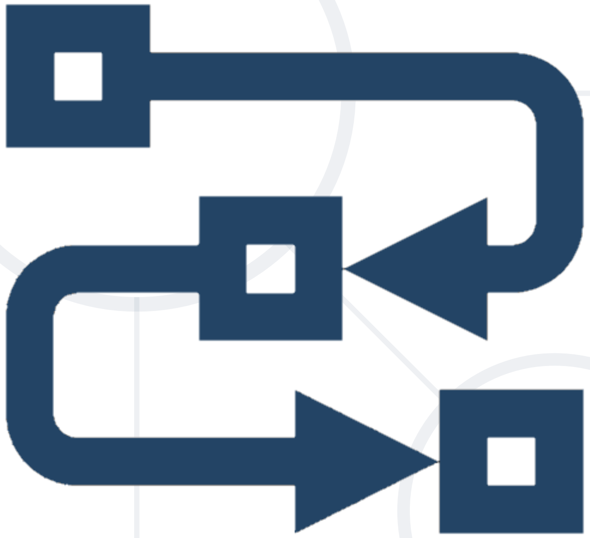
Methods

Defining and Using Methods, Overloads



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Void Method

Simple Methods

- **Named block of code**, that can be invoked later
- Sample method **definition**:

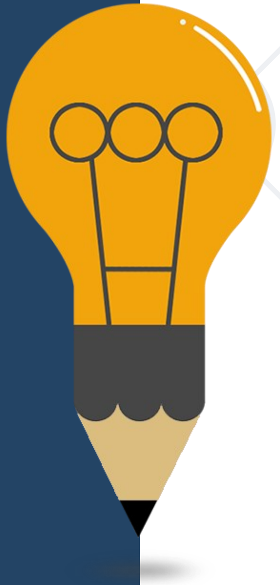
```
static void PrintHelloWorld()
{
   Console.WriteLine("Hello World");
}
```

Method named **PrintHelloWorld**

Method **body** is always surrounded by **{ }**

- **Invoking** (calling) the method several times:

```
PrintHelloWorld();
PrintHelloWorld();
```



Why Use Methods?

- Methods make code **maintainable**
  - Splits large problems into small pieces
  - Better organization of the program
  - Improves code **readability**
  - Improves code **understandability**
- Avoiding **repeating code**
  - Improves code maintainability
- Code **reusability**
  - Using existing methods several times

Void Type Method

- Executes the code between the brackets
- Does not return result

```
static void PrintHello()
{
  Console.WriteLine("Hello");
}
```

Prints "Hello" on the console

```
static void Main()
{
  PrintHello();
}
```

Main() is also a method

Declaring and Invoking Methods

Declaring Methods

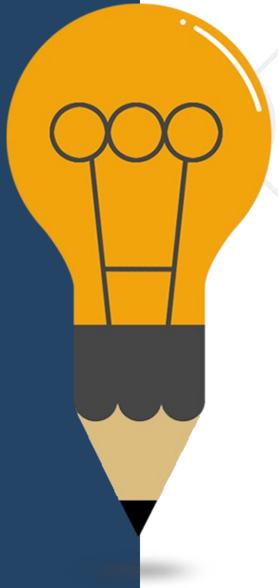
Return type

Method name

Parameters

Method body

```
static void PrintText(string text)
{
  Console.WriteLine(text);
}
```



- Methods are declared **inside a class**
- Variables inside a method are **local**

Invoking a Method (1)

- Methods are first **declared**, then **invoked** (many times)

```
static void PrintHeader()
{
  Console.WriteLine("----------");
}
```

Method **declaration**

- **Methods** can be **invoked** (called) by their **name** + **( )**:

```
static void Main()
{
  PrintHeader();
}
```

Method **invocation**

Invoking a Method (2)

