Debugging Techniques

Objectives

- Basic Debugging Technique
- Breakpoints
- Watches
- Stepping
- Stopping the Debugger
- Conditions and Hit Counts
- Break on Exception
- Step Into
- Trace and Assert

Basic Debugging Technique

- The debugger is a tool to help correct runtime and semantic errors
- note that no debugging tools are useful in solving *compiler errors.*
- Compiler errors are those that show at the bottom of the screen when compiling

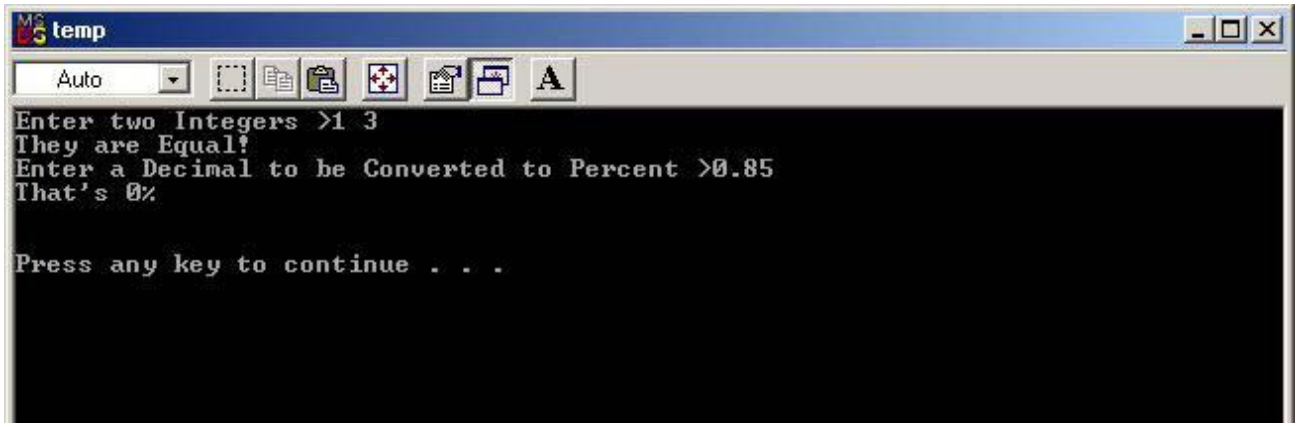
Basic Debugging Technique

- If the program isn't working correctly, one of two things could be going wrong:
  - ✓ *Data is corrupt somewhere*
  - ✓ The code isn't correct
- Example

```
int a = 0;
int b = 1;
printf("%d", (b/a));
```

A Buggy Program

- Trying to debug a program that's working perfectly is rather pointless



The Buggy Code

```
#include <stdio.h>
int toPercent (float decimal);
int main() {
        int a, b;
        float c;
        int cAsPercent;
        printf("Enter A >");
        scanf("%d", &a);
        printf("Enter B >");
        scanf("%d", &b);

        if (a = b) printf("They are Equal!\n");
        else if (a > b) printf("The first one is bigger!\n");
        else printf("The second one is bigger!\n");
        printf("Enter a Decimal to be Converted to Percent >");
        scanf("%f", &c);
        cAsPercent = toPercent(c);
        printf("That's %d %\n", cAsPercent);
        printf("\n\n");
        return 0;
}
```

The Buggy Code

```
/* ToPercent():
Converts a given float (eg 0.9) to a percentage (90).
*/
int toPercent (float decimal) {
    int result;
    result = int(decimal) * 100;
    return result;
}
```

Debug Mode or Not?

