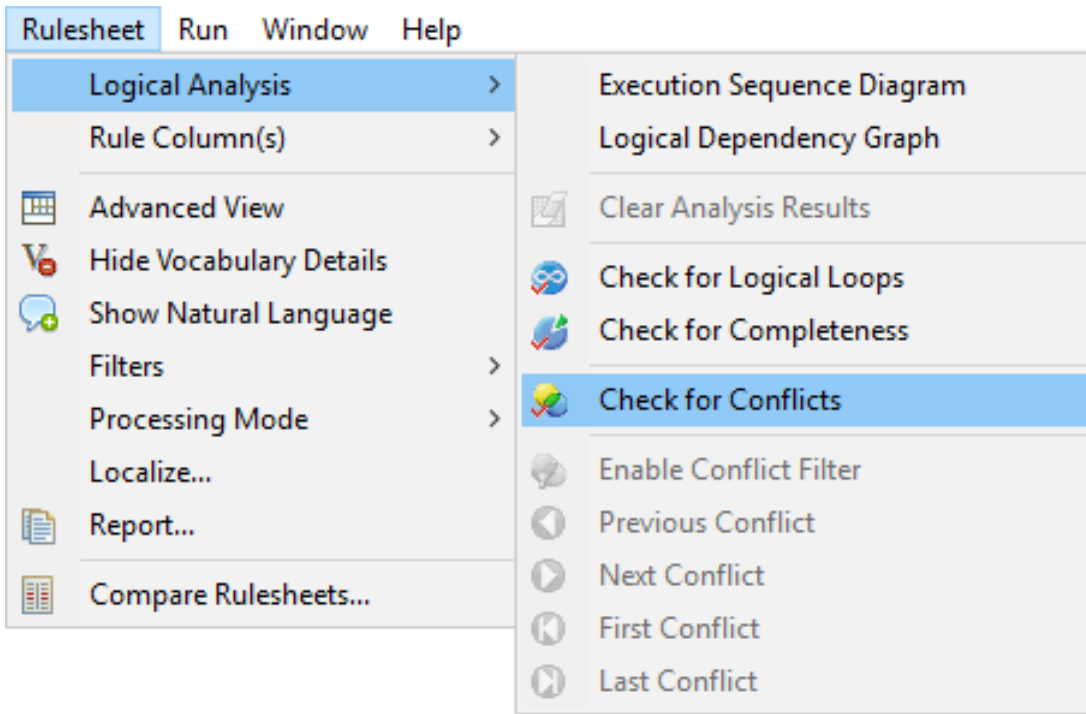
Check for conflicts

Begin by checking for conflicts in the rules:

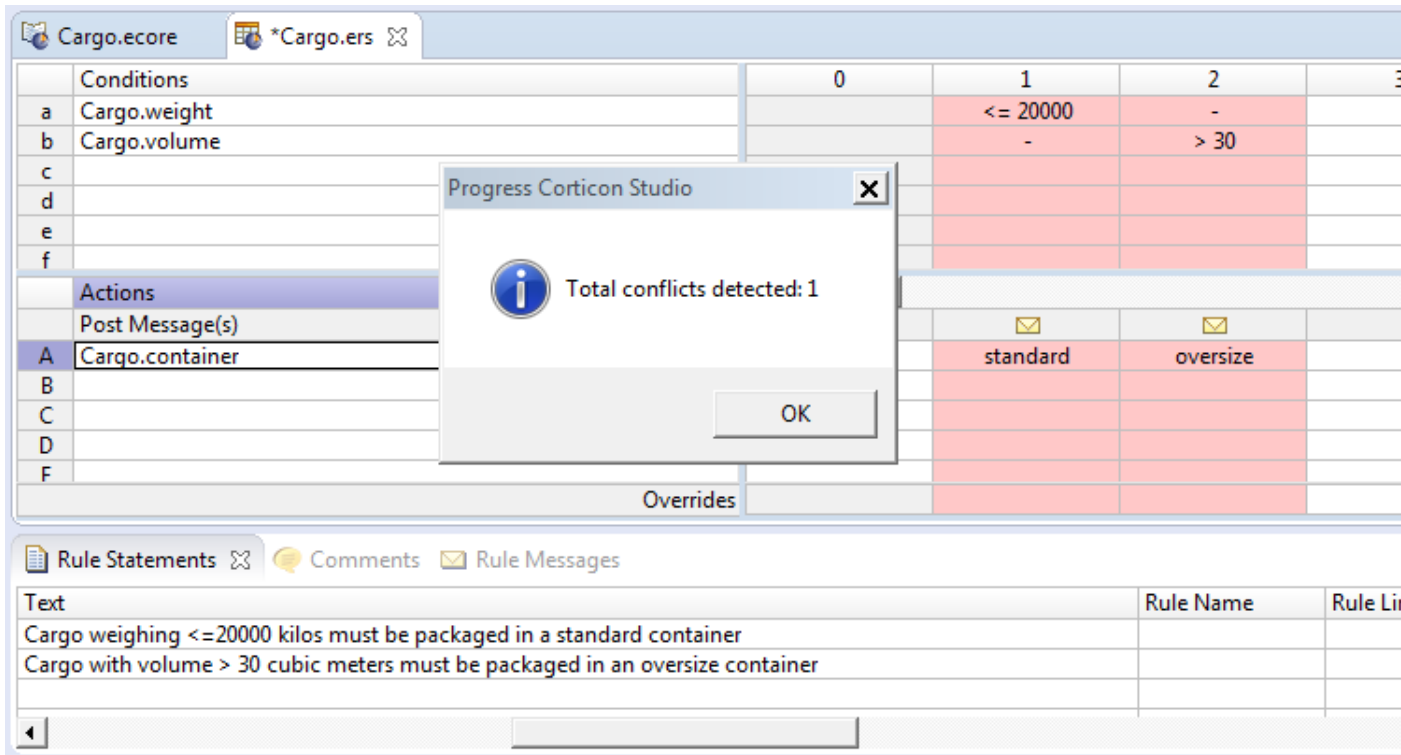
1. Open the Rulesheet and select the **Cargo.ers** tab.



2. Select **Rulesheet > Logical Analysis > Check for Conflicts**.



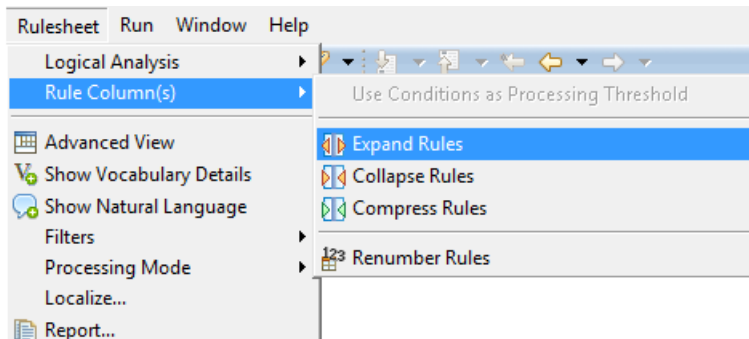
If one or more columns contain conflicting rules, Corticon detects them and highlights the columns in pink. The total number of conflicts is also displayed in a dialog box.



3. Click **OK** to dismiss the dialog box.

Resolve conflicts

Sometimes, conflicts may not be immediately visible just by looking at the rules because each rule is actually made up of sub-rules (rules without dashes) and it is the sub-rules that are in conflict. To see these sub-rules, select **Rulesheet > Rule Column(s) > Expand Rules**.



It helps you pinpoint the source of the conflict.

Conditions		0	1.1	1.2	1.3	2.1	2.2	2.3
a	Cargo.weight		<= 20000	<= 20000	<= 20000	<= 20000	> 20000	null
b	Cargo.volume		<= 30	> 30	null	> 30	> 30	> 30
c								
d								
e								
f								

Actions							
Post Message(s)			✉	✉	✉	✉	✉
A	Cargo.container		standard	standard	standard	oversize	oversize
B							
C							
D							
E							
Overrides							

Ref	ID	Post	Alias	Text
1		Info	Cargo	Cargo weighing <= 20,000 kilos must be packaged in a standard container
2		Info	Cargo	Cargo with volume > 30 cubic meters must be packaged in an oversize container

Rule 1 is expanded into three columns, 1.1, 1.2, and 1.3, and rule 2 is expanded into three columns 2.1, 2.2, and 2.3. The expansion shows all of the logical possibilities for each rule. Rule 1 states Cargo weighing <= 20,000 kilos, regardless of volume, must be packaged in a standard container. Corticon Studio recognizes three possible ranges for Cargo.volume (<=30, >30, and null), as seen in the expanded rules.

With the rules expanded, the source of the conflict becomes obvious. Scenarios with Cargo.weight <=20000 and Cargo.volume > 30 are in conflict, because they define mutually exclusive actions (rule 1.2 assigns a standard container while rule 2.1 assigns an oversize container). To get your rules right, this conflict must be addressed.

To resolve the conflict, you can either change your original rules, or decide that one rule should override the other. To implement the override:

1. Collapse your rules back to the original state by selecting **Rulesheet > Rule Column(s) > Collapse Rules**.
2. Override Rule 1 with Rule 2. In the **Overrides** cell in Rule 2, select the column number of the rule that you want Rule 2 to override—in this case, Rule 1.

Conditions		0	1	2
a	Cargo.weight		<= 20000	-
b	Cargo.volume		-	> 30
c				
d				
e				
f				

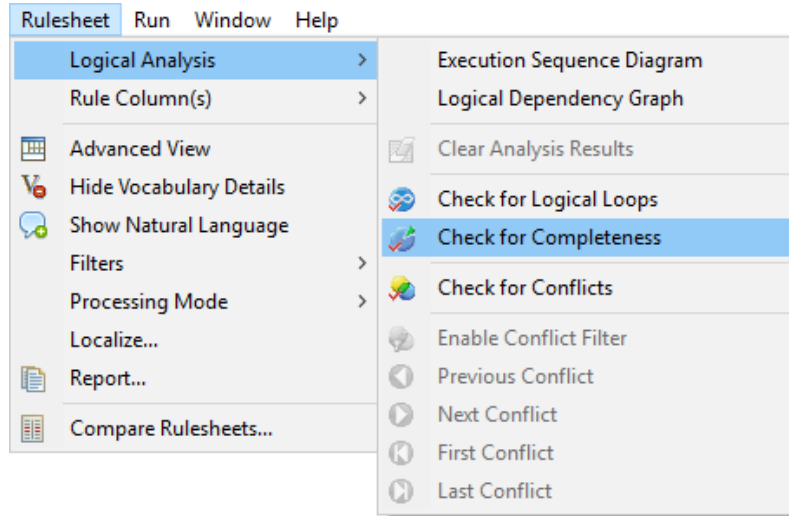
Actions			
Post Message(s)			✉
A	Cargo.container		oversize
B			
C			
D			
E			
Overrides			1

3. Check for conflicts again by selecting **Rulesheet > Logical Analysis > Check for Conflicts**. You see that the conflict has been resolved. With the override, Rule 2 now means “Use oversized containers when volume is >30, **even when** weight is <=20000.”
4. Dismiss the dialog box by clicking **OK**.
5. Save your Rulesheet by clicking on the **Save** icon on the toolbar or by choosing **File>Save**.