- A method can be invoked:
  - From the **main method**

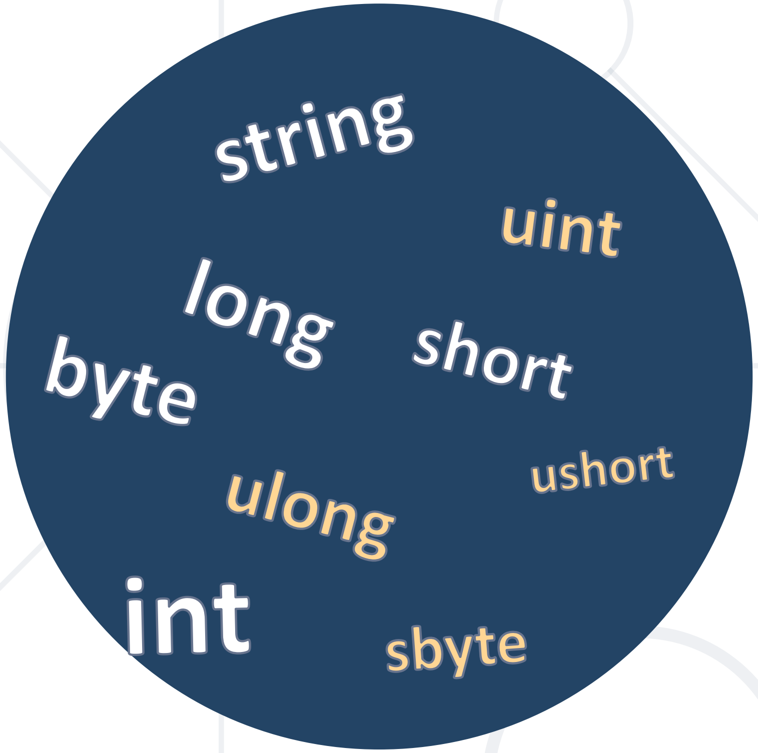
```
static void Main()
{
  PrintHeader();
}
```

  - From some **other method**

```
static void PrintHeader()
{
  PrintHeaderTop();
  PrintHeaderBottom();
}
```

  - From **its own body** – recursion

```
static void Crash()
{ Crash(); }
```



Methods with Parameters

Method Parameters (1)

- Method **parameters** can be of **any data type**

```
static void PrintNumbers(int start, int end)
{
  for (int i = start; i <= end; i++)
    Console.Write("{0} ", i);
}
```

Multiple parameters **separated by comma**

- Call the method with certain values (**arguments**)

```
static void Main()
{
  PrintNumbers(5, 10);
}
```

Passing arguments at invocation

Method Parameters (2)

- You can pass **zero** or **several** parameters
- You can pass parameters of **different types**
- Each parameter has **name** and **type**

Multiple parameters of different types

Parameter type

Parameter name

```
static void PrintStudent(string name, int age, double grade)
{
    Console.WriteLine("Student: {0}; Age: {1}, Grade: {2}",
        name, age, grade);
}
```

Short Syntax for Defining Methods

- Methods with short body can be defined using the **=>** operator:

```
static int Sum(int a, int b) => a + b;
```

- This is the same as:

```
static int Sum(int a, int b)
{
  return a + b;
}
```

- Another example:

```
static void Print(int x) => Console.WriteLine(x);
```

Problem: Grades

- Write a method that receives a **grade** between 2.00 and 6.00 and prints the corresponding **grade in words**
  - 2.00 - 2.99 - "Fail"
  - 3.00 - 3.49 - "Poor"
  - 3.50 - 4.49 - "Good"
  - 4.50 - 5.49 - "Very good"
  - 5.50 - 6.00 - "Excellent"

$$\boxed{\texttt{3.33}} \Rightarrow \boxed{\texttt{Poor}}$$

$$\boxed{\texttt{4.50}} \Rightarrow \boxed{\texttt{Very good}}$$

$$\boxed{\texttt{2.99}} \Rightarrow \boxed{\texttt{Fail}}$$

Solution: Grades

```
static void Main() =>
  PrintInWords(double.Parse(Console.ReadLine()));

private static void PrintInWords(double grade)
{
  string gradeInWords = string.Empty;
  if (grade >= 2 && grade <= 2.99)
    gradeInWords = "Fail";
  // TODO: continue with the rest
  Console.WriteLine(gradeInWords);
}
```

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/3160#0

Problem: Sign of Integer Number

- Create a method that prints the **sign** of an integer number **n**:

`2`	`The number 2 is positive.`
`-5`	`The number -5 is negative.`
`0`	`The number 0 is zero.`

Solution: Sign of Integer Number

```
static void Main() =>
  PrintSign(int.Parse(Console.ReadLine()));

static void PrintSign(int number)
{
  if (number > 0)
    Console.WriteLine("The number {0} is positive", number);
  else if (number < 0)
    Console.WriteLine("The number {0} is negative.", number);
  else
    Console.WriteLine("The number {0} is zero.", number);
}
```

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/3160#1

Optional Parameters

- Parameters can accept **default values**:

```
static void PrintNumbers(int start = 0, int end = 100)
{
  for (int i = start; i <= end; i++)
  {
    Console.Write("{0} ", i);
  }
}
```

Default values

- The above method can be called in several ways:

```
PrintNumbers(5, 10);
```

```
PrintNumbers(end: 40, start: 35);
```

```
PrintNumbers(15);
```

```
PrintNumbers();
```

Can be skipped at method invocation

Problem: Printing Triangle

- Create a method for printing triangles as shown below:

```
3
```

```
1
1 2
1 2 3
1 2
1
```

```
4
```

```
1
1 2
1 2 3
1 2 3 4
1 2 3
1 2
1
```

