

Arrays

A variable: a named position of memory

For example: x1, x2, x3.....x10

An array: a collection of variables of the same type that are referenced by a common name. A specific element of an array can be accessed by using a subscript.

For example: x(1), x(2), x(3).....x(10)

What is the main difference?

Subscript in an array is a number. It is easier to get access to the *i*th element of an array $x(i)$ than to get access to x_i in a program.

When an array is declared, a block of memory is reserved for that array.

Declaration of Arrays

Use same keywords as to declare variables:

```
real x(10)           ! x(1).....x(10)
real x(1:10)        ! x(1).....x(10)
real x(0:10)        ! x(0).....x(10)
integer M(10,10)    ! 100 elements
integer N(3,3,3)    ! 27 elements
```

Or use DIMENSION to declare:

```
real x, y
dimension x(10), y(10)
```

Arrays Input/Output

```
real x(10), y(10)
```

```
real pi
```

```
do i = 1, 10
```

```
read(*,*) x(i)      ! Input 10 angles in degrees
```

```
end do
```

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

```
do i = 1, 10
```

```
y(i) = x(i)*pi/180.0  ! Calculate radians
```

```
end do
```

```
do i = 1, 10
```

```
write(*,*) y(i)      ! Output 10 angles in radians
```

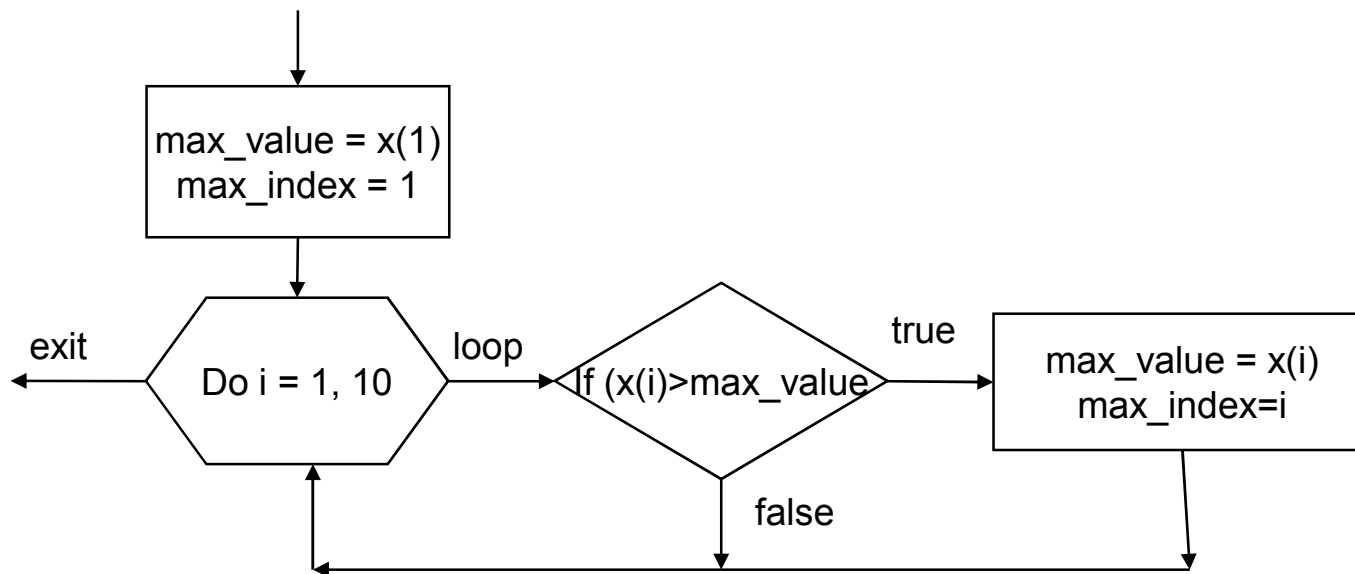
```
end
```

Finding the maximum value

real x(10)

```
do i = 1, 10  
  read(*,*) x(i)  
end do
```

! Temperatures of 10 consecutive days



Finding the maximum value

```
real x(10)

do i = 1, 10
  read(*,*) x(i)          ! Temperatures of 10 consecutive days
end do

max_value = x(1)
max_index = 1
do i = 1, 10
  if (x(i) > max_value) then
    max_value = x(i)
    max_index = i
  end if
end do

print *, 'The maximum temperature of', max_value, 'is on day', max_index
```

Input values:

25, 26, 24, 29, 23.5, 20, 24.5, 28.5, 26, 25

What is the output?