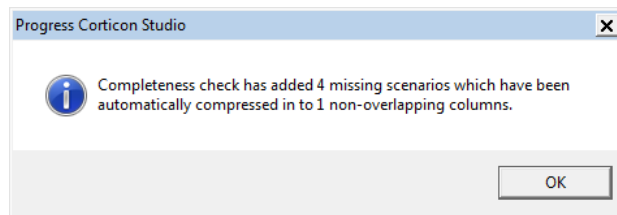
Check for completeness

Conflict is one form of logical error. Another form is incompleteness in the logic.

To see if the rules are complete, select **Rulesheet > Logical Analysis > Check for Completeness**.



A message window opens informing you that the rules are incomplete. You missed some scenarios.



The completeness checking algorithm calculates the set of all possible combinations of values in all conditions. The algorithm then compares this set of possible combinations to those already specified in the Rulesheet and automatically inserts missing combinations of conditions as new columns. These new columns are highlighted in green.

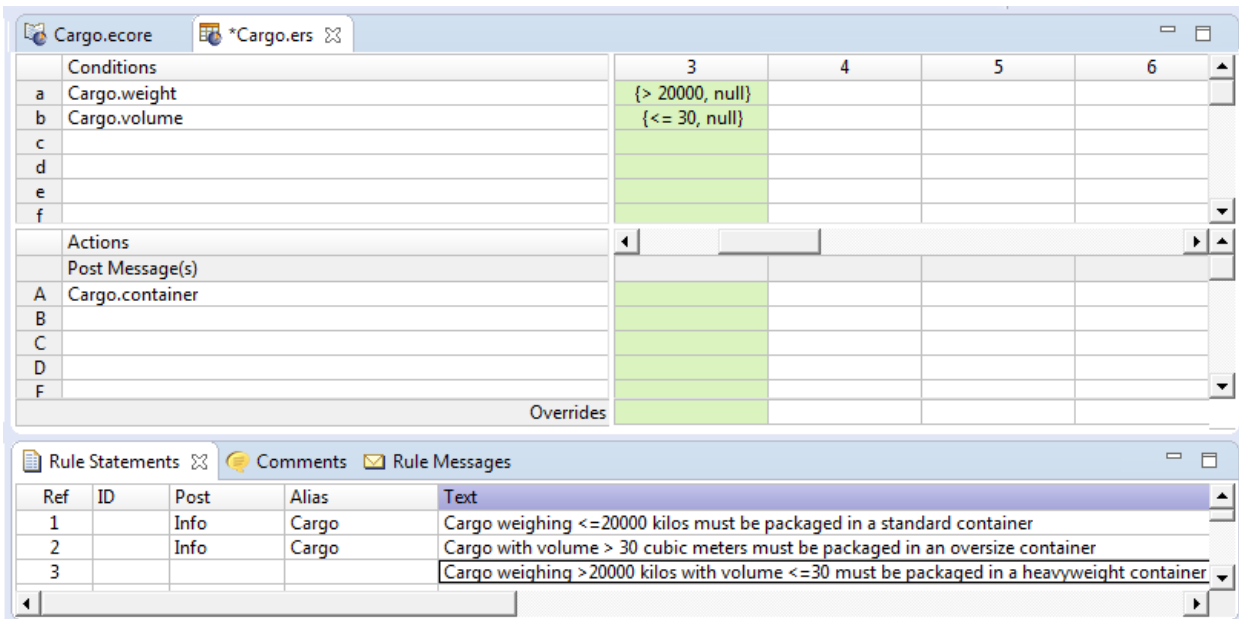
In this case, Corticon Studio has added a new rule in column 3—where the cargo weighs > 20000 and the cargo volume is less than or equal to 30. The completeness check adds condition values, but does not choose actions—leaving it to the rule modeler.

Click **OK** to dismiss the window.

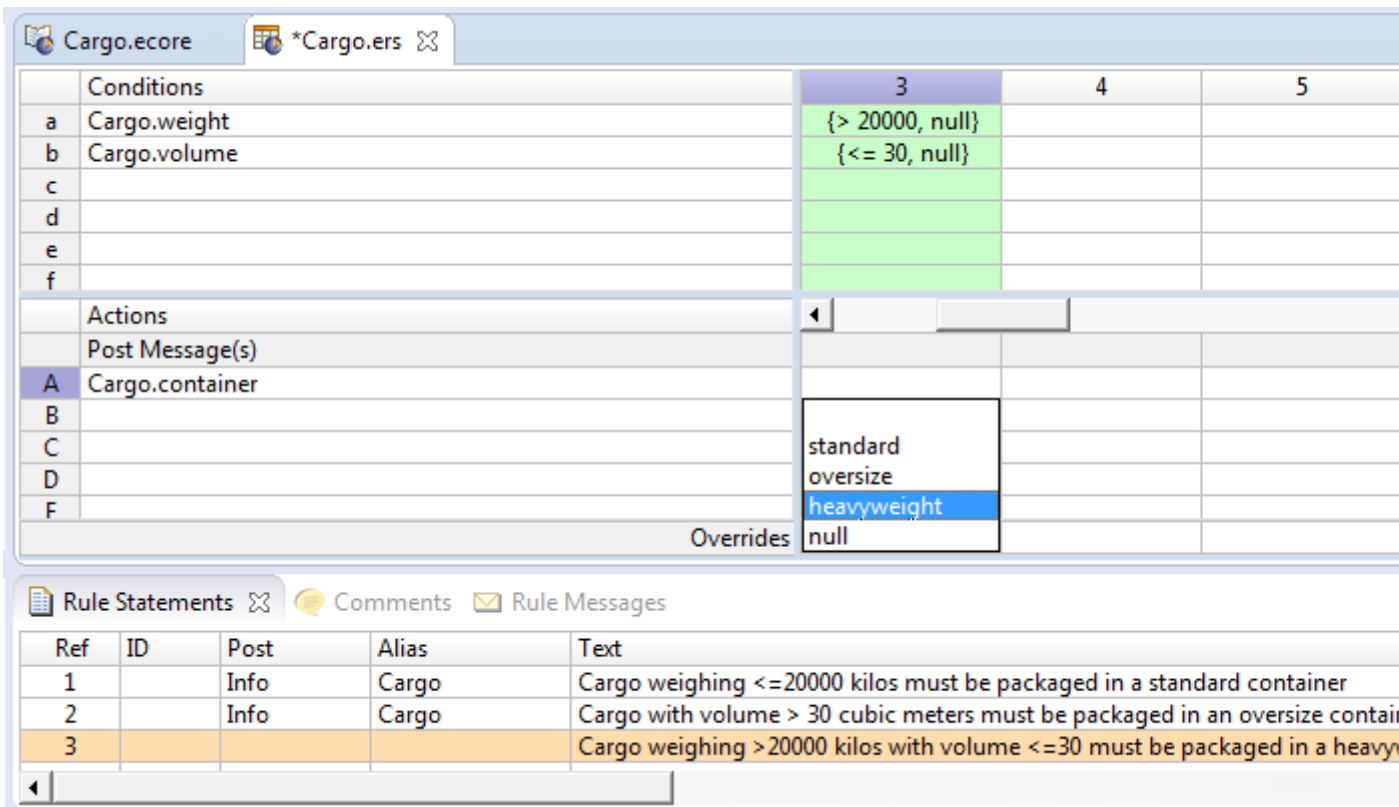
Resolve completeness errors

1. Add a new rule statement for Rule 3: **Cargo weighing > 20,000 kilos, with volume <= 30 cubic meters, must be packaged in a heavyweight container.**

Note: Do not forget to link the rule statement with the corresponding column.



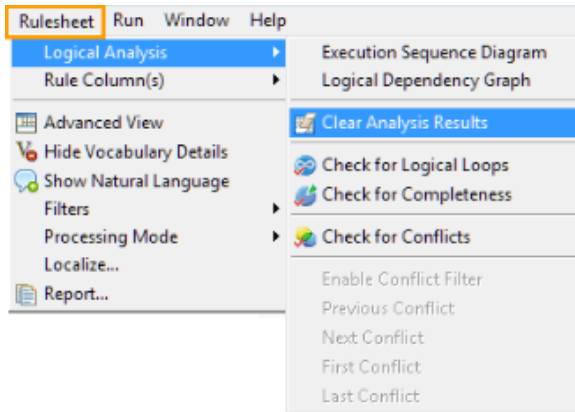
2. Define an action in rule cell 3A. In this case, select **heavyweight** as the container option.



3. Post an Info message to the Cargo entity as you did for the first two rules in the Rulesheet.

Ref	ID	Post	Alias	Text
1		Info	Cargo	Cargo weighing <=20000 kilos must be packaged in a standard container
2		Info	Cargo	Cargo with volume > 30 cubic meters must be packaged in an oversize container
3		Info	Cargo	Cargo weighing >20000 kilos with volume <=30 must be packaged in a heavyweight container

4. Select **Rulesheet > Logical Analysis > Clear Analysis Results** to remove the highlighting in Rule 3.



After you clear analysis results, your Rulesheet looks like this.

The screenshot shows the Corticon Studio interface. The 'Rulesheet' tab is active, displaying a table with conditions and actions. The 'Logical Analysis' results are shown below the table, with Rule 3 highlighted in blue.

