Meta

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GitHub URL: https://github.com/vivekduttamishra/202506-lnw-api

This Notebook

[202506-lnw-api]()

What is API?

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- It is an application package used to create a generic design
    - Through remote
        - Like REST
    - Or offline access

- It is an interface
    - To get data

- To fetch the data for your application.

- To establish communication between two independent application or entities like libraries or service provider.

- Means to interact with other application.

- Application
- Library
- Framework
- API

Application

- ~~Collection of libraries~~
    - ~~Using the libraries~~.

- Is a complete solution for performing specific task

Library

- ~~Collection of Framework~~
- Set of related functionalities
- A reusable collection of functionalities.
    - Not a complete solution.
    - They are helpers
- Smallest unit of reuse.
- Any function/class you write is a library.
- Typically a user defined code invokes the library.

Framework

- **Structure to develop an application**
- **Contains generic elements of the solution**
- **Specialized using user defined codes.**
- **Framework invokes user defined code**
    - **Reverse of how you use**

- **Framework invokes user defined code**
    - **Reverse of how you use library.**

Quiz

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You are driving on ITPL road on a busy morning and someone asks

What are you doing?

1. I am burning the fuel
    - When we press accclerator it creates cumbtion
2. I am driving. Following the traffic rules and maps.
    - Learning to drive
3. I am going to the office for work
4. I am going to office for work.
    - Work from Home.
4. You didn't stop, just moved on.

What is a program?

- A set of instructions to perform a task.

OO Fundamentals

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Abstraction?

- Hiding Data?
- Conceptual representation of an idea.
- Showing only the needful things.
- Giving the output without showing the process.

```
interface Shape{
        double
        Perimeter();
}


class Triangle :
Shape{
  //data is hidden

  public double
Perimeter(){
        //logic is also
        hidden.
 }

}
```

Encapsulation?

It is meaningless unless we know why we are binding

- Binding data and methods together.
- Applies cohession
    - Incidental/illogical
    - Temporal
        - Things work at same time
        - May still be unrealated
    - Hierarchial
        - Of same class hirarchy
        - Often mutually exclusive
    - Functional
        - The real Why
- Forms a unit of Responsibility
    - Only a responsible design can be effectively reusable.
    - It is a unit of reuse

Assignment

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- What is the relationship between a Car and a Taxi.
  - Create necessary classes and programming element (class, function, interface) to depict the relationship

```
interface Vehicle
{
        void Move();
}

class Car : Vehicle
{
      public void Move(){…}
}
```

InheritianceW

- Represents "Is A"
- Reusability?

Solution A

```
class Taxi : Car
{

}


Car hondaCity= new Car();

Taxi taxi = new Taxi();
```

Problem:

- No company manufactures Taxi
- Taxi may not always be a Car. It may be
  - Bike
  - Halicoptor
- When I talk about Car, which car?

Solution B

```
class Veichle{
        public string Type; //private or taxi
}

class Car : Veichle{


}
class Bike: Veichle{

}


var car1 = new Car("private");
var  taxi1 = new Car("taxi");

var bike=new Bike("private");
var taxi2 = new Bike("taxi");
```

Advantage

- Has A model
- More Realistic.

Disadvantage

- Enum/string merges multiple codes in the same functionality
- Nested if-else

Use Case

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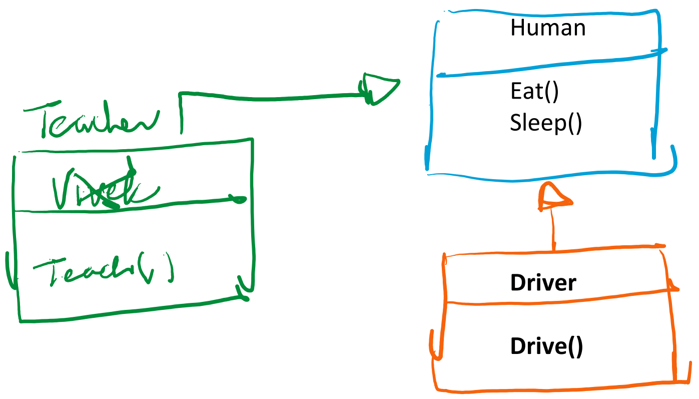
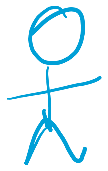
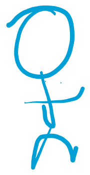


```
class Teacher  :  Human{

        public void Teach(){…}
}

class Driver : Human{
        public void Drive(){…}
}
```





```
var vivek= new Teacher();
var vivek = new Vivek();

vivek.Eat();
vivek.Sleep();
```

vivek.Teach();

vivek.Drive();

```
var prabhat= new Human()
prabhat.Eat();
prabhat.Sleep();
```

var vivek = new Teacher() or new Driver() ???

Parent-Child Relationship

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~~var santa = new Father();~~

~~var banta = new Son();~~

```
class Son : Father{

}
```

Should be is a type of

How will banta inherit Santa's bank balance?

```
var  santa = new Person();

var banta = new Person();

bank.Transfer(santa.BankAccount, banta.BankAccount, amount, password);
banta.Dna.Inherit(santa.Dna)
```

Inheritance is NOT Parent-Child Relationship.

- Realworld inheritance is between two Objects
    - These objects are often of the same type.
    - It is more give and take.

- In OO, inheritance is between two classes
    - They do not represent parent-child
    - They represent is-a-type-of

Inheritance And Reuse

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```
class Crow{

        public Egg LayEgg(){return new CrowEgg(); }
        public void Fly(){...}
        public Color Color{get{return Color.black; } }
}

class  Parrot : Crow
{
   public override Color Color { get{return Color.green;}}

}


[Test]
public void CrowsAreBlack()
{
    Crow crow = new Parrot();  //parrot is a type of Crow

    Assert.Equal( Color.black, crow.Color); //crow is green

}

[Test]
public void ParrotBabiesAreParrot()
{
    Parrot parrot=new Parrot();
    object baby = parrot.LayEgg().Hatch();

    Assert.That( baby is Parrot );

}
```

```
class CrowEgg
{
    object Hatch(){
        return Crow();
    }
}
```

Solution

```
public override Egg LayEgg(){
     return new ParrotEgg();
}
```

- This works.
- But what is point of inheritance if we need to override
    - We lost reuse?

- We have inherited LayEgg but not overridden it
    - It will return a Crow's egg (implementation)
        - Will hatch to a Crow Object

Employee

Programmer ProjectManager Accountant

```
var  vivek = new Employee();
```

Inheritance Summary

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- Inheritance is a class-to-class relationship
    - Class-to-class relationship is static and at design time
    - It doesn't model parent-child relationship
- It shouldn't be used for reusability
    - Static and non-scalable design.

- It shouldn't model a parent-child relationship
    - .In the real world inheritance is between two objects
        - In programming it is between to classes
            - Class and objects are not same.
- INHERIT ONLY IF THERE EXISTS A RELATIONSHIP
    - IS A TYPE OF
    - AN HIERARCHY
- DO NOT USE INHERITANCE FOR
    - REUSE
    - FOR RELATIONSHIPS LIKE
        - PARENT-CHILD RELATIONSHIP
        - HAS A
        - IS LIKE A
        - IS SIMILAR TO
        - WORKS TOGETHER

Law of OO Design

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Prefer "Has A" (composition) over "Is A" (inheritance)

- "Is a" static relationship; "Has a" is a dynamic relationship
  - You can change whatever you have
    - You can choose not to have
      - If I have a cellphone
        - I can change it
        - I can decide not to have it
  - You can't change who you are "Is A"
    - You can't change the fact that you are a human
- "Is a" is non-scalable; "Has A" is scalable
  - If I have a cellphone, I can have two or three
  - I can't be two times human being.

Try to change "Is A" relationship in your design to "Has A" relationship.

- "vivek" is an Employee
  - Attempt #1
    - vivek "has an" Employee
      - It is not same.
      - Meaning changes.
  - Attemp #2
    - Vivek "has an" Employement
      - You may need to change the design.
    - Advantage?
      - Vivek can choose to
        - Change the job: vivek.Employement = new SelfEmployment();
        - Leave the job: vivek.Employement=null;

- If vivek is an Employee
  - He can be a one time employee
- If Vivek has an employement
  - He can have multiple Employements

