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International Advanced School
on
Space Weather
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Introduction on RSI IDL Programming

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An Introduction to RSI Interactive Data Language IDL

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Scheme of the Presentation

- **What is RSI IDL ?**

- **Supported Platforms**

- **The IDL Development Environment (IDLDE)**
  - Using IDLDE (Launching & Menu, Using the Online Help)
  - Setting IDLDE Preferences
  - Creating, Compiling and Running Procedures
  - Creating, Compiling and Running Projects

- **A Primer on IDL Programming**
  - Structuring Programs
  - Defining Procedures and Functions
  - Including Comments
  - Using Constants and Variabless (System and User Defined)
  - Using Arrays and Structures
  - Calling External Procedures and Functions
  - Controlling Program Flow (Branching & Cycling)
  - Graphing Results

- **Acknowledgements**

What is RSI IDL ?

- A meta-language
  - Instructions embed sets of basic instructions i.e. a single symbolic instruction performs a complex set of actions
- A non-compiled language
  - A set of instructions is compiled to an intermediate pseudo-code, which is executed at run-time, but no executable program is generated $\rightarrow$ the interpreter must always be running to execute the p-code
- A non-declarative language
  - It is not required to explicitly declare the typology of constants and variables
- An effective software package for image processing, numerics, data handling, graphing and analyzing
- A commercial software package
- A “de facto” standard in space and ground-based data analysis

Supported Platforms

- All
  - Windows
  - Mac OS X
  - Linux
  - Unix

- Detailed information → RSI web site

  http://www.rsinc.com

The IDL Development Environment

IDLDE

What is IDLDE?

- IDLDE is a Graphical User Interface (GUI) that allows to interactively build and run IDL codes, i.e.
  - – Editing IDL procedures
  - – Compiling IDL procedures
  - – Debugging IDL procedures
  - – Running IDL procedures
- IDLDE allows also direct command line control over most IDL features

Launching IDLDE

- At the command prompt type

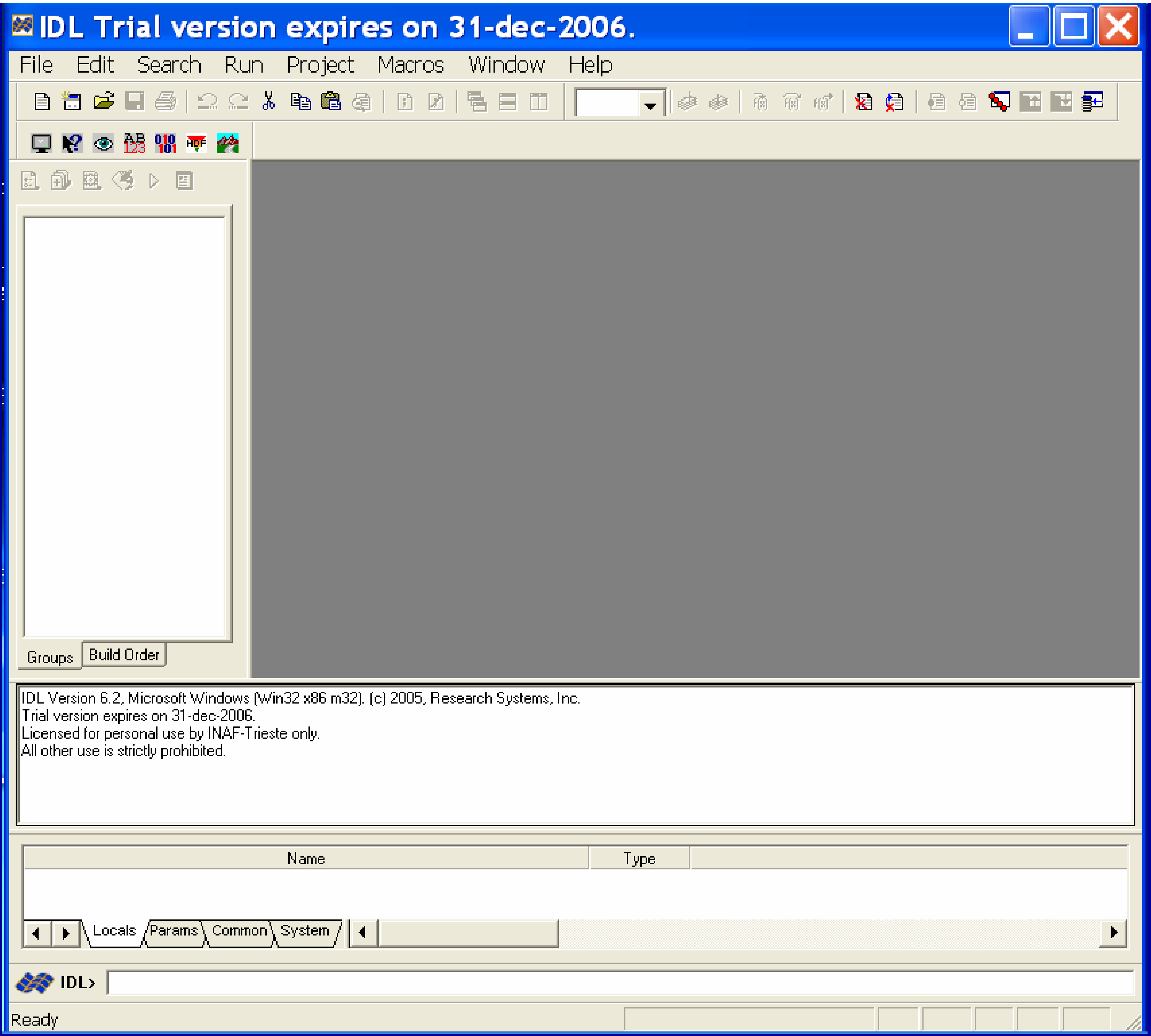
> idlde <Return>

OR

- Identify the program with the GUI and click on it

OR

- Click on the relevant icon on the Desktop



```
IDL Version 6.2, Microsoft Windows (Win32 x86 m32). (c) 2005, Research Systems, Inc.
Trial version expires on 31-dec-2006.
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All other use is strictly prohibited.
```

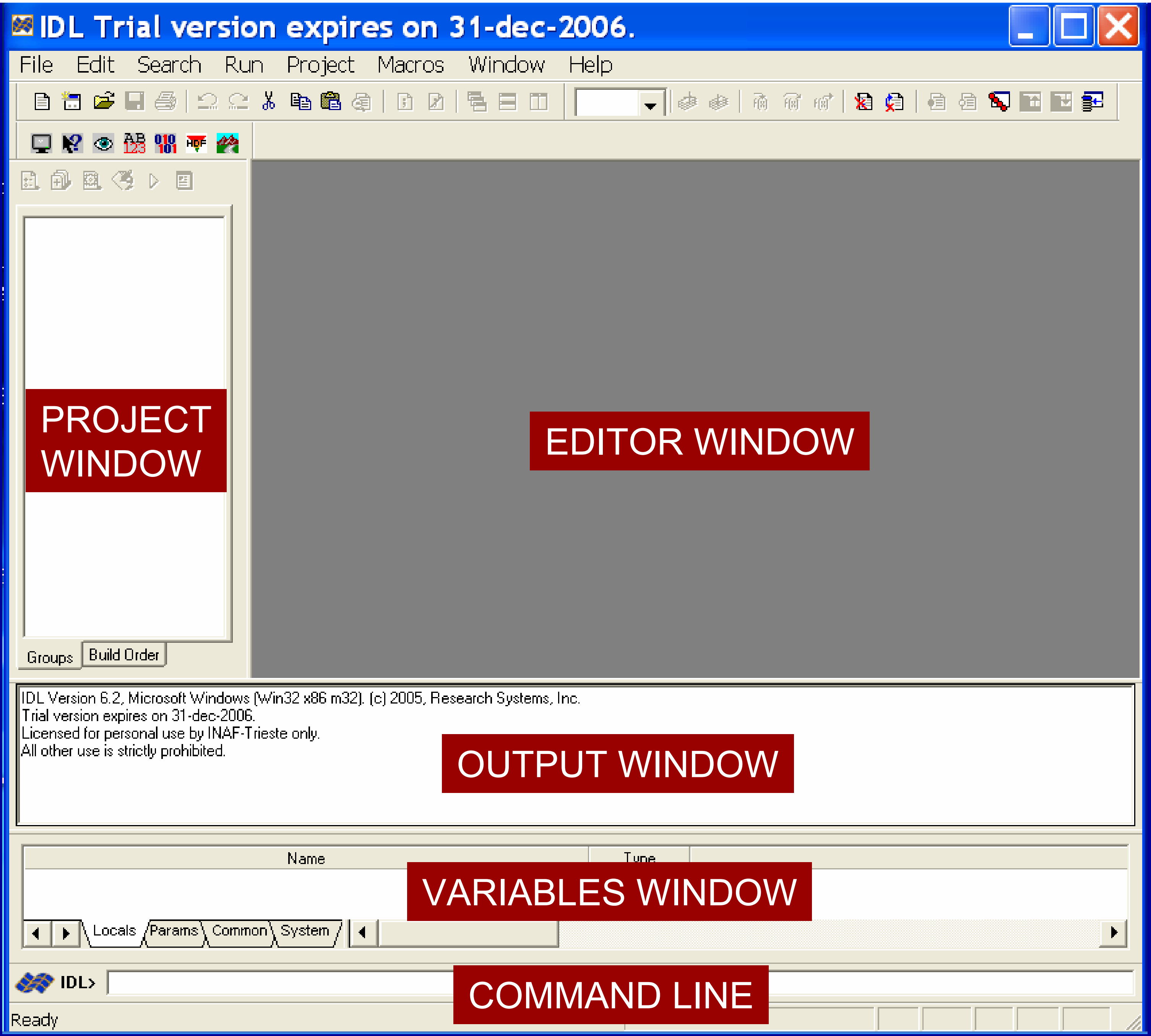

```
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```
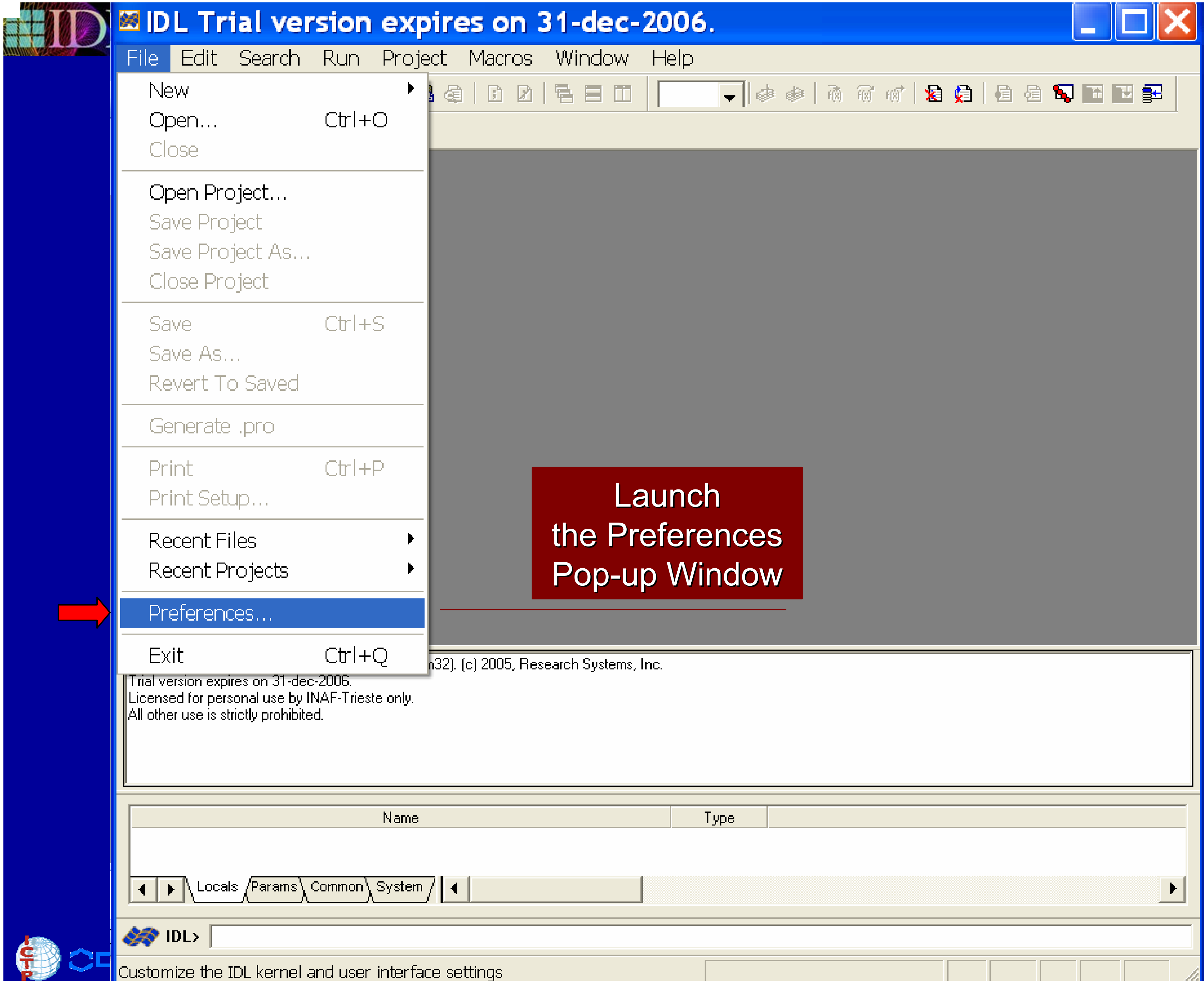

Setting IDLDE Preferences

Why IDL Preferences Setting?

The user can tune the way IDLDE is performing in all the phases of code development and code running to make all the phases more suitable to his/her way of operating and to the hardware/software platform by specifying the way the environment is managing e.g.:

- the editor
- the graphics
- the access to file and external libraries.



n32). (c) 2005, Research Systems, Inc.
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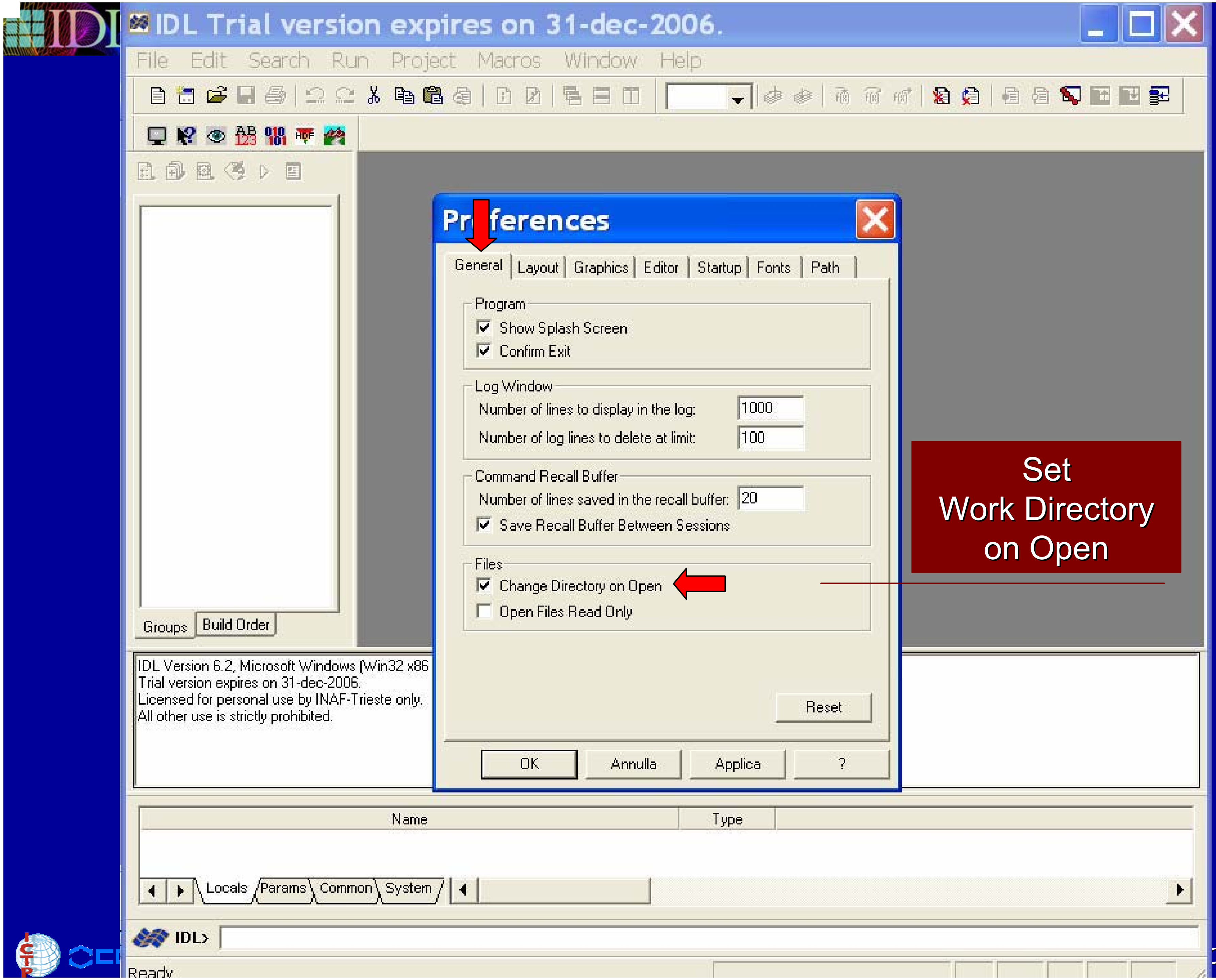
Customize the IDL kernel and user interface settings

Launch
the Preferences
Pop-up Window



Program
- [✓] Show Splash Screen
- [✓] Confirm Exit

Log Window

Number of lines to display in the log:	1000
Number of log lines to delete at limit:	100

Command Recall Buffer

Number of lines saved in the recall buffer:	20

- [✓] Save Recall Buffer Between Sessions

Files
- [✓] Change Directory on Open
- [ ] Open Files Read Only

