Embedded computing for scientific and industrial imaging applications

Lecture 4 - C demo, Newton’s method

Outline

C demo with visual studio

- Computing square roots by Newton's method
- Incremental developing by using git

Computing square roots

Hardware arithmetic units can add, subtract, multiply, divide. Other mathematical functions usually take some software.

$\sqrt{2} \simeq 1.4142135623730951$

In most languages, sqrt(2) computes this.

```
#include <math.h>

sqrt(2);
```

Newton's method

Problem: Find a solution of $f(s) = 0$ (zero or root of f)

Idea: Given approximation $s^{[k]}$,
approximate $f(s)$ by a linear function,
the tangent line at $(s^{[k]},\ f(s^{[k]}))$.

Find unique zero of this function and use as $s^{[k+1]}$.

Updating formula:

$$s^{[k+1]} = s^{[k]} - \frac{f(s^{[k]})}{f'(s^{[k]})}$$

Approximate s = √x

Newton's method to find root of $s^2 - x = 0$.

```
double s = 1.;
for (int i = 0; i < maxiter; i++)
{
    s = 0.5 * (s + x / s);
}
```

where `maxiter` is some maximum number of iterations.

Demo

Goals:

- Develop our own version of sqrt function.
- Start simple and add complexity in stages.
- Illustrate some C programming.
- Illustrate use of git to track our development
- Get familiar with visual studio IDE

We will do this in codes/mysqrt directory so you can examine the various versions later.

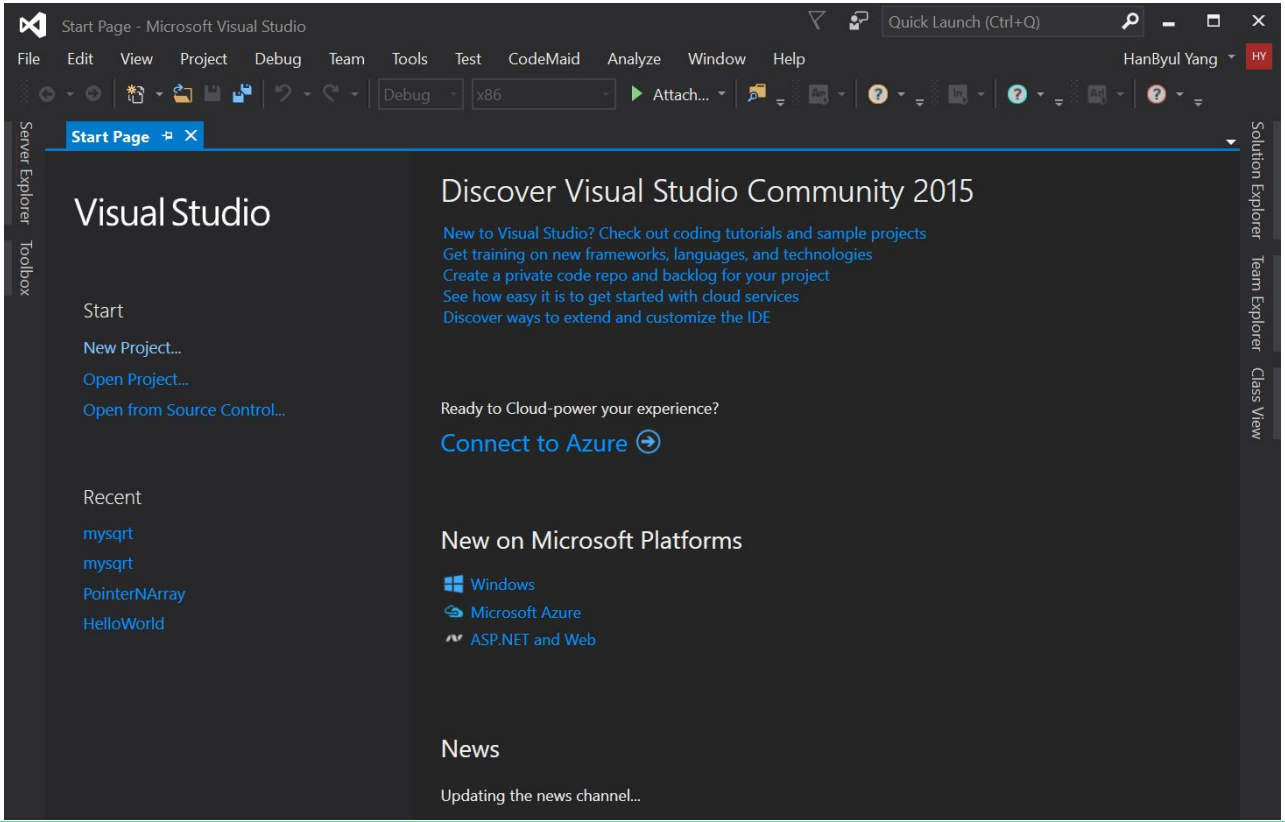
Demo : mysqrt.c

```
#include <stdio.h>
#include <math.h>

int main()
{
    double x = 2;
    double s = sqrt(x);
    printf(“sqrt(%f) = %f\n”, x, s);
}
```

Demo : visual studio

Start “New Project”

