IC221: Systems Programming
06-Week Written Exam

February 12, 2014

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page. Show all work, but please be legible. *Microscopic writing will not be graded*.

You are allowed a single crib sheet for this exam on one-side of an 8.5"x11" sheet of paper, hand written. You must turn in your crib sheet with your exam.

Name: ____________________

Section: ____________________

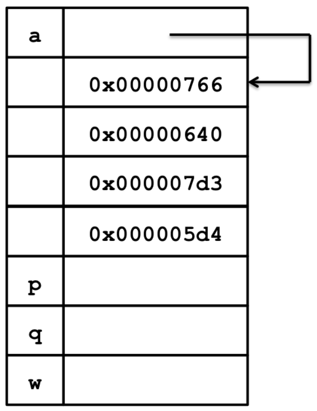
Alpha: ____________________

Question	Points	Score
1	20	
2	20	
3	20	
4	20	
5	20	
Total:	100	

1. Consider the following program:

```
int main(int argc, char * argv[]){

  //array of integers described in hex
  int a[4] = {0x00000766,  // (hint: two hex digits
              0x00000640,  //   represents one byte)
              0x000007d3,
              0x000005d4};


  int * p = a+3;
  int * q = p-2;

  char * w = (char *) &(a[1]); /* MARK */

  //print output as hex values with leading 0x
  printf("*p = 0x%x\n", *p);
  printf("q[1] = 0x%x\n", q[1]);

  printf("w[0] = 0x%x\n", w[0]);

  return 0;
}
```

(a) **[5 points]** Complete the memory diagram below for the pointers `p`, `q`, and `w`.



(b) **[3 points]** What is the output of the program for `*p` and `q[1]`:

`*p =`

`q[1] =`

(c) **[3 points]** Assume the address of the array `a` is at `0x0bffff04` what is the address of the second integer in the array, i.e., `&a[1]` or `a+1`? Explain.

(d) **[3 points]** Explain why the pointer cast at the line `MARK` is valid with respect to the data size of a pointer type? While the underlying data being referenced does not change, what does change when using a different pointer type?

(e) **[3 points]** What is the output for the `w[0]` output? *(Hint: it should be one byte or two hex digits.)*

`w[0] =`

(f) **[3 points]** Which of the byte orderings, Big Endian or Little Endian, is used on most computers? Which has the *most significant* byte first, that is the byte most to the left, reading bytes left to right?

2. Consider the following `ls -al` output

```
aviv@saddleback: prob2 $ ls -al
total 32
drwxr-x--- 4 aviv scs  4096 Feb  6 10:19 .
drwx--x--x 5 aviv scs  4096 Feb  6 10:16 ..
drwxr-x--- 2 aviv scs  4096 Feb  6 10:17 bar
-rw-r----- 1 aviv mids    0 Feb  6 10:17 baz
drwxr-x--- 2 aviv scs  4096 Feb  6 10:17 foo
-rwxr----- 1 aviv mids 8516 Feb  6 10:18 helloworld
-rw-r----- 1 aviv scs   114 Feb  6 10:18 helloworld.c
```

(a) [**3 points**] What are the names of all the directories listed in the `ls -al` output?

(b) [**2 points**] What does `.` and `..` refer to?

(c) [**2 points**] Which users currently has access to *read* the file `baz`? Is there anything to read in this file?

(d) [**3 points**] Provide a *single* command to change the permission of `baz` so that the owner has read, write, and execute permission, the group has read and execute, and everyone else just has execute permission.

(e) [**5 points**] Consider the executable file *helloworld* which has group read permission but not execute? Explain how this does not properly secure the file from unauthorized execution by users in the `mids` group? How could the owner better protect the file?

(f) [**3 points**] Who has the privilege to change the permissions and group of a file/directory? Who has the privilege to change the owner of a file/directory?

(g) [**2 points**] What command will update the time stamp on the file `baz` to the current time (right now, as you take this exam)?

3. (a) **[3 points]** Consider the program below:

```
int main(int argc, char * argv[]){
  char str[12];

  if( argc < 2) //require a command
     return 1;  //line argument

  //copy the argument to str
  strcpy(str,argv[1]);

  //print it out
  printf("arg[1]: %s\n",str);

  return 0;
}
```

What is the *longest* command line argument, in terms of the number of characters, that will not *overflow* the character array `str` during the `strcpy`? Explain briefly?

