优化软件与应用

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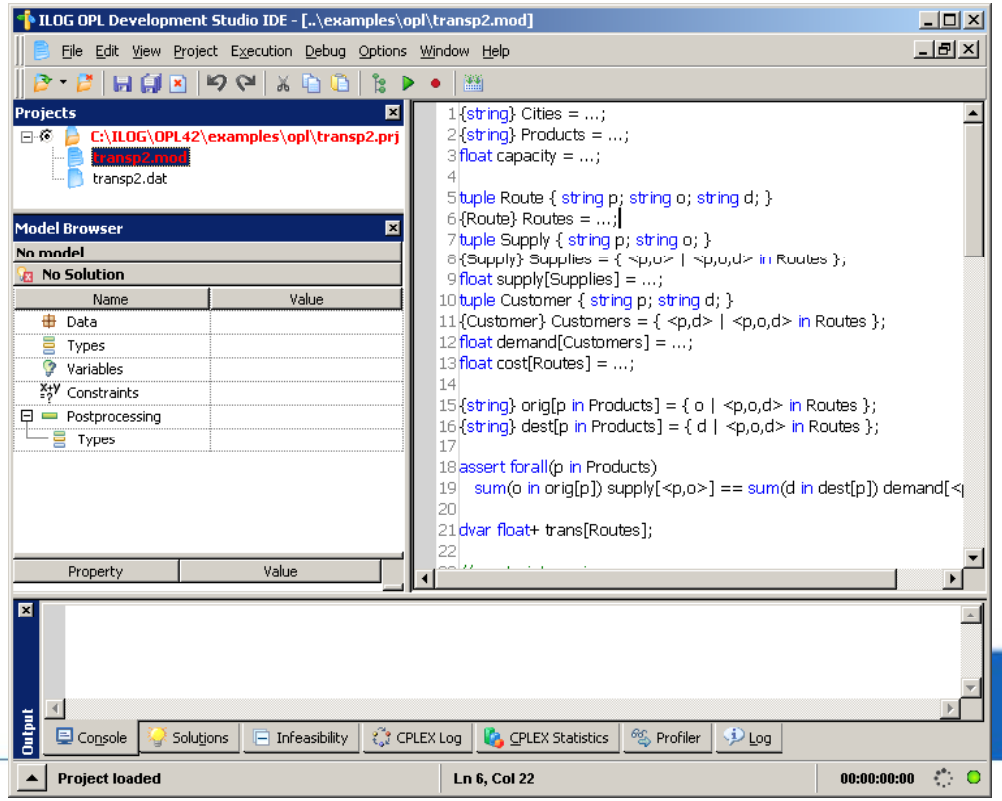
第七章 OPL 界面

IDE 介绍

IDE 是什么：integrated development environment (IDE) for mathematical programming and combinatorial optimization applications. It is the graphical user interface (GUI) for the OPL modeling language and the ILOG Script for OPL scripting language.



第七章 OPL 界面

IDE 介绍

IDE能做什么：

- ✓**Create and modify model, data, and project files using the editing capabilities**
- ✓**Execute a project**
- ✓**Generate a compiled model**
- ✓**Generate external data files or calculated data files to various formats**
- ✓**Visualize OPL results in text or tabular form**
- ✓**Visualize the state of variables at some point during the search for a solution**
- ✓**Set GUI options and mathematical programming options**
- ✓**Connect to a database or to a spreadsheet to read and write data**
- ✓**Work with ILOG Script for OPL, the scripting language**
- ✓**Profile the execution of a model**
- ✓**Search for relaxations of variables and constraints, and for conflicts between constraints**
- ✓**Debug scripts using the debug facilities**

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IDE 介绍

IDE 环境处理三种文件：model files, data files, and project files

Models：保持OPL语句及ILOG脚本，后缀是.mod。也可以生成编译后的模型格式，后缀是.opl。

Data: 对于较大规模问题，可以分离数据之数据文件(.dat)，数据文件中也可以说明外部数据源，如Excel文件或ODBC数据库源等。

Projects：文本格式，XML表示。说明project关联的模型和数据文件。类似VC的工程文件。

File Extension	Description
.mod	Files containing models and script statements
.opl	Compiled model files
.dat	Files containing data instances
.prj	Project files

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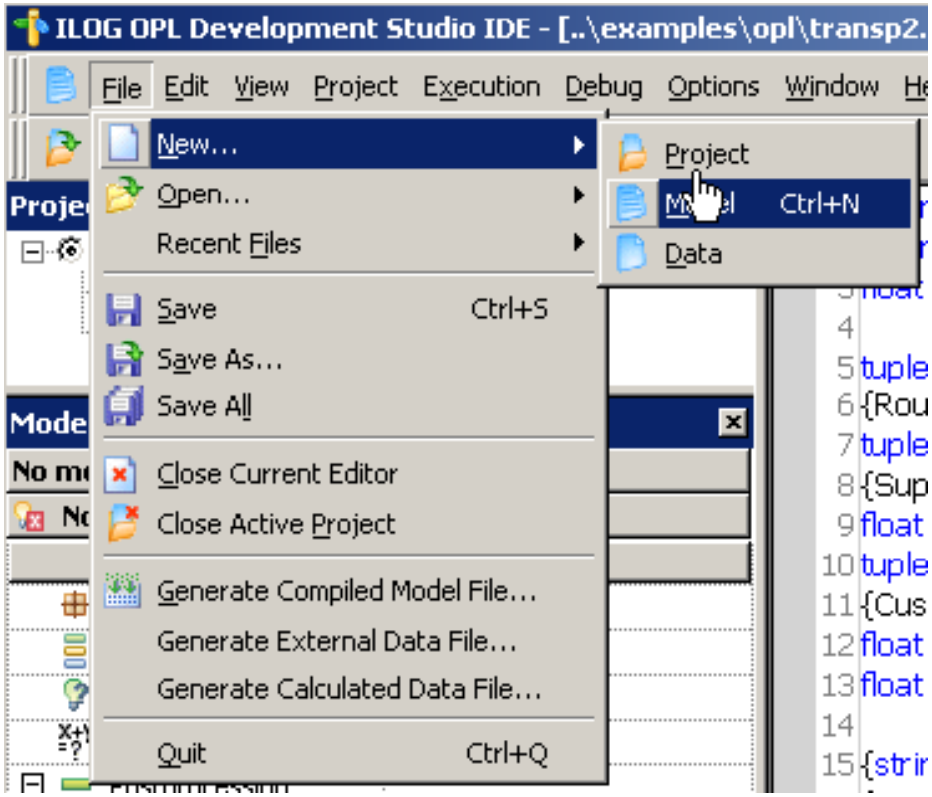
IDE 介绍

创建新文件：



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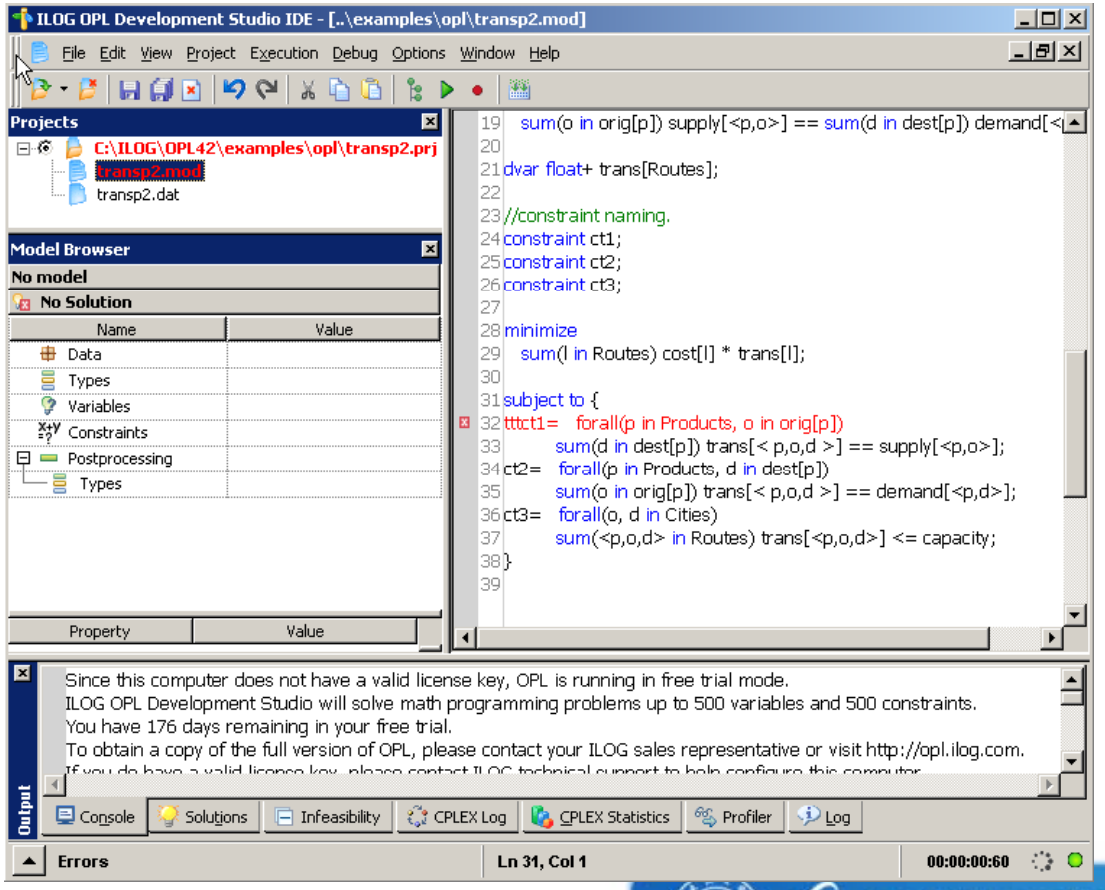
IDE 介绍

