

IBM ILOG CPLEX Optimization Studio SPSS Connector in CPLEX Studio

Version 12 Release 6

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SPSS Connector in CPLEX Studio

The SPSS Connector connects IBM SPSS Modeler to IBM ILOG CPLEX Studio and enables you to read data from an SPSS stream into an OPL tuple set. The SPSS Connector is available on Windows 32-bit and 64-bit platforms.

Chapter 1. Prerequisites for using this tutorial

It is assumed that SPSS Modeler is installed and you know how to use it.

- IBM SPSS Modeler must be installed on the same machine as the CPLEX Studio IDE. You can download it from: http://www-01.ibm.com/software/analytics/spss/downloads/.
- You must have a license for SPSS Modeler. A trial license is included with the installation and lasts for 90 days. The license can be renewed at: https://spss.subscribenet.com/control/ibmp/RegisterToAccount.
- This tutorial assumes you have a working knowledge of SPSS Modeler.

A video of the SPSS Modeler overview can be obtained from: http://www-01.ibm.com/software/analytics/spss/downloads/videos.html. A demo and a tutorial on SPSS Modeler can be obtained from: http://www-01.ibm.com/software/analytics/spss/downloads/demos.html.

Chapter 2. Preparatory steps

Before you can work with an SPSS stream in CPLEX Studio, you need to take some preparatory steps.

- "Enabling SPSS Modeler" in CPLEX Studio
- "Setting the SPSS Modeler environment variable" on page 4
- "Importing an SPSS data stream into the IDE" on page 4
- "Adapting the SPSS stream for CPLEX Studio" on page 5

Enabling SPSS Modeler

- 1. Launch the CPLEX Studio IDE.
- 2. Ensure that the IDE preferences indicate the installation path for SPSS Modeler. Click **Window** > **Preferences** and select **SPSS**.

Preferences			
type filter text	SPSS		• → • •
⊡- General ⊡- Help	SPSS general preferences page		
E OPL E Run/Debug SPSS E Team	SPSS Installation Directory C: \Program File	:s ψBM \SPSS \Modeler \14	<u>B</u> rowse
		Restore <u>D</u> efaults	Apply
?		ОК	Cancel

3. You should see SPSS in the Import list.

New Import Copy Files to Proje	:	 Z Z 3% · O · i Example, Existing OPL projects
Open File in Editor.		SPSS Import
Close Close All	Ctrl+W Ctrl+Shift+W	Higrate OPL 5.x projects
Save Save As	Ctrl+S	
Save All	Ctrl+Shift+S	
Print	Ctrl+P	
Export		

Setting the SPSS Modeler environment variable

The OPL run time software needs to find a valid SPSS installation. Set the environment variable to refer to your SPSS Modeler installation. For example, on Windows:

Start > Control Panel > System > Advanced > Environment Variables > New

Variable name: CLE0_DEMOS

Variable value: C:\Program Files\IBM\SPSS\Modeler\14\Demos

If SPSS Modeler is not installed in the default folder (C:\Program Files\IBM\SPSS\Modeler\14), you need to define the environment variable OPL_SPSS_HOME with the alternative installation path as its value.

If this environment variable is absent, OPL will search in the default SPSS installation location.

You are advised to restart the IDE after setting the environment variable, to avoid problems when running the optimization model later in this tutorial.

Importing an SPSS data stream into the IDE

The example stream we use in this tutorial is pm_selflearn.str, and can be found in the Demos directory of your SPSS Modeler installation. For example:

C:\Program Files\IBM\SPSS\Modeler\14\Demos\streams\pm_selflearn.str

1. Create a new, empty OPL project in the IDE (File > New > OPL Project) and name it spss_example.

Check the box **Add a default Run Configuration**. You will need a default run configuration later in this tutorial.

2. Right-click spss_example and import the SPSS stream pm_selflearn.str.

🛉 SPSS Im	port Wizard		
General			
Import an S	PSS stream from the local file system into the workspace		
Select File:	C:\Program Files\IBM\SPSS\Modeler\14\Demos\streams\pm_selfe	earn.str	Browse
Enter or sele	ect the parent folder:		
spss_exam	ple		
sp:	ss_example		
New File Nar	me: pm_selflearn.str		
?		<u>F</u> inish	Cancel

Adapting the SPSS stream for CPLEX Studio

OPL cannot process SPSS terminal nodes; it processes only operation nodes such as Filter. You must, therefore, modify SPSS streams so that OPL can use them.

In the IDE, right-click the stream pm_selflearn.str and select Open With > SPSS Modeler.

