Lab Assignment 9: Module Dependency and Cohesion Analysis

Setting up virtual environment:

```
@Destructor169 → /workspaces/STT-LAB-9 (main) $ python3 -m venv venv
@Destructor169 → /workspaces/STT-LAB-9 (main) $ source venv/bin/activate
(venv) @Destructor169 → /workspaces/STT-LAB-9 (main) $
```

Installing dependencies:

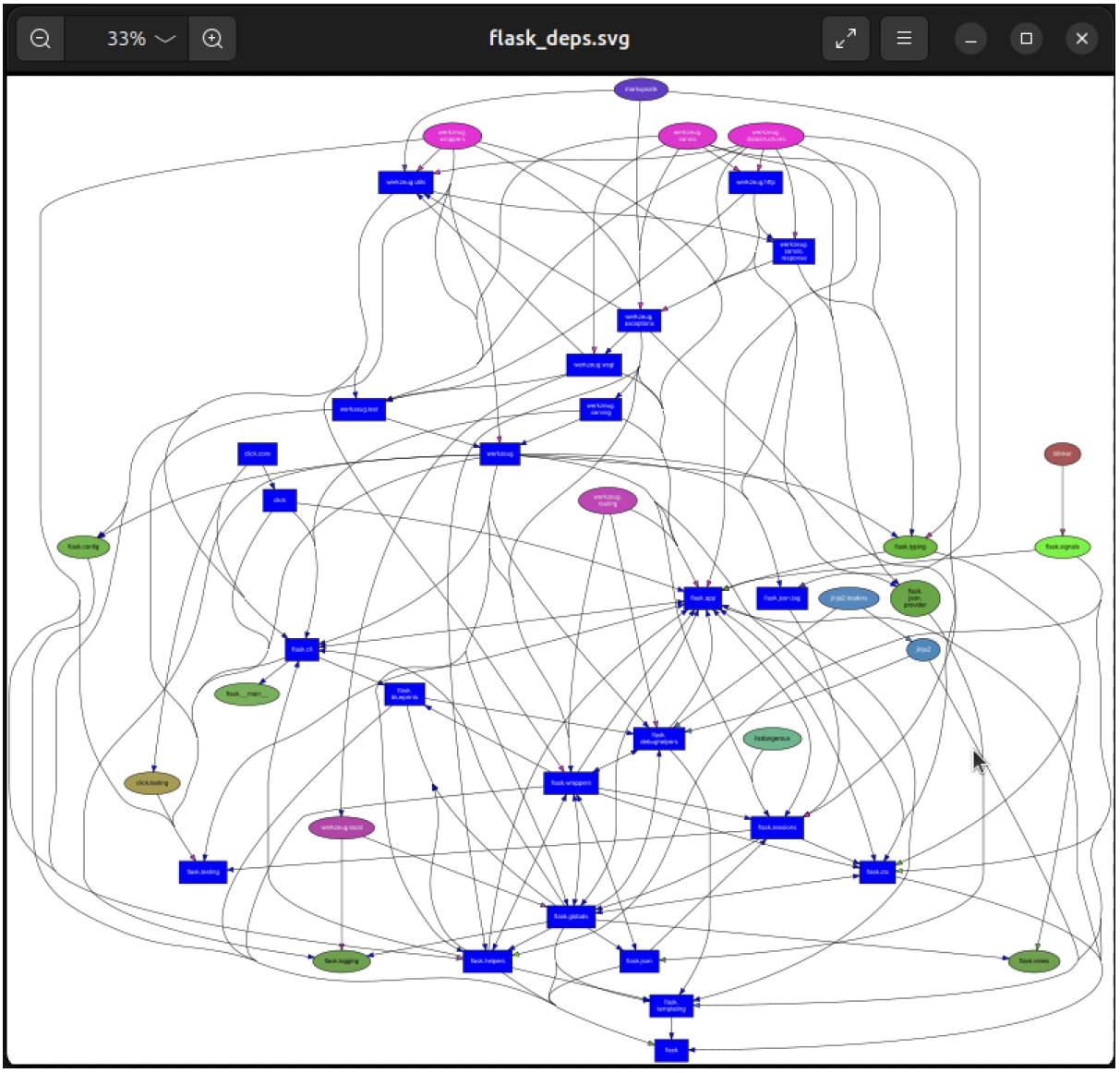
```
(venv) @Destructor169 → /workspaces/STT-LAB-9/flask (main) $ pip install pydeps
Collecting pydeps
  Downloading pydeps-3.0.1-py3-none-any.whl.metadata (22 kB)
Collecting stdlib_list (from pydeps)
  Downloading stdlib_list-0.11.1-py3-none-any.whl.metadata (3.3 kB)
Downloading pydeps-3.0.1-py3-none-any.whl (47 kB)
Downloading stdlib_list-0.11.1-py3-none-any.whl (83 kB)
Installing collected packages: stdlib_list, pydeps
Successfully installed pydeps-3.0.1 stdlib_list-0.11.1
```

Cloning the repository:

```
(venv) @Destructor169 → /workspaces/STT-LAB-9 (main) $ git clone https://github.com/pallets/flask.git
Cloning into 'flask'...
remote: Enumerating objects: 25432, done.
remote: Counting objects: 100% (32/32), done.
remote: Compressing objects: 100% (14/14), done.
remote: Total 25432 (delta 19), reused 18 (delta 18), pack-reused 25400 (from 3)
Receiving objects: 100% (25432/25432), 10.49 MiB | 15.59 MiB/s, done.
Resolving deltas: 100% (17011/17011), done.
(venv) @Destructor169 → /workspaces/STT-LAB-9 (main) $ cd flask
```

Running pydeps command on the repository

```
(venv) aditya@aditya:~/Desktop/STT/flask$ pydeps src/flask --no-config -o flask_deps.svg
(venv) aditya@aditya:~/Desktop/STT/flask$
```



Generates a dependency graph analysis (in JSON format)

```
(venv) aditya@aditya:~/Desktop/STT/flask$ pydeps $(python -c "import flask; print(flask.__path__[0])") --show-deps > flask_deps.json
```

Run a python script to:

Analyze

- Identify highly coupled modules and their dependencies.
- Detect cyclic dependencies and explain how they affect maintainability.
- Check for unused and disconnected modules.
- Assess the depth of dependencies.

and utilize this JSON to calculate fan-in and fan-out of each module and Perform a dependency
impact assessment.

```
(venv) aditya@aditya:~/Desktop/STT/flask$ python calc_metrics.py flask_deps.json

Module Fan-in/Fan-out Analysis:
======================================================================
Module                                          Fan-in     Fan-out
----------------------------------------------------------------------
__main__                                        0          4
bacon                                           43         0
blinker                                         0          4
click                                           0          5
click.core                                      0          5
click.testing                                   0          5
flask                                           0          5
flask.__main__                                  0          5
flask.app                                       0          5
flask.blueprints                                0          5
flask.cli                                       0          5
flask.config                                    0          5
flask.ctx                                       0          5
flask.debughelpers                              0          5
flask.globals                                   0          5
flask.helpers                                   0          5
flask.json                                      0          5
flask.json.provider                             0          5
flask.json.tag                                  0          5
flask.logging                                   0          5
flask.sessions                                  0          5
flask.signals                                   0          5
flask.templating                                0          5
flask.testing                                   0          5
flask.typing                                    0          5
flask.views                                     0          5
flask.wrappers                                  0          5
imported_by                                     42         0
imports                                         35         0
itsdangerous                                    0          4
jinja2                                          0          5
jinja2.loaders                                  0          4
markupsafe                                      0          4
name                                            43         0
path                                            43         0
werkzeug                                        0          5
werkzeug.datastructures                         0          4
werkzeug.exceptions                             0          5
werkzeug.http                                   0          5
```

```
markupsafe                                0          4
name                                      43         0
path                                      43         0
werkzeug                                  0          5
werkzeug.datastructures                   0          4
werkzeug.exceptions                       0          5
werkzeug.http                             0          5
werkzeug.local                            0          5
werkzeug.routing                          0          4
werkzeug.sansio                           0          4
werkzeug.sansio.response                  0          5
werkzeug.serving                          0          5
werkzeug.test                             0          5
werkzeug.utils                            0          5
werkzeug.wrappers                         0          4
werkzeug.wsgi                             0          5

Highest Fan-in: bacon with 43 incoming dependencies
Highest Fan-out: click with 5 outgoing dependencies
```

```
Highly Coupled Modules:
================================================================================
No highly coupled modules detected

Cyclic Dependencies:
================================================================================
No cyclic dependencies detected - this is good for maintainability!

Unused and Disconnected Modules:
================================================================================
Unused modules (not imported by any other module):
  - __main__
  - blinker
  - click
  - click.core
  - click.testing
  - flask
  - flask.__main__
  - flask.app
  - flask.blueprints
  - flask.cli
  - flask.config
  - flask.ctx
  - flask.debughelpers
  - flask.globals
  - flask.helpers
  - flask.json
  - flask.json.provider
  - flask.json.tag
  - flask.logging
  - flask.sessions
  - flask.signals
  - flask.templating
  - flask.testing
  - flask.typing
  - flask.views
  - flask.wrappers
  - itsdangerous
  - jinja2
  - jinja2.loaders
```

```
  - jinja2
  - jinja2.loaders
  - markupsafe
  - werkzeug
  - werkzeug.datastructures
  - werkzeug.exceptions
  - werkzeug.http
  - werkzeug.local
  - werkzeug.routing
  - werkzeug.sansio
  - werkzeug.sansio.response
  - werkzeug.serving
  - werkzeug.test
  - werkzeug.utils
  - werkzeug.wrappers
  - werkzeug.wsgi
No disconnected modules detected

Dependency Depth Analysis:
============================================================================
Maximum dependency depth: 1 (from __main__)

Depth analysis by root module:
  - __main__: 1 levels deep
  - blinker: 1 levels deep
  - click: 1 levels deep
  - click.core: 1 levels deep
  - click.testing: 1 levels deep

Interpretation:
  - Shallow dependency tree (≤3 levels): Good design with low complexity
```

```
Dependency Impact Assessment:
======================================================================
Core Modules and Their Impact:

Core Module: bacon
  Fan-in: 43, Fan-out: 0
  Direct dependents: 43
  Total affected modules: 43 (89.6% of codebase)
  Impact risk: VERY HIGH
  Key affected modules:
    - click
    - click.core
    - click.testing

Core Module: name
  Fan-in: 43, Fan-out: 0
  Direct dependents: 43
  Total affected modules: 43 (89.6% of codebase)
  Impact risk: VERY HIGH
  Key affected modules:
    - click
    - click.core
    - click.testing

Core Module: path
  Fan-in: 43, Fan-out: 0
  Direct dependents: 43
  Total affected modules: 43 (89.6% of codebase)
  Impact risk: VERY HIGH
  Key affected modules:
    - click
    - click.core
    - click.testing

Core Module: imported_by
  Fan-in: 42, Fan-out: 0
  Direct dependents: 42
  Total affected modules: 42 (87.5% of codebase)
  Impact risk: VERY HIGH
```

```
Core Module: imported_by
  Fan-in: 42, Fan-out: 0
  Direct dependents: 42
  Total affected modules: 42 (87.5% of codebase)
  Impact risk: VERY HIGH
  Key affected modules:
    - click
    - click.core
    - click.testing

Core Module: imports
  Fan-in: 35, Fan-out: 0
  Direct dependents: 35
  Total affected modules: 35 (72.9% of codebase)
  Impact risk: VERY HIGH
  Key affected modules:
    - click
    - click.core
    - click.testing

Modules at Risk if Modified:
======================================================================

Risky Module: click
  Fan-out: 5 (depends on 5 modules)
  Cycle involvement: 0 cycles
  Risk level: MEDIUM
  Reason: Moderate dependencies on other modules
  Key dependencies:
    - bacon (Fan-in: 43)
    - name (Fan-in: 43)
    - path (Fan-in: 43)

Risky Module: click.core
  Fan-out: 5 (depends on 5 modules)
  Cycle involvement: 0 cycles
  Risk level: MEDIUM
  Reason: Moderate dependencies on other modules
  Key dependencies:
    - bacon (Fan-in: 43)
```

```
Risky Module: click.testing
  Fan-out: 5 (depends on 5 modules)
  Cycle involvement: 0 cycles
  Risk level: MEDIUM
  Reason: Moderate dependencies on other modules
  Key dependencies:
    - bacon (Fan-in: 43)
    - name (Fan-in: 43)
    - path (Fan-in: 43)

Risky Module: flask
  Fan-out: 5 (depends on 5 modules)
  Cycle involvement: 0 cycles
  Risk level: MEDIUM
  Reason: Moderate dependencies on other modules
  Key dependencies:
    - bacon (Fan-in: 43)
    - name (Fan-in: 43)
    - path (Fan-in: 43)

Risky Module: flask.__main__
  Fan-out: 5 (depends on 5 modules)
  Cycle involvement: 0 cycles
  Risk level: MEDIUM
  Reason: Moderate dependencies on other modules
  Key dependencies:
    - bacon (Fan-in: 43)
    - name (Fan-in: 43)
    - path (Fan-in: 43)
```

