

lab 05 Pointers

Instructions: It is *vital* that you understand pointers and, consequently, the different memory spaces: static, stack, and heap. Please answer the following questions:

Note: When a question asks for the *value* of a variable, if it is a known number write the number. If it is a memory address write what the memory address is pointing to (Ex: The variable x holds the memory address of the variable y.) If it cannot be determined, write undefined.

1. (15 pts) Consider the following code:

```
1 #include <stdio.h>
2
3 int main(int argc, char *argv[]) {
4     int x = 32;
5     int *y = &x;
6     int z = *y;
7     printf("z = %d\n", z);
8     return 0;
9 }
```

- (a) What is the output?
- (b) What is the *value* of y?
- (c) In what memory (static, stack, or heap) do the variable x, y, z exist during runtime?

2. (15 pts) Consider the following code:

```
1 #include <stdio.h>
2
3 int main(int argc, char *argv[]) {
4     int *x = (int *)200;
5     long z = (long)x;
6     printf("z = %d\n", z);
7     return 0;
8 }
```

- (a) What is the output?
- (b) In what memory (static, stack, or heap) do the variable x, z exist during runtime?
- (c) Why is this code bad practice (even though it compiles/runs without a seg fault)?

3. (15 pts) Consider the following code:

```
1 #include <stdio.h>
2
3 int main(int argc, char *argv[]) {
4     int *x = new int[100];
5     x[0] = 500;
6     int z = x[25];
7     printf("z = %d\n", z);
8     return 0;
9 }
```

- (a) What is the output? (Careful, a compile/run will not give you the correct answer.)
- (b) In what memory (static, stack, or heap) do the variable x, z exist during runtime?
- (c) What is stored on the heap?
- (d) What is the memory issue?

4. (15 pts) Consider the following code:

```
1 #include <stdio.h>
2
3 int main(int argc, char *argv[]) {
4     int *x = new int[100];
5     int *y = x+10;
6
7     for (int i = 0; i < 100; i++) {
8         x[i] = i;
9     }
10
11     printf("y[10] = %d\n", y[10]);
12     return 0;
13 }
```

- (a) Why is the output?:
 $y[10] = 20$
- (b) Write a line of code that would free up memory using only x.
- (c) Write a line of code that would free up memory using only y.

5. (15 pts) Consider the following code:

```
1 #include <stdio.h>
2
3 int main(int argc, char *argv[]) {
4     int *x = new int[100];
5     int *y = new int[100];
6     int **z = NULL;
7
8     for (int i = 0; i < 100; i++) {
9         x[i] = i;
10        y[i] = 100-i;
11    }
12
13    z = &x;
14    printf("(z)[10] = %d\n", (*z)[10]);
15    z = &y;
16    printf("(z)[10] = %d\n", (*z)[10]);
17    return 0;
18 }
```

- (a) What is the *value* of x and y?
- (b) What is the *value* z on lines 14 and 16?
- (c) What does the code fragment “(*z)[10]” mean? (Describe what the code must do to evaluate that code fragment.)
- (d) Why are there two different outputs for “(*z)[10]”? Here is the output of the program:
(*z)[10] = 10
(*z)[10] = 90
- (e) Write the commands to free memory.

6. (25 pts) Consider the following code:

```
1 #include <stdio.h>
2 #include <stdlib.h>
3
4 class Student {
5     public:
6         int mId;
7         double mGPA;
8 };
9
10 int main(int argc, char *argv[]) {
11     Student *students = new Student[100];
12     Student ** studentsPtr = new Student*[100];
13
14     srand(100); // Seed random number generator
15     for (int i = 0; i < 100; i++) {
16         students[i].mId = i+1;
17
18         // Generate a "random" GPA from 0.0-4.0
19         students[i].mGPA = 4 * (((double)rand())/RAND_MAX);
20
21         studentsPtr[i] = students+i;
22     }
23
24     // This is Bubble Sort:
25     for (int i = 0; i < 100; i++) {
26         for (int j = 1; j < 100; j++) {
27             // Based on GPA
28             if (studentsPtr[j-1]->mGPA > studentsPtr[j]->mGPA) {
29                 Student *temp = studentsPtr[j];
30                 studentsPtr[j] = studentsPtr[j-1];
31                 studentsPtr[j-1] = temp;
32             }
33         }
34     }
35
36     for (int i = 0; i < 100; i++) {
37         printf("%f\n", studentsPtr[i]->mGPA);
38     }
39
40     return 0;
41 }
```

- (a) What is the *value* of students?
- (b) What is the *value* of studentsPtr?

- (c) Which of the above is being sorted?
- (d) Write the code to sort students using a single for loop.
- (e) Write the commands to free memory.

How to turn in:

Turn in via GitHub. Ensure the file(s) are in your directory and then:

- `$ git add <files>`
- `$ git commit`
- `$ git push`

Due Date: January 23, 2019 2359

Teamwork: No teamwork, your work must be your own.