

ProblemBook.NET



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To view the source code and the actual version of the text, visit:

<https://github.com/AndreyAkinshin/ProblemBook.NET>

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Introduction

This book is a collection of problems on the knowledge of the .NET platform and the C# programming language. To avoid misunderstandings, just want to say that the book *is not*:

- This book is not a universal way to check your knowledge platform .NET. If you are easily solved all problems, it does not mean that you is a wonderful .NET-programmer. And if you met a lot of new things for yourself, then it does not mean that you don't know .NET.
- This book is not a compilation of new, previously unseen problems. Many examples can be found in the literature, in questions on [StackOverflow](#), in programmer's blogs. Just because they have become classics.
- This book is not focused on those who already feel Senior .NET Developer and want to learn a lot.

So what is this book? ProblemBook.NET is an attempt to gather in one place a variety of interesting practical problems on the knowledge platform. Problems are divided into chapters, so you can not read everything, but only questions of those areas that are of interest to you. In this book you will not find a deep philosophical questions such as "What is a class?" or "Why is polymorphism needed?". Most of the problems is a piece of C#-code for which you should to determine the result. Each question is provided with a solution (sometimes with a description of why .NET behaves this way).

It is recommended to treat the problem is not as a way to test your knowledge as well as the starting point for the discussion of various aspects of the platform. If you find something new for yourself, it's a great cause to learn .NET a little more detail. Try to play around with the code: modify it and learn how changes affect the result. Read the relevant literature. Think about how the new knowledge can be useful to you in your work.

ProblemBook.NET distributed electronically, the development is on GitHub. It should also be noted that at present the problem book is far from the final version. The book will be updated with new problems and old will be refined and improved.

Technical Details

Today, there are two popular platform implementation .NET: The original Microsoft .NET Framework (hereinafter - MS.NET) and Mono. It is known that the behavior of some code fragments may change when you change the implementation. Similarly, the behavior might depends on the CLR or processor architecture. If the result of the fragment of the code depends on the environment, it is likely that the answers will be given an explanation. However, it is *not guaranteed*. If one of the examples you have received an answer that is different from this in the book, please contact the author, that he corrected this mistake.

Examples of code in all tasks can be run from [LINQPad](#) (in C# Statements or C# Program, depending on the availability of the method `Main`), but you should import the following namespace (Query -> Query Properties -> Additional Namespace Imports):

```
System.Globalization  
System.Runtime.InteropServices  
System.Runtime.CompilerServices
```

Thanks

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The author evinces appreciation to Ekaterina Demidova for the kindly providing illustrations.

Problems

1 OOP (Problems)

1. What will the following code display?

```
void Foo(object a)
{
    Console.WriteLine("object");
}
void Foo(object a, object b)
{
    Console.WriteLine("object, object");
}
void Foo(params object[] args)
{
    Console.WriteLine("params object[]");
}
void Foo<T>(params T[] args)
{
    Console.WriteLine("params T[]");
}
class Bar { }
void Main()
{
    Foo();
    Foo(null);
    Foo(new Bar());
    Foo(new Bar(), new Bar());
    Foo(new Bar(), new object());
}
```

[Solution](#)

2. What will the following code display?

```
class Foo
{
    public virtual void Quux(int a)
    {
        Console.WriteLine("Foo.Quux(int)");
    }
}
class Bar : Foo
{
    public override void Quux(int a)
    {
        Console.WriteLine("Bar.Quux(int)");
    }
    public void Quux(object a)
    {
        Console.WriteLine("Bar.Quux(object)");
    }
}
class Baz : Bar
{
    public override void Quux(int a)
    {
        Console.WriteLine("Baz.Quux(int)");
    }
    public void Quux<T>(params T[] a)
    {
        Console.WriteLine("Baz.Quux(params T[])");
    }
}
void Main()
{
    new Bar().Quux(42);
    new Baz().Quux(42);
}
```

[Solution](#)