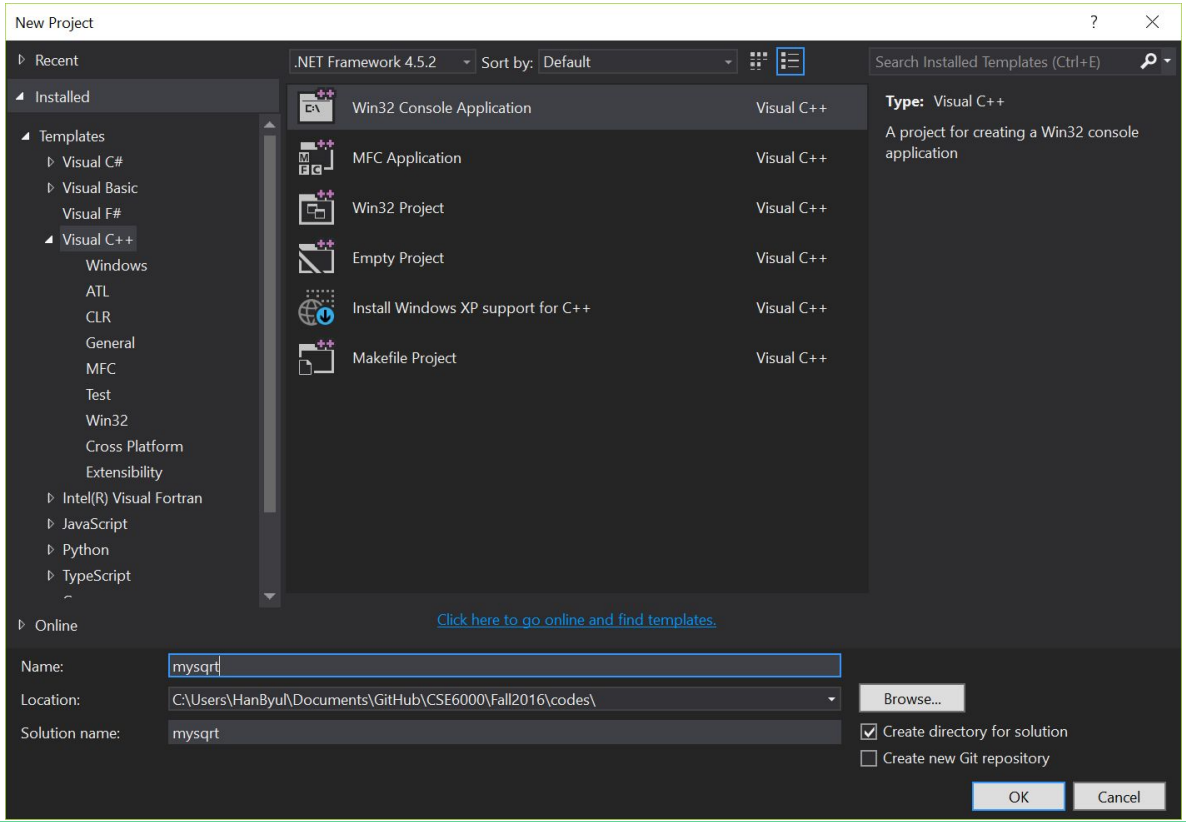


Demo : new project

Visual c++

Win32 Console application

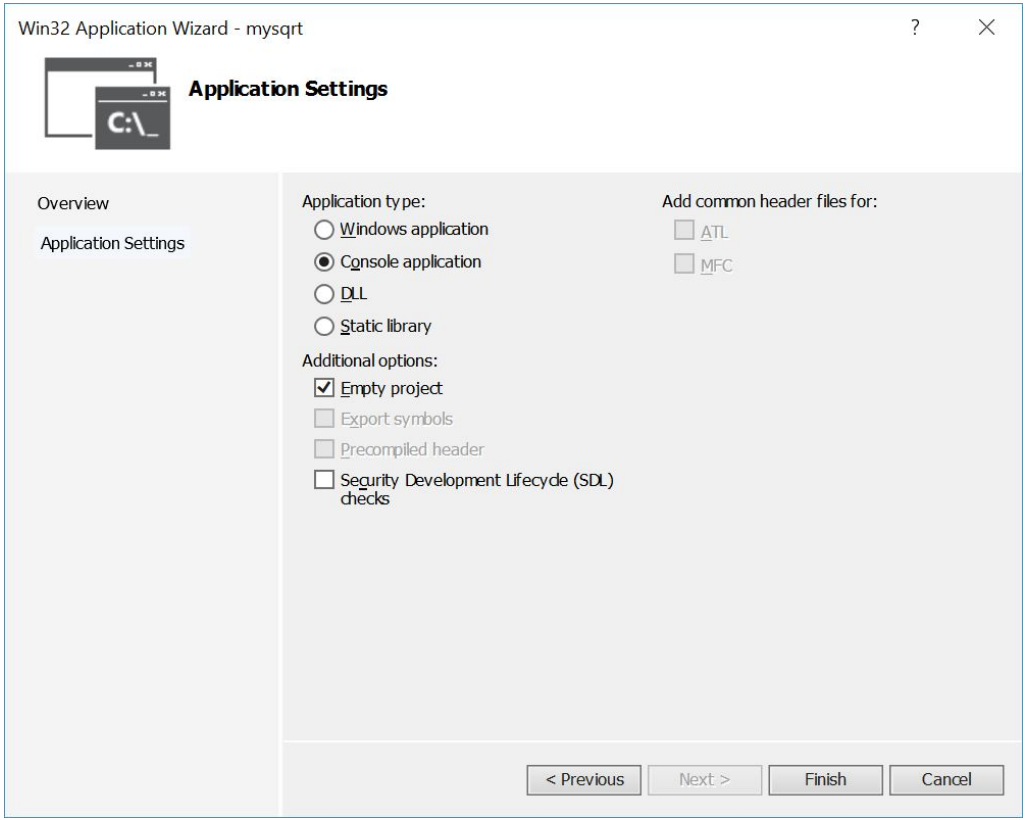
“mysqrt”