IBM ILOG CPLEX Opt	imization Studio		
ile Edit Navigate Sei	arch Run Window Help		
📬 • 🖪 🖷 📤 -	🖇 🖓 📑 💼 💼 📔 z 🛛 z] 🏇 • 🔾 • 💽 • 💁 • 💷 🖷] 🛷 •]	*
🖥 OPL Projects 🛛 🕄	🎋 Debug	🖻 🔩 🎙	
🗉 🔑 spss_example			
Run Configur	ations		
pm_selflearn.	str		
		<u></u>	
	Open		
	Open With	SPSS Modeler	
	Сору	Ctrl+C SPSS Stream Editor	N.
	👔 Paste	Ctrl+V Text Editor	
	💢 Delete	Delete System Editor	
	Rename	F2 In-Place Editor	
	Import	Default Editor	
	Export	Other	
	🐑 Refresh	F5	
	Run SPSS stream and display	/ table results	
	Run SPSS stream and gener	ate OPL files	
	Team	*	
	Compare With	•	
	Replace With		
	Properties	Alt+Enter	

SPSS Modeler opens with the stream pm_selflearn.str in the editor.

2. If you run the SPSS stream as it is (run pm_customer_train3.sav), it will display a very big result table containing all possible fields. In order to display only the fields of interest for this example, you need to insert an operation node, such as a Filter node, between the campaign node and the result table, and edit the Filter.

Drag the Filter node from the Field Ops tab into the editor.

3. Insert the **Filter** node between the **Campaign** node and the terminal node, **Table**. (Select **Campaign** and connect to **Filter**. Select **Filter** and connect to **Table**.)

The stream now looks like this in the editor.

pm_selflearn* - IBM® SPSS® Modeler	-OX
De Ear lizeu Āem Toos Zabeucos ⊼unom Teb	
Unmap pm_customer_train1.s. Filler Type Reclassify campaign	Streams
om customer tran2 s.	en e
pm_customer_train3.s	CRISP-DM
Filter	
Severates Sources Record Ops Field Ops Graphs Modeling Output Export OBMS SPSS® Statistics	
Auto Data Prep Type Filter Derive Ensemble Filler Anonymize Reclassify Binning RFM Analysis Partition SetToFlag Restructure	Transpose Tim
Server: Local Server	274MB / 386MB

- 4. To edit the **Filter** node, right-click the node and select **Edit**, or double-click the node.
- Click the Filter options icon to display the list of options and select Remove All Fields.

filtered, 0 renamed, 35
eld
J#index

Then click a red cross to select each field you want. For this example, you need the five fields:

customer_id, \$S-campaign-1, \$SC-campaign-1, \$S-campaign-2, \$SC-campaign-2.

6. Here we see the last four fields, at the bottom of the table, selected.

		0 -	
Filter Annotations			
7-) 📮 🗰		Fields: 35 in, 30 filtered, 0 renamed	d, 5 o
Field	Filter	Field	
number_products	- X >	number_products	
number_transactions	-X >	number_transactions	
non_worker_percentage	- X >	non_worker_percentage	
white_collar_percentage	— × →	white_collar_percentage	
rfm_score	— × →	rfm_score	
X_random	— × →	X_random	
\$S-campaign-1	\rightarrow	\$S-campaign-1	
SSC-campaign-1	\rightarrow	SSC-campaign-1	
\$S-campaign-2	\rightarrow	\$S-campaign-2	
0.00	\rightarrow	\$SC-campaign-2	

Click **Apply**, then **OK** to close the Filter node.

7. Run the stream in SPSS Modeler to check that the results table contains only the five required fields.

Right-click pm_customer_train3.sav and select **Run From Here**. The table should look like this:

Die File	Edit 😤) <u>G</u> enerate	8 8 4 8		0
Table	Annotations				
	customer_id	\$S-campaign-1	\$SC-campaign-1	\$S-campaign-2	\$SC-campaign-2
1	139987	Pension	0.132	Mortgage	0.107
2	140030	Savings	0.957	Pension	0.844
3	140089	Savings	0.957	Pension	0.802
4	140097	Pension	0.132	Mortgage	0.107
5	139068	Pension	0.805	Savings	0.284
6	139154	Pension	0.132	Mortgage	0.107
7	139158	Pension	0.132	Mortgage	0.107
8	139169	Pension	0.132	Mortgage	0.107
9	139220	Pension	0.132	Mortgage	0.107
10	139261	Pension	0.132	Mortgage	0.107
11	139416	Pension	0.132	Mortgage	0.107
12	139422	Pension	0.132	Mortgage	0.107
13	139532	Savings	0.957	Mortgage	0.823
14	139549	Savings	0.164	Pension	0.132
15	139560	Savings	0.957	Pension	0.868
16	139577	Pension	0.132	Mortgage	0.107

8. Save the stream and exit SPSS Modeler.

Note:

You cannot modify streams in OPL, so any changes to streams must be made with SPSS Modeler.