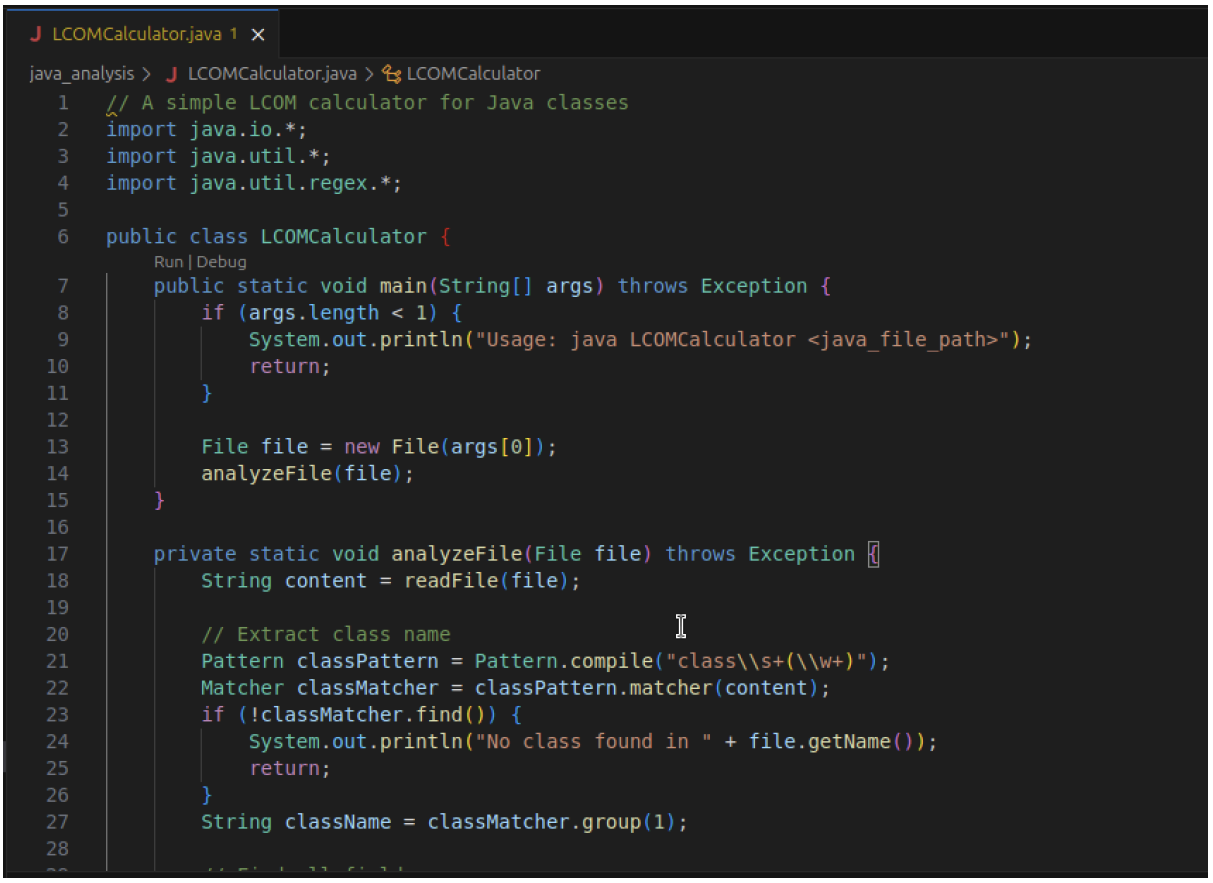
Making a new directory and Cloning Google's guava repository for LCOM analysis.

```
(venv) aditya@aditya:~/Desktop/STT/flask$ # Create a new directory for your Java analysis
mkdir -p ~/Desktop/STT/java_analysis
cd ~/Desktop/STT/java_analysis

# Clone Google Guava repository
git clone https://github.com/google/guava.git
Cloning into 'guava'...
remote: Enumerating objects: 491098, done.
remote: Counting objects: 100% (948/948), done.
remote: Compressing objects: 100% (308/308), done.
Receiving objects:  31% (155806/491098), 165.47 MiB | 1.89 MiB/s
```

Installing JAVA:

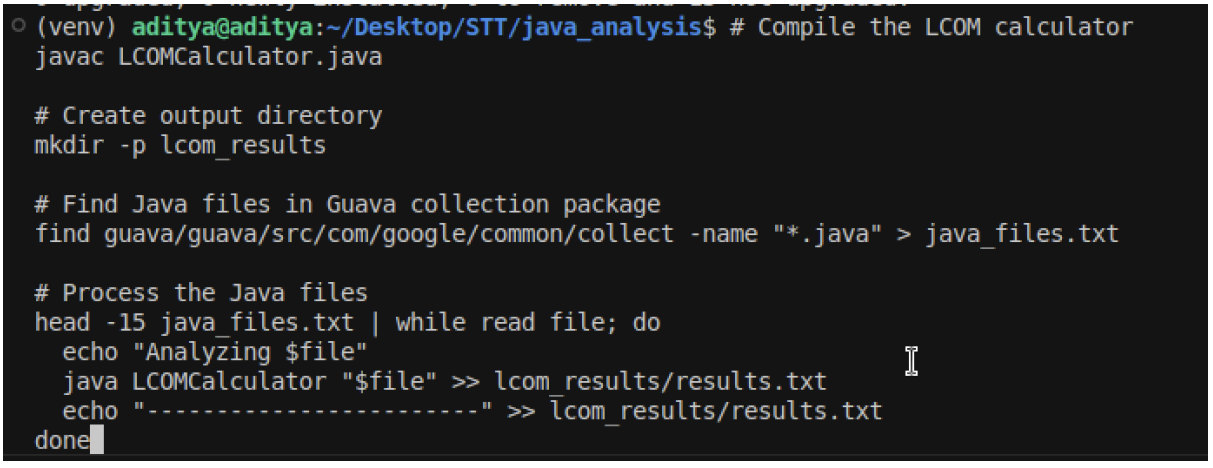
```
(venv) aditya@aditya:~/Desktop/STT/java_analysis$ sudo apt install default-jdk
```

Custom LCOM Calculator Implementation



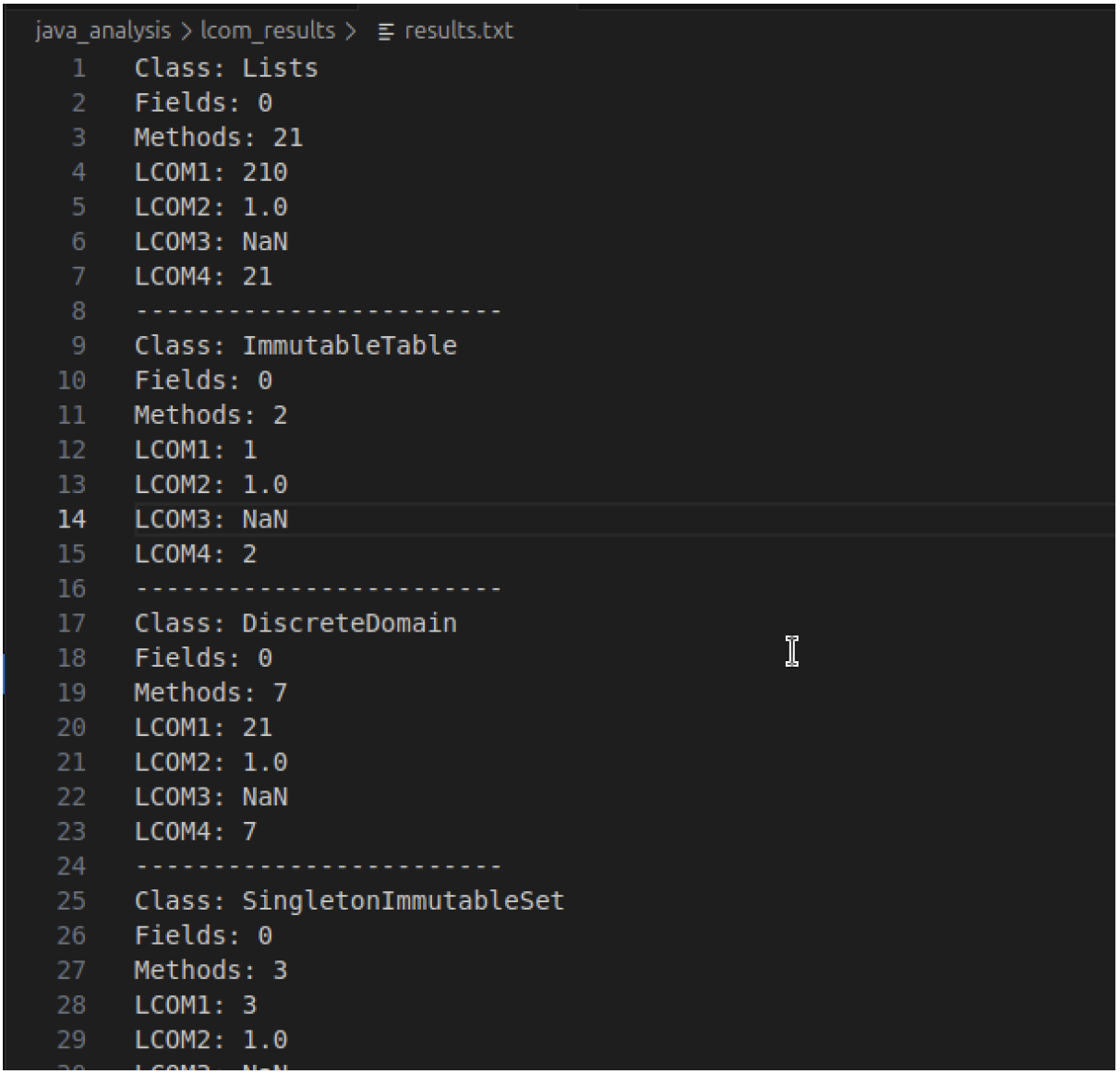
```java
// A simple LCOM calculator for Java classes
import java.io.*;
import java.util.*;
import java.util.regex.*;

public class LCOMCalculator {
    Run | Debug
    public static void main(String[] args) throws Exception {
        if (args.length < 1) {
            System.out.println("Usage: java LCOMCalculator <java_file_path>");
            return;
        }

        File file = new File(args[0]);
        analyzeFile(file);
    }

    private static void analyzeFile(File file) throws Exception {
        String content = readFile(file);

        // Extract class name
        Pattern classPattern = Pattern.compile("class\\s+(\\w+)");
        Matcher classMatcher = classPattern.matcher(content);
        if (!classMatcher.find()) {
            System.out.println("No class found in " + file.getName());
            return;
        }
        String className = classMatcher.group(1);
```

Running the Analysis



```
(venv) aditya@aditya:~/Desktop/STT/java_analysis$ # Compile the LCOM calculator
javac LCOMCalculator.java

# Create output directory
mkdir -p lcom_results

# Find Java files in Guava collection package
find guava/guava/src/com/google/common/collect -name "*.java" > java_files.txt

# Process the Java files
head -15 java_files.txt | while read file; do
  echo "Analyzing $file"
  java LCOMCalculator "$file" >> lcom_results/results.txt
  echo "------------------------" >> lcom_results/results.txt
done
```

LCOM results saved in results.txt



Creating a Formatted Results Table:

The code takes the results from the results.txt and generates a formatted table and store it in lcom_table.md

java_analysis > lcom_table_generator.py > ...

```python
import re
import pandas as pd
from tabulate import tabulate

def parse_lcom_results(file_path):
    """Parse the LCOM results file and extract class metrics."""
    with open(file_path, 'r') as f:
        content = f.read()

    # Split by separator
    class_entries = content.split('------------------------')

    results = []
    for entry in class_entries:
        if not entry.strip():
            continue

        # Extract class name
        class_match = re.search(r'Class: (\w+)', entry)
        if not class_match:
            continue

        class_name = class_match.group(1)

        # Skip likely parsing errors (class names that are keywords)
        if class_name in ['for', 'is', 'specification']:
            continue

        # Extract metrics
        fields_match = re.search(r'Fields: (\d+)', entry)
```

The result:

java_analysis > lcom_table.md > # LCOM Analysis Results for Google Guava > ## Recommendations

LCOM Analysis Results for Google Guava

Class Name	Fields	Methods	LCOM1	LCOM2	LCOM3	LCOM4	LCOM5	YALCOM	Interpretation	Recommendation
Lists	0	21	210	100.00%	N/A	21	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
ImmutableTable	0	2	1	100.00%	N/A	2	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
DiscreteDomain	0	7	21	100.00%	N/A	7	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
SingletonImmutableSet	0	3	3	100.00%	N/A	3	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
IndexedImmutableSet	0	3	3	100.00%	N/A	3	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
ImmutableSortedMultiset	0	0	0	0.00%	0.0	0	N/A	N/A	Good Cohesion	Well-structured class
MapMaker	0	5	10	100.00%	N/A	5	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
JdkBackedImmutableBiMap	0	1	0	0.00%	0.0	1	N/A	N/A	Good Cohesion	Well-structured class

Interpretation

- LCOM1: Number of method pairs not sharing instance variables
- LCOM2: Normalized metric (0-100%); higher values indicate poorer cohesion
- LCOM3: Range varies; higher values indicate poorer cohesion
- LCOM4: Number of connected components in method-field graph; higher values indicate poorer cohesion

Analysis of Classes with High LCOM Values

After examining the LCOM metrics for Google Guava classes, I've identified several classes with high LCOM values that warrant further analysis.

Identifying High LCOM Classes
Based on the table results, these classes show particularly poor cohesion:

Class Name	LCOM1	LCOM2	LCOM4	Interpretation
Lists	210	100%	21	Very Poor Cohesion
DiscreteDomain	21	100%	7	Very Poor Cohesion
MapMaker	10	100%	5	Very Poor Cohesion
SingletonImmutableSet	3	100%	3	Very Poor Cohesion
IndexedImmutableSet	3	100%	3	Very Poor Cohesion

What High LCOM Values Suggest About Class Design
High LCOM values indicate several potential design issues:

Poor cohesion: Methods within these classes operate on different attributes with minimal sharing of class fields.

Multiple responsibilities: Classes may be violating the Single Responsibility Principle by trying to do too many things.

Increased complexity: High LCOM classes are typically harder to understand and maintain.

Higher defect probability: Code with low cohesion tends to have more bugs and is harder to test effectively.

Increased coupling: Classes with low internal cohesion often exhibit higher external coupling.

Functional Decomposition Opportunities
Several classes show strong potential for decomposition:

Lists (LCOM4 = 21):

The very high LCOM4 value indicates 21 disconnected components
Could be decomposed into multiple utility classes grouped by functionality
Potential separate classes: ListCreation, ListTransformation, ListAccess, ListManipulation
DiscreteDomain (LCOM4 = 7):

Seven disconnected components suggest seven distinct responsibilities
Could be split into domain-specific implementation classes

MapMaker (LCOM4 = 5):

Five disconnected components indicate five separate concerns
Could be refactored into specialized builder classes for different map characteristics
Special Considerations
It's worth noting that:

All analyzed classes have 0 fields detected, which is unusual and suggests:

They might be utility classes with primarily static methods
Our field detection might have limitations with Google Guava's code structure
Utility classes often intentionally group related functionality even when methods don't share fields, which can artificially inflate LCOM values.

The actual implementation details of each class should be examined before decomposing, as high LCOM doesn't always indicate poor design in utility libraries.