Demo : application setting

Console application

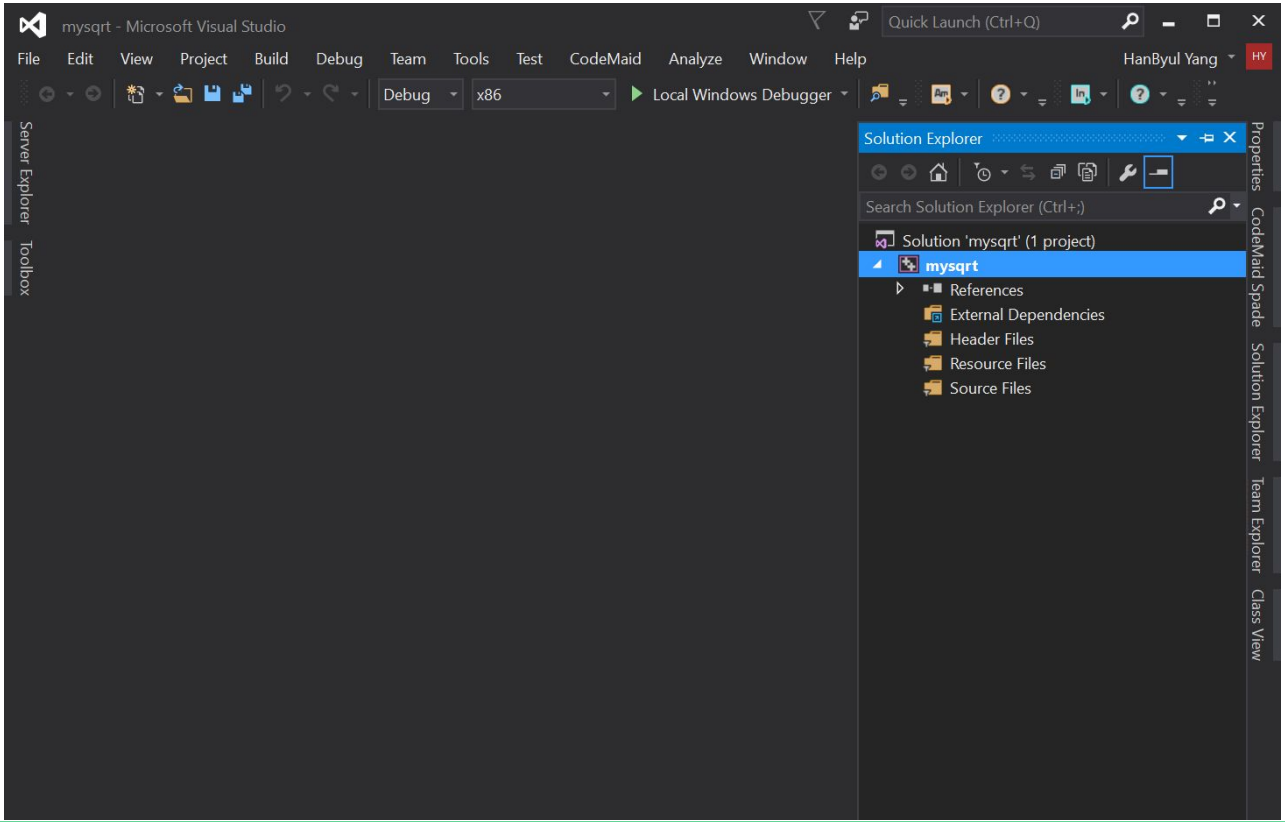
Empty project



Demo : Solution Explorer

Solution

Project

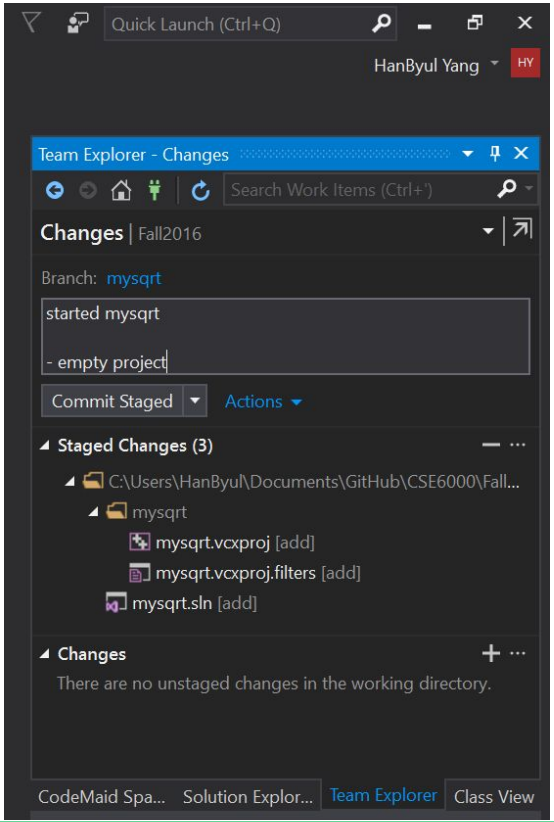