Conditions	0	1	2	3	4
a Cargo.weight		<= 20000	-	> 20000	
b Cargo.volume		-	> 30	<= 30	
c					
d					

Actions	0	1	2	3	4
Post Message(s)		✉	✉	✉	
A Cargo.container		standard	oversize	heavyweight	
B					
C					
Overrides			1		

Alias	Text	Rule Name	Rule L
Cargo	Cargo weighing <= 20,000 kilos must be packaged in a standard container.		
Cargo	Cargo with volume > 30 cubic meters must be packaged in an oversize container.		
Cargo	Cargo weighing > 20,000 kilos, with volume <= 30 cubic meters, must be packaged in a heavyweight container.		

The 'Properties' tab is also visible, showing the 'Rule Vocabulary' set to '/Tutorial/Tutorial-Done/Cargo.ecore'.

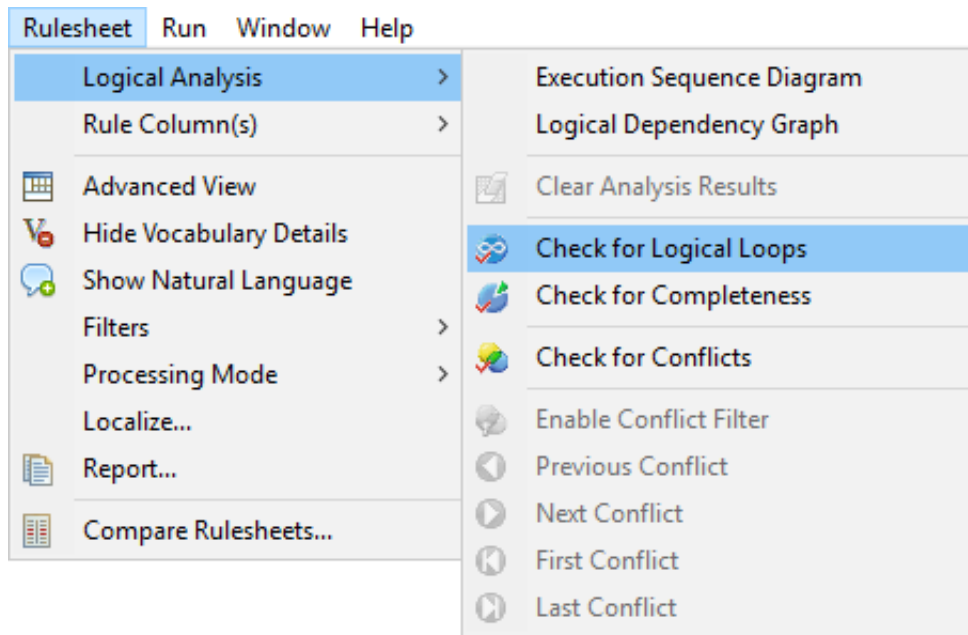
5. Run the completeness check again. The dialog box should indicate that the Rulesheet is complete.
6. Click **OK** in the dialog box.

Note: Although checking for completeness can identify rules that you should include in your Decision Service, there may be situations where you do not want a newly-added rule. In this case, you can just delete the rule.

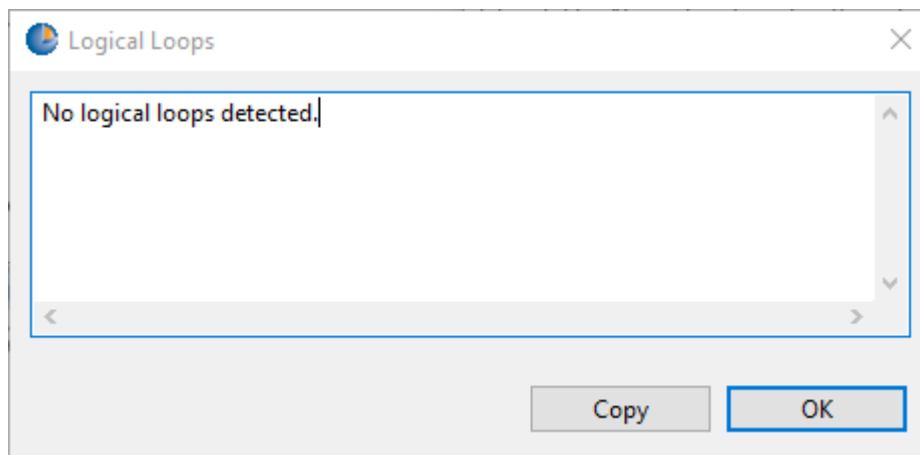
7. Save your Rulesheet.

Check for logical loops

A third form of logical error is circular logic or loops. To check for this, select **Rulesheet > Logical Analysis > Check for Logical Loops**.



You see the following result.



This Rulesheet is very simple and contains no logical loops. Click **OK** in the dialog box to dismiss it.

Note: While unintended logical loops should be fixed, sometimes logical loops are a useful technique for implementing rule logic that requires recursive reasoning.

Test rule execution

While the analyze phase helps to ensure the logical integrity of the rules, the Test phase helps to ensure that the rules give correct business results.

First, define a test case for each one of the rules by defining some input values and expected results. Corticon Studio enables you to define our expected results, and then highlights any differences between the actual test results and the expected results. The following table defines one test case for each rule in the Rulesheet.

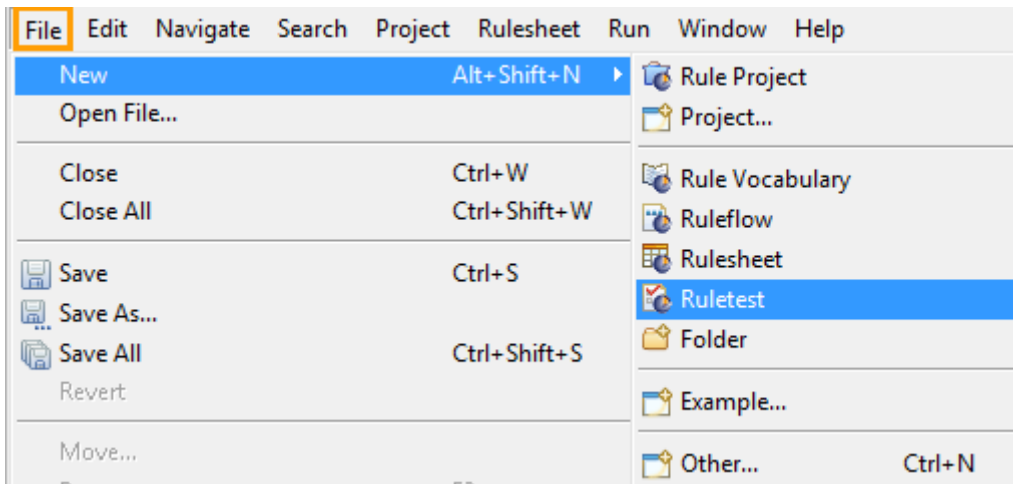
	Test Case 1	Test Case 2	Test Case 3
Input Values			
Cargo.weight	1000	1000	30000
Cargo.volume	10	40	20
Expected Results			
Cargo.container	standard	oversize	Heavyweight
Rule that should fire	Rule 1	Rule 2	Rule 3

For Test Case 2, we expect Rule 2 to override Rule 1. Even though the cargo weight is less than 20,000, which also satisfies the condition of Rule 1, the cargo volume is greater than 30, so Rule 2 overrides Rule 1 and is triggered.

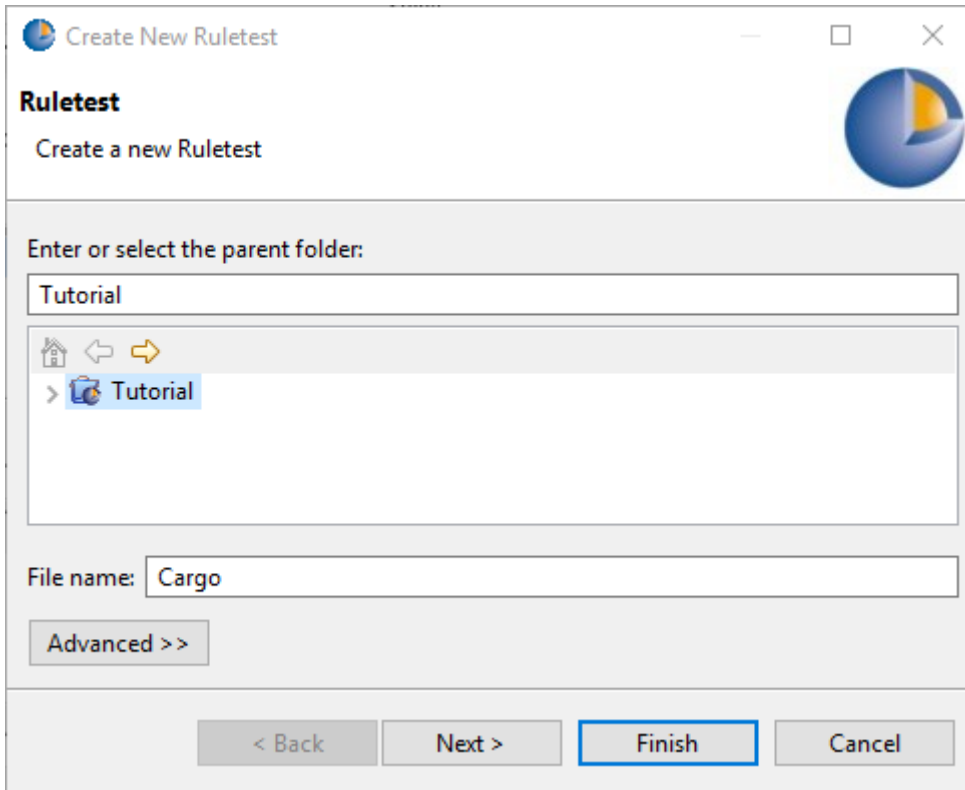
Create a Ruletest file

To begin testing, create a Ruletest file:

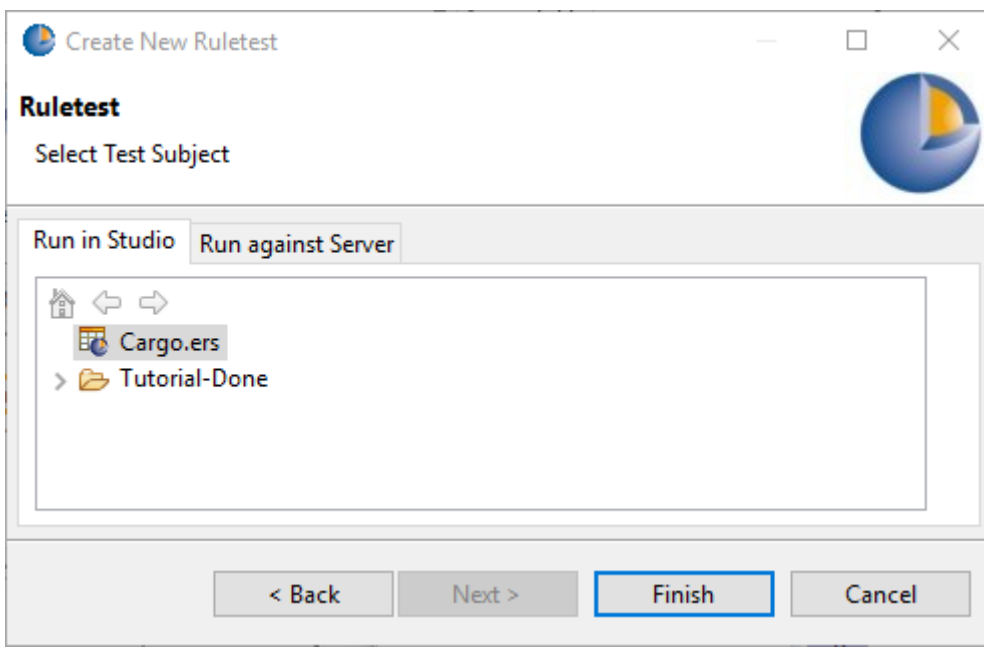
1. Select **File > New > Ruletest**.



