

Message-Passing Programming

Memory allocation and ordering



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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

Array Layout in Memory

C: $\mathbf{x}[16]$

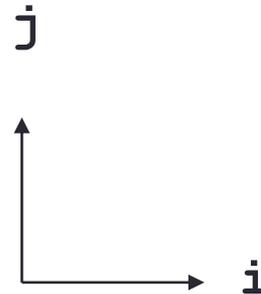
F: $\mathbf{x}(16)$

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
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C: $\mathbf{x}[4][4]$

F: $\mathbf{x}(4, 4)$

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

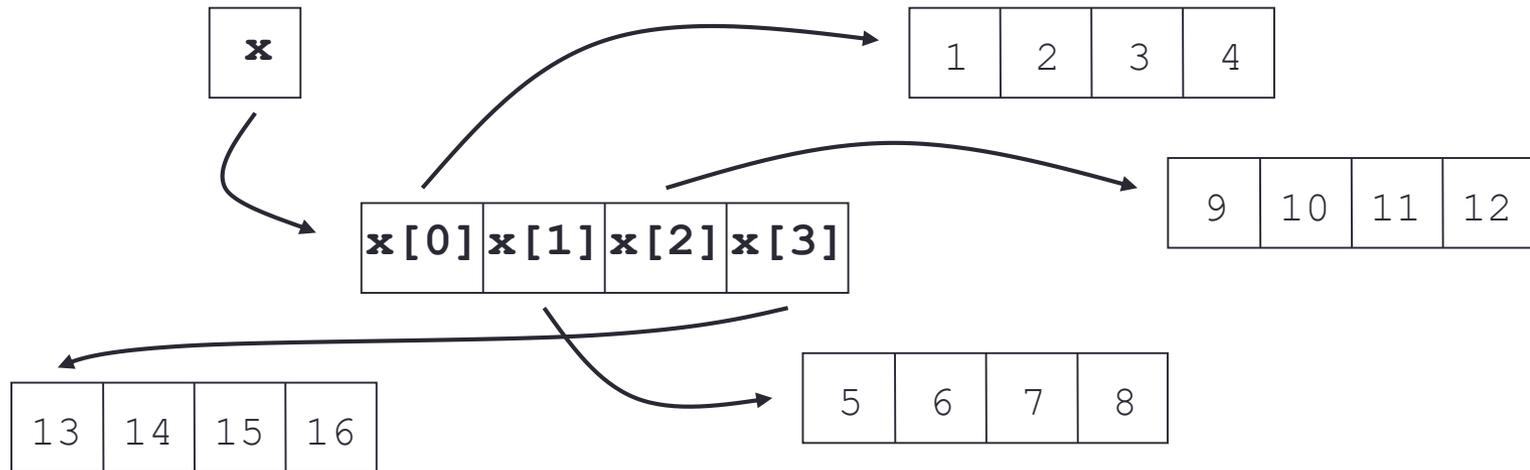


13	14	15	16
9	10	11	12
5	6	7	8
1	2	3	4

- Data is contiguous in memory
 - different conventions in C and Fortran
 - for statically allocated C arrays $\mathbf{x} == \&\mathbf{x}[0][0]$

Aside: Dynamic Arrays in C

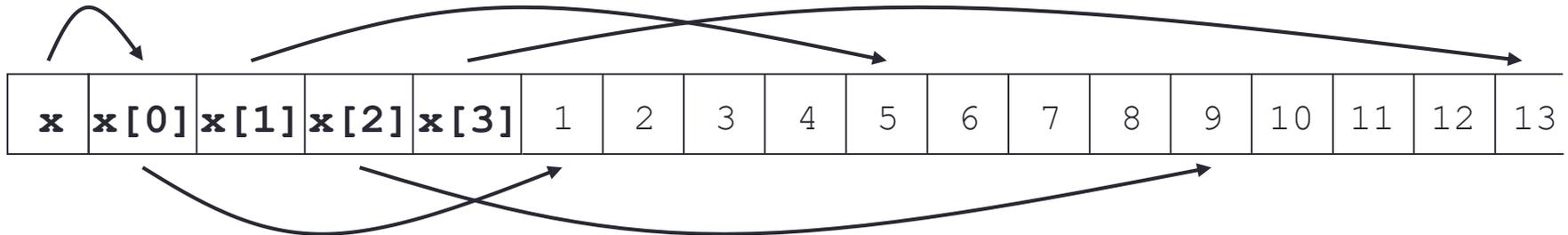
```
float **x = (float **) malloc(4, sizeof(float *));  
  
for (i=0; i < 4; i++)  
{  
    x[i] = (float *) malloc(4, sizeof(float));  
}
```



- 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 **MPP-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