- Ctrl+F5 to run your program
- The F5 key alone will also run in debug mode.
- Build for Debug
- Build for Release

Breakpoints

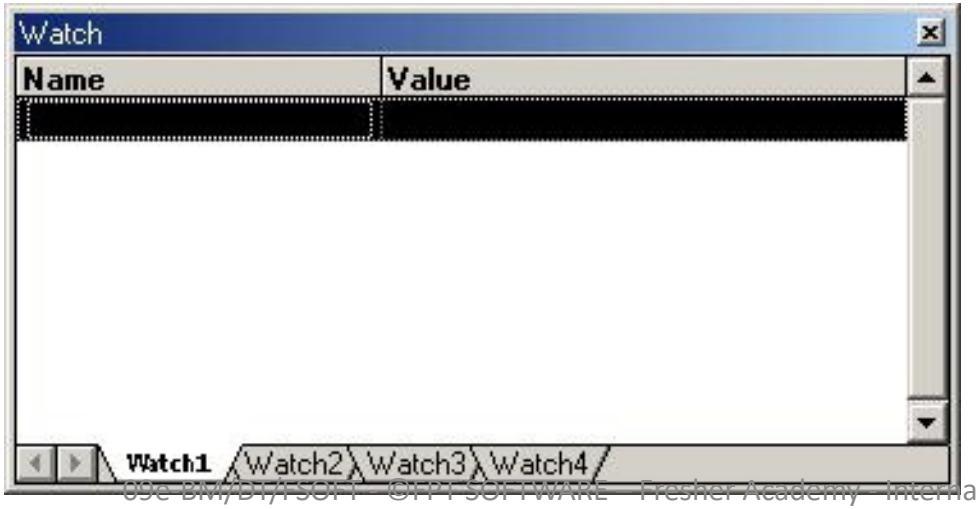
- Breakpoints are the lifeblood of debugging.
- Right-click and select "Insert/Remove Breakpoint" or press the F9 key

```
printf("Enter A >");
scanf("%d", &a);
printf("Enter B >");
scanf("%d", &b);

if (a = b) printf("They are Equal!\n");
else if (a > b) printf("The first one is bigger!\n");
else printf("The second one is bigger!\n");
printf("Enter a Decimal to be Converted to Percent >");
scanf("%f", &c);
```

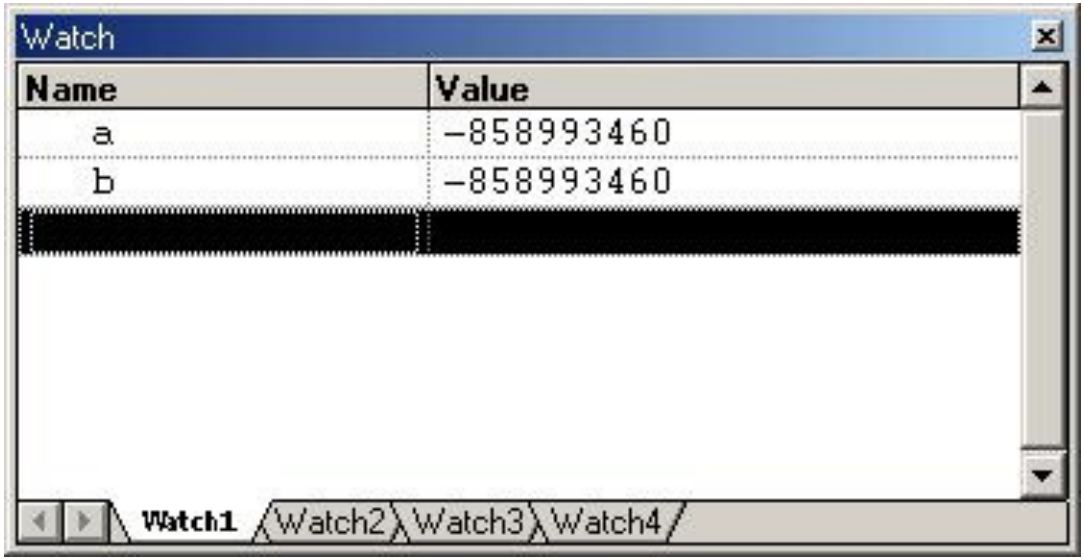
Watches

- The "Watch" window lets you *watch the contents of any variables you select as your program* executes.
- Open it from the View menu (Debug Windows > Watch), or by clicking the "Watch" icon in the toolbar, or by pressing Alt+3



