Message-Passing Programming

Memory allocation and ordering

Dr David Henty
HPC Training and Support Manager
d.henty@epcc.ed.ac.uk
+44 131 650 5960

Fortran array syntax

- MPI derived types enable strided data to be sent/received
  - no explicit copy in/out required
- For Fortran
  - why not use Fortran array syntax?
- Some subtleties for non-blocking operations
  - see notes on Learn

Arrray Layout in Memory

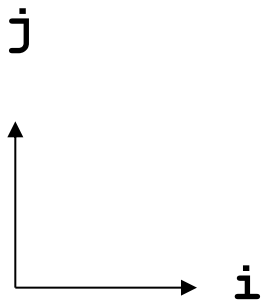
C: **`x[16]`**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

F: **`x(16)`**

C: **`x[4][4]`**

4	8	12	16
3	7	11	15
2	6	10	14
1	5	9	13



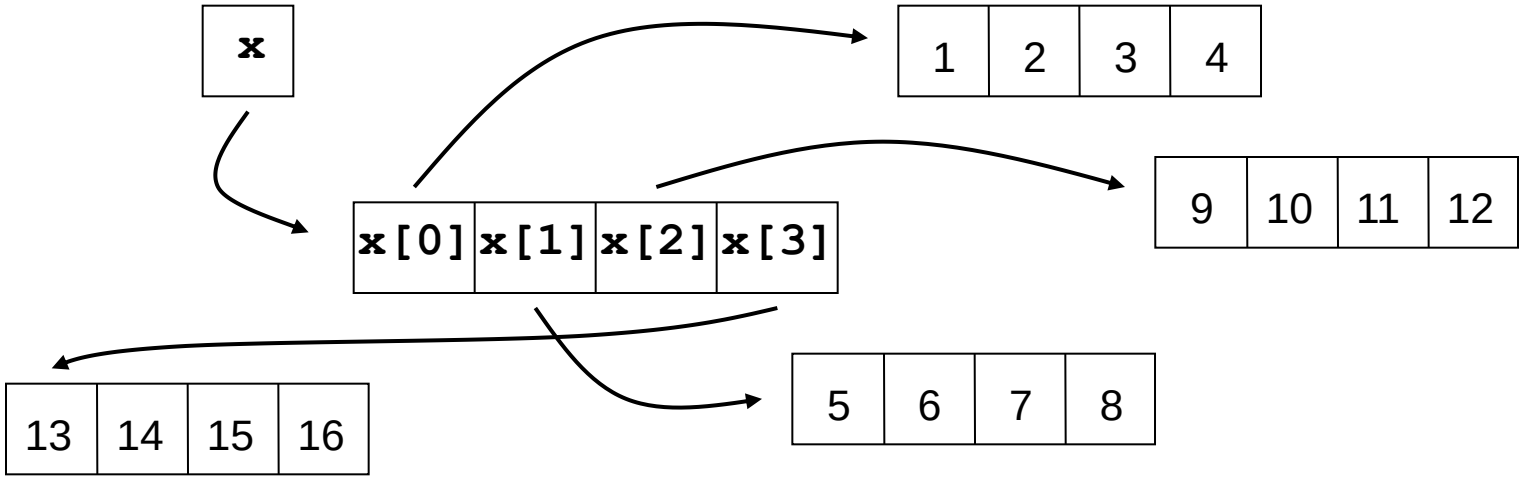
F: **`x(4,4)`**

13	14	15	16
9	10	11	12
5	6	7	8
1	2	3	4

- Data is contiguous in memory
  - different conventions in C and Fortran
  - for statically allocated C arrays **`x == &x[0][0]`**

Aside: Dynamic Arrays in C

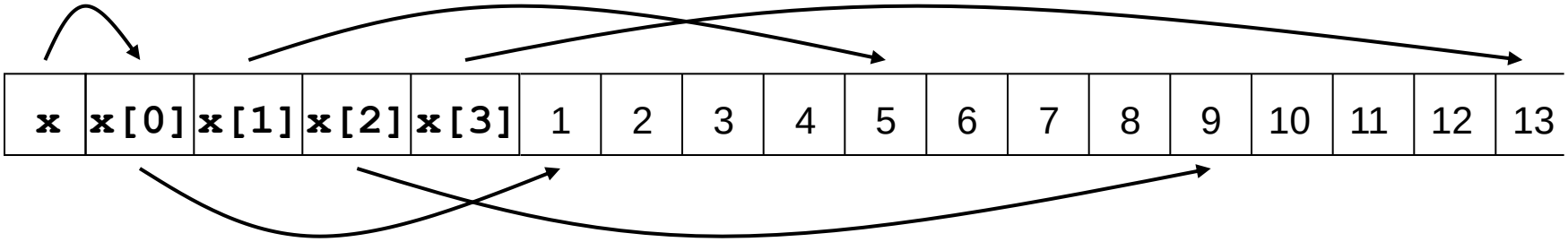
```
float **x = (float **) malloc(4, sizeof(float *));

for (i=0; i < 4; i++)
{
  x[i] = (float *) malloc(4, sizeof(float));
}
```



- Data non-contiguous, and **`x != &x[0][0]`**
  - cannot use regular templates such as vector datatypes
  - cannot pass **`x`** to any MPI routine

Arralloc

```
float **x = (float **) arralloc(sizeof(float), 2, 4, 4);
/* do some work */
free((void *) x);
```



- Data is now contiguous, but still **`x != &x[0][0]`**
  - can now use regular template such as vector datatype
  - must pass **`&x[0][0]`** (start of contiguous data) to MPI routines
  - see **`PSMA-arralloc.tar`** for example of use in practice

- Will illustrate all calls using **`&x[i][j]`** syntax
  - correct for both static and (contiguously allocated) dynamic arrays