Module 2

Types basics

Value vs reference type

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- this IS NOT true
- this IS NOT even a good simplification
- this IS an implementation detail:
  - stack vs heap - describes the concept from **the implementation** point of view
  - does NOT explain the true difference behind those two categories

    (although it may be useful in memory-aware code, as we will see...)

"value types are allocated on the stack and reference types are allocated on the heap"

Value type vs reference type

ECMA-335:

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- *"type, reference: A type such that an instance of it **contains a reference to its data**."* (...) *"A value described by a reference type **denotes the location of another value**."*

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- *"type, reference: A type such that an instance of it **contains a reference to its data**."* (...) *"A value described by a reference type **denotes the location of another value**."*

So, we can say the true difference is the instance "shape" and bahaviour:

	Shape	Sharing	Lifetime	Identity
Value type	Only data	Pass-by-value - cannot be shared (we can only send **a copy** of it*)	As long as the instance itself	Does not have (instances are equal if all bits are equal**)
Reference type	Reference and data	Pass-by-reference - can be shared (many references to the same data)	Needs to be discovered (multiple instances to shared data)	Location-based (the same if and only if their locations are the same**)

* although you can use so-called *managed pointer* to pass a pointer to it, ** although you can override it in user-defined types

Value type vs reference type

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A(x)
{
    var y = x;
    return y;
}
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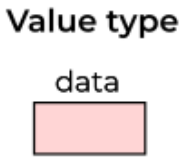

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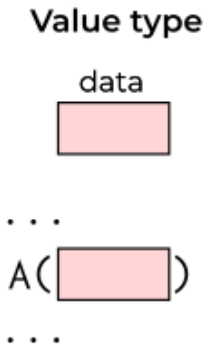

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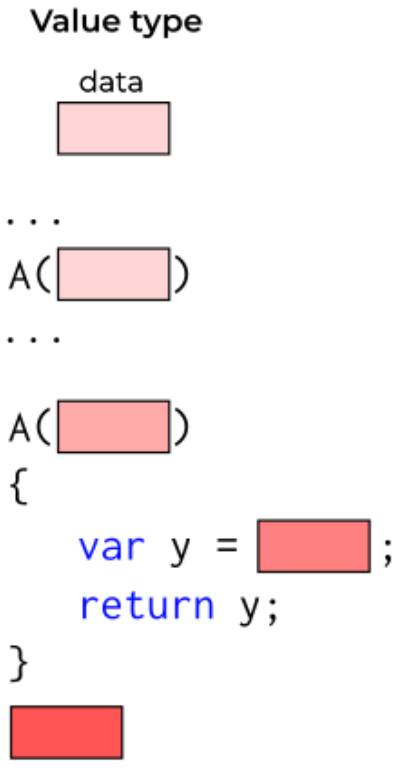

pass-by-value semantics

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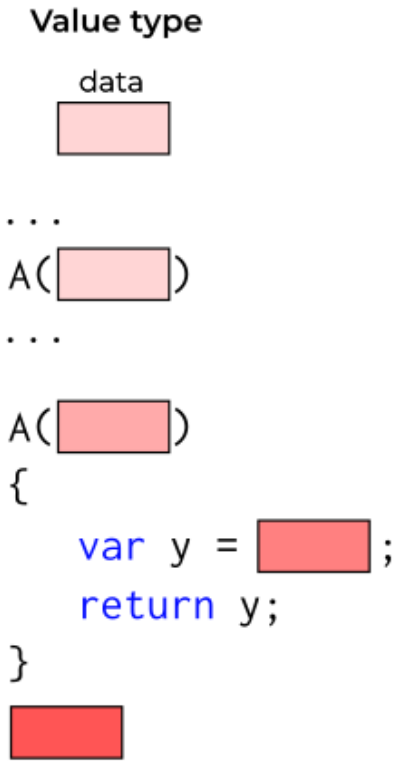

