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Methods

Subroutines in Computer Programming

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What is a Method?

- A method is a kind of building block that solves a small problem
  - A piece of code that has a name and can be called from the other code
  - Can take parameters and return a value
- Methods allow programmers to construct large programs from simple pieces
- Methods are also known as functions, procedures, and subroutines

Why to Use Methods?

- More manageable programming
  - Split large problems into small pieces
  - Better organization of the program
  - Improve code readability
  - Improve code understandability
- Avoiding repeating code
  - Improve code maintainability
- Code reusability
  - Using existing methods several times

Declaring and Creating Methods

Declaring and Creating Methods

```
static void PrintLogo()
{
    Console.WriteLine("Telerik Corp.");
    Console.WriteLine("www.telerik.com");
}
```

Method name

- Each method has a name
  - It is used to call the method
  - Describes its purpose

Declaring and Creating Methods (2)

```
static void PrintLogo()
{
    Console.WriteLine("Telerik Corp.");
    Console.WriteLine("www.telerik.com");
}
```

- Methods declared `static` can be called by any other method (static or not)
  - This will be discussed later in details
- The keyword `void` means that the method does not return any result

Declaring and Creating Methods (3)

```
static void PrintLogo()
{
    Console.WriteLine("Telerik Corp.");
    Console.WriteLine("www.telerik.com");
}
```

Method body

- Each method has a body
  - It contains the programming code
  - Surrounded by { and }

Declaring and Creating Methods (4)

```
using System;

class MethodExample
{
    static void PrintLogo()
    {
        Console.WriteLine("Telerik Corp.");
        Console.WriteLine("www.telerik.com");
    }

    static void Main()
    {
        // ...
    }
}
```

- Methods are always declared inside a `class`
- `Main()` is also a method like all others

Calling Methods

Calling Methods

- To call a method, simply use:
  1. The method's name
  2. Parentheses (don't forget them!)
  3. A semicolon (;)

```
PrintLogo();
```

- This will execute the code in the method's body and will result in printing the following:

```
Telerik Corp.
www.telerik.com
```

Calling Methods (2)

- A method can be called from:
  - The `Main()` method

```
static void Main()
{
    // ...
    PrintLogo();
    // ...
}
```

  - Any other method
  - Itself (process known as recursion)

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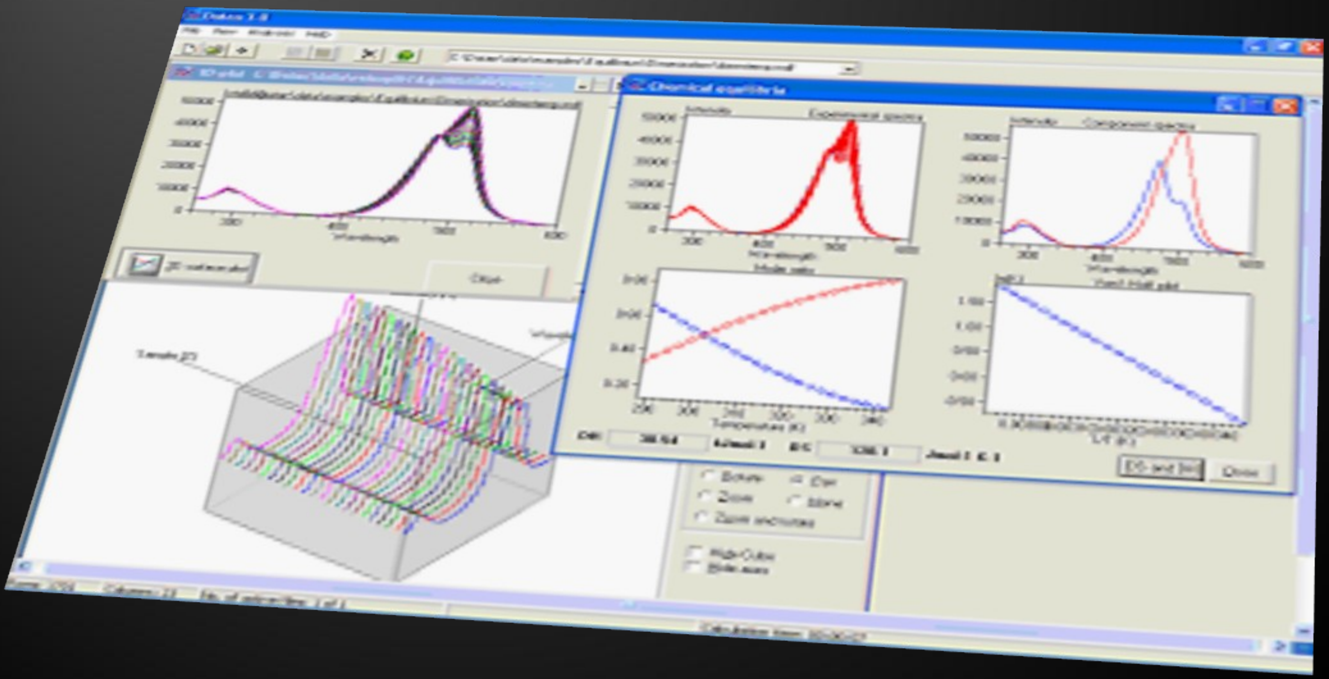
Declaring and Calling Methods