3. What will the following code display?

```
class Foo
{
    public Foo()
    {
        Quux();
    }
    public virtual void Quux()
    {
        Console.WriteLine("Foo.Quux()");
    }
}
class Bar : Foo
{
    protected string name;
    public Bar()
    {
        name = "Bar";
    }
    public override void Quux()
    {
        Console.WriteLine("Bar.Quux(), " + name);
    }
    public void Quux(params object[] args)
    {
        Console.WriteLine("Bar.Quux(params object[])");
    }
}
class Baz : Bar
{
    public Baz()
    {
        name = "Baz";
        Quux();
        ((Foo)this).Quux();
    }
}
void Main()
{
    new Baz();
}
```

[Solution](#)

4. What will the following code display?

```
class Foo
{
    protected class Quux
    {
        public Quux()
        {
            Console.WriteLine("Foo.Quux()");
        }
    }
}
class Bar : Foo
{
    new class Quux
    {
        public Quux()
        {
            Console.WriteLine("Bar.Quux()");
        }
    }
}
class Baz : Bar
{
    public Baz()
    {
        new Quux();
    }
}
void Main()
{
    new Baz();
}
```

[Solution](#)

2 LINQ (Problems)

1. What will the following code display?

```
public static string GetString(string s)
{
    Console.WriteLine("GetString: " + s);
    return s;
}
public static IEnumerable<string> GetStringEnumerable()
{
    yield return GetString("Foo");
    yield return GetString("Bar");
}
public static string[] EnumerableToArray()
{
    var strings = GetStringEnumerable();
    foreach (var s in strings)
        Console.WriteLine("EnumerableToArray: " + s);
    return strings.ToArray();
}
void Main()
{
    EnumerableToArray();
}
```

[Solution](#)

2. What will the following code display?

```
public IEnumerable<int> Foo()
{
    yield return 1;
    Console.WriteLine("Foo");
}
void Main()
{
    foreach (var i in Foo())
        Console.Write(i);
}
```

[Solution](#)

3. What will the following code display?

```
var actions = new List<Action>();
foreach (var i in Enumerable.Range(1, 3))
    actions.Add(() => Console.WriteLine(i));
foreach (var action in actions)
    action();
```

Solution

4. What will the following code display?

```
var list = new List<string> {"A", "BB", "CCC"};
var query = list.Where(c => c.Length == 2);
list.Remove("BB");
Console.WriteLine(query.Count());
```

Solution

5. What will the following code display?

```
var list = new List<string> {"A", "BB", "CCC"};
var minLength = 3;
var query = list.Where(c => c.Length >= minLength);
minLength = 2;
query = query.Where(c => c.Length >= minLength);
Console.WriteLine(query.Count());
```

Solution

6. What will the following code display?

```
int Inc(int x)
{
    Console.WriteLine("Inc: " + x);
    return x + 1;
}
void Main()
{
    var numbers = Enumerable.Range(0, 10);
    var query =
        (from number in numbers
         let number2 = Inc(number)
         where number2 % 2 == 0
         select number2).Take(2);
    foreach (var number in query)
        Console.WriteLine("Number: " + number);
}
```

[Solution](#)

7. At what point will happen Exception?

```
public static IEnumerable<int> GetSmallNumbers()
{
    yield return 1;
    throw new Exception();
    yield return 2;
}
void Main()
{
    var numbers = GetSmallNumbers();
    var evenNumbers = numbers.Select(n => n * 2);
    Console.WriteLine(evenNumbers.FirstOrDefault());
}
```

[Solution](#)

8. At what point will happen Exception?

```
public static IEnumerable<int> GetSmallNumbers()
{
    throw new Exception();
    yield return 1;
    yield return 2;
}
void Main()
{
    var numbers = GetSmallNumbers();
    var evenNumbers = numbers.Select(n => n * 2);
    Console.WriteLine(evenNumbers.FirstOrDefault());
}
```

[Solution](#)

3 Mathematics (Problems)

1. What will the following code display?

```
Console.WriteLine(
    "| Number | Round | Floor | Ceiling | Truncate | Format |");
foreach (var x in new[] { -2.9, -0.5, 0.3, 1.5, 2.5, 2.9 })
{
    Console.WriteLine(string.Format(CultureInfo.InvariantCulture,
        "| {0,6} | {1,5} | {2,5} | {3,7} | {4,8} | {0,6:N0} |",
        x, Math.Round(x), Math.Floor(x),
        Math.Ceiling(x), Math.Truncate(x)));
}
```