Watches

- Enter to add *variables to your Watch* list:



Watches

- Watch a range of values inside array:

  Syntax: array + <offset>, <range>

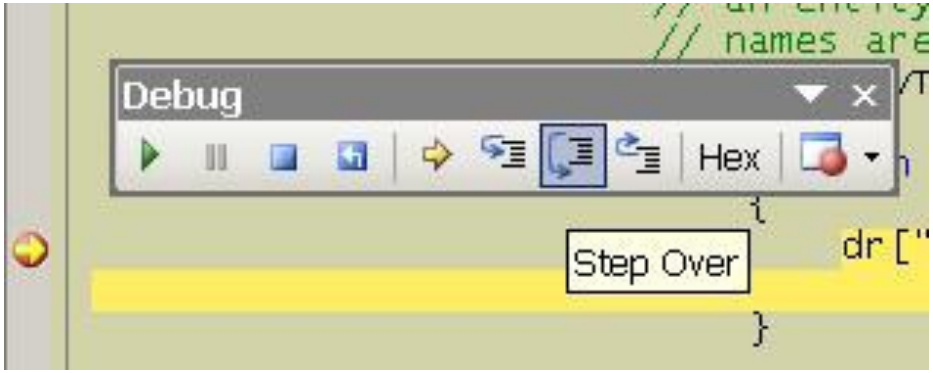
```
1  #include <iostream>
2  #include <stdexcept>
3
4  using namespace std;
5
6  void main()
7  {
8      int* arr = new int[1000];
9
10     for(int i = 0; i < 1000; i++)
11     {
12         arr[i] = i;
13     }
14 }
```

Watch 1

Name	Value
arr, 3	0x00801290
[0]	0
[1]	1
[2]	2
arr + 3, 3	0x0080129c
[0]	3
[1]	4
[2]	5

Stepping

- Step Over F10
- Step Into F11 (Some code inside a function may *or may not need to be examined*)
- Step Out Shift + F11



Stepping

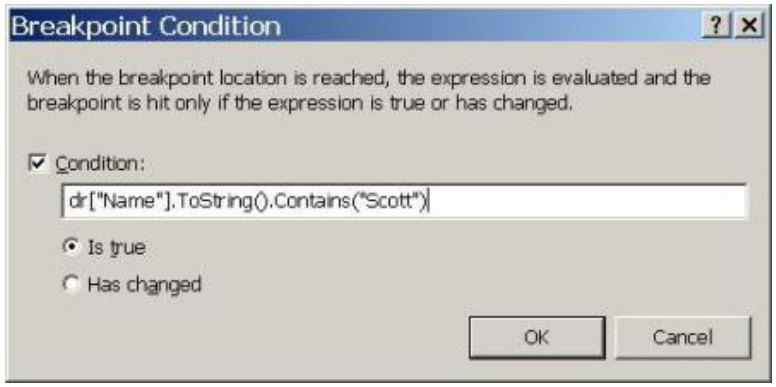
- When you are tired of stepping through the code, F5 resumes execution.

```
printf("Enter A >");
scanf("%d", &a);
printf("Enter B >");
scanf("%d", &b);

if (a = b) printf("They are Equal!\n");
else if (a > b) printf("The first one is bigger!\n");
else printf("The second one is bigger!\n");
printf("Enter a Decimal to be Converted to Percent >");
scanf("%f", &c);
```

Stopping the Debugger

When you've found a problem to correct, it may be tempting to press Ctrl+C in your program window to end the program