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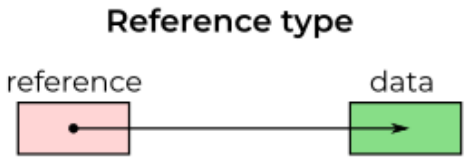

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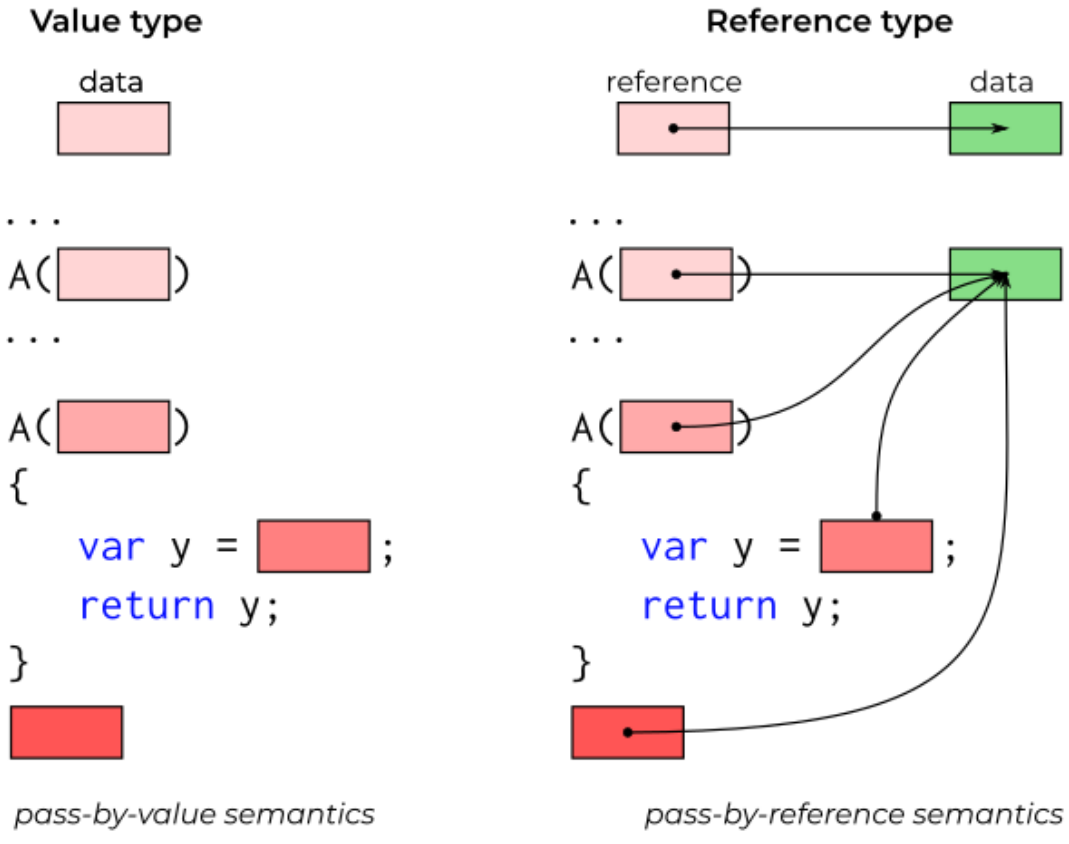