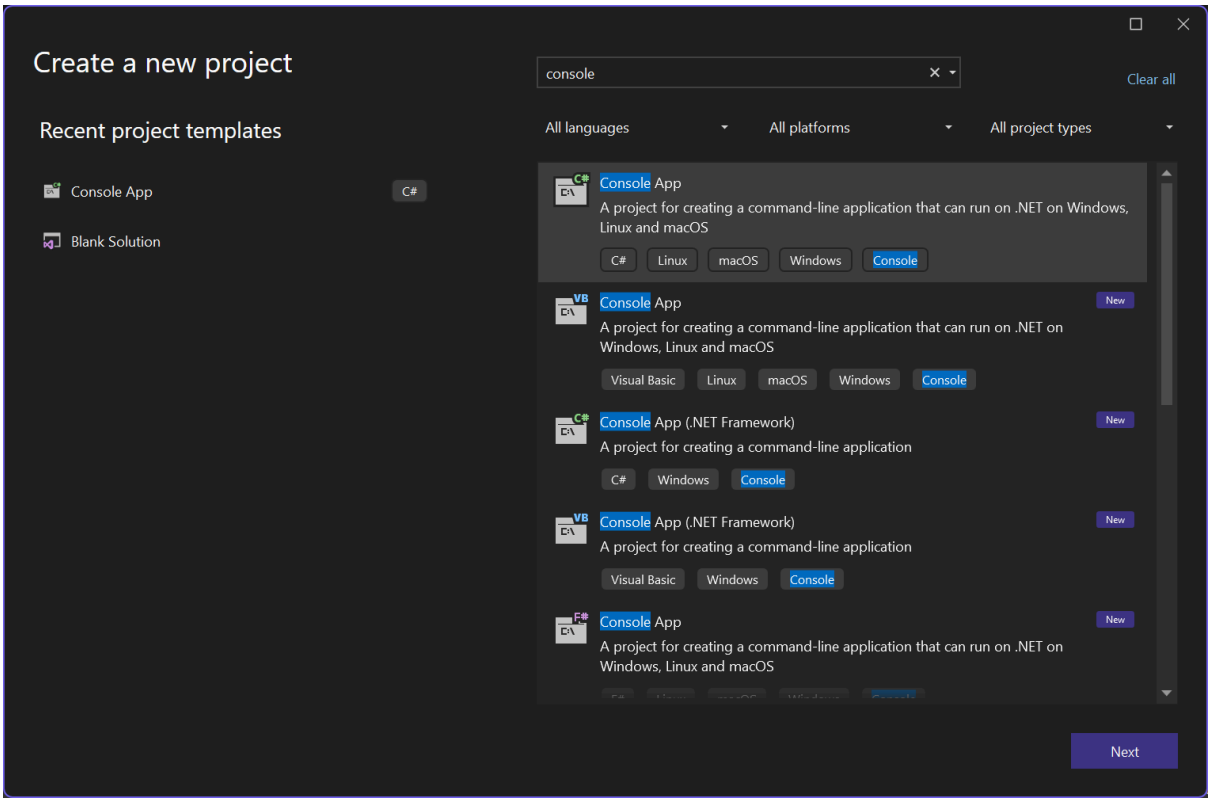
A careful manual review of each high-LCOM class would be the next step before recommending specific refactoring strategies.

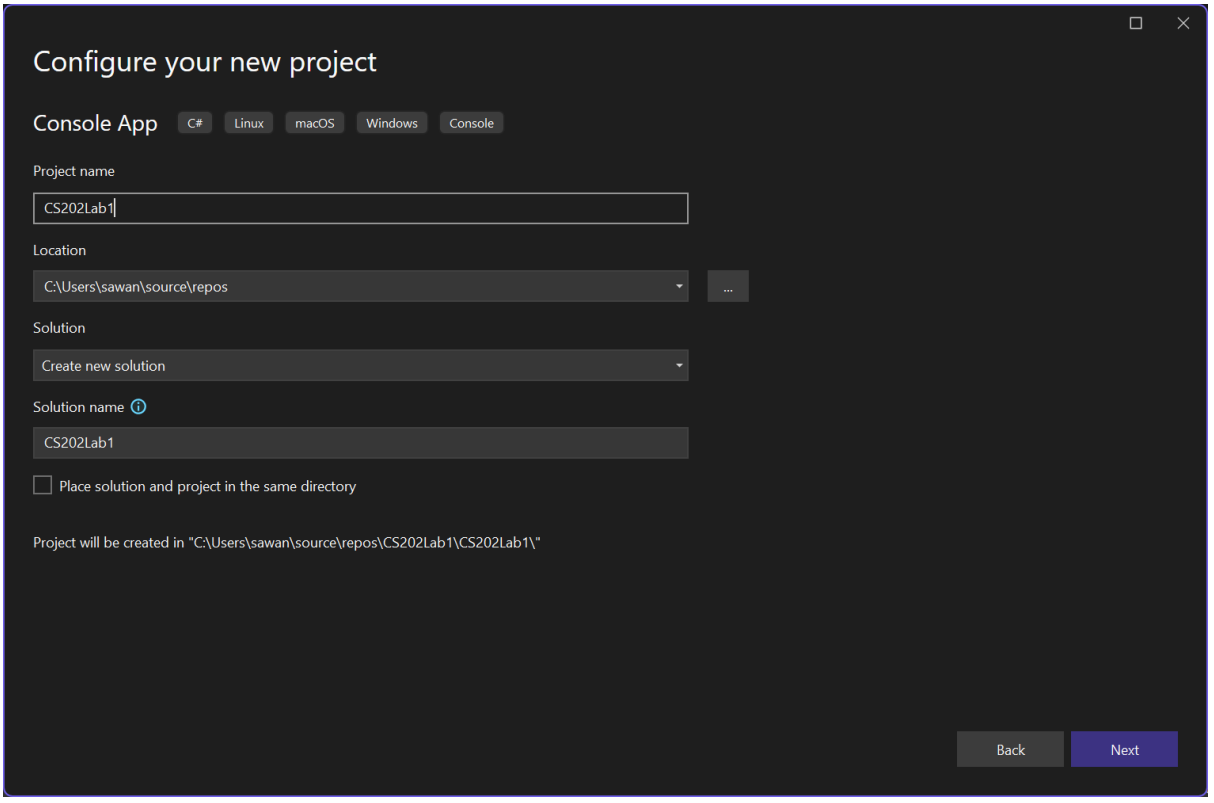
🧩 Class Cohesion Analysis

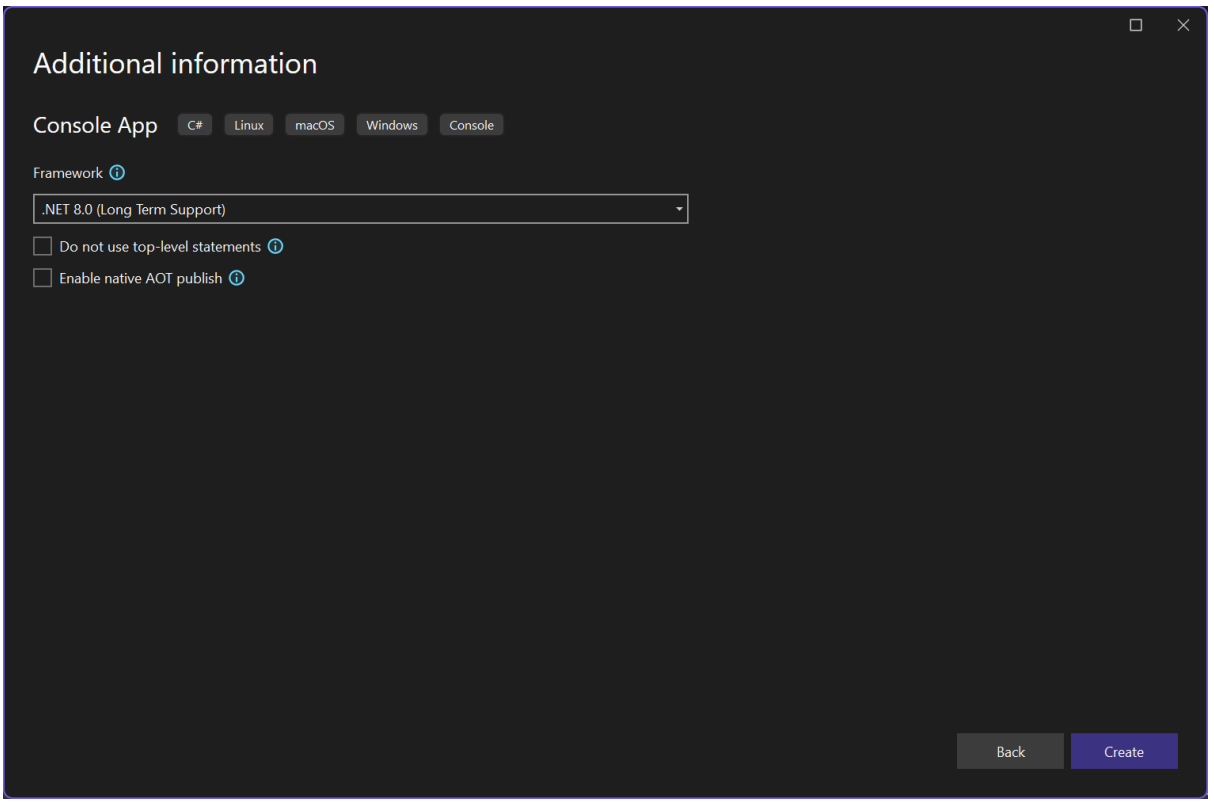
Class Name	Fields	Methods	LCOM1	LCOM2	LCOM3	LCOM4	LCOM5	YALCOM	Interpretation	Recommendation
Lists	0	21	210	100.00%	N/A	21	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
ImmutableTable	0	2	1	100.00%	N/A	2	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
DiscreteDomain	0	7	21	100.00%	N/A	7	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
SingletonImmutableSet	0	3	3	100.00%	N/A	3	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
IndexedImmutableSet	0	3	3	100.00%	N/A	3	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
ImmutableSortedMultiset	0	0	0	0.00%	0.0	0	N/A	N/A	Good Cohesion	Well-structured class
MapMaker	0	5	10	100.00%	N/A	5	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
JdkBackedImmutableBiMap	0	1	0	0.00%	0.0	1	N/A	N/A	Good Cohesion	Well-structured class
constructors	0	53	1378	100.00%	N/A	53	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
DescendingMultiset	0	2	1	100.00%	N/A	2	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
ComparatorOrdering	0	4	6	100.00%	N/A	4	N/A	N/A	Very Poor Cohesion	Consider decomposing this class
ComputationException	0	0	0	0.00%	0.0	0	N/A	N/A	Good Cohesion	Well-structured class
does	0	12	66	100.00%	N/A	12	N/A	N/A	Very Poor Cohesion	Consider decomposing this class

Lab Assignment 10: Topic:Development of C# Console Applications

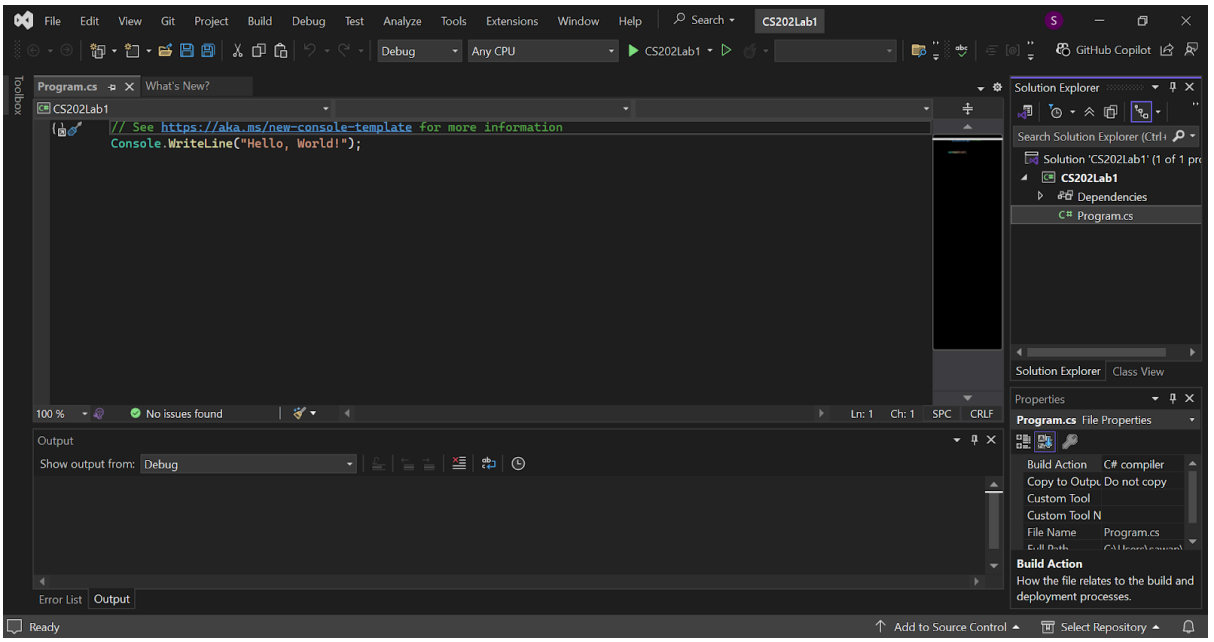
1. Setting up .Net Development Environment