Solution: Printing Triangle (1)

- Create a method that **prints a single line**, consisting of numbers from a **given start** to a **given end**:

```
static void PrintLine(int start, int end)
{
  for (int i = start; i <= end; i++)
  {
    Console.Write(i + " ");
  }
  Console.WriteLine();
}
```

Solution continues on next slide

Solution: Printing Triangle (2)

- Create a method that prints the **first half (1..n)** and then the **second half (n-1…1)** of the triangle:

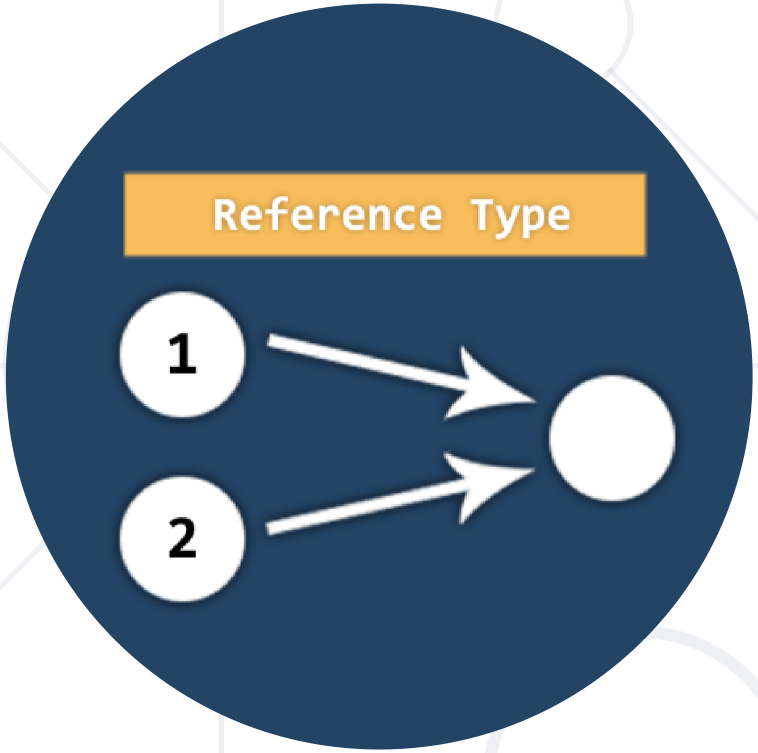
```
static void PrintTriangle(int n)
{
  for (int line = 1; line <= n; line++)
    PrintLine(1, line);

  for (int line = n - 1; line >= 1; line--)
    PrintLine(1, line);
}
```

Method with **parameter n**

Lines 1…n

Lines n-1…1

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/3160#3

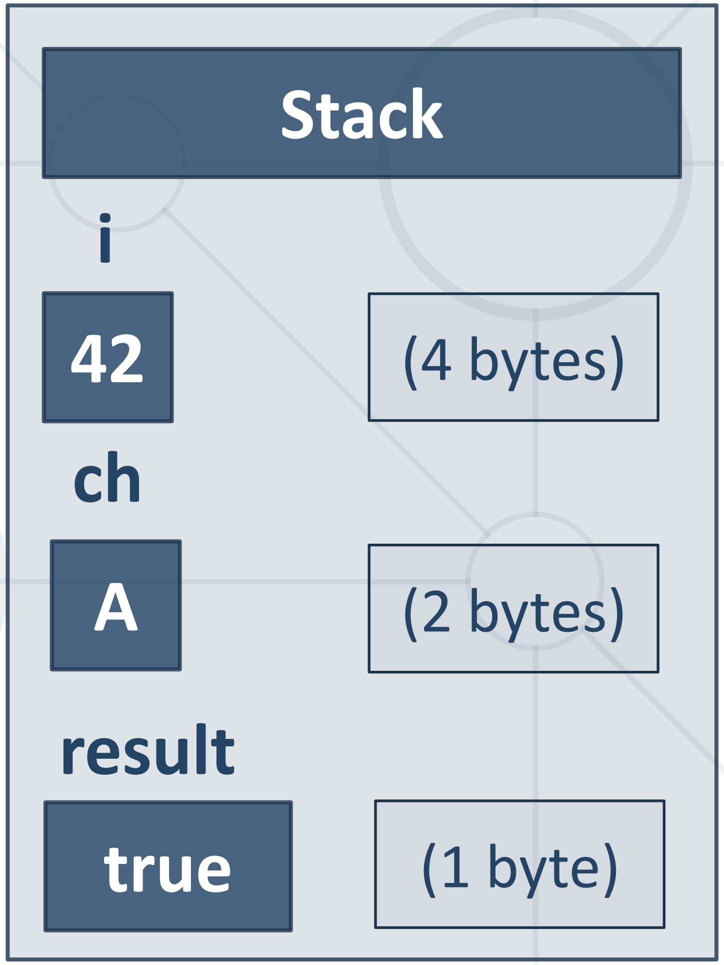


Memory Stack and Heap

Value Types

- **Value type** variables hold directly their value
  - **`int`, `float`, `double`, `bool`, `char`, `BigInteger`, …**
- Each variable has its own **copy** of the **value**

```
int i = 42;
char ch = 'A';
bool result = true;
```