Demo : Team Explorer

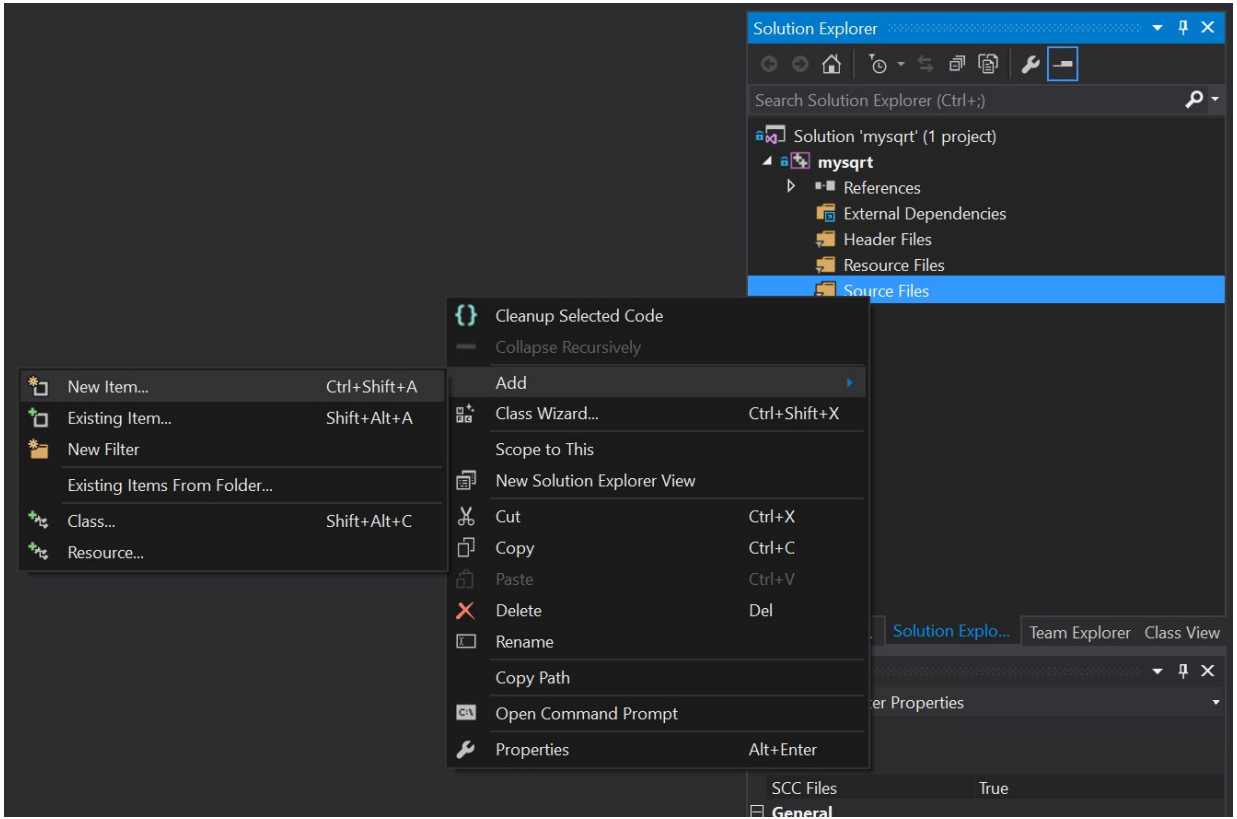
Branch : mysqrt

Commit 3 files

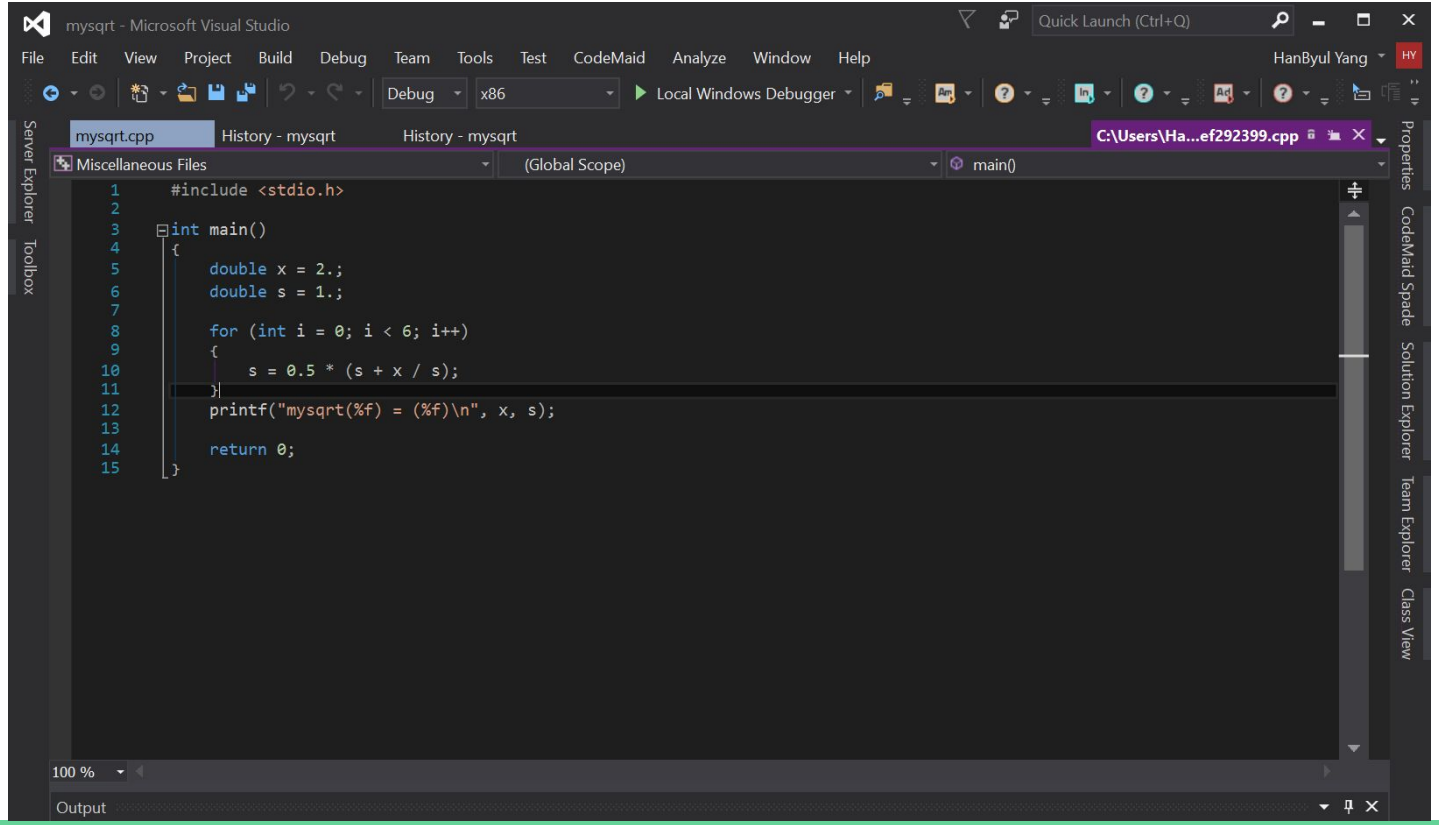
- mysqrt.sln
- mysqrt.vcxproj
- mysqrt.vcxproj.filters