[Solution](#)

2. What will the following code display?

```
Action<int,int> print = (a, b) =>
    Console.WriteLine("{0,2} = {1,2} * {2,3} + {3,3} ",
        a, b, a/b, a%b);
Console.WriteLine(" a = b * (a/b) + (a%b)");
print(7, 3);
print(7, -3);
print(-7, 3);
print(-7, -3);
```

[Solution](#)

3. What will the following code display?

```
Console.WriteLine("0.1 + 0.2 {0} 0.3",  
    0.1 + 0.2 == 0.3 ? "==" : "!=");
```

[Solution](#)

4. What will the following code display?

```
var zero = 0;  
try  
{  
    Console.WriteLine(42 / 0.0);  
    Console.WriteLine(42.0 / 0);  
    Console.WriteLine(42 / zero);  
}  
catch (DivideByZeroException)  
{  
    Console.WriteLine("DivideByZeroException");  
}
```

[Solution](#)

5. What will the following code display?

```
var maxInt32 = Int32.MaxValue;
var maxDouble = Double.MaxValue;
var maxDecimal = Decimal.MaxValue;
checked
{
    Console.Write("Checked Int32 increased max: ");
    try { Console.WriteLine(maxInt32 + 42); }
    catch { Console.WriteLine("OverflowException"); }
    Console.Write("Checked Double increased max: ");
    try { Console.WriteLine(maxDouble + 42); }
    catch { Console.WriteLine("OverflowException"); }
    Console.Write("Checked Decimal increased max: ");
    try { Console.WriteLine(maxDecimal + 42); }
    catch { Console.WriteLine("OverflowException"); }
}
unchecked
{
    Console.Write("Unchecked Int32 increased max: ");
    try { Console.WriteLine(maxInt32 + 42); }
    catch { Console.WriteLine("OverflowException"); }
    Console.Write("Unchecked Double increased max: ");
    try { Console.WriteLine(maxDouble + 42); }
    catch { Console.WriteLine("OverflowException"); }
    Console.Write("Unchecked Decimal increased max: ");
    try { Console.WriteLine(maxDecimal + 42); }
    catch { Console.WriteLine("OverflowException"); }
}
```

Solution

6. What will the following code display?

```
int a = 0;
int Foo()
{
    a = a + 42;
    return 1;
}
void Main()
{
    a += Foo();
    Console.WriteLine(a);
}
```

Solution

4 Value types (Problems)

1. What will the following code display?

```
struct Foo
{
    int value;
    public override string ToString()
    {
        if (value == 2)
            return "Baz";
        return (value++ == 0) ? "Foo" : "Bar";
    }
}

void Main()
{
    var foo = new Foo();
    Console.WriteLine(foo);
    Console.WriteLine(foo);
    object bar = foo;
    object qux = foo;
    object baz = bar;
    Console.WriteLine(baz);
    Console.WriteLine(bar);
    Console.WriteLine(baz);
    Console.WriteLine(qux);
}
```

[Solution](#)

2. What will the following code display?

```
public struct Foo
{
    public int Value;
    public void Change(int newValue)
    {
        Value = newValue;
    }
}
public class Bar
{
    public Foo Foo { get; set; }
}
void Main()
{
    var bar = new Bar { Foo = new Foo() };
    bar.Foo.Change(5);
    Console.WriteLine(bar.Foo.Value);
}
```

[Solution](#)

3. What will the following code display?

```
var x = new
{
    Items = new List<int> { 1, 2, 3 }.GetEnumerator()
};
while (x.Items.MoveNext())
    Console.WriteLine(x.Items.Current);
```

[Solution](#)

4. What will the following code display?

```
public struct Foo
{
    public byte Byte1;
    public int Int1;
}
public struct Bar
{
    public byte Byte1;
    public byte Byte2;
    public byte Byte3;
    public byte Byte4;
    public int Int1;
}
void Main()
{
    Console.WriteLine(Marshal.SizeOf(typeof(Foo)));
    Console.WriteLine(Marshal.SizeOf(typeof(Bar)));
}
```