Chapter 3. Running an SPSS stream in the IDE

After preparing the environment and adapting the stream, you can run an SPSS data stream in CPLEX Studio.

 In the IDE, right-click on the stream pm_selflearn.str and select Open With > SPSS Stream Editor to display the nodes of the stream.



Note: If several nodes have the same name, the names of those nodes are displayed in red.

When the SPSS Stream Editor is open, three zoom buttons become available:



Zoom Fit, Zoom Out, Zoom In.

- **2**. The following run commands are available in the SPSS Stream Editor when you right-click on a node:
 - SPSS Run and display results as tables
 - SPSS Run and generate OPL files

To avoid a warning message in the IDE, you need to have a default configuration in the IDE before executing the command. Earlier in this tutorial we created Configuration1 as the default configuration.

3. Select the **Table** node and click **SPSS Run and display results as tables for Table** to display a snapshot of the results table in the IDE. This is the results table that was modified in SPSS Modeler.

ne gut wavgate segrif gun grindwigep P • □ • □ • □ • • • • • • • • • • • • •							_
	Row	customer_id	\$S-campaign-1	\$SC-campaign-1	\$S-campaign-2	\$SC-campaign-2	
	1	139987	Pension	0.13220734169634984	Mortgage	0.10656436487638533	-
E Bun Configurations	2	140030	Savings	0.9567846589847688	Pension	0.844458503770094	
	3	140089	Savings	0.9567843456335158	Pension	0.8023269869514575	
m selflearn str	4	140097	Pension	0.13221308682551575	Mortgage	0.10656436487697411	
ph_sencentise	5	139068	Pension	0.805058681043989	Savings	0.2839102232834573	
	6	139154	Pension	0.1322059310432454	Mortgage	0.10656436487638533	1
	7	139158	Pension	0.132205435281992	Mortgage	0.10656436487660943	
	8	139169	Pension	0.13221285060965077	Mortgage	0.1065643648877725	
	9	139220	Pension	0.13220518281448504	Mortgage	0.10656436487641001	
	10	139261	Pension	0.13220518275337192	Mortgage	0.10656436487810525	
	11	139416	Pension	0.13220545963687952	Mortgage	0.10656436487657174	Ĩ

4. Select the Table node and click SPSS Run and generate OPL files for Table.

This command copies a snapshot of the results table into an OPL .dat file and creates a skeleton of the optimization model. This allows you to work with data from SPSS Modeler in OPL format. A run configuration that uses the two newly-generated files is created automatically.

OPL data file

The new data file created, pm_selflearn.str.dat, contains the output of the table in OPL format.

PPL & Debu PD] pm_selflearn.str.dat 🛛	, D
⊟ 🔄 🎽	11 Table = {<139987 "Pension" 0.13221 "Mortgage" 0.10656> <	•
🗆 🔛 spss_example	12 "Pension" 0.84446> <140089 "Savings" 0.9567	
🗄 💯 Run Configurations	13 <140097 "Pension" 0.13221 "Mortgage" 0.1065	
Configuration 1 (default	14 0.80506 "Savings" 0.28391> <139154 "Pensior	
pm_selflearn.str	15 0.10656> <139158 "Pension" 0.13221 "Mortgag	
pm_selflearn.str.mod : CPL	16 "Pension" 0.13221 "Mortgage" 0.10656> <1392	
pm selflearn.str.dat	17 "Mortgage" 0.10656> <139261 "Pension" 0.132	
pm selflearn.str	18 <139416 "Pension" 0.13221 "Mortgage" 0.1065	
pm selflearn.str-	19 0.13221 "Mortgage" 0.10656> <139532 "Saving"	_
	20 0.81622> <139549 "Savings" 0.16428 "Pensior	
	21 "Savings" 0.95678 "Pension" 0.86779> <13957	
	22 "Mortgage" 0.10656> <139580 "Pension" 0.132	-1
•		

OPL model file

The new model file created, pm_selflearn.str.mod, contains the definition of the table using tuple schemas.

As OPL cannot process the characters \$, &, #, %, -, ., or an empty string, it automatically replaces them with an underscore (_). So, for example, \$S-campaign-1 is renamed _S_campaign_1.



With the SPSS Connector, you can create and modify an optimization model in the IDE, and manipulate data from an SPSS stream, without repeatedly launching the stream in SPSS Modeler.