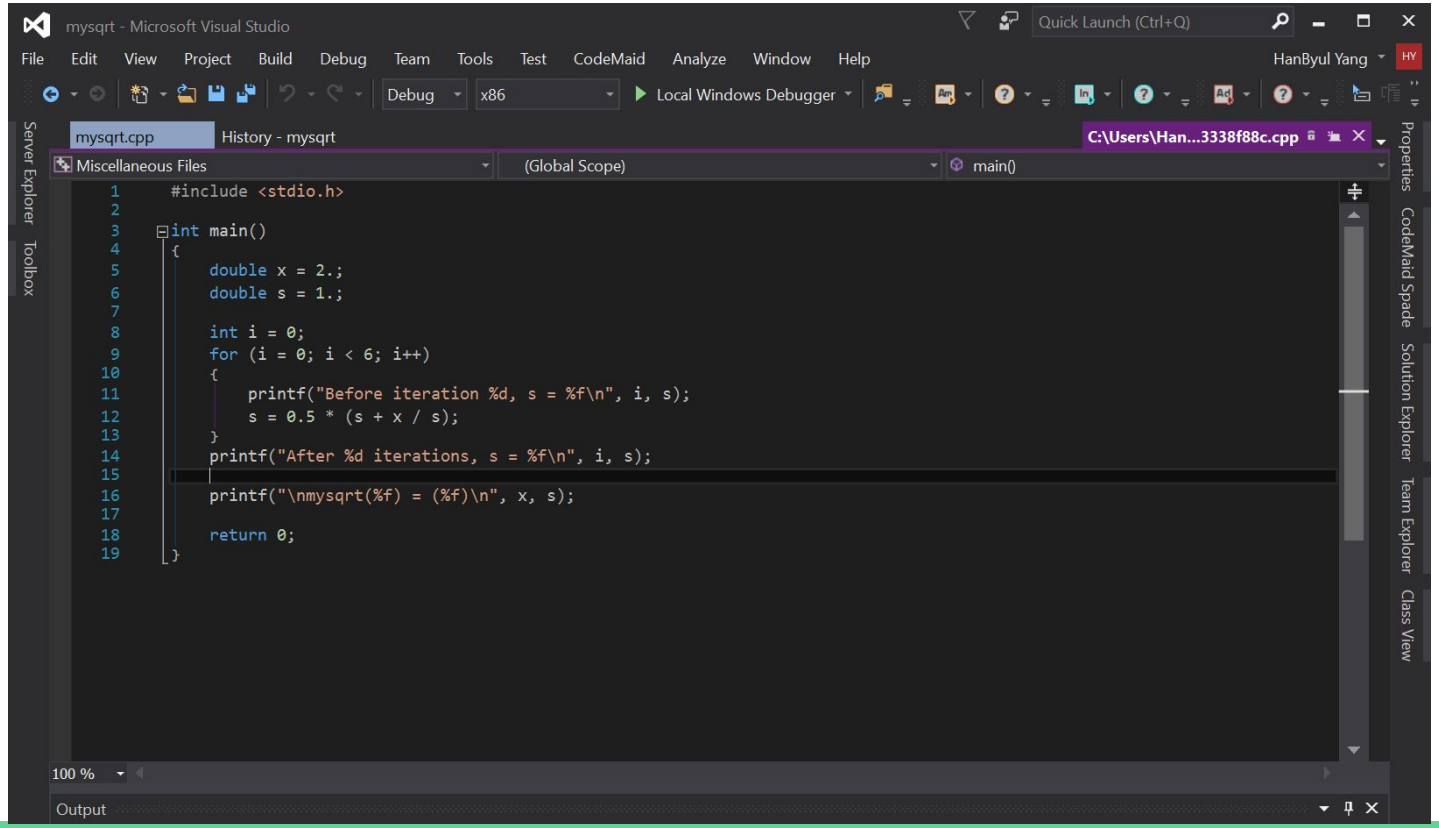
Add “New Item”


Solution Explorer
Search Solution Explorer (Ctrl+;)
Solution 'mysqrt' (1 project)
mysqrt
References
External Dependencies
Header Files
Resource Files
Source Files
Cleanup Selected Code
Collapse Recursively
Add
Class Wizard... Ctrl+Shift+X
Scope to This
New Solution Explorer View
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
Delete Del
Rename
Copy Path
Open Command Prompt
Properties Alt+Enter
New Item... Ctrl+Shift+A
Existing Item... Shift+Alt+A
New Filter
Existing Items From Folder...
Class... Shift+Alt+C
Resource...
Solution Explo...
Team Explorer
Class View
SCC Files
True
General