```
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```
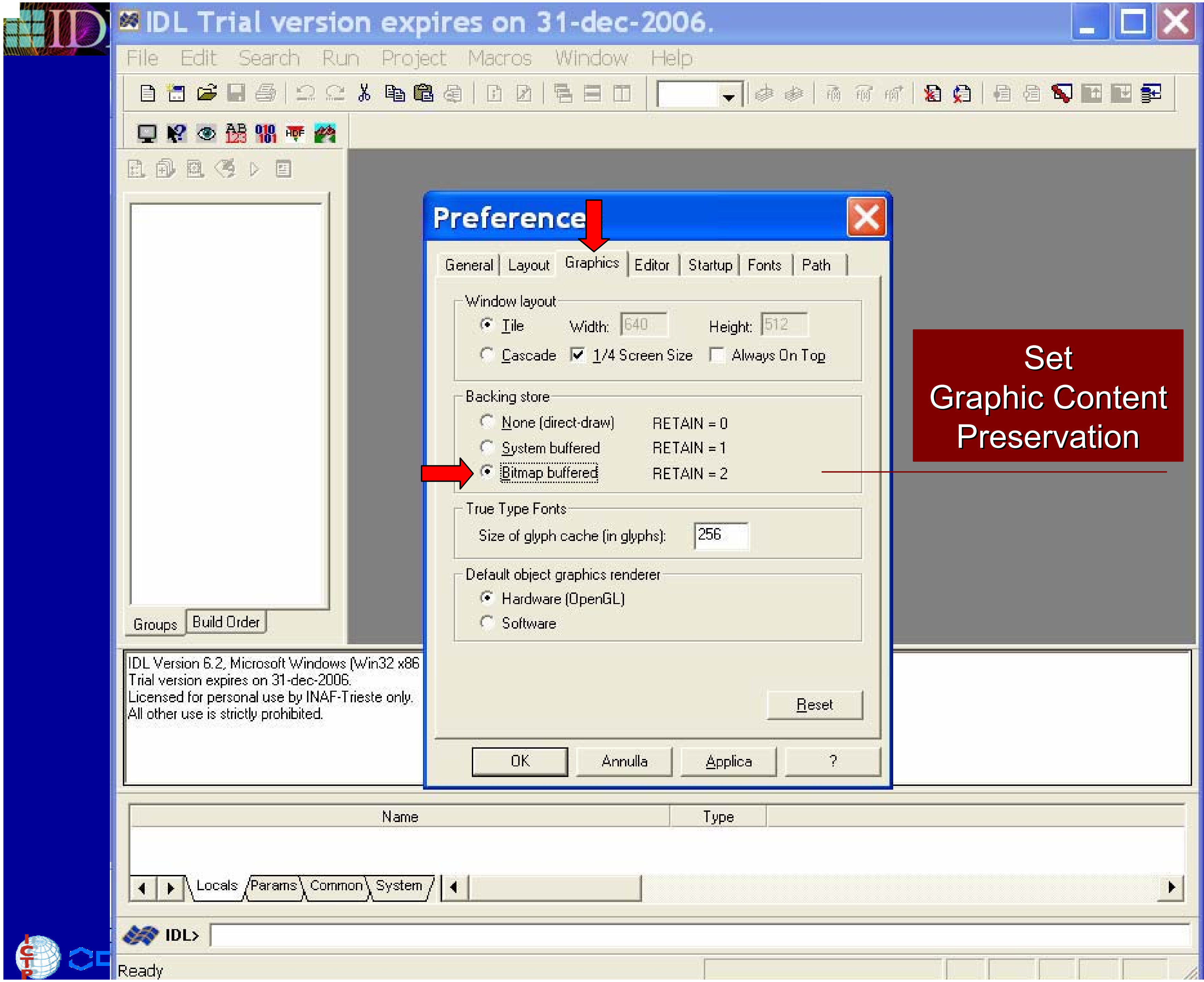

Set
Work Directory
on Open



IDL Trial version expires on 31-dec-2006.

Preference

General | Layout | Graphics | Editor | Startup | Fonts | Path

Window layout
- [✓ Tile] Width: 640 Height: 512
- Cascade [✓ 1/4 Screen Size] Always On Top

Backing store
- None (direct-draw) RETAIN = 0
- System buffered RETAIN = 1
- [✓ Bitmap buffered] RETAIN = 2

True Type Fonts
- Size of glyph cache (in glyphs): 256

Default object graphics renderer
- [✓ Hardware (OpenGL)]
- Software

```
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```
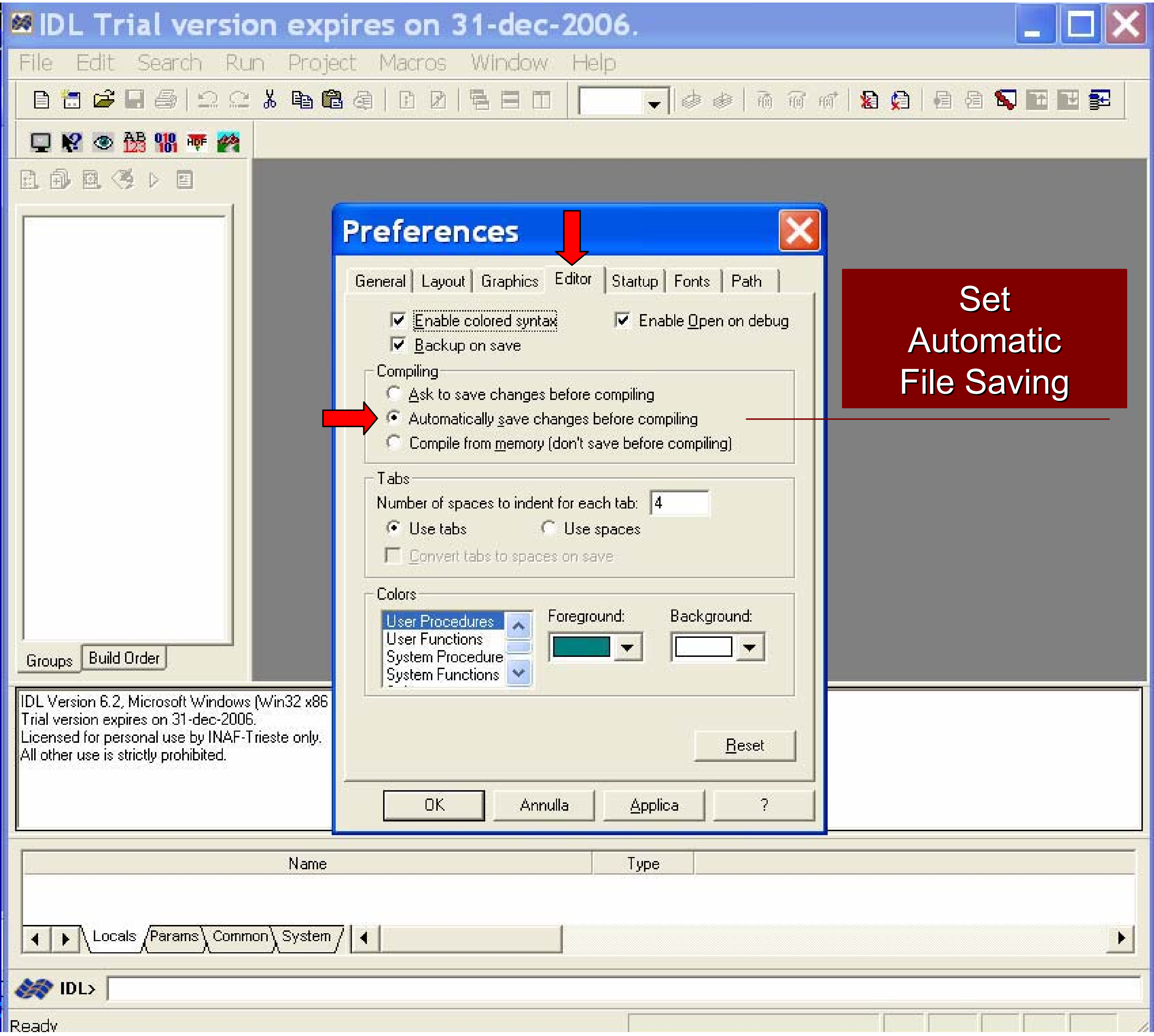

Set Graphic Content Preservation


IDL Trial version expires on 31-dec-2006.
File Edit Search Run Project Macros Window Help
Preferences
General Layout Graphics Editor Startup Fonts Path
Groups Build Order
Name Type
Locals Params Common System
IDL>
Ready
OK Annulla Applica ?
Reset

Preferences – Editor:

- [✓] Enable colored syntax
- [✓] Enable Open on debug
- [✓] Backup on save

Compiling

- ( ) Ask to save changes before compiling
- (●) Automatically save changes before compiling
- ( ) Compile from memory (don't save before compiling)

Tabs

Number of spaces to indent for each tab: 4

- (●) Use tabs
- ( ) Use spaces
- [ ] Convert tabs to spaces on save

Colors

User Procedures, User Functions, System Procedure, System Functions

Foreground: 🟦 Background: ⬜

```
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```
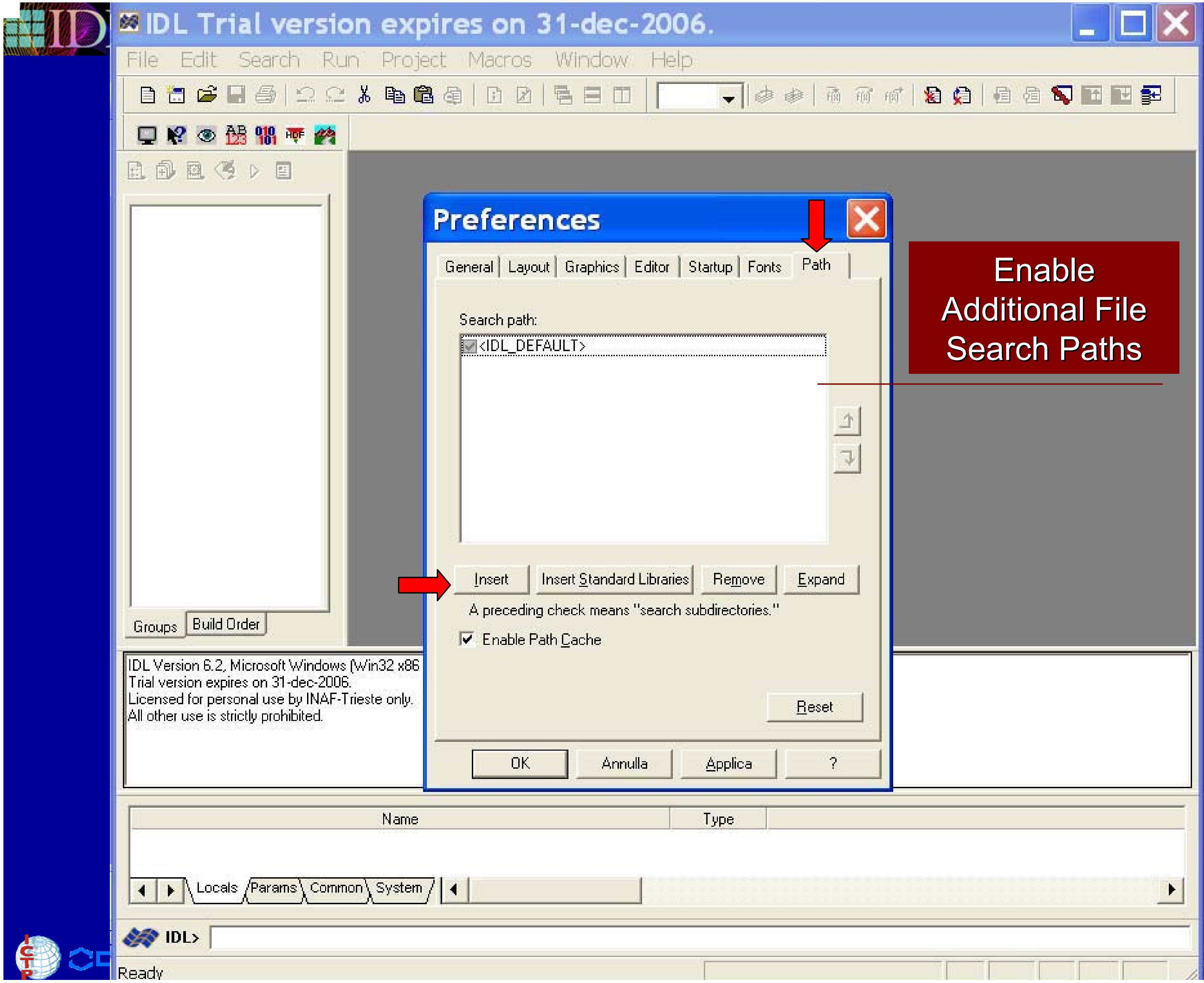

Set Automatic File Saving



IDL Trial version expires on 31-dec-2006.

Search path:

<IDL_DEFAULT>

A preceding check means "search subdirectories."