```
Class ________{

    //Employement Employeent;

  List<Employement> Employements;
}
```

Reuse Using Inheritance

- We can reuse using inheritance
  - It works!
    - But slum houses also work.

- What is the problem?
  - Bad Relationship
    - Game is not a List
  - What if I need more than one list
    - List of Scores
    - List of Players
    - List of Moves

```
Class Game : List<Score>{



        Score FindScore( int gameId){

                return (score from this
                        where score.gameId==gameId
                        select score).FirstOrDefault();
        }
}

var game = new Game();

game.Add( new Score(…));
```

Has A for Resuse

- Encapsulate to reuse.
- Think Reuse, think encapsulation
- Dynamic, Scalable

```
Class Game {
        List<Score> scores;
        List<Player> players;
        List<Move> moves;

        void AddScore(Score score){
                scores.Add(score);
        }

        Score FindScore( int gameId){

                return (score from scores
                        where score.gameId==gameId
                        select score).FirstOrDefault();
        }
}

var game = new Game();

game.Add( new Score(…));
```

DESIGN PRINCIPLES

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- They are fundamental best practices in a software design.

1. Open-Close Principle

- Ultimate goal of a software design!
- Your design should be
    - Open
        - Extension
            - New Feature (Additional new feature)
            - Modify Existing Feature
            - Delete Existing Feature
        - Why?
            - Requirement changes over a period of time
            - Our design should be ready to accommodate future changes
                - Future Proof!
    - Close
        - Modification
            - At the source code level!
            - DON'T MEND IT IF NOT BROKEN
        - Why?
            - Change triggers a cycle of
                - Test
                - Deploy
                - Distribute
            - Change may induce new Bugs
            - A change may not be acceptable to all stakeholders.
                - It may be a matter of choice.
- How?
    - All changes should be additive.
        - To add new feature write new code
        - To modify existing feature write new code
        - To delete existing feature write new code

    - 100% OCP is not feasible
        - Often not desirable.
        - Idea is to reduce the surface area of change
            - Changes should be minimal
            - Shouldn't have ripple effects.

2. Single Responsibility Principle

- You code (component, function, object) should have a single responsibility
    - One Reason to Exist
    - One Reason to change.
        - Theoretically closed for all except one reason!
            - Practially most of the time such codes are completely closed. (follows 100% OCP)

- One Responsible <> One Function per class.
    - It certainly means few related functions
        - A Printer
            - should have
                - Print()
                - Eject()
                - Cancel()
            - Shouldn't have
                - Scan()
                    - Printers! Don't scan!
        - A Car
            - should have
                - Start
                - Turn
                - Move
                - Stop
            - Shouldn't have
                - Drive
                    - Cars don't drive themselves.

How do we achieve SRP?

1. Meaningful Names

- Your class, methods, objects should have meaningful name
- Name=>responsibility
    - If name is not clear we can't enforce SRP?
- Can
    - Bird Fly?
        - Yes
    - Fish Fly?
        - No
    - Foo do Bar?
        - We don't know what is foo and bar
        - Can't know if it is a right model

2. Avoid composite names joined by And/Or

- IncomeAndSalesTaxCalculator
    - Responsible for
        - Income Tax
        - Sales Tax
- InsertOrUpdate
    - Responsible for
        - Insert
        - Update
- CreateAndAdd

        - Creates and adds
        - Can't create for future additional
        - Can't add existing object

3. Avoid Abstract name for a concrete class

- TaxCalculator
    - Still calculating Income and Sales Tax
- Save
    - Still using insert / delete

4. Most methods should use most field most of the time

- Shouldn't have mutually exclusive/option fields
- Shouldn't have fields/parameters are always null in a given scenario.

3. DRY (Don't Repeat Yourself)

- Redundant code MUST be avoided
- It suggests same responsibility (task) is listed at multiple places
    - No clear responsibility definition.
    - When that code need to change, it must be changed at multiple places.
- More problematic in case of partial redundancy.

Solution: Two Step Solution

1. Encapsulate Whatever Repeats
    - Create class and function to encapsulate redundant code (steps)
        - It may have some gaps where code is specific to the scenario.
            - □ Parameterize if change is just data
2. Abstract whatever Changes
    - Implementation would be a specific use case
    - Parameterize the repeating code with an abstract element

Assignment #2

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- Create a simple Calculator

Use Case:

Simple Test for Calcualtor

```
var calculator = new Calculator();

calculator.Calculate( 20, "plus", 30);
calculator.Calculate(20, "minus", 4);
calculator.Calculator(20, "foo", 5);
```

- You shouldn't change the method signature

```
//expected output

20 plus 30 = 50
20 minus 4 = 16
Invalid Operator: foo
```

- Create a Application to take user input and provide result
- Should work in two modes

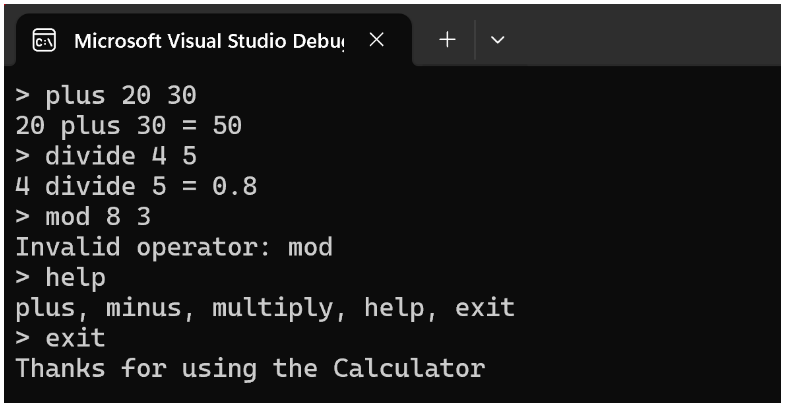
Command Line Argument Driven

```
c:\project>calculator plus 20 30
20 plus 30 = 50
```

Shell Input (User Input) Driven

```
c:\project> calculator
> help
Plus, minus, multiply, divide, exit
> plus 20 30
20 plus 30 = 50
>minus 4 4
4 minus 4 = 0
>exit

c:\>
```

Expected Result



```
> plus 20 30
20 plus 30 = 50
> divide 4 5
4 divide 5 = 0.8
> mod 8 3
Invalid operator: mod
> help
plus, minus, multiply, help, exit
> exit
Thanks for using the Calculator
```

Version #1