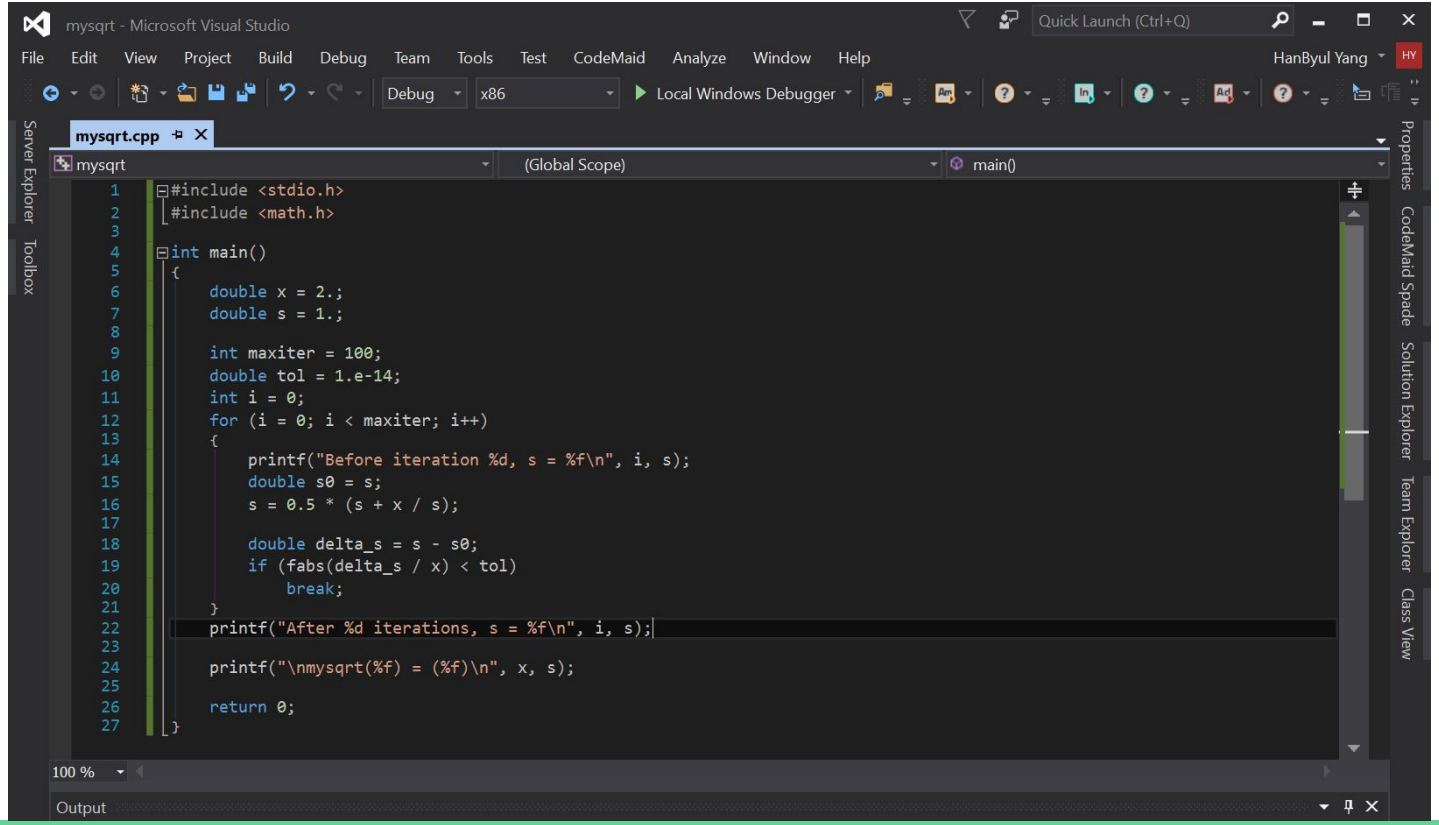
Demo : First version of mysqrt



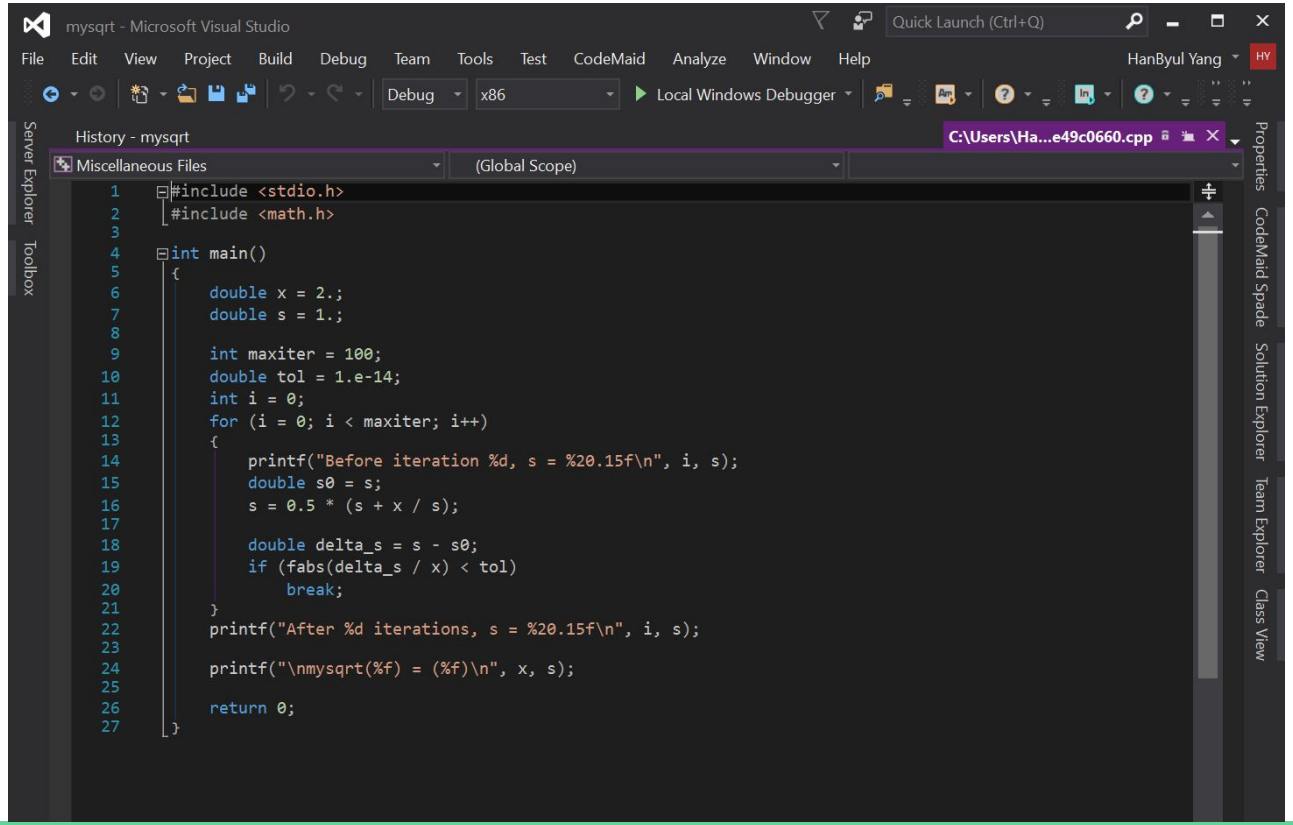
Demo : Print each iteration



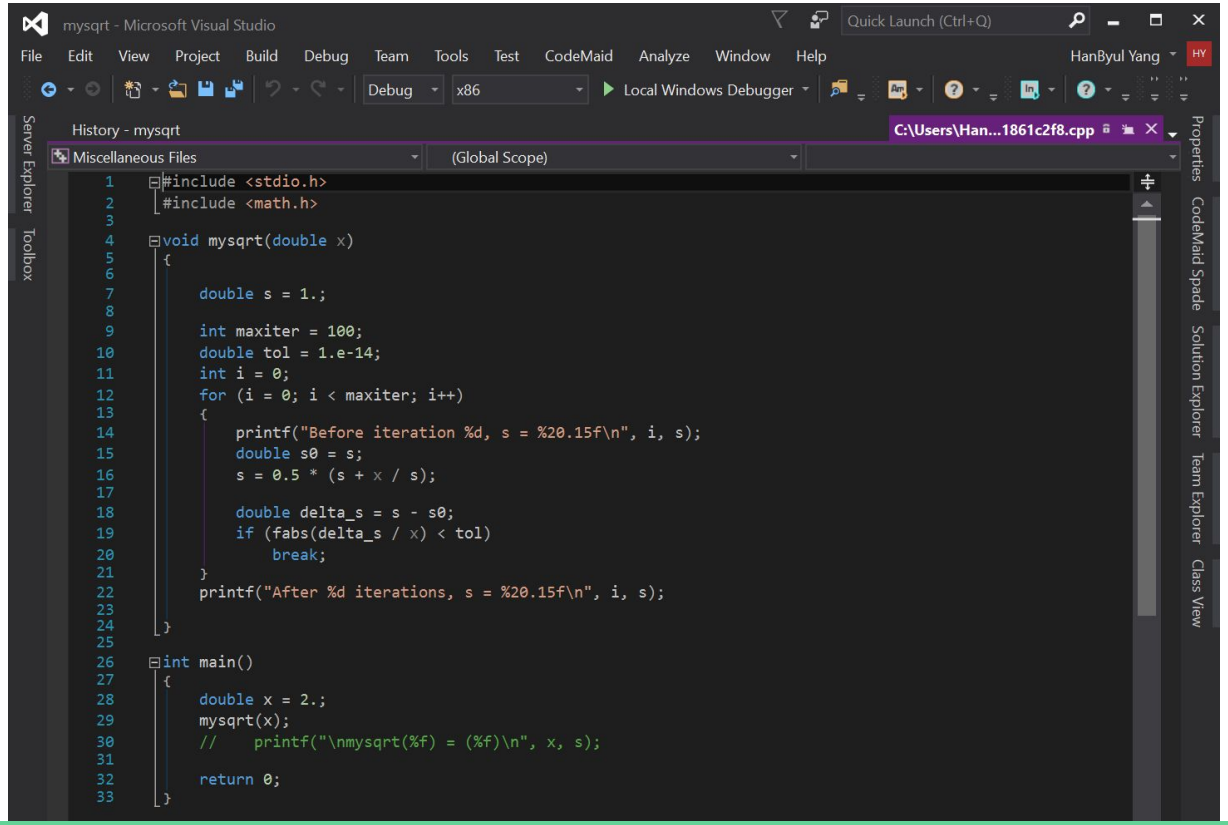