[✓] Enable Path Cache

```
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```

Ready

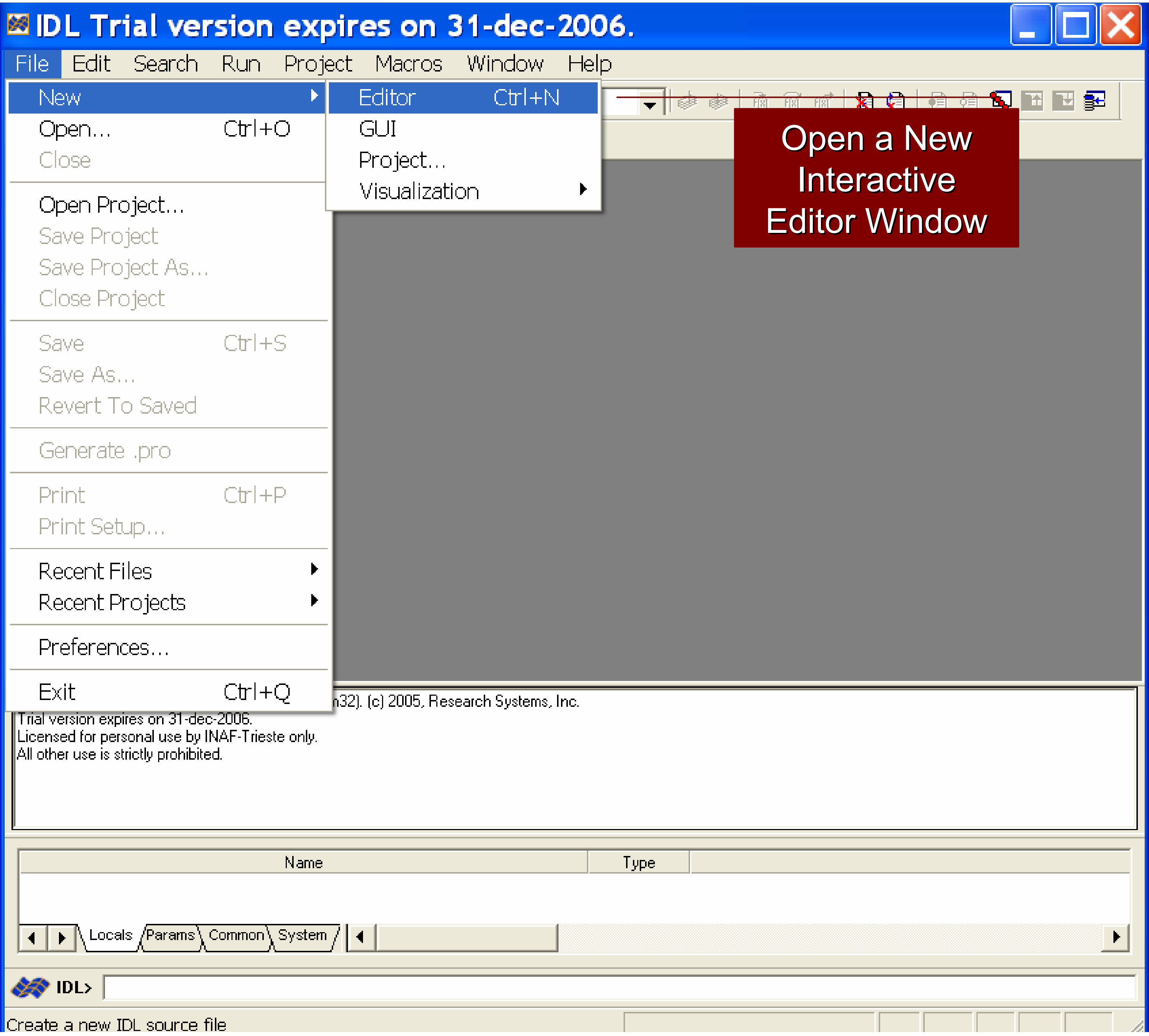
Enable Additional File Search Paths

The IDLDE GUI and Menu

IDLDE Menu Organization

The IDLDE Menu GUI is provided with:

- Selection TABS → Mouse operated → Open sub-menu
- Selection ICONS → Mouse operated → Activate processes
- Interactive Windows → Mouse and Keyboard text entry
- Console Window → Display IDL messages & code printouts
- Diagnostic Window → Display System and Code Variables
- Command Line → Keyboard operated → Command entry



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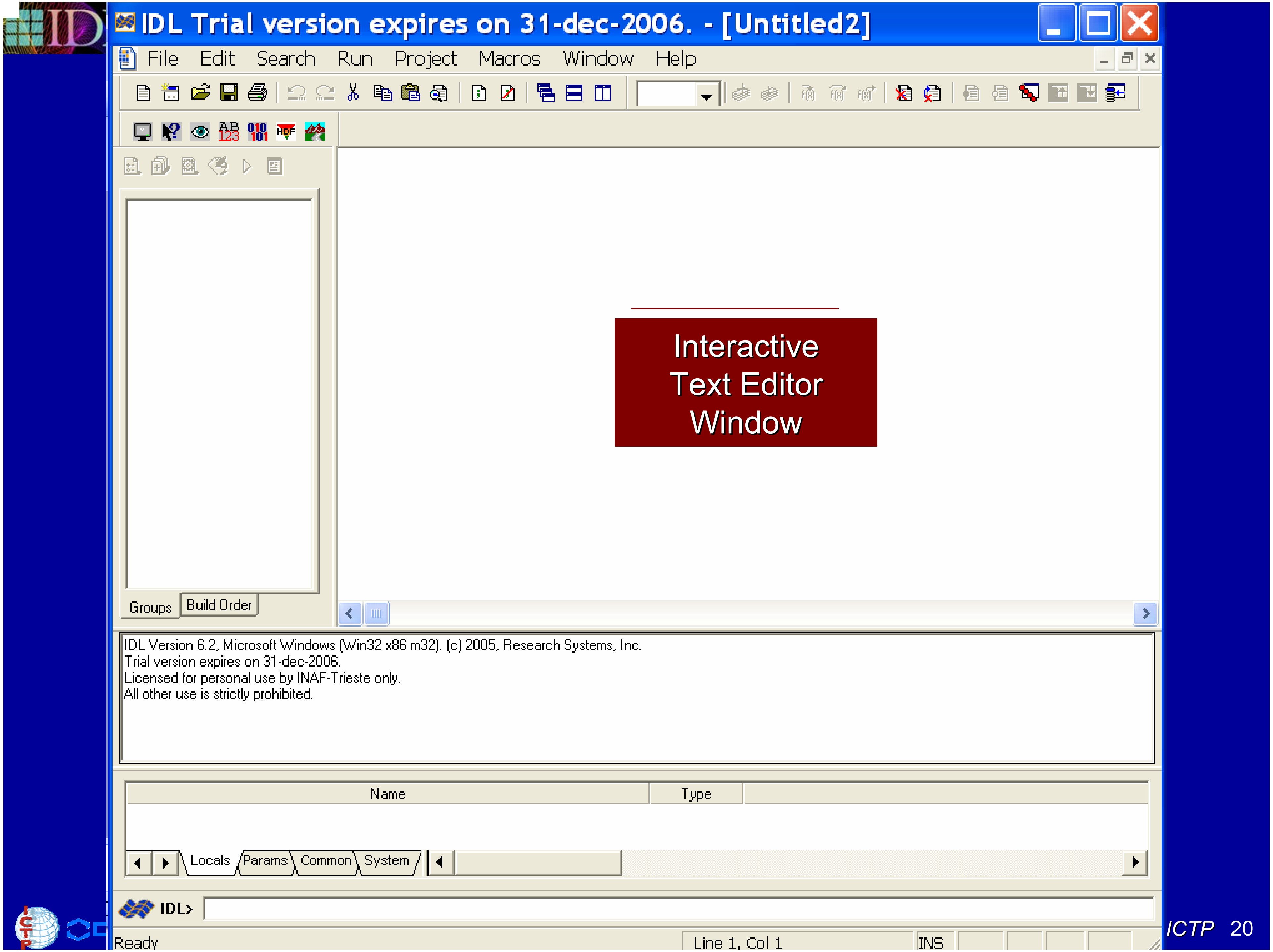
Create a new IDL source file

Open a New Interactive Editor Window



Interactive Text Editor Window

```
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```
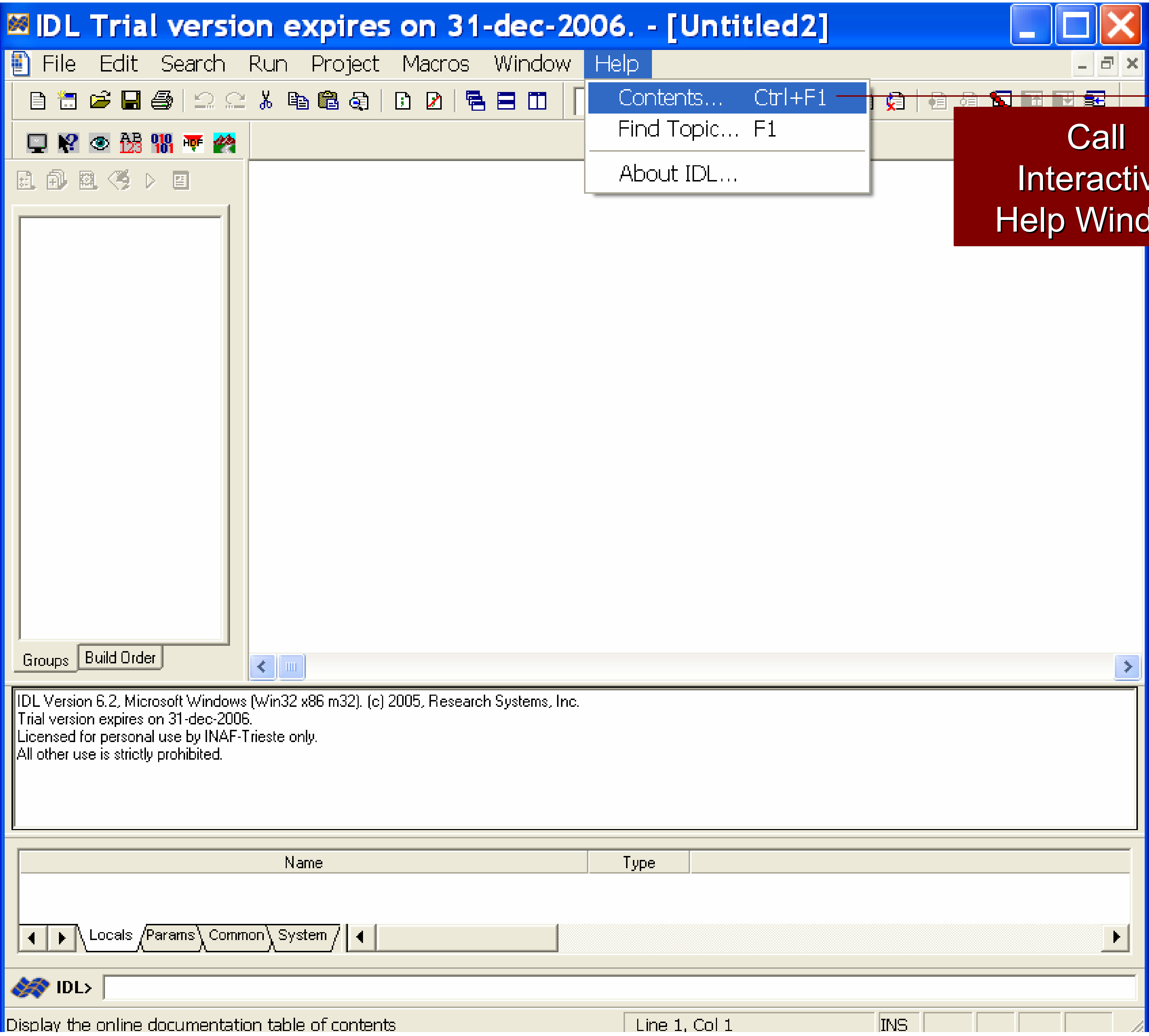

Ready | Line 1, Col 1 | INS

Using the Online Help



```
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```
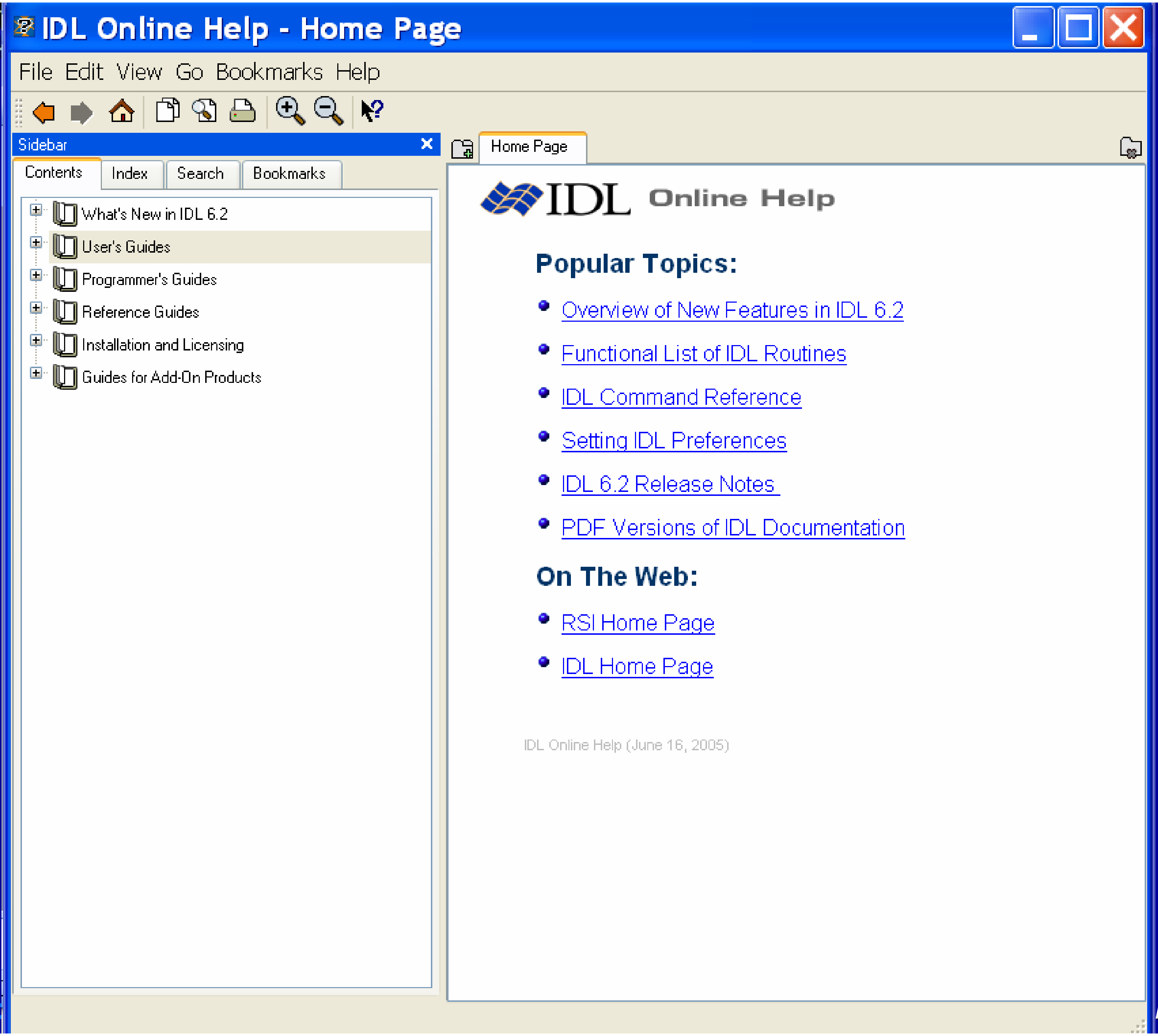

Call Interactive Help Window



IDL Online Help - Home Page

File Edit View Go Bookmarks Help

Sidebar

Contents | Index | Search | Bookmarks

- What's New in IDL 6.2
- User's Guides
- Programmer's Guides
- Reference Guides
- Installation and Licensing
- Guides for Add-On Products

Home Page

IDL Online Help

Popular Topics:

- Overview of New Features in IDL 6.2
- Functional List of IDL Routines
- IDL Command Reference
- Setting IDL Preferences
- IDL 6.2 Release Notes
- PDF Versions of IDL Documentation

On The Web:

- RSI Home Page
- IDL Home Page

IDL Online Help (June 16, 2005)

Creating Procedures

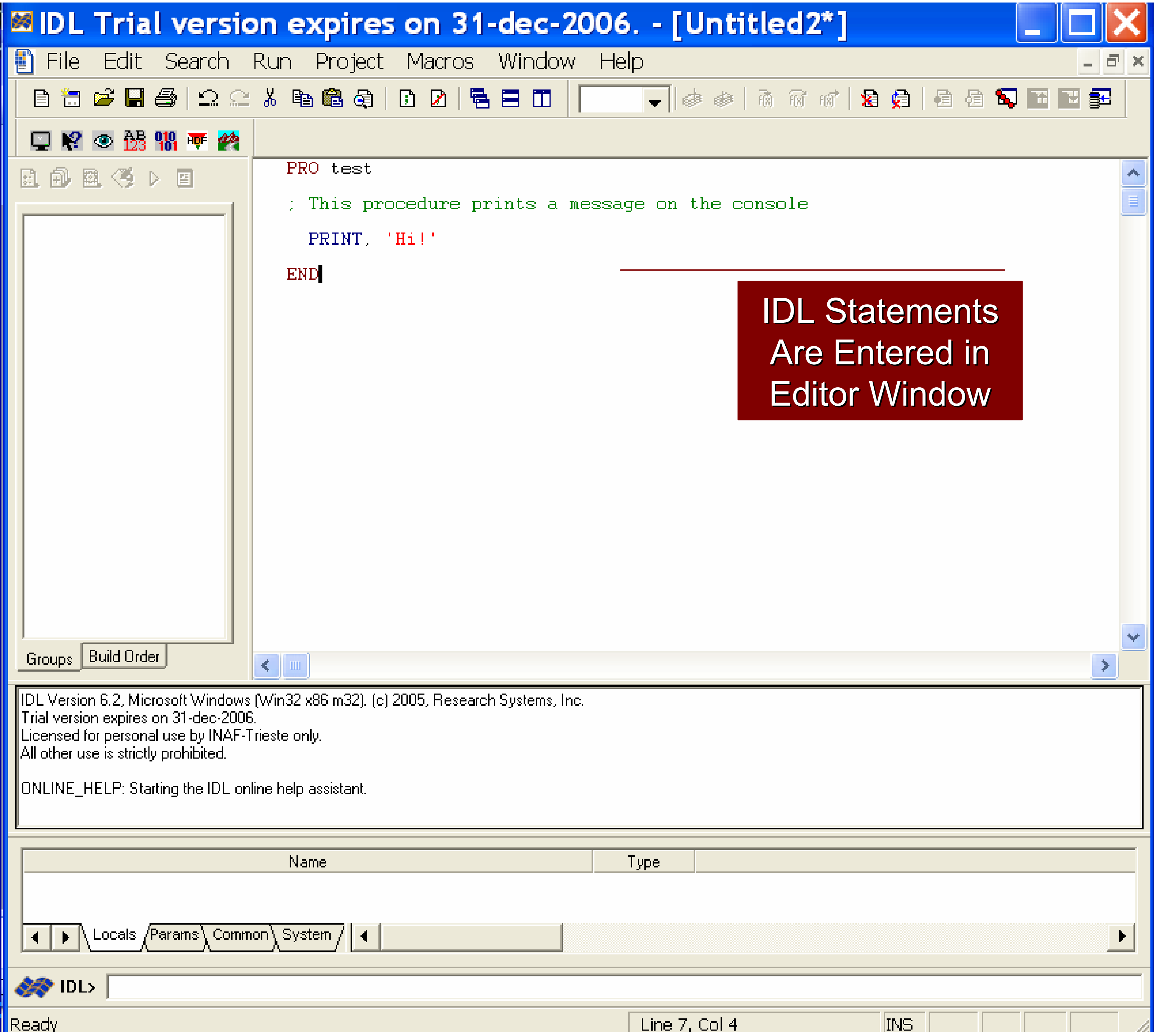
Steps in Creating Procedures

Any IDL procedure is just a text file made of IDL statements and it is created by:

1. Entering IDL statements via the embedded editor

2. Saving the text file with the prescriptions:
   - The file name must be the same as the procedure's name.
   - The file extension must be "pro".

e.g. procedurename.pro


IDL Trial version expires on 31-dec-2006. - [Untitled2*]
File Edit Search Run Project Macros Window Help
Groups Build Order
Name Type
Locals Params Common System
IDL>
Ready
Line 7, Col 4
INS

