

# Programming Languages: Encapsulation

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# Encapsulation

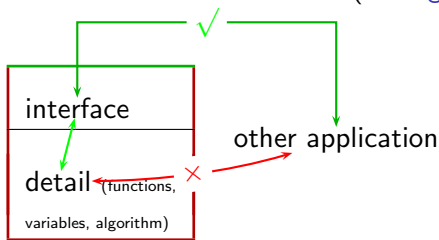
Managing the complexity → Re-usable code and abstraction.

Example:

50 lines	no abstraction is essential, all in main()
500 lines	function/procedure abstraction sufficient
5,000 lines	function groups forming modules, modules are combined to form the application
500,000 lines	heavy abstraction and modularization, all parts designed for reuse (libraries, components etc)

# Modularization and Encapsulation

- Building an independent and self complete set of function and variable declarations (**Packaging**)
- Restricting access to this set only via a set of interface function and variables. (**Hiding and Encapsulation**)



# Advantages of Encapsulation

- High volume details reduced to interface definitions ([Ease of development/maintenance](#))
- Many different applications use the same module via the same interface ([Code re-usability](#))
- Lego like development of code with building blocks ([Ease of development/maintenance](#))
- Even details change, applications do not change (as long as interface is kept same) ([Ease of development/maintenance](#))
- Module can be used in following projects ([Code re-usability](#))

- A group of declarations put into a single body.
- C has indirect way of packaging per source file.
- C++

```
namespace Trig {  
    const double pi=3.14159265358979;  
    double sin(double x) { ... }  
    double cos(double x) { ... }  
    double tan(double x) { ... }  
    double atan(double x) { ... }  
    ...  
};
```

- `Trig::sin(Trig::pi/2+x)+Trig::cos(x)`
- C++: (`::`) Scope operator.
- Identifier overlap is avoided. `List::insert(...)` ve `Tree::insert(...)` no name collisions.

# Hiding

- A group of functions and variables hidden inside. The others are interface. Abstraction inside of a package:

```
double taylorseries(double);  
double sin(double x);  
double pi=3.14159265358979;  
double randomseed;  
double cos(double x);  
double errorcorrect(double x);
```

```
{-- only sin, pi and cos are accessible --}  
module Trig(sin,pi,cos) where  
  taylorseries x = ...  
  sin x = ...  
  pi=3.14159265358979  
  randomseed= ...  
  cos x = ...  
  errorcorrect x = ...
```

# Abstract data types

- Internals of the datatype is hidden and only interface functions provide the access.
- Example: rational numbers:  $3/4$ ,  $2/5$ ,  $19/3$   
data Rational = Rat (Integer,Integer)  
x = Rat (3,4)  
add (Rat(a,b)) (Rat(c,d)) = Rat (a\*d+b\*c,b\*d)
  - 1 Invalid value? Rat (3,0)
  - 2 Multiple representations of the same value?  
Rat (2,4) = Rat (1,2) = Rat(3,6)
- Solution: avoid arbitrary values by the user.



Main purpose of abstract data types is to use them transparently (as if they were built-in) without losing **data integrity**.

```

module Rational(Rational, rat, add, subtract, multiply, divide) where
  data Rational = Rat (Integer, Integer)
  rat (x,y) = simplify (Rat(x,y))
  add (Rat(a,b)) (Rat(c,d)) = rat (a*d+b*c, b*d)
  subtract(Rat(a,b)) (Rat(c,d)) = rat (a*d-b*c, b*d)
  multiply(Rat(a,b)) (Rat(c,d)) = rat (a*c, b*d)
  divide (Rat(a,b)) (Rat(c,d)) = rat (a*d, b*c)
  gcd x y = if (x==0) then y
            else if (y==0) then x
            else if (x<y) then gcd x (y-x)
            else gcd y (x-y)
  simplify (Rat(x,y)) = if y==0 then Rat(div x y, 1)
                        else let a=gcd x y
                              in Rat(div x a, div y a)

```

Initial value? We need **constructor** function/values. (remember we don't have the data definition)

rat (x,y) instead of Rat (x,y)

# Object

- Packages containing hidden variables and access is restricted to interface functions.
- Variables with state
- Data integrity and abstraction provided by the interface functions.
- Entities in software can be modelled in terms of functions (server, customer record, document content, etc). Object oriented design.
- Example (invalid syntax! imaginary C++)

```
namespace Counter {  
private:    int counter=0;  
public:    int get() { return counter;}  
public:    void increment() { counter++; }  
};  
Counter::get()           Counter::increment()
```

# Class

- The set of same typed objects form a **class**
- An object is an **instance** of the class that it belongs to (a counter type instead of a single counter)
- Classes have similar purposes to abstract data types
- Some languages allows both objects and classes
- C++ class declaration (valid syntax):

```
class Counter {  
private:    int counter;  
public:    Counter() { counter=0; }  
           int get() { return counter;}  
           void increment() { counter++; }  
} men, vehicles;  
men.increment(); vehicles.increment();  
men.get(); vehicles.get();
```

## Abstract data type

**interface** (constructor, functions)

**detail** (data type definition, auxiliary functions)

## Object

**interface** (constructor, functions)

**detail** (variables, auxiliary functions)

## Purpose

- preserving data integrity,
- abstraction,
- re-usable codes.

## Further Re-usability

- Class relations. Extending one class definition to create more specific class definitions.
- Classes containing other classes
- Classes derived from other classes: [inheritance](#)
- Abstract classes and [interfaces](#)
- Polymorphism
- [Design patterns](#): standard object oriented designs applicable to a family of similar software problems. Not included in this course.