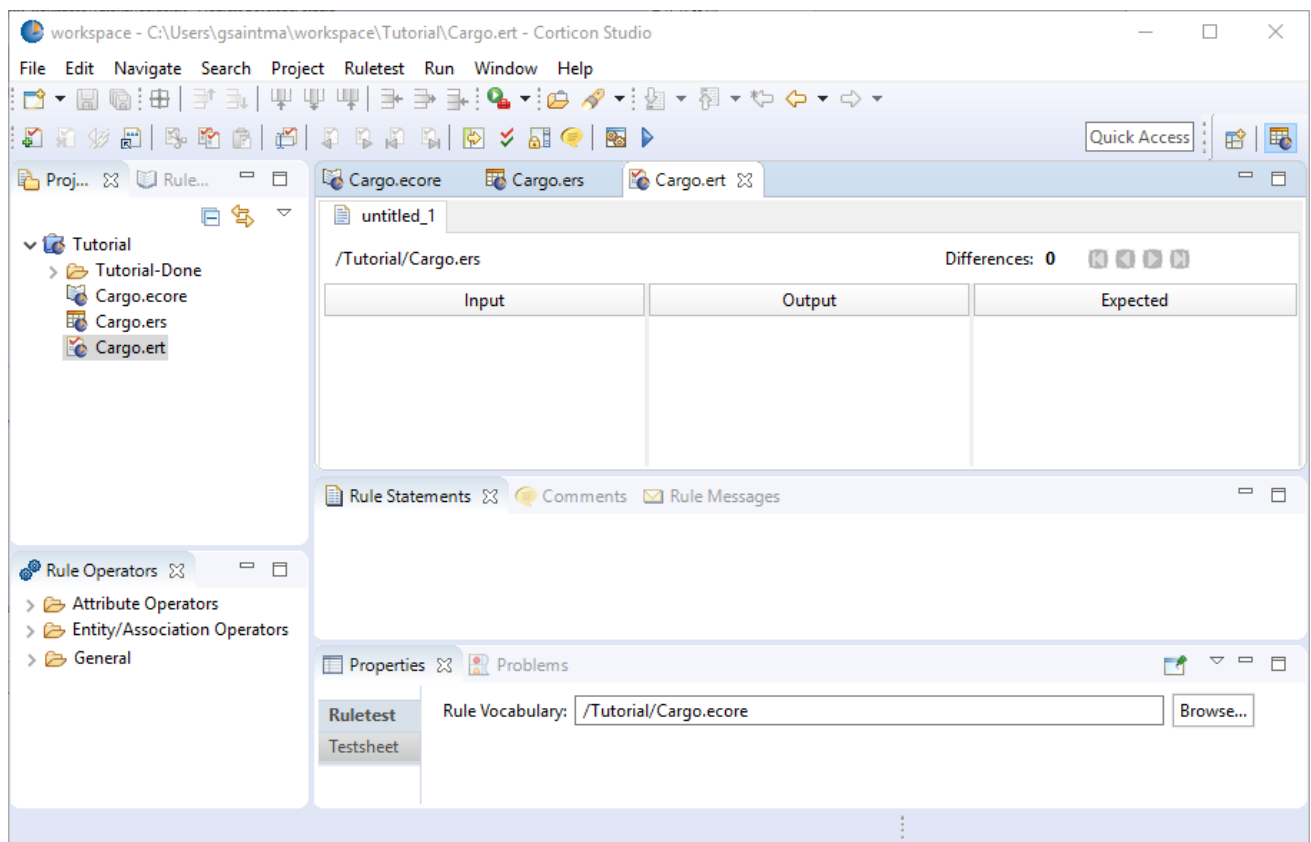
2. In the **Create New Ruletest** wizard, check that the parent folder is **Tutorial**, and then enter **Cargo** as the file name. Click **Next**.



3. Ensure that **Cargo.ers** is selected as the **Test Subject**, and then click **Finish**.



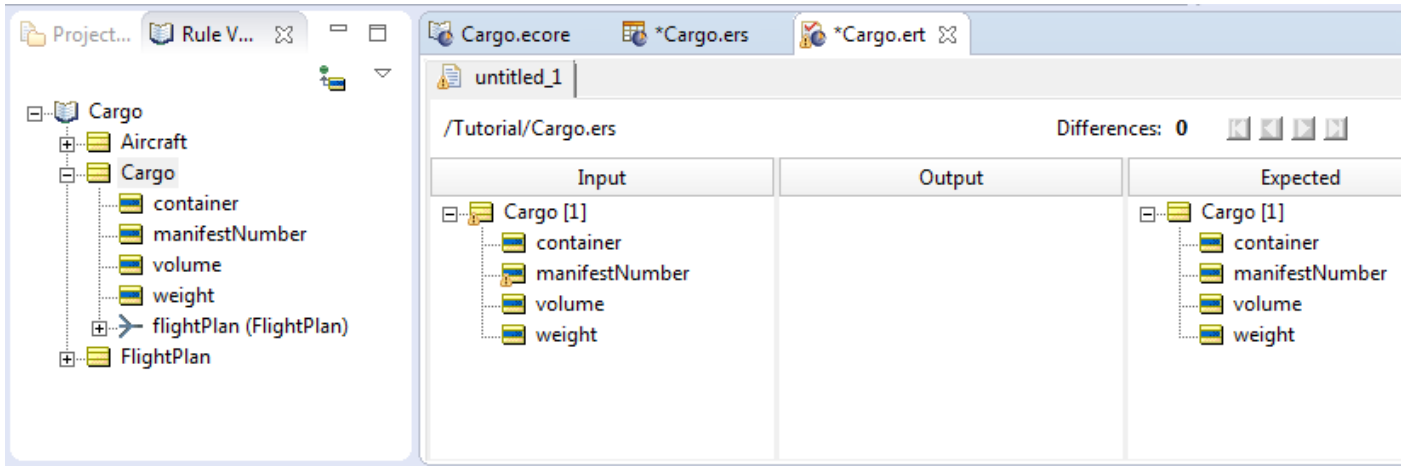
The Ruletest file opens in Corticon Studio on a new testsheet, **untitled_1**, as shown.



As you can see, your new Ruletest is associated with the appropriate Rulesheet, ensuring that your Ruletest scenario tests the right rules.

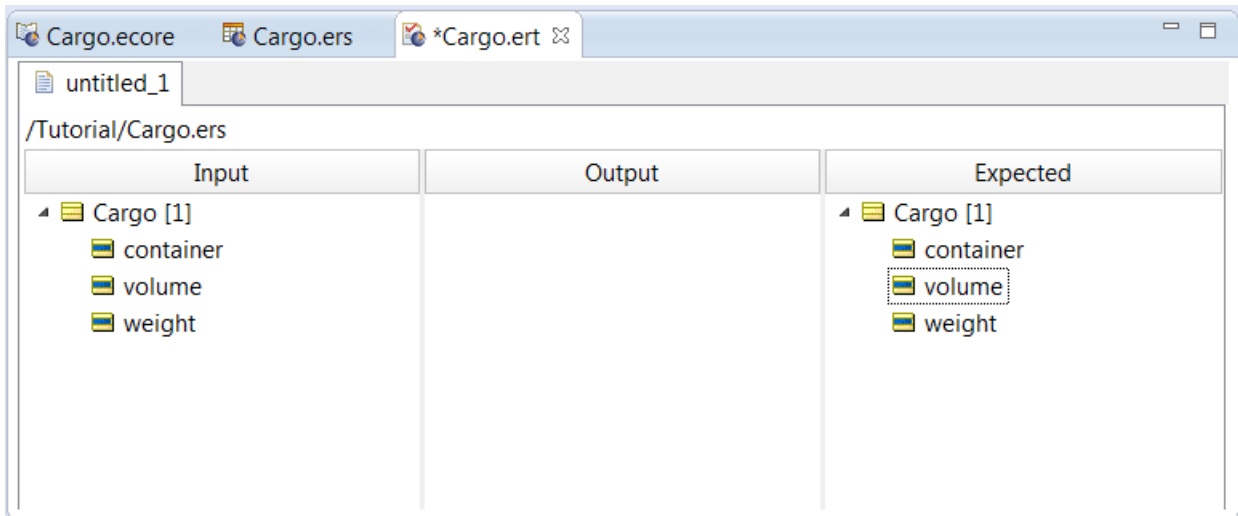
Set up test cases

1. Drag the **Cargo** entity from the Vocabulary and drop it anywhere in the **Input** and the **Expected** panes of the Ruletest.



Note: **Cargo [1]** on the **Input** and **Expected** panes represents a single instance or example of the Cargo entity. Changes you make to any Corticon Studio file causes an asterisk character to appear in the file's tab as a reminder to save the file.