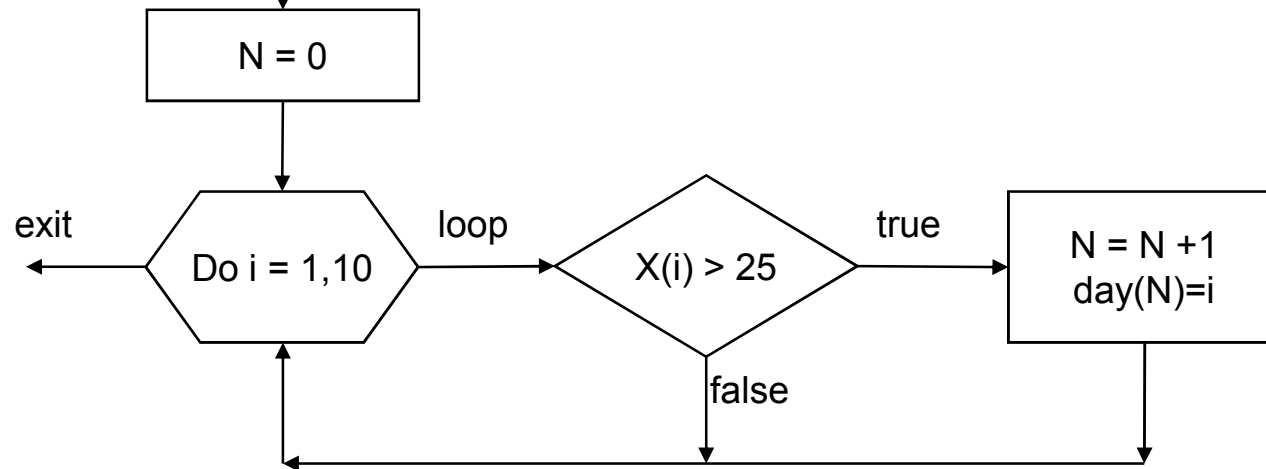
The maximum temperature of 29 is on day 4

Counting the number of days ($>25^{\circ}\text{C}$)

```
real x(10),  
integer day(10)
```

```
do i = 1, 10  
  read(*,*) x(i)  
end do
```

! Temperatures of 10 consecutive days



Counting IF.....

```
real x(10),  
integer day(10)
```

```
do i = 1, 10  
  read(*,*) x(i)           ! Temperatures of 10 consecutive days  
end do
```

```
N = 0           ! Initializing the counter  
do i = 1, 10  
  if (x(i) > 25) then      ! Counting temperature >25  
    N = N + 1  
    day(N)=i  
  end if  
end do
```

```
print *, 'The number of days of temperature higher than 25 C is', N  
print *, ' Temperature higher than 25 C on day(s):'  
do i = 1, N  
  print *, day(i)  
end do
```

Input values:

25, 26, 24, 29, 23.5, 20, 24.5, 28.5, 26, 25

What is the output?

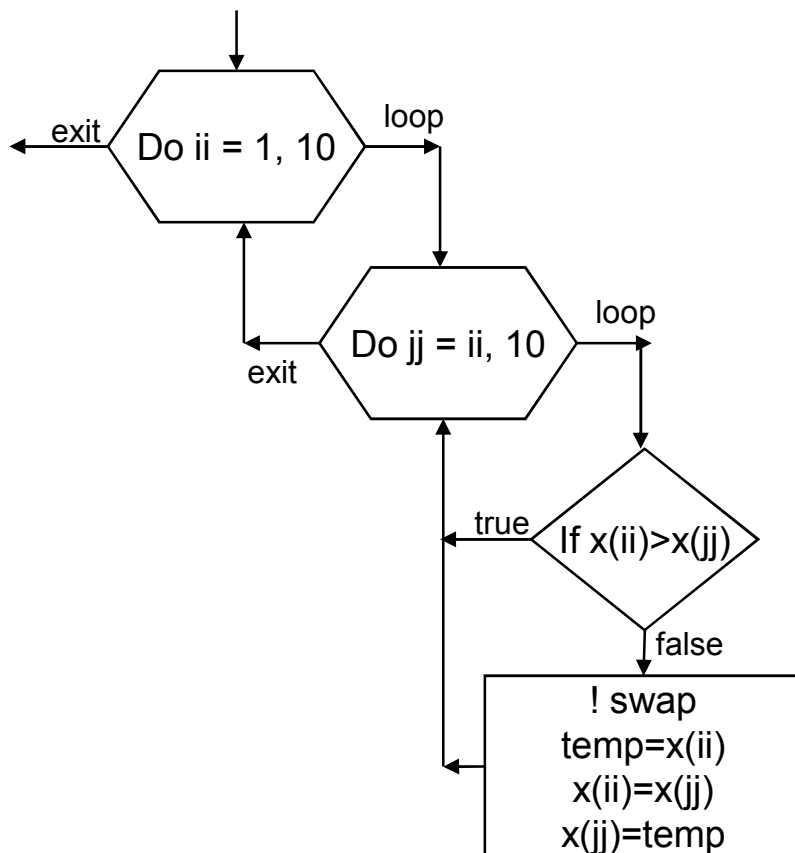
The number of days of temperature higher than 25 C is 4