```
PRO test
; This procedure prints a message on the console
  PRINT, 'Hi!'
END
```

```
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ONLINE_HELP: Starting the IDL online help assistant.
```
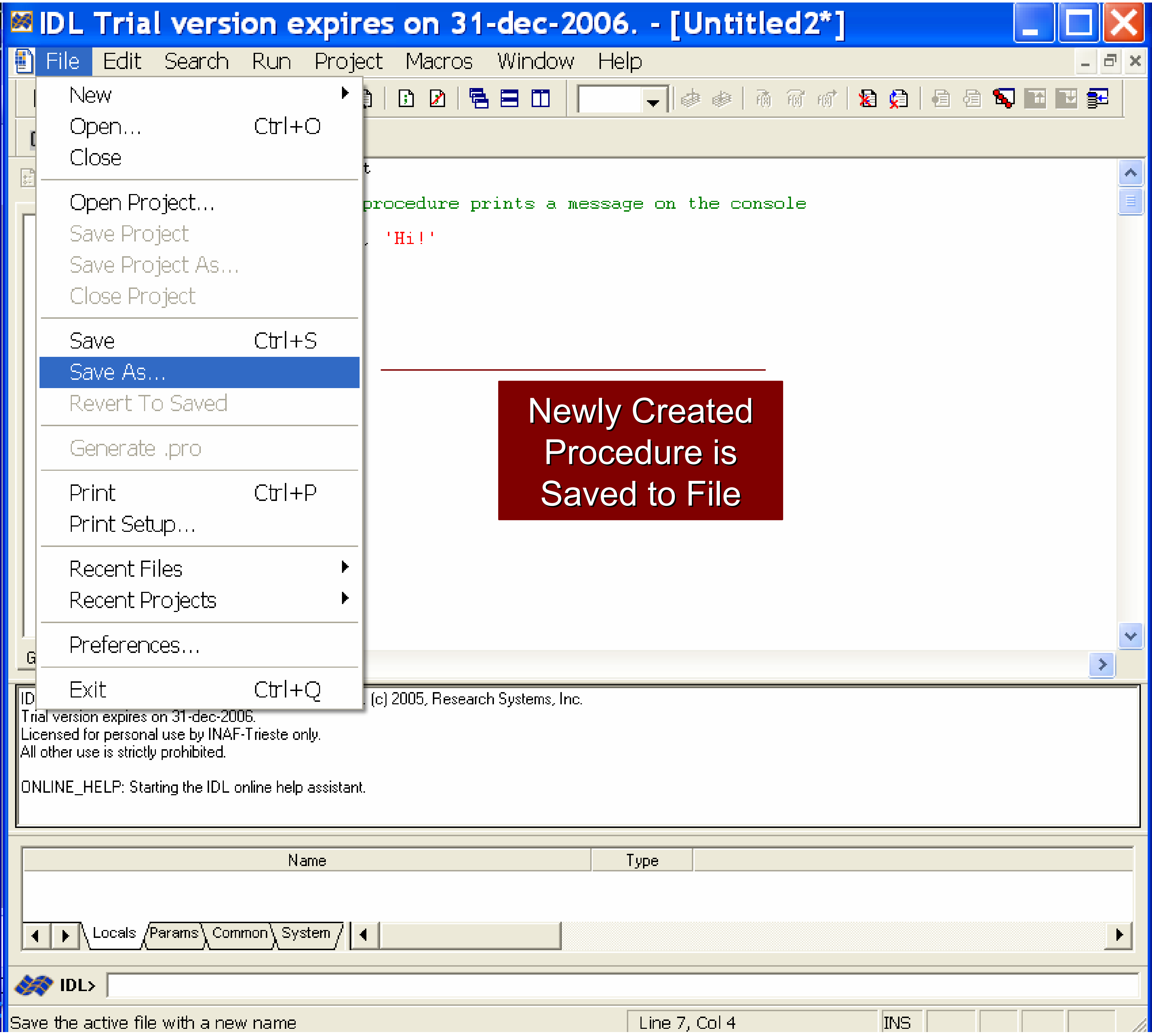

IDL Statements Are Entered in Editor Window



```
procedure prints a message on the console
, 'Hi!'
```

```
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ONLINE_HELP: Starting the IDL online help assistant.
```
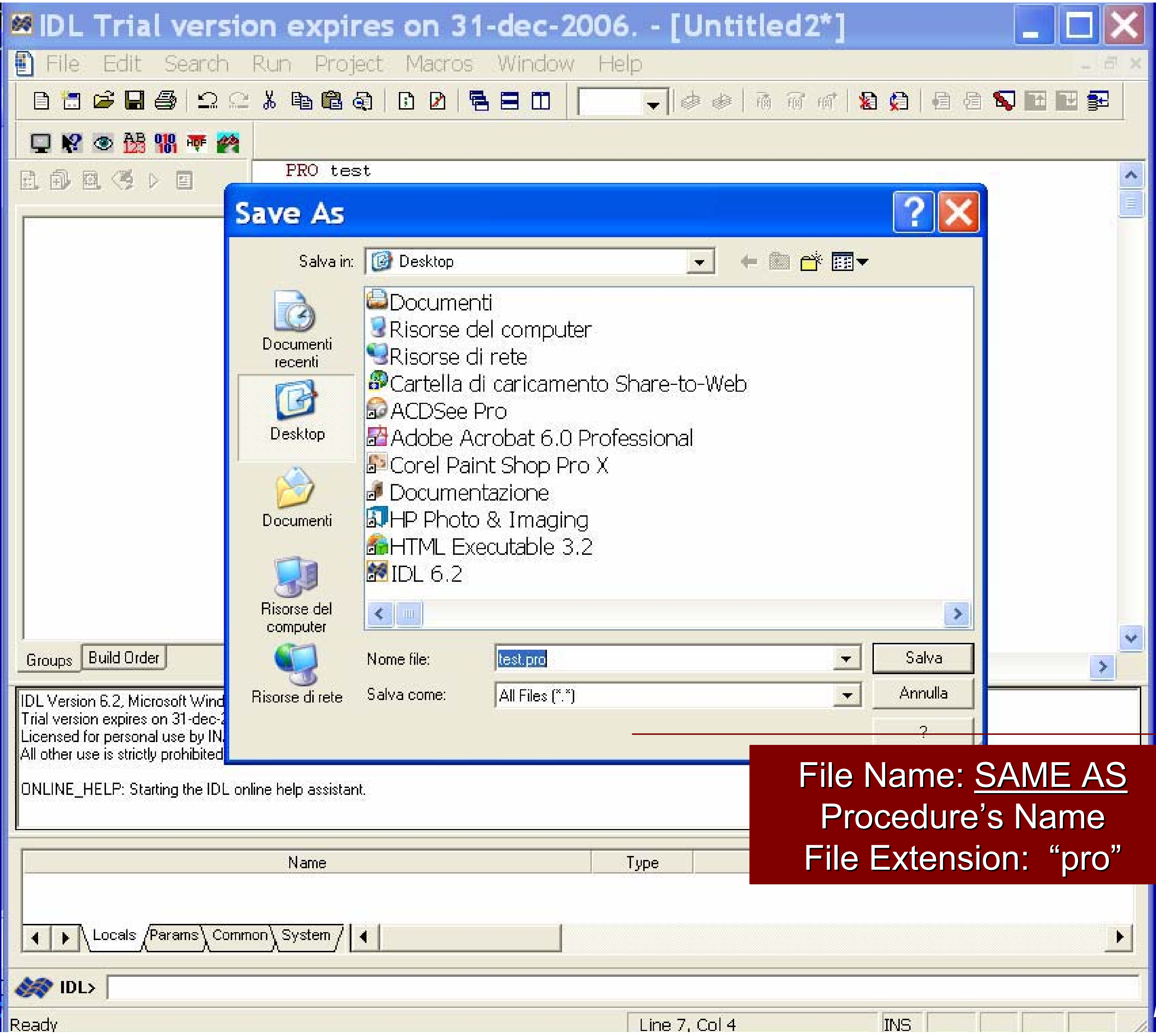

Newly Created Procedure is Saved to File



```
PRO test
```

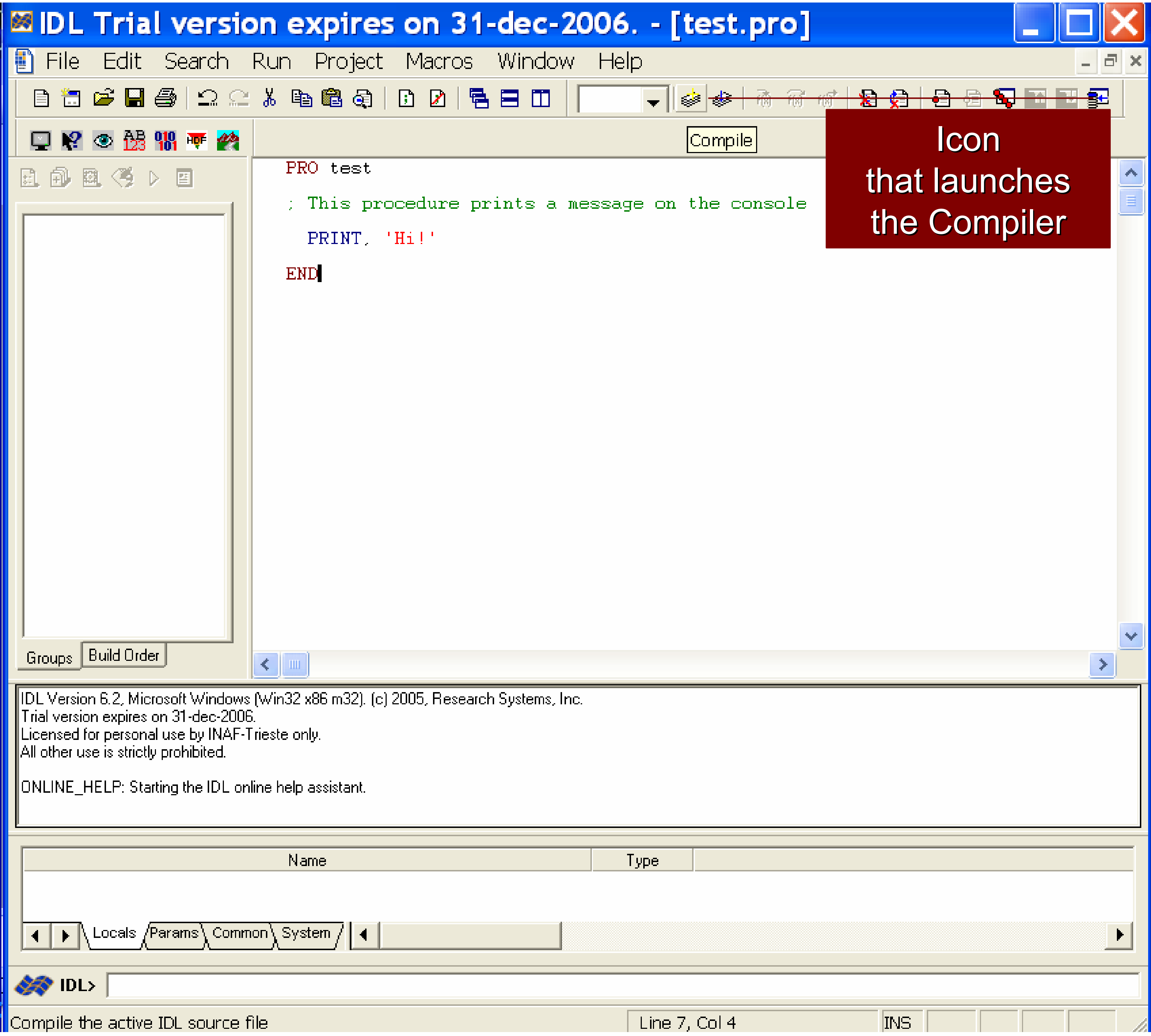
Nome file: test.pro

Salva come: All Files (*.*)

```
IDL Version 6.2, Microsoft Wind
Trial version expires on 31-dec-
Licensed for personal use by IN
All other use is strictly prohibited

ONLINE_HELP: Starting the IDL online help assistant.
```

File Name: SAME AS Procedure's Name
File Extension: "pro"

Compiling Procedures


IDL Trial version expires on 31-dec-2006. - [test.pro]
File Edit Search Run Project Macros Window Help
Compile
Groups
Build Order
Name
Type
Locals
Params
Common
System
IDL>

Icon that launches the Compiler

```
PRO test
; This procedure prints a message on the console
  PRINT, 'Hi!'
END
```

