Computers in Engineering COMP 208

Matrices

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Matrices

- 2 dimensional array of numbers
  - Spreadsheet in Excel
  - Used in Linear Algebra
  - Systems of Equations

Adding Matrices

- With two matrices A and B
- Add all components of A to components of B:

$$\begin{pmatrix} 2 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 2 & 3 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 2 \\ 0 & 2 & 0 & 0 & 1 & 0 \end{pmatrix} + \begin{pmatrix} 2 & 2 & 2 & 3 & 3 & 2 \\ 2 & 2 & 2 & 3 & 3 & 3 \\ 2 & 2 & 2 & 3 & 3 & 2 \\ 2 & 2 & 3 & 3 & 3 & 3 \end{pmatrix} = \begin{pmatrix} 4 & 2 & 3 & 4 & 3 & 3 \\ 2 & 2 & 4 & 6 & 4 & 3 \\ 3 & 3 & 2 & 3 & 3 & 4 \\ 2 & 4 & 3 & 3 & 4 & 3 \end{pmatrix}$$

Sum Two Matrices

```
INTEGER :: SIZE = 20
REAL :: A(20,20), B(20,20), C(20,20)
INTEGER :: i, j

DO i = 1, SIZE
  DO j = 1, SIZE
    C(i,j) = A(i,j) + B(i,j)
  END DO
END DO
```

More Matrix Processing

- So far we have just focused on reading values into a matrix
- Here are some more examples of applications where we process the cells of a two dimensional array

Initialize a Matrix to be the Identity Matrix

```
INTEGER :: SIZE = 20
INTEGER :: Ident (20, 20)
INTEGER :: i, j
DO i = 1, SIZE
  DO j = 1, SIZE
    IF (i == j) THEN
      Ident(i,i) = 1
    ELSE
      Ident(i,j) = 0
    END IF
  END DO
END DO
```

Transpose a Square Matrix

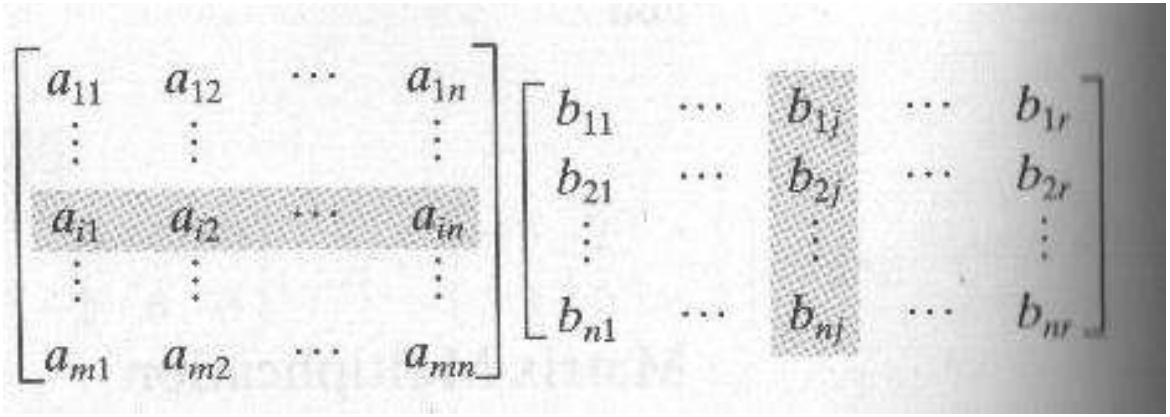
```
INTEGER :: SIZE = 20
REAL :: A(20,20), B(20,20), C(20,20)
INTEGER :: i, j
REAL :: Temp

DO i = 1, SIZE
  DO j = i+1, SIZE
    Temp = A(i,j)
    A(i,j) = A(j,i)
    A(j,i) = Temp
  END DO
END DO
```

What if j's initial value was 1 instead of i+1?

Multiplying Matrices

- Multiply each row component with each column component of the second matrix and sum each value to obtain the result for their intersection point in the resultant matrix



Multiply Square Matrices

```
INTEGER :: SIZE = 20
REAL :: A(20,20), B(20,20), C(20,20)
INTEGER :: i, j, k

DO i = 1, SIZE
  DO j = 1, SIZE
    C(i,j) = 0
    DO k = 1, SIZE
      C(i,j) = C(i,j) + A(i,k)*B(k,j)
    END DO
  END DO
END DO
```

An Application

- A power generating station has four generators
- To determine productivity of each of the generators we sample the power supplied at six different time periods
- How do we represent the data?

Data Representation

- Use a two dimensional array with each column representing the power supplied by a generator
- Each row represents a time of measurement

```
INTEGER :: gens = 4
INTEGER :: samples = 6
REAL :: power(6, 4)
```

Power Output

We can calculate the power output by the entire plant at each sample time

```
REAL :: power_output(samples)
. . .
DO time = 1, samples
  power_output(time) = 0
  DO gen = 1, gens
    power_output(time) = &
            power_output(time)+ power(time,gen)
  END DO
END DO
```

Generator Output

We can calculate the average output of each generator

```
REAL :: gen_sum(gens), gen_avg(gens)
. . .
DO gen = 1, gens
  gen_sum(gen) = 0
  DO time = 1, samples
    gen_sum(gen) = &
            gen_sum(gen) + power(time,gen)
  END DO
  gen_avg(gen) = gen_sum(gen)/samples
END DO
```