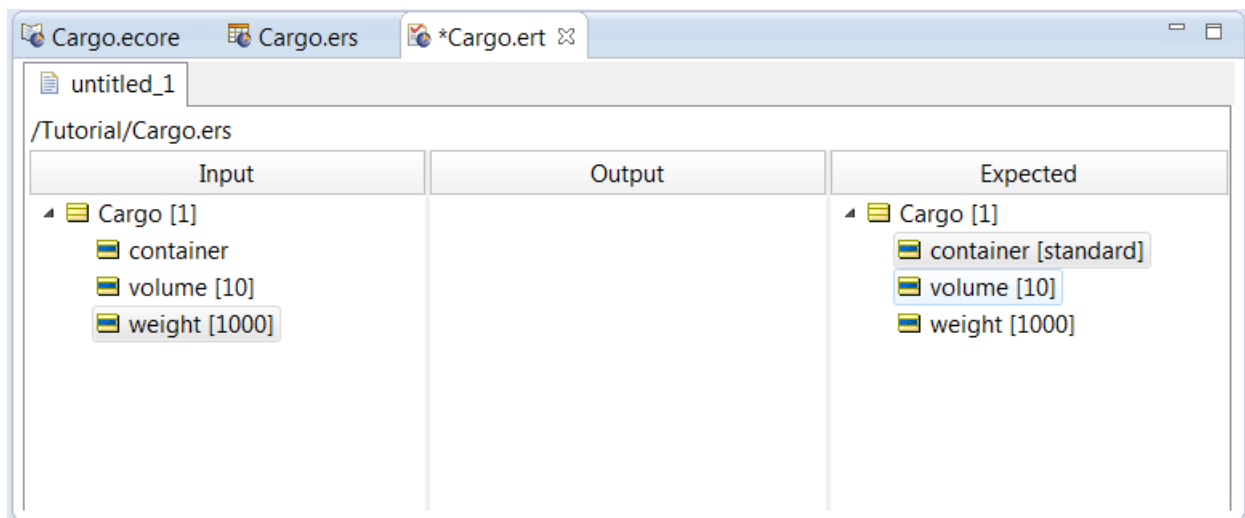
2. Remove unneeded attributes by selecting them and pressing the Delete key. In this case, remove **manifestNumber** from both **Input** and **Expected** as it is not needed to test these rules.



3. Add test data for Test Case 1 to the TestSheet, as in this table.

	Test Case 1	Test Case 2	Test Case 3
Input Values			
Cargo.weight	1000	1000	30000
Cargo.volume	10	40	20
Expected Results			
Cargo.container	standard	oversize	Heavyweight
Rule that should fire	Rule 1	Rule 2	Rule 3

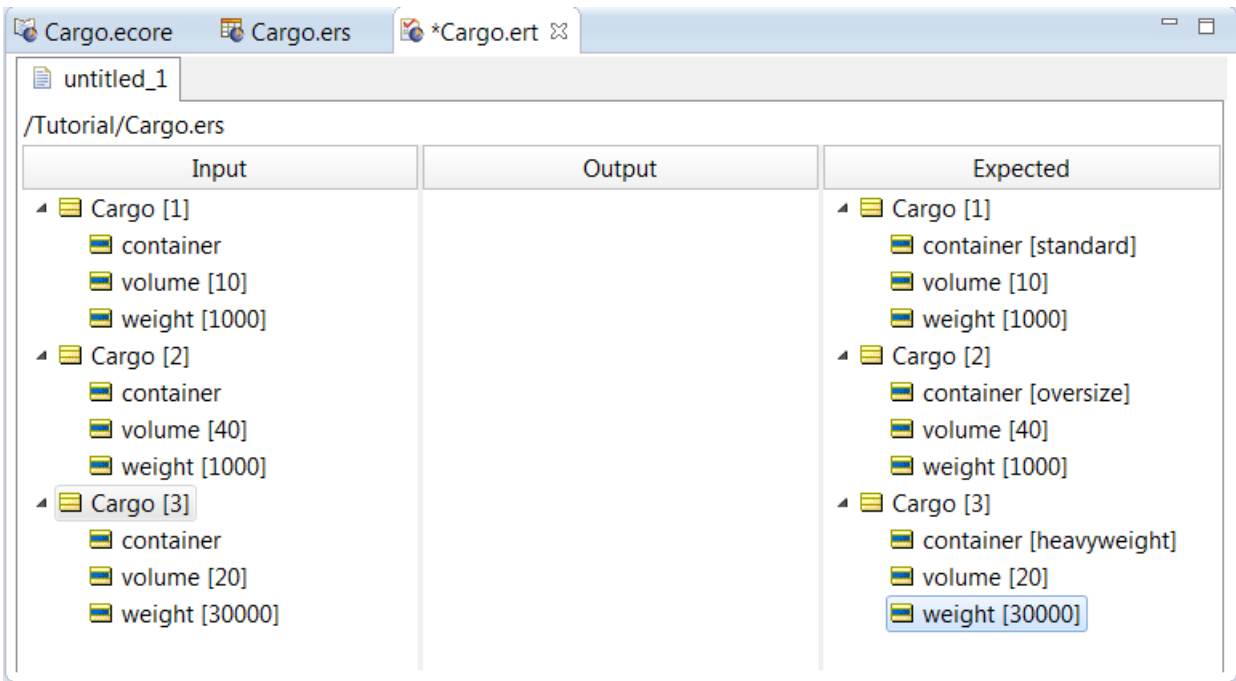
4. Double-click the terms weight and volume in the **Input** column to enter their values.
5. Do the same in the **Expected** column by entering the **container** value.



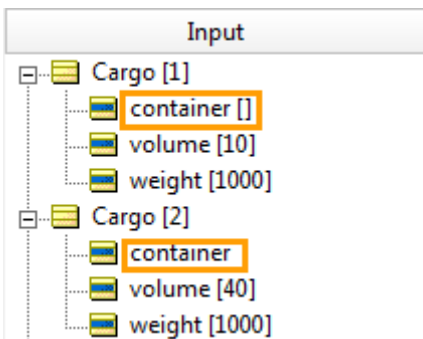
6. Enter the remaining test data based on the test cases in the table.

	Test Case 1	Test Case 2	Test Case 3
Input Values			
Cargo.weight	1000	1000	30000
Cargo.volume	10	40	20
Expected Results			
Cargo.container	standard	oversize	Heavyweight
Rule that should fire	Rule 1	Rule 2	Rule 3

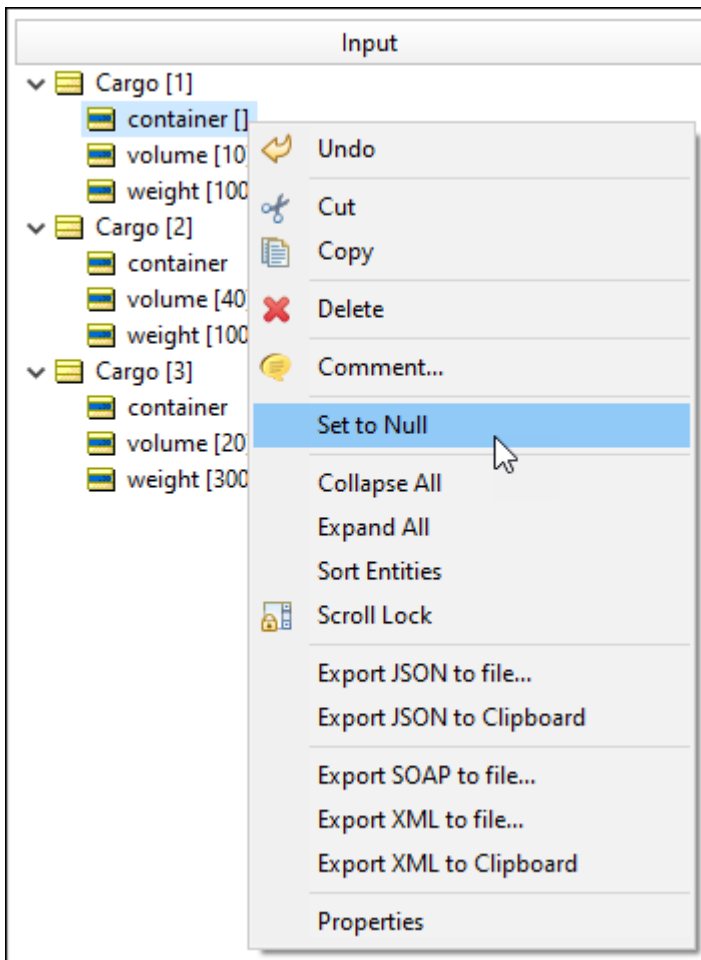
7. Duplicate the first test case by selecting Cargo [1], copying it, and then pasting it in the **Input** pane. Then, modify the input values based on the test cases. Repeat these steps for the **Expected** pane. Press **Tab** to advance through the entry boxes. Specify values for **container** in the **Expected** pane—you can select these values from the **container** drop-down list. Your Ruletest should now look like this:



The **Input** column expects all its **container** values to be null. If you click **container** and enter nothing, you still set a value, as illustrated for Cargo [1]:

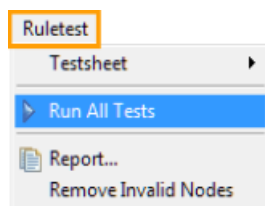


- To correct it, click **container []** and then right-click to choose **Set to Null**, as shown:



Run the Ruletest and verify the results

Run the Ruletest by selecting **Ruletest > Run All Tests**.



Running the Ruletest sends the data on the **Input** pane to the rules engine. The rules engine fires the appropriate rules and displays the results in the **Output** pane. The first time rules are executed, they are automatically compiled from the rule model into an optimized executable form, then deployed into the engine, which may take a few seconds. Once deployed, the rules execute much faster on subsequent tests.

Check the outcome of your test in the TestSheet's **Output** pane.

The screenshot displays the Corticon Studio interface for testing rule execution. The top pane, titled 'untitled_1', shows the rule execution results for the file 'Cargo.ers'. It is divided into three columns: 'Input', 'Output', and 'Expected'. Each column contains a tree view of cargo entities and their attributes.