```
IDL Version 6.2, Microsoft Windows (Win32 x86 m32). (c) 2005, Research Systems, Inc.
Trial version expires on 31-dec-2006.
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ONLINE_HELP: Starting the IDL online help assistant.
```
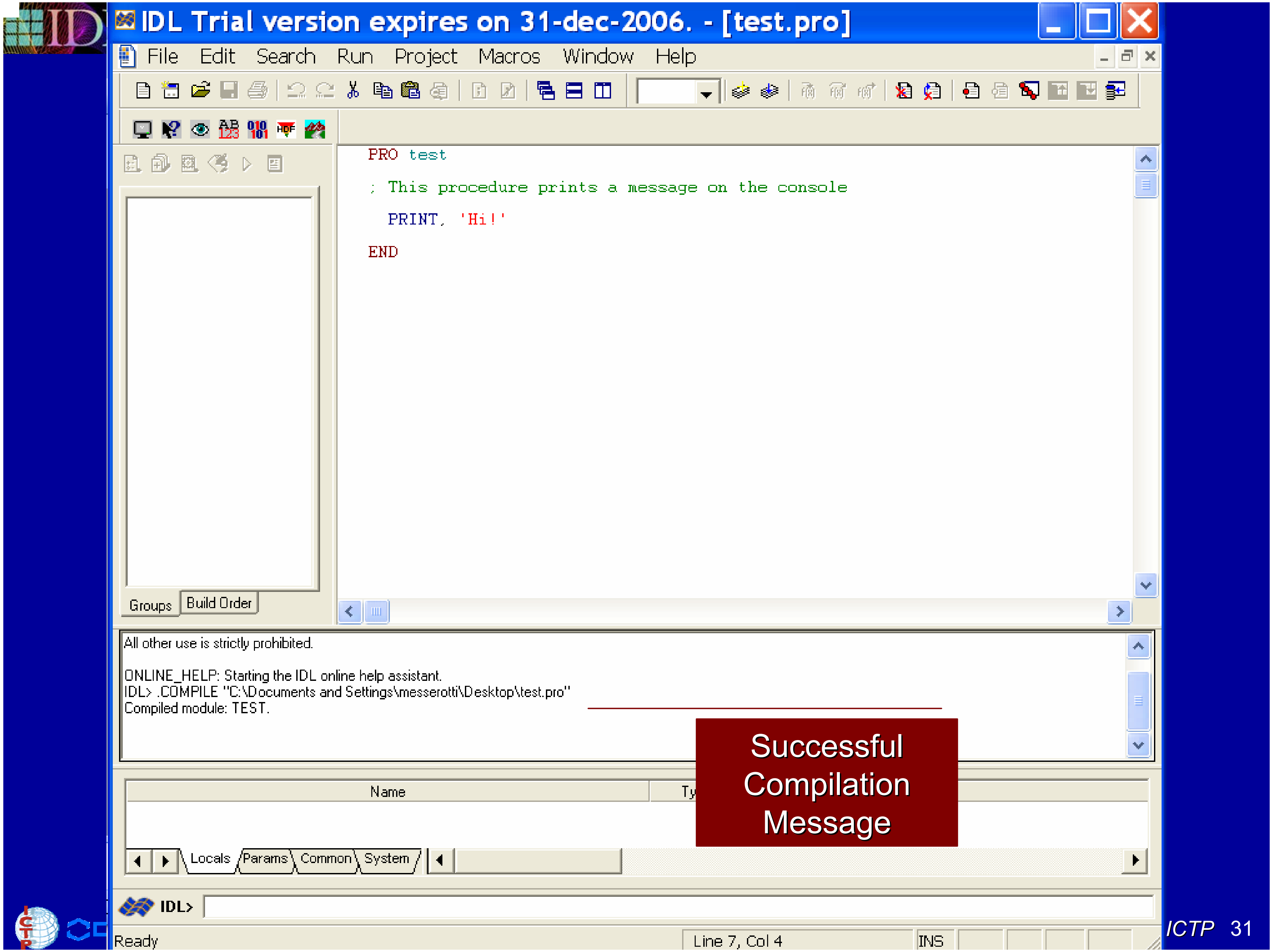

Compile the active IDL source file   Line 7, Col 4   INS

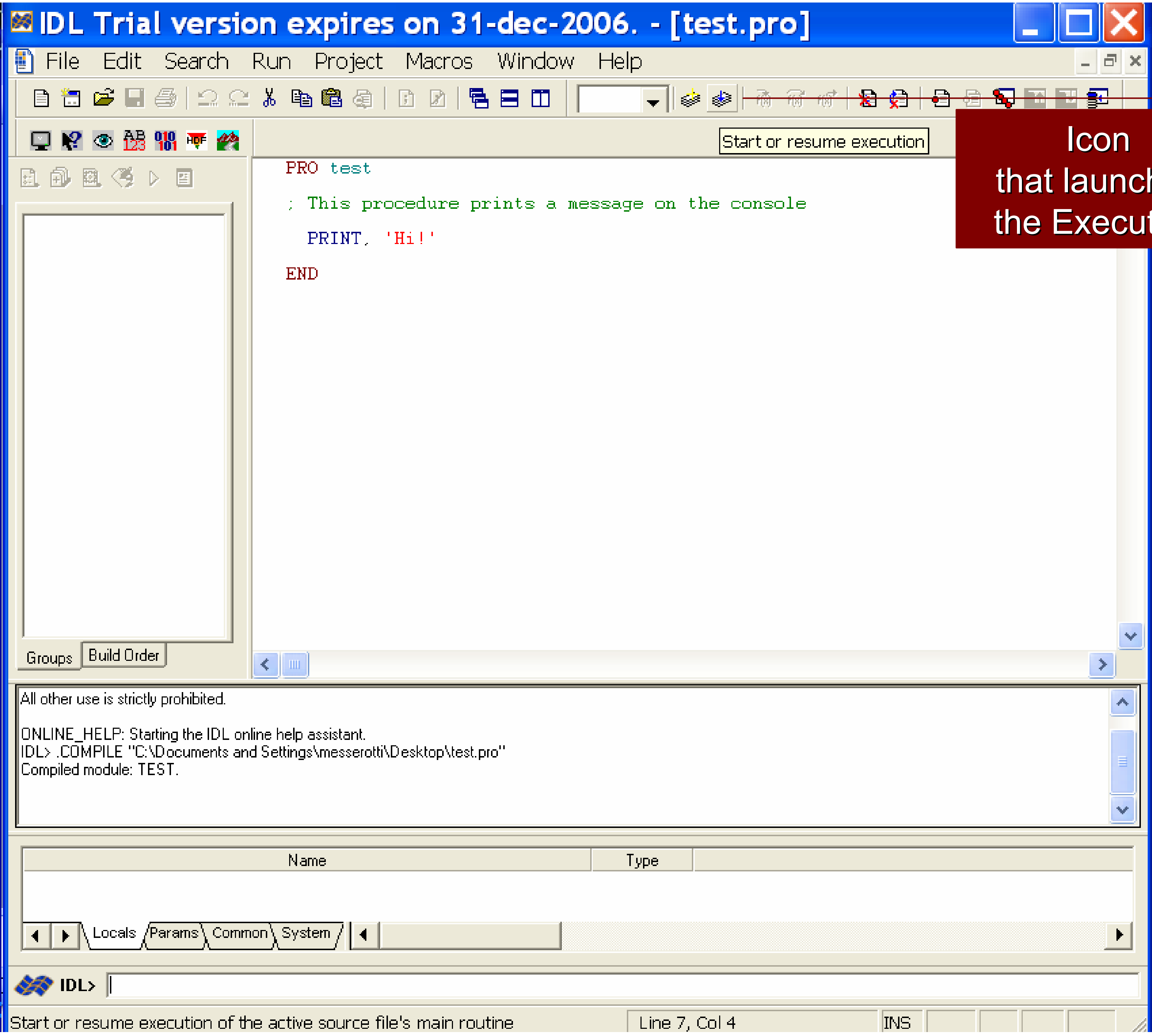

IDL Trial version expires on 31-dec-2006. - [test.pro]
File Edit Search Run Project Macros Window Help
Groups
Build Order
Name
Locals
Params
Common
System
IDL>
Ready
Line 7, Col 4
INS

```
PRO test
; This procedure prints a message on the console
  PRINT, 'Hi!'
END
```

```
All other use is strictly prohibited.

ONLINE_HELP: Starting the IDL online help assistant.
IDL> .COMPILE "C:\Documents and Settings\messerotti\Desktop\test.pro"
Compiled module: TEST.
```

Successful Compilation Message

Running Procedures

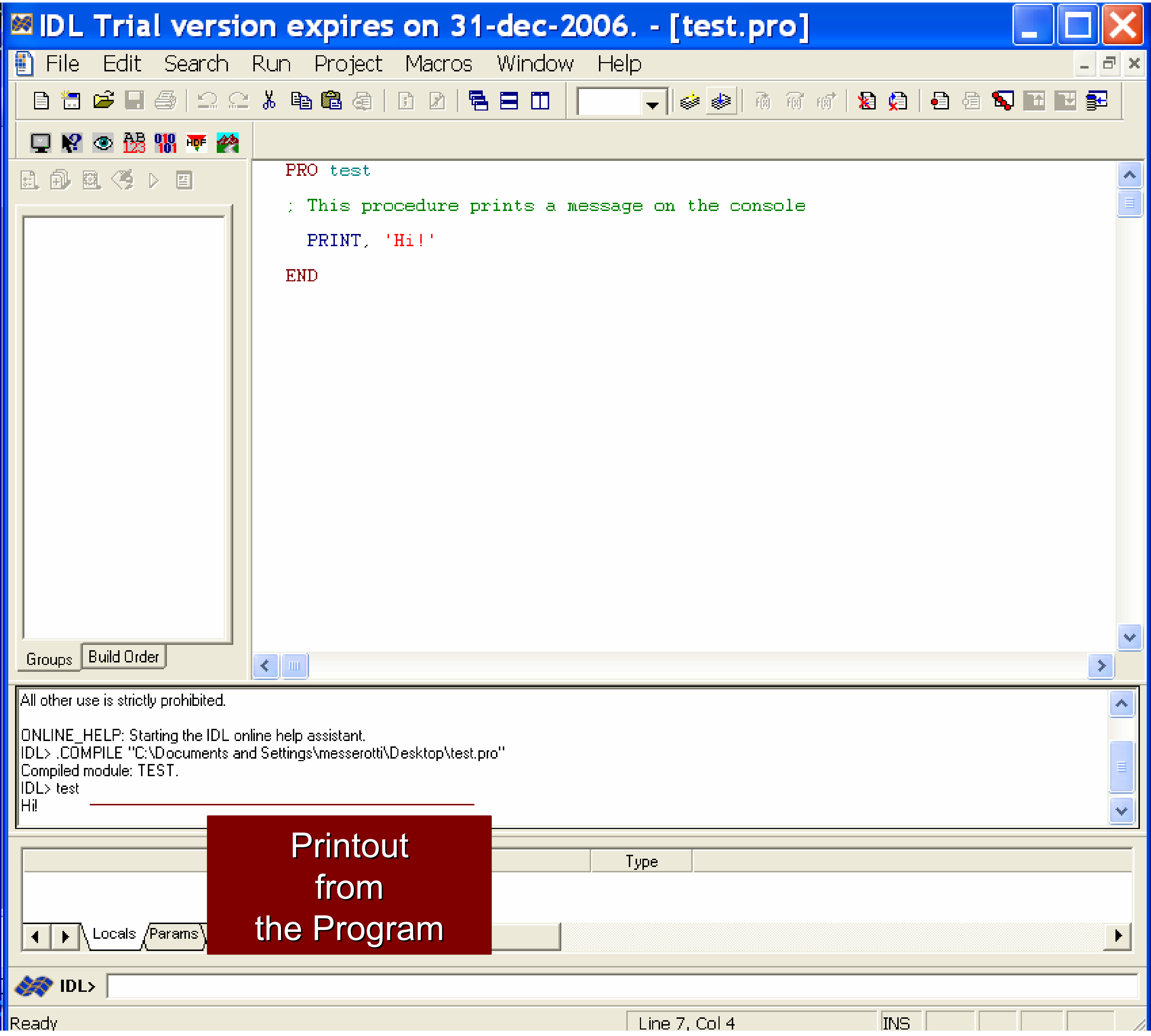

IDL Trial version expires on 31-dec-2006. - [test.pro]
File Edit Search Run Project Macros Window Help
Start or resume execution
Groups
Build Order
Name
Type
Locals
Params
Common
System
IDL>
Line 7, Col 4
INS

```
PRO test
; This procedure prints a message on the console
  PRINT, 'Hi!'
END
```

```
All other use is strictly prohibited.

ONLINE_HELP: Starting the IDL online help assistant.
IDL> .COMPILE "C:\Documents and Settings\messerotti\Desktop\test.pro"
Compiled module: TEST.
```

Start or resume execution of the active source file's main routine

Icon that launches the Execution


IDL Trial version expires on 31-dec-2006. - [test.pro]
File Edit Search Run Project Macros Window Help
Groups
Build Order
Type
Locals
Params
IDL>
Ready
Line 7, Col 4
INS

```
PRO test
; This procedure prints a message on the console
  PRINT, 'Hi!'
END
```

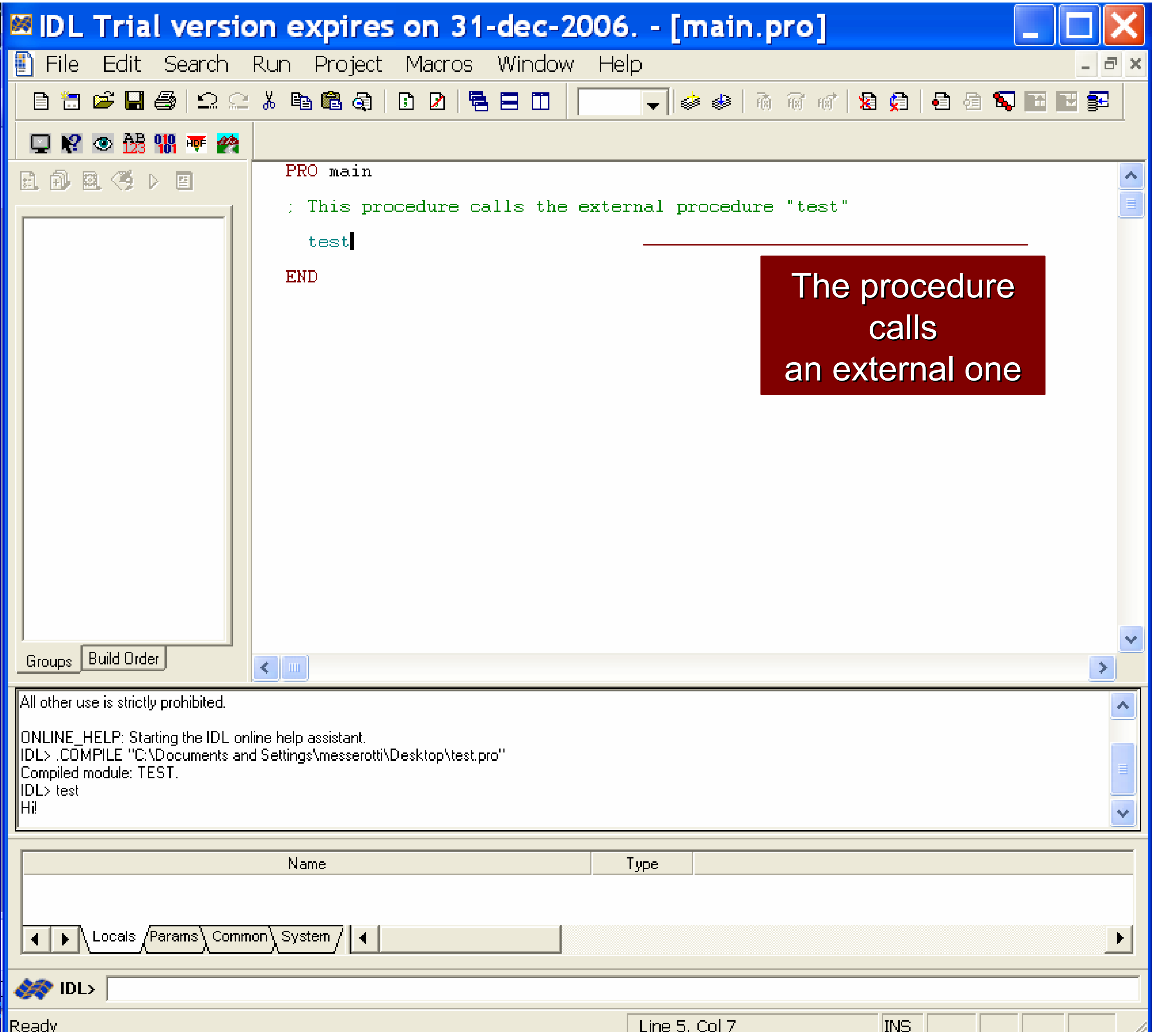
```
All other use is strictly prohibited.