[Solution](#)

5 Strings (Problems)

1. What will the following code display?

```
Console.WriteLine(1 + 2 + "A");
Console.WriteLine(1 + "A" + 2);
Console.WriteLine("A" + 1 + 2);
```

[Solution](#)

2. What will the following code display?

```
Console.WriteLine(1 + 2 + 'A');
Console.WriteLine(1 + 'A' + 2);
Console.WriteLine('A' + 1 + 2);
```

[Solution](#)

3. Are the following methods of comparison term `a` and `b` insensitive equivalent:

```
Console.WriteLine(  
    string.Compare(a.ToUpper(), b.ToUpper()));  
Console.WriteLine(  
    string.Compare(a, b, StringComparison.OrdinalIgnoreCase));
```

Solution

4. Please, append the following code so that it displays the console output contained the string `Foo`, without redefining the standard method `Console.WriteLine`?

```
// ???  
Console.WriteLine(-42);
```

Solution

5. Look to the following code:

```
Thread.CurrentThread.CurrentUICulture =  
    CultureInfo.CreateSpecificCulture("ru-RU");  
Thread.CurrentThread.CurrentCulture =  
    CultureInfo.CreateSpecificCulture("en-US");  
var dateTime = new DateTime(2014, 12, 31, 13, 1, 2);  
Console.WriteLine(dateTime);
```

Which locale will be choose for date formatting?

Solution

6. Can the two lines coincide by the `String.CompareTo` method, but differ by the `String.Equals` method? How to contact them the `==`?

Solution

7. Please, append the following code so that it displays the console output the `aaaaa` string, without redefining the standard method `Console.WriteLine`?

```
// ???  
Console.WriteLine("Hello");
```

Solution

8. What will the following code display?

```
var x = "AB";
var y = new StringBuilder().Append('A').Append('B').ToString();
var z = string.Intern(y);
Console.WriteLine(x == y);
Console.WriteLine(x == z);
Console.WriteLine((object)x == (object)y);
Console.WriteLine((object)x == (object)z);
```

[Solution](#)

9. Look to the following code:

```
[assembly: CompilationRelaxationsAttribute
(CompilationRelaxations.NoStringInterning)]
```

Does it mean, that the literal string in this assembly now will be interned?

[Solution](#)

10. If the mechanism of internment lines under this version of the CLR is disabled and in a literal line of code "Hello" occurs twice, how many times it will occur in the assembly metadata?

[Solution](#)

11. Keep in regular strings secret data (such as a password) is a bad way, since string is stored in memory in the clear, hackers can easily get to it. What are the standard tools to protect data?

[Solution](#)

12. Suppose we have an array of different strings. Can the sorting method from time to time give different results?

[Solution](#)

13. Will be copying the character array when calling `StringBuilder.ToString ()`?

```
var builder = new StringBuilder(10);
for (int i = 0; i < 10; i++)
    builder.Append('a');
var str = builder.ToString();
```

[Solution](#)

14. Let's say we have a `StringBuilder`, keeping the strings of the three characters. Is a scenario in which the replacement of the first character produces memory allocation for the new character array?

[Solution](#)

15. Can the number of text elements (which can be accessed via `TextElementEnumerator`) of string differ from the number of char-forming her character?

[Solution](#)

16. How to include a literal string character backslash without an escape sequence?

[Solution](#)

Solutions

6 OOP (Solutions)

1. [Problem “Oop-Overloading1”](#)

```
params object[]  
params object[]  
params T[]  
params T[]  
object, object
```

2. [Problem “Oop-Overloading2”](#)

```
Bar.Quux(object)  
Baz.Quux(params T[])
```

3. [Problem “Oop-Overloading3”](#)

```
Bar.Quux(),  
Bar.Quux(params object[])  
Bar.Quux(), Baz
```

4. [Problem “Oop-InheritanceNestedClass”](#)

```
Foo.Quux()
```

7 LINQ (Solutions)

1. [Problem “Linq-EnumerableToArray”](#)

```
GetString: Foo
EnumerableToArray: Foo
GetString: Bar
EnumerableToArray: Bar
GetString: Foo
GetString: Bar
```