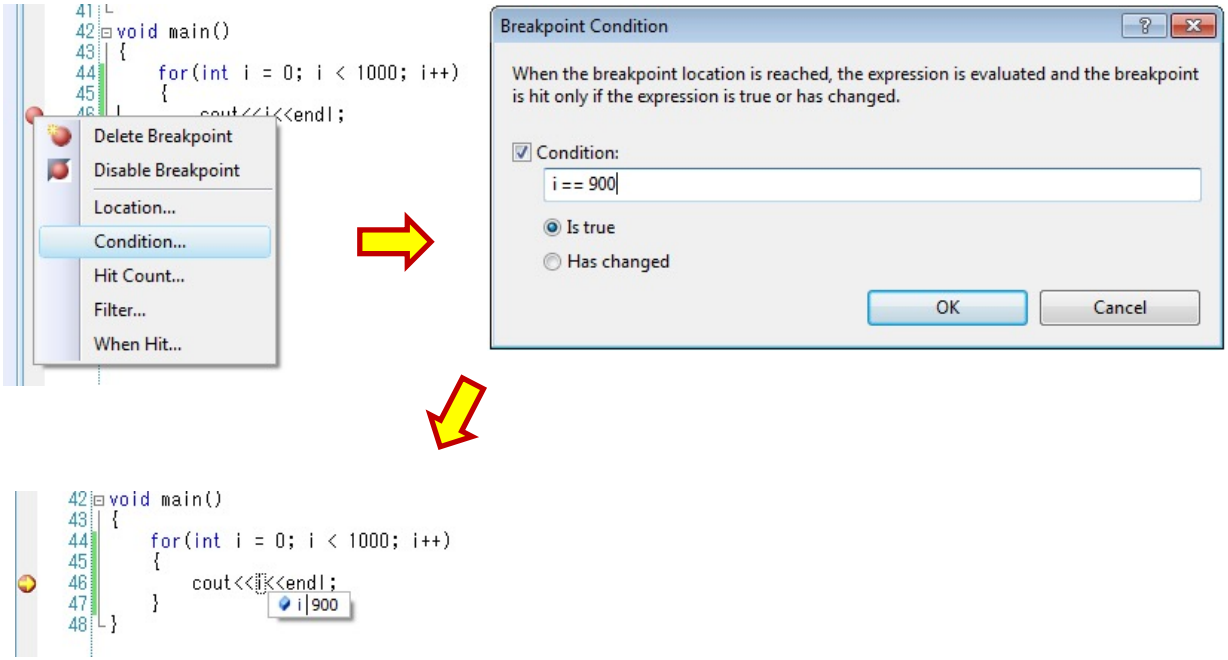
Select "Stop Debugging" from the Debug menu or on the toolbar or press Shift+F5.

Conditions and Hit Counts

- Breakpoint can use conditions and hit counts
- Conditions and hit counts are useful if you don't want the debugger to halt execution *every time the program reaches the breakpoint*
- Only when a condition is true, or a condition has changed, or execution has reached the breakpoint a specified number of times.