ONLINE_HELP: Starting the IDL online help assistant.
IDL> .COMPILE "C:\Documents and Settings\messerotti\Desktop\test.pro"
Compiled module: TEST.
IDL> test
Hi!
```

Printout from the Program

Creating Projects

Why Projects ?

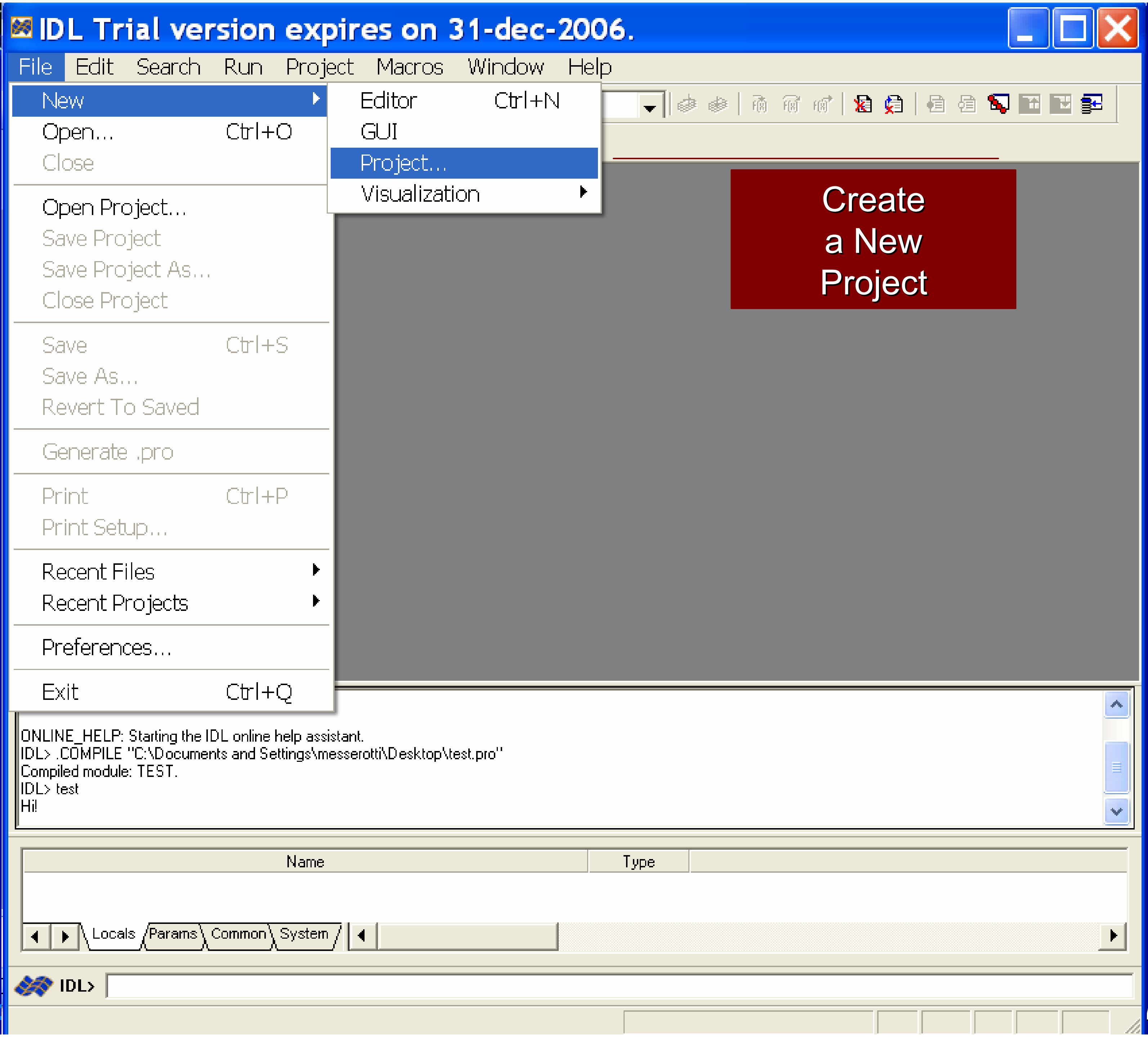
- An IDL code is calling external procedures and functions, i.e., IDL procedures that are stored
  - in the same directory as the calling code
  - in another directory
  - in other directories
- To avoid entering many path names via the Preferences menu


IDL Trial version expires on 31-dec-2006. - [main.pro]
File Edit Search Run Project Macros Window Help
Groups
Build Order
Name
Type
Locals
Params
Common
System
IDL>
Ready
Line 5, Col 7
INS

```
PRO main
; This procedure calls the external procedure "test"
  test
END
```

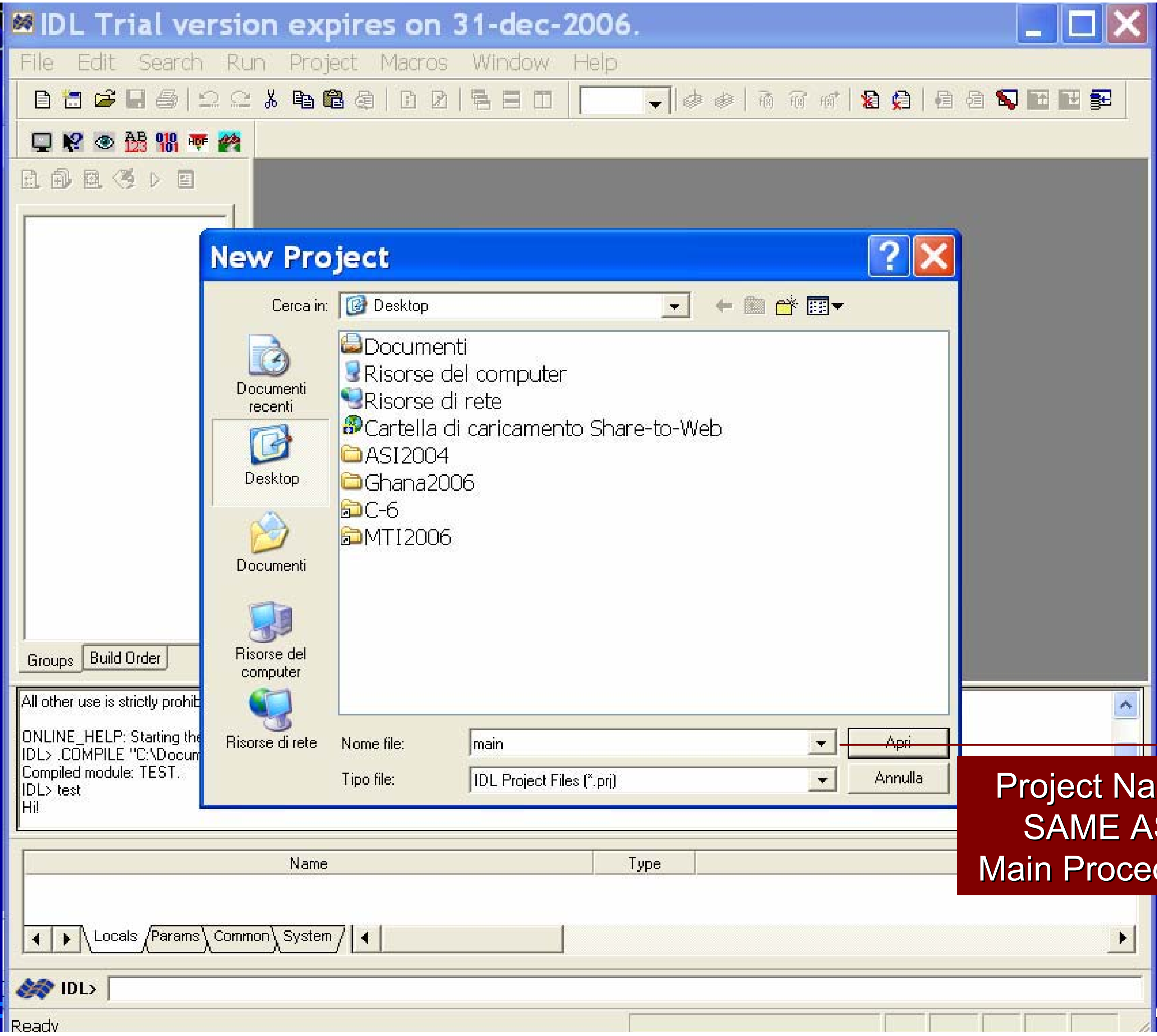
The procedure calls an external one

```
All other use is strictly prohibited.

ONLINE_HELP: Starting the IDL online help assistant.
IDL> .COMPILE "C:\Documents and Settings\messerotti\Desktop\test.pro"
Compiled module: TEST.
IDL> test
Hi!
```



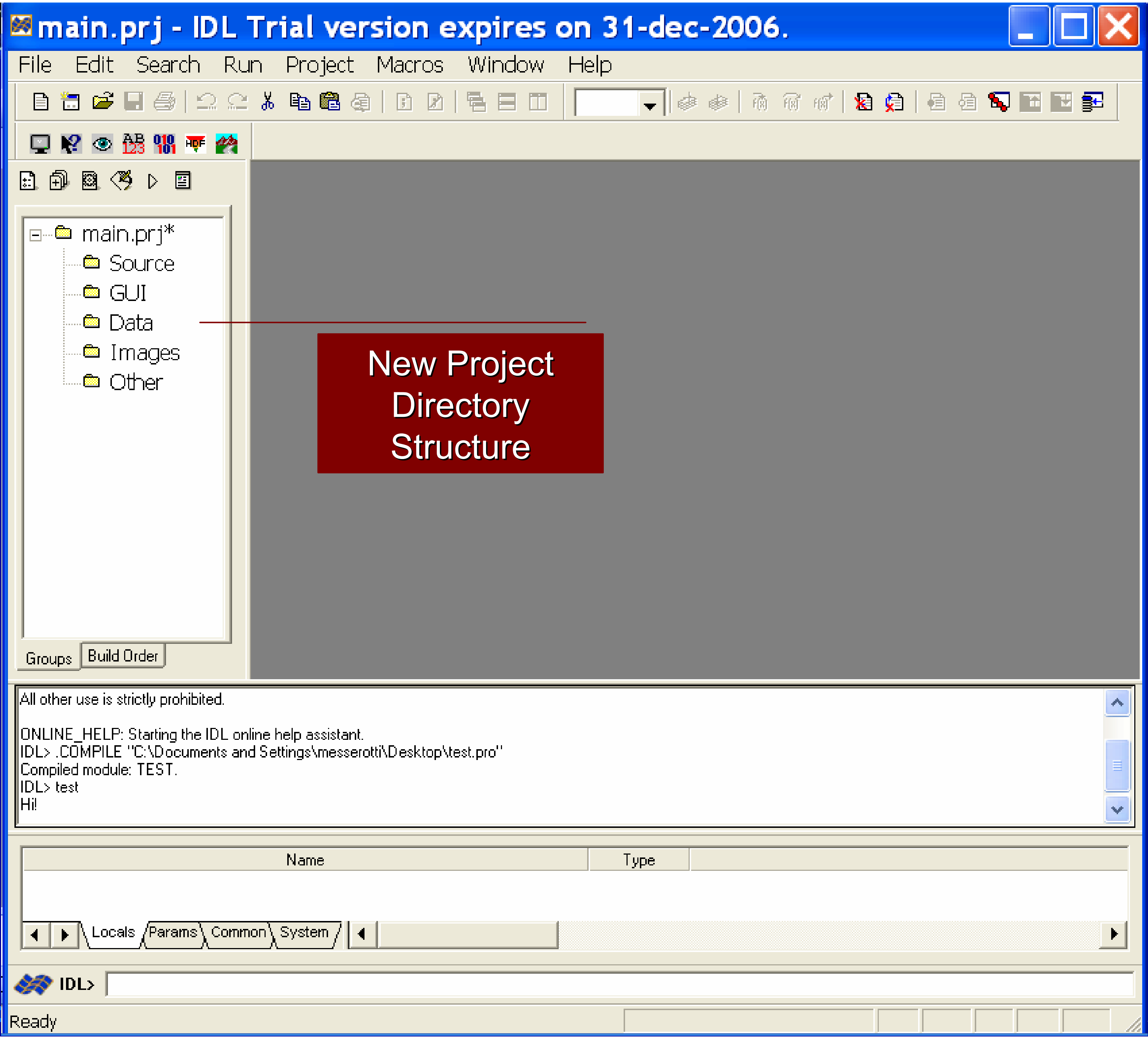
```
ONLINE_HELP: Starting the IDL online help assistant.
IDL> .COMPILE "C:\Documents and Settings\messerotti\Desktop\test.pro"
Compiled module: TEST.
IDL> test
Hi!
```

Create
a New
Project



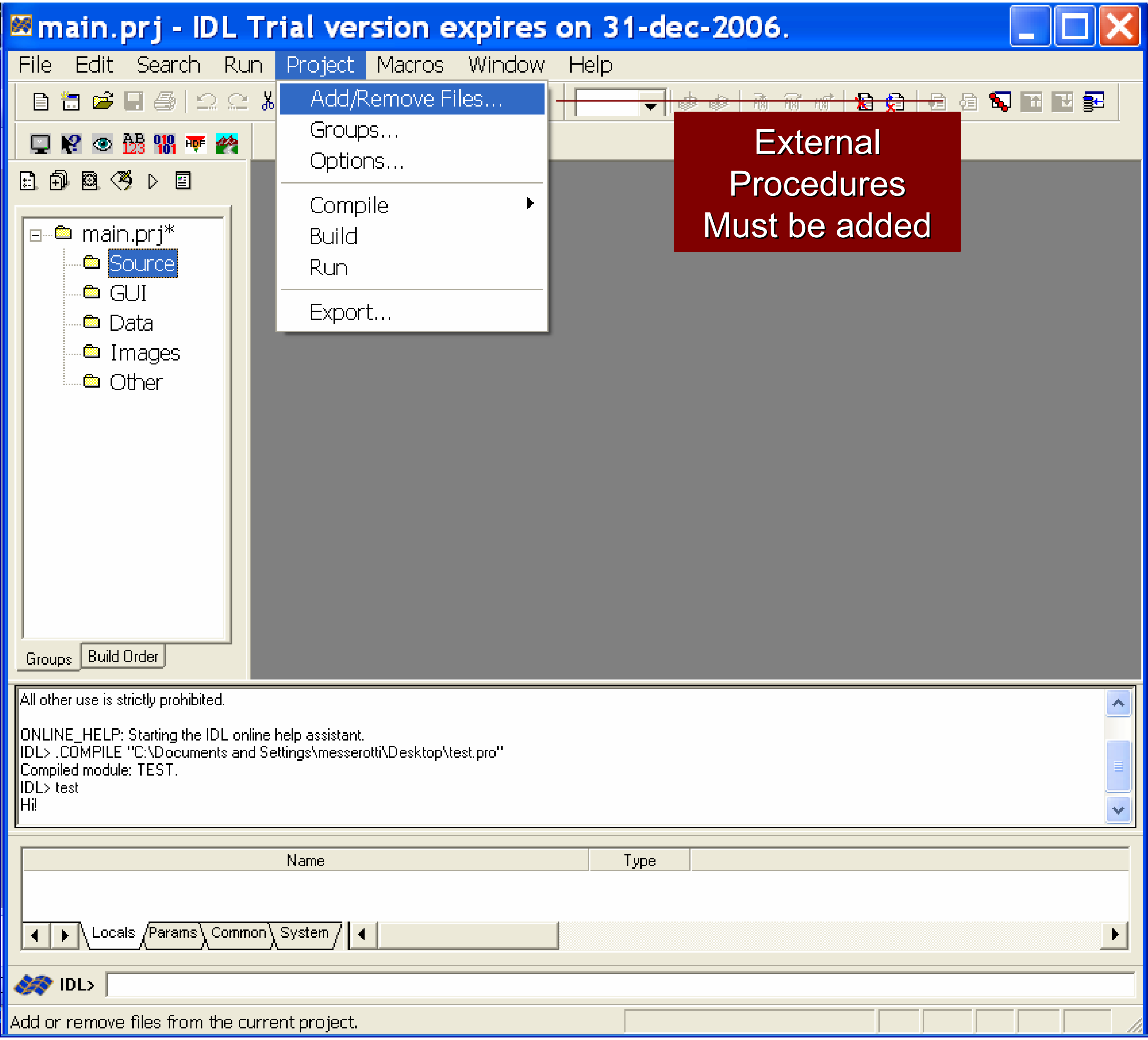
```
All other use is strictly prohib
ONLINE_HELP: Starting the
IDL> .COMPILE "C:\Docum
Compiled module: TEST.
IDL> test
Hi!
```

Project Name SAME AS Main Procedure



New Project Directory Structure

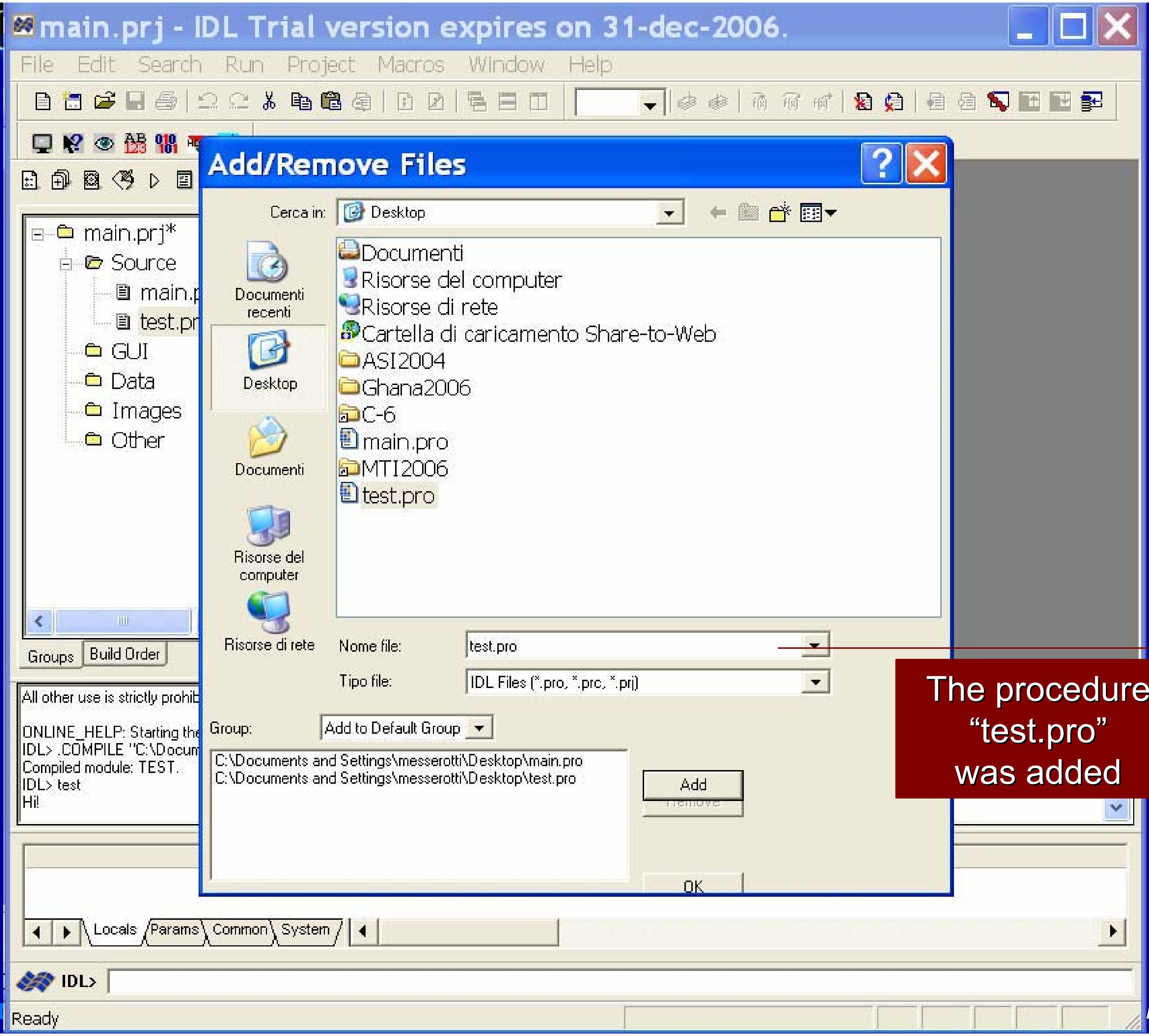
```
All other use is strictly prohibited.

