

Derived Types and Modules in Fortran

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Types

Structures: type

- Fortran has structures too.
- Structures are a derived type: you can create variables of that type, but it's not a built-in type.
- Fortran derived types are declared in a type definition;
- the type keyword is also used for making structure variables.

Type declaration

Type name / End Type block.

Component declarations inside the block:

```
type mytype  
  integer :: number  
  character :: name  
  real(4) :: value  
end type mytype
```

Creating a type structure

Declare a type object in the main program:

```
Type(mytype) :: object1,object2
```

Initialize with type name:

```
object1 = mytype( 1, 'my_name', 3.7 )
```

Copying:

```
object2 = object1
```

Member access

Access structure members with %

```
Type(mytype) :: typed_object  
typed_object%member = ....
```

Example

```
type point  
  real :: x,y  
end type point
```

```
type(point) :: p1,p2  
p1 = point(2.5, 3.7)  
  
p2 = p1  
print *,p2%x,p2%y
```

Type definitions can go in the main program
(or use a module; see later)

Structures as subprogram argument

Structures can be passed as subprogram argument, just like any other datatype. This example:

- Takes a structure of `type(point)` as argument; and
- returns a `real(4)` result.
- The structure is declared as `intent(in)`.

Function with structure
argument:

```
real(4) function length(p)
  implicit none
  type(point), intent(in) :: p
  length = sqrt( p%x**2 + p%y )
end function length
```

Function call

```
print *, "Length:", length(p2)
```


Exercise 1

Write a program that has the following:

- A type `Point` that contains real numbers `x,y`;
- a type `Rectangle` that contains two `Points`, corresponding to the lower left and upper right point;
- a function `area` that has one argument: a `Rectangle`.

Test your program.

Modules

Module definition

Modules look like a program, but without executable code:

```
Module definitions
  type point
    real :: x,y
  end type point
contains
  real(4) function length(p)
    implicit none
    type(point),intent(in) :: p
    length = sqrt( p%x**2 + p%y**2 )
  end function length
end Module definitions
```

Module use

Module imported through use statement;
comes before implicit none

Code:

Program size

```
use definitions
implicit none
```

```
type(point) :: p1,p2
p1 = point(2.5, 3.7)
```

```
p2 = p1
print *,p2%x,p2%
print *, "length:", length(p2)
```

end Program size

Output

[structf] typemod:

```
gfortran -g -c typemod.F90 \
        -O2 \
        -o typemod.o
typemod.F90:34:18:
```

```
print *,p2%x,p2%
                        1
```

Error: Expected structure component
make[2]: *** [typemod.o] Error 1

Exercise 2

Take exercise 1 and put all type definitions and all functions in a module.

Separate compilation of modules

Suppose program is split over two files:

`theprogram.F90` and `themodule.F90`.

- Compile the module: `ifort -c themodule.F90`; this gives
- an object file (extension: `.o`) that will be linked later, and
- a module file `modulename.mod`.
- Compile the main program:
`ifort -c theprogram.F90` will read the `.mod` file; and finally
- Link the object files into an executable:
`ifort -o myprogram theprogram.o themodule.o`
The compiler is used as linker: there is no compiling in this step.

Important: the module needs to be compiled before any (sub)program that uses it.