运行项目：

如何检查语法：
运行项目后，出错的语法会以红色标识。修改错误后，继续运行项目。



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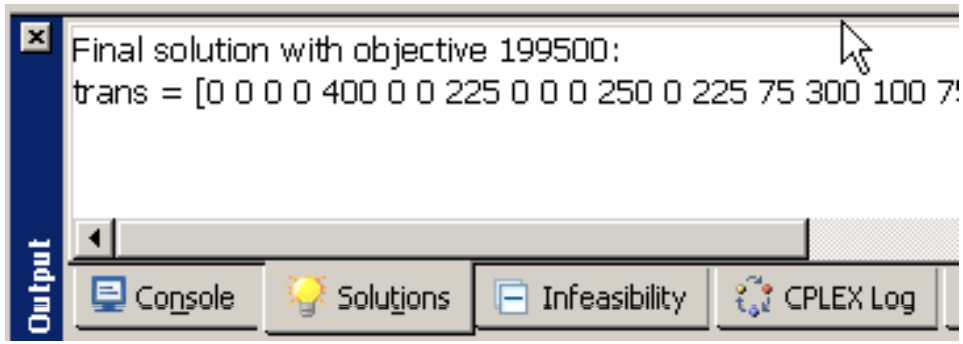
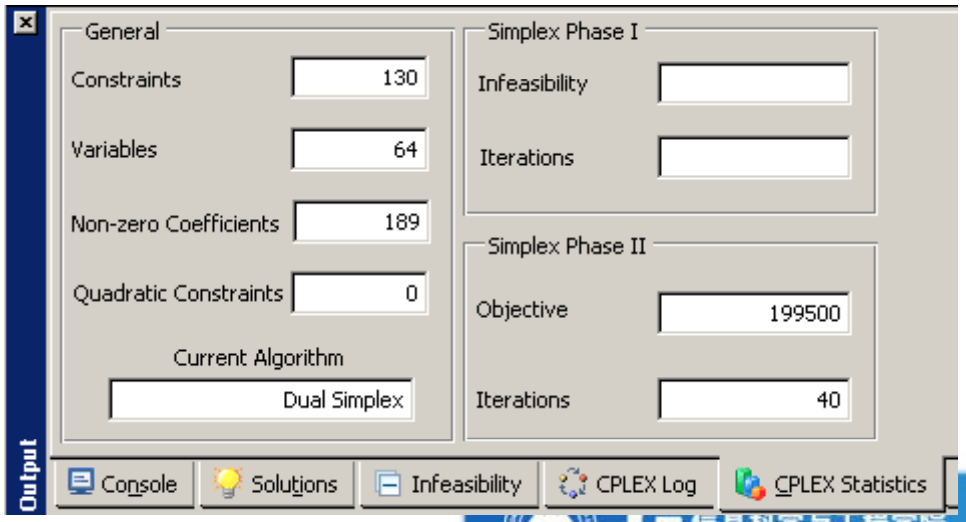
IDE 介绍

查看运行结果：

Solution TAB显示运行的结果。

CPLEX statistics显示算法的具体运行参数。当然，可以通过**Options**设置显示的项。





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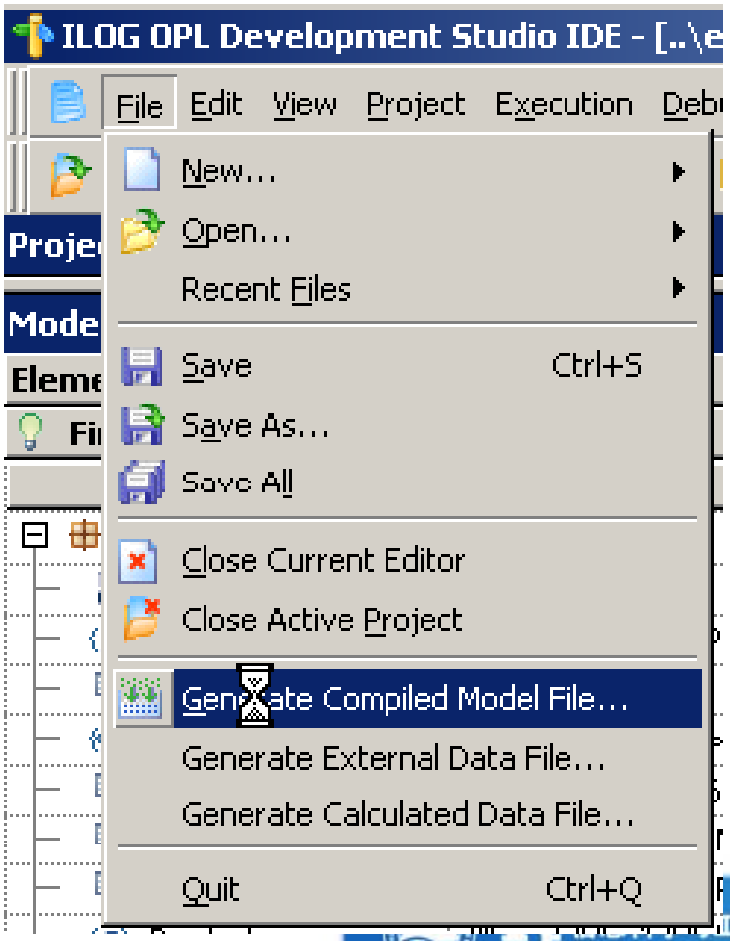
IDE 介绍

产生一个编译的**opl**文件：

File->Generate Compiled Model File…



第七章 OPL 界面

IDE 介绍

```
31 subject to {
32 ct1=   forall(p in Products, o in orig[p])
33         sum(d in dest[p]) trans[< p,o,d >] == supply[<p,o>];
34 ct2=   forall(p in Products, d in dest[p])
35         sum(o in orig[p]) trans[< p,o,d >] == demand[<p,d>];
36 ct3=   forall(o, d in Cities)
37         sum(<p,o,d> in Routes) trans[<p,o,d>] <= capacity;
38 }
39 execute {
40   writeln("Result=", trans);
```

IDE文本编辑的特色：

- ✓**MDI approach；**
- ✓**Syntax coloring；**
- ✓**Multiple levels of Undo and Redo；**
- ✓**Automatic indentation Blocks： as delimited by curly brackets ；**
- ✓**Bracket (or brace) matching； When typing], } or), highlighted；**
- ✓**Margin symbols**
  - ✓**the yellow arrow that indicates the current line**
  - ✓**the red box that indicates an error**
  - ✓**the red circle that indicates a breakpoint**

```
39 execute {
40   writeln("Result=", trans);
41   writeln("Trans=", trans);
```

```
40 qq writeln("Result=", trans);
```

- ✓**Reload prompt： If you modify a file with an external editor, you are prompted to reload Customization：**
- ✓**options to customize the editor**

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IDE 介绍

数据库支持：

- ✓**OPL通过ILOG DBLink 5.0 支持RDBMS ；**
- ✓支持的数据库类型：

Database Name	Connection String
DB2	username/password/database (The client configuration will find the server.)
MS SQL	userName/password/database/dbServer
ODBC	dataSourceName/userName/password
Oracle8, Oracle8.1. Oracle 9	userName/password@dbInstance

- ✓**OPL数据库支持通过函数DBconnection 来实现，该函数主要有两个参数：**
  - ✓**the database client you want to use： e.g. "oracle81"**
  - ✓**the connection string: e.g. "scott/tiger@ilog “**
- ✓后面我们有一个详细的数据库连接的例子。

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IDE 介绍

为什么使用**ILOG** 脚本？

- ✓**Add preprocessing to prepare data for the model**
- ✓**Control the flow while solving the model**
- ✓**Set CPLEX parameters**
- ✓**Add postprocessing to aggregate, transform, and format data (including results data) for display or for sending to another application, for example, a spreadsheet**
- ✓**Solve repeated instances of the same model**
- ✓**Feedback：Create algorithmic solutions where the output of one model instance is used as the input of a second model instance**

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IDE 介绍

ILOG 脚本的入口点

- ✓**The main statement for a flow control script**
- ✓**The execute statement for preprocessing and postprocessing scripts**

没有独立的脚本文件；脚本文件总是和模型文件结合使用

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例：IDE Project

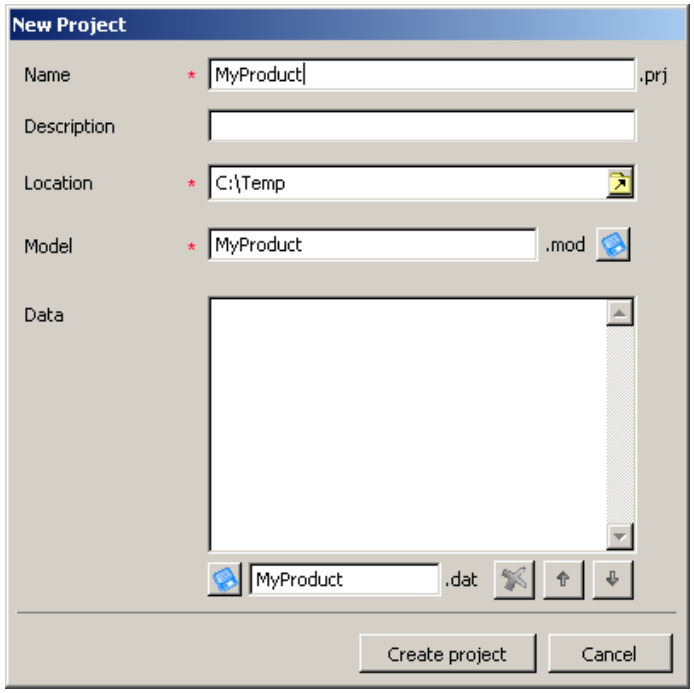
1、在IDE界面中，File>New>Project.