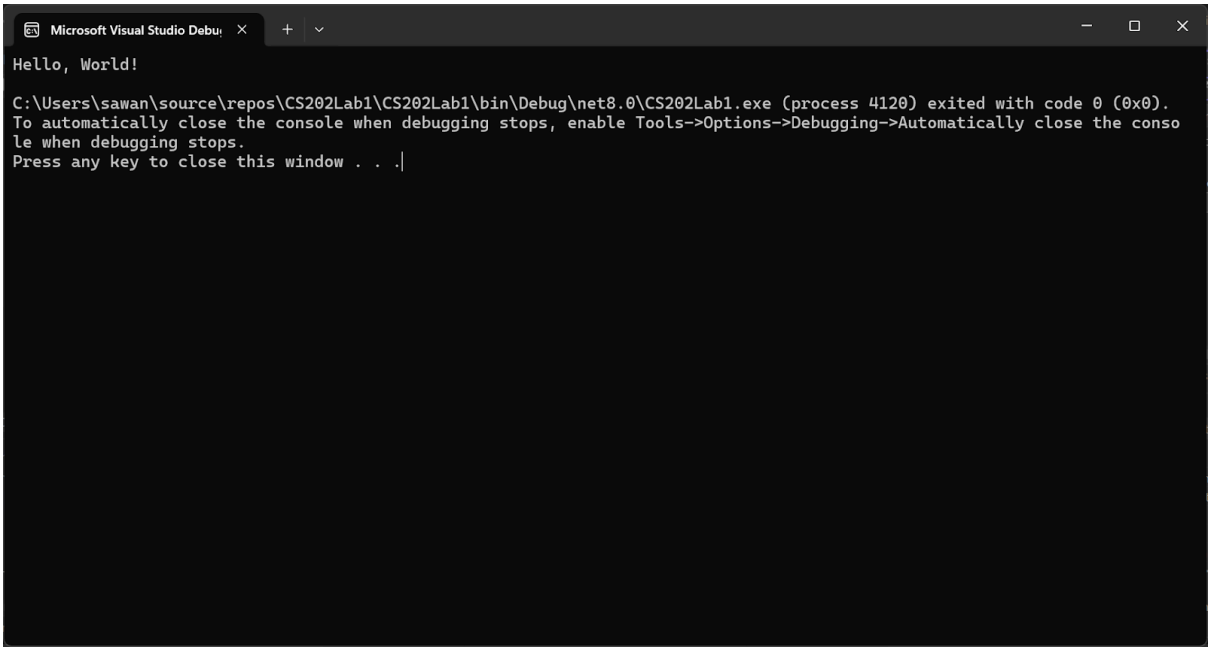




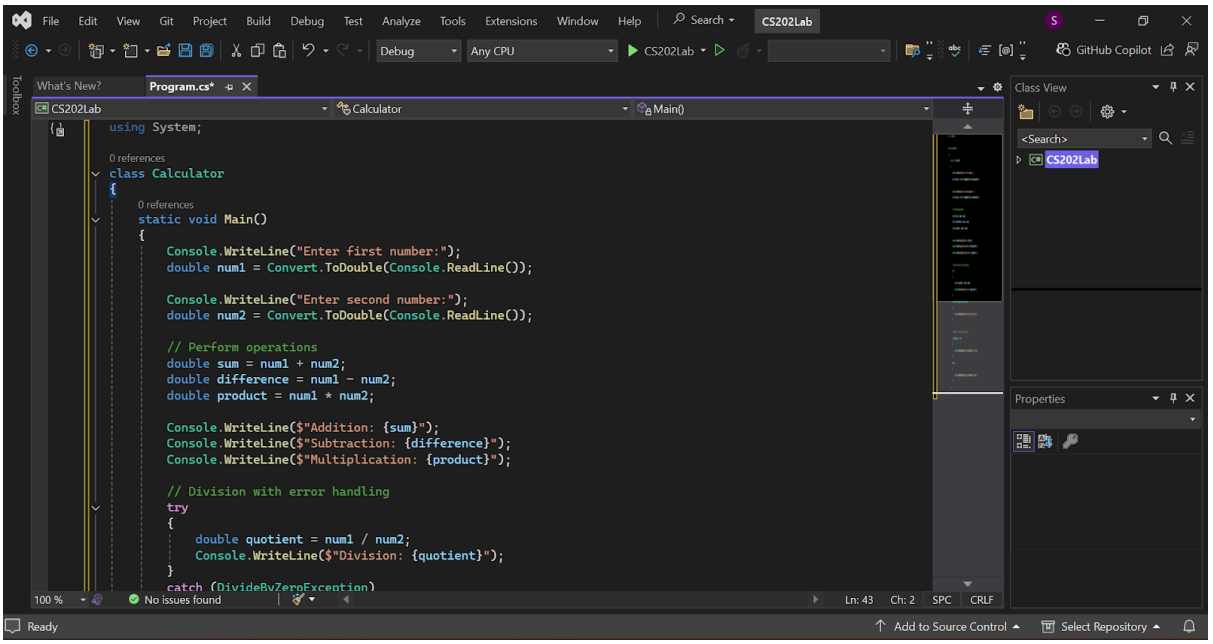


A simple Hello world program

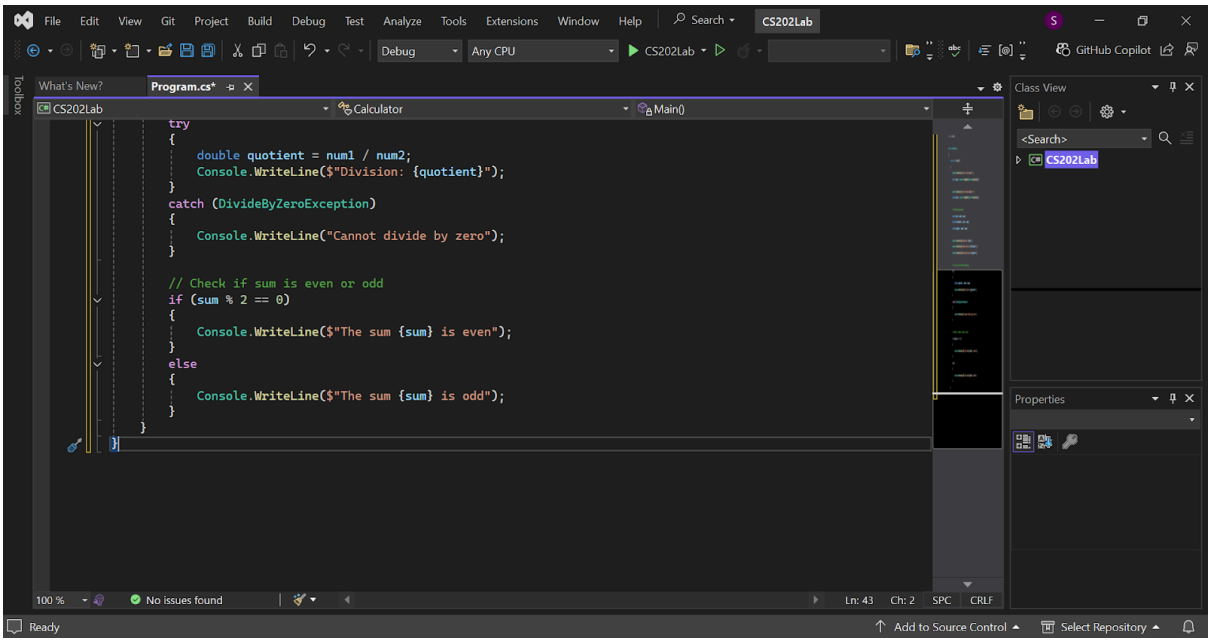



Microsoft Visual Studio Debu
Hello, World!
C:\Users\sawan\source\repos\CS202Lab1\CS202Lab1\bin\Debug\net8.0\CS202Lab1.exe (process 4120) exited with code 0 (0x0).
To automatically close the console when debugging stops, enable Tools->Options->Debugging->Automatically close the conso
le when debugging stops.
Press any key to close this window . . .

2. Basic Syntax and Control Structures

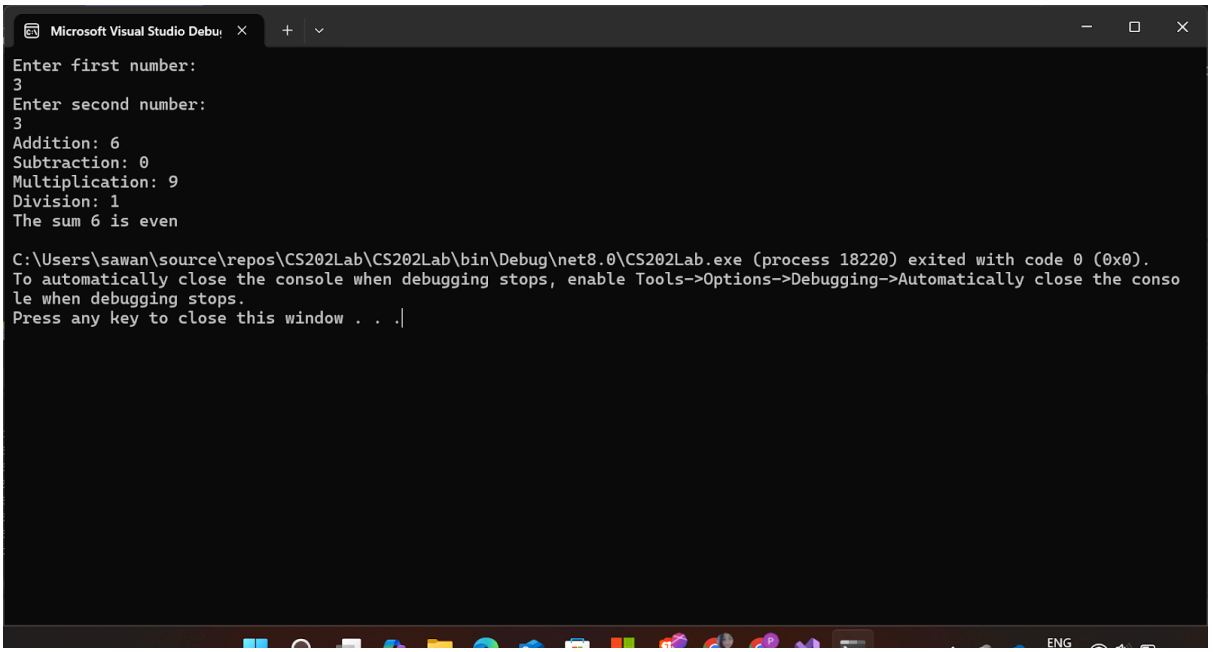


```
using System;

0 references
class Calculator
{
    0 references
    static void Main()
    {
        Console.WriteLine("Enter first number:");
        double num1 = Convert.ToDouble(Console.ReadLine());

        Console.WriteLine("Enter second number:");
        double num2 = Convert.ToDouble(Console.ReadLine());

        // Perform operations
        double sum = num1 + num2;
        double difference = num1 - num2;
        double product = num1 * num2;

        Console.WriteLine($"Addition: {sum}");
        Console.WriteLine($"Subtraction: {difference}");
        Console.WriteLine($"Multiplication: {product}");

        // Division with error handling
        try
        {
            double quotient = num1 / num2;
            Console.WriteLine($"Division: {quotient}");
        }
        catch (DivideByZeroException)
```

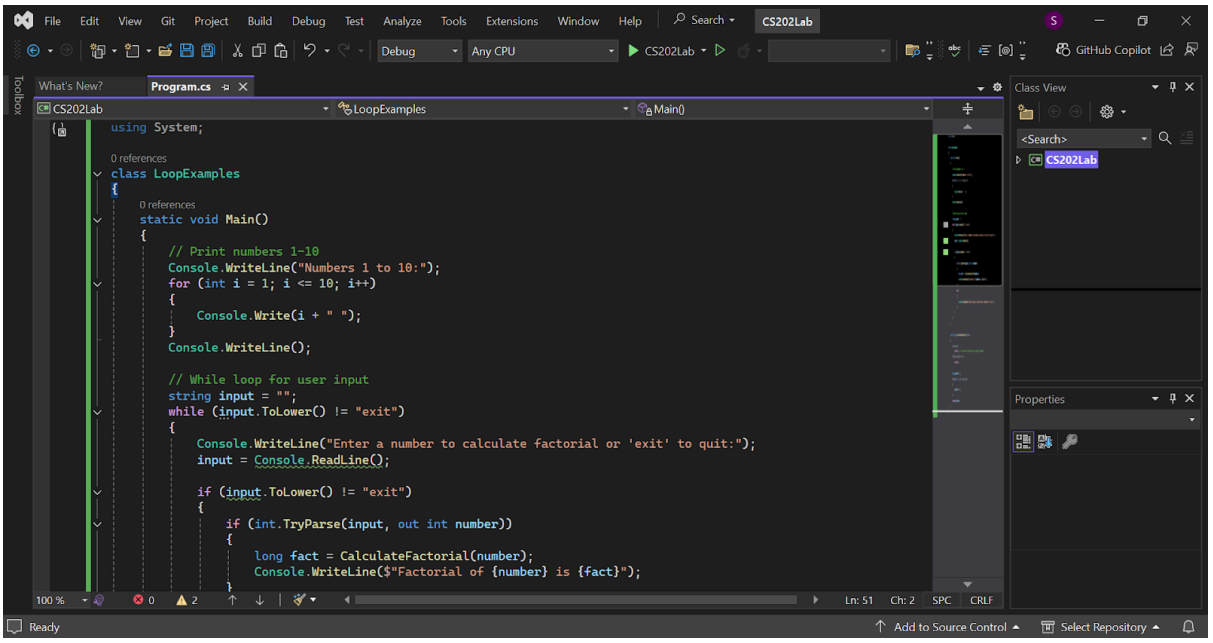


```
        try
        {
            double quotient = num1 / num2;
            Console.WriteLine($"Division: {quotient}");
        }
        catch (DivideByZeroException)
        {
            Console.WriteLine("Cannot divide by zero");
        }

        // Check if sum is even or odd
        if (sum % 2 == 0)
        {
            Console.WriteLine($"The sum {sum} is even");
        }
        else
        {
            Console.WriteLine($"The sum {sum} is odd");
        }
    }
}
```

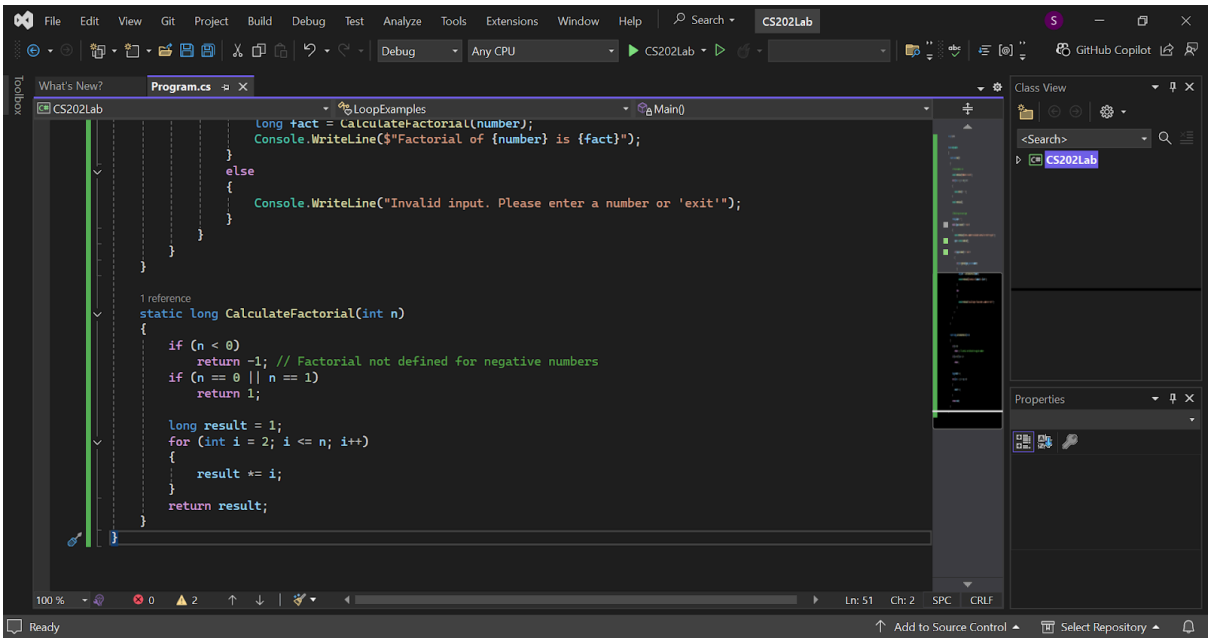
Running for user input:



3. Implement Loops and Functions

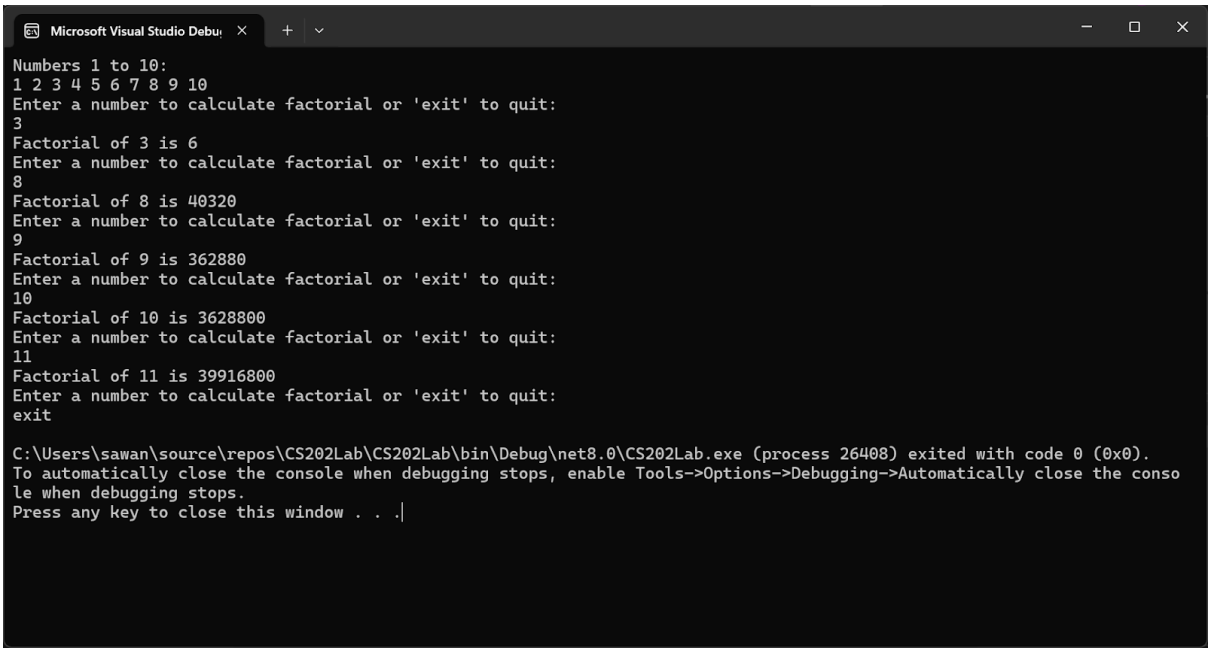


```
using System;

0 references
class LoopExamples
{
    0 references
    static void Main()
    {
        // Print numbers 1-10
        Console.WriteLine("Numbers 1 to 10:");
        for (int i = 1; i <= 10; i++)
        {
            Console.Write(i + " ");
        }
        Console.WriteLine();

        // While loop for user input
        string input = "";
        while (input.ToLower() != "exit")
        {
            Console.WriteLine("Enter a number to calculate factorial or 'exit' to quit:");
            input = Console.ReadLine();

            if (input.ToLower() != "exit")
            {
                if (int.TryParse(input, out int number))
                {
                    long fact = CalculateFactorial(number);
                    Console.WriteLine($"Factorial of {number} is {fact}");
                }
```

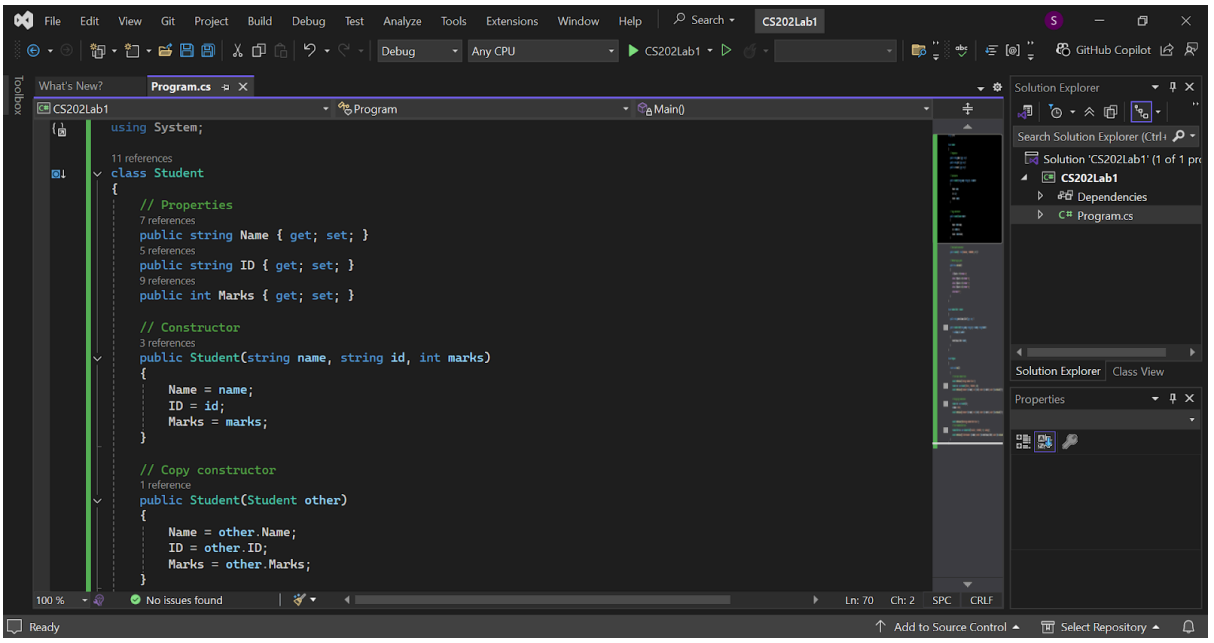


```
                    long fact = CalculateFactorial(number);
                    Console.WriteLine($"Factorial of {number} is {fact}");
                }
                else
                {
                    Console.WriteLine("Invalid input. Please enter a number or 'exit'");
                }
            }
        }
    }

    1 reference
    static long CalculateFactorial(int n)
    {
        if (n < 0)
            return -1; // Factorial not defined for negative numbers
        if (n == 0 || n == 1)
            return 1;

        long result = 1;
        for (int i = 2; i <= n; i++)
        {
            result *= i;
        }
        return result;
    }
}
```

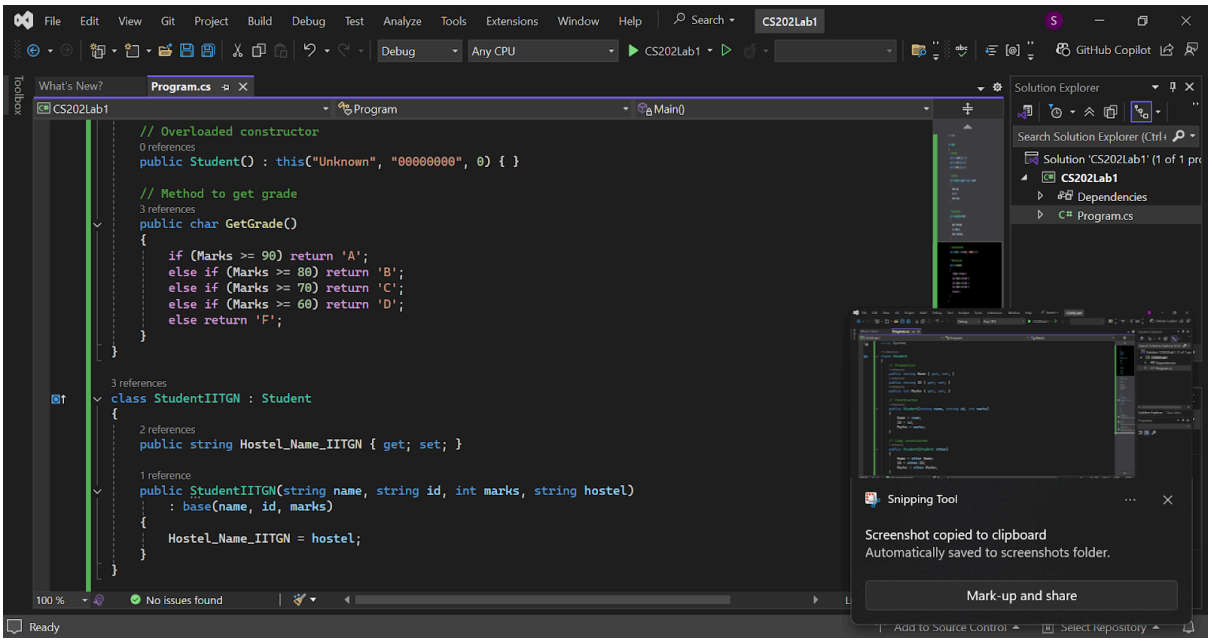
Running the program:



4. Perform Object-Oriented Programming in C#



```
using System;

11 references
class Student
{
    // Properties
    7 references
    public string Name { get; set; }
    5 references
    public string ID { get; set; }
    9 references
    public int Marks { get; set; }

    // Constructor
    3 references
    public Student(string name, string id, int marks)
    {
        Name = name;
        ID = id;
        Marks = marks;
    }

    // Copy constructor
    1 reference
    public Student(Student other)
    {
        Name = other.Name;
        ID = other.ID;
        Marks = other.Marks;
    }
```

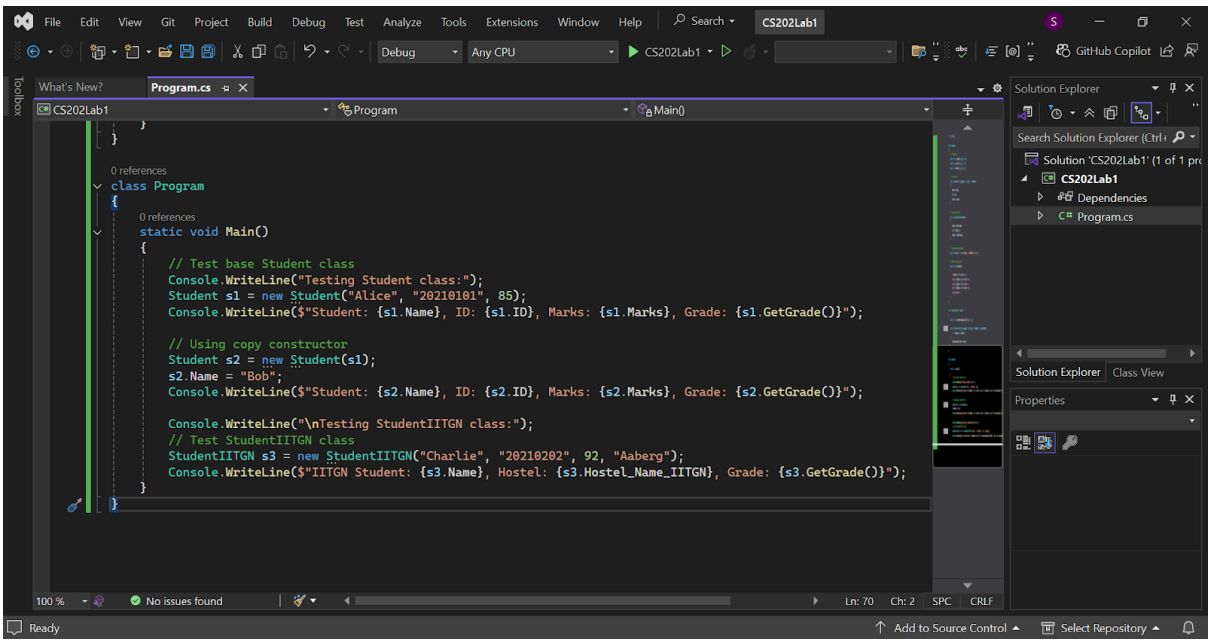


```
    // Overloaded constructor
    0 references
    public Student() : this("Unknown", "00000000", 0) { }

    // Method to get grade
    3 references
    public char GetGrade()
    {
        if (Marks >= 90) return 'A';
        else if (Marks >= 80) return 'B';
        else if (Marks >= 70) return 'C';
        else if (Marks >= 60) return 'D';
        else return 'F';
    }
}

3 references
class StudentIITGN : Student
{
    2 references
    public string Hostel_Name_IITGN { get; set; }

    1 reference
    public StudentIITGN(string name, string id, int marks, string hostel)
        : base(name, id, marks)
    {
        Hostel_Name_IITGN = hostel;
    }
}
```

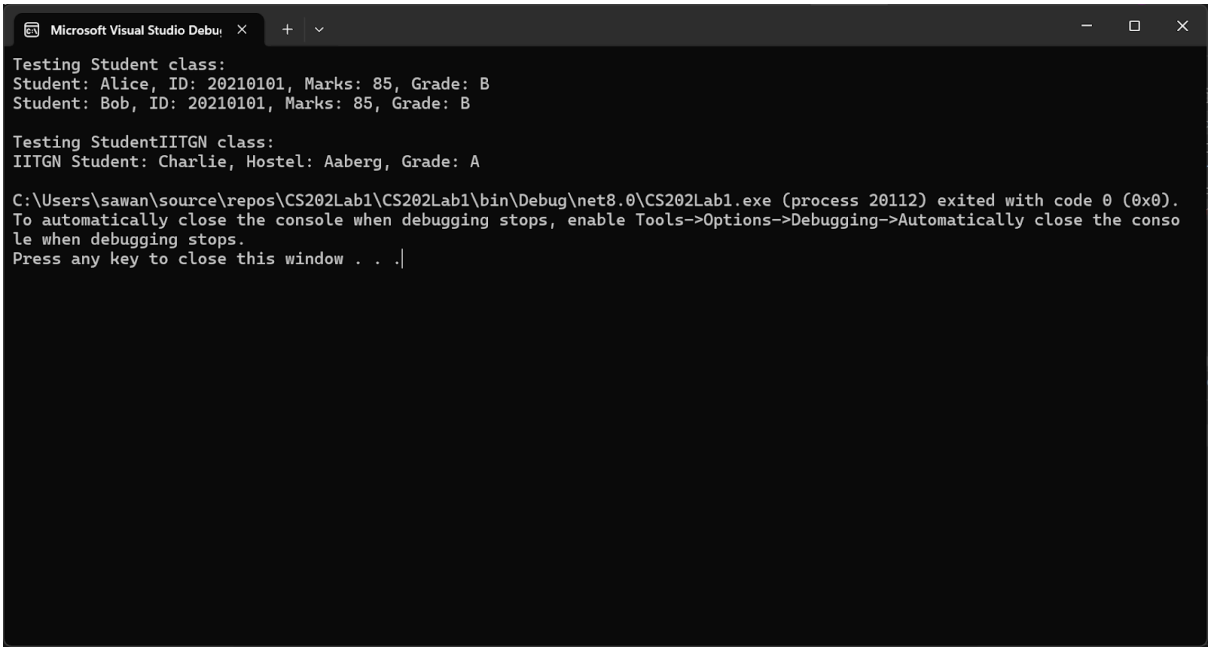
Snipping Tool

Screenshot copied to clipboard
Automatically saved to screenshots folder.

