Introduction to Computer Science and Programming in C

Session 20: November 13, 2008

Columbia University

Announcements

- Homework 4 is out, due last day of class: December 4 before class
- Final Exam: Tuesday, 12/16, 1:10 pm - 4:00 pm Mudd 233 (our normal room)

Review

- Modular Programming (almost object oriented)
  - Think of programs as modules/objects interacting
- Makefiles
  - Use “make” to automate compilation

Today

- Homework 3 solutions
- Revisiting pointers
  - Pointers to pointers
  - Pointers to functions

Homework 3 Solutions

- http://www.cs.columbia.edu/~bert/courses/1003/homework3_soln.txt

Pointers to pointers

- Recall that C arrays and pointers are basically the same:

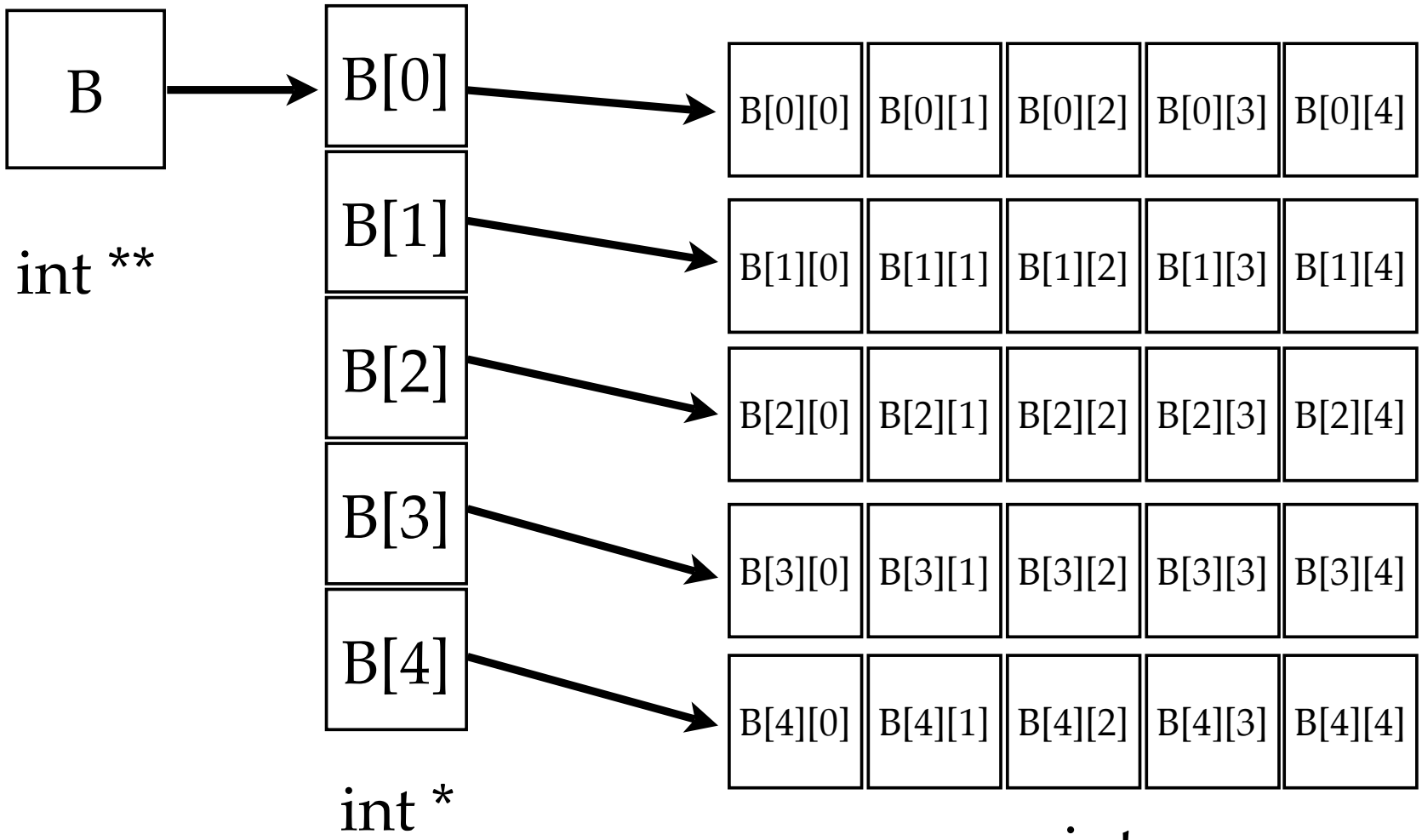
```
int A[10];
int *A_ptr = A;
```

- How does C store 2d arrays?

```
int B[10][10];
```

- **B** is a pointer to an array of pointers

Pointers to pointers



malloc()

- We can dynamically allocate multi-dimensional arrays

```
int **C;
C = (int**) malloc(N*sizeof(int*));
```

```
for (i=0; i<N; i++) {
    C[i] = (int*)malloc(N*sizeof(int));
}
```

Pointers to functions

- It is occasionally useful to use pointers to functions
- Since functions are stored in memory, we can reason about their addresses too
- This allows us to say, “run the function at address _____ on these arguments”
- Useful for being truly general, e.g. stdlib qsort

Function Pointer Syntax

- ```
  int (*f_ptr)();
  /* pointer to function that returns an int */
  ```

- Parentheses are important. Without parentheses, **f_ptr** looks like it returns a pointer to an int.

- ```
  int (*f_ptr)(int, int);
  /* function takes 2 ints as arguments */
  ```

- ```
  int greater_than(int a, int b);
  f_ptr = greater_than;
  ```
  ```

qsort example

- Stdlib's qsort function is a general sorting function.
- Sort an array of any type, using any comparison criterion
- Define that comparison as a function pointer
- ```
  void qsort(void *base, size_t n, size_t size,
        int (*cmp)(const void *, const void *));
  ```
  ```

qsort example

- Compare function should take two entries A and B,
  - return +1 if A>B
  - return -1 if A<B
  - return 0 if A==B

qsort example

```
int greater_than(const void *x, const void *y)
{
  float *a = (float*)x, *b = (float*)y;

  if (*a>*b)
    return 1;
  if (*a<*b)
    return -1;
  return 0;
}

void mySort(float A[], int N)
{
  int (*f_ptr)(const void *, const void *)
          = greater_than;
  qsort((void*)A, N, sizeof(float), f_ptr);
}
```

Reading

- The C Programming Language. Chapter 5 (describes pointers in great detail)