Conditions and Hit Counts

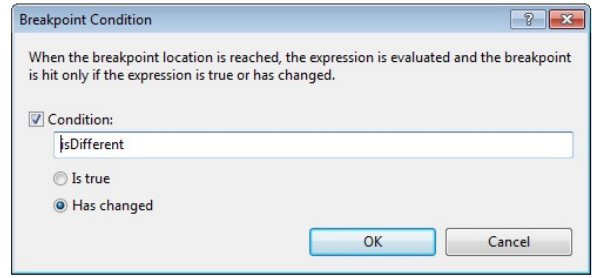
- Condition: Is true



Conditions and Hit Counts

- Condition: Has changed

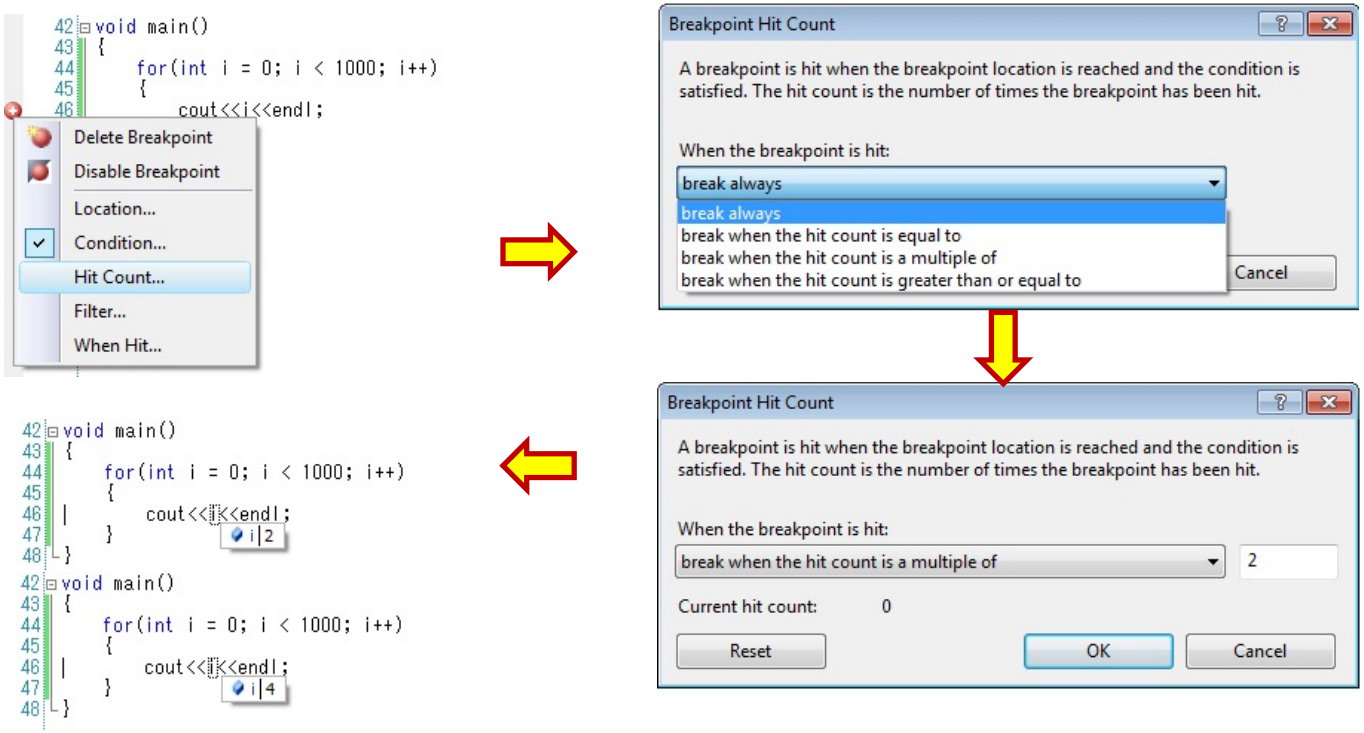
```
1  #include <iostream>
2
3  using namespace std;
4
5  void main()
6  {
7      bool isDifferent = false;
8
9      int arr1[10] = {0, 0, 0, 0, 0, 0, 0, 0, 0, 0};
10     int arr2[10] = {0, 0, 0, 0, 0, 0, 0, 0, 0, 1};
11
12     for(int i = 0; i < 10; i++)
13     {
14         if(arr1[i] != arr2[i])
15         {
16             isDifferent = true;
17         }
18
19         cout<<"arr1 = "<<arr1[i]<<" and arr2 = "<<arr2[i]<<endl;
20     }
21 }
```