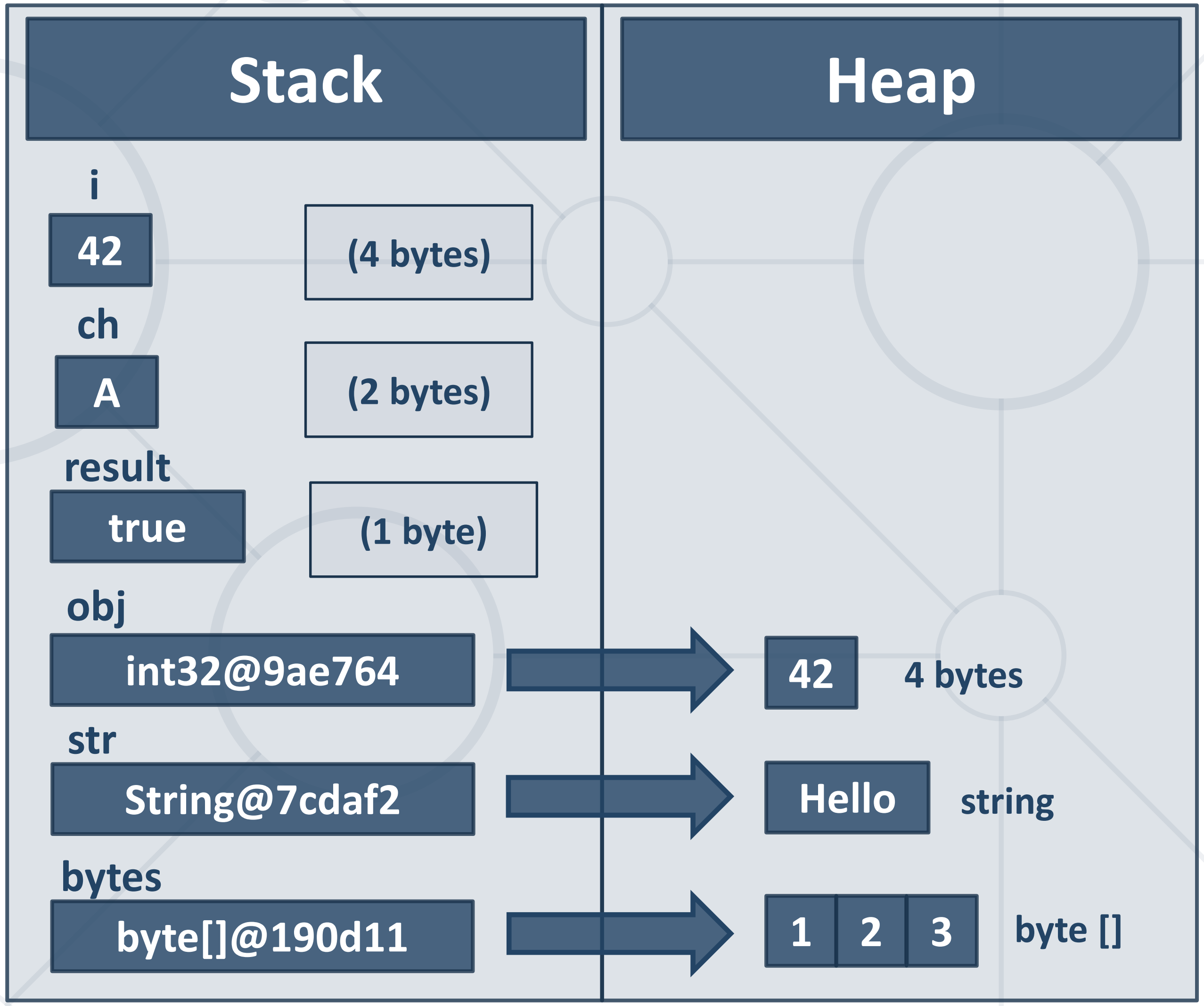


Reference Types

- **Reference type** variables hold a reference (pointer / memory address) of the value itself
  - **string**, **int[]**, **char[]**, **string[]**, **Random**
- Two reference type variables can **reference** the **same object**
  - Operations on both variables access/modify **the same data**