Demo : Add convergence test



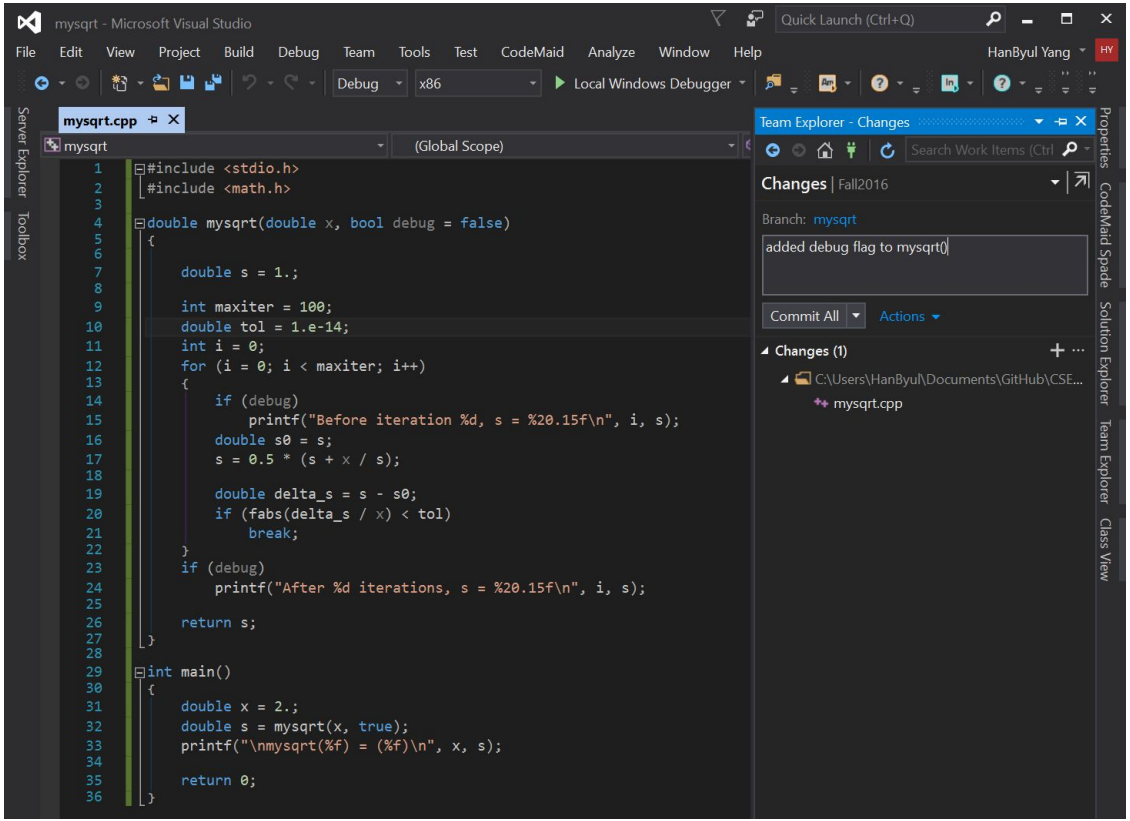
Demo : Refinement of printing floating point number



Demo : mysqrt() function



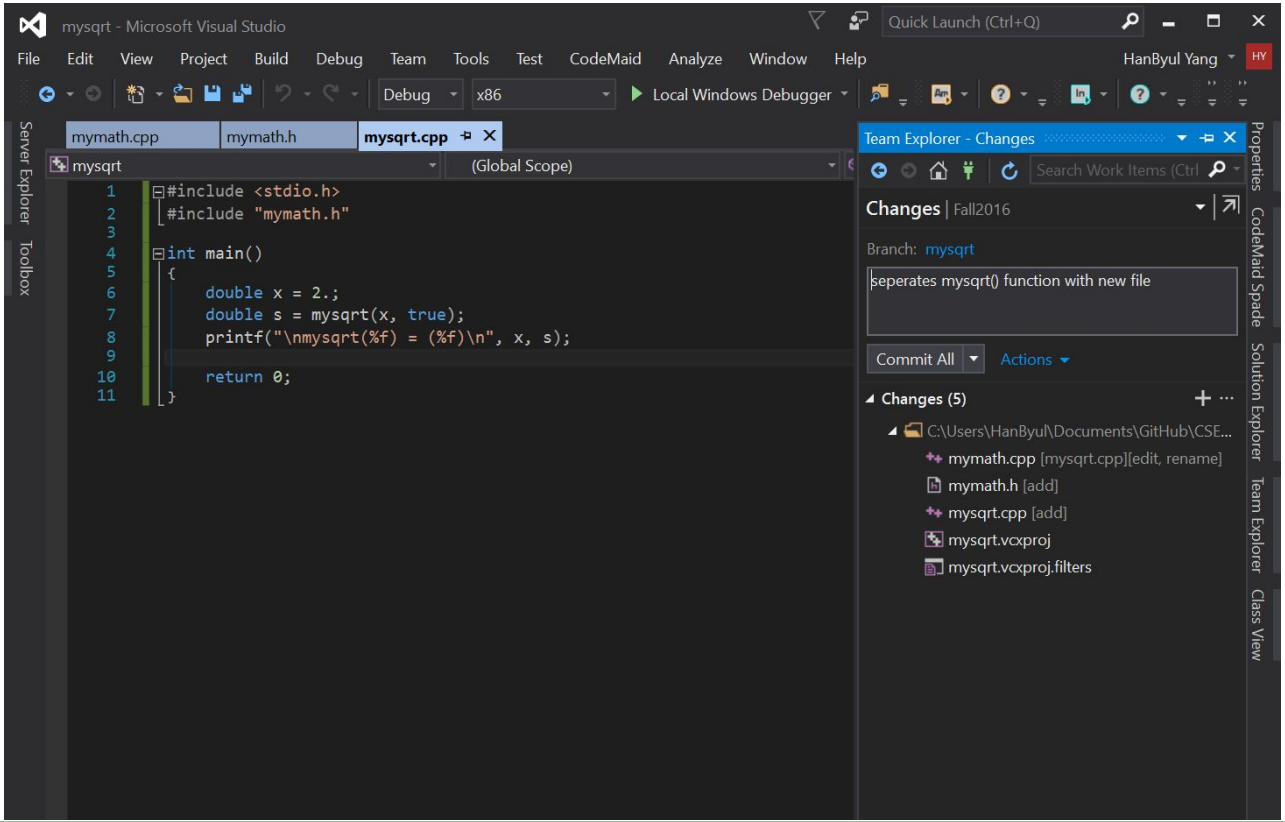
Demo : mysqrt() function with debug flag



Demo : separates mysqrt()

New files

- mymath.h
- mymath.cpp



Links

- Getting Started with C++ in Visual Studio
- Visual C++ in Visual Studio 2015
- C++ Language Reference