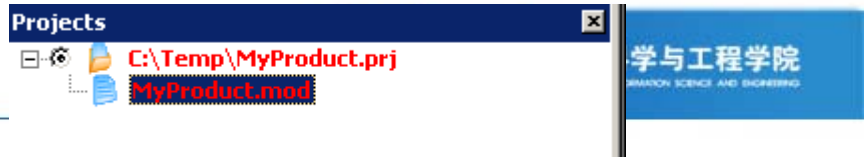
红色的星号表示是必选项。选择**Location**为**C:\Temp**，在项目**Name**中键入**MyProject**；

可以看到系统自动命名**mod**文件和**dat**文件为**MyProject**。用户也可以对其名称进行修改，或者点选其右面的图标，选择一个现有的文件添加到本项目中；

注意一个项目中**mod**文件只有**1**个，**dat**文件可以有多个；

点击“**Create Project**”，可以看到系统在**C:\Temp**下创建了两个文件，**Project**窗口如右图。





例：IDE Project

2、拷贝下面的代码到mod文件中，保存.

```
{string} Products = ...;
{string} Resources = ...;
tuple ProductData {
  float demand;
  float insideCost;
  float outsideCost;
  float consumption[Resources];
}
ProductData product[Products] = ...;
float capacity[Resources] = ...;

dvar float+ inside[Products];
dvar float+ outside[Products];

execute CPX_PARAM {
  cplex.preind = 0;
  cplex.simdisplay = 2;
}
minimize
  sum(p in Products) (product[p].insideCost*inside[p] +
                      product[p].outsideCost*outside[p]);
subject to {
  forall(r in Resources)
    sum(p in Products) product[p].consumption[r] * inside[p] <= capacity[r];
  forall(p in Products)
    inside[p] + outside[p] >= product[p].demand;
}
```

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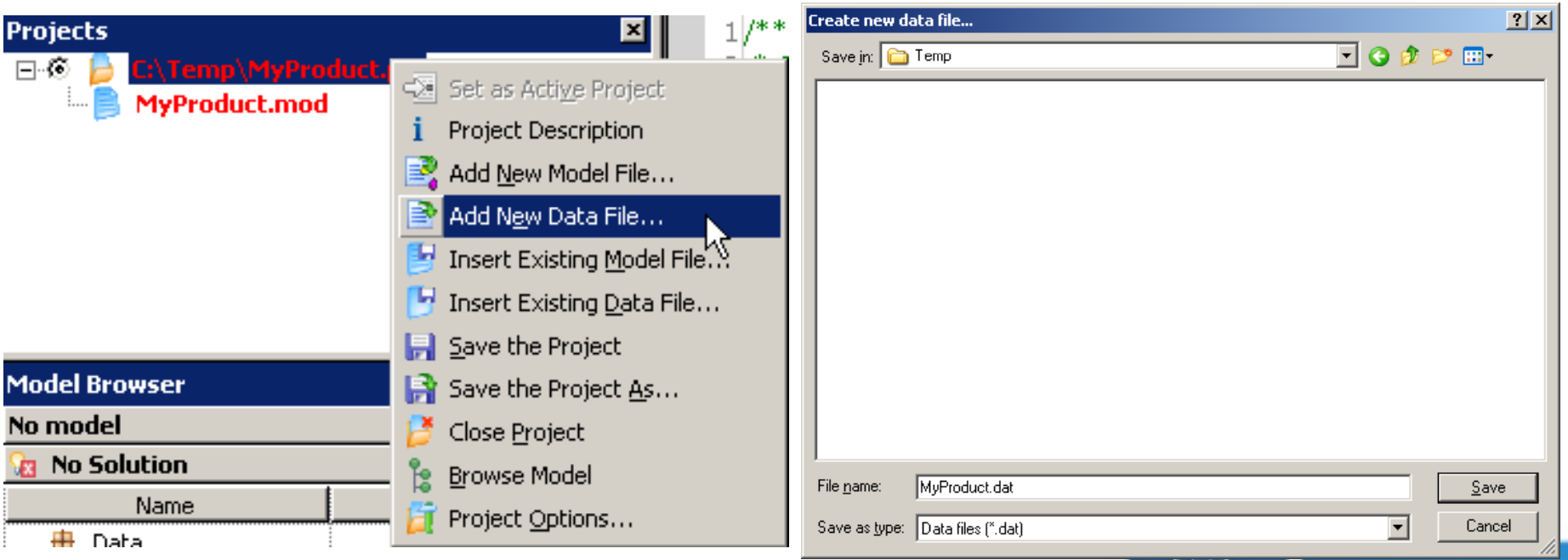
例：IDE Project

3、如图，选择“Add new data file”，选择和project文件相同的文件夹，输入文件名称MyProject.dat，保存.



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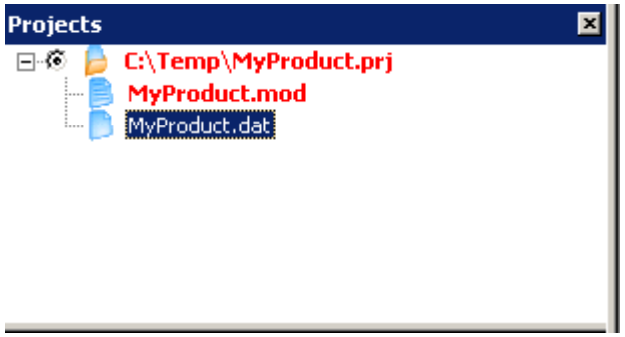
例：IDE Project

4、双击MyProject.dat，将下面的代码拷贝到右侧的编辑区，保存。运行文件，结果如图.




```
Products =  { "kluski", "capellini", "fettucine" };
Resources = { "flour", "eggs" };
product = #[
     kluski : < 100, 0.6, 0.8, [ 0.5, 0.2 ] >,
     capellini : < 200, 0.8, 0.9, [ 0.4, 0.4 ] >,
     fettucine : < 300, 0.3, 0.4, [ 0.3, 0.6 ] >
        ]#;
capacity = [ 20, 40 ];
```

```
Final solution with objective 372:
inside = [40 0 0];
outside = [60 200 300];
```

注意：项目可以有多个**dat**文件。一个**dat**中的变量定义可能参考另一个**dat**文件，**IDE**调取**dat**文件的顺序是从上到下。因此，可以通过点选**dat**文件右键菜单的**move up**来调整顺序。

