

Notes on Fortran 77 Arrays

- *Recall array declarations:*

```
real*8      a1d(100)
real*8      a2d(100,200)
real*8      a3d(100,200,300)
```

(Standard Fortran 77 allows up to 7 dimensions, or *rank-7* arrays)

- Fortran 77 array storage

- Fortran 77 arrays are *always* stored in *contiguous* memory locations.
- For 1-d (rank-1) arrays, memory layout is obvious:

```
real*8      v(5)
```

| | | | | |
|------|------|------|------|------|
| v(1) | v(2) | v(3) | v(4) | v(5) |
|------|------|------|------|------|

- For multidimensional arrays, storage is “linearized” (“one-dimensionalized”) using “column-major” order—1st subscript varies most rapidly, then 2nd, then 3rd, etc.
- 2-d (rank-2) example:

```
real*8      a(3,2)
```

| | | | | | |
|--------|--------|--------|--------|--------|--------|
| a(1,1) | a(2,1) | a(3,1) | a(1,2) | a(2,2) | a(3,2) |
|--------|--------|--------|--------|--------|--------|

– 3-d (rank-2) example:

```
real*8      b(2,2,2)
```

| | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|
| b(1,1,1) | b(2,1,1) | b(1,2,1) | b(2,2,1) | b(1,1,2) | b(2,1,2) | b(1,2,2) | b(2,2,2) |
|----------|----------|----------|----------|----------|----------|----------|----------|

- It is relatively easy to write Fortran 77 programs which can handle “run-time dimensioned” arrays *provided* all array manipulation is performed by subroutines or functions.

- *Computing “effective 1-d index” of multidimensional array element:*

– 1-d (rank-1)

```
real*8      a1d(d1)
```

```
a1d(i)      --->   v1d( i )
```

– 2-d (rank-2)

```
real*8      a2d(d1,d2)
```

```
a2d(i,j)    --->   v1d( (j-1)*d1 + i )
```

– 3-d (rank-3)

```
real*8      a3d(d1,d2,d3)
```

```
a3d(i,j,k)  --->   v1d( (k-1)*d1*d2 + (j-1)*d1 + i )
```

This “linearization” (index, or offset, computation) is essentially how Fortran 77 handles *all* array expressions.

- *Consequences of Fortran 77 index computation*

- Index computation makes it apparent why array bounds *must* be passed to a **subroutine** along with the array.
- From the point of view of *storage* (memory layout), arrays of *any* dimension are *indistinguishable*, provided that they have the same total number of elements. Example:

```
real*8      c1d(64)
real*8      c2d(8,8)
real*8      c3d(4,4,4)
```