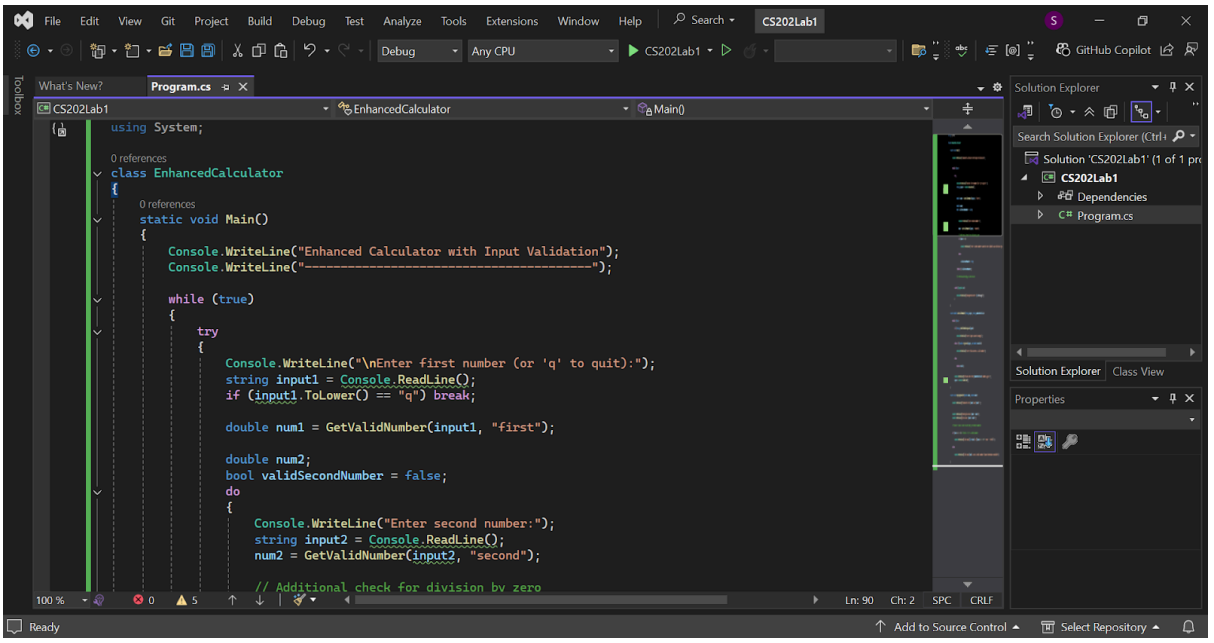
Mark-up and share


File Edit View Git Project Build Debug Test Analyze Tools Extensions Window Help
Search
CS202Lab1
Debug
Any CPU
CS202Lab1
GitHub Copilot
What's New?
Program.cs
CS202Lab1
Program
Main()
Solution Explorer
Search Solution Explorer (Ctrl+
Solution 'CS202Lab1' (1 of 1 pro
CS202Lab1
Dependencies
Program.cs
Solution Explorer
Class View
Properties
0 references
class Program
{
0 references
static void Main()
{
// Test base Student class
Console.WriteLine("Testing Student class:");
Student s1 = new Student("Alice", "20210101", 85);
Console.WriteLine($"Student: {s1.Name}, ID: {s1.ID}, Marks: {s1.Marks}, Grade: {s1.GetGrade()}");
// Using copy constructor
Student s2 = new Student(s1);
s2.Name = "Bob";
Console.WriteLine($"Student: {s2.Name}, ID: {s2.ID}, Marks: {s2.Marks}, Grade: {s2.GetGrade()}");
Console.WriteLine("\nTesting StudentIITGN class:");
// Test StudentIITGN class
StudentIITGN s3 = new StudentIITGN("Charlie", "20210202", 92, "Aaberg");
Console.WriteLine($"IITGN Student: {s3.Name}, Hostel: {s3.Hostel_Name_IITGN}, Grade: {s3.GetGrade()}");
}
}
100 %
No issues found
Ln: 70
Ch: 2
SPC
CRLF
Ready
Add to Source Control
Select Repository

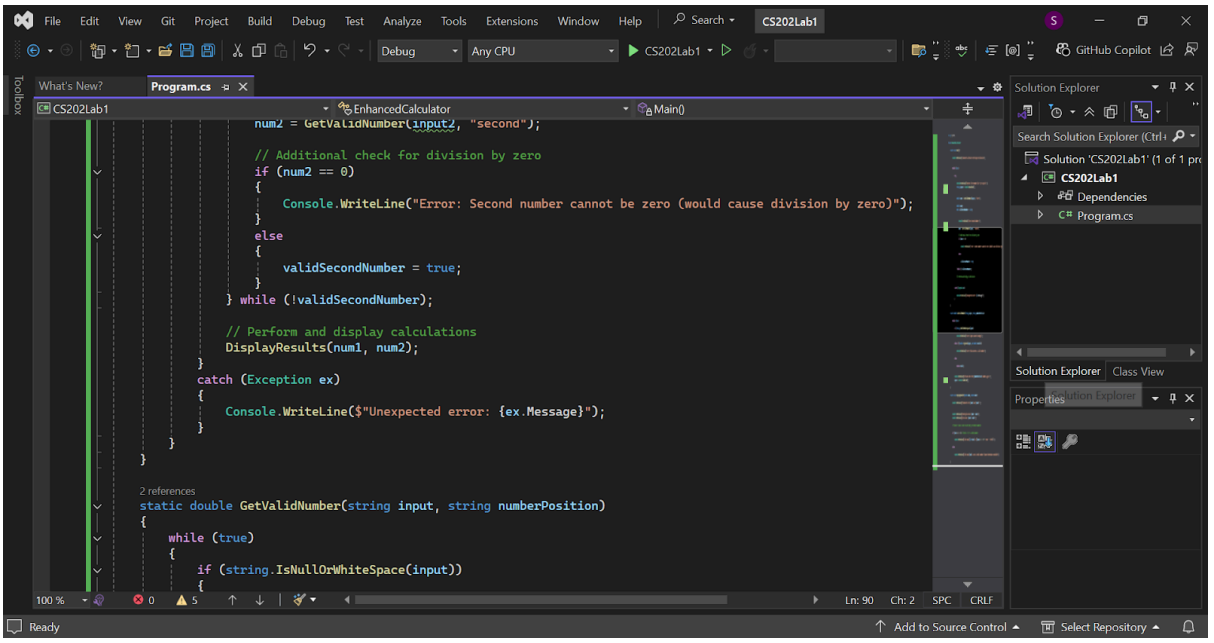
Running:


Microsoft Visual Studio Debu
Testing Student class:
Student: Alice, ID: 20210101, Marks: 85, Grade: B
Student: Bob, ID: 20210101, Marks: 85, Grade: B
Testing StudentIITGN class:
IITGN Student: Charlie, Hostel: Aaberg, Grade: A
C:\Users\sawan\source\repos\CS202Lab1\CS202Lab1\bin\Debug\net8.0\CS202Lab1.exe (process 20112) exited with code 0 (0x0).
To automatically close the console when debugging stops, enable Tools->Options->Debugging->Automatically close the conso
le when debugging stops.
Press any key to close this window . . .