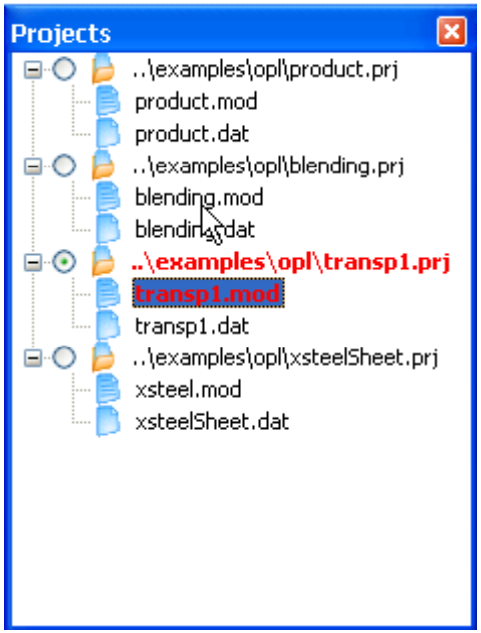
另外，从项目中移除一个文件也可以通过右键菜单来实现。

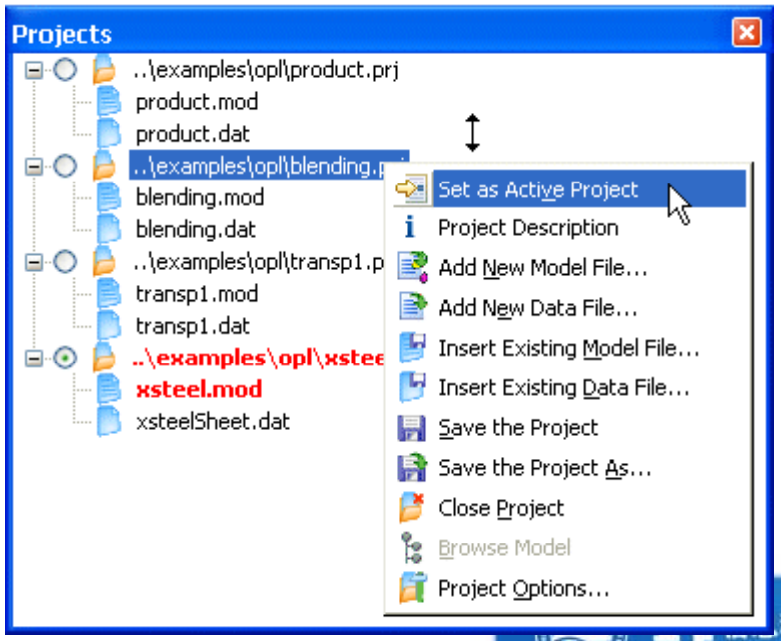
第七章 OPL 界面

例：IDE Project

另外，**IDE**也支持同时打开多个项目。例如，图中打开了**4**个项目，红色的、单选框选中的是当前项目。

当前项目可以通过右键菜单中的“**set as active project**”来设定。





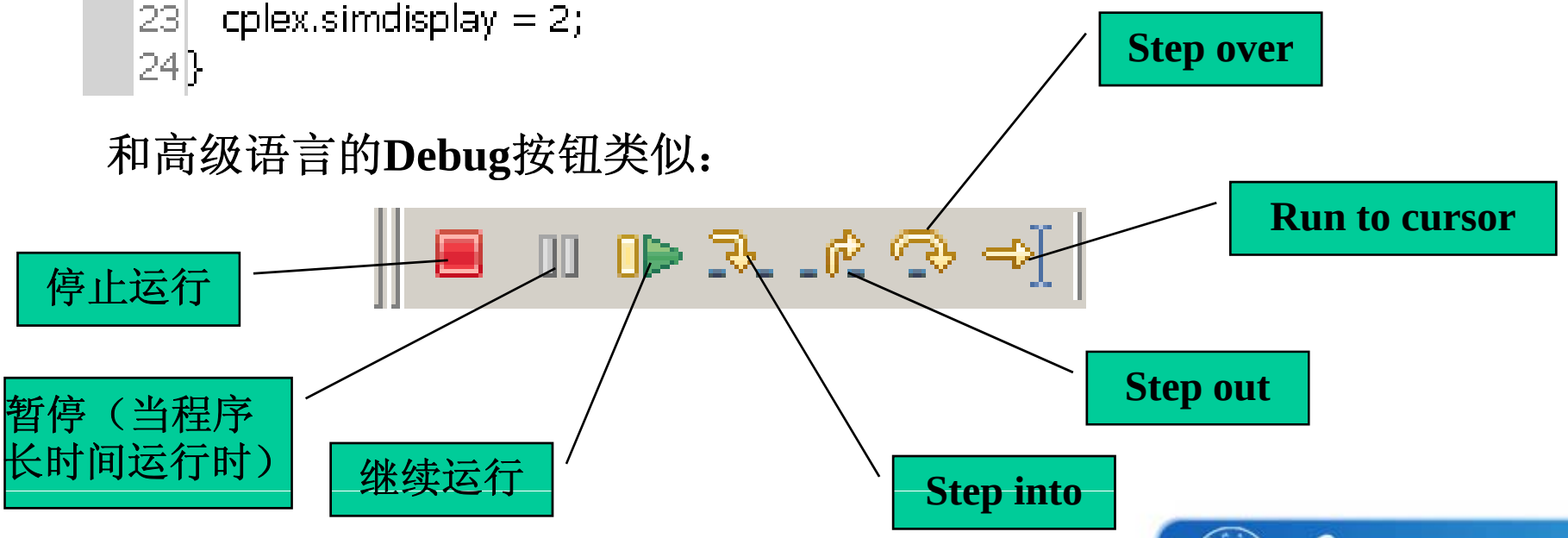
第七章 OPL 界面

例：IDE Project

5、在execute处设置一个断点，然后运行项目。

```
21 execute CPX_PARAM {
22   cplex.preind = 0;
23   cplex.simdisplay = 2;
24 }
```

和高级语言的Debug按钮类似：



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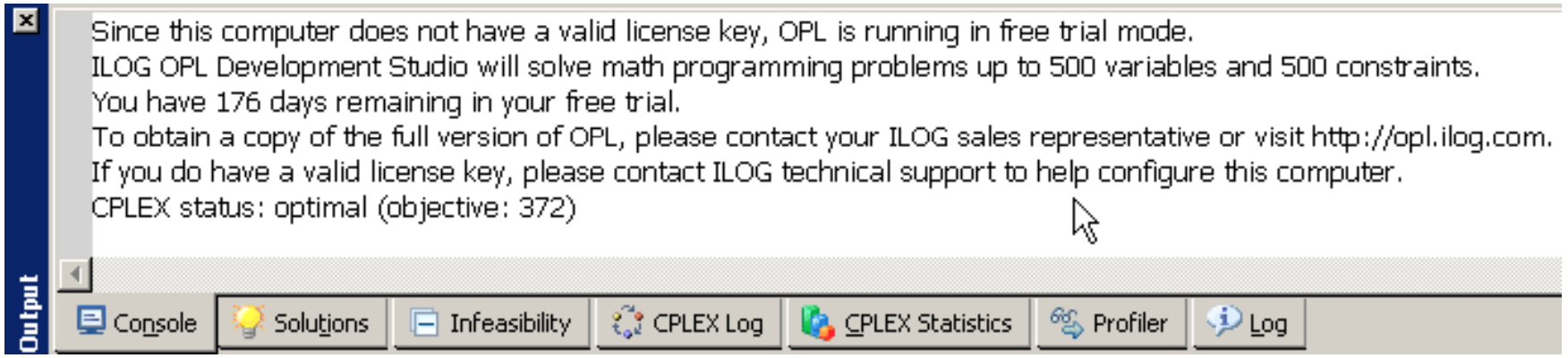
例：IDE Project

6、取消断点，继续运行项目。
下面以这个例子的结果为例，介绍IDE的界面元素。

首先是Output窗口中的Console标签页：

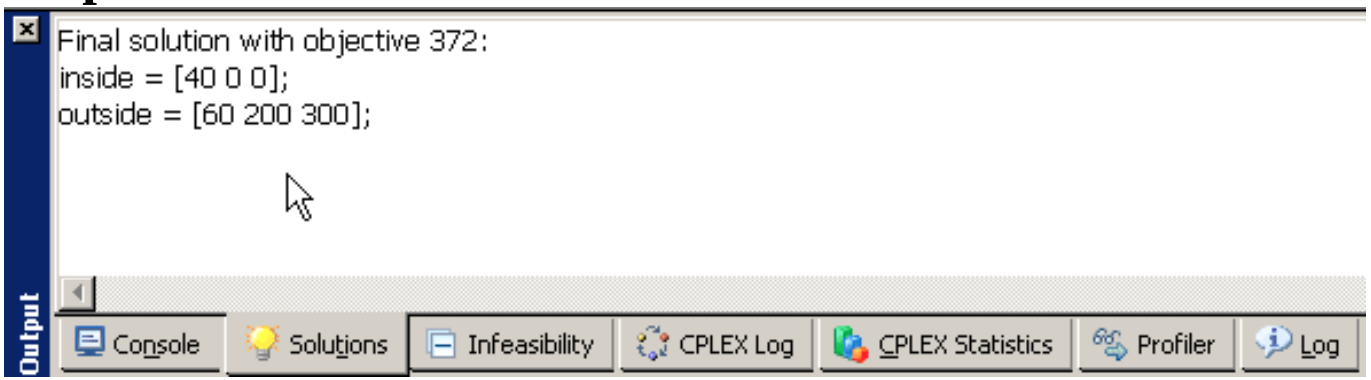


如果编译出错，则显示语法错误；如果求解成功显示最优解状态

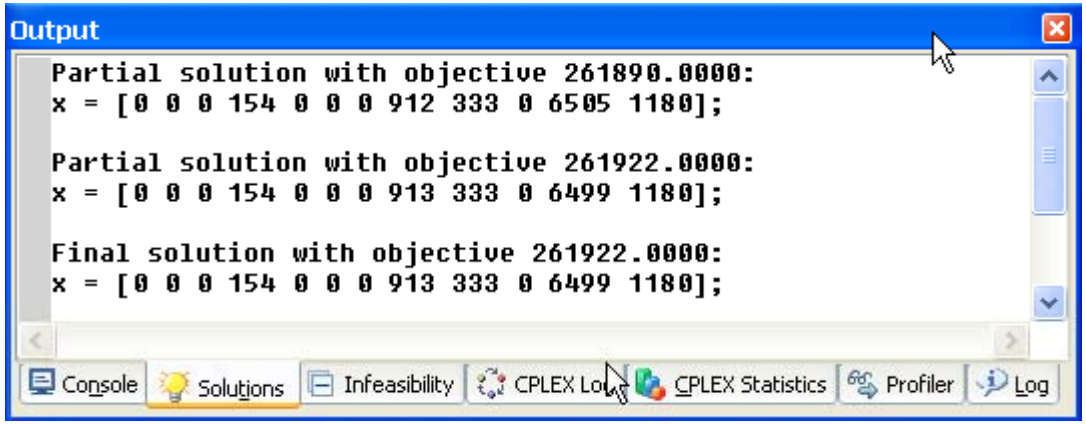
第七章 OPL 界面

例：IDE Project

Output窗口中的Solution标签页：



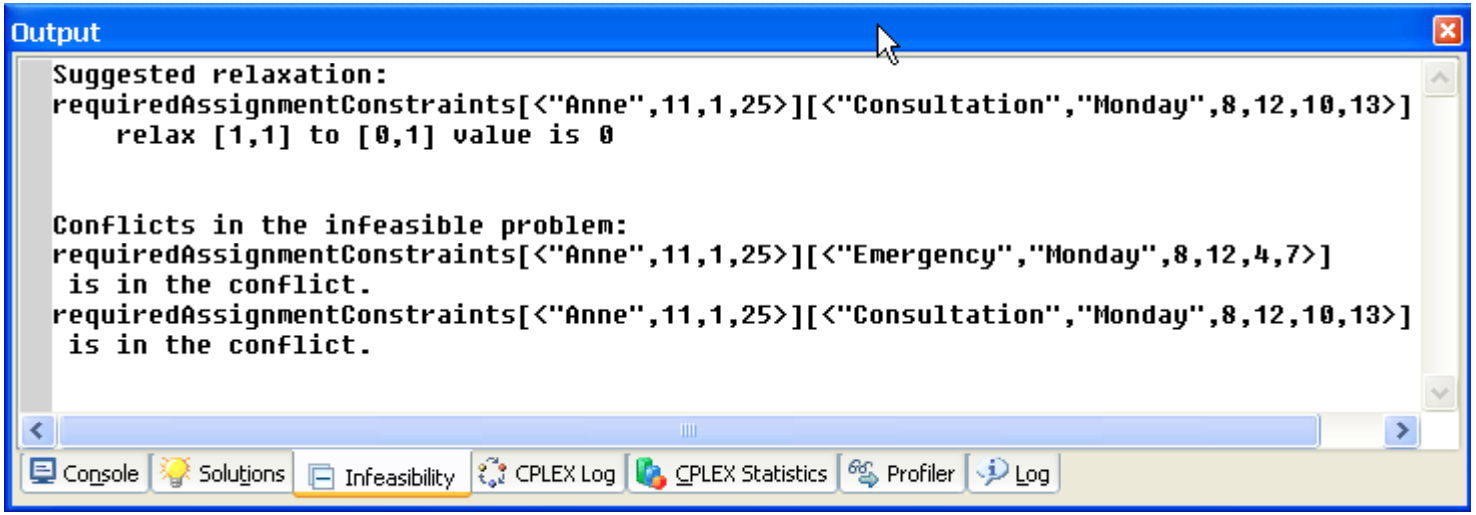
显示局优解**partial solutions (**如果有**)**和最优解。下面是另一个例子的结果。