```
0 references
public class CalculatorV1
{
    0 references
    public void Calculate(double number1, string oper, double number2)
    {
        switch (oper.ToLower())
        {
            case "plus":
                Console.WriteLine($"{number1} {oper} {number2} = {number1+number2}");
                break;
            case "minus":
                Console.WriteLine($"{number1} {oper} {number2} = {number1 - number2}");
                break;
            case "multiply":
                Console.WriteLine($"{number1} {oper} {number2} = {number1 * number2}");
                break;
            default:
                Console.WriteLine($"Invalid Operator: {oper}");
                break;
        }
    }
}
```

Redundant Code

- What if tomorrow we need a different formatting for the result?
- We need to change at n Places.

Solution: DRY

- Check out in Design Principles

DRY Resolved

Version #2

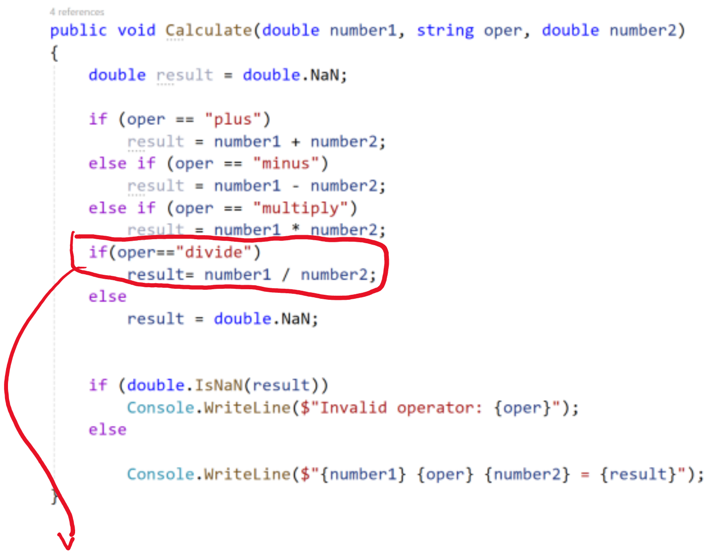
```
double result = double.NaN;
switch (oper.ToLower())
{
    case "plus":
        result = number1 + number2;
        break;
    case "minus":
        result = number1 - number2;
        break;
    case "multiply":
        result = number1 * number2;
        break;
    default:
        break;
}

if (result == double.NaN)
    Console.WriteLine($"Invalid operator: {oper}");
else

    Console.WriteLine($"{number1} {oper} {number2} = {result}");
```

But it still violates SRP

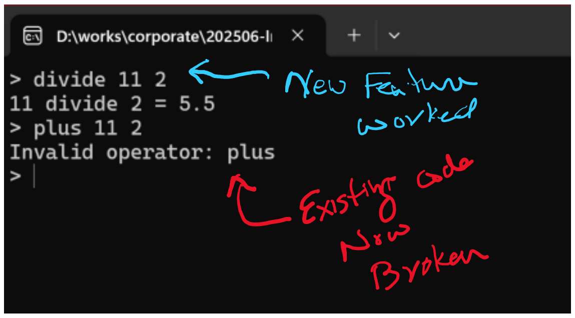
- Typically, all switch-case and if-else ladder violates SRP (and in turn OCP)
- Avoid them

Why OCP violation is BAD?

- Check out Design Principles nodes for more details
- In this case a new code may introduce breaking changes



```
4 references
public void Calculate(double number1, string oper, double number2)
{
    double result = double.NaN;

    if (oper == "plus")
        result = number1 + number2;
    else if (oper == "minus")
        result = number1 - number2;
    else if (oper == "multiply")
        result = number1 * number2;
    if(oper=="divide")
        result= number1 / number2;
    else
        result = double.NaN;


    if (double.IsNaN(result))
        Console.WriteLine($"Invalid operator: {oper}");
    else

        Console.WriteLine($"{number1} {oper} {number2} = {result}");
}
```



```
D:\works\corporate\202506-I
> divide 11 2
11 divide 2 = 5.5
> plus 11 2
Invalid operator: plus
>
```

Switch Case

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```
void  DoJob ( Context context) {

    switch(context){

        case context.A:
            DoJobA();
            break;
        case context.B:
            DoJobB();
            break;
        default:
            DoDefaultJob();
            break;

    }

}
```

- Three different responsibilities for three different context
- They are merged together
- Violates SRP
    - Mutually exclusive code blocks

- There is a Job (doJob)
    - That has multiple implementation (Forms)
        - JobA
        - JobB
        - JobC
    - Form varies based on context
- Explanation 2
    - One Name (DoJob)
    - Many Forms (DoJobA, DoJobB, DoJobC)
    - Varies on context

Is this polymorphism?

- NO
- It is avoiding polymorphism

Switch case to Polymorphism

```
void  DoJob ( Context context) {

    switch(context){

        case context.A:
            new JobA().DoJob();
            break;
        case context.B:
            new JobB().DoJob();
            break;
        default:
            new DefaultJob().DoJob();
            break;
```

- Interface IJob
    - Implemented by
        - JobA
        - JobB
        - DefaultJob

```
        }

    }
```

POLYMORPHISM REPLACES CASE BODY NOT case selection

- Polymorphism is not a complete replacement switch case
- It replaces what we do in different cases
- It can't decide which case to execute
    - It doesn't include switching (selection) logic

What can really replace switch or nested if-else

- There are two patterns to use
    - Chain Of Responsibility
        - Use for-if loop
    - Use a Dictionary to replace switch case
        - Key —> case

Polymorphism?

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What is polymorphism

- One name many forms

How to achieve Polymorphism?

- Overloading
- Overriding

```
class  ParkerPen
{

        public  void Use( Hand hand){

                Console.WriteLine("writing")
        }

        public void Use(Pocket pocket){

                Console.WriteLine("status")
        }

}

public void TestPen(){

        var p= new ParkerPen();
        var context= GetHandOrPocket(); //assume it returns pocket
        if( context is Hand)
                p.Use(context as Hand)
        else if(context is Pocket)
                p.Use(context as Pocket);
}
```

