Functions and Subroutines

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Rationale

- Actions/operations which have to be performed more than once
- Test only parts of the code
- One big problem split into clearer and simpler sub-problems

Functions

- Special type of Fortran subprogram that is expected to return a single result or answer
- Typically accept some kind of input information and based on that information, return a result.
- Invoked by inserting the function name.
- It is called only when its result is needed.

Syntax for a User-Defined Function

```
1   type FUNCTION funct-name(arg1,...,argn) [result (return-value-na
2       IMPLICIT NONE
3       [specification part]
4       [execution part]
5   END FUNCTION funct-name
6   The function returns a single value.
```

Example of Function: Leap Year

```fortran
FUNCTION calcAverage (a, b, c) result(av)
 implicit none
 real(kind=4), intent(in) :: a, b, c
 real(kind=4) :: av

 av = (a + b + c)/3.0

END FUNCTION calcAverage
```

Few Fortran Intrinsic Functions

```
abs        int        trim        aimag       maxval
exp        nint       len         real        minval
log        real       len_trim    cmplx       sum
exp        mod
cos
sin
tan
acos
asin
atan
```

Subroutines

- Accept some kind of input information and based on that information, return a result or series of results.
- Each of the passed arguments must be declared and the declaration must include the type and the intent.
- The arguments in the calling routine and the subroutine must match and are matched up by position.
- Invoked with the CALL statement.

Syntax for a Subroutine

```
1
2  SUBROUTINE subroutine-name(arg1, arg2,...,argn)
3      IMPLICIT NONE
4      [specification part]
5      [execution part]
6  END SUBROUTINE subroutine-name
```

If the subroutine does not require any arguments, the (arg1, arg2,...,argn) can be omitted.

Example of Subroutine: Compute Sum/Average of Numbers

```fortran
subroutine sumAverage (a, b, c, sm, av)
real(kind=4), intent(in) :: a, b, c
real(kind=4), intent(out) :: sm, av

sm = a + b + c
av = sm / 3.0

return
end subroutine sumAverage
```

Exercise

Write a subroutine that returns the sum, the average and the standard deviation of 5 numbers.

$$
\begin{aligned}
s &= \sum_{i=1}^{5} a_i \\
\mu &= \frac{s}{5} \\
std &= \sqrt{\frac{\sum_{i=1}^{5}(a_i - \mu)^2}{5}}
\end{aligned}
$$

$$(1)$$