Modules in Fortran: Types, Functions and Subroutines

Project Details

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- **Language:** Fortran
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1. Purpose

The purpose of this program is to practice modular programming in Fortran by defining and using simple mathematical and geometrical functions.
The program performs basic operations such as addition, swapping two numbers, and calculating the area of simple shapes.

2. Modules Description

2.1. Module types:

Defines two kind parameters to ensure numerical precision and consistency across

- ikind: for integer variables (selected_int_kind(9))
- rkind: for real (floating-point) variables (selected_real_kind(p=15, r=300))

```
module types
  implicit none
  integer, parameter :: ikind = selected_int_kind(9)
  integer, parameter:: rkind= selected_real_kind (p=15 , r=300)
end module types
```

2.2. Module mathfun:

- **Contains:**
  1. `add(a, b)` → returns the sum of two real numbers.
  2. `swap(x, y)` → exchanges the values of two numbers using a temporary variable (`hold`).
- **Description:**
  This module demonstrates how to use subroutines and functions with arguments and intent attributes.

```
module mathfun
  use types
  implicit none
  private
  public :: add, swap

contains

  function add(a, b) result(res)
    real(kind=rkind), intent(in) :: a, b
    real(kind=rkind) :: res
    res = a + b
  end function add

  subroutine swap(x , y)
    real(kind=rkind), intent(inout) :: x, y
    !temporary variable used to store x value during swap
    real(kind=rkind) :: hold
    hold = x
    x = y
    y = hold
  end subroutine swap

end module mathfun
```

2.3. Module geom2d:

- **Contains:**
  1. `carea(radius)` → computes the area of a circle using the formula: $\pi \times r^2$.
  2. `sarea(side)` → computes the area of a square using the formula: side*side.
  3. `rectap(length, width, A, P)` → computes the area and perimeter of a rectangle.

Value of π:
The value of π is calculated using:

```
pi = 4.0 * atan(1.0)
```

which is a standard and portable method in Fortran.

```
module geom2d
  use types
  implicit none
  private
  public :: carea, sarea, rectap

contains

  function carea(radius) result(ci_area)
    real(kind=rkind), intent(in) :: radius
    real(kind=rkind) :: ci_area
    real(kind=rkind) :: pi
    pi = 4.0_rkind * atan(1.0_rkind)
    ci_area = pi * radius**2
  end function carea

  function sarea(side) result(sq_area)
    real(kind=rkind), intent(in) :: side
    real(kind=rkind):: sq_area
    sq_area = side * side
  end function sarea

  subroutine rectap(length, width, A,P)
    real(kind=rkind), intent(in) :: length, width
    real(kind=rkind), intent(out) :: A, P
    A = length * width
    P = 2.0_rkind*(length + width)
  end subroutine rectap

end module geom2d
```

3. Main Program:

1. Prompts the user to enter two real numbers.
2. Uses `add()` to calculate and print their sum.
3. Calls `swap()` to exchange the numbers and prints the new values.
4. Computes:
    - The circle area using the first number after swap (`v1`).
    - The square area using the second number after swap (`v2`).
5. Finally, prints all results clearly to the screen.

```
program main
  use types
  use geom2d
  use mathfun
  implicit none

  real(kind=rkind) :: v1, v2
  real(kind=rkind) :: total
  real(kind=rkind) :: area_cir
  real(kind=rkind) :: area_sq

  print*, 'Enter two real numbers (use space or Enter to separate them):'
  read(*,*) v1, v2

  total = add(v1, v2)
  print *, "Sum of the two real numbers is:", total

  call swap(v1, v2)
  print *, 'After swapping: v1 =', v1, ' v2 =', v2

  !now v1 and v2 are swapped, so circle area uses the new v1 value
  area_cir = carea(v1)
  print *, "Area of circle (radius =", v1, ") =", area_cir

  area_sq = sarea(v2)
  print *, "Area of square (side =", v2, ") =", area_sq

end program main
```

4. Output:

```
fariba1184@DESKTOP-PQ1J1MT:/mnt/c/Users/farib/OneDrive/Desktop/types.f90$ gfortran types.f90 geom2d.f90 mathfun.f90 main.f90 -o f
fariba1184@DESKTOP-PQ1J1MT:/mnt/c/Users/farib/OneDrive/Desktop/types.f90$ ./f
 Enter two real numbers (use space or Enter to separate them):
1.2 0.1
 Sum of the two real numbers is:   1.300000000000000
 After swapping: v1 =  0.1000000000000001      v2 =   1.200000000000000
 Area of circle (radius =  0.1000000000000001     ) =   3.1415926535897934E-002
 Area of square (side =   1.200000000000000     ) =   1.4399999999999999
```

5. Conclusion:

This project demonstrates:

1. The use of modular structure for code organization.
2. The application of functions and subroutines with argument passing and intent.
3. Basic arithmetic operations and geometric computations in Fortran.