Input	Output	Expected
<ul style="list-style-type: none"> Cargo [1] <ul style="list-style-type: none"> container volume [10] weight [1000] Cargo [2] <ul style="list-style-type: none"> container volume [40] weight [1000] Cargo [3] <ul style="list-style-type: none"> container volume [20] weight [30000] 	<ul style="list-style-type: none"> Cargo [1] <ul style="list-style-type: none"> container [standard] volume [10] weight [1000] Cargo [2] <ul style="list-style-type: none"> container [oversize] volume [40] weight [1000] Cargo [3] <ul style="list-style-type: none"> container [heavyweight] volume [20] weight [30000] 	<ul style="list-style-type: none"> Cargo [1] <ul style="list-style-type: none"> container [standard] volume [10] weight [1000] Cargo [2] <ul style="list-style-type: none"> container [oversize] volume [40] weight [1000] Cargo [3] <ul style="list-style-type: none"> container [heavyweight] volume [20] weight [30000]

The bottom pane, titled 'Rule Messages', shows a table of messages generated during rule execution:

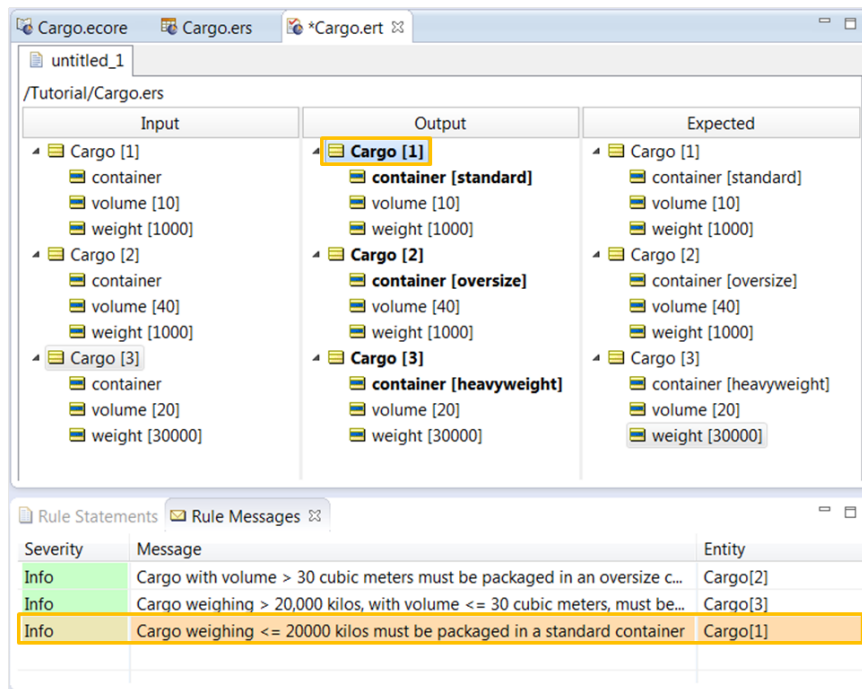
Severity	Message	Entity
Info	Cargo with volume > 30 cubic meters must be packaged in an oversize c...	Cargo[2]
Info	Cargo weighing > 20,000 kilos, with volume <= 30 cubic meters, must be...	Cargo[3]
Info	Cargo weighing <= 20000 kilos must be packaged in a standard container	Cargo[1]

Any attributes altered by the rules, including the entities to which they belong, are shown in **bold** text in the **Output** pane. Any unchanged attributes and values are displayed in normal style.

Messages contain the text of the **Rule Statements** and are shown in the **Rule Messages** pane. They are produced using the **Post** command in your **Rule Statements**. **Severity** indicates whether a message contains information, warnings, or violations. **Message** contains the text of the Rule Statement. **Entity** shows the entity to which this message is posted.

When you select the **Cargo[1]** entity within the **Output** pane, the first rule message is highlighted, showing the audit trail of rules that fired for that entity (in this case only one rule fired for **Cargo[1]**).

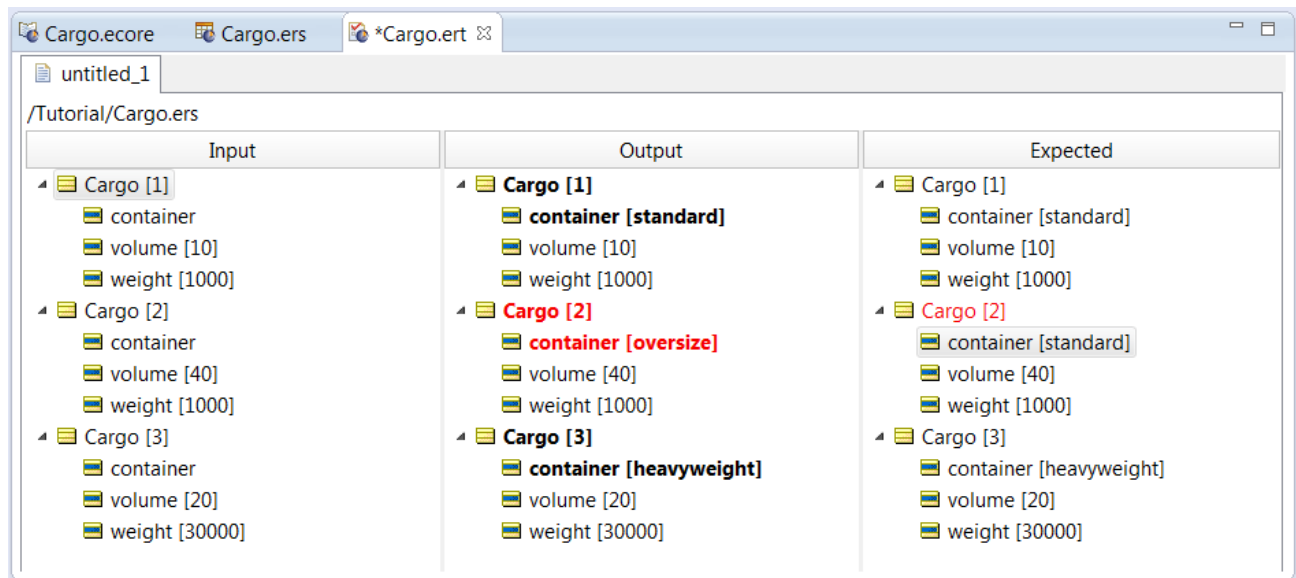
Use the Expected pane



So far, the actual results in the **Output** pane match the expected results in the **Expected** pane. To see what happens when the output does not match expected results, change one of the test cases. In the **Expected** pane, change the container value in **Cargo[2]** to **standard**.

Run the test again.

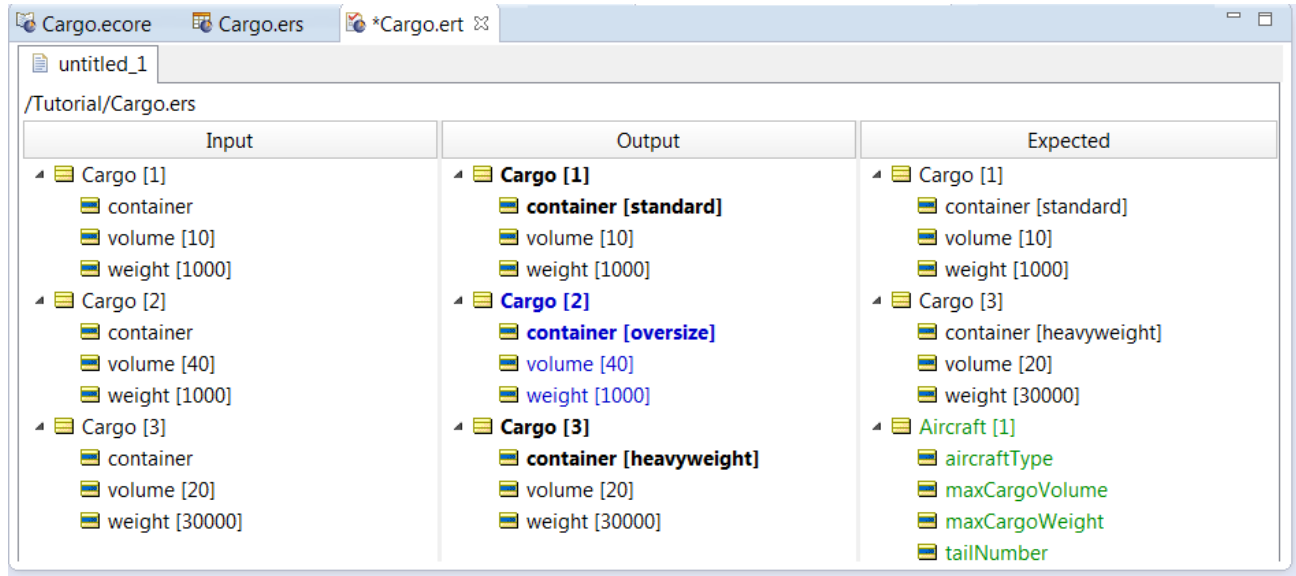
Your Ruletest should now look like this:



Here you see that **Cargo[2]** and the container attribute are highlighted red in both the **Output** and **Expected** panes, indicating that the output results differ from our expected results.

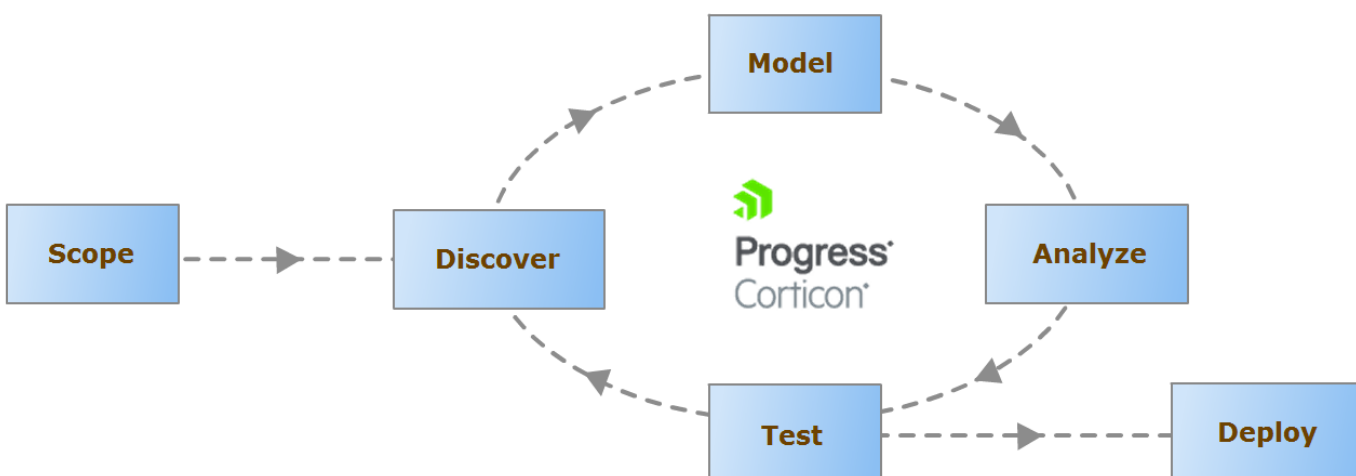
Remember to change the container value of **Cargo[2]** in the **Expected** pane back to **oversize** and save the test for future use by selecting **File > Save**.