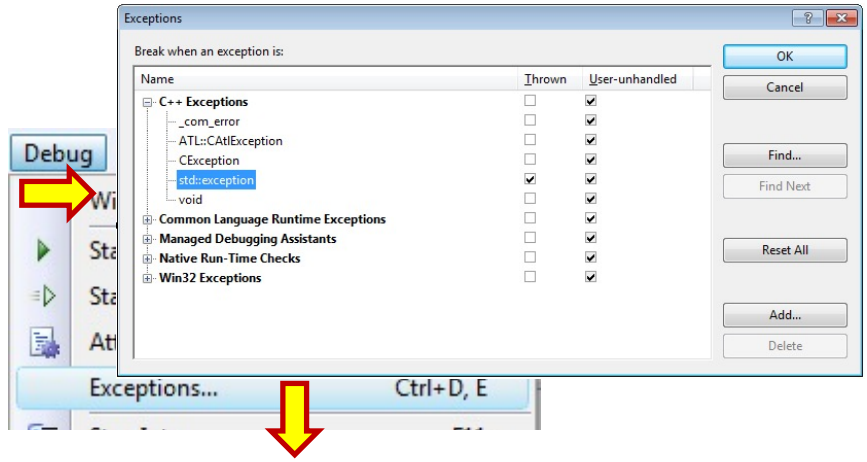

```
1  #include <iostream>
2
3  using namespace std;
4
5  void main()
6  {
7      bool isDifferent = false;
8
9      int arr1[10] = {0, 0, 0, 0, 0, 0, 0, 0, 0, 0};
10     int arr2[10] = {0, 0, 0, 0, 0, 0, 0, 0, 0, 1};
11
12     for(int i = 0; i < 10; i++)
13     {
14         if(arr1[i] != arr2[i])
15         {
16             isDifferent = true;
17         }
18
19         cout<<"arr1 = "<<arr1[i]<<" and arr2 = "<<arr2[i]<<endl;
20     }
21 }
```

Conditions and Hit Counts

- Hit Count: is a multiple of



Break on Exception



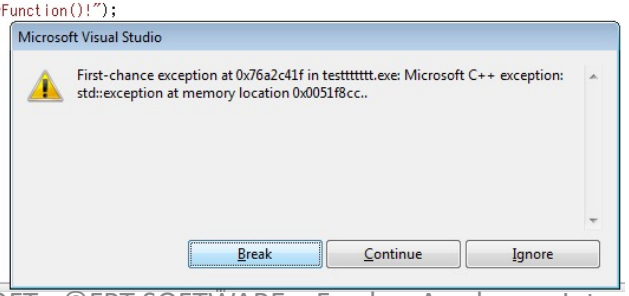

```
#include <iostream>
#include <stdexcept>

using namespace std;

void myFunction()
{
    throw exception("Throw exception from myFunction()!");
}

void callMyFunction()
{
    try
    {
        myFunction();
    }
    catch(exception ex)
    {
        cout<<ex.what()<<endl;
    }
}

void main()
{
```



Stepping Into Assembly

- Be careful when you "Step Into" lines involving printf, scanf, or other system functions!

```
int __cdecl scanf (
        const char *format,
        ...
        )
{
        va_list arglist;
        va_start(arglist, format);
        return vscanf(_input_l, format, NULL, arglist);
}
```

Debug commands

Command	Meaning
Ctrl+F5	Run program
F5	Run in debug mode
F9	Create breakpoint
F10	Step over
F11	Step into
Shift + F11	Step out
Shift + F5	Stop debugging
Ctrl + Tab	Change window

Trace and Assert

- Trace: Allows the programmer to put a log message onto the main output window
- Assert: To check program assumptions

Trace and Assert

```
3   #include "stdafx.h"
4
5   using namespace System::Diagnostics;
6
7   void main()
8   {
9       double result = 0.0;
10
11      Trace::WriteLine("START OPERATION");
12      for(int i = 0; i < 10; i++)
13      {
14          int numToDevide     = i - 10;
15          int numToBeDevided  = i;
16
17          Trace::WriteLine(result);
18
19          result = numToBeDevided / numToDevide;
20      }
21      Trace::WriteLine("END OPERATION");
22  }
```

Press F5

Output

Show output from: Debug

```
'AssertTrace.exe': Loaded 'C:¥Windows¥assembly¥NativeImages_v2.0.50
'AssertTrace.exe' (Managed): Loaded 'C:¥Windows¥assembly¥GAC_MSIL¥S
START OPERATION
0
0
0
0
0
0
-1
-1
-2
-4
END OPERATION
The thread 'Win32 Thread' (0x424) has exited with code 0 (0x0).
```