Creating API

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API Design

Two essential Elements

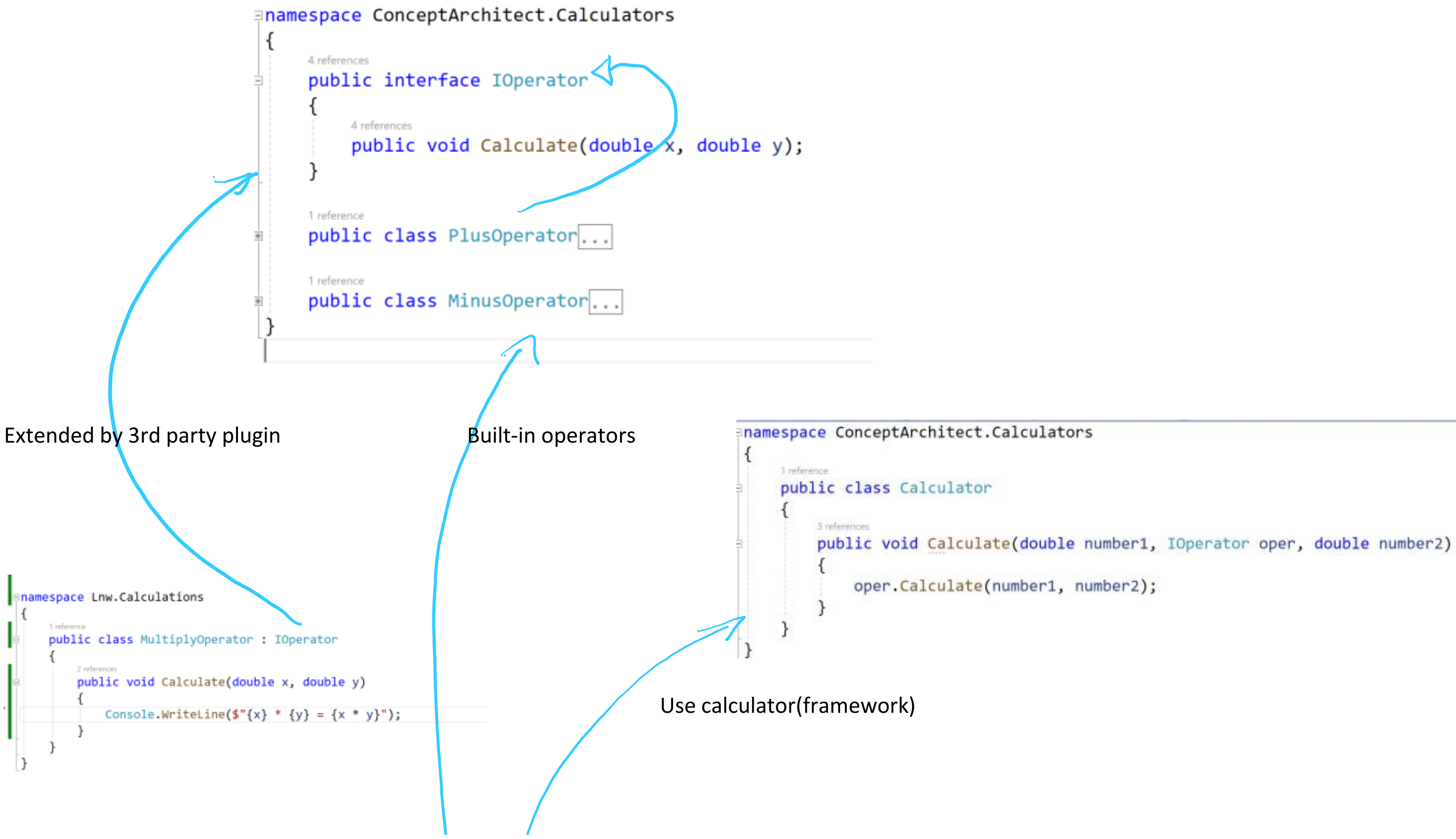
1. Framework

- Includes common/generic functionalities that defines the core of the system.
- Exposes public interfaces (or contracts) to create new functionality that can work with the framework
    - This enables OCP
- Should have ability to **plugin** new capabilities dynamically without modifying the framework.

2. API Implementation (Extension/Plugin)

- Implements the API (interface) for the enhanced capabilities.
- Can be done internally (same organisation) or at the community level
    - Community contribution is NOT core or MUST for API
        - It may be for internal use cases only

- The functionalities are expected to work under the control of framework and not stand alone
- We don't call framework
    - The framework calls my logic
        - This is also known as Inversion of Control



```
namespace ConceptArchitect.Calculators
{
    4 references
    public interface IOperator
    {
        4 references
        public void Calculate(double x, double y);
    }

    1 reference
    public class PlusOperator...

    1 reference
    public class MinusOperator...
}
```

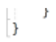
Extended by 3rd party plugin

Built-in operators

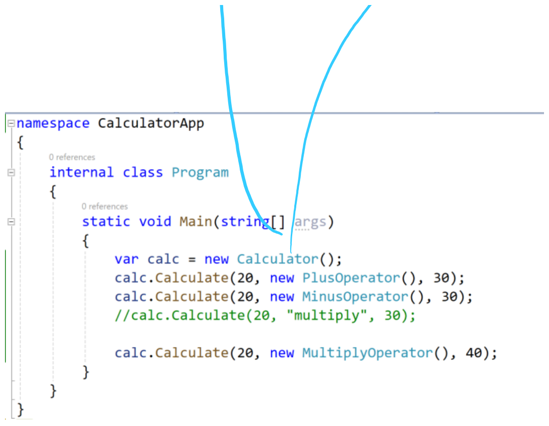
```
namespace ConceptArchitect.Calculators
{
    1 reference
    public class Calculator
    {
        3 references
        public void Calculate(double number1, IOperator oper, double number2)
        {
            oper.Calculate(number1, number2);
        }
    }
}
```

```
namespace Lnw.Calculations
{
    1 reference
    public class MultiplyOperator : IOperator
    {
        2 references
        public void Calculate(double x, double y)
        {
            Console.WriteLine($"{x} * {y} = {x * y}");
        }
    }
}
```

Use calculator(framework)



```
    }
}
```

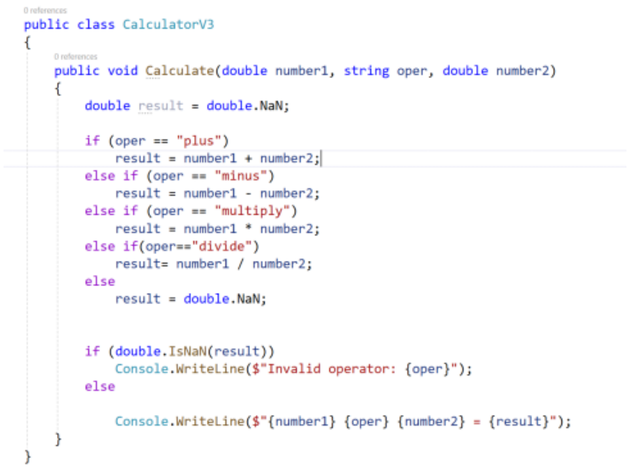


```
namespace CalculatorApp
{
    internal class Program
    {
        static void Main(string[] args)
        {
            var calc = new Calculator();
            calc.Calculate(20, new PlusOperator(), 30);
            calc.Calculate(20, new MinusOperator(), 30);
            //calc.Calculate(20, "multiply", 30);

            calc.Calculate(20, new MultiplyOperator(), 40);
        }
    }
}
```

Key design elements

1. Calculator exposes an interface (Dependency Inversion Principle)
    - It doesn't know the exact operation.
2. Each operation is independent and Singly Responsible
    - They are not directly related or connected
    - This allows us to add new features without changing existing design.
3. This is different from original design



```
public class CalculatorV3
{
    public void Calculate(double number1, string oper, double number2)
    {
        double result = double.NaN;

        if (oper == "plus")
            result = number1 + number2;
        else if (oper == "minus")
            result = number1 - number2;
        else if (oper == "multiply")
            result = number1 * number2;
        else if(oper=="divide")
            result= number1 / number2;
        else
            result = double.NaN;


        if (double.IsNaN(result))
            Console.WriteLine($"Invalid operator: {oper}");
        else

            Console.WriteLine($"{number1} {oper} {number2} = {result}");
    }
}
```

User Input

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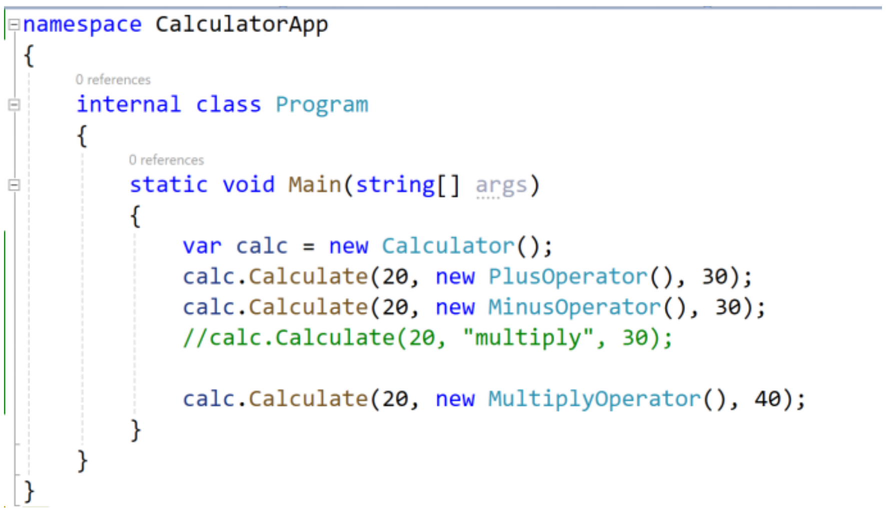
How do I use the calculator with Console Application (command line / Shell)

- When we using Console.ReadLine() we read a String
  - String can't be converted to a new Object creation easily

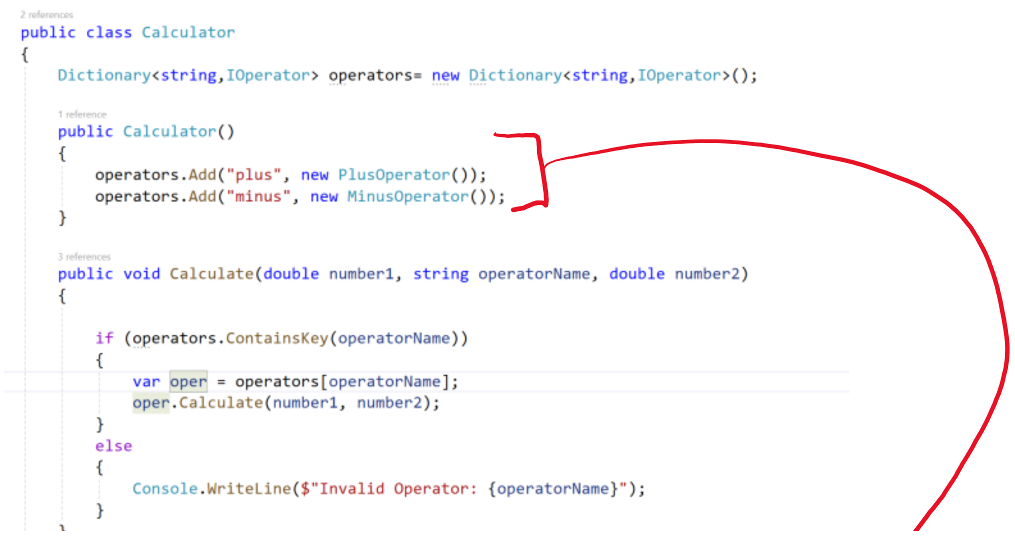


```
namespace CalculatorApp
{
    0 references
    internal class Program
    {
        0 references
        static void Main(string[] args)
        {
            var calc = new Calculator();
            calc.Calculate(20, new PlusOperator(), 30);
            calc.Calculate(20, new MinusOperator(), 30);
            //calc.Calculate(20, "multiply", 30);

            calc.Calculate(20, new MultiplyOperator(), 40);
        }
    }
}
```

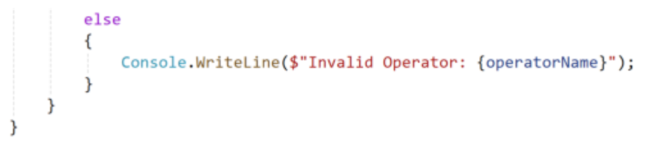
How do we input the operation (string)

Dictionary of Operations

- It's a generic pattern to replace switch case in your code.



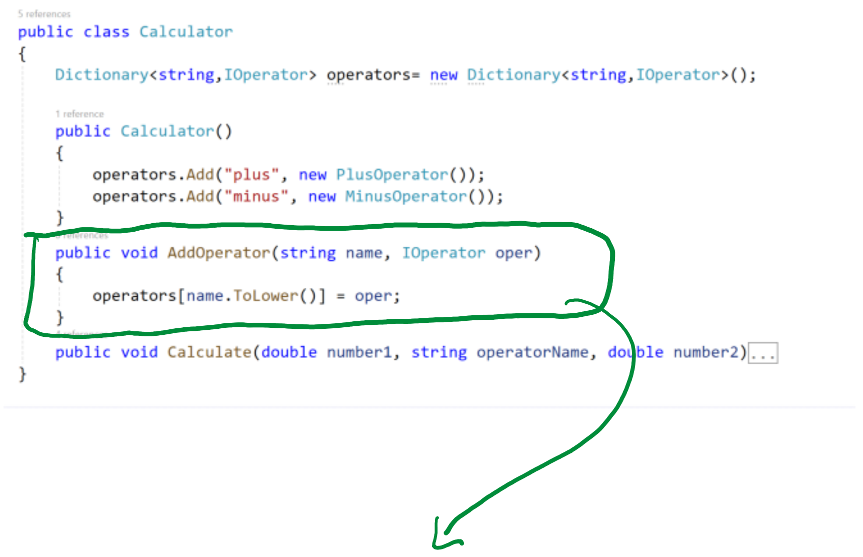
```
2 references
public class Calculator
{
    Dictionary<string,IOperator> operators= new Dictionary<string,IOperator>();

    1 reference
    public Calculator()
    {
        operators.Add("plus", new PlusOperator());
        operators.Add("minus", new MinusOperator());
    }

    3 references
    public void Calculate(double number1, string operatorName, double number2)
    {

        if (operators.ContainsKey(operatorName))
        {
            var oper = operators[operatorName];
            oper.Calculate(number1, number2);
        }
        else
        {
            Console.WriteLine($"Invalid Operator: {operatorName}");
        }
```



```
            else
            {
                Console.WriteLine($"Invalid Operator: {operatorName}");
            }
        }
    }
```

- We have 2 hard coded operators
- Framework doesn't give provision to expand and introduce new plugins
    - No Dependency Injection option provided.

Solution



```
5 references
public class Calculator
{
    Dictionary<string,IOperator> operators= new Dictionary<string,IOperator>();

    1 reference
    public Calculator()
    {
        operators.Add("plus", new PlusOperator());
        operators.Add("minus", new MinusOperator());
    }
    public void AddOperator(string name, IOperator oper)
    {
        operators[name.ToLower()] = oper;
    }
    public void Calculate(double number1, string operatorName, double number2)...
}
```

Assignment 2.1

Thursday, June 19, 2025 4:06 PM

- Take the code for GIT Hub
- Introduce the formatting and display option
- Make sure I should be able to use
  - different styles of formatting
  - Different architecture
    - Console
    - GUI
  - Display Error and Results differently

Phase 2

- Currently for every operator we need to
  - Create a class
  - Implement interface
  - Write the logic
- But the interface has a single method
- Can we replace this interface with a delegate.
- The Calculator should continue to work with current operators
  - Calculator should work with operators that are either interface or delegate

Assignment 2.2

Thursday, June 19, 2025 5:38 PM

Create a CLI Framework

It should support

1. Command Line Argument Mode

```
d:\>  cli book-list
d:\>  cli find-book author=vivek
d:\>  cli export-books books.json
```

2. Shell Mode (Interactive mode

```
d:\> cli
> help
book-list  find-book export-books add-book remove-book
> help export-books
Exports books in a given format based on file extension
export-book  books.json

> remove-book rashmirathi
> exit
```

The Exact commands should be added as a plugin model

- CLI should be able to run different commands that are added to the CLI
- Each command will have
  - One or more names (like alias)
    - book-list get-all-books books
  - Help Text to explain what this command does
  - The command may take as many parameter as it needs
  - If command returns something it should be displayed
  - Command may be async or synchronous

```
void Main(string []args){

    Cli app = new Cli();

    app.AddCommand(new BookListCommand())
    app.AddCommand(new BookDeleteCommand());
    …

    app.Run(args);
}
```

Assignment 2.3

Thursday, June 19, 2025 5:50 PM

Create a switch-case API that can be used in place of traditional switch case statement.

- It should eliminate the basic problems of switch case like
    - OCP
- Should by dynamic.

Animal Hierarchy

Friday, June 20, 2025 10:44 AM

```
public abstract class  Animal
{
    public abstract void Eat();
    …
}

class Horse : Animal
{
    public override void Eat(){
         Console.WriteLine("Grass");
    }
}

class Tiger : Animal
{
    public void Hunt(){
        Console.WriteLine("Hunts its
        prey");
    }

    public override void Eat(){
        Hunt();
        Console.WriteLine("Eats Flesh");
    }

}
```

```
Horse h =new Horse();
h.Eat();  //Grass

Animal a = h;
a.Eat();

Tiger t = new Tiger();
t.Hunt();  //Hunts it prey

t.Eat();  // Hunt its prey. Eats Flesh

Animal a2 = t;

a2.Hunt(); //compile time error. Animal doesn't have hunt
```

Why is it printing Grass?