第七章 OPL 界面

例：IDE Project

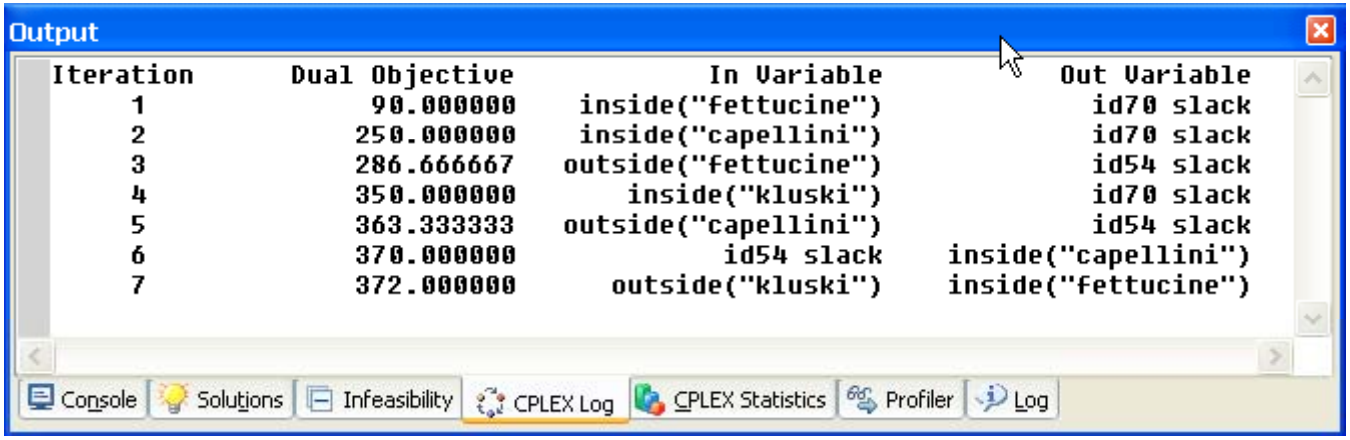
Output窗口中的Infeasibility标签页：
因为本例有解，所以标签页为空白。下面是另一个例子的结果。



第七章 OPL 界面

例：IDE Project

Output窗口中的CPLEX Log标签页：



显示CPLEX求解过程中的日志信息，包括每个迭代过程的换基过程

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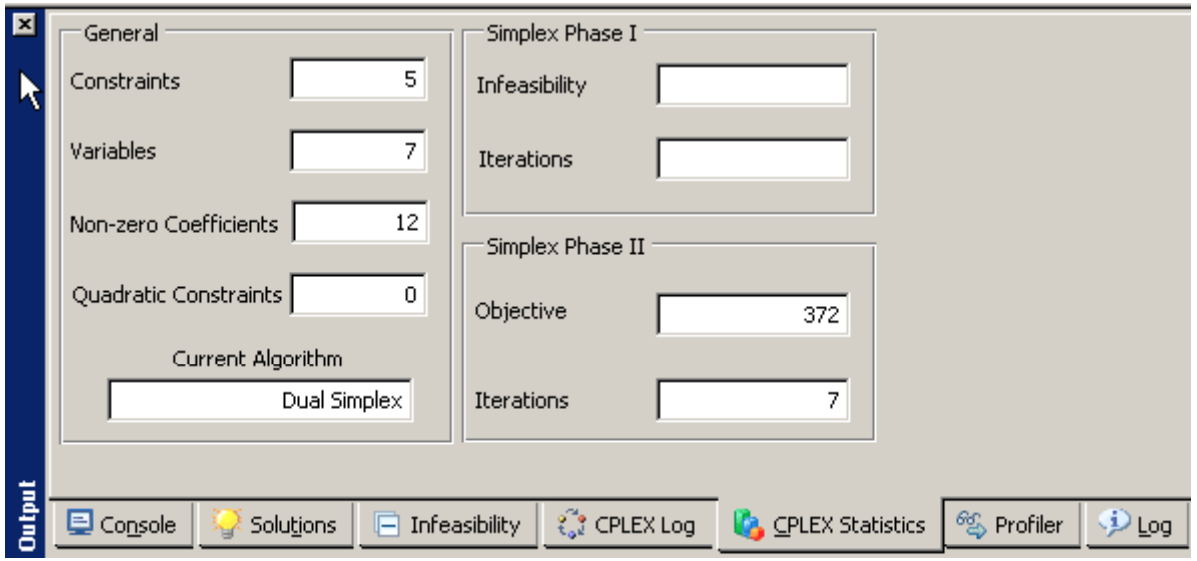
例：IDE Project

Output窗口中的CPLEX Statistics标签页：

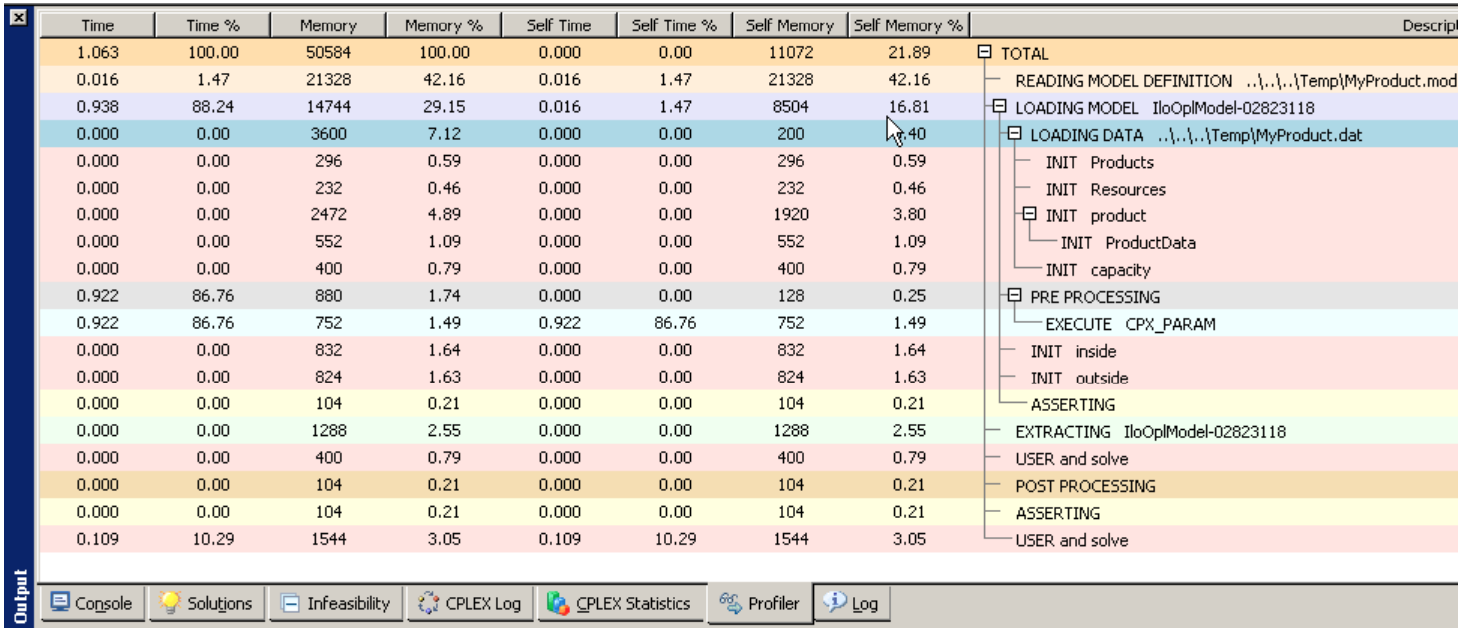


显示CPLEX求解的各种统计信息，包括变量个数、约束个数、算法类型、迭代次数等等。

第七章 OPL 界面

例：IDE Project

Output窗口中的Profiler标签页：



Time	Time %	Memory	Memory %	Self Time	Self Time %	Self Memory	Self Memory %	Descript
1.063	100.00	50584	100.00	0.000	0.00	11072	21.89	TOTAL
0.016	1.47	21328	42.16	0.016	1.47	21328	42.16	READING MODEL DEFINITION ..\..\..\Temp\MyProduct.mod
0.938	88.24	14744	29.15	0.016	1.47	8504	16.81	LOADING MODEL IloOplModel-02823118
0.000	0.00	3600	7.12	0.000	0.00	200	0.40	LOADING DATA ..\..\..\Temp\MyProduct.dat
0.000	0.00	296	0.59	0.000	0.00	296	0.59	INIT Products
0.000	0.00	232	0.46	0.000	0.00	232	0.46	INIT Resources
0.000	0.00	2472	4.89	0.000	0.00	1920	3.80	INIT product
0.000	0.00	552	1.09	0.000	0.00	552	1.09	INIT ProductData
0.000	0.00	400	0.79	0.000	0.00	400	0.79	INIT capacity
0.922	86.76	880	1.74	0.000	0.00	128	0.25	PRE PROCESSING
0.922	86.76	752	1.49	0.922	86.76	752	1.49	EXECUTE CPX_PARAM
0.000	0.00	832	1.64	0.000	0.00	832	1.64	INIT inside
0.000	0.00	824	1.63	0.000	0.00	824	1.63	INIT outside
0.000	0.00	104	0.21	0.000	0.00	104	0.21	ASSERTING
0.000	0.00	1288	2.55	0.000	0.00	1288	2.55	EXTRACTING IloOplModel-02823118
0.000	0.00	400	0.79	0.000	0.00	400	0.79	USER and solve
0.000	0.00	104	0.21	0.000	0.00	104	0.21	POST PROCESSING
0.000	0.00	104	0.21	0.000	0.00	104	0.21	ASSERTING
0.109	10.29	1544	3.05	0.109	10.29	1544	3.05	USER and solve