ONLINE_HELP: Starting the IDL online help assistant.
IDL> .COMPILE "C:\Documents and Settings\messerotti\Desktop\test.pro"
Compiled module: TEST.
IDL> test
Hi!
```



```
All other use is strictly prohibited.

ONLINE_HELP: Starting the IDL online help assistant.
IDL> .COMPILE "C:\Documents and Settings\messerotti\Desktop\test.pro"
Compiled module: TEST.
IDL> test
Hi!
```

Add or remove files from the current project.

External Procedures Must be added

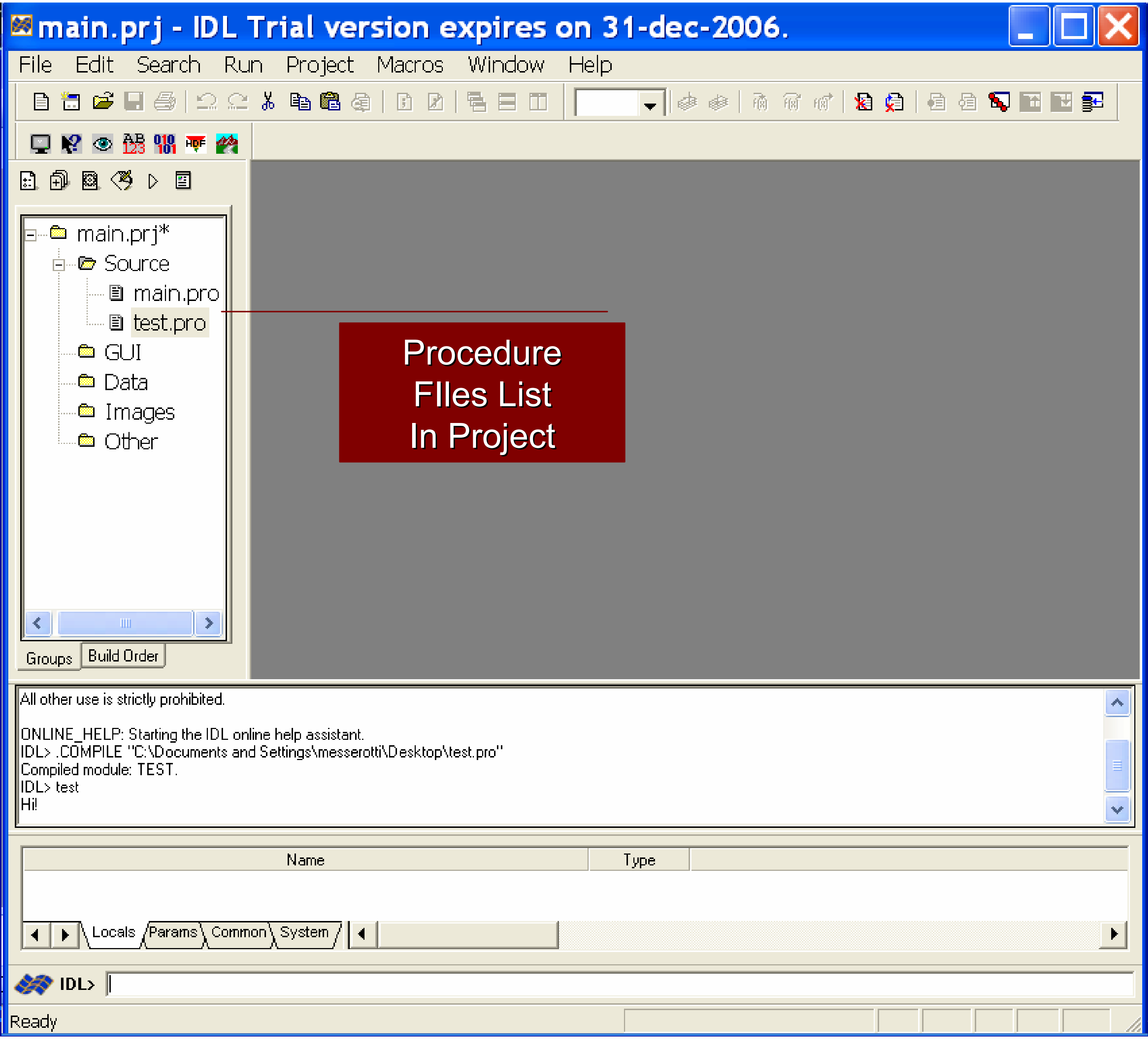


Nome file: test.pro
Tipo file: IDL Files (*.pro, *.prc, *.prj)
Group: Add to Default Group

```
C:\Documents and Settings\messerotti\Desktop\main.pro
C:\Documents and Settings\messerotti\Desktop\test.pro
```

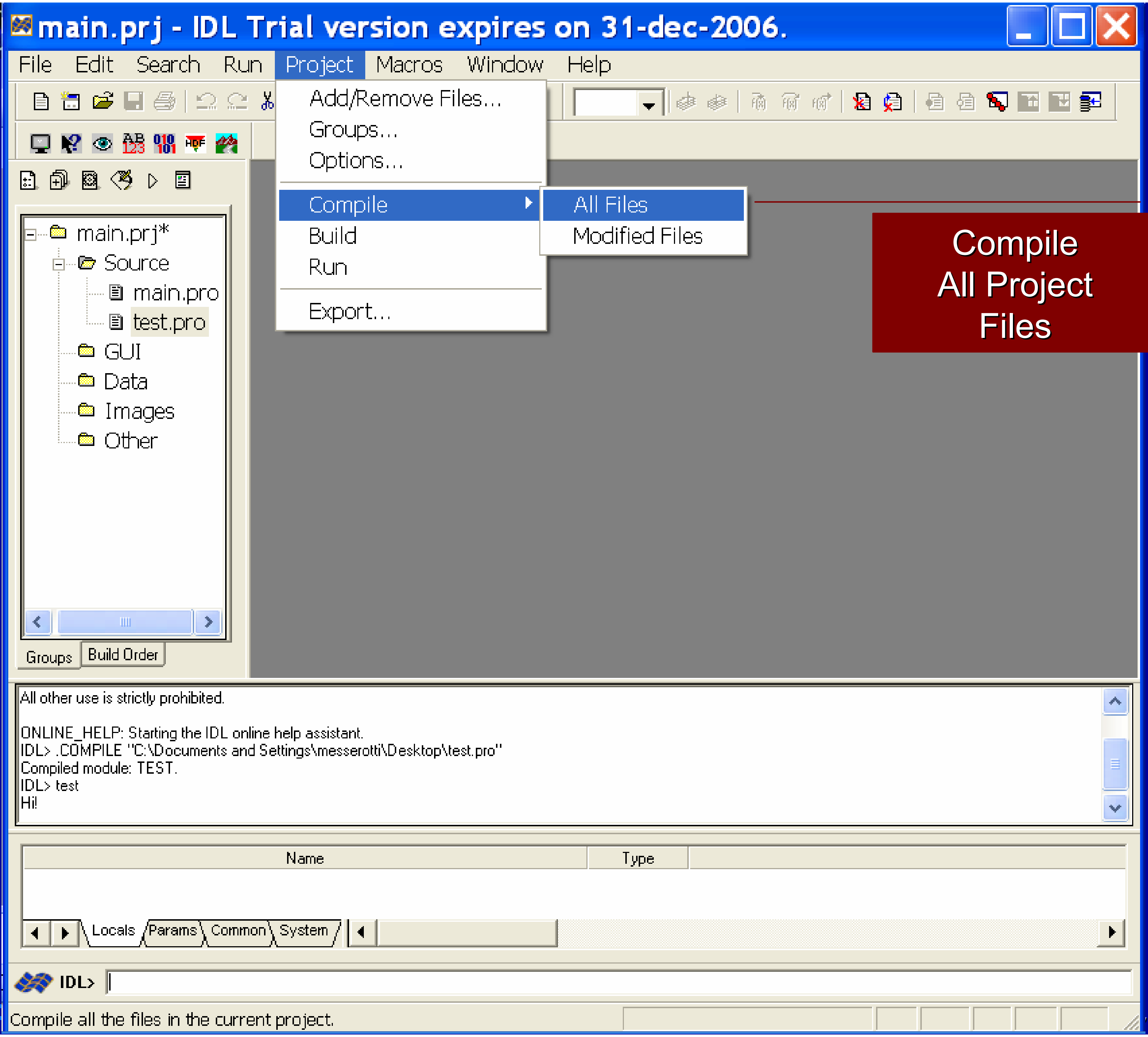
```
All other use is strictly prohib
ONLINE_HELP: Starting the
IDL> .COMPILE "C:\Docum
Compiled module: TEST.
IDL> test
Hi!
```

The procedure "test.pro" was added


main.prj - IDL Trial version expires on 31-dec-2006.
File Edit Search Run Project Macros Window Help
main.prj*
Source
main.pro
test.pro
GUI
Data
Images
Other
Groups
Build Order
Procedure FIles List In Project
Name
Type
Locals
Params
Common
System
IDL>
Ready

```
All other use is strictly prohibited.

ONLINE_HELP: Starting the IDL online help assistant.
IDL> .COMPILE "C:\Documents and Settings\messerotti\Desktop\test.pro"
Compiled module: TEST.
IDL> test
Hi!
```

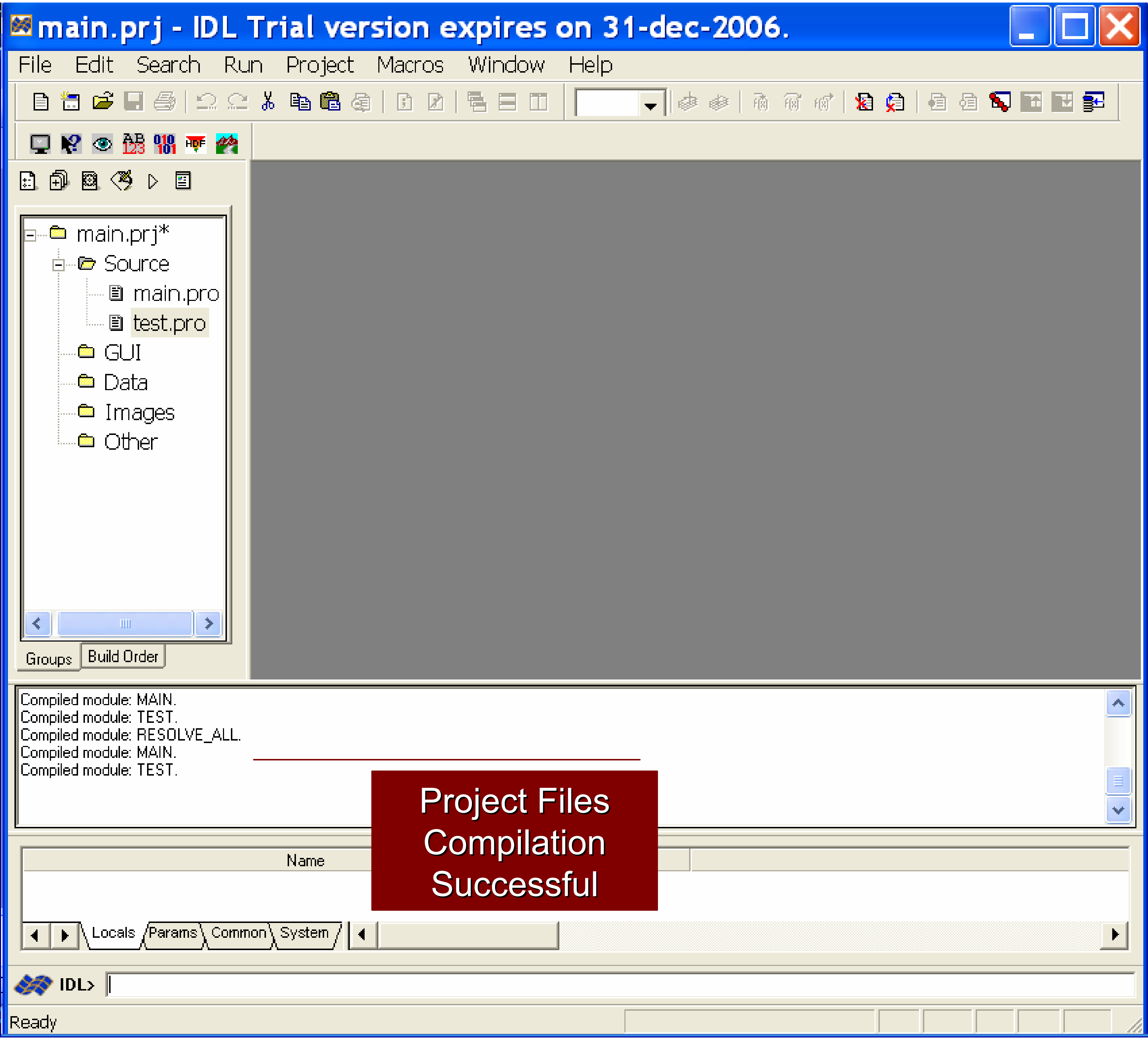
Compiling Projects



```
All other use is strictly prohibited.

ONLINE_HELP: Starting the IDL online help assistant.
IDL> .COMPILE "C:\Documents and Settings\messerotti\Desktop\test.pro"
Compiled module: TEST.
IDL> test
Hi!
```

Compile all the files in the current project.

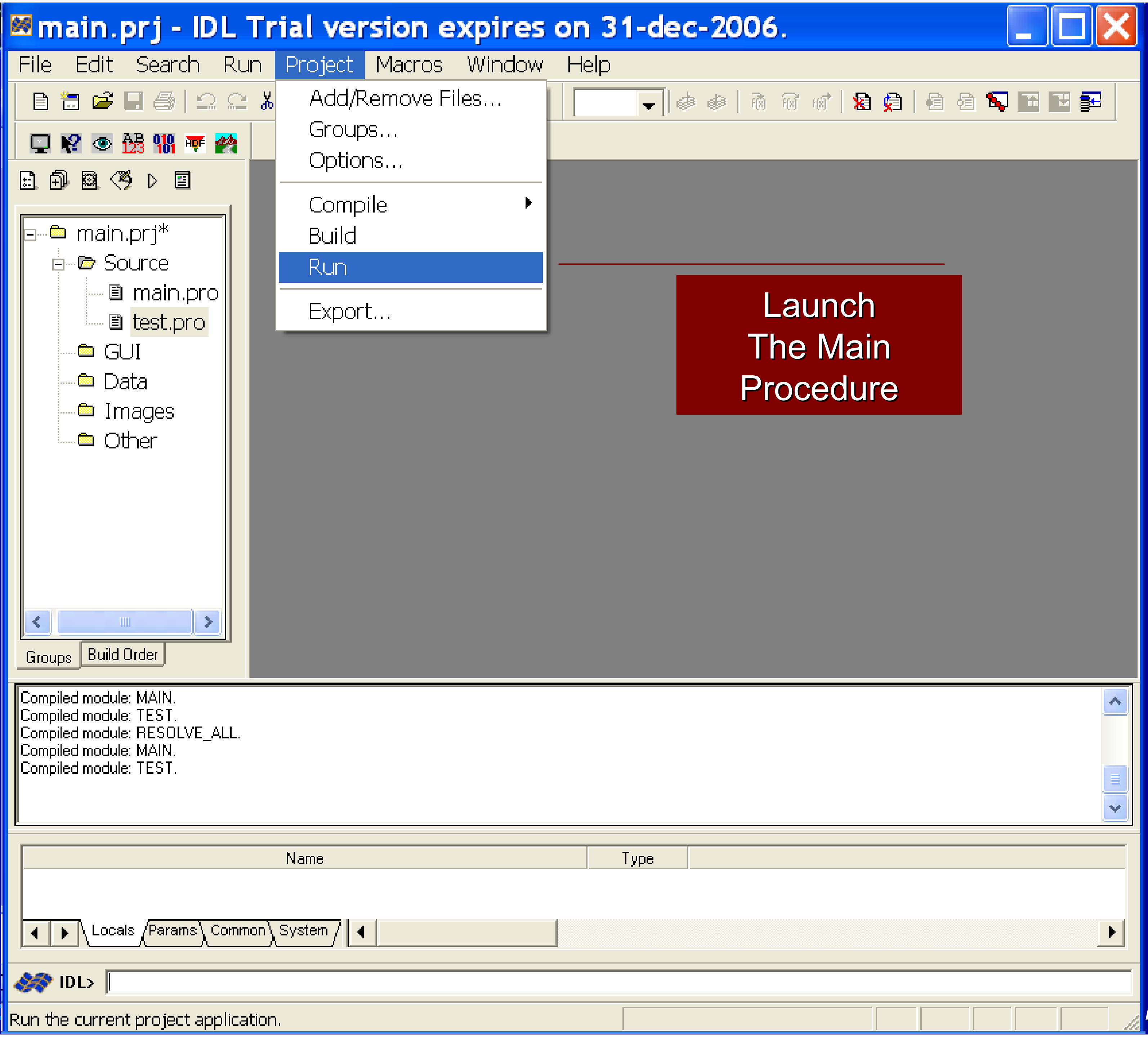
Compile All Project Files



```
Compiled module: MAIN.
Compiled module: TEST.
Compiled module: RESOLVE_ALL.
Compiled module: MAIN.
Compiled module: TEST.
```

Project Files Compilation Successful

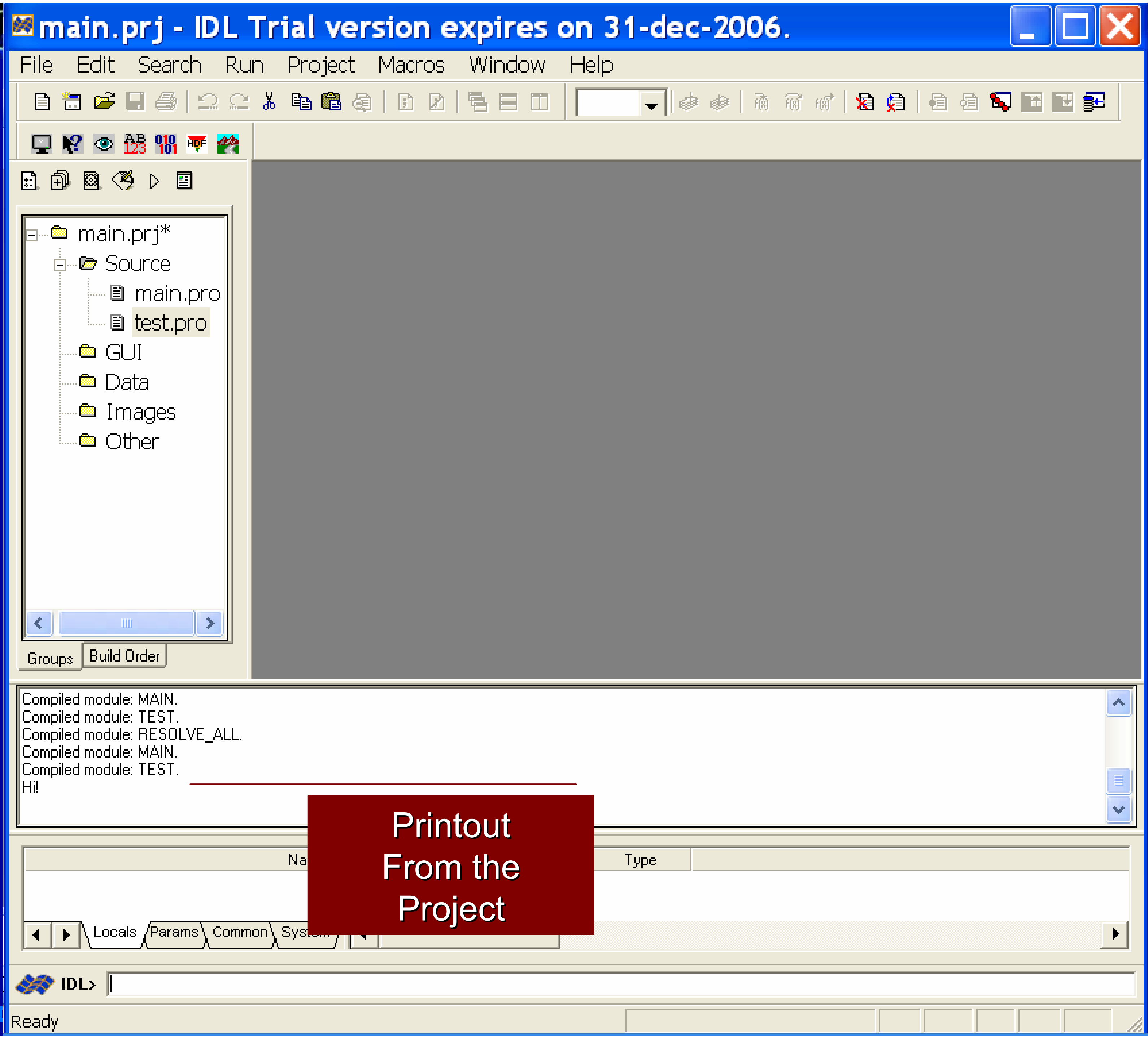
Running Projects



```
Compiled module: MAIN.
Compiled module: TEST.
Compiled module: RESOLVE_ALL.
Compiled module: MAIN.
Compiled module: TEST.
```

Run the current project application.

Launch The Main Procedure



```
Compiled module: MAIN.
Compiled module: TEST.
Compiled module: RESOLVE_ALL.
Compiled module: MAIN.
Compiled module: TEST.
Hi!
```

Printout From the Project

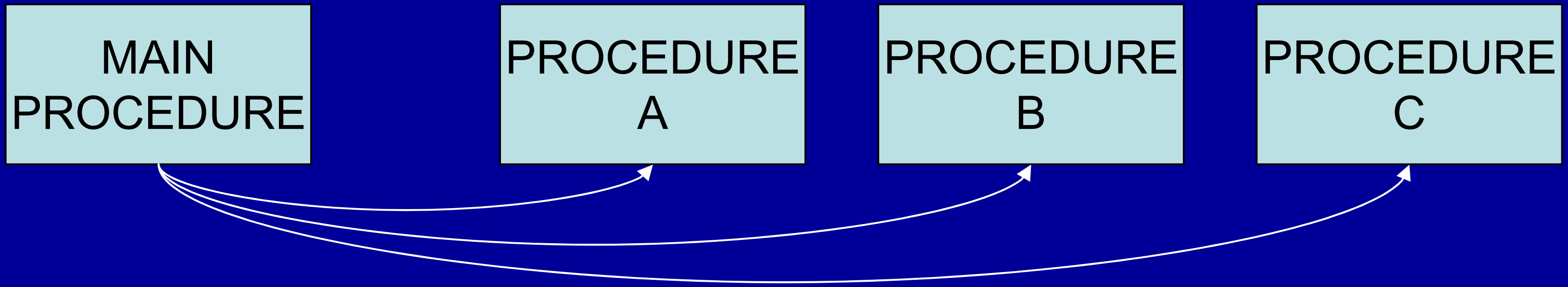
IDL Programming

A Primer

Structuring Programs

- Any program MUST be structured in procedures aimed at specific actions

- A main procedure manages the secondary procedures by properly calling them



Defining Procedures

```
PRO name, var1, var2,
   var3, …

(statements)

END
```

```
PRO test, a, b, c

  c = a * b

END
```

Defining Functions

```
FUNCTION name, var1,
   var2, var3, …

   (statements)

   RETURN, var_name

END
```

```
FUNCTION sum, a, b

   c = a + b

   RETURN, c

END
```

Including Comments

```
FUNCTION sum, a, b

   ; This function performs the sum of two input
        variables “a” and “b”

   c = a + b

   RETURN, c

END
```

Using Constants

```
PRO test

    ; Define constants

    a = 10B      ; Byte
    b = 10       ; Integer
    c = 10L      ; Long Integer
    d = 10.      ; Single Precision Floating Point
    e = 10.D     ; Double Precision Floating Point
    f  = ‘Hi’    ; Character String
    g = !PI      ; Greek Pi as predefined system constant

END
```

Using Arrays

```
PRO test

    ; Define arrays

    a = BYTARR(10, 10, …)   ; Byte Array
    b = INTARR(10, 10, …)   ; Integer Array
    c = LONARR(10, 10, …)   ; Long Integer Array
    d = FLTARR(10, 10, …)   ; Single Precision Array
    e = DBLARR(10, 10, …)   ; Double Precision Array
    f = STRARR(10, 10, …)   ; String Array

END
```

Using Structures

A structure is an array of elements which can be respectively e.g.

- constants
- arrays
- structures

Definition

{structure_name, tag_name_1 : tag_definition_1, …, tag_name_n : tag_definition_n}

Example

temp = {trieste, lat : 45., long : 13.}

PRINT, trieste.lat, trieste.long

Syntax
To Address
Struct Elements

Calling External Procedures & Functions

```
PRO main
    a = 3
    b = 2
    sum, a, b, result
    PRINT, a, b, result
END
```

```
PRO sum, var1, var2, var3
    var3 = var1 + var2
END
```

Proc “main”
Calls
Proc “sum”

Controlling Program Flow

Branching Statements: GO TO

```
PRO test

  GOTO, label

  (statements)

  label:

END
```

Program Execution Jump to “label”

Skipped Set of Statements

Program Execution Jump Here

Branching Statements: IF

```
PRO test

  IF condition THEN BEGIN

   (statements)

  ENDIF

END
```

Statements Executed IF Condition True

Branching Statements: CASE

```
PRO test

  CASE variable OF

    condition1 :  statement1

    condition2 :  statement2

  ENDCASE

END
```

Statement Executed When Condition1 True

Statement Executed When Condition2 True

Cycling Statements: FOR

```
PRO test

  FOR counter = val1, val2, step DO BEGIN

    (statements)

  ENDFOR

END
```

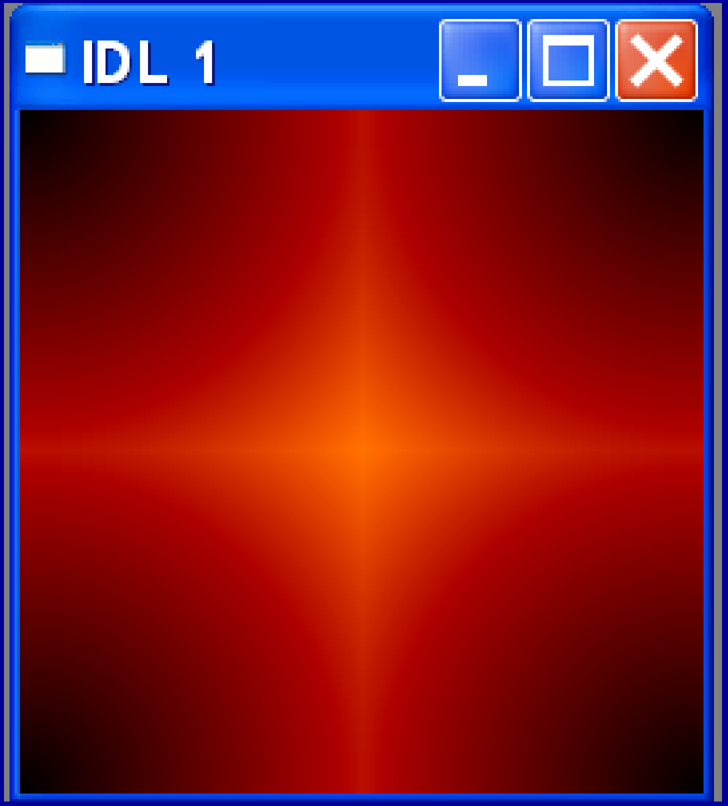
Statements Executed N Times

Graphing Results

e.g. Via Direct Graphics

Example of Direct Graphics

```
PRO graph

    DEVICE,
    DECOMPOSED  = 0

    LOADCT, 3

    WINDOW, 1, XSIZE =
          256, YSIZE = 256

    TV, DIST(256, 256)

END
```



MORE INFORMATION

More information is available on the web site of RSI at:

http://www.rsinc.com

RSI IDL codes can run also under the "IDL Virtual Machine" package, which does not require the full RSI IDL package and is freely downloadable from the RSI IDL web site.

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