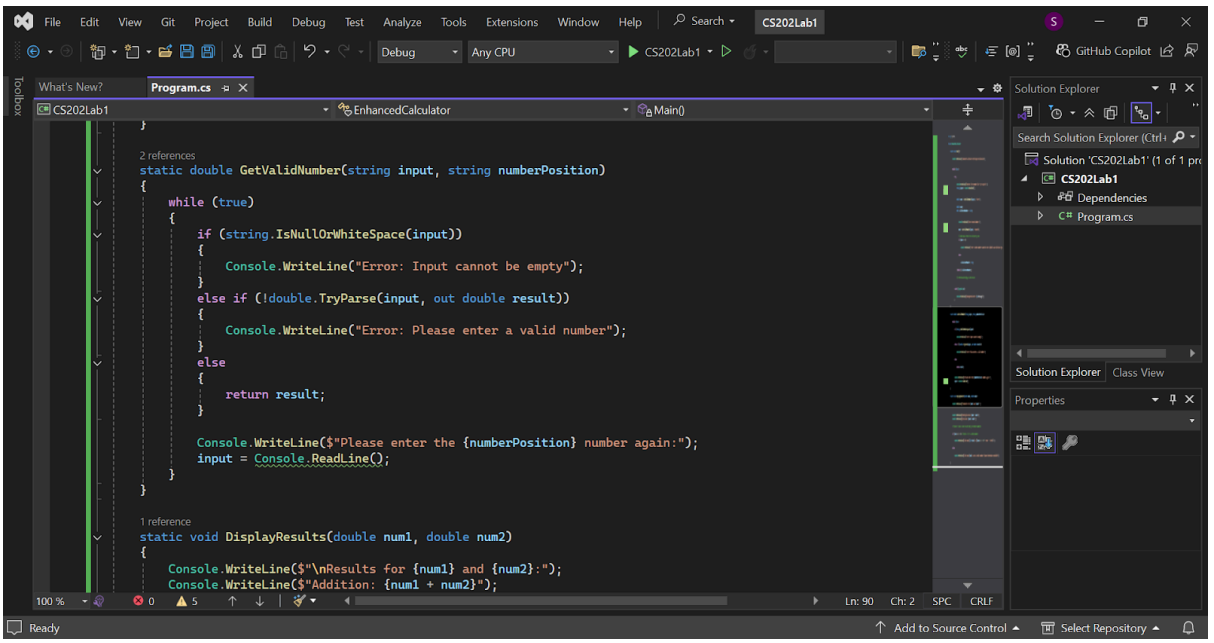
5. Exception Handling:



```
using System;

0 references
class EnhancedCalculator
{
    0 references
    static void Main()
    {
        Console.WriteLine("Enhanced Calculator with Input Validation");
        Console.WriteLine("-----------------------------------------");

        while (true)
        {
            try
            {
                Console.WriteLine("\nEnter first number (or 'q' to quit):");
                string input1 = Console.ReadLine();
                if (input1.ToLower() == "q") break;

                double num1 = GetValidNumber(input1, "first");

                double num2;
                bool validSecondNumber = false;
                do
                {
                    Console.WriteLine("Enter second number:");
                    string input2 = Console.ReadLine();
                    num2 = GetValidNumber(input2, "second");

                    // Additional check for division by zero
```



```
                    num2 = GetValidNumber(input2, "second");

                    // Additional check for division by zero
                    if (num2 == 0)
                    {
                        Console.WriteLine("Error: Second number cannot be zero (would cause division by zero)");
                    }
                    else
                    {
                        validSecondNumber = true;
                    }
                } while (!validSecondNumber);

                // Perform and display calculations
                DisplayResults(num1, num2);
            }
            catch (Exception ex)
            {
                Console.WriteLine($"Unexpected error: {ex.Message}");
            }
        }
    }

    2 references
    static double GetValidNumber(string input, string numberPosition)
    {
        while (true)
        {
            if (string.IsNullOrWhiteSpace(input))
            {
```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Any CPU
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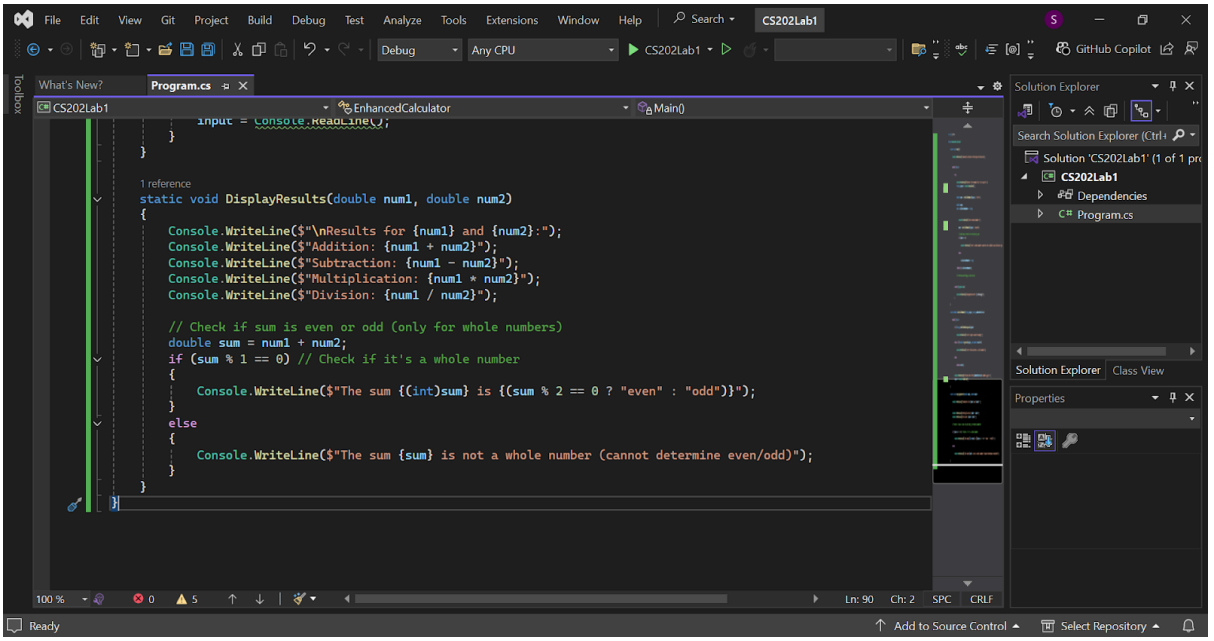
What's New?
Program.cs
CS202Lab1
EnhancedCalculator
Main()
Solution Explorer
Search Solution Explorer (Ctrl+
Solution 'CS202Lab1' (1 of 1 pr
CS202Lab1
Dependencies
Program.cs
Solution Explorer
Class View
Properties
2 references
static double GetValidNumber(string input, string numberPosition)
{
while (true)
{
if (string.IsNullOrWhiteSpace(input))
{
Console.WriteLine("Error: Input cannot be empty");
}
else if (!double.TryParse(input, out double result))
{
Console.WriteLine("Error: Please enter a valid number");
}
else
{
return result;
}
Console.WriteLine($"Please enter the {numberPosition} number again:");
input = Console.ReadLine();
}
}
1 reference
static void DisplayResults(double num1, double num2)
{
Console.WriteLine($"\nResults for {num1} and {num2}:");
Console.WriteLine($"Addition: {num1 + num2}");
100 %
0
5
Ln: 90
Ch: 2
SPC
CRLF
Ready
Add to Source Control
Select Repository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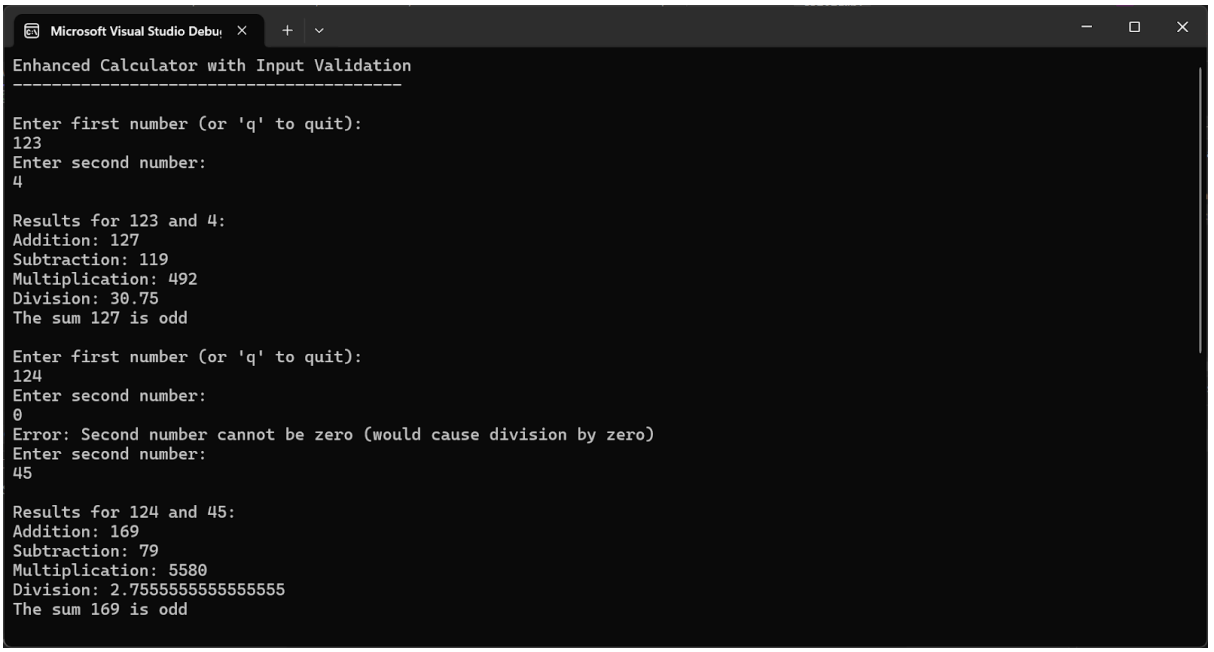
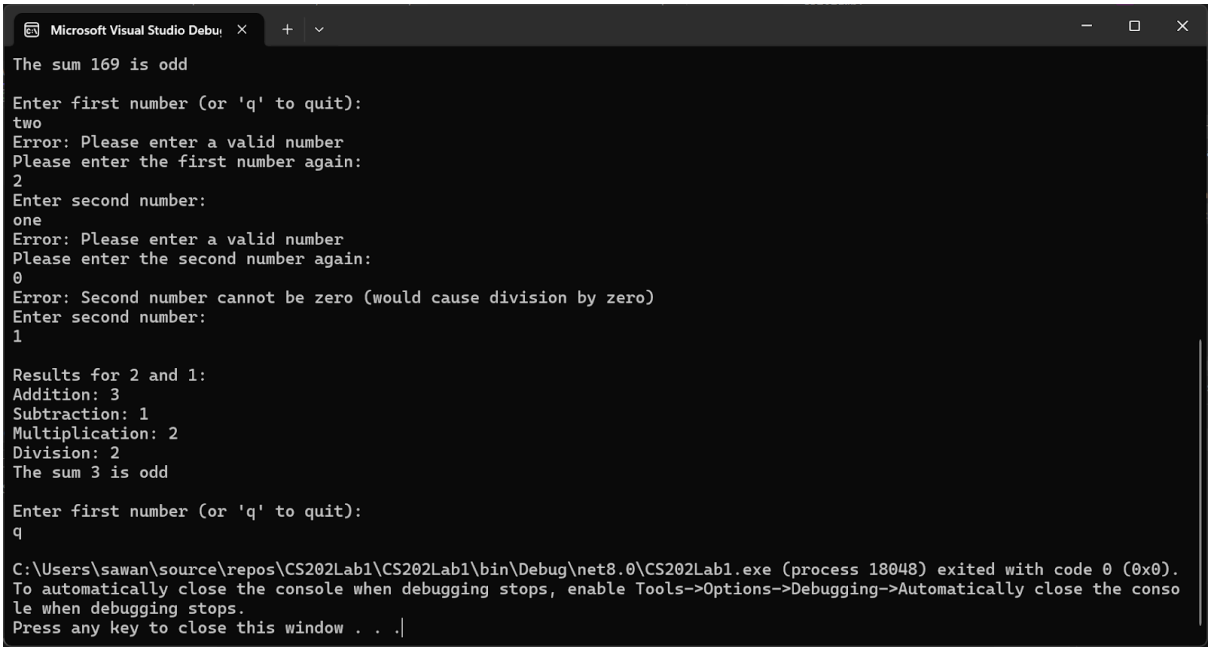
EnhancedCalculator
Main()
Solution Explorer
Search Solution Explorer (Ctrl+
Solution 'CS202Lab1' (1 of 1 pr
CS202Lab1
Dependencies
Program.cs
Solution Explorer
Class View
Properties
input = Console.ReadLine();
}
}
1 reference
static void DisplayResults(double num1, double num2)
{
Console.WriteLine($"\nResults for {num1} and {num2}:");
Console.WriteLine($"Addition: {num1 + num2}");
Console.WriteLine($"Subtraction: {num1 - num2}");
Console.WriteLine($"Multiplication: {num1 * num2}");
Console.WriteLine($"Division: {num1 / num2}");
// Check if sum is even or odd (only for whole numbers)
double sum = num1 + num2;
if (sum % 1 == 0) // Check if it's a whole number
{
Console.WriteLine($"The sum {(int)sum} is {(sum % 2 == 0 ? "even" : "odd")}");
}
else
{
Console.WriteLine($"The sum {sum} is not a whole number (cannot determine even/odd)");
}
}
}
100 %
0
5
Ln: 90
Ch: 2
SPC
CRLF
Ready
Add to Source Control
Select Repository

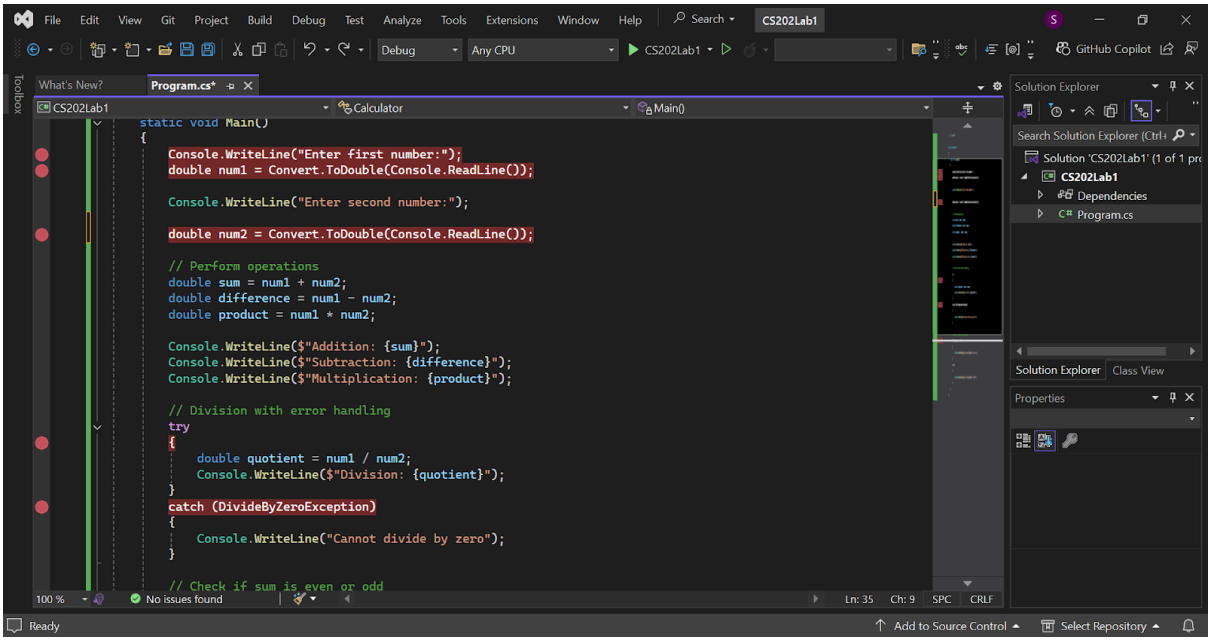
Running with different scenarios:



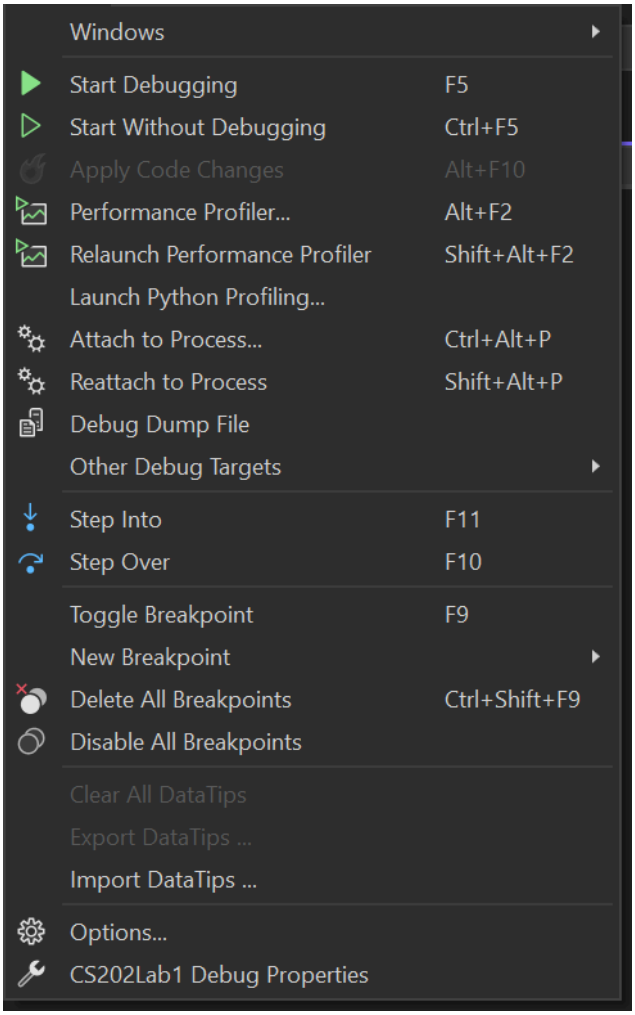


6. Debugging using Visual Studio Debugger

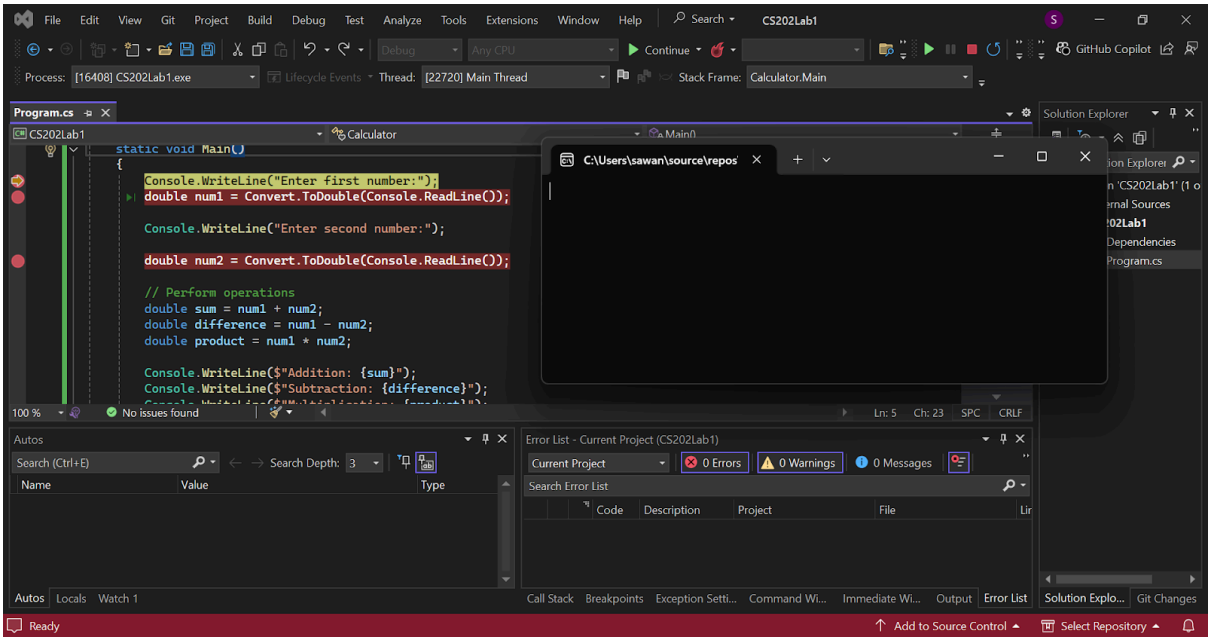
Marking breakpoints in the program

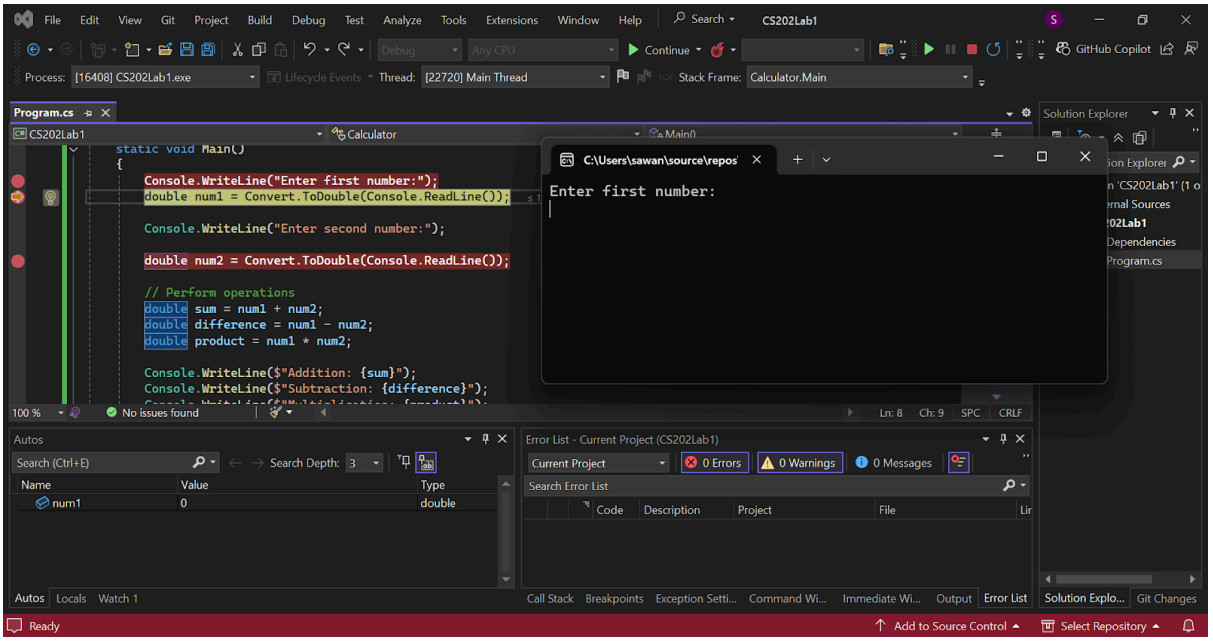


After this go to debug and choose start debugging

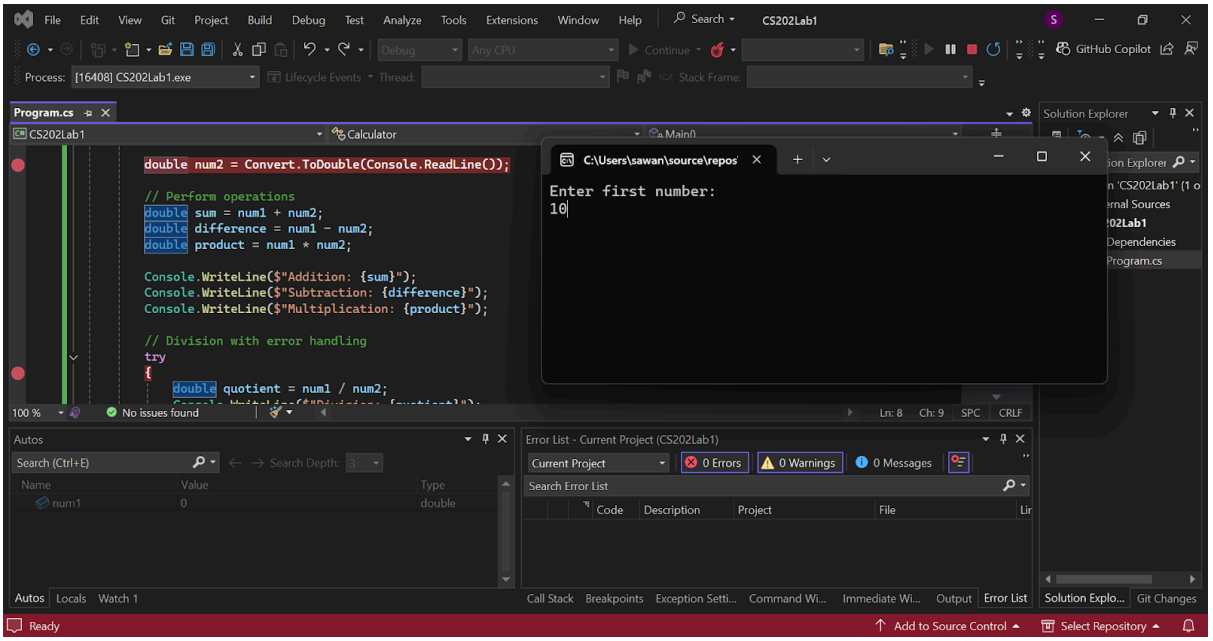


Yellow arrows have appeared and program have stop before the breakpoint thus nothing in the terminal and on pressing continue it executes

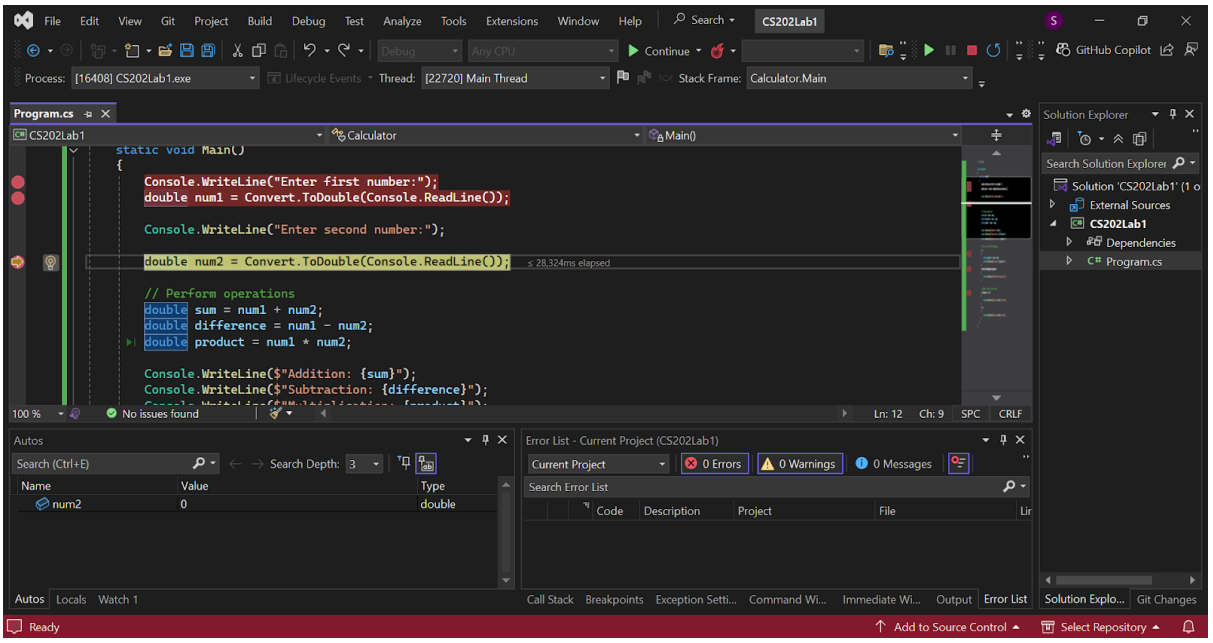


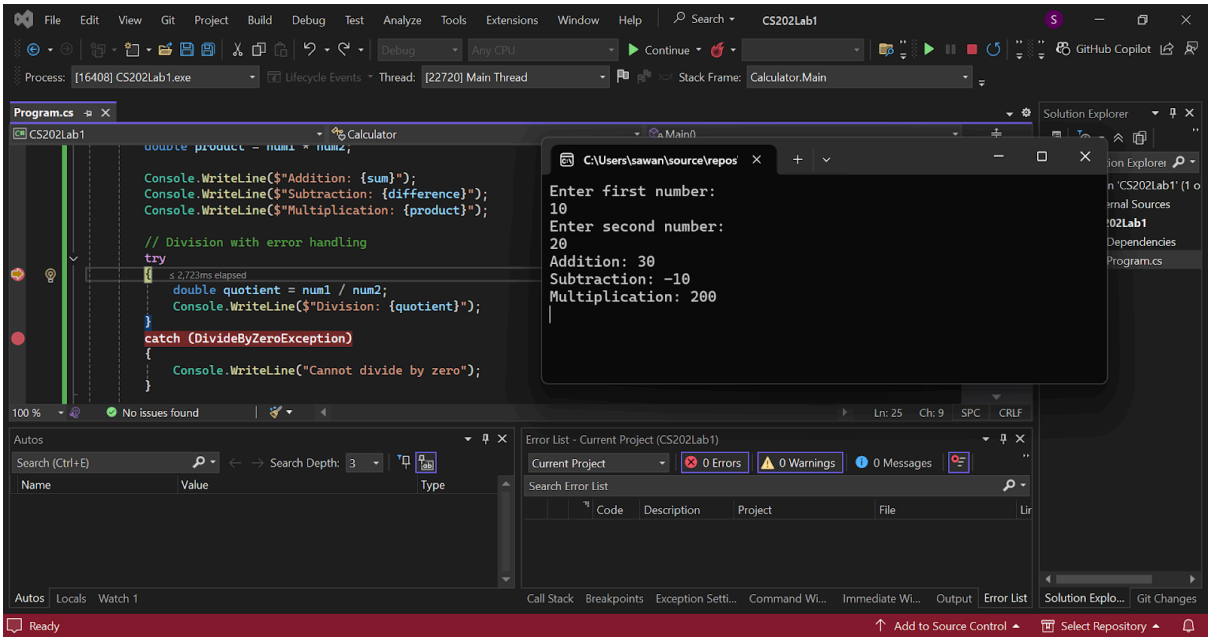


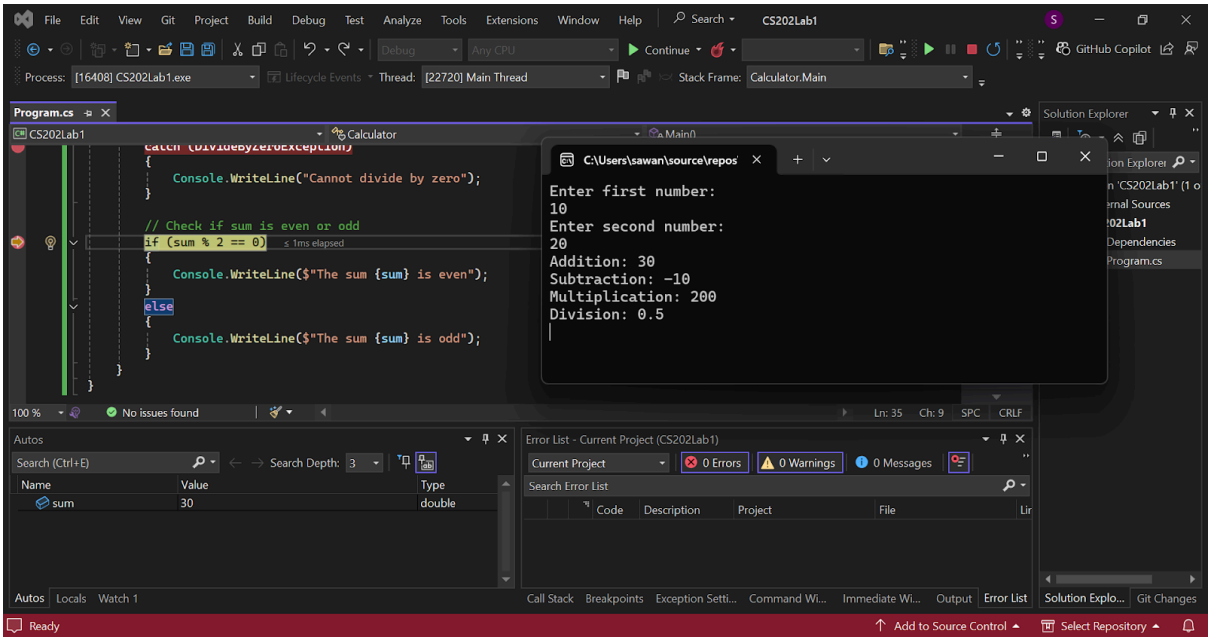
Giving input but nothing on screen because the input is not being read because the Command not executed.



Now on execution of the command input appears







Thats how the program run on multiple breakpoints and every program have breakpoints like this.

Breakpoints allow you to pause program execution at specific lines of code to inspect variables, control flow, and identify bugs. In Visual Studio:

Setting Breakpoints

Click the left margin (gray area) next to a line number (🔴 red circle appears).

When the program runs, it stops at the breakpoint (yellow arrow ▶️).

How It Works

The debugger freezes execution at each breakpoint.

You can inspect variables, modify values, and step through code.

Useful for checking:

Input values (num1, num2)

Arithmetic results (sum, product)

Exception handling (DivideByZeroException)

Breakpoints in Activity 2

BP1: Program start (before first input)

BP2: After num1 is entered

BP3: After num2 is entered

BP4: Before division (checks num2 == 0)

BP5: If division by zero occurs

BP6: Before checking if sum is even/odds

Stepping Commands in Debugging

Step Over: Executes the current line and moves to the next without entering method calls.

F10 Use for simple statements (e.g., Console.WriteLine(), arithmetic operations).

Step Into: Enters a method call to debug inside it (e.g., Convert.ToDouble()).

F11 Use when you want to inspect a method's internal logic.

Step Out: Exits the current method and returns to the caller.

Shift+F11 Use when you're done debugging inside a method.

Example Debugging Session

1. Test Case: num1 = 10, num2 = 0 (division by zero)
2. Program starts, pauses at BP1 (before input).
3. Press F10 (Step Over) to move to num1 input.
4. Enter 10, hits BP2 (after num1 is stored).
5. Hover over num1 → should show 10.
6. Enter 0, hits BP3 (after num2 is stored).

7. Press F10 to move to calculations.
8. Hits BP4 (before division).
9. Press F10 to attempt division.
10. Exception occurs, jumps to BP5 (catch block).
11. Inspect error in Locals Window.
12. Press F10 to see "Cannot divide by zero" message.
13. Hits BP6 (even/odd check).
14. Press F10 to see output ("The sum 10 is even").