Output | Console | Solutions | Infeasibility | CPLEX Log | CPLEX Statistics | Profiler | Log

右面是执行步骤，左面是计算时间和使用内存。通过分析这些信息，可以改进模型（缩短时间和减少内存）

第七章 OPL 界面

例：IDE Project

Profiler标签页中，执行步骤主要分为以下两类：

Execution steps	Notation
Script block execution	EXECUTE <block_name>
Data initialization	INIT <data_element_name>

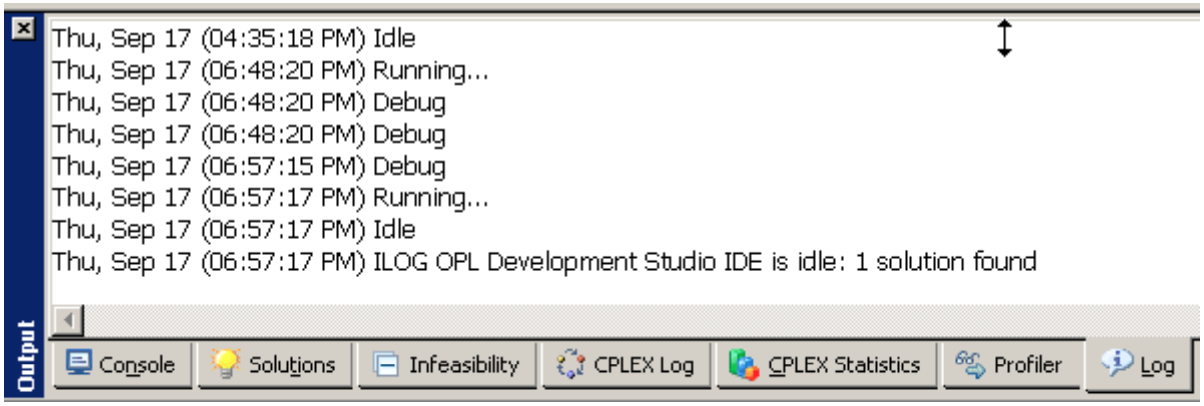
左面的计算时间和使用内存的含义见下表：

Info for each execution step	Definition
Time	The total time consumed by the item...
Percentage of time	...as a proportion of the total time
Memory	The total memory used by the item...
Percentage of memory	...as a proportion of the total memory
Self time	The time used by the item minus the time used by the subitems...
Percentage of self time	...as a proportion of the total time
Self memory	The memory used by the item minus the memory used by the subitems...
Percentage of self memory	...as a proportion of the total memory

第七章 OPL 界面

例：IDE Project

Output窗口中的Log标签页：



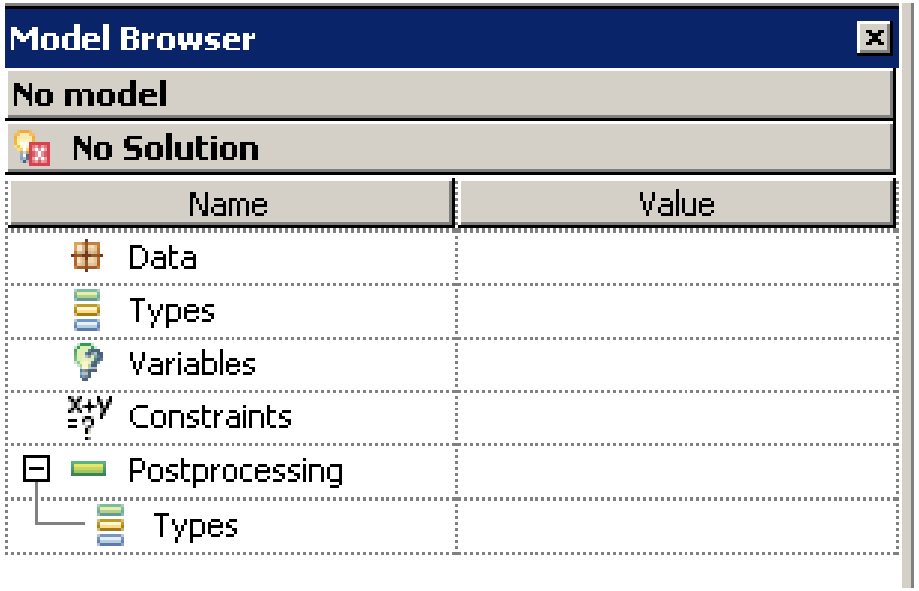
显示运行日志信息。

第七章 OPL 界面

例：IDE Project

下面介绍**IDE**的模型窗口。

7、关闭当前项目。



模型窗口显示如图。

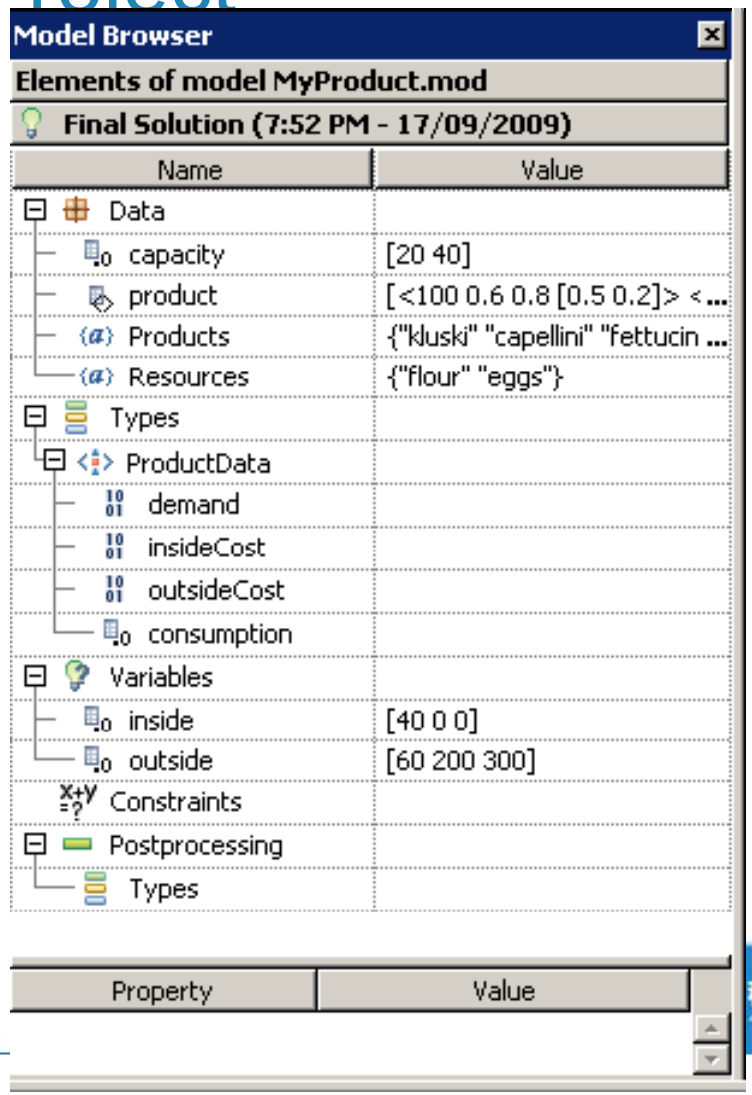
第七章 OPL 界面

例：IDE Project

8、重新调入刚才的项目，运行项目。

可以显示模型的类型、常量、变量、变量的初始化数据。

用鼠标点选**Data**或者**Variables**中的变量或常量，下面的**Property**和**Value**会显示相应的值；同时，右面的编辑区也会定位的模型的相关代码处。



例：IDE Project

注意到前面的模型窗口中，**Contraints**没有详细的信息。这是因为**mod**文件中没有给约束命名。

9、修改模型代码如下，然后重新运行项目。

```
 constraint ct1;
 constraint ct2;
subject to {
ct1=   forall(r in Resources)
     sum(p in Products) product[p].consumption[r] * inside[p] <=
capacity[r];
ct2=   forall(p in Products)
     inside[p] + outside[p] >= product[p].demand;
}
```