Value Types vs. Reference Types

```
int i = 42;
char ch = 'A';
bool result = true;
object obj = 42;
string str = "Hello";
byte[] bytes ={ 1, 2, 3 };
```



Example: Value Types

```
public static void Main() {
    int number = 5;
    Increment(number, 15);
    Console.WriteLine(number);
}

public static void Increment(int num, int value)
{
    num += value;
}
```

number == 5

num == 20

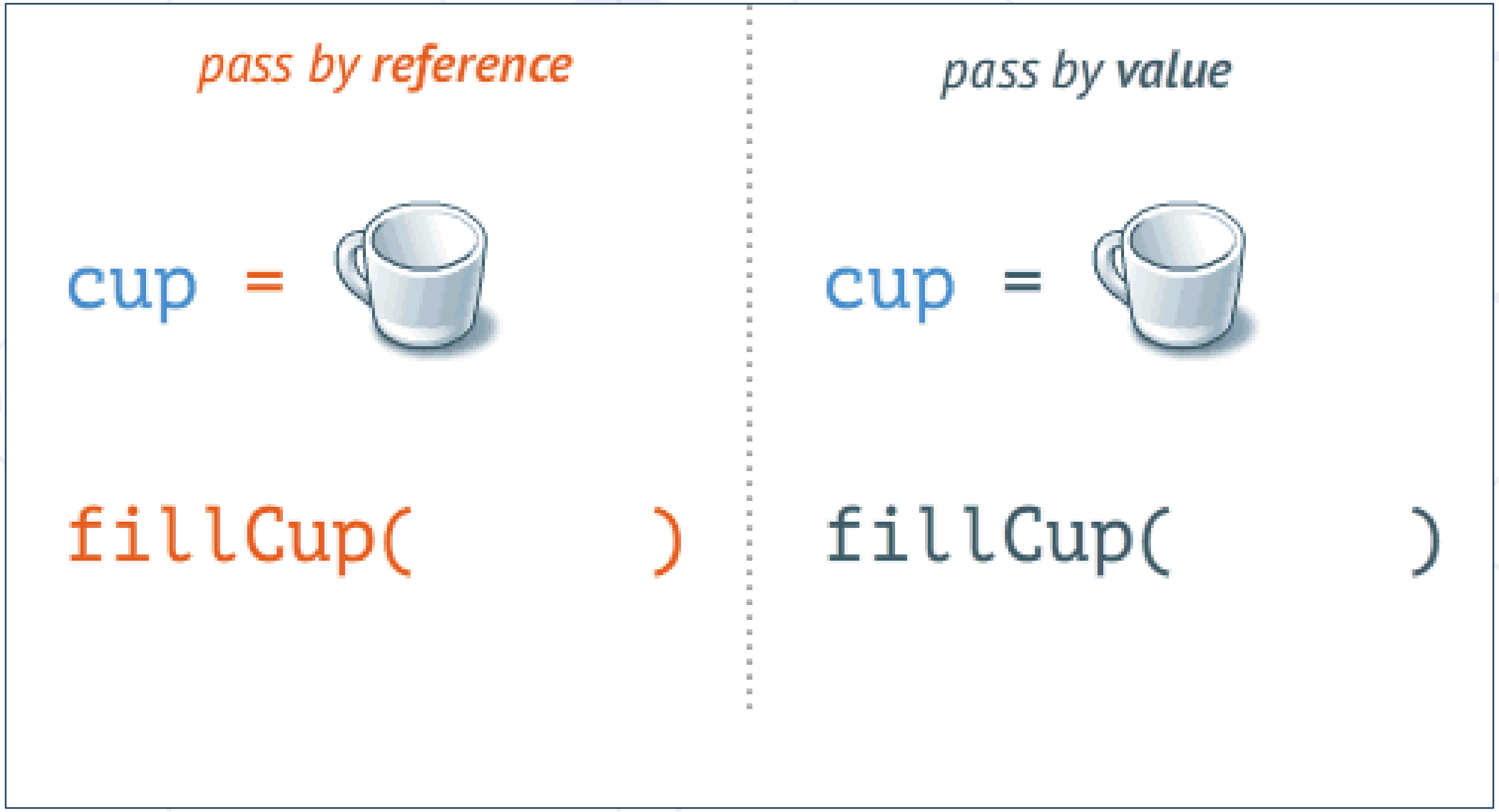
Example: Reference Types

```
public static void Main() {
   int[] nums = { 5 };
   Increment(nums, 15);
   Console.WriteLine(nums[0]);
}

public static void Increment(int[] nums, int value)
{
   nums[0] += value;
}
```