Live Demo

Methods with Parameters

Passing Parameters and Returning Values



Method Parameters

- To pass information to a method, you can use parameters (also known as arguments)
  - You can pass zero or several input values
  - You can pass values of different types
  - Each parameter has name and type
  - Parameters are assigned to particular values when the method is called
- Parameters can change the method behavior depending on the passed values

Defining and Using Method Parameters

```
static void PrintSign(int number)
{
    if (number > 0)
        Console.WriteLine("Positive");
    else if (number < 0)
        Console.WriteLine("Negative");
    else
        Console.WriteLine("Zero");
}
```

- Method's behavior depends on its parameters
- Parameters can be of any type
  - int, double, string, etc.
  - arrays (int[], double[], etc.)

Defining and Using Method Parameters (2)

- Methods can have as many parameters as needed:

```
static void PrintMax(float number1, float number2)
{
    float max = number1;
    if (number2 > number1)
        max = number2;
    Console.WriteLine("Maximal number: {0}", max);
}
```

- The following syntax is not valid:

```
static void PrintMax(float number1, number2)
```

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Calling Methods with Parameters

- To call a method and pass values to its parameters:
  - Use the method's name, followed by a list of expressions for each parameter
- Examples:

```
PrintSign(-5);
PrintSign(balance);
PrintSign(2+3);

PrintMax(100, 200);
PrintMax(oldQuantity * 1.5, quantity * 2);
```

Calling Methods with Parameters (2)

- Expressions must be of the same type as method's parameters (or compatible)
  - If the method requires a `float` expression, you can pass `int` instead
- Use the same order like in method declaration
- For methods with no parameters do not forget the parentheses

Using Methods With Parameters

Examples

Methods Parameters – Example

```
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);
}

static void PrintMax(float number1, float number2)
{
  float max = number1;
  if (number2 > number1)
  {
    max = number2;
  }
  Console.WriteLine("Maximal number: {0}", max);
}
```

Method Parameters

Live Demo

Months – Example

- Display the period between two months in a user-friendly way

```
using System;

class MonthsExample
{
  static void SayMonth(int month)
  {
    string[] monthNames = new string[] {
      "January", "February", "March",
      "April", "May", "June", "July",
      "August", "September", "October",
      "November", "December"};
      Console.Write(monthNames[month-1]);
  }
                                   (the example continues)
```

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Months – Example (2)

```
  static void SayPeriod(int startMonth, int endMonth)
  {
    int period = endMonth - startMonth;
    if (period < 0)
    {
      period = period + 12;
      // From December to January the
      // period is 1 month, not -11!
    }
    Console.Write("There are {0} " + months from ", period);
    SayMonth(startMonth);
    Console.Write(" to ");
    SayMonth(endMonth);
  }
}
```

Months

Live Demo

Printing Triangle – Example

- Creating a program for printing triangles as shown below:

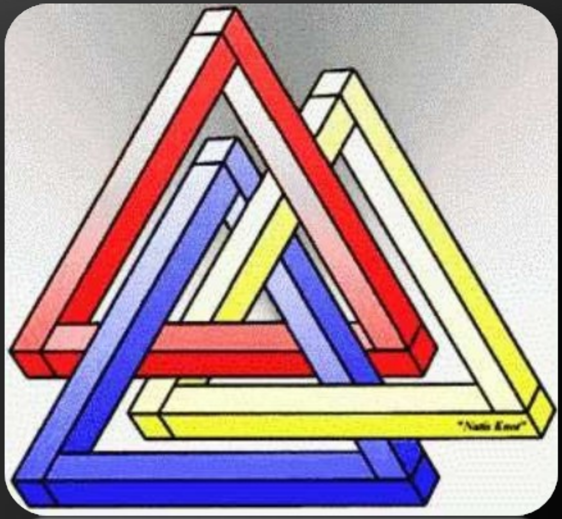
```
                                  1
                      1           1  2
                      1  2        1  2  3
                      1  2  3     1  2  3  4
                      1  2  3  4     1  2  3  4  5
n=5    →  1  2  3  4  5      n=6   →  1  2  3  4  5  6
                      1  2  3  4     1  2  3  4  5
                      1  2  3     1  2  3  4
                      1  2        1  2  3
                      1           1  2
                                  1
```

Printing Triangle – Example

```
static void Main()
{
    int n = int.Parse(Console.ReadLine());

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

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



Printing Triangle

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Optional Parameters

- C# 4.0 supports optional parameters with default values:

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

- The above method can be called in several ways:

```
PrintNumbers(5, 10);
PrintNumbers(15);
PrintNumbers();
PrintNumbers(end: 40, start: 35);
```

Optional Parameters

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Returning Values From Methods

Returning Values From Methods

- A method can return a value to its caller
- Returned value:
  - Can be assigned to a variable:

```
string message = Console.ReadLine();
// Console.ReadLine() returns a string
```

  - Can be used in expressions:

```
float price = GetPrice() * quantity * 1.20;
```

  - Can be passed to another method:

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

Defining Methods That Return a Value

- Instead of void, specify the type of data to return

```
static int Multiply(int firstNum, int secondNum)
{
    return firstNum * secondNum;
}
```

- Methods can return any type of data (int, string, array, etc.)
- void methods do not return anything
- The combination of method's name, parameters and return value is called method signature
- Use return keyword to return a result

The `return` Statement

- The `return` statement:
  - Immediately terminates method's execution
  - Returns specified expression to the caller
  - Example:

```
return -1;
```

- To terminate `void` method, use just:

```
return;
```

- Return can be used several times in a method body

Returning Values From Methods

Examples

Returning Values From Methods

Examples

Temperature Conversion – Example

- Convert temperature from Fahrenheit to Celsius:

```
static double FahrenheitToCelsius(double degrees)
{
  double celsius = (degrees - 32) * 5 / 9;
  return celsius;
}

static void Main()
{
  Console.Write("Temperature in Fahrenheit: ");
  double t = Double.Parse(Console.ReadLine());
  t = FahrenheitToCelsius(t);
  Console.Write("Temperature in Celsius: {0}", t);
}
```

Temperature Conversion

Live Demo

Positive Numbers – Example

- Check if all numbers in a sequence are positive:

```
static bool ArePositive(int[] sequence)
{
    foreach (int number in sequence)
    {
        if (number <= 0)
        {
            return false;
        }
    }
    return true;
}
```

Positive Numbers

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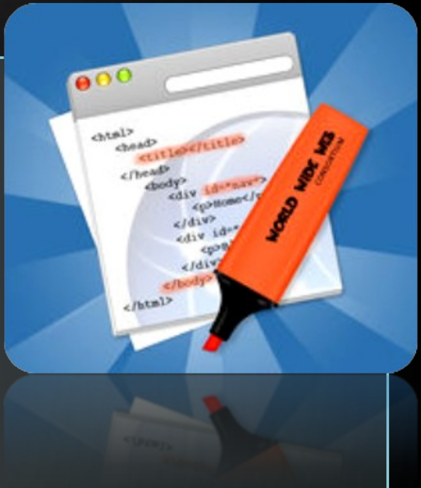
Data Validation – Example

- Validating input data:



```
using System;

class ValidatingDemo
{
  static void Main()
  {
    Console.WriteLine("What time is it?");

    Console.Write("Hours: ");
    int hours = int.Parse(Console.ReadLine());

    Console.Write("Minutes: ");
    int minutes = int.Parse(Console.ReadLine());

                  // (The example continues on the next slide)
```

Data Validation – Example

```
    bool isValidTime =
      ValidateHours(hours) &&
      ValidateMinutes(minutes);
    if (isValidTime)
      Console.WriteLine("It is {0}:{1}",
        hours, minutes);
    else
      Console.WriteLine("Incorrect time!");
  }

  static bool ValidateMinutes(int minutes)
  {
    bool result = (minutes>=0) && (minutes<=59);
    return result;
  }

  static bool ValidateHours(int hours) { ... }
}
```

Data Validation

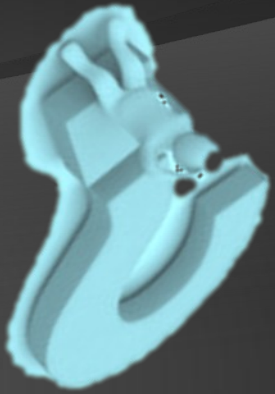
Live Demo

Methods – Best Practices

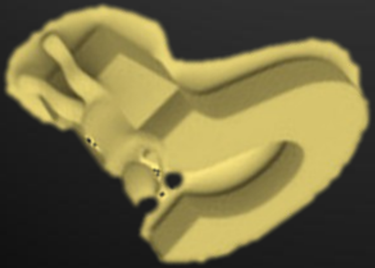
- Each method should perform a single, well-defined task
- Method's name should describe that task in a clear and non-ambiguous way
  - Good examples: `CalculatePrice`, `ReadName`
  - Bad examples: `f`, `g1`, `Process`
  - In C# methods should start with capital letter
- Avoid methods longer than one screen
  - Split them to several shorter methods

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
  - Parameters take actual values when calling a method
- Methods can return a value or nothing



Questions?



Exercises

1. Write a method that asks the user for his name and prints “Hello, <name>” (for example, “Hello, Peter!”). Write a program to test this method.
2. Write a method `GetMax()` with two parameters that returns the bigger of two integers. Write a program that reads 3 integers from the console and prints the biggest of them using the method `GetMax()`.
3. Write a method that returns the last digit of given integer as an English word. Examples: 512 → "two", 1024 → "four", 12309 → "nine".

Exercises (2)

1. Write a method that counts how many times given number appears in given array. Write a test program to check if the method is working correctly.
2. Write a method that checks if the element at given position in given array of integers is bigger than its two neighbors (when such exist).
3. Write a method that returns the index of the first element in array that is bigger than its neighbors, or -1, if there's no such element.
   - Use the method from the previous exercise.

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Exercises (3)

1. Write a method that reverses the digits of given decimal number. Example: 256 → 652
2. Write a method that adds two positive integer numbers represented as arrays of digits (each array element `arr[i]` contains a digit; the last digit is kept in `arr[0]`). Each of the numbers that will be added could have up to 10 000 digits.
3. Write a method that return the maximal element in a portion of array of integers starting at given index. Using it write another method that sorts an array in ascending / descending order.

Exercises (4)

1. Write a program to calculate `n!` for each n in the range `[1..100]`. Hint: Implement first a method that multiplies a number represented as array of digits by given integer number.

2. Write a method that adds two polynomials. Represent them as arrays of their coefficients as in the example below:

   $x^2 + 5 = 1x^2 + 0x + 5 \rightarrow \boxed{5 \mid 0 \mid 1}$

4. Extend the program to support also subtraction and multiplication of polynomials.

Exercises (5)

1. Write a program that can solve these tasks:
   - Reverses the digits of a number
   - Calculates the average of a sequence of integers
   - Solves a linear equation ***a* * *x* + *b* = 0**

   Create appropriate methods.

   Provide a simple text-based menu for the user to choose which task to solve.

   Validate the input data:
   - The decimal number should be non-negative
   - The sequence should not be empty
   - *a* should not be equal to 0