(b) **[3 points]** What string library function can you replace `strcpy()` with to ensure that `str` is not overflowed? Provide the function and its arguments below:

(c) **[4 points]** What is the output of the program to the right?

```
int main(int argc, char *argv[]){
  char s1[] = "Go Navy! Beat Army!";
  char *p = s1;

  printf("strlen(s1): %d\n",strlen(s1));
  printf("sizeof(s1): %d\n",sizeof(s1));

  printf(" strlen(p): %d\n",strlen(p));
  printf(" sizeof(p): %d\n",sizeof(p));
}
```

(d) **[3 points]** What is the difference between `sizeof()` and `strlen()`?

(e) **[4 points]** Complete the function below which should return the equivalent of the `strlen()` function:

```
int my_strlen( char * string) {
  int len = 0;



  return len;
}
```

(f) **[3 points]** What does the following code snippet print:

```
char data[]="Don't\0 Panic!\0 And bring a towel!\0";
printf("%s\n",data+8);
```

4. For this question, assume you have a comma separated file (`database.csv`) with the following fields:

```
First Name,Last Name,Street Address,City,State,Phone Number
```

The state is a two-character postal code (e.g. MD for Maryland and CA for California). The phone number is always formatted like 999-999-9999. The `database.csv` is not corrupted, and none of the fields may have a comma in it.

(a) [**3 points**] Write a command line to count the number of unique states in `database.csv`. Your command should contain pipes and/or redirects.

(b) [**5 points**] What are the three guiding principles of the Unix design philosophy? Explain how the command above achieves these principles.

(c) [**3 points**] Write a single command line to save all the phone numbers to a file called `phone.txt`. Your command may contain pipes and/or redirects.

(d) [**3 points**] Suppose there is a second database file, `moredata.csv`, that has the same format. Write a command to append the phone numbers from `moredata.csv` to the end of the `phone.txt` file you created in the previous question. Your command may contain pipes and/or redirects.

(e) [**3 points**] Suppose you have a whole directory of database files formatted like above with names from `database.00.csv`, `database.01.csv`, `database.02.csv` and up to `database.99.csv`. Write a *single* glob with `wc` to count the number of lines in the database files number in the 10's, 30's, and 70's, but not database file 15, 35, or 75.

```
wc -l
```

(f) [**3 points**] Consider now that you are currently in a directory that contains five sub-directories full of database files numbered between 00 and 99, like above. Each the directories have the following naming scheme: `data_2015`, `data_2016` `data.2017`, `data.2018`. Write a *single* glob with `wc` to count the number of lines in all the databases found in year 2015 and 2017 sub-directories? *(Note: the separators _ and . are used in the sub-directory names)*

```
wc -l
```

5. The questions refers to the program below:

```
typedef struct{
  int left;
  int right;
} pair_t;

int main(int argc, char * argv[]){
  int num, i;

  if ( argc < 2 ){
    fprintf(stderr,
            "%s: ERROR: require number of pairs\n",
            argv[0]);
  }

  num = atoi(argv[1]);

  /* MARK 1*/
  pair_t * pairs[num];

  printf("Enter space separated pairs\n");
  for( i=0; i<num; i++ ){
    pairs[i] = malloc(sizeof(pair_t);
    scanf("%d %d", &(pairs[i]->left)),
                   &(pairs[i]->right));
  }
  /* END MARK 1*/

  for( i=0; i<num;i++){
   printf("(%d,%d)\n", pairs[i]->left,
                       pairs[i]->right);
  }

  /* MARK 2 */
  return 0;
}
```

(a) **[3 points]** In the program to the left, **circle** the command(s) that write to standard output, **square** the command(s) that read from standard input, and **underline** the command(s) that write to standard error.

(b) **[3 points]** Suppose the program is compiled to `pair-reader` and executed like such, without any additional arguments, what is the output of the program?

```
./pair-reader
```

(c) **[2 points]** What is the output of the program when executed as follows:

```
echo "1 8 5 4" | ./pair-reader 2
```

(d) **[5 points]** The program has a memory leak, describe the memory leak below, and provide the code to be inserted at `MARK 2` that will properly deallocate all the memory:

(e) **[3 points]** Consider replacing the `MARK 1` portion of the program with the following function call:

```
pairs = get_pairs(num);
```

where `get_pairs()` is defined as follows

```
pairs_t * get_pairs(int num){
   pair_t * pairs[num]; /* MARK 3*/

   printf("Enter space separated pairs\n");
   for( i=0; i<num; i++ ){
    pairs[i] = malloc(sizeof(pair_t);
    scanf("%d %d", &(pairs[i]->left)),
                   &(pairs[i]->right));
  }

  return pairs;
}
```

Describe what is *wrong* with this modification to the program with respect to the program memory layout? Be sure to mention stack and heap.

(f) **[4 points]** Rewrite the line of code at `MARK 3` to fix the error: