



# Getting Started Tutorial: Analyzing Memory Errors

Intel® Inspector XE 2013 for Windows\* OS

Fortran Sample Application Code

Document Number: 327648-002US

World Wide Web: <http://developer.intel.com>

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# Overview

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Discover how to find and fix memory errors using the Intel® Inspector XE and the `nqueens_fortran` Fortran sample application.

<b>About This Tutorial</b>	<p>This tutorial demonstrates an end-to-end workflow you can ultimately apply to your own applications:</p> <ol style="list-style-type: none"><li>1. Build an application to produce an optimal inspection result.</li><li>2. Inspect an application to find memory errors.</li><li>3. Edit application code to fix the memory errors.</li><li>4. Investigate memory errors using interactive debugging.</li><li>5. Rebuild and reinspect the application.</li></ol>
<b>Estimated Duration</b>	10-15 minutes.
<b>Learning Objectives</b>	<p>After you complete this tutorial, you should be able to:</p> <ul style="list-style-type: none"><li>• List the steps to find and fix memory errors using the Intel Inspector XE.</li><li>• Define key Intel Inspector XE terms.</li><li>• Identify compiler/linker options that produce the most accurate and complete analysis results.</li><li>• Run memory error analyses.</li><li>• Influence analysis scope and running time.</li><li>• Navigate among windows in the Intel Inspector XE results.</li><li>• Display a prioritized <i>to-do</i> list for fixing errors.</li><li>• Access help for fixing specific errors.</li><li>• Access source code to fix errors.</li><li>• Launch an interactive debugging session to investigate problems more deeply.</li></ul>
<b>More Resources</b>	<p>The concepts and procedures in this tutorial apply regardless of programming language; however, a similar tutorial using a sample application in another programming language may be available at <a href="http://software.intel.com/en-us/articles/intel-software-product-tutorials/">http://software.intel.com/en-us/articles/intel-software-product-tutorials/</a>. This site also offers tutorials for other Intel® products and a printable version (PDF) of tutorials.</p> <p>In addition, you can find more resources at <a href="http://software.intel.com/en-us/articles/intel-parallel-studio-xe/">http://software.intel.com/en-us/articles/intel-parallel-studio-xe/</a>.</p>





# Navigation Quick Start



Intel® Inspector XE is a dynamic memory and threading error checking tool for users developing serial and multithreaded applications on Windows\* and Linux\* operating systems. You can also use the Intel Inspector XE to visualize and manage static analysis results created by Intel® compilers in various suite products.

## Intel Inspector XE Access

To access the Intel Inspector XE in the Visual Studio\* IDE: From the Windows\* **Start** menu, choose **All Programs > Intel Parallel Studio XE 2013 > Parallel Studio XE 2013 with [VS2008 | VS2010]**.

To access the Standalone Intel Inspector XE GUI, do one of the following:

- From the Windows\* **Start** menu, choose **All Programs > Intel Parallel Studio XE 2013 > Intel Inspector XE 2013**.
- From the Windows\* **Start** menu, choose **All Programs > Intel Parallel Studio XE 2013 > Command Prompt > Parallel Studio XE with Intel Compiler > IA-32 Visual Studio [2008 | 2010] mode** to set up your environment, then type `inspxe-gui` in the **Command Prompt** window.

## Intel Inspector XE/Visual Studio\* IDE Integration

The screenshot displays the Intel Inspector XE 2013 GUI integrated into the Visual Studio IDE. The main window is titled 'Detect Deadlocks and Data Races' and shows a list of problems. The 'Problems' pane lists several data race issues, with the first one selected. The 'Code Locations' pane shows the source code for the selected problem, highlighting the relevant lines. The 'Timeline' pane shows the execution flow, with the selected problem highlighted. The 'Solution Explorer' on the right shows the project structure, including the 'Inspector XE Results' folder. Callouts A1, A2, and A3 highlight specific UI elements: A1 points to the 'Debug' button in the top toolbar, A2 points to the 'Intel Inspector XE 2013' icon in the bottom-left corner, and A3 points to the 'Inspector XE Results' folder in the Solution Explorer.

ID	Problem	Sources	Modules	State
P1	Data race	nqueens_threading.f90	threading_issues.exe	Not fixed
	Data race	nqueens_threading.f90	threading_issues.exe	Not fixed
	Data race	nqueens_threading.f90	threading_issues.exe	Not fixed
	Data race	nqueens_threading.f90	threading_issues.exe	Not fixed
P2	Data race	nqueens_threading.f90	threading_issues.exe	Not fixed
	Data race	nqueens_threading.f90	threading_issues.exe	Not fixed
	Data race	nqueens_threading.f90	threading_issues.exe	Not fixed

Description	Source	Function	Module
Read	nqueens_threading.f90:135	NQUEENS_ip_SETQUEEN	threading_issues.exe
Write	nqueens_threading.f90:143	NQUEENS_ip_SETQUEEN	threading_issues.exe
Allocation site	nqueens_threading.f90:79	NQUEENS	threading_issues.exe

**A1** - **A3**

The menu, toolbar, and **Solution Explorer** offer different ways to perform many of the same functions.

**A1**

Use the **Tools > Intel Inspector XE 2013** menu to create dynamic analysis results, compare results, and import result archive files and results from other Intel® error-detection products.

**A2**

Use the **Intel Inspector XE** toolbar to open the *Getting Started* page, create dynamic analysis results, compare results, and configure projects.

**A3**

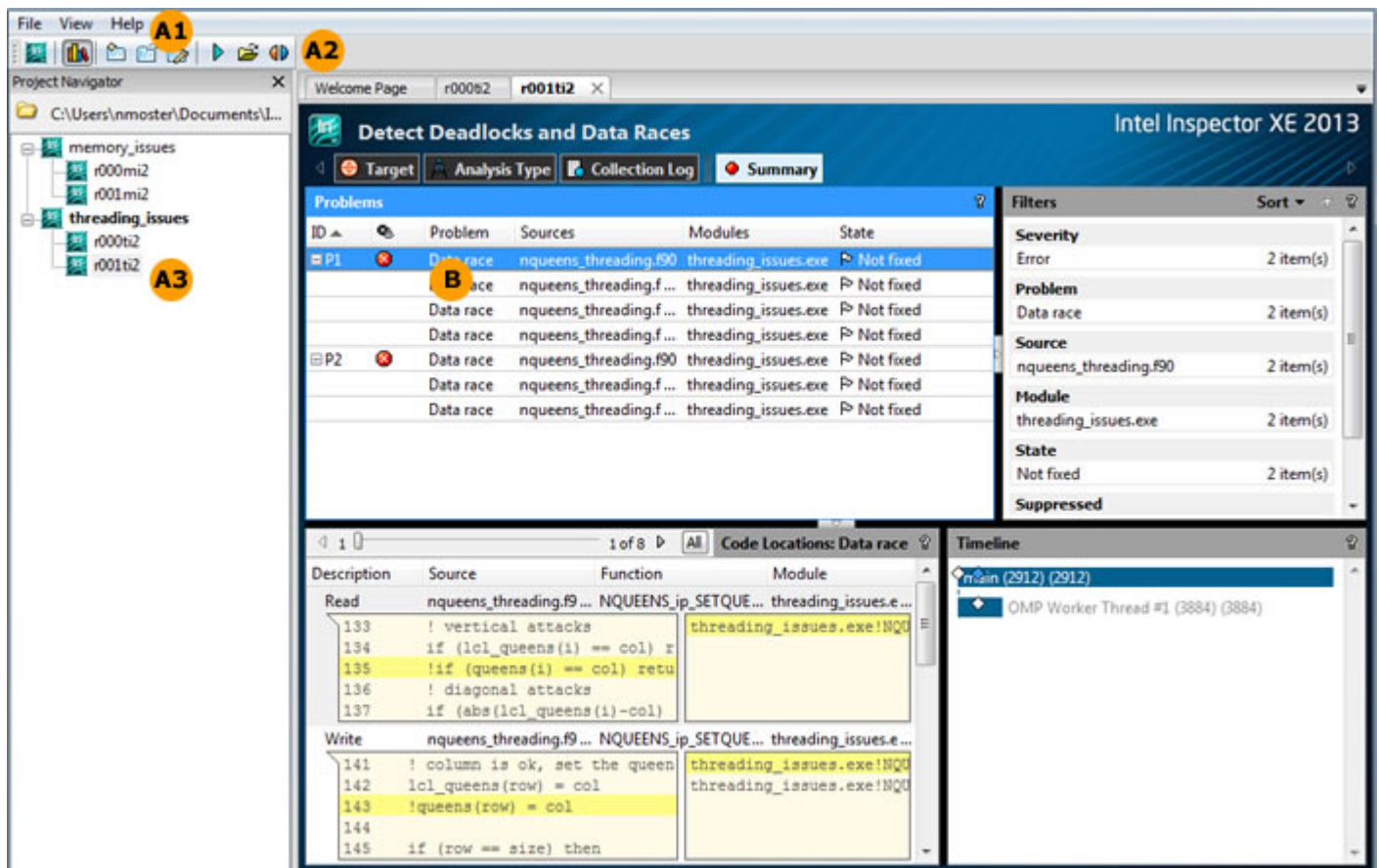
**Solution Explorer** context menus (right-click to open):

- Use the **Intel Inspector XE 2013** menu on the **Solution Explorer** project context menu to create dynamic analysis results and configure projects.
- Use the context menu on a result in the **Inspector XE Results** folder to open results, export result archive files, create dynamic analysis results, and manage results.

**B**

Use the Intel Inspector XE result tabs to manage result data.

## Standalone Intel Inspector XE GUI

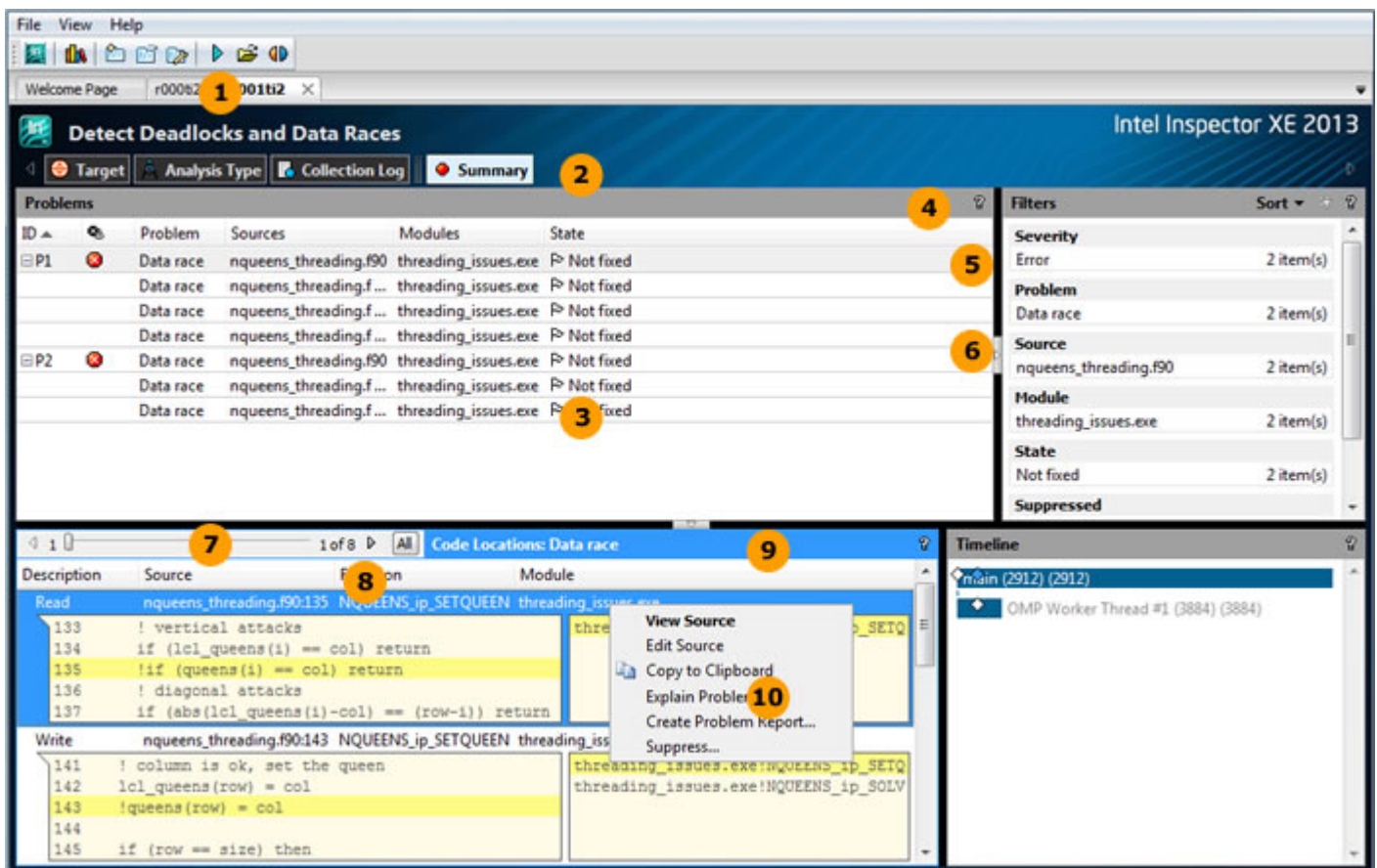


**A1** - **A3**






The menu, toolbar, and **Project Navigator** offer different ways to perform many of the same functions.

- A1** Use the menu to create projects and dynamic analysis results, import result archive files and results from other Intel® error-detection products, open projects and results, compare results, configure projects, set various options, and access the *Getting Started* page and *Help*.
- A2** Use the toolbar to open the *Getting Started* page; create, configure, and open projects; create dynamic analysis results; and open and compare results.
- A3** Use the **Project Navigator**:
  - **Tree** to see a hierarchical view of your projects and results based on the directory where the opened project resides.
  - **Context menus** (right-click to open) to perform functions available from the menu and toolbar plus delete or rename a selected project or result, close all opened results, and copy various directory paths to the system clipboard.
- B** Use result tabs to view and manage result data.

## Intel Inspector XE Result Tabs



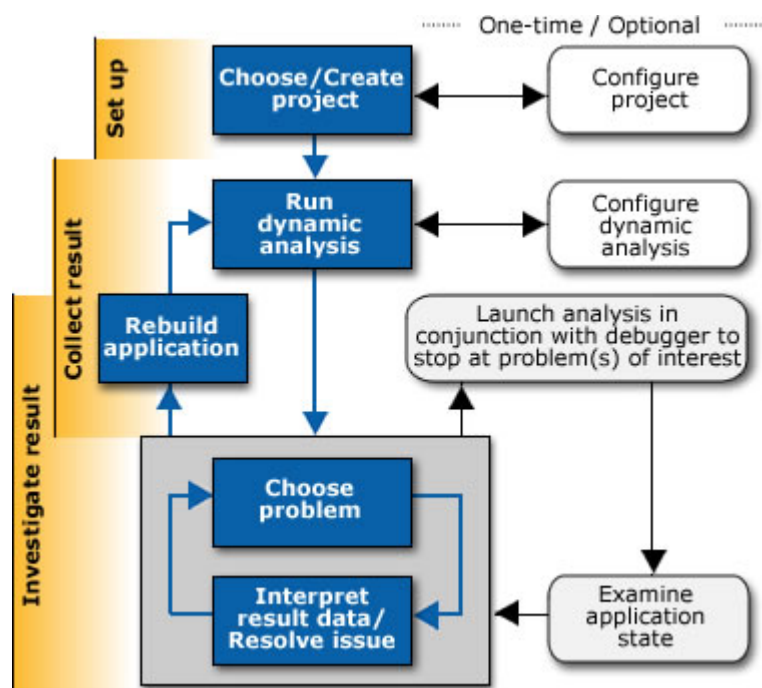
- 1** Use result tab names to distinguish among results.
- 2** Click buttons on the navigation toolbar to change window views.

- 3 Use window panes to view and manage result data.
- 4 Click  buttons to display help pages that describe how to use window panes.
- 5 Drag window pane borders to resize window panes.
- 6 Click , , , and  controls to show/hide window panes.
- 7 Click window pane data controls to adjust result data within the pane (and possibly in adjacent panes).
- 8 Data column headers - Drag to reposition the data column; drag the left or right border to resize the data column; click to sort results in ascending or descending order by column data.
- 9 Use title bars to identify window panes.
- 10 Right-click data in window panes to display context menus that provide access to key capabilities.

# Analyzing Memory Errors



There are many ways to take advantage of the power and flexibility of the Intel Inspector XE. The following workflow, which shows how to find and fix memory errors in serial or parallel programs, is one way to help maximize your productivity as quickly as possible.



<b>Step 1: Unpack and set up sample for analysis</b>	Do one of the following: <ul style="list-style-type: none"> <li>In the Visual Studio* IDE: <a href="#">Choose a project, verify settings, and build an application to inspect for memory errors.</a></li> <li>In the Standalone Intel Inspector XE GUI: <a href="#">Build an application to inspect for memory errors and create a new project.</a></li> </ul>
<b>Step 2: Collect result</b>	<ul style="list-style-type: none"> <li><a href="#">Configure a memory error analysis.</a></li> <li><a href="#">Run the memory error analysis on the application.</a></li> </ul>
<b>Step 3: Investigate result</b>	<ul style="list-style-type: none"> <li><a href="#">Choose a problem set in the analysis result.</a></li> <li><a href="#">Interpret the result data.</a></li> <li><a href="#">Resolve the issue.</a></li> <li><a href="#">Investigate another problem using interactive debugging.</a></li> </ul>
<b>Step 4: Check your work</b>	<a href="#">Rebuild the application and rerun the memory error analysis.</a>

## Visual Studio\* IDE: Choose Project and Build Application





Follow these steps only if you are using the Intel Inspector XE plug-in to the Visual Studio\* IDE to complete this tutorial.

To create an application the Intel Inspector XE can inspect for memory errors:

- [Get software tools.](#)
- [Open a Visual Studio\\* solution.](#)
- [Choose a startup project.](#)
- [Verify optimal compiler/linker settings.](#)
- [Verify the application is set to build in debug mode.](#)
- [Build and test the application.](#)

### Get Software Tools

You need the following tools to try tutorial steps yourself using the `nqueens_fortran` sample application:

- Intel Inspector XE, including sample applications
- .zip file extraction utility
- Supported compiler (see *Release Notes* for more information)

### Acquire the Intel Inspector XE

If you do not already have access to the Intel Inspector XE, you can download an evaluation copy from <http://software.intel.com/en-us/articles/intel-software-evaluation-center/>.

### Install and Set Up the Intel Inspector XE Sample Applications

1. Copy the `nqueens_fortran.zip` file from the `<install-dir>\samples\<locale>\Fortran` directory to a writable directory or share on your system. The default `<install-dir>` is `C:\Program Files (x86)\Intel\Inspector XE 2013\`  
  
(on certain systems, instead of `Program Files (x86)`, the directory name is `Program Files (x86)`).
2. Extract the sample from the .zip file.



- Samples are non-deterministic. Your screens may vary from the screen captures shown throughout this tutorial.
  - Samples are designed only to illustrate the Intel Inspector XE features; they do not represent best practices for creating code.
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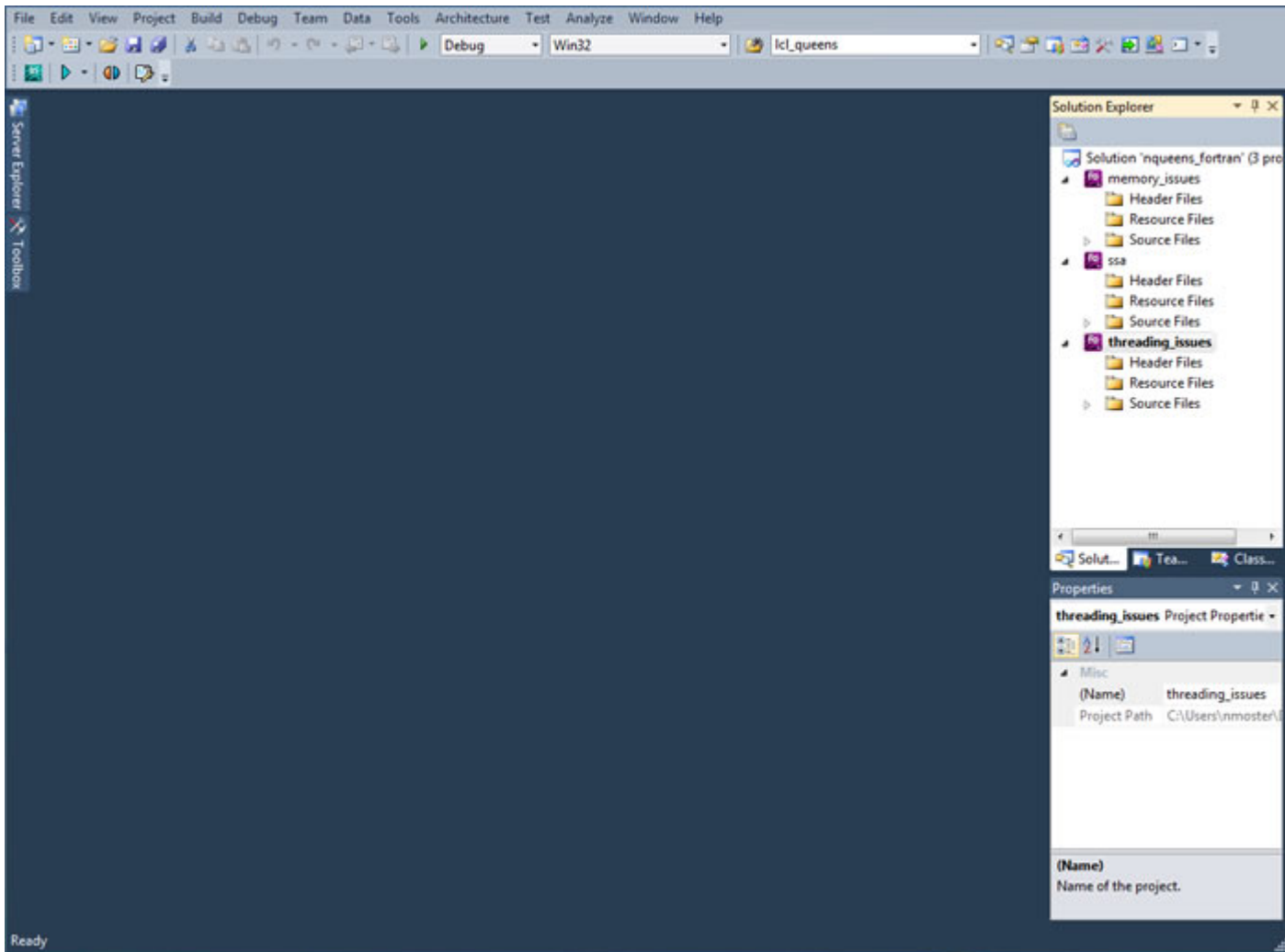
### Open a Visual Studio\* Solution

1. Choose **File > Open > Project/Solution**.
2. In the **Open Project** dialog box, open the `nqueens_fortran\nqueens_fortran.sln` file to display the **nqueens\_fortran** solution in the **Solution Explorer**.



**NOTE** The `nqueens_fortran.sln` solution was created using the Visual Studio\* 2008 IDE. If the Visual Studio\* conversion wizard appears, follow the steps to convert the solution to run on your installed version of the Visual Studio\* IDE.

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### Choose a Startup Project

If the **memory\_issues** project is not the startup project (project typeface in the **Solution Explorer** is not bold),

1. Right-click the **memory\_issues** project in the **Solution Explorer** is not bold.
2. Choose **Set as StartUp Project**, which changes the project typeface to bold.

### Verify Optimal Compiler/Linker Settings

You can use the Intel® Inspector XE to analyze:

- Memory errors in debug and release modes of:
  - C++ binaries - The Intel Inspector XE can analyze native code in native and mixed native/managed binaries.
  - Fortran binaries - The Intel Inspector XE can analyze native code in native binaries.
- Threading errors in debug and release modes of:
  - C++ binaries - The Intel Inspector XE can analyze native and managed code in native, managed, and mixed native/managed binaries.
  - Fortran binaries - The Intel Inspector XE can analyze native code in native binaries.

Applications compiled/linked in debug mode using the following settings produce the most accurate and complete analysis results.

Compiler/Linker Property	Correct C/C++ Setting	Correct Fortran Setting	Impact If Not Set Correctly
Debug information	Enabled (/Zi or /ZI)	Enabled (/debug:full)	Missing file/line information
Optimization	Disabled (/Od)	Disabled (/Od)	Incorrect file/line information
Dynamic runtime library	Selected (/MD or /MDd)	Selected (/libs:dll/threads or libs:dll/threads/dbglibs)	False positives or missing code locations
Basic runtime error checks	Disabled (do not use /RTC; <b>Default</b> option in Visual Studio* IDE)	None (/check:none)	False positives

1. Right-click the **memory\_issues** project in the **Solution Explorer**.
2. Choose **Properties** to display the **Property Pages** dialog box.
3. Verify the **Configuration** drop-down list is set to **Debug** or **Active(Debug)**.
4. In the left pane, choose **Configuration Properties > Fortran**.
  - Choose **Debugging** and verify the **Debug Information Format** field is set to **Full (/debug:full)**.
  - Choose **Optimization** and verify the **Optimization** field is set to **Disable (/Od)**.
  - Choose **Libraries** and verify the **Runtime Library** field is set to **Multithread DLL (/libs:dll/threads)** or **Debug Multithread DLL (libs:dll/threads/dbglibs)**.
  - Choose **Run-time** and verify the **Runtime Error Checking** field is set to **None (/check:none)**.
5. In the left pane, choose **Configuration Properties > Linker > Debugging** and verify the **Generate Debug Info** field is set to **Yes (/DEBUG)**.

### Verify the Application is Set to Build in Debug Mode

1. Click the **Configuration Manager** button.
2. Verify the **Active solution configuration** drop-down list is set to **Debug**.
3. Click the **Close** button to close the **Configuration Manager** dialog box.
4. Click the **OK** button to close the **Property Pages** dialog box.

### Build and Test the Application

1. Choose **Build > Project Only > Build Only memory\_issues** to build a single project in the solution.
2. Check the messages in the **Output** window to confirm the build succeeded.
3. Choose **Debug > Start Without Debugging** to test the application.
4. If the Visual Studio\* IDE responds any projects are out of date, click **No**.
5. Check for non-deterministic application output (that also varies by number of cores) similar to the following:

```
Usage: memory_issues.exe boardSize
Using default size of 10
Starting nqueens solver for size 10 with 2 thread(s)
Number of solutions: 724
Correct result!
Calculations took 47 ms.
Press any key to continue...
```

### Key Terms

False positive



## Standalone GUI: Build Application and Create New Project

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Follow these steps only if you are using the Standalone Intel Inspector XE GUI to complete this tutorial.

To create an application the Intel Inspector XE can inspect for memory errors:

- Get software tools.
- Verify optimal compiler/linker settings.
- Build the application.
- Verify the application runs outside the Intel Inspector XE.
- Open the Standalone Intel Inspector XE GUI.
- Create a new project.

### Get Software Tools

You need the following tools to try tutorial steps yourself using the `nqueens_fortran` sample application:

- Intel Inspector XE, including sample applications
- .zip file extraction utility
- Supported compiler (see *Release Notes* for more information)

### Acquire the Intel Inspector XE

If you do not already have access to the Intel Inspector XE, you can download an evaluation copy from <http://software.intel.com/en-us/articles/intel-software-evaluation-center/>.

### Install and Set Up the Intel Inspector XE Sample Applications

1. Copy the `nqueens_fortran.zip` file from the `<install-dir>\samples\<locale>\Fortran\` directory to a writable directory or share on your system. The default `<install-dir>` is `C:\Program Files (x86)\Intel\Inspector XE 2013\` (on certain systems, instead of `Program Files (x86)`, the directory name is `Program Files`).
2. Extract the sample from the .zip file to create the `nqueens_fortran` directory.



- Samples are non-deterministic. Your screens may vary from the screen captures shown throughout this tutorial.
  - Samples are designed only to illustrate the Intel Inspector XE features; they do not represent best practices for creating code.
- 

### Verify Optimal Compiler/Linker Settings

You can use the Intel® Inspector XE to analyze:

- Memory errors in debug and release modes of:
  - C++ binaries - The Intel Inspector XE can analyze native code in native and mixed native/managed binaries.
  - Fortran binaries - The Intel Inspector XE can analyze native code in native binaries.
- Threading errors in debug and release modes of:
  - C++ binaries - The Intel Inspector XE can analyze native and managed code in native, managed, and mixed native/managed binaries.
  - Fortran binaries - The Intel Inspector XE can analyze native code in native binaries.

Applications compiled/linked in debug mode using the following settings produce the most accurate and complete analysis results.

Compiler/Linker Property	Correct C/C++ Setting	Correct Fortran Setting	Impact If Not Set Correctly
Debug information	Enabled (/Zi or /ZI)	Enabled (/debug:full)	Missing file/line information
Optimization	Disabled (/Od)	Disabled (/Od)	Incorrect file/line information
Dynamic runtime library	Selected (/MD or /MDd)	Selected (/libs:dll/threads or libs:dll/threads/dbglibs)	False positives or missing code locations
Basic runtime error checks	Disabled (do not use /RTC; <b>Default</b> option in Visual Studio* IDE)	None (/check:none)	False positives

### Build the Application

1. From the Windows\* **Start** menu, choose **All Programs > Intel Parallel Studio XE 2013 > Command Prompt > Parallel Studio XE with Intel Compiler > IA-32 Visual Studio [2008 | 2010] mode** to set up your environment.
2. Change directory to the nqueens\_fortran\ directory in its unzipped location.
3. If you chose **IA-32 Visual Studio 2010 mode**, type `devenv nqueens_fortran.sln` to convert the nqueens\_fortran.sln solution. When conversion is complete, close the Visual Studio\* IDE.
4. Type `devenv nqueens_fortran.sln /Build` to build all projects in the solution.



**NOTE** Do not be concerned if you see a Build: 2 succeeded, 1 failed message because of static analysis build errors.

### Verify the Application Runs Outside the Intel Inspector XE

1. Change directory to `memory_issues\Debug\`.
2. Type `memory_issues.exe` to execute the application.
3. Check for non-deterministic application output (that also varies by number of cores) similar to the following:

```
Usage: memory_issues.exe boardSize
Using default size of 10
Starting nqueens solver for size 10 with 2 thread(s)
Number of solutions: 724
Correct result!
Calculations took 62 ms.
```



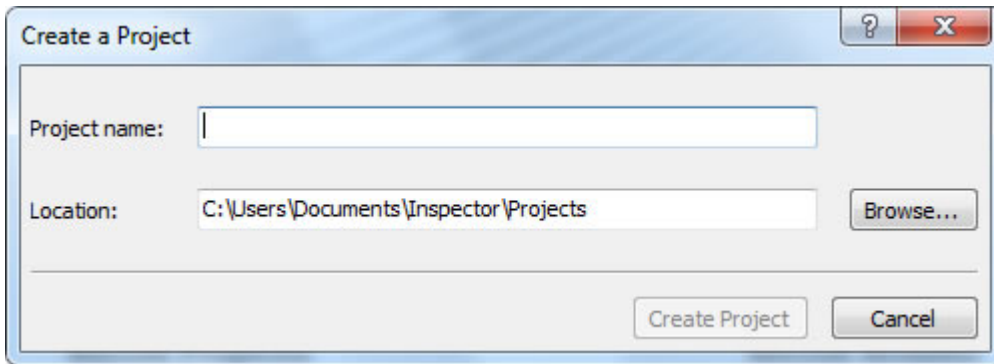
**TIP** Keep the command prompt window open.

### Open the Standalone Intel Inspector XE GUI

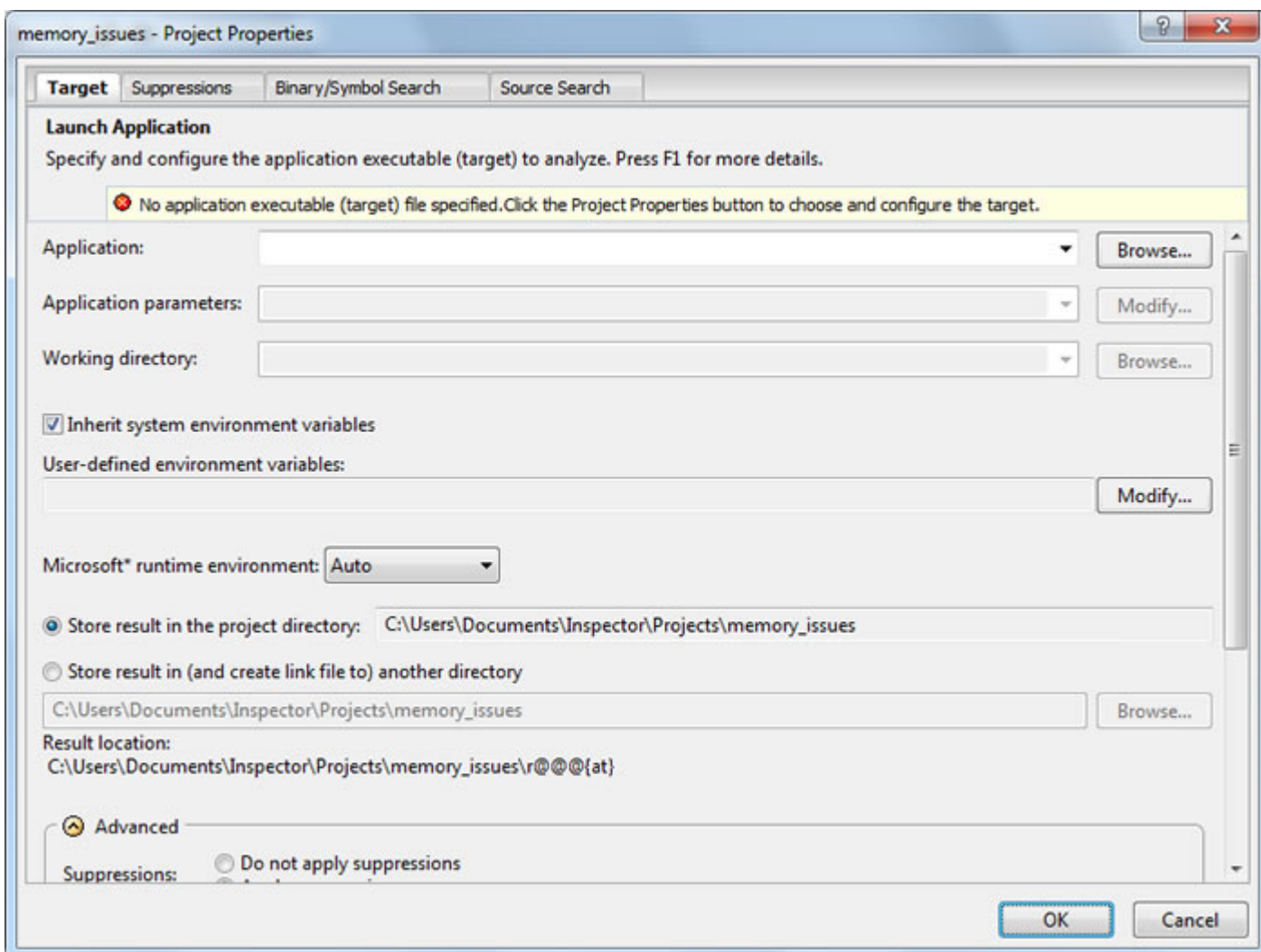
From the Windows\* **Start** menu, choose **All Programs > Intel Parallel Studio XE 2013 > Intel Inspector XE 2013**.

### Create a New Project

1. Choose **File > New > Project...** to display a dialog box similar to the following:



2. In the **Project name** field, type `memory_issues`. Then click the **Create project** button to create a `config.inspxproj` file in the `\Inspector\Projects\memory_issues\` directory (default location) and display a dialog box similar to the following:



3. Click the **Browse...** button next to the **Application** field and select the `nqueens_fortran\memory_issues\Debug\memory_issues.exe` application. Notice the Intel Inspector XE autofills the project **Working directory** field for you. Then click the **OK** button to return to the Welcome page, where the name of the opened project displays in the title bar and in the **Project Navigator** pane. (If necessary, choose **View > Project Navigator** to display the **Project Navigator**.)

## Key Terms

False positive

## Configure Analysis



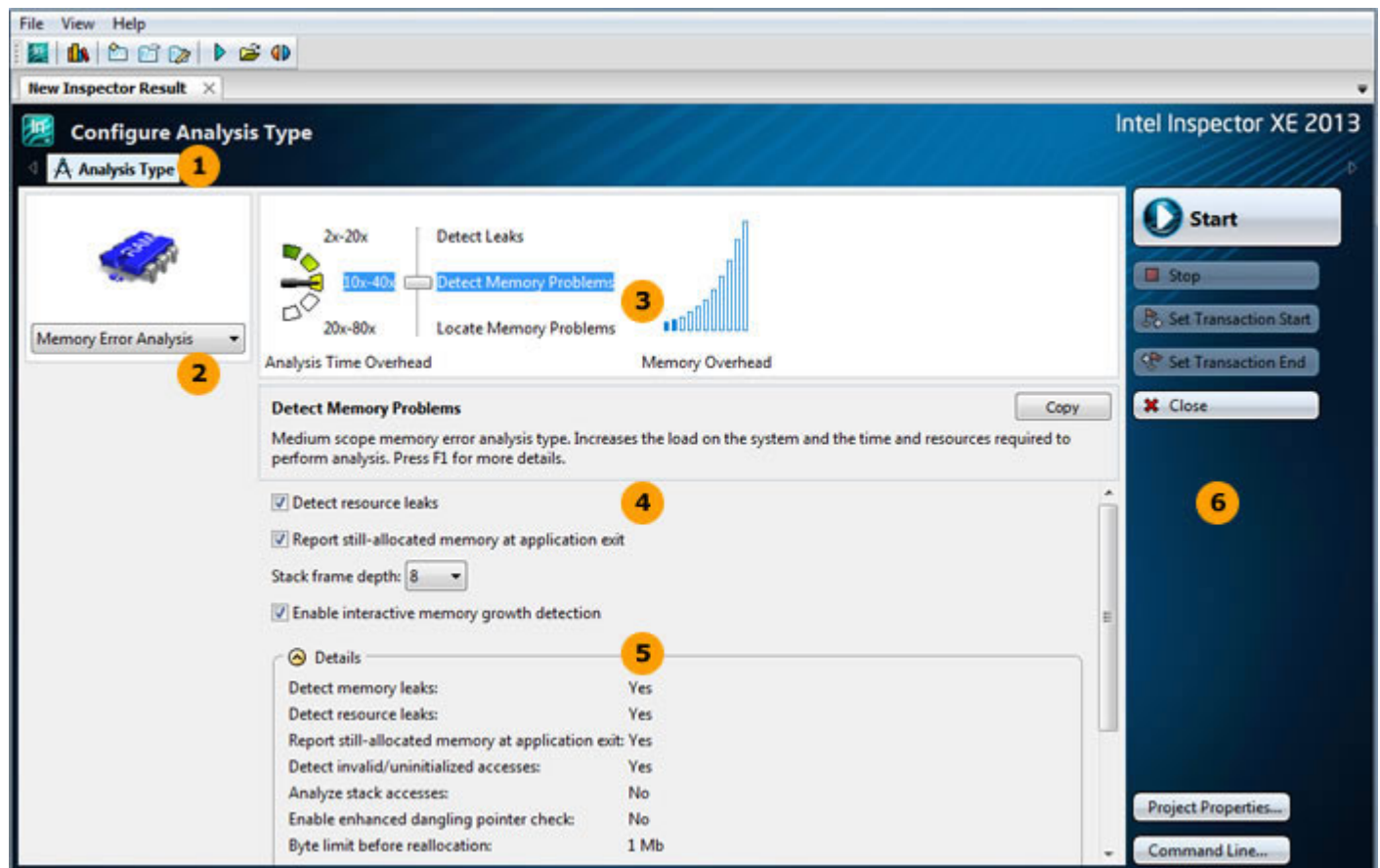
Intel Inspector XE offers a range of preset memory analysis types to help you control analysis scope and cost. The analysis type with the narrowest scope minimizes the load on the system and the time and resources required to perform the analysis; however, it detects the narrowest set of errors and provides minimal details. The analysis type with the widest scope maximizes the load on the system and the time and resources required to perform the analysis; however, it detects the widest set of errors and provides context and the maximum amount of detail for those errors.

To configure a memory error analysis, choose a memory analysis type.

### Choose a Memory Error Analysis Type

To display an **Analysis Type** window similar to the following:

- From the Visual Studio\* menu, choose **Tools** > **Intel Inspector XE 2013** > **New Analysis...**
- From the Standalone Intel Inspector XE GUI menu, choose **File** > **New** > **Analysis...**



**NOTE** Your screen includes interactive debugging options if you are working in the Visual Studio\* IDE.

- 1 Use the **Navigation** toolbar to navigate among the Intel Inspector XE windows. The buttons on the toolbar vary depending on the displayed window.
- 2 Use the Analysis Type drop-down list to choose an analysis type category: **Memory Error Analysis**, **Threading Error Analysis**, or **Custom Analysis Types**.  
Choose the **Memory Error Analysis** type category.



**NOTE** This tutorial covers memory error analysis types, which you can use to search for resource leak, incorrect `memcpy` call, invalid deallocation, invalid memory access, invalid partial memory access, memory growth, memory leak, memory not deallocated, mismatched allocation/deallocation, missing allocation, uninitialized memory access, and uninitialized partial memory access errors. Use threading error analysis types to search for data race, deadlock, lock hierarchy violation, and cross-thread stack access errors.

- 3 Use the configuration slider to choose a preset analysis type and the corresponding gauges to assess the *cost* of that choice. The preset analysis type at the top of the slider has the narrowest scope; the preset analysis type at the bottom has the widest.  
Choose the **Detect Memory Problems** preset analysis type.  
The **Analysis Time Overhead** gauge helps you quickly estimate the time it may take to collect a result using this preset analysis type. Time is expressed in relation to normal application execution time. For example, 2x - 20x is 2 to 20 times longer than normal application execution time. If normal application execution time is 5 seconds, estimated collection time is 10 to 100 seconds.  
The **Memory Overhead** gauge helps you quickly estimate the memory the Intel Inspector XE may consume to detect errors using this preset analysis type. Memory is expressed in blue-filled bars.



**NOTE** The gauge does not show memory used by the running application during analysis.

- 4 Use the checkbox(es) and drop-down list(s) to fine-tune some, but not all, preset analysis type settings.



**NOTE** If you need to fine-tune more analysis type settings, you can choose another analysis type or create a custom analysis type.

- 5 Use the **Details** region to view all current settings for this analysis type.
- 6 Use the **Command** toolbar to control analysis runs and perform other functions. For example, use the **Project Properties** button to display the **Project Properties** dialog box, where you can change the default result directory location, set parameters to potentially speed up analysis, and perform other project configuration functions.

If you experimented with various settings, make sure you choose the **Detect Memory Problems** preset analysis type (and ensure your settings match the image above) before proceeding.

## Key Terms

### Analysis

## Run Analysis



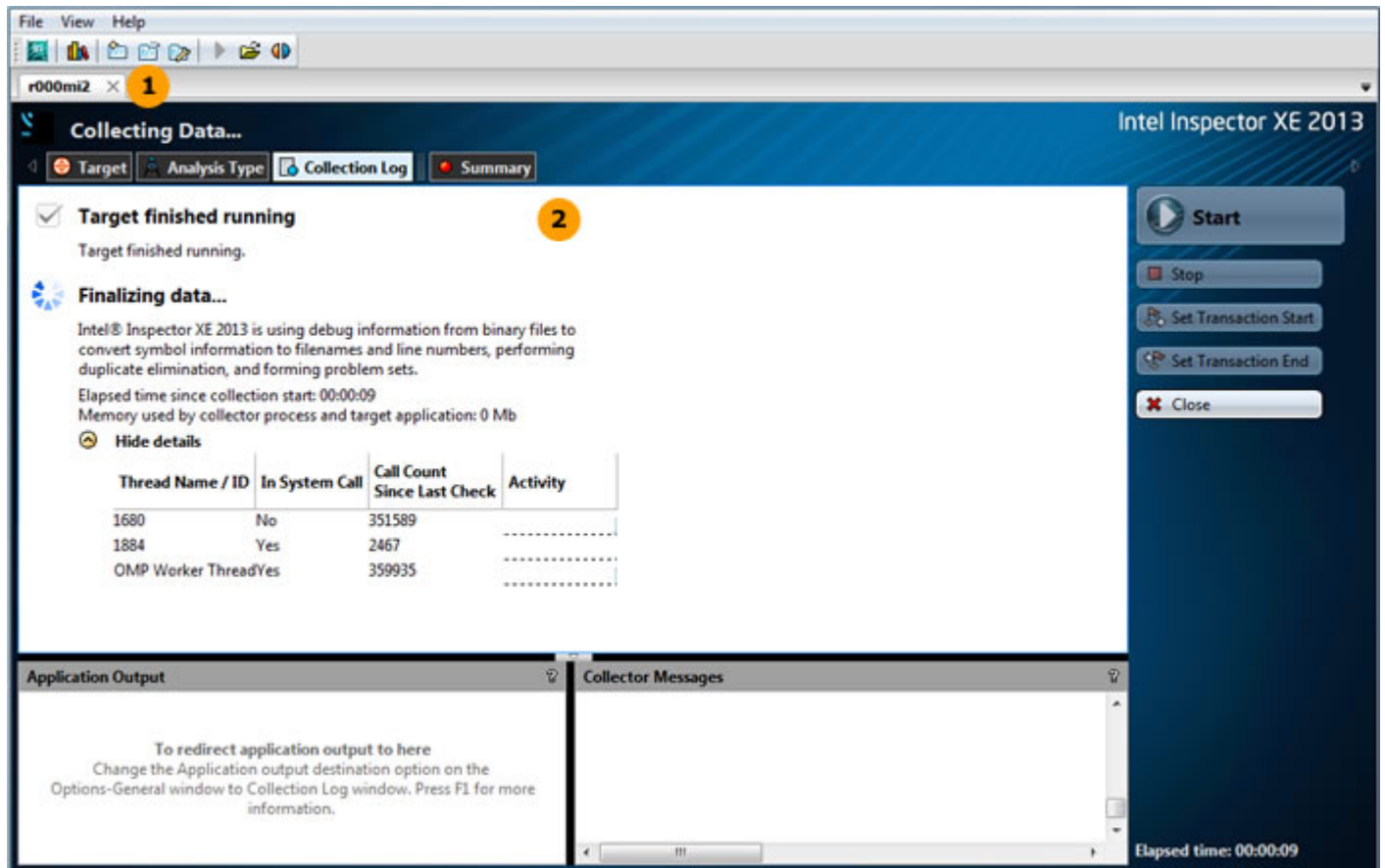
To find memory errors that may need fixing, run a memory error analysis.

### Run Memory Error Analysis

Click the **Start** button on the **Analysis Type** window and the Intel Inspector XE:

- Executes the `memory_issues.exe` application.
- Identifies memory errors that may need handling.
- Collects the result in a directory in the:
  - `nqueens_fortran\memory_issues\My Inspector XE Results - memory_issues\ directory (Visual Studio* IDE)`
  - `Inspector\Projects\memory_issues\ directory (Standalone Intel Inspector XE GUI)`
- Finalizes the result.

During analysis, the Intel Inspector XE displays a **Collection Log** window similar to the following:



The result name appears in the tab. Here, the name of the result is **r000mi2**, where

- `r` = constant
- `000` = next available number
- `mi` = memory error analysis type

- 2 = preset analysis type of medium scope



**NOTE** Intel Inspector XE also offers a pointer to the result in the **Solution Explorer** (Visual Studio\* IDE) and **Project Navigator** (standalone GUI).

2

The **Collection Log** pane shows analysis progress and milestones.

Notice you can start to manage results before analysis (collection and finalization) is complete by clicking the **Summary** button; however, this tutorial does not cover handling issues before analysis is complete.



**NOTE** This tutorial explains how to run an analysis from the Intel Inspector XE GUI. You can also use the Intel Inspector XE command-line interface (`inspxe-cl` command) to run an analysis.

The **Summary** window automatically displays after analysis completes successfully.

## Key Terms

- Analysis
- Collection
- Finalization

## Choose Problem



To start exploring a detected memory error:

- Understand Summary window panes.
- Choose a problem.

## Understand Summary Window Panes



The screenshot displays the Intel Inspector XE 2013 interface. The top menu bar includes File, View, and Help. The main window is titled 'Detect Memory Problems' and 'Intel Inspector XE 2013'. The 'Summary' tab (1) is selected, showing a list of problems (2) in the 'Problems' pane. The problems are categorized by ID, Problem, Sources, Modules, Object Size, and State. The 'Code Locations' pane (3) shows the source code snippet for the selected problem, including the function 'NQUEENS\_ip\_SETQUEEN' and the module 'memory\_issues.exe'. The 'Timeline' pane shows the execution flow, including the function 'RtlQueryEnvironmentVariable'.

- 1 The **Summary** window is the starting point for managing result data. It groups problems into problem sets and then prioritizes the problem sets by severity and size.
- 2 Think of the **Problems** pane as a *to-do* list. Start at the top and work your way down. Try viewing the problems in various problem sets by clicking the corresponding icon.
- 3 The **Code Locations** pane shows the code location summary, surrounding source code snippet, call stack, and thread and timeline information for all code locations in one or all occurrences of the problem(s) highlighted in the **Problems** pane.

### Choose a Problem

When you are finished experimenting, double-click the data row for the **Memory leak** problem set to display the **Sources** window, which provides more visibility into the cause of the error.

### Key Terms

- Code location
- Problem
- Problem set
- Result

## Interpret Result Data

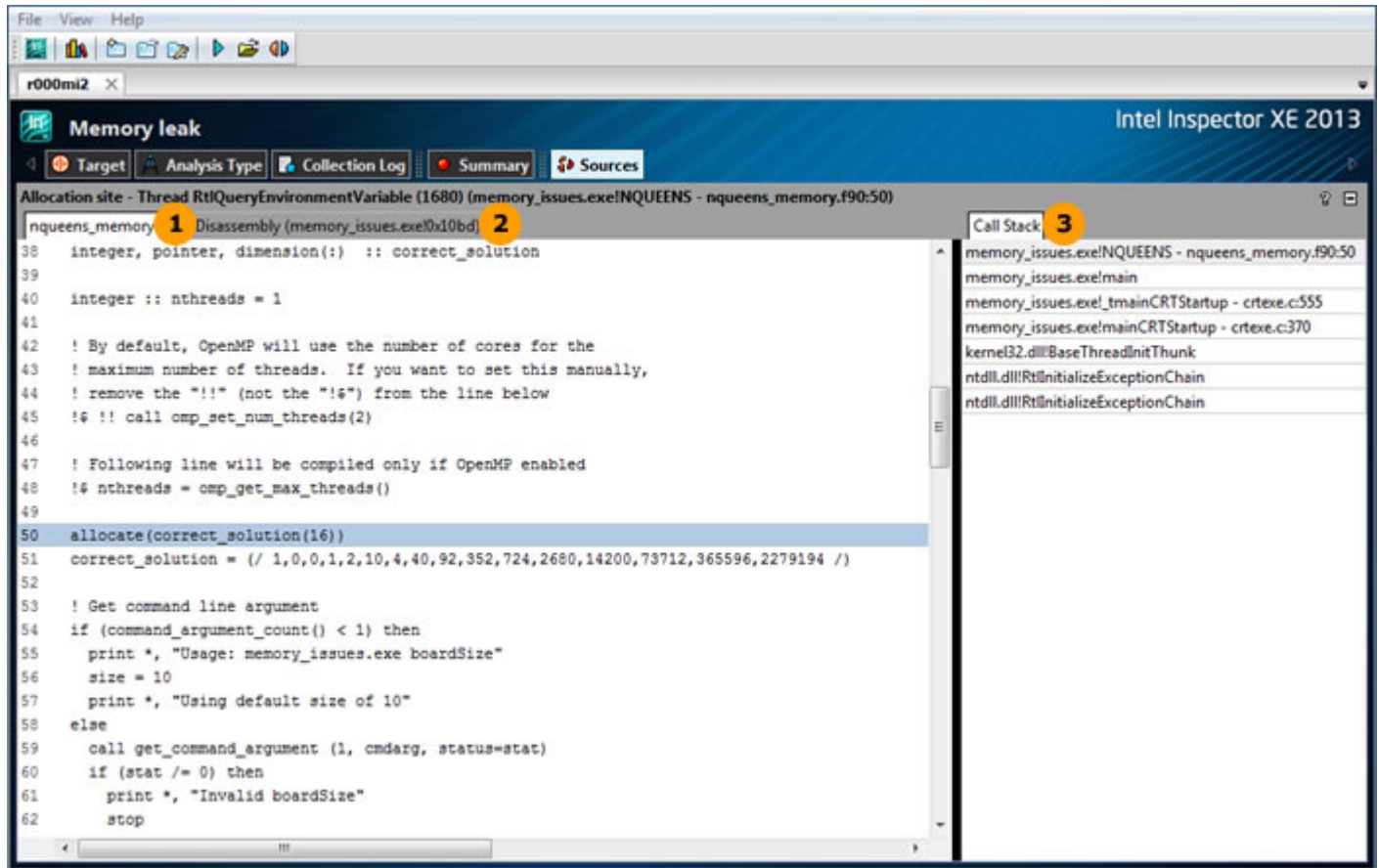


To determine the cause of the detected memory error:



- Interpret Sources window pane tabs.
- Access more information on interpreting and resolving problems.

## Interpret Sources Window Pane Tabs



1

The **Source** tab shows the complete source surrounding one code location in the **Memory leak** problem: **Allocation site**.



The **Allocation site** code location represents the location from which the memory block was allocated. Notice the source code corresponding to the **Allocation site** code location is highlighted.

2

The **Disassembly** tab shows low-level operations for the **Allocation site** code location in the **Memory leak** problem.

3

The **Call Stack** tab shows the complete call stack for the **Allocation site** code location in the **Memory leak** problem.

Use the / icons to expand/collapse source, disassembly, and call stack information for each code location region in a problem.

## Access More Information on Interpreting and Resolving Problems

1. Right-click anywhere in the **Source** or **Disassembly** tab.
2. Choose **Explain Problem** to display the Intel Inspector XE Help information for the **Memory leak** problem type.

### Key Terms

- Code location
- Problem

## Resolve Issue



To fix the detected memory error:

- Investigate the issue.
- Access an editor directly from the Intel Inspector XE.
- Change the source code.

### Investigate the Issue

Scroll to near line 94. The embedded commenting in the `nqueens_memory.f90` sample file reveals the cause of the **Memory leak** error: The `deallocate` call near line 95 that releases the memory is commented out.

### Access an Editor

Double-click near line 94 in the **Source** tab to open the `nqueens_memory.f90` source file in an editor:

```
nqueens_memory.f90
allocate (queens(size))
!initialize the queens array to 0 to avoid "uninitialized memory access" issue
!queens = 0
call solve (queens)
call system_clock (time_end, count_rate)
print 101, "Number of solutions: ", nrOfSolutions
if (nrOfSolutions == correct_solution(size+1)) then
    print 101, "Correct Result!"
else
    print 101, "Incorrect Result!"
end if

print 101, "Calculations took ", (time_end-time_start) / (count_rate/1000), "ms."
deallocate (queens)
!deallocate the pointer to avoid a memory leak
!deallocate (correct_solution)
contains

! Routine to print the board

subroutine print (queens)
    implicit none
    integer, intent(in) :: queens(:)
    integer :: row, col

    do row=1,size
        do col=1,size
            if (queens(row) == col) then
                write (*,'(A)',advance='no') "Q"
            else
                write (*,'(A)',advance='no') "- "
            end if
        end do
        write (*,'(A)')
    end do
    write (*,"")
end subroutine print
```

### Change the Source Code

1. Uncomment `!deallocate (correct_solution)`.
2. Save your edits (automatic if you are using the Visual Studio\* IDE editor).

3. Click the result tab to return to the **Sources** window.



**NOTE** The **Sources** window data is unchanged because it is a snapshot of the source code at the time of analysis.

4. Click the **Summary** button to display the **Summary** window.

## Key Terms

Code location

# Investigate Problem Using Interactive Debugging



If you are using the Visual Studio\* IDE, you can investigate a problem more deeply with an interactive debugging session during analysis.

- [Launch an interactive debugging session.](#)
- [Experiment using standard debugging commands.](#)
- [Stop the analysis and interactive debugging session.](#)

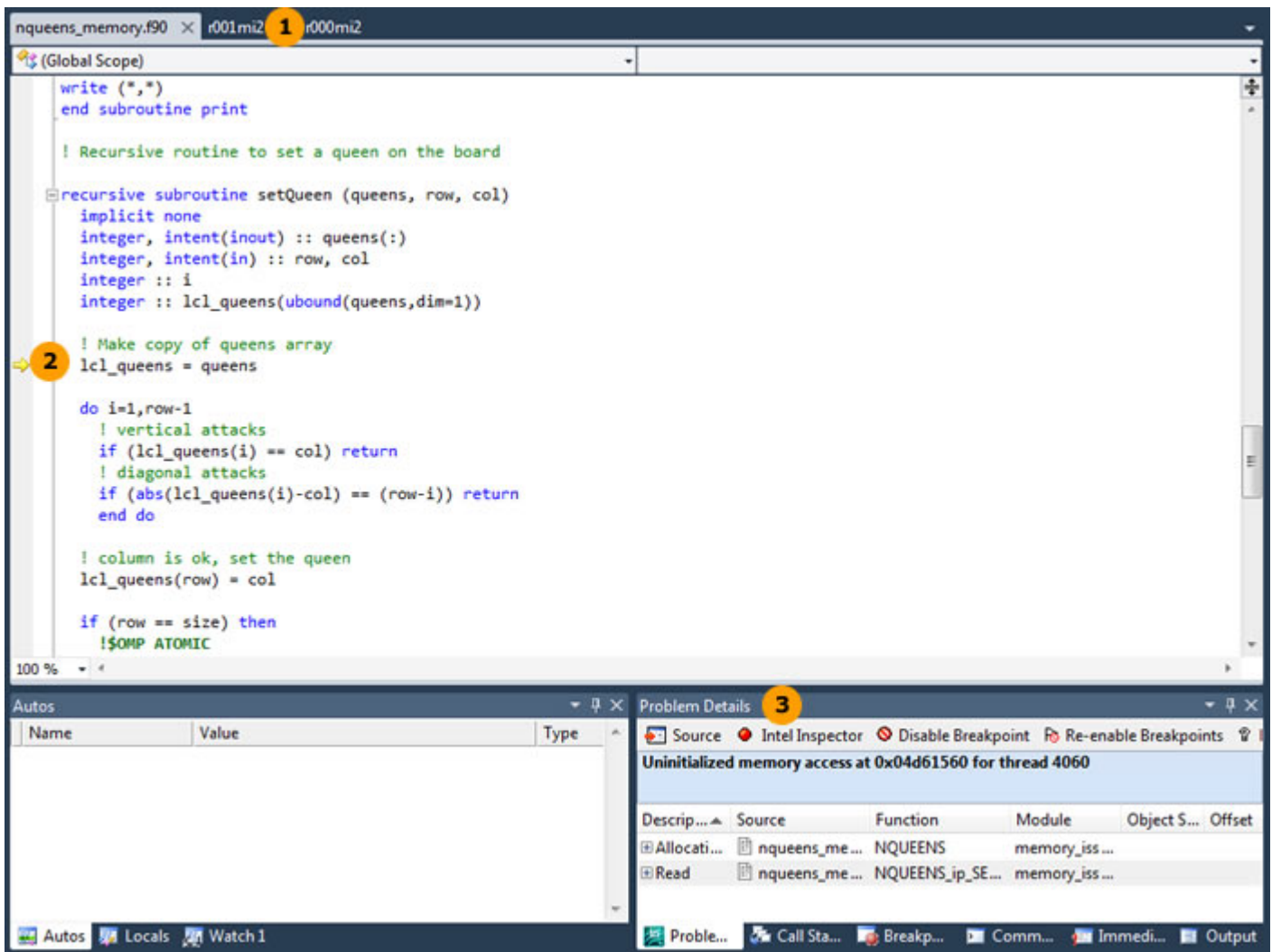
## Launch an Interactive Debugging Session

In the **Problems** pane on the **Summary** window, right-click the data row for the **Uninitialized memory access** problem set to display a context menu, then choose **Debug this problem** to:

- Launch a new analysis, of the same type, optimized to detect only the **Uninitialized memory access** problem.
- Halt application execution and open a debugging session when the Intel Inspector XE detects the first (and only) occurrence the **Uninitialized memory access** problem.



**NOTE** If the Intel Inspector XE tells you to rebuild the project, click the **OK** button to continue using the original build.



- 1 Intel Inspector XE launches a new analysis, **r001mi2**, with the same configuration settings used to create the **r000mi2** result, except the analysis is optimized to detect only the **Uninitialized memory access** problem.
- 2 Intel Inspector XE halts execution and opens a debugging session when it detects the **Uninitialized memory access** problem. In the Visual Studio\* IDE, this problem breakpoint is indicated by a yellow arrow at the appropriate source line.
- 3 The **Problem Details** pane appears when the problem breakpoint occurs. Use this pane to view the same problem details found in the Intel Inspector XE result, duplicated within the debugger workspace for convenient referencing while you examine the application state for debugging purposes.

### Experiment Using Standard Debugging Commands

During the interactive debugging session, use the normal Visual Studio\* debugger actions to examine memory and other state information, set code breakpoints, and continue execution. Only the use of data breakpoints is not supported.

### Stop the Analysis and Interactive Debugging Session

When you are finished experimenting in the debugger workspace, stop both the interactive debugging session and the analysis:

1. Click the **Intel Inspector** button on the **Problem Details** pane to display the still-running **r001mi2** result.
2. Click the **Stop** button on the Intel Inspector XE **Command** toolbar.
3. Click the **Collection Log** button for the new **r001mi2** result to wait for finalization to complete.

When finalization is complete, the Intel Inspector XE displays a **Summary** window for the new **r001mi2** result that contains only the **Uninitialized memory access** problem.



**TIP** Intel Inspector XE automatically adjusts the debugging session analysis to return to the **Uninitialized memory access** problem more quickly; however the analysis adjustments do not correspond to individual problem types. Consequently, the Intel Inspector XE may detect and report additional problems, but it will break only for the **Uninitialized memory access** problem.

## Key Terms

- Problem
- Problem breakpoint
- Problem set

## Rebuild and Rerun Analysis



To check if your edits resolved the **Memory leak** problem:

- [Rebuild the application with your edited source code.](#)
- [Rerun the analysis.](#)

### Rebuild the Application

If you are using the Visual Studio\* IDE:

1. Choose **Build > Clean Solution**.
2. Choose **Build > Project Only > Build Only memory\_issues**.

If you are using the Standalone Intel Inspector XE GUI:

1. In the previously opened command prompt window, change directory to the `nqueens_fortran` directory.
2. Type `devenv nqueens_fortran.sln /Clean`.
3. Type `devenv nqueens_fortran.sln /Build`.



**NOTE** Do not be concerned if you see a `Build: 1 succeeded, 1 failed` message because of static analysis build errors.

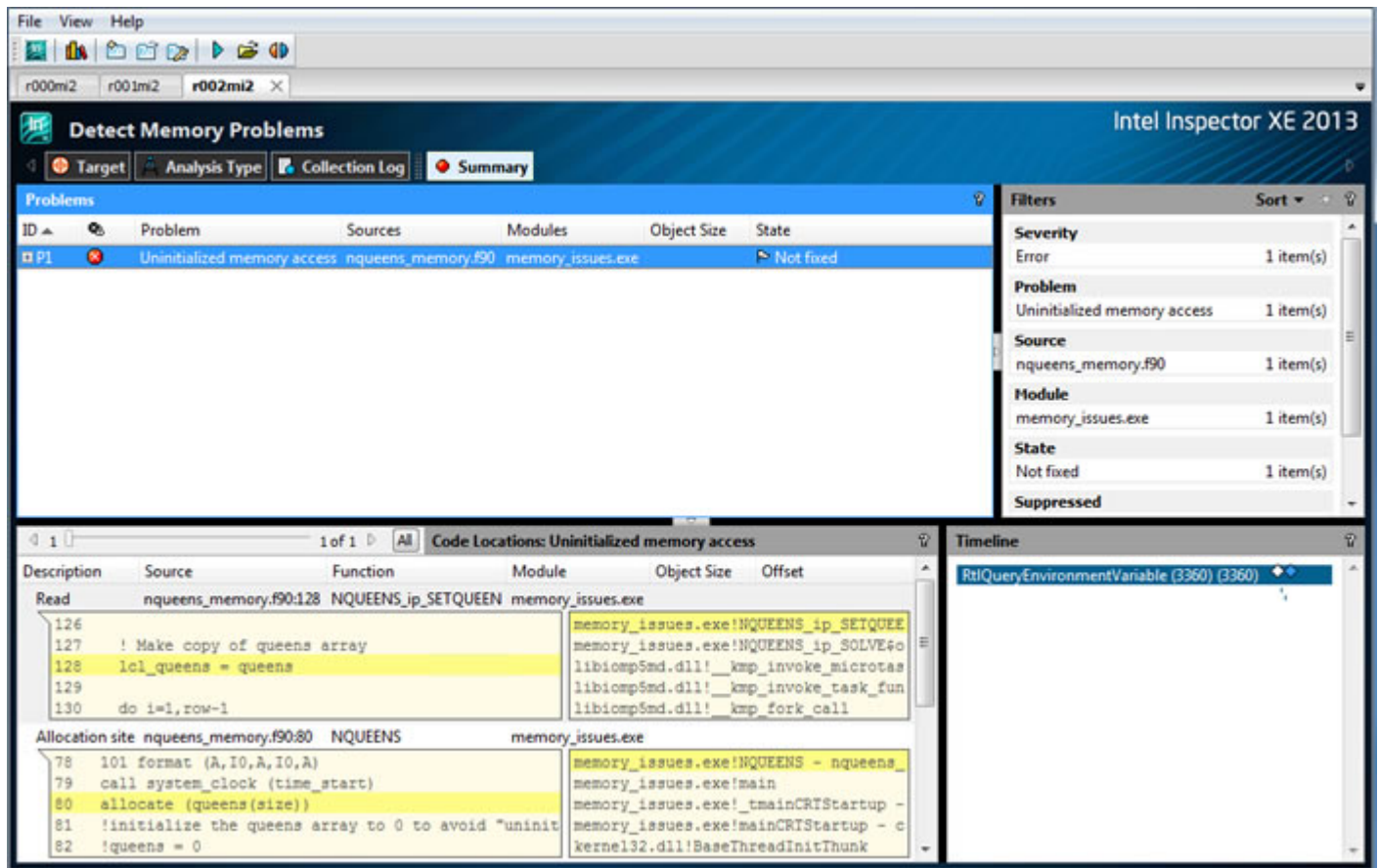
### Rerun the Analysis

To run another analysis of the same analysis type:

- From the Visual Studio\* menu, choose **Tools > Intel Inspector XE 2013 > Memory Error Analysis / Detect Memory Problems**.
- From the Standalone Intel Inspector XE GUI menu, choose **File > Memory Error Analysis / Detect Memory Problems**.

## 2 Getting Started Tutorial: Analyzing Memory Errors

The **Summary** window automatically displays after analysis (both collection and finalization) completes successfully:



Notice the Intel Inspector XE:

- Created a new result tab: **r002mi2**.
- No longer detects the **Memory leak** problem.

### Key Terms

Analysis



# Summary



This tutorial demonstrated an end-to-end workflow you can ultimately apply to your own applications.

Step	Tutorial Recap	Key Tutorial Take-aways
<b>1. Set up</b>	<p>If you used the Visual Studio* IDE: You chose a project; verified the project is set to produce the most accurate and complete analysis results; built and ensured the application runs on your system outside the Intel Inspector XE.</p> <p>If you used the standalone GUI: You built and ensured the application runs on your system outside the Intel Inspector XE, and created a project to hold analysis results.</p>	<p>Applications compiled and linked in debug mode using the following options produce the most accurate and complete analysis results: <code>/debug:full, /Od, /libs:dll/threads</code> or <code>libs:dll/threads/dbglibs</code>, and <code>/check:none</code>.</p>
<b>2. Collect result</b>	<p>You chose an analysis type and ran an analysis. During analysis, the Intel Inspector XE:</p> <ul style="list-style-type: none"> <li>Ran the application, identified errors that may need handling, collected a result, and displayed the result in a result tab.</li> <li>Added a pointer to the result in the <b>Solution Explorer</b> (Visual Studio* IDE) or <b>Project Navigator</b> (standalone GUI).</li> </ul>	<ul style="list-style-type: none"> <li>Intel Inspector XE offers preset analysis types to help you control analysis scope and cost. Widening analysis scope maximizes the load on the system, and the time and resources required to perform the analysis.</li> <li>Run error analyses from the <b>Tools</b> menu (Visual Studio* IDE), <b>File</b> menu (Standalone Intel Inspector XE GUI), toolbar, or command line using the <code>inspxe-cl</code> command.</li> </ul>
<b>3. Investigate result</b>	<p>You explored detected problems, interpreted the result data, accessed an editor directly from the Intel Inspector XE, and changed source code. You also investigated a problem using interactive debugging if you used the Visual Studio* IDE.</p>	<ul style="list-style-type: none"> <li>Key terms: A <i>code location</i> is a fact the Intel Inspector XE observes at a source code location. A <i>problem</i> is one or more occurrences of a detected issue. A <i>problem set</i> is a group of problems with a common problem type and a shared code location that might share a common solution.</li> <li>Think of the <b>Problems</b> pane on the <b>Summary</b> window as a <i>to-do</i> list: Start at the top and work your way down.</li> <li>Double-click a code location or problem on the <b>Summary</b> window to navigate to the <b>Sources</b> window. Click the <b>Summary</b> button on the <b>Sources</b> window to return to the <b>Summary</b> window.</li> </ul>

### 3 *Getting Started Tutorial: Analyzing Memory Errors*

Step	Tutorial Recap	Key Tutorial Take-aways
		<ul style="list-style-type: none"><li>• Right-click various places on the <b>Summary</b> or <b>Sources</b> window to display a context menu, then choose <b>Explain Problem</b> to access more information on interpreting and resolving the problem.</li><li>• Double-click a code location on the <b>Sources</b> window to open an editor.</li><li>• Right-click a problem, then choose <b>Debug This Problem</b> to launch an interactive debugging session (Visual Studio* IDE).</li></ul>
<b>4. Check your work</b>	You recompiled, relinked, and reinspected the application.	

**Next step:** Prepare your own application(s) for analysis. Then use the Intel Inspector XE to find and fix errors.



# Key Terms

---



The following terms are used throughout this tutorial.

**analysis:** A process during which the Intel Inspector XE performs collection and finalization.

**code location:** A fact the Intel Inspector XE observes at a source code location, such as a *write* code location. Previously called an *observation*.

**collection:** A process during which the Intel Inspector XE executes an application, identifies issues that may need handling, and collects those issues in a result.

**false positive:** A reported error that is not an error.

**finalization:** A process during which the Intel Inspector XE uses debug information from binary files to convert symbol information into filenames and line numbers, performs duplicate elimination (if requested), and forms problem sets.

**problem:** One or more occurrences of a detected issue, such as an uninitialized memory access. Multiple occurrences have the same call stack but a different thread or timestamp. You can view information for a problem as well as for each occurrence.

**problem breakpoint:** A breakpoint that halts execution when a memory or threading analysis detects a problem. In the Visual Studio\* debugger, a problem breakpoint is indicated by a yellow arrow at the source line where execution halts.

**problem set:** A group of problems with a common problem type and a shared code location that might share a common solution, such as a problem set resulting from deallocating an object too early during program execution. You can view problem sets only after analysis is complete.

**project:** A compiled application; a collection of configurable attributes, including suppression rules and search directories; and a container for analysis results.

**result:** A collection of issues that may need handling.

**target:** An application the Intel Inspector XE inspects for errors.