Temperature higher than 25 C on day(s):

2
4
8
9

Sorting Data (bubble sort)

```
do i = 1, 10  
  read(*,*) x(i)  
end do
```



ll = 1:

x(1) is compared with x(1), x(2) x(10)

x(1) has the highest value of all

ll = 2:

x(2) is compared with x(2), x(3)....x(10)

x(2) has the highest value among x(2)....x(10)

.....

ll = 9

x(9) is compared with x(9) and x(10)

x(9) has the higher value

ll = 10

x(10) is compared with x(10)

nothing changes.

Sorting Data

```
integer N
real x(10)
N=10

do i = 1, N
  read(*,*) x(i)
end do

DO 110 II=1,N
DO 110 JJ=II+1,N
IF (X(II).GE.X(JJ)) GO TO 110
TEMP=X(II)
X(II)=X(JJ)
X(JJ)=TEMP
110 CONTINUE

do i = 1, N
  write(*,*) x(i)
end
```

II = 1:

x(1) is compared with x(1), x(2) x(10)

x(1) has the highest value of all

II = 2:

x(2) is compared with x(2), x(3)....x(10)

x(2) has the highest value among x(2)....x(10)

.....

II = 9

x(9) is compared with x(9) and x(10)

x(9) has the higher value

II = 10

x(10) is compared with x(10)

nothing changes.

Matrix Operations

To read a 5x5 matrix

```
REAL x(5,5)    !declare x as a 2D array
Do 10 I=1,5
Do 10 J=1,5
Read(*,*) x(I,J)    ! read 5x5=25 data from keyboard
10 continue
```

note: The program will wait for 25 numbers to be entered via keyboard.

Q: Which element of the array will have the first number, the 11th number and the 20th number entered from the keyboard?

Ans: $x(1,1)$ – 1st
 $x(3,1)$ – 11th
 $x(4,5)$ – 20th

Matrix Operations

To display a 5x5 matrix with 5 rows and 5 columns

```
REAL x(5,5)
Do 10 I=1,5
  Write(*, 1000) (x(I,J), J=1,5) ! write 5 numbers on one row
10  continue
1000 format(5f8.2)

(1,1) (1,2).....(1,5)
(2,1) (2,2).....(2,5)
.....
(5,1) (5,2).....(5,5)
```

Matrix Multiplication

Given two matrices $A = (a_{ij})$ and $B = (b_{ij})$ we can only find AB if the number of columns of A is the same as the number of rows of B . Suppose that

A is m -by- n and B is n -by- p , then

$C = AB$ is an m -by- p matrix where the elements of C , c_{ij} , are given by

$$c_{ij} = a_{i1}b_{1j} + a_{i2}b_{2j} + \dots + a_{in}b_{nj} = \sum_{k=1}^n a_{i,k} b_{k,j}$$

i.e. To get the ij element of C , multiply the elements of row i from A with the corresponding elements of column j from B and add.

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 3 & 6 \end{bmatrix} \times \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 3 & 6 \end{bmatrix} = \begin{bmatrix} 3 & 6 & 10 \\ 6 & 14 & 25 \\ 10 & 25 & 46 \end{bmatrix}$$

Using Fortran arrays for A, B and C : $c(i, j) = \sum_{k=1}^n a(i, k) \cdot b(k, j)$

Matrix Multiplication

Result of multiplication of two 5x5 matrices will be a 5x5 matrix.

REAL a(5,5), b(5,5), c(5,5) ! z is multiplication of x and y

```
Do 10 I=1,5
```

```
Do 10 J=1,5
```

```
  c(I,J)=0
```

```
    Do 20 K=1,5
```

```
      c(I,J)=c(I,J)+a(I,K)*b(K,J)
```

```
    20 continue
```

```
  10 continue
```

i = 1,2,3,4,5

j = 1,2,3,4,5

$$c(i, j) = \sum_{k=1}^5 a(i, k) \cdot b(k, j)$$