- "a" is Animal Reference (not Horse reference)
- Animal class Eat doesn't print Grass
- Why is this code printing grass?
  - Because it calls the method from "object" class and not from "reference" class
    - This is polymorphism

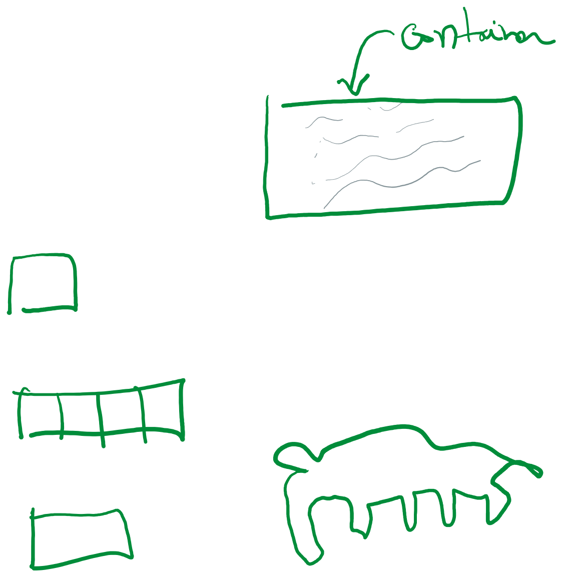
Why should this line give error

- "a" refers to a tiger object
- We already know methods are invoked from object class and not from reference class
- Tiger object has hunt.
- So why should this line give error
- Here Hunt is (indirectly) called using Animal reference
  - Technically it is possible to call hunt using Animal reference

```
a2.Eat(); //Hunts its prey. Eats Flesh
```

Delegate?

Friday, June 20, 2025 11:14 AM



- Delegates are Objects
- The are containers for a method
- Once they wrap a method they can be used just like mehthod.
- But now you can also
    - Refer (Store) this object using a variable
    - Can add this object to an array/list/dictionary

- For each different method signature there is a differnent delegate type

How Function and Delegate Signature Match

- To refer to a function like one below

```
void Welcome(string name){

}
```

- We create a delegate type

```
delegate void Greeter(string name)
```

Important Note

- Here Greeter is not a function reference or pointer or variable.
- Internally Greeter is a **class**
- This is a shortcut for autogenerating a class like one below

```
public  class Greeter : MulticastDelegate{

     public void Invoke( string name ){
         //some logic that will call your function here
     }
     //more code here
}
```

To Refer to the function we need a Object of type Greeter

Greeter g1= new Greeter(Welcome);

Now we can use "g1" that contains Welcome function as Welcome

```
g1.Invoke("LNW");  //internally calls Welcome("LNW");
```

Greeter object doesn't work only with Welcome

- It can work with any function that matches the same signature like

```
void GoodBye(string name){}
void Wish(string xyz) { }
void PerformComplexOperation(string operationName) {}
```

- But it can't work with functions that don't match signature

```
void Greet( string name1, string name2) {…}  //two parameter
string GetGreetingMessage(string name) {} //non void return type
```

Simplified Delegate Signature

Auto Boxing of a method to Delegate

Greeter g2 = GoodBye ; //same as **new Greeter(GoodBye)**

Implicit Invoke call

- **You can invoke a delegate as if it is a function**

```
g2.Invoke("Lnw") ;   // same as g2.Invoke("lnw") =>   GoodBye("Lnw")
```

What does Delegate Signature include (and not include)

```
delegate void Greeter( string name );
```

What does this signature include?

- The function returns void
- The function takes a string argument
- Extra Information
  - The name of this argument may be "name"

        - Not compulsary

What does this signature doesn't include?

- Implementation details (body)
    - Function can do anything under given constraint of parameter type and return type.
- Method Name
    - The function can have any name
        - Welcome
        - GoodBye
        - DeleteUserById
- Class Name
    - This function can belong to any class
- Scope
    - This function can any scope
        - Public
        - Private
        - Static
        - Non-static

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What does this Code Mean?

```
interface IBinaryOperator{

     double Calculate( double x, double y)
}
```

- It will represent an Object
  - That can be of any class
    - Name doesn't matter
      - PlusOperator
      - MinusOperator
      - ...
  - But it must
    - Implement IBinaryOperator
    - Must have a function
      - called Calculate
        - You can't change this name
      - Should be
        - public
        - Non-static
      - Concern
        - There can only one function matching this signature in a class
        - For each different implementation we need a different class

```
delegate double BinaryOperator(double x, double)
```

- `It represents an Object`
  - `That contains a function`
    - `That MUST match the same signature`

- What doesn't matter
  - Class Name
    - PlusOperator
    - MinusOperator
  - Function Name
    - It can be any name need not be Calculate
      - Plus
      - Minus
      - Multiply
      - ...
  - Scope of the funciton
    - Private
    - Public
    - Static
    - Non-static
- Advantage
  - Multiple matching functions can be present in same class
  - No interface implementation required.
    - You can use existing codes if signature matches.
      - Math.Power

Built-in Generic Delegate Types

Friday, June 20, 2025 12:54 PM

- C# provides some built-in generic delgate types that we can use instead of creating our own
- There are two families of such delegates

Action Delegates

- They are delegates that take 0 or more parameters and returns nothing

What we need	User defined Example	Action version

A function that takes nothing and returns nothing	delegate void Job();
	Job j= DoSomething;
		delegate void Action()
		Action a = DoSomething;

A void function that takes an int parameter	delegate void OneIntArg(int x); OneIntArg x = PrintTable	Action<T> Action<int> x = PrintTable
A void function that takes and int and string	delegate void TwoArg(int x, string y); TwoArg x = SomeFunction	Action<A,B> Action<int,string> x = SomeFunction