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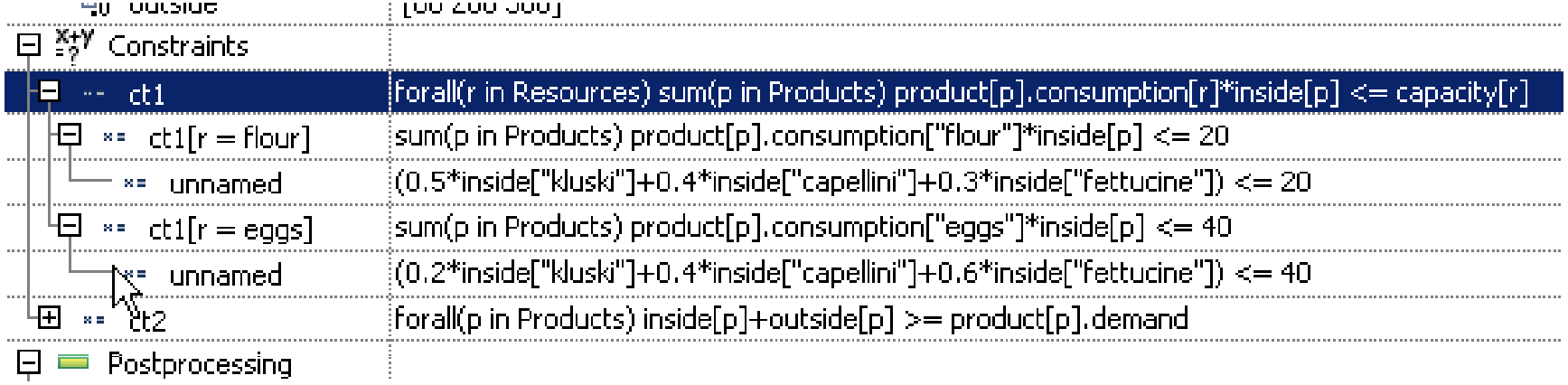
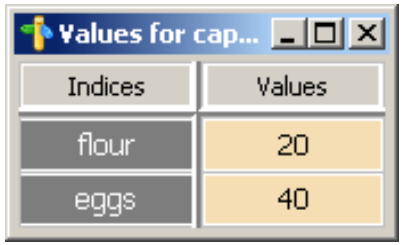
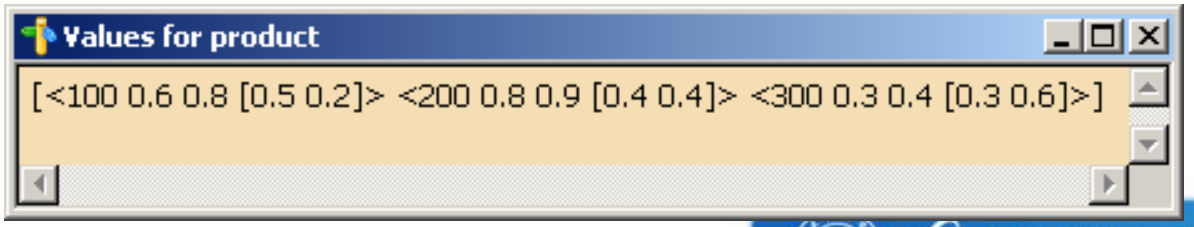
例：IDE Project

现在可以看到详细的约束信息（打开小加号）：



另外，在模型窗口中，也可以双击元素，可以弹出窗口，显示详细信息。





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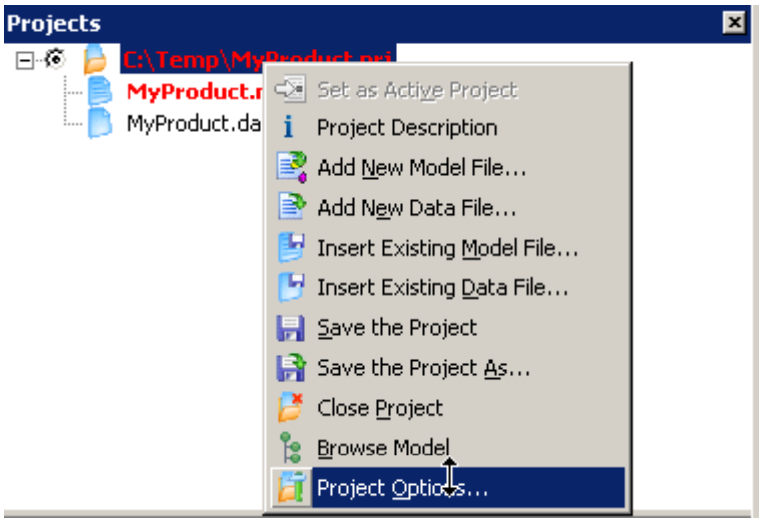
例：IDE Project

下面再介绍一点**IDE**的选项设置。

10、如图方式选择；或者从菜单选择Options>Project Options



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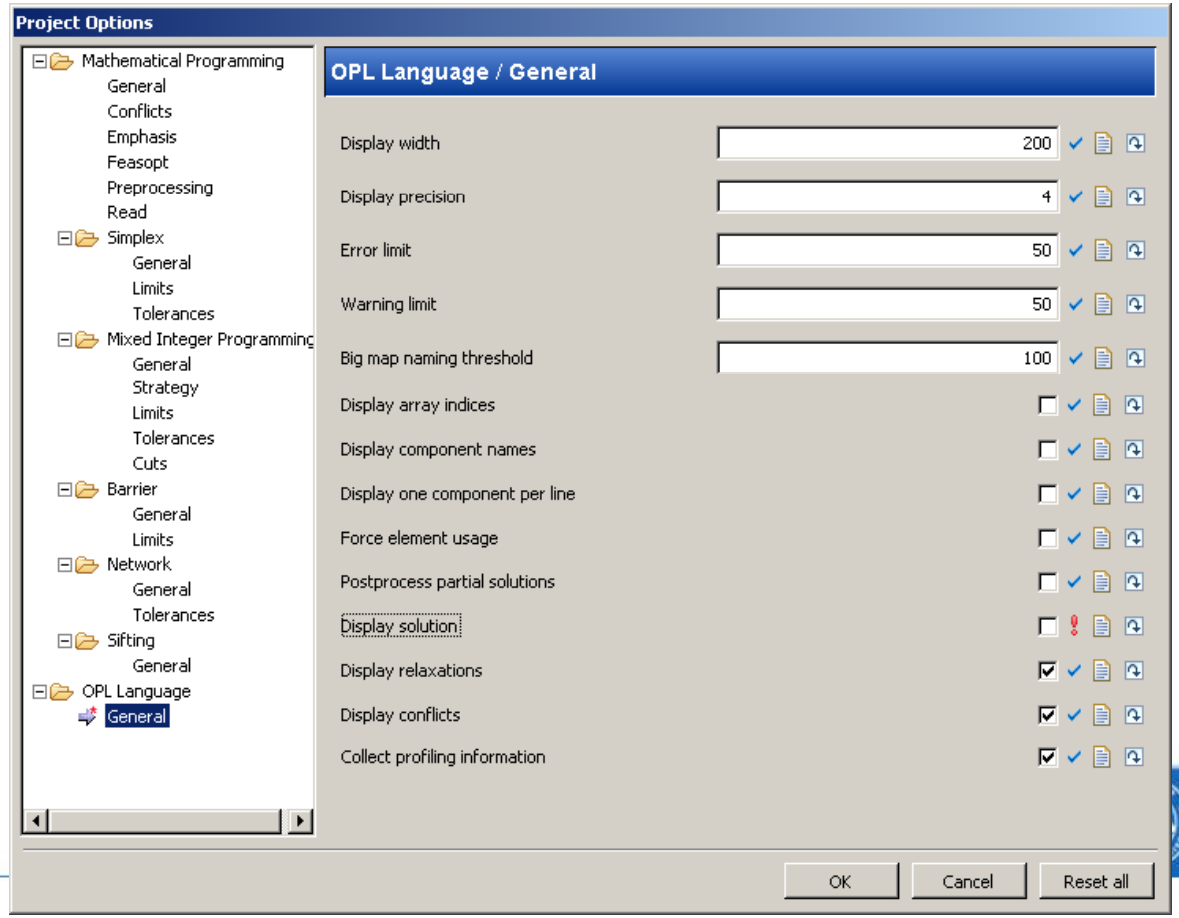
例：IDE Project