nums[0] == 20

nums[0] == 20

Value vs. Reference Types



Returning Values from Methods

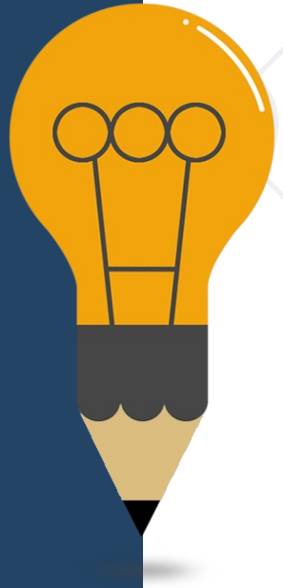
The Return Statement

- The **return** keyword immediately stops the method's execution
- Returns the specified value

```
static string ReadFullName()
{
  string firstName = Console.ReadLine();
  string lastName = Console.ReadLine();
  return firstName + " " + lastName;
}
```

Returns a **string**

- Void methods can be **terminated** by just using **return**



Using the Return Values

- Return value can be:
  - **Assigned** to a variable:

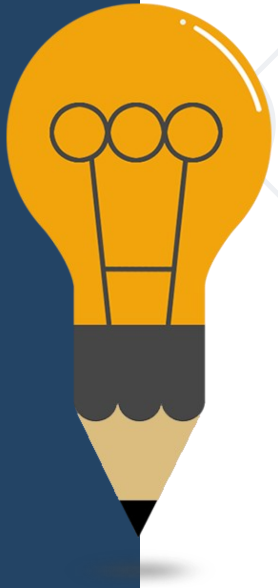
```
int max = GetMax(5, 10);
```

  - **Used** in expression:

```
decimal total = GetPrice() * quantity * 1.20m;
```

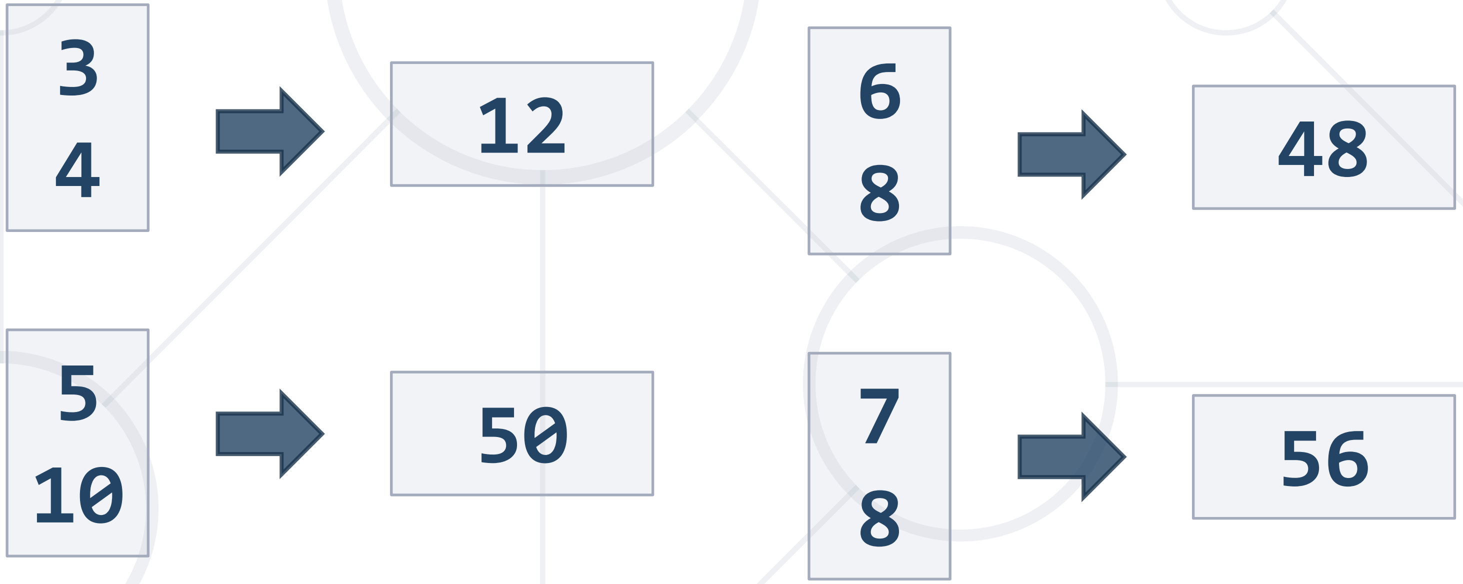
  - **Passed** to another method:

```
int age = int.Parse(Console.ReadLine());
```



Problem: Calculate Rectangle Area

- Create a method which returns **rectangle area** by given **width** and **height**



Solution: Calculate Rectangle Area

```
static void Main()
{
  double width = double.Parse(Console.ReadLine());
  double height = double.Parse(Console.ReadLine());
  double area = CalcRectangleArea(width, height);
  Console.WriteLine(area);
}
```

```
static double CalcRectangleArea(double width,double height)
{
  return width * height;
}
```