- There are 18 overloaded types that can take from 0 to 17 parameter

Func Delegate

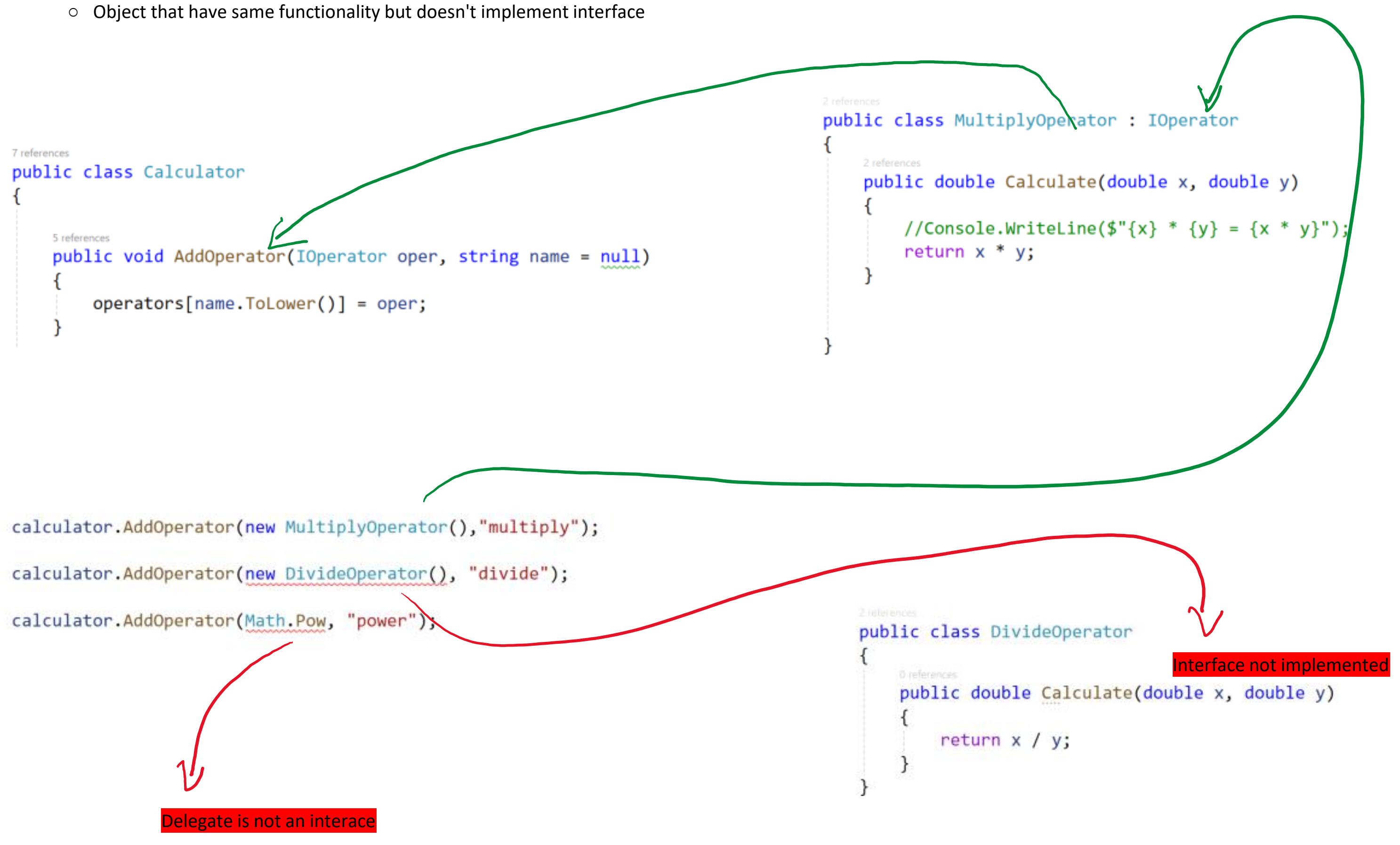
- They are functions that can take 0 or parameter and return a value.
- Note return type is always mentioned at the end
- There are again 18 overloads.

What we need	User Define Example	Func version
A function that takes nothing and returns an int	delegate int GetValue() GetValue v= GetRandomValue	Func<int> v = GetRandomValue;
A function that takes an int and returns a bool	delegate bool IntChecker() IntChecker c = IsPrime	Func<int,bool> v = IsPrime
A function that takes two int and returns a string	delegate string Del(int a, int b) Del d = CallSomeFunc	Func<int,int,string> v =CallSumFun

Calculator supporting both inerface and delegate operators

Friday, June 20, 2025 1:10 PM

- Currently calculator takes only interface
- It can' work with
  - Delegate
  - Object that have same functionality but doesn't implement interface



```
7 references
public class Calculator
{
    5 references
    public void AddOperator(IOperator oper, string name = null)
    {
        operators[name.ToLower()] = oper;
    }
```

```
2 references
public class MultiplyOperator : IOperator
{
    2 references
    public double Calculate(double x, double y)
    {
        //Console.WriteLine($"{x} * {y} = {x * y}");
        return x * y;
    }

}
```

```
calculator.AddOperator(new MultiplyOperator(),"multiply");

calculator.AddOperator(new DivideOperator(), "divide");

calculator.AddOperator(Math.Pow, "power");
```

```
2 references
public class DivideOperator
{
    0 references
    public double Calculate(double x, double y)
    {
        return x / y;
    }
}
```

Interface not implemented

Delegate is not an interace

Adapter Design Pattern

- It translates the contract (interface)
- Useful an object has functionality but doesn't match the interface requirement

Problem

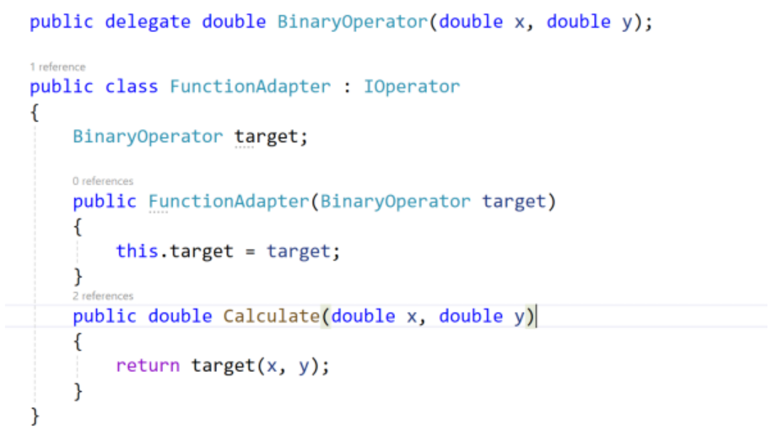
- My current design works with IOperator interface
  - It can work with only those objects that implements IOperator

- I have many built-in functions like Math.pow that can't support Ioperator
  - They are operations that can't work for my framework

Solution: Adapter

- Create a single Object that implements Ioperator
  - This object can be easily used with my Calcualtor
    - Calculator or application need not change

- It should wrap delegate as a parameter
- When user calls Calculate it internally calls delegate



```
public delegate double BinaryOperator(double x, double y);

1 reference
public class FunctionAdapter : IOperator
{
    BinaryOperator target;

    0 references
    public FunctionAdapter(BinaryOperator target)
    {
        this.target = target;
    }
    2 references
    public double Calculate(double x, double y)
    {
        return target(x, y);
    }
}
```

Reflection

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Object	Property	Behavior	Code

employee	• Id
	• Name
	• Email
	• Phone
	• Salary
		• Work	class Employee{
			    int id;
			   string name;
			   double salary;
			   short workingHours;
			
			   public void Work(){}
			
			}

tiger	• Age
	• Weight
	• Name
		• Eat()
		• Hunt()
		• Move()
			class Tiger : Animal{
			    public void Hunt(){
			
			   }
			}

class	• Name
	• Fields
	• Methods
	• Properties
	• Constructors
	• Namespace
	• BaseClass
	• Interfaces
	• Scope
		• createObject	class Type
			{
			    string name;
			    string namespace;
			    MethodInfo[] methods;
			    …
			    public object CreateObject();
			}

method	• Name
	• Return type
	• Parameters
	• Scope
	• Defining class
		• Invoke	Class MethodInfo
			{
			    string name;
			    …
			    public void Invoke();
			}

Reflection

- Reflection is a set of classes that helps us identify (and use) programming elements at runtime without knowing their exact names
- Programming element may mean
  - Types like class, interface, struct, enum
  - Methods
  - Fields
  - Parameters
  - Constructors

- Reflection will allow to
  - Access information related to those elements like
    - Type
      - Name
      - Namespace
      - Methods
      - Fields
      - Constructors

        - Method
            - Name
            - Return type
            - Parameters
            - Scope
        - Field
            - Name
            - Type
            - Defining class

    - Use that particular type programmetically
        - Type
            - You can create an object
        - Method
            - You can invoke the method
        - Field/Property
            - You can get or set values

Plugin Discovery

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What we are currently doing.

