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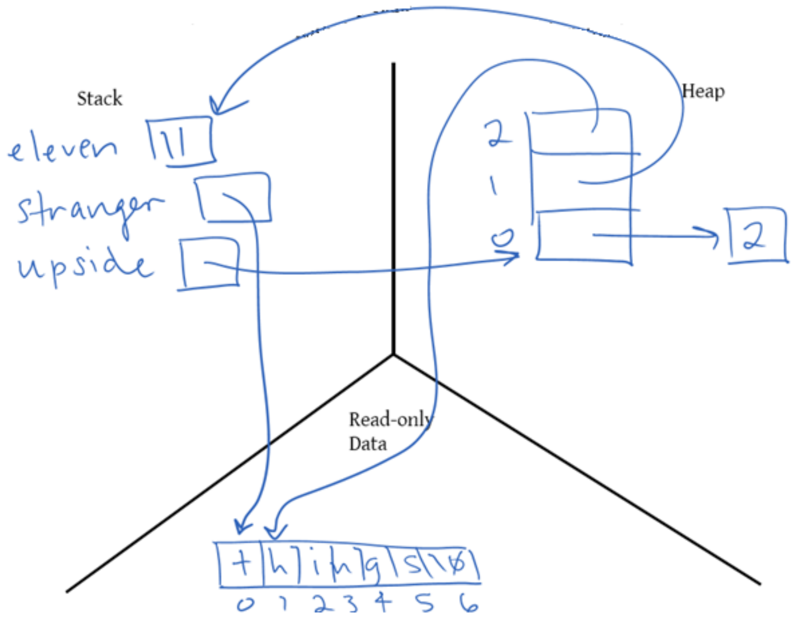
CS107 Midterm Practice Problems SOLUTIONS

Problem 1

```
(a)     -20
(b)     31B or 0x31B
(c)     1110111101010110 1
(d)     00010101
(e)     11110001
```

Problem 2
(see diagram at right)



Text description of the diagram at right:

eleven is an int on the stack that stores the value 11.

stranger is a char * on the stack, which points to the index 0 element (the 't') of an array of 7 characters in the read-only data segment (a string literal) containing the characters "things" and a null terminator. The character 't' is at index 0, 'h' at index 1, 'i' at index 2, 'n' at index 3, 'g' at index 4, 's' at index 5, and '\0' at index 6.

upside is an int ** on the stack, which points to the index 0 element of an array of 3 int *s on the heap. The index 0 element of this array points to a heap-allocated int (elsewhere on the heap) containing the value 2. The index 1 element of this array pointed to by **upside** points to the **eleven** variable on the stack. The index 2 element of this array pointed to by **upside** points to the index 1 element (the 'h') in the string literal in the data segment also pointed to by **stranger**.

Problem 3

(a) b = 'v', ' ' (space)

(b) Bug fix 1: char **return_array = malloc(2 * sizeof(char*));

Bug fix 2: add +1 to malloc bytes (for null terminating character)
Bug fix 3: make comparison <= or make bound be +1

Problem 4:

```
bool odd_cols(unsigned int n)  {
      unsigned char *ptr = (unsigned char*)&n;
      unsigned char row0, row1, row2, row3;
      row0 = ptr[0];
      row1 = ptr[1];
      row2 = ptr[2];
      row3 = ptr[3];
      return (unsigned char) ~(row0 ^ row1 ^ row2 ^ row3) == 0;
}
```

Problem 5: Strings and Pointers Short Answer

(a) 1000 