选择 **OPL Language**下的**General**，右面的**Display Solution**不选。
重新运行项目，将只显示最优目标。



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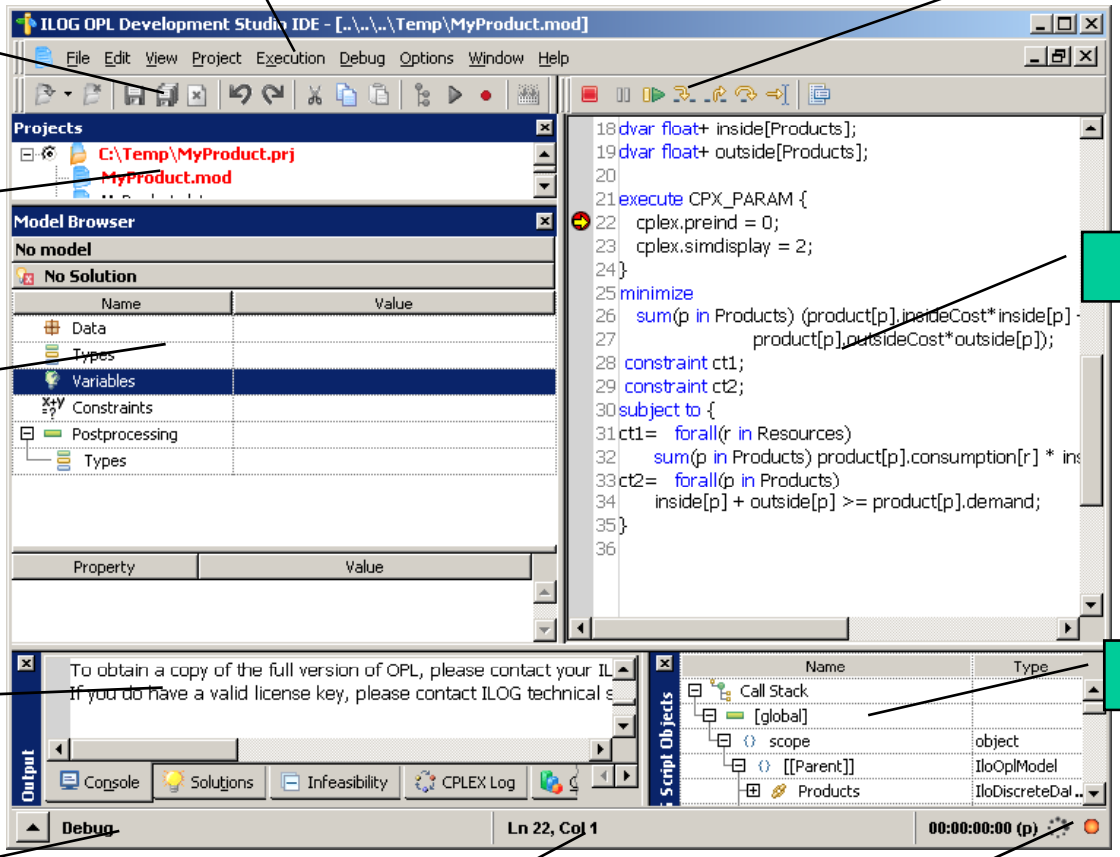
IDE主环境

IDE 界面详解



菜单

执行工具栏

主工具栏

项目 浏览器

编辑区域

模型 浏览器

输出 窗口

脚本对象浏览器

状态显示

当前行和列

状态显示

第七章 OPL 界面

IDE 界面详解

菜单命令详解

File菜单

New	Creates a new file. Displays a submenu to specify a model, project, or data file.
Open	Opens a file. Displays a submenu to specify a model, project, or data file. In each case, the IDE displays an Open File dialog box requesting the file name you want to open.
Recent Files	You can open a file that you have used recently by selecting its name from the submenu.
Save	Saves the current file in the Editing area with its current name and at the current location.
Save As	Saves the current edited file with a new name.
Save All	Saves all the files in the Editing area with their current names and at the current location.

第七章 OPL 界面

IDE 界面详解

File菜单

Close Current Editor	Closes the active file in the Editing area. If it is a model file, an error message warns you that cannot close the model of the current project. If it is a data file, its window disappears from the Editing Area but its name remains displayed in the Projects tree.
Close Active Project	Closes the active project file (.prj) and prompts you to save it if one of its associated files contains unsaved modifications. If one of its associated files is not write-accessible, an error message warns you that you cannot save it.
Generate Compiled Model File	Generates a compiled model file (.opl) which you can later pass as an argument when using the OPL API to integrate your model in an application.

第七章 OPL 界面

IDE 界面详解

File菜单

Generate External Data File	Opens a Save As dialog box which enables you to export the data to a file that can later be used as input.
Generate Calculated Data File	Opens a Save As dialog box which enables you to export the calculated data to a file that can later be used as input.
Quit	Exits the IDE and prompts you to save any unsaved project.

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IDE 界面详解

Edit菜单

Undo	Undoes the last action in the current editor (unlimited).
Redo	Redoes the previously undone action in the current editor (unlimited).
Cut	Removes the selected text and copies it to the clipboard, from where you can paste it elsewhere.
Copy	Copies the selected text, from the Editing area or Output window, to the clipboard, from where you can paste it elsewhere.
Paste	Pastes from the clipboard to the current editor.
Kill Line	Deletes a line from the cursor position onward and copies it to the clipboard, replacing the existing clipboard content.
Select All	Selects the entire content of the current editor.

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IDE 界面详解

Edit菜单

Find	Displays the Find dialog box for specifying search criteria.
Find Next	Finds the next occurrence of the text displayed in the Find box.
Find Previous	Finds the previous occurrence of the text displayed in the Find box.
Replace	Displays the Replace dialog box for specifying search criteria and replacing specified strings.
Go To	Displays the Go To dialog box for specifying a line where the cursor should be placed in the Editing area.
Recenter	Places the current line in the middle of the window, if possible.
Indent Lines	Adds a tabulation at the beginning of selected lines. (You must highlight the line, not just click in it.) 按Tab键是相同的结果

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IDE 界面详解

Edit菜单

Outdent Lines	Removes the tabulation from the beginning of selected lines. 按Shift+Tab键是相同的结果
Comment	Transforms selected lines to comments, using the // delimiter. You can also add comments manually using /* and */ as opening and closing delimiters. However, in this case, the Uncomment command is ineffective.
Uncomment	Removes the // comment delimiters from the selected lines. If you used the /* and */ characters as comment delimiters, the Uncomment command does not work,
Complete Word	Searches upward for a string in the same file and completes with the first string that matches the same beginning letters. The search begins upward at the left of the current cursor position.

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IDE 界面详解

View菜单

Show/Hide Projects	Hides or redisplays the Projects window containing the project tree.
Show/Hide Model Browser	Hides or redisplays the Model Browser window containing information about the data structures defined in the active model in alphabetical order of name.
Show/Hide Output	Hides or redisplays the Output window.
Show/Hide ILOG Script Objects	Alternately displays or hides the part of the Output Window that contains the debug information on objects in scripts.

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IDE 界面详解

Project菜单：其内容根据当前选定的对象而改变

Set as Active Project Set as Active Model	This command is available only when you select a project or stand-alone model that is not already active, to enable you to make it the active project or model.
Project Description	Displays a dialog box where you can type a few words to describe the purpose or content of the project. Your description then appears in the list of Recent files in the Start window.
Add New Model File	Adds a new, empty model file to the project. If you select an existing model file by mistake in the file chooser, a message warns you that it will be overwritten by the new empty model file.
Add New Data File	Adds a new, empty data file to the project.

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IDE 界面详解

Project菜单

Insert Existing Model File	Adds an existing model file to the project. A project can have only one model file.
Insert Existing Data File	Adds an existing data file to the project.
Save the Project	Saves the project's options and its components.
Save the Project As	Changes the name and/or location of an existing project.
Close Project	Closes the project and its associated files.
Browse Model	Builds or rebuilds the model tree of the data structures defined in the active model or project.

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IDE 界面详解

Execution菜单

Browse Active Model	Builds or rebuilds the model tree of the data structures defined in the active model or project.
Run	Submits the active model or project for execution. The button turns grey during execution. After you click Run, the Pause Execution button becomes available, as well as other buttons of the Execution toolbar in certain cases.
Abort	Appears when you click the Run button, to enable you to stop execution of a model, project or script. After you click the Abort button, the IDE returns to a normal editing session but keeps the solution information in the Output window.

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IDE 界面详解

Execution菜单

Pause	Suspends execution of a model or project temporarily. You can resume with the Continue button.
Continue	Requests the IDE to continue execution after a pause.
Step Into	Steps into a loop in a script.
Step Out	Steps into a function in a script, to the first statement, or steps to the instruction after the current one if there is no function called.
Step Over	Skips an instruction in a loop: either a function call, then going to the statement after the function call, or an instruction, then going to the instruction after it.
Run To Cursor	Makes the script run to the cursor position once you have set a first breakpoint. Useful when you debug scripts.

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IDE 界面详解

Debug菜单

Add/Remove Break Point	Alternately sets and removes breakpoints in the search procedure of an OPL model or script.

Options菜单

General Settings	Displays the General Settings dialog box that allows you to change GUI options for all projects. You cannot change any general settings for standalone models. You must first include them in a project.
Project Options	Displays the Project Options dialog box that allows you to change math programming and language options for the active project only. There are tooltips for the math programming options. Math programming options are CPLEX parameters.

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IDE 界面详解

Window菜单

Cascade	Organizes windows to overlap in the Editing area so that all are partly visible.
Tile Horizontally	Organizes windows horizontally in the Editing area.
Tile Vertically	Organizes windows vertically in the Editing area.
Start Window	Displays the Start window in the Editing area, with the list of the files opened most recently. Choose this command if you want to see the Start window when it is hidden behind the contents of a model or data file displayed in the Editing area.

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IDE 界面详解

Help菜单

Contents	Opens the Help window, displaying the presentation page.
Keyword Help	Opens the Help window, displaying the page corresponding to the OPL keyword selected in the text editor.
About	Indicates the version of the IDE and the ILOG products used by that version of ILOG OPL Development Studio; and contains copyright information.

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IDE 界面详解

模型窗口的图标含义

Array		Num array	
String Array		Constant	
Constraint		Constraints	
Data		Int Range	
Num Range		Postprocessed	
String		Tuple	
Types		Unknown	
Variable		Variables	

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IDE 界面详解

状态图标的含义

Color	Label	Meaning
Green	Idle	The IDE is idle. You can create, edit, or examine files in the Editing area.
Orange	Running	The IDE is executing the active model or project.
Orange	Debug	The IDE has stopped executing at a breakpoint. You can examine the debug information.
Blue	Paused	The IDE is paused after the Pause Execution button has been clicked during execution.
Yellow	Waiting	The IDE is waiting, also called browsing mode, after finding a final solution.
Red	Aborting	The IDE is aborting execution after the Abort Execution button has been clicked during execution.

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IDE 界面详解

数据类型图标的含义