For example, if the SPSS analyst is not the same person as the OR expert, this method provides a way for them to work together. The SPSS analyst continues to work on the stream in SPSS Modeler, while the optimization specialist builds a run configuration in the IDE based on a small fixed data set.

Next step

When the model is ready to go to production, the optimization specialist needs to create a new run configuration with the .mod file, and a new .dat file containing a connection to the SPSS stream.

The next section explains how to establish the connection with the stream.

Chapter 4. Running an optimization model in the IDE and reading data from SPSS Modeler

Activate the SPSS Connector to run an optimization model in the IDE and read data from an SPSS stream.

 Create a new run configuration in the IDE, with the skeleton model pm_selflearn.str.mod and an empty .dat file. In this example, we use the default run configuration Configuration1 created earlier.

We rename the configuration test_selflearn for clarity.

- 2. Create a new data file, test_selflearn.dat, in which you will enter OPL code to declare that you want to:
 - · Work with SPSS Modeler
 - Create a connection between OPL and an SPSS stream
 - Read data from the stream into an OPL tuple set
- **3**. To activate the connection with SPSS Modeler, enter the following OPL code at the beginning of the .dat file:

prepare {includeScript("oplspss.js");}

4. Then add the SPSSConnection keyword in the .dat file to connect to the stream pm_selflearn.str in SPSS Modeler.

SPSSConnection spss("pm_selflearn.str","");

The second argument to SPSSConnection, the empty string "", is for future extensions of the SPSS connector.

5. Add the SPSSRead keyword in the .dat file to read the tuple set Table in the stream, from the Filter node.

Table from SPSSRead(spss,"Filter");

6. The OPL data file, test_selflearn.dat, now looks like this:



Save the file test_selflearn.dat.

- 7. Run the configuration test_selflearn.
- 8. The Problems tab displays warnings about the renamed characters.



9. The results table is displayed in the Scripting log.

🛃 Problems 📮 Scriptin	ing log 🕱 🖉 Solutions) 💤 Conflicts) 🞘 Relaxations) 🔅 Engine log) 🖉 Statistics) 🎕 Pro	ofiler 🗖 🗖
	e	@ 🕞 🚮
Interactive scripting	 Scripting log (drop script code here to execute it) 	
*	Table= {<139987 "Pension" 0.13221 "Mortgage" 0.10656>	-
	<140030 "Savings" 0.95678 "Pension" 0.84446>	
	<140089 "Savings" 0.95678 "Pension" 0.80233>	
	<140097 "Pension" 0.13221 "Mortgage" 0.10656>	
	<139068 "Pension" 0.80506 "Savings" 0.28391>	
	<139154 "Pension" 0.13221 "Mortgage" 0.10656>	
	<139158 "Pension" 0.13221 "Mortgage" 0.10656>	
	<139169 "Pension" 0.13221 "Mortgage" 0.10656>	
	<139220 "Pension" 0.13221 "Mortgage" 0.10656>	
	<139261 "Pension" 0.13221 "Mortgage" 0.10656>	
	<139416 "Pension" 0.13221 "Mortgage" 0.10656>	
	<139422 "Pension" 0.13221 "Mortgage" 0.10656>	
-	<139532 "Savings" 0.95676 "Mortgage" 0.81622>	-
E F		× ·

10. In the Problem browser, the results set can be displayed if you hover the mouse over the value cell of the Table data item.

lution		
Name	Value	
Data (1)		
(? Table	{<139987 "Pension" 0.13221 "Mortgage" 0.10656	> <140030 "Savings
	<pre>{<139987 "Pension" 0.13221 "Mortgage" 0.10 <140030 "Savings" 0.95678 "Pension" 0.8444 <140089 "Savings" 0.95678 "Pension" 0.8023 <140097 "Pension" 0.13221 "Mortgage" 0.10 <139068 "Pension" 0.13221 "Mortgage" 0.10 <139158 "Pension" 0.13221 "Mortgage" 0.10 <139169 "Pension" 0.13221 "Mortgage" 0.10 <13920 "Pension" 0.13221 "Mortgage" 0.10 <13920 "Pension" 0.13221 "Mortgage" 0.10 <13922 "Pension" 0.13221 "Mortgage" 0.10 <139261 "Pension" 0.13221 "Mortgage" 0.10 <139422 "Pension" 0.13221 "Mortgage" 0.10 <139456 "Pension" 0.13221 "Mortgage" 0.10 <139456 "Pension" 0.13221 "Mortgage" 0.10 <139577 "Pension" 0.13221 "Mortgage" 0.10 <139560 "Savings" 0.95676 "Mortgage" 0.10 <139560 "Savings" 0.95678 "Pension" 0.1322 <139560 "Savings" 0.13221 "Mortgage" 0.10 <139647 "Pension" 0.13221 "Mortgage" 0.10 <139560 "Savings" 0.15428 "Pension" 0.1322 </pre>	656> 6> 3> 556> 556> 556> 556> 556> 556>