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/3160#4

Problem: Repeat String

- Write a method that receives a **string** and a repeat count **n**
  - The method should return a **new string**, holding the **input string**, repeated **n times**

abc 3	abcabcabc
String 2	StringString

Solution: Repeat String (1)

```
static void Main()
{
  string inputStr = Console.ReadLine();
  int count = int.Parse(Console.ReadLine());

  string result = RepeatString(inputStr, count);
  Console.WriteLine(result);
}
```

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/3160#5

Solution: Repeat String (2)

```
private static string RepeatString(string str, int count)
{
  StringBuilder result = new StringBuilder();
  for (int i = 0; i < count; i++)
  {
    result.Append(str);
  }
  return result.ToString();
}
```

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/3160#5

Problem: Math Power

- Create a method that calculates and returns the value of a **number raised to a given power**

2^8 → 256 3^4 → 81

```
static double MathPower(double number, int power)
{
  double result = 1;
  for (int i = 0; i < power; i++)
    result *= number;
  return result;
}
```

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/3160#6

Overloading Methods

Method Signature

- The combination of method's **name** and **parameters** is called **signature**

```
static void Print(string text)
{
  Console.WriteLine(text);
}
```

Method's **signature**

- Signature **differentiates** between methods with same names
- When methods with the **same name** have **different signature**, this is called method "**overloading**"

Overloading Methods

- Using same name for multiple methods with different **signatures** (method **name** and **parameters**)

```
static void Print(string text)
{
  Console.WriteLine(text);
}
```

```
static void Print(int number)
{
  Console.WriteLine(number);
}
```

```
static void Print(string text, int number)
{
  Console.WriteLine(text + ' ' + number);
}
```

Different method signatures

Signature and Return Type

- Method's return type **is not part** of its signature

```
static void Print(string text)
{
  Console.WriteLine(text);
}

static string Print(string text)
{
  return text;
}
```

Compile-time error!

- How would the compiler know **which method to call**?

Program Execution Flow

Program Execution

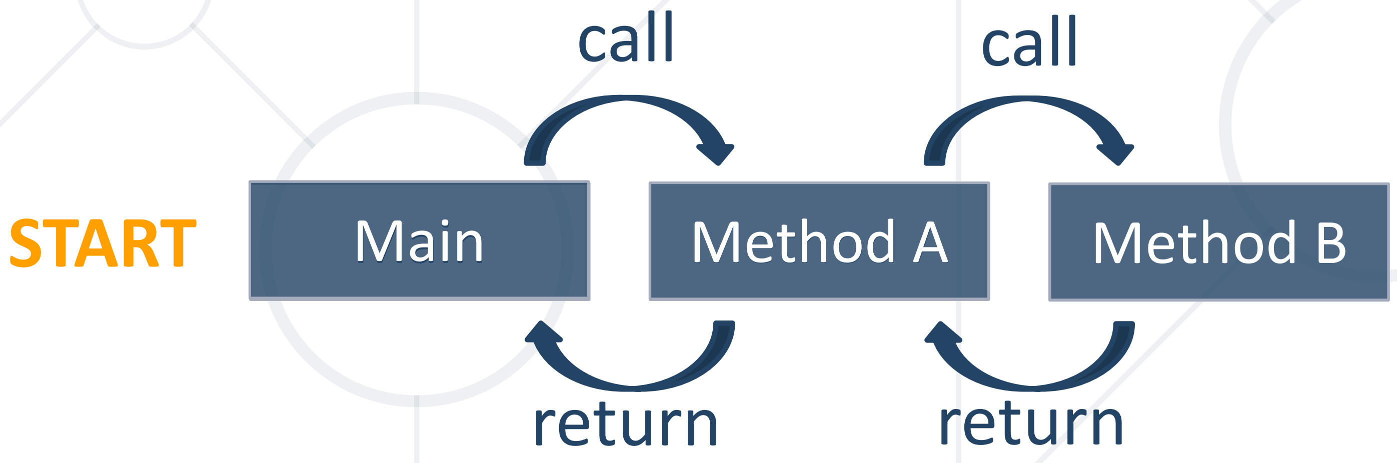
- The program **continues**, after a method **execution completes**:

```
static void Main()
{
  Console.WriteLine("before method executes");
  PrintLogo();
  Console.WriteLine("after method executes");
}
```

```
static void PrintLogo()
{
  Console.WriteLine("Company Logo");
  Console.WriteLine("http://www.companywebsite.com");
}
```