LINQ queries use deferred/lazy execution. It means, a LINQ query without a cast method like [ToArray\(\)](#) or [ToList\(\)](#) is not executed immediately. The execution will be deferred until we do not explicitly require the results. Thus, the line

```
var strings = GetStringEnumerable();
```

will not print anything to the console. Next, in the loop

```
foreach (var s in strings)
    Console.WriteLine("EnumerableToArray: " + s);
```

query execution will be performed. Moreover, first will be evaluated the first [yield](#) (print `GetString: Foo`), next the loop body will be evaluated for the first enumerable element (print `EnumerableToArray: Foo`). Next, the [foreach](#) loop will require the second enumerable element, the second [yield](#) will be evaluated (print `GetString: Bar`), the loop body will be evaluated for the second element (print `EnumerableToArray: Bar`).

Next, the following line will be executed:

```
return strings.ToArray();
```

Our LINQ query will be performed again. So, the lines `GetString: Foo` and `GetString: Bar` will be printed again.

2. [Problem “Linq-LifeAfterYield”](#)

```
1Foo
```

3. [Problem “Linq-Closure”](#)

C# 1.0 — C# 4.0: 3 3 3 C# 5.0+: 1 2 3

4. [Problem “Linq-QueryAfterRemove”](#)

```
0
```

5. [Problem “Linq-ClouseAndVariable”](#)

2

6. [Problem “Linq-QueryWithInc”](#)

```
Inc: 0
Inc: 1
Number: 2
Inc: 2
Inc: 3
Number: 4
```

7. [Problem “Linq-YieldExceptionYield”](#)

Exception is not going to happen

8. [Problem “Linq-ExceptionYieldYield”](#)

Call of `evenNumbers.FirstOrDefault()`.

8 Mathematics (Solutions)

1. [Problem “Math-Rounding1”](#)

Number	Round	Floor	Ceiling	Truncate	Format
-2.9	-3	-3	-2	-2	-3
-0.5	0	-1	0	0	-1
0.3	0	0	1	0	0
1.5	2	1	2	1	2
2.5	2	2	3	2	3
2.9	3	2	3	2	3

If the number is exactly halfway between two possibilities, the following rules will work:

`Math.Round` rounds to the nearest even integer (by default).

`Math.Floor` rounds down towards the negative infinity.

`Math.Ceiling` rounds up towards the positive infinity.

`Math.Truncate` rounds down or up towards zero.

`String.Format` rounds towards the number away from zero (see also [Standard Numeric Format Strings](#), [Custom Numeric Format Strings](#)).

2. [Problem “Math-Rounding2”](#)

```
a = b * (a/b) + (a%b)
7 = 3 * 2 + 1
7 = -3 * -2 + 1
-7 = 3 * -2 + -1
-7 = -3 * 2 + -1
```

3. [Problem “Math-Eps”](#)

““ 0.1 + 0.2 != 0.3

4. [Problem “Math-DivideByZero”](#)

```
Infinity
Infinity
DivideByZeroException
```

5. [Problem “Math-Overflow”](#)

```
Checked Int32 increased max: OverflowException
Checked Double increased max: 1,79769313486232E+308
Checked Decimal increased max: OverflowException
Unchecked Int32 increased max: -2147483607
Unchecked Double increased max: 1,79769313486232E+308
Unchecked Decimal increased max: OverflowException
```

6. [Problem “Math-AugmentedAssignment”](#)

```
1
```

The construction

```
a += Foo();
```

will be transformed to

```
a = a + Foo();
```

9 Value types (Solutions)

1. [Problem “ValueTypes-Boxing”](#)

```
Foo
Foo
Foo
Bar
Baz
Foo
```

2. [Problem “ValueTypes-MutableProperty”](#)

```
0
```

3. [Problem “ValueTypes-Enumerator”](#)
Loop hangs, zeros will be displayed.
4. [Problem “ValueTypestructLayout”](#)

```
8
8
```

10 Strings (Solutions)

1. [Problem “StringslusString”](#)

```
3A
1A2
A12
```

2. [Problem “StringslusChar”](#)

```
68
68
68
```

3. [Problem “Strings-CaseInComparison”](#)

No, it depends from current `CultureInfo`. An example:

```
var a = "i";
var b = "I";
Thread.CurrentThread.CurrentCulture =
    CultureInfo.CreateSpecificCulture("tr-TR");
Console.WriteLine(
    string.Compare(a.ToUpper(), b)); // '1'
Console.WriteLine(
    string.Compare(a, b, StringComparison.OrdinalIgnoreCase)); // '0'
```

See [The Turkey Test](#).