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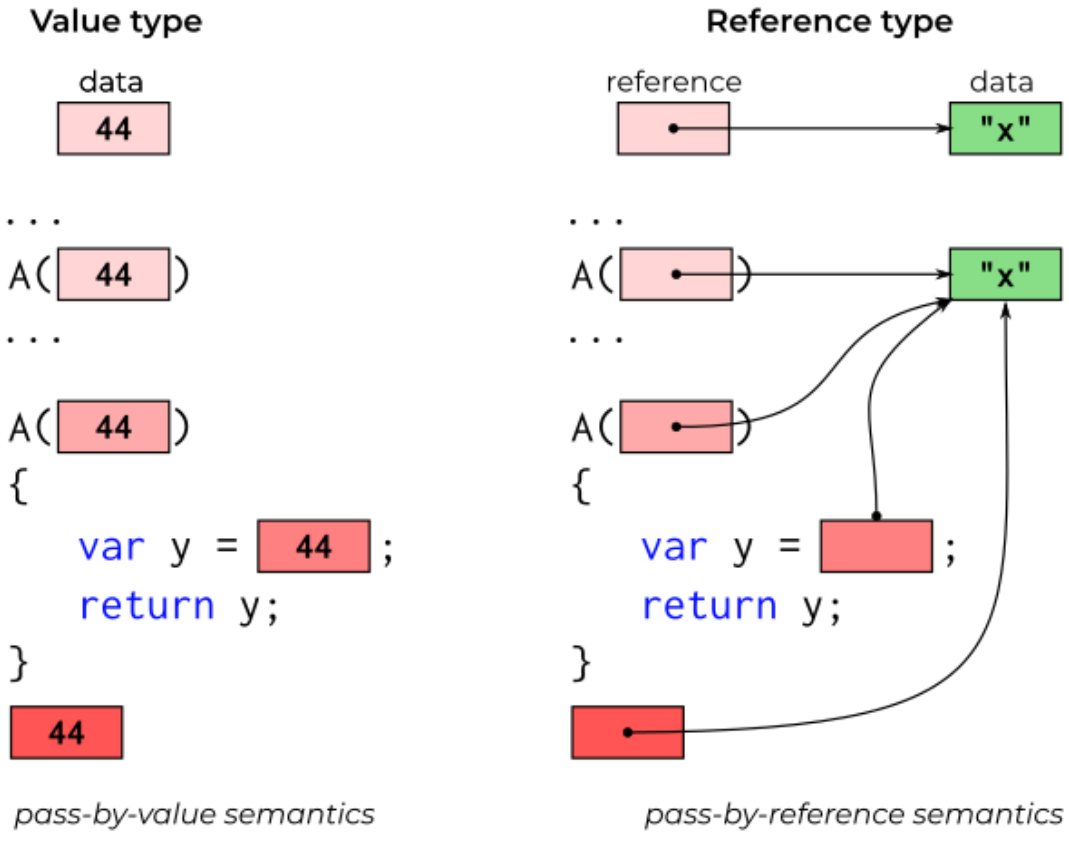

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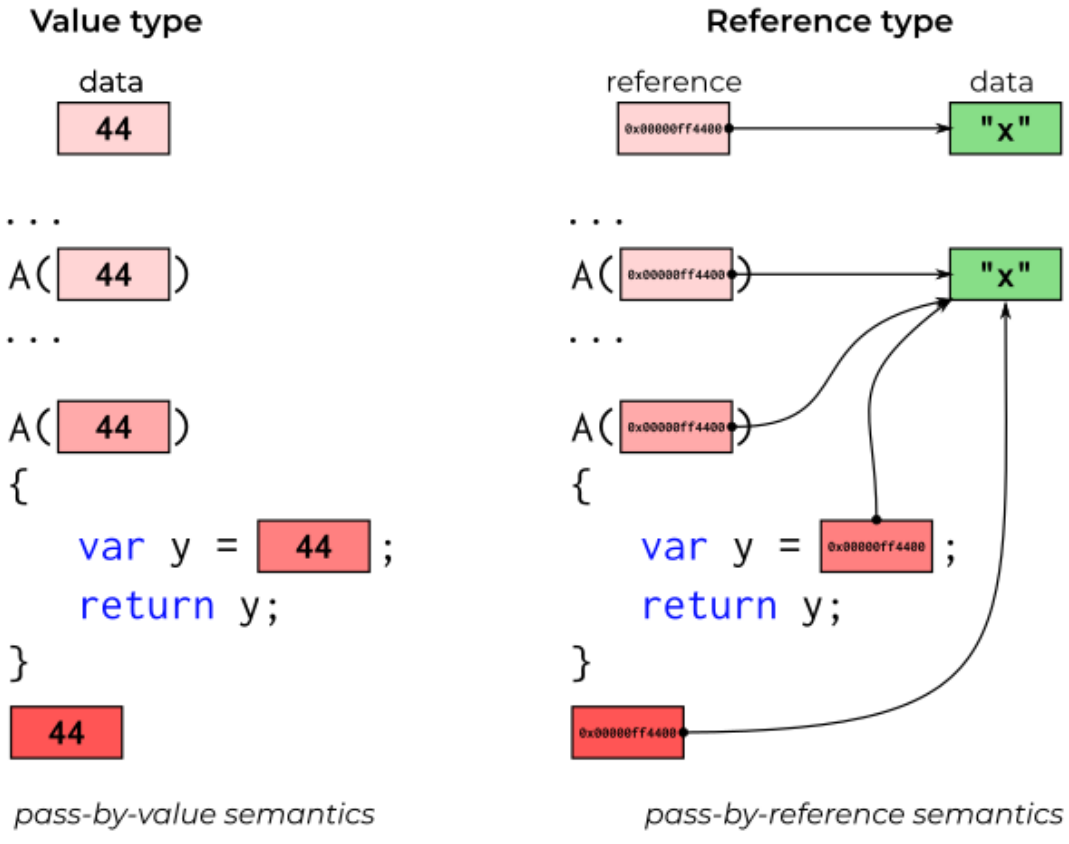