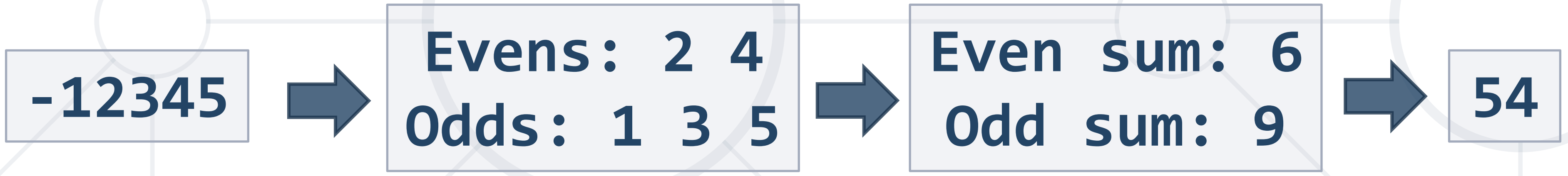
Program Execution – Call Stack

- "The stack" **stores information** about the **active subroutines** (methods) of a computer program
- Keeps track of **the point** to which each active subroutine should **return control** when it **finishes executing**



Problem: Multiply Evens by Odds

- Create a program that **multiplies the sum** of **all even digits** of a number **by the sum of all odd digits** of the same number:



  - Create a method `GetSumOfEvenDigits()`
  - Create a method `GetSumOfOddDigits()`
  - Create a method called `GetMultipleOfEvensAndOdds()`
  - You may need to use `Math.Abs()` for negative numbers

Solution: Multiply Evens by Odds (1)

```
static int GetSumOfEvenDigits(int number)
{
  int evenSum = 0;
  while (number >= 1)
  {
    int digit = number % 10;
    if (digit % 2 == 0)
      evenSum += digit;
    number /= 10;
  }
  return evenSum;
}
```

```
static int GetSumOfOddDigits(int number)
{
   // Use the same logic …
}
```

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/3160#8

Solution: Multiply Evens by Odds (2)

```
static int GetMultipledEvensAndOdds(int number)
{
  int evenSum = GetSumOfEvenDigits(number);
  int oddSum = GetSumOfOddDigits(number);
  int result = evenSum * oddSum;
  return result;
}
```

```
static void Main(string[] args)
{
  int num = int.Parse(Console.ReadLine());
  int number = Math.Abs(num);
  int result = GetMultipledEvensAndOdds(number);
  Console.WriteLine(result);
}
```

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/3160#8

Naming and Best Practices

Naming Methods

- Methods naming guidelines
  - Use **meaningful** method names, use [**Verb**]
  - Method names should answer the question:
    - **What does this method do**?

✓ `FindStudent`, `LoadReport`, `Sine`

  - If you cannot find a good name for a method, think about whether it has a **clear intent**

🚫 `Method1`, `DoSomething`, `HandleStuff`, `SampleMethod`, `DirtyHack`

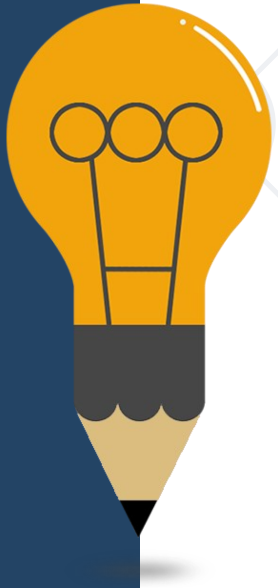
Naming Method Parameters

- Method parameters names
  - Preferred form: [**Noun**] or [**Adjective**] + [**Noun**]
  - Should be in `camelCase`
  - Should be **meaningful**

```
firstName, report, speedKmH,
usersList, fontSizeInPixels, font
```

  - Unit of measure should be obvious

```
p, p1, p2, populate, LastName, last_name, convertImage
```



Methods – Best Practices

- Each method should perform a **single**, well-defined task
  - A Method's name should **describe that task** in a clear and non-ambiguous way
- **Avoid** methods **longer than one screen**
  - **Split them** to several shorter methods

```
private static void PrintReceipt()
{
    PrintHeader();
    PrintBody();
    PrintFooter();
}
```

Self documenting and **easy to test**

Code Structure and Code Formatting

- Make sure to use correct **indentation**

```
static void Main()
{
    // some code…
    // some more code…
}
```

```
static void Main()
    {
        // some code…
// some more code…
}
```

- Leave a **blank line** between **methods**, after **loops** and after **if** statements
- Always use **curly brackets** for loops and `if` statements bodies
- **Avoid long lines** and **complex expressions**

Summary

- Break large programs into simple **methods** that solve small sub-problems
- Methods consist of **declaration** and **body**
- Methods are invoked by their **name** + **()**
- Methods can accept **parameters**
- Methods can **`return`** a value or nothing (**`void`**)

Questions?

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