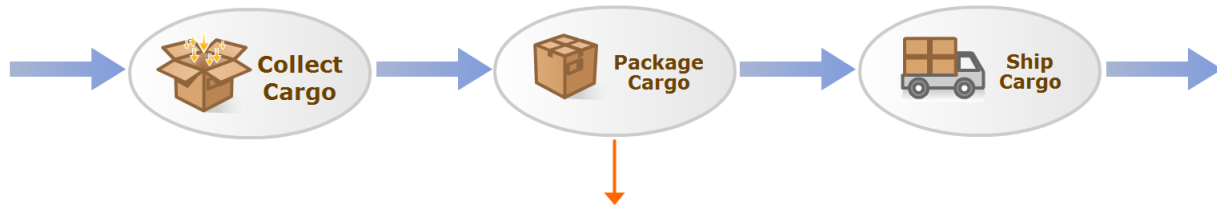
Note: Corticon Studio highlights other types of differences also. For example, unexpected entities in the **Output** pane are highlighted in blue, while missing entities are highlighted in green in the **Expected** pane, as shown in the following example:



Iterate through the lifecycle again

Rule modeling is an iterative process. As your business needs change, you may need to make changes to your rules. See how easy it is in Corticon Studio by adding, analyzing, and testing a new rule in the Rulesheet.





Initial Rules:

- Cargo weighing $\leq 20,000$ kilos must be packaged in a standard container
- Cargo with volume > 30 cubic meters must be packaged in an oversize container

Added after Completeness Check:

- Cargo weighing $> 20,000$ kilos, with volume ≤ 30 cubic meters, must be packaged in a heavyweight container

New Rule (to add now):

- Cargo requiring refrigeration must be packaged in a reefer container

Begin by adding a rule statement for the new rule.

Add a new rule statement

1. Switch back to your Rulesheet by clicking the **Cargo.ers** tab. If you closed it earlier, reopen it by double-clicking the file inside the **Rule Project Explorer** pane.

Conditions	0	1	2	3	4	5
a Cargo.weight		≤ 20000	-	$\{> 20000, null\}$		
b Cargo.volume		-	> 30	$\{\leq 30, null\}$		
c						
d						
e						
f						
g						
h						

Actions	0	1	2	3	4	5
Post Message(s)		✉	✉	✉		
A Cargo.container		standard	oversize	heavyweight		
B						
C						
D						
E						
F						
G						
Overrides			1			

Ref	ID	Post	Alias	Text
1		Info	Cargo	Cargo weighing ≤ 20000 kilos must be packaged in a standard container
2		Info	Cargo	Cargo with volume > 30 cubic meters must be packaged in an oversize container
3		Info	Cargo	Cargo weighing $> 20,000$ kilos, with volume ≤ 30 cubic meters, must be packaged in a heavyweight container

2. Enter the new Rule Statement—**Cargo requiring refrigeration must be packaged in a reefer container**. It acts as a guide while modeling the new rule.

Ref	ID	Post	Alias	Text	Rule
1		Info	Cargo	Cargo weighing <= 20000 kilos must be packaged in a standard container	
2		Info	Cargo	Cargo with volume > 30 cubic meters must be packaged in an oversize container	
3		Info	Cargo	Cargo weighing > 20,000 kilos, with volume <= 30 cubic meters, must be packaged in a ...	
				Cargo requiring refrigeration must be packaged in a reefer container	

3. To model this rule, edit the Vocabulary by:

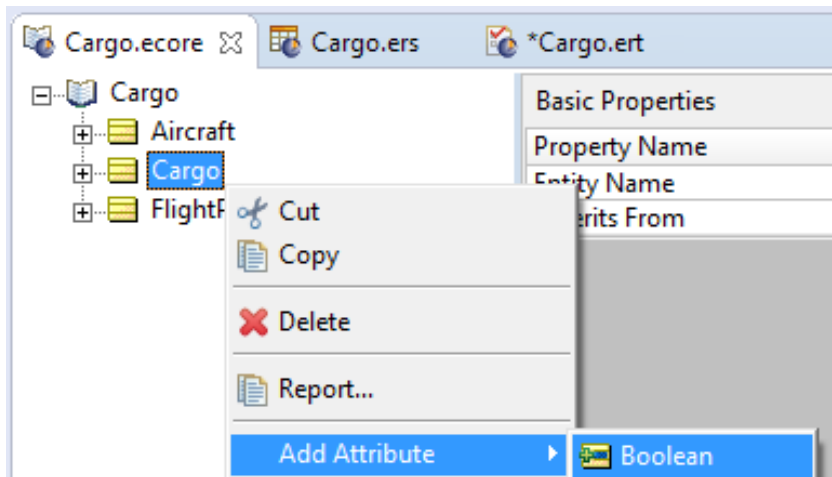
- a. Adding a new attribute to the **Cargo** entity to define whether the cargo requires refrigeration or not (let's call this **needsRefrigeration**).
- b. Adding **reefer** as another possible selection option for the container attribute.

Open and edit the Vocabulary

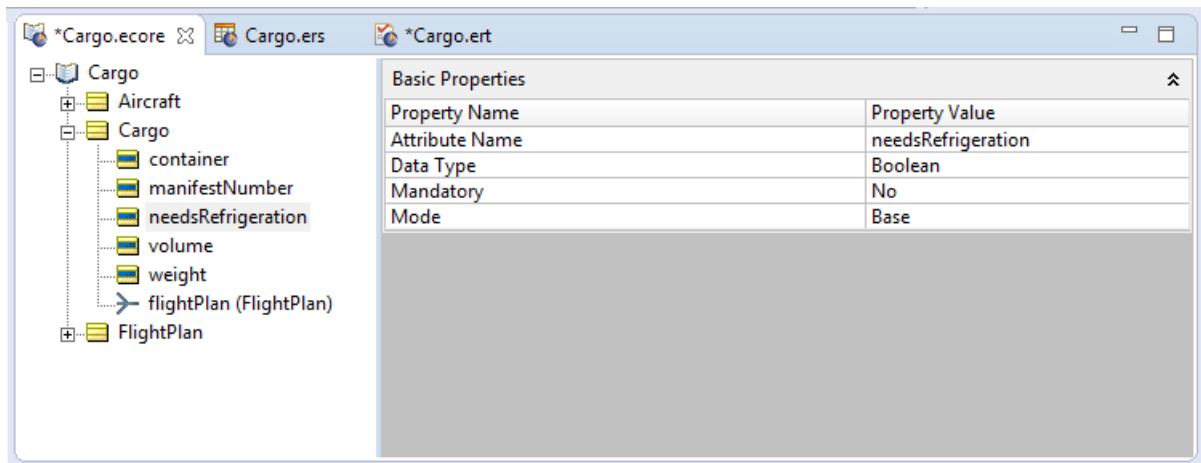
1. Open the Vocabulary tab, **Cargo.ecore**. If you closed it, open it again by selecting **Cargo.ecore** from the **Recent File** list at the bottom of the **File** menu or double-click the file in the **Rule Project Explorer** pane. The Vocabulary opens in the Vocabulary editor.

2. Add a Boolean attribute named **needsRefrigeration**:

- a. In the Vocabulary editor, right-click **Cargo** and choose **Add Attribute** and then **Boolean** from the submenu:

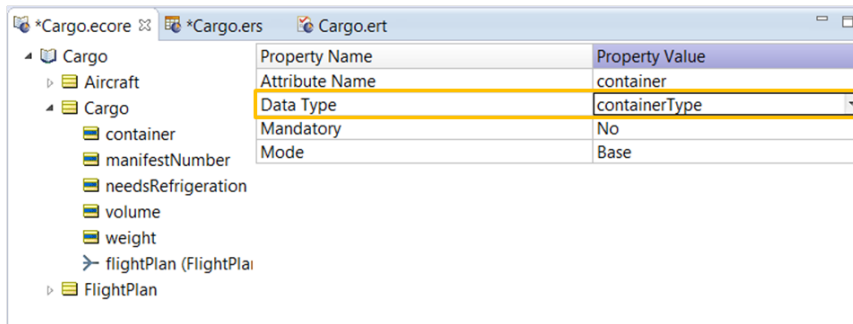


- b. Define the attribute name by double-clicking the default attribute name value (**Attribute_1**) and changing it to **needsRefrigeration**.

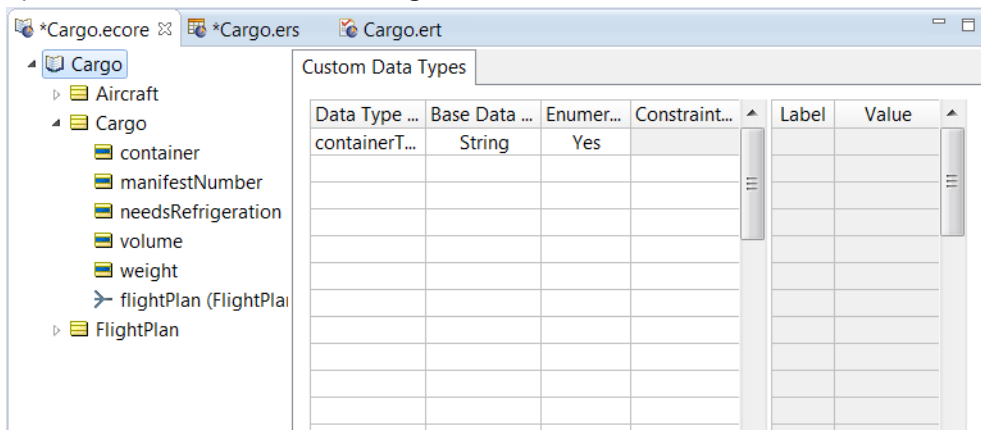


3. Add **reefer** as another allowable type of container:

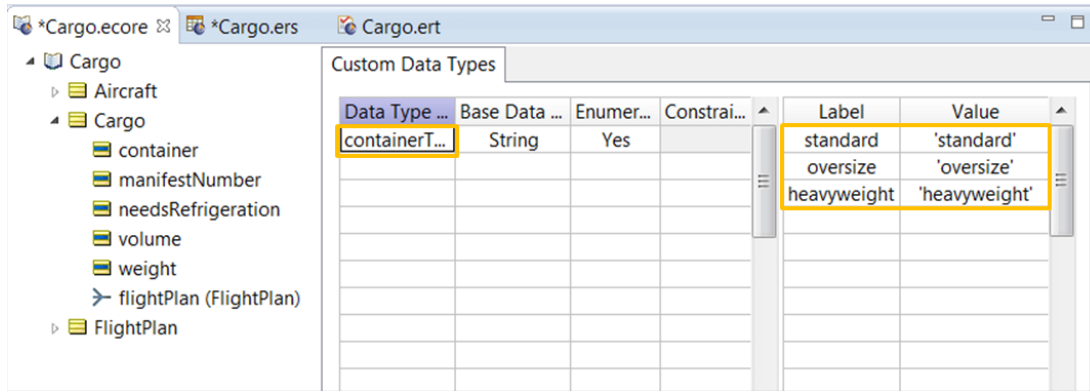
- a. Select the container attribute and note the Data Type: containerType. This custom data type defines a set of allowable values for container (an enumerated set).



