

# Object-oriented programming

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## Week 4 – Operator overloading

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# What will be discussed?

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- What is function overloading?
- Operator overloading
- Overloading `cin` and `cout`

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# Overloading

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- ❑ There are many different “definitions” for the same name
- ❑ In C++, overloading functions are differentiated by their signatures (i.e. number/types of arguments)
- ❑ **Note:** the return type is not considered in differentiating overloading functions.

# Operator Overloading

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- ❑ To define operator implementations for our new user-defined types
- ❑ For example, operators such as  $+$ ,  $-$ ,  $*$ ,  $/$  are already defined for built-in types
- ❑ When we have a new data type, e.g. **Fraction**, we need to define new operator implementations to work with it.

# Operators can be overloaded

+	-	*	/	%	^	&
	~	!	=	<	>	+=
--	*=	/=	%=	^=	&=	=
<<	>>	>>=	<<=	==	!=	<=
>=	&&		++	--	->*	,
->	[]	()	new	new[]	delete	delete[ ]

- Operator `::` or `.` or `.*` cannot be defined by users.
- Operators `sizeof`, `typeid`, `?:` cannot be overloaded.
- Operators `=`, `->`, `[]`, `()` can only be overloaded by non-static functions

# Overloading guidelines

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- ❑ Do what users expect for that operator.
- ❑ Define them if they make logical sense.  
E.g. subtraction of dates are ok but not multiplication or division
- ❑ Provide a complete set of properly related operators:  $a = a + b$  and  $a += b$  have the same effect

# Syntax

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- ❑ Declared & defined like other methods, except that the keyword *operator* is used.

<returned-type> **operator**<op> (arguments)

Example:

```
bool FullName::operator==(const FullName& rhs)
{
    return ((sFirstName==rhs.sFirstFName) &&
            (sSurname==rhs.sSurName));
}
```

# Operators in use

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```
int main()
{
    FullName s1, s2;
    if (s1 == s2) //s1.operator==(s2)
    {
        ...
    }
    ...
}
```

# Exercise

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□ Implement a **Fraction** class with basic arithmetic operators:  $+$ ,  $-$ ,  $*$ ,  $/$

□ Remember to handle:

```
Fraction x, y;
```

```
y = x + 5;
```

```
y = 5 + x;
```

□ Implement prefix and postfix increment:

$x++$  and  $++x$ . Hint: using dummy `int`

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# The keyword: **friend**

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- ❑ With the keyword **friend**, you grant access to other functions or classes
- ❑ Friend functions give a flexibility to the class. It doesn't violate the encapsulation of the class.
- ❑ Friendship is “directional”. It means if class A considers class B as its friend, it doesn't mean that class B considers A as a friend.

# Example

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```
class Date
{
    public:
        ...
        friend void doSomething();
    private:
        int iDay, iMonth, iYear;
}
```

- ❑ In `doSomething()`, we can have access to private data members of the class `Date`

# Friend functions

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- ❑ Friend functions is called like  $f(x)$  while member functions is called  $x.f()$
- ❑ Use member functions if you can. Only choose friend functions when you have to.
- ❑ Sometimes, friend functions are good:
  - Binary infix arithmetic operators, e.g.  $+$ ,  $-$
  - Cannot modify original class, e.g. `ostream`

# Member and non-member functions

```
int main()
{
    FullName s1, s2;
    if (s1 == s2)
        // member: s1.operator==(s2)
        // or non-member: operator==(s1, s2)
        {
            ...
        }
    ...
}
```

# Overloading `cin` and `cout`

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- ❑ We do not have access to the *istream* or *ostream* code → cannot overload `<<` or `>>` as member functions
- ❑ They cannot be members of the user-defined class because the first parameter must be an object of that type
- ❑ Operators `<<` and `>>` must be non-members, but it needs to access to private data members → make them friend functions

# Typical syntax

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- The general syntax for insertion and extraction operator overloadings:

```
ostream& operator<<(ostream& out, const Fraction& x)
{
    out << x.numerator << " / " << x.denominator;
    return out;
}
```

```
istream& operator>>(istream& in, Fraction& x);
```

# Exercises

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- Implement insertion and extraction operators for **Fraction** and **Date** class

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# Final notes about Op overloading

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- Subscript operators often come in pair

```
const A& operator[] (int index) const;  
A& operator[] (int index);
```

- Maintain the usual identities for  $x == y$  and  $x != y$
- Prefix/Postfix operators for  $++$  and  $--$ 
  - Prefix returns a reference
  - Postfix return a copy