11. Finally, you can display the results table in the IDE editor by clicking the **Show data view** button.

🛉 IBM ILOG CPLEX Optimization Studio							
File Edit Navigate Search Run Window Help							
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🛜 OPL Projects 🛛 🔅 Debug 📄 😑 🖏 🏹	P D 🕕 Value for Table 🙁			- 6			
🖃 🥵 spss_example	↓ customer_id	S_campaign_1	sc_campaign_1	S_campaign_2	An outline is not		
🖻 🦉 Run Configurations	139987	Pension	0.13220734169635	Mortgage	available.		
🖻 🚺 pm_selflearn.str	140030	Savings	0.956784658984769	Pension			
pm_selflearn.str.mod : CPLEX	140089	Savings	0.956784345633516	Pension			
🛗 pm_selflearn.str.dat	140097	Pension	0.132213086825516	Mortgage			
🗄 🔂 test_selflearn (default)	139068	Pension	0.805058681043989	Savings			
😿 pm_selflearn.str.mod : CPLEX	139154	Pension	0.132205931043245	Mortgage			
🚰 test_selflearn.dat	139158	Pension	0.132205435281992	Mortgage	Pr 8 - E		
pm_selflearn.str.mod : CPLEX	139169	Pension	0.132212850609651	Mortgage			
	139220	Pension	0.132205182814485	Mortgage			
	139261	Pension	0.132205182753372	Mortgage	E 🌦 🗷 🛃		
pm_selflearn.str	139416	Pension	0.13220545963688	Mortgage	Pro Value		
pm_selflearn.str-	139422	Pension	0.132205277634862	Mortgage 🚽	Ext True		
	4			E E			
Problem browser 🕄 😡= Variables 🤷 Breakpoints			🗲 Conflicts 🔀 Relavati 🤶	Engine In Statistics	% Profiler		
	2				TO 🥂 🖼 🙆		
Solution	Interactive scripting	 Scripting log (drop scrip 	t code nere to execute it)				
Name Value		<140020 NG	rension 0.13221	noice# 0.944465	302		
🖻 💑 Data (1)		<140030 "Savings" 0.956/8 "Pension" 0.4446>					
13221 "Mor 42 {<139987 "Pension" 0.13221 "Mor	tga	<140009 "Do	avings" 0.95678 "Pe	IBION" 0.802335			
Channe die bestellter		<140097 "Pt	Ension" 0.13221 "Mo	rtgage- 0.10656>	-		
Snow data View		<139068 "Pe	ension" 0.80506 "Sa	Vings" 0.28391>			
		<139154 "Pe	ension" 0.13221 "Mo	rtgage" 0.10656>			
		<133128 "be	ension" 0.13221 "Mo	rugage" 0.10656>			
		<139169 "Pe	ension" 0.13221 "Mo	rtgage" 0.10656>			
		<139220 "Pe	ension" U.13221 "Mo	rtgage" 0.10656>			
		<139261 "Pe	ension" U.13221 "Mo	rtgage" 0.10656>	e		
		0			<u>*</u>		

From this point you can continue working with your optimization model.

Chapter 5. Getting more information on SPSS stream execution

After stream execution, the log from SPSS can be displayed in the engine log of the IDE.

If you execute an SPSS stream in verbose mode, the log information from SPSS Modeler is displayed in the engine log of the CPLEX Studio IDE. To enable the verbose mode, add the statement SetVerboseSPSS to the .dat file.

```
For example, the file test_selflearn.dat now contains:
```

```
prepare {
    includeScript("oplspss.js");
    SetVerboseSPSS();
}
SPSSConnection spss("pm_selflearn.str","");
Table from SPSSRead(spss,"Filter");
```

If you run the configuration test_selflearn, the log information from SPSS Modeler is displayed in the engine log of the IDE.

🖹 Problem 📮 Scripting 🖽 Solution 🔗 Conflicts 😹 Relaxatio 🔅 Engine log 🛛 🖉 Statistic 🚳 Profiler	
	B
SPSS: executing	
SPSS: Stream execution started	
SPSS: Stream execution complete, Elapsed=2.39 sec, CPU=0.5 sec	
SPSS: success	
Parallel mode: deterministic, using up to 2 threads for concurrent optimization.	
Tried aggregator 1 time.	
No LP presolve or aggregator reductions.	
Dual simplex solved model.	-
	•

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