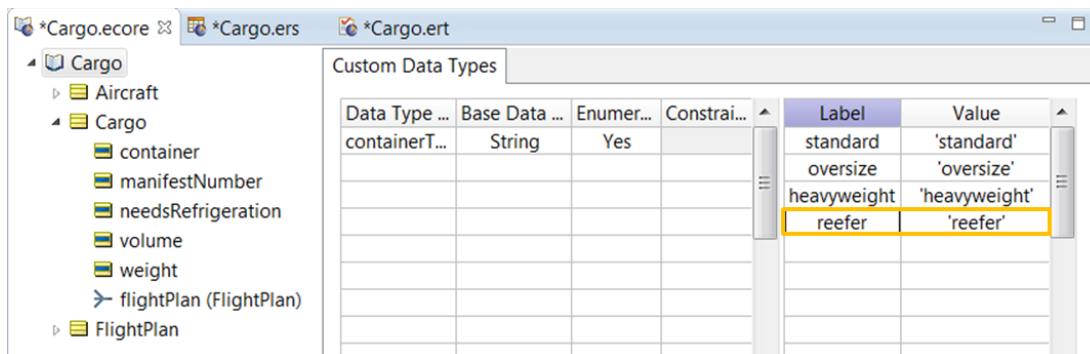
- b. To define custom data types, you must first click on the root node of the Vocabulary, denoted by the open book icon—in this case, **Cargo**.



- c. Click the **containerType** entry.



d. Add **reefer** as both a **Label** and a **Value**.



4. Save the Vocabulary by selecting **File > Save** and close the **Vocabulary Editor** pane.

Custom data types are a powerful capability, which help you define a Vocabulary that matches how you think about your business.

Model the new rule

Now that the Vocabulary contains the new terms required by the new rule, you can model the new rule—**Cargo requiring refrigeration must be packaged in a reefer container**. After completion, your Rulesheet should look like this:

Conditions	0	1	2	3	4	5
a Cargo.weight		<= 20000	-	{> 20000, null}	-	
b Cargo.volume		-	> 30	{<= 30, null}	-	
c Cargo.needsRefrigeration		-	-	-	T	
d						
e						
f						
g						
h						

Actions	0	1	2	3	4	5
Post Message(s)						
A Cargo.container		standard	oversize	heavyweight	reefer	
B						
C						
D						
E						
F						
G						
Overrides			1			

Be sure to define the Reference link from the Rule Statement to column 4 and add **Post** and **Alias** as shown here.

Conditions	0	1	2	3	4	5
a Cargo.weight		<= 20000	-	{> 20000, null}	-	
b Cargo.volume		-	> 30	{<= 30, null}	-	
c Cargo.needsRefrigeration		-	-	-	T	
d						
e						
f						
g						
h						

Actions	0	1	2	3	4	5
Post Message(s)						
A Cargo.container		standard	oversize	heavyweight	reefer	
B						
C						
D						
E						
F						
G						
Overrides			1			

Ref	ID	Post	Alias	Text
1		Info	Cargo	Cargo weighing <= 20000 kilos must be packaged in a standard container
2		Info	Cargo	Cargo with volume > 30 cubic meters must be packaged in an oversize container
3		Info	Cargo	Cargo weighing > 20,000 kilos, with volume <= 30 cubic meters, must be packaged in
4		Info	Cargo	Cargo requiring refrigeration must be packaged in a reefer container

Analyze the new rule

Whenever you add or change rules, re-analyze them.

1. Start by checking for conflicts. You can either select **Rulesheet > Logical Analysis > Check for Conflicts** or click the **Check for Conflicts** button .

As you can see, adding the new rule has caused three new conflicts, one with each of our three existing rules.

Conditions	0	1	2	3
a Cargo.weight		<= 20000	-	{> 20000, null}
b Cargo.volume		-	> 30	{<= 30, null}
c Cargo.needsRefrigeration		-	-	-
d				
e				
f				

Actions	0	1	2	3
Post Message(s)		✉	✉	✉
A Cargo.container		standard	oversize	heavyweight
B				
C				
D				
E				

Ref	ID	Info	Cargo	Rule Statement
1				
2				
3		Info	Cargo	Cargo weighing >20000 kilos with volume <=30 must be packaged in a heavy
4		Info	Cargo	Cargo requiring refrigeration must be packaged in a reefer container

- Step through multiple conflicts, and filter the Rulesheet to view only the conflicting rules, using the buttons to the right of the **Conflict Check** button.



Rules 1, 2, and 3 each define a specific container type for cargo based on weight and volume, while Rule 4 defines the container type based on whether the cargo needs refrigeration. The conflict occurs because a cargo load that requires refrigeration may also trigger Rules 1, 2, or 3.

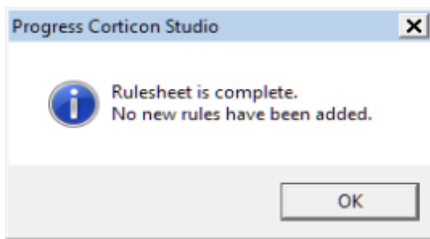
- Assume that reefer containers are only available for standard and heavyweight loads, but not for oversize loads. So, set Rule 4 to override rules 1 and 3, and set Rule 2 to override Rules 1 and 4.

Note: Remember, you can select multiple values in the override cell by pressing and holding the **CTRL** key.

After you have made these changes, your Rulesheet looks like this:

		0	1	2	3	4
Conditions						
a	Cargo.weight		<= 20000	-	{> 20000, null}	-
b	Cargo.volume		-	> 30	{<= 30, null}	-
c	Cargo.needsRefrigeration		-	-	-	T
d						
e						
f						
g						
h						
Actions						
Post Message(s)						
A	Cargo.container		standard	oversize	heavyweight	reefer
B						
C						
D						
E						
F						
G						
Overrides				{1, 4}		{1, 3}

4. Check for completeness by selecting **Rulesheet > Logical Analysis > Check for Completeness**.

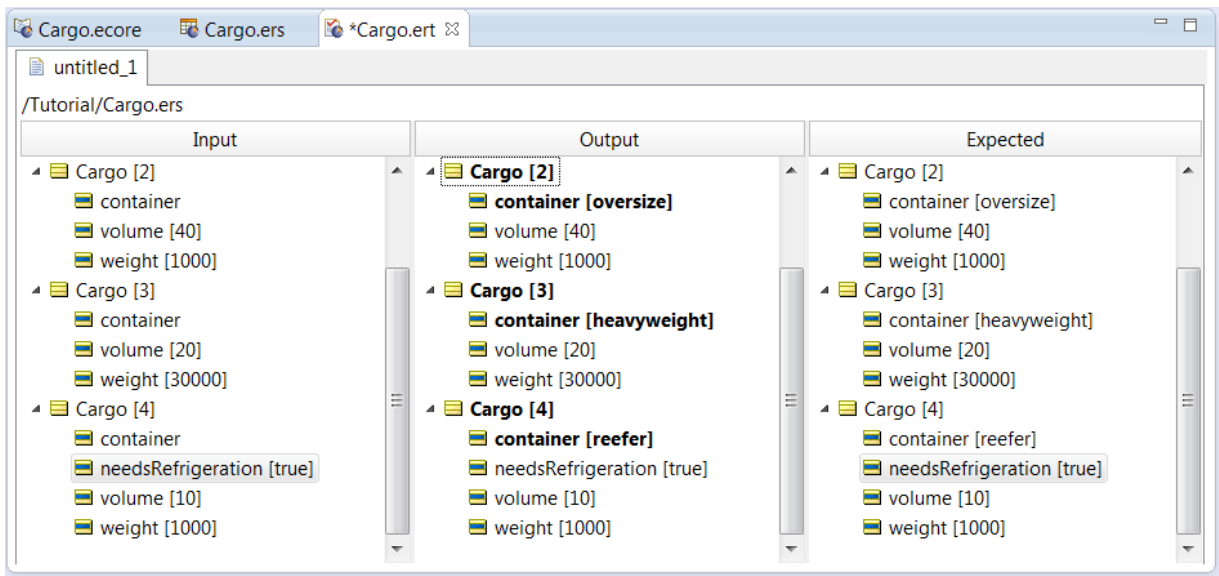


After the Rulesheet is complete, click **OK** in the dialog box and save the Rulesheet file.

Run the Ruletest again

The last step is to modify your test case to test the new rule.

1. Open **Cargo.ert**.
2. Copy and paste **Cargo[1]** to create **Cargo[4]**, in both the Input and Expected panes.
3. Drag and drop the **needsRefrigeration** attribute from your Vocabulary onto both **Cargo[4]** entities.
4. In both panes, set the value of **needsRefrigeration** to **true**.
5. In the **Expected** pane, change the value of container in **Cargo[4]** to **reefer**.
6. Run the test. Your Ruletest should now look like this:



As you can see, the actual results match the expected results.

Congratulations! You have now completed two full iterations of the Corticon decision service development lifecycle and understood the basic concepts of rule modeling, analysis, and testing in Corticon Studio.

To learn more rule modeling techniques, take the *Advanced Rule Modeling Tutorial*.