- Various different operators may be present in different assemblies
  - ConceptArchitect.Calculators (core library)
  - CalculatorApp (My main application)
  - Lnw.Calculations (third party library)
  - Lnt.Operations (another third party library)

- In the application project I need to add the project reference
  - If tomorrow we have more operators from another source
    - We will need to add them as references
    - We will need to
      - Recompile
      - Redistribute full application

-
- In (Main)
  - we need to manually add different operators to the calculator
    - calc.AddOperator(new MultiplyOperator(), "multiply");
  - If we need to add a new operator
    - We need to change main function
    - We will need to
      - Recompile
      - redistribute

What we want

- Various different Operators can come from different assemblies (dll files)
- Main Application will be compiled only with core library
  - No third party library reference added

- Any new feature (plugin) will be compiled as a separate dll
  - We don't need to compile main application

- We will copy the new feature.dll into a folder called plugins

- Calculator app while starting will automatically
  - Search all the available dll
  - Load them in memory
  - Search them for any IOperator present
  - Automatically add them to the calculator

[CalculatorBinary]
- Calculator.exe
- ConceptArchitect.Calculators.dll
- [plugins] <———— files are just dropped here. They will be read automatically
  - Lnw.Calculations
  - Lnt.TrigonometryLibrary

Attributes

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- Attributes are like meta Information (additional information) that we can attach to our programming elements like
  - Type
  - Method
  - Field
  - Parameter

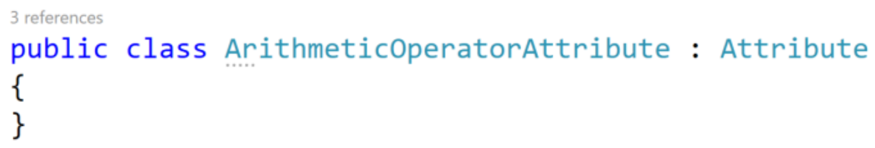
- They are actually Objects that can have
  - Fields
  - Properties
  - Behaviors

- They can be attached to an element like example below

```
[Hunter]
class Tiger{


}

class  Cow{

    [SpecialBehavior]
    public string ProvideMilk(){

    }

}


[Operator( Name="Permutation", Alias="per,p", Help="Calculates Permutation of
two numbers")]
class PermutationOperator : IOperator{

}
```

How do we create these attributes

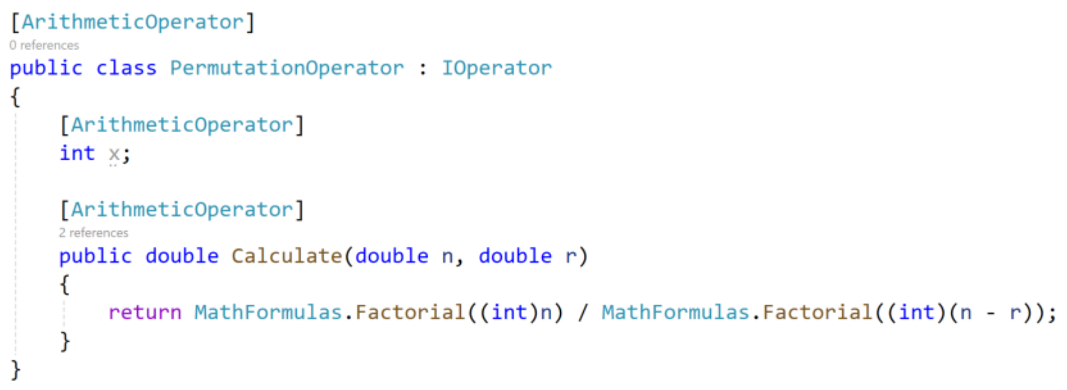
- We create a class that
  - Must inherit Attribute class
  - Should have an Attribute suffix



```
public class ArithmeticOperatorAttribute : Attribute
{
}
```

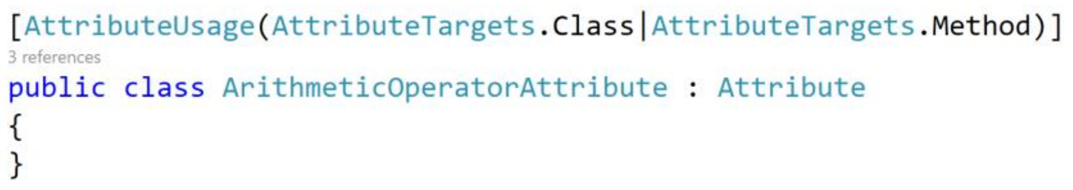
- Now we can apply it to any programming element

- Note we don't need to write Attribute suffix when adding attribute



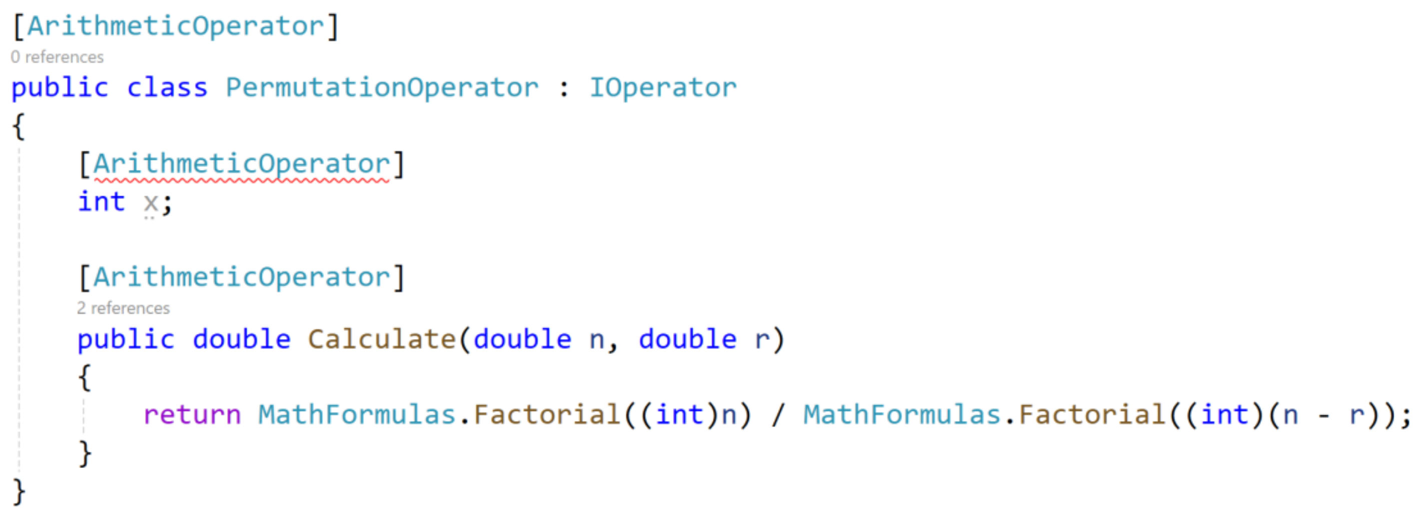
```
[ArithmeticOperator]
0 references
public class PermutationOperator : IOperator
{
    [ArithmeticOperator]
    int x;

    [ArithmeticOperator]
    2 references
    public double Calculate(double n, double r)
    {
        return MathFormulas.Factorial((int)n) / MathFormulas.Factorial((int)(n - r));
    }
}
```

- Problem
  - We can apply it to anything
  - We want to apply it only to classes or methods but not to fields



```
[AttributeUsage(AttributeTargets.Class|AttributeTargets.Method)]
3 references
public class ArithmeticOperatorAttribute : Attribute
{
}
```

- Now I can't apply it to a field



```
[ArithmeticOperator]
0 references
public class PermutationOperator : IOperator
{
    [ArithmeticOperator]
    int x;

    [ArithmeticOperator]
    2 references
    public double Calculate(double n, double r)
    {
        return MathFormulas.Factorial((int)n) / MathFormulas.Factorial((int)(n - r));
    }
}
```

What happens when we apply an attribute

- NOTHING
  - They are like dead objects

    - They sit and do nothing

- We can access and use the attribute objects only using reflection

```
var  arithemticOperator = type.GetCustomAttribute()
```