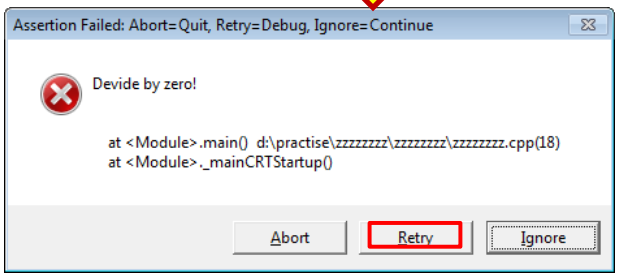
- Keep tracing code processing by output value during debugging

Trace and Assert

```
3   #include "stdafx.h"
4
5   using namespace System::Diagnostics;
6
7   void main()
8   {
9       double result = 0.0;
10
11      Trace::WriteLine("START OPERATION");
12      for(int i = 0; i < 11; i++)
13      {
14          int numToDevide     = i - 10;
15          int numToBeDevided  = i;
16
17          Trace::Assert(numToBeDevided != 0, "Devide by zero!");
18          Trace::WriteLine(result);
19
20          result = numToBeDevided / numToDevide;
21      }
22      Trace::WriteLine("END OPERATION");
23  }
```

This code contain potential bug, if another developer change 10 to other values (such as 11)

We use Assert to validate that the value is valid or not



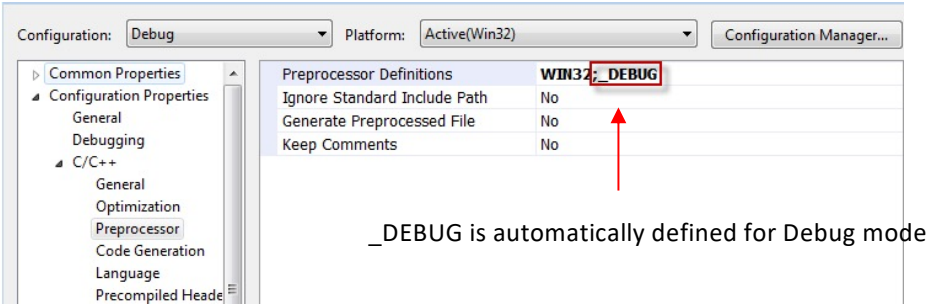

```
3   #include "stdafx.h"
4
5   using namespace System::Diagnostics;
6
7   void main()
8   {
9       double result = 0.0;
10
11      Trace::WriteLine("START OPERATION");
12      for(int i = 0; i < 11; i++)
13      {
14          int numToDevide     = i - 10;
15          int numToBeDevided  = i;
16
17          Trace::Assert(numToBeDevided != 0, "Devide by zero!");
18          Trace::WriteLine(result);
19
20          result = numToBeDevided / numToDevide;
21      }
22      Trace::WriteLine("END OPERATION");
23  }
```

Press Retry allow us to debug after Assert

Trace and Assert

- The behavior for Trace will not change between a debug and a release build
- This mean that we must #ifdef any Trace-related code to prevent debug behavior in a release build

Trace and Assert



_DEBUG is automatically defined for Debug mode

```
3   #include "stdafx.h"
4
5   using namespace System::Diagnostics;
6
7   void main()
8   {
9       double result = 0.0;
10
11  #ifdef _DEBUG
12      Trace::WriteLine("START OPERATION");
13  #endif
14
15      for(int i = 0; i < 10; i++)
16      {
17          int numToDevide     = i - 10;
18          int numToBeDevided  = i;
19
20  #ifdef _DEBUG
21          Trace::WriteLine(result);
22  #endif
23
24          result = numToBeDevided / numToDevide;
25      }
26  #ifdef _DEBUG
27      Trace::WriteLine("END OPERATION");
28  #endif
29
30  }
```

We can use #ifdef _DEBUG to prevent debug behavior in release mode

Thank you

Q&A