4. [Problem “Strings-CorruptedNumber”](#)

You can use custom `CultureInfo`:

```
var culture = (CultureInfo) CultureInfo.InvariantCulture.Clone();
culture.NumberFormat.NegativeSign = "Foo";
Thread.CurrentThread.CurrentCulture = culture;
Console.WriteLine(-42); // Displays "Foo42"
```

5. [Problem “Strings-CurrentCulture”](#)

.NET Runtime will be use `CurrentCulture`. Thus, the `en-US` locale will be used:

```
12/31/2014 1:01:02 PM
```

The result in the `ru-RU` locale:

```
31.12.2014 13:01:02
```

6. [Problem “Strings-CompareToVsEquals”](#)

Yes because of `CompareTo` executes according to `CultureInfo`, `Equals` — without.

An example: the string `"ß"` (`Eszett`, 00df) and `"ss"` will be equal by `CompareTo` in German `CultureInfo`.

The `==` operator works like the `String.Equals` method.

7. [Problem “Strings-CorruptedString”](#)

You can use the internment mechanism:

```
var s = "Hello";
string.Intern(s);
unsafe
{
    fixed (char* c = s)
        for (int i = 0; i < s.Length; i++)
            c[i] = 'a';
}
Console.WriteLine("Hello"); // Displays: "aaaaa"
```

8. [Problem “Strings-ExplicitlyInternment”](#)

```
True
True
False
True
```

9. [Problem “Strings-NoStringInterning”](#)

No, see [documentation](#).

10. [Problem “Strings-InternmentAndMetadata”](#)

One time.

11. [Problem “Stringsecure”](#)

You should use `SecureString`.

12. [Problem “StringstableSorting”](#)

Yes, the standard sorting .NET is unstable, which means that if we, say, sort rows insensitive, the strings " AAA " and " aaa " can accommodate in any order.

13. [Problem “StringstringBuilderToString”](#)

CLR 2.0: No, the new string will refer to the same character array as the original `StringBuilder`.

CLR 4.0: Yes, in this version of the platform array is always copied.

14. [Problem “StringstringBuilderMemory”](#)

Yes, if we use the `StringBuilder.ToString()` method and the CLR version less 4.0.

15. [Problem “Strings-TextElementEnumerator”](#)

Yes, because FCL supports encoding using more than 16 bits: one text element can be determined by several `char`-symbols.

16. [Problem “Strings-VerbatimString”](#)

You should use verbatim string: `@\"`.

Bibliography

Some useful books about .NET:

1. [Standard ECMA-335: Common Language Infrastructure \(CLI\)](#)
2. [Standard ECMA-334: C# Language Specification](#)
3. [«CLR via C#»](#) by Jeffrey Richter
4. [«C# in Depth»](#) by Jon Skeet
5. [«Pro C# 2010 and the .NET 4 Platform»](#) by Andrew Troelsen
6. [«C# 4.0: The Complete Reference»](#) by Herbert Schildt
7. [«C# Unleashed»](#) by Joseph Mayo
8. [«Essential C# 5.0»](#) by Mark Michaelis, Eric Lippert
9. [«Pro .Net Performance»](#) by Sasha Goldshtein, Dima Zurbalev, Ido Flatow
10. [«Under the Hood of .NET Memory Management»](#) by Chris Farrell, Nick Harrison
11. [«Effective C#: 50 Specific Ways to Improve Your C#»](#) by Bill Wagner
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13. [«Advanced .NET Debugging»](#) by Mario Hewardt, Patrick Dessud
14. [«Essential .Net Volume 1: The Common Language Runtime»](#) by Don Box