Value type vs reference type

structs are value types (having *pass-by-value* semantics):

```
var x = new SomeStruct() { Field = 44 };
C.M(x);
Console.WriteLine(x.Field);

static public SomeStruct M(SomeStruct s)
{
    s.Field++;
    return s;
}

public struct SomeStruct
{
    public int Field;
}
```

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What is the result?!

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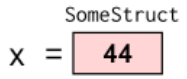

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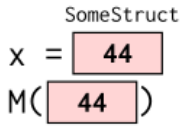

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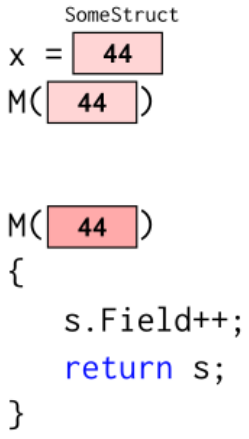

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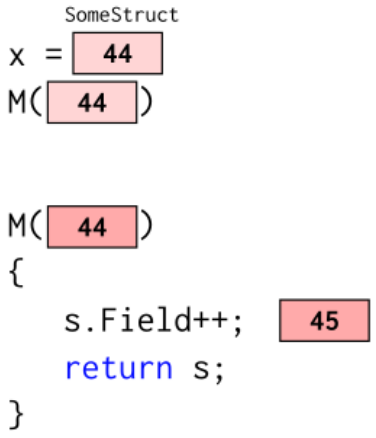

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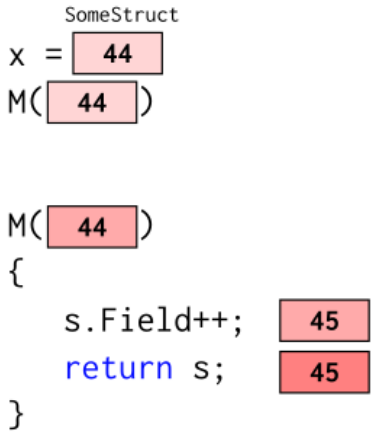

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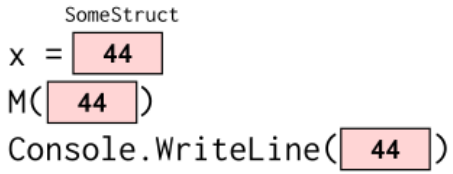

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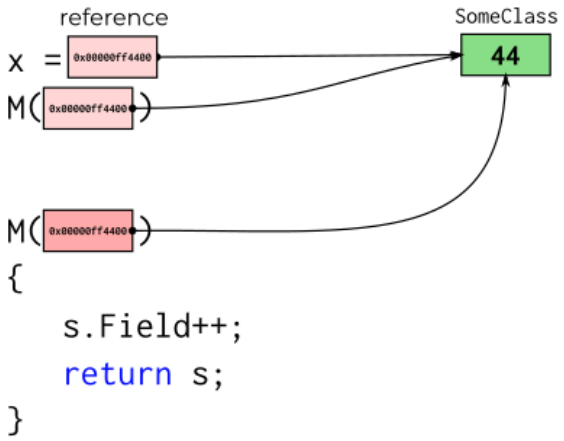

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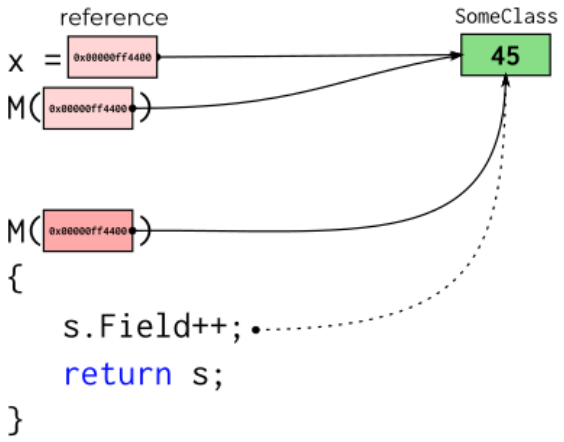

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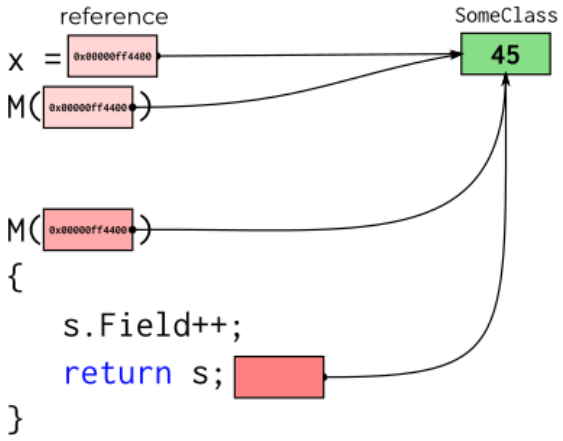

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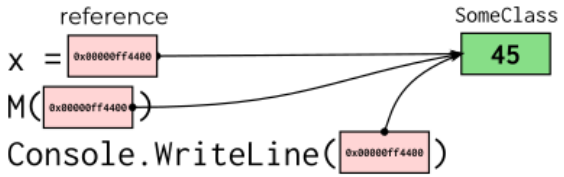

Value type vs reference type

Value types:

- built-in types: **`bool`**, **`char`**, **`float`**, **`double`**, **`int`** variations
- enums
- user-defined **`struct`**

Reference types:

- user-defined **`class`**
- built-in types: **`string`**, **`object`**, arrays
- boxed types
- delegates
- interface type
- pointer type

Value type vs reference type

```
public struct SomeStruct
{
    public int Value1;
    public int Value2;
    public int Value3;
    public int Value4;
}
```

Value1	Value2	Value3	Value4
4B	4B	4B	4B

- only fields, no additional data (*"The values described by a value type are **self-contained**"*)
- automatic layout*

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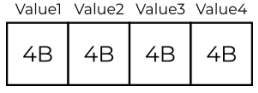

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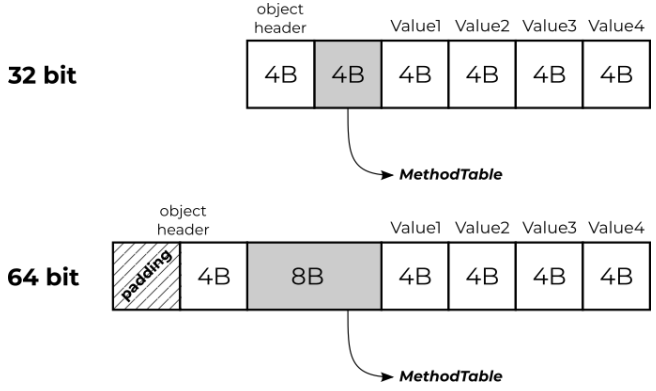

- object header
- ***MethodTable*** pointer to the type description
- fields with automatic layout*

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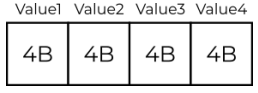

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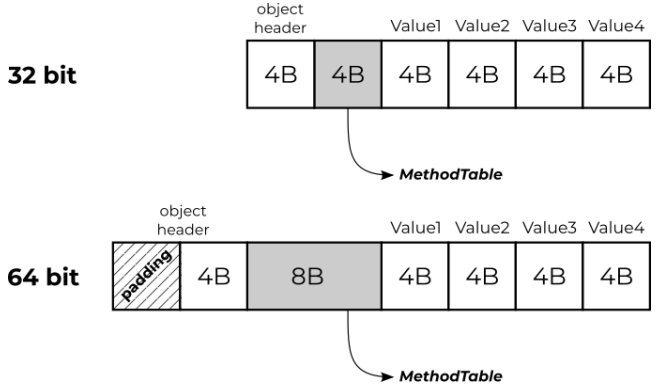

- object header
- ***MethodTable*** pointer to the type description
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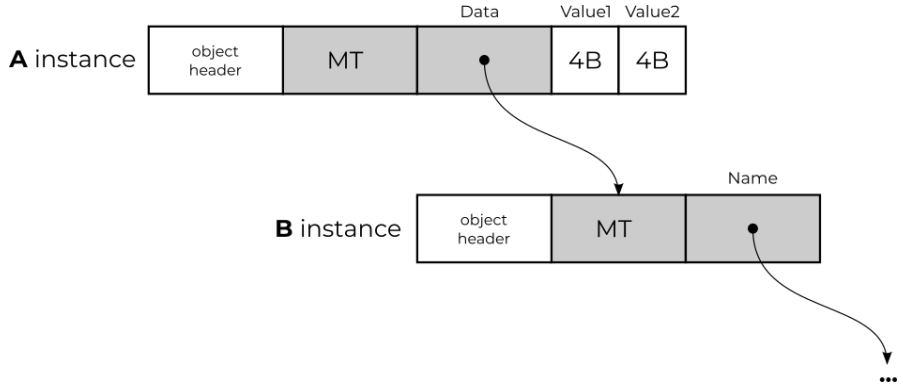
* we will cover controlling layout by the end of the course

Reference types

```
class A
{
  public B Data;
  public int Value1;
  public int Value2;
}

class B
{
  public string Name;
}
```

References (values of reference types) point to the ***MethodTable***:



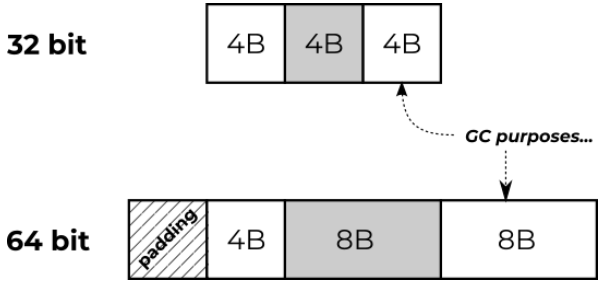
References may have also **`null`** value - we'll explain it in one of the next lessons.

Minimum object size

```
struct S
{
}
```

Is *one byte*. Period.

```
class C
{
}
```



Is:

- 12 bytes on 32-bit runtime
- 24 bytes on 64-bit runtime

Maximum object size

- in general - **2 GB**. Period.

Maximum object size

- in general - **2 GB**. Period.
- but... since .NET 4.5 - `<gcAllowVeryLargeObjects>` flag for 64-bit runtime
  - size fitting 64-bit signed long value - huuuge,
  - but... the maximum number of elements in an array is `UInt32.MaxValue` (4,294,967,295)
  - the maximum size for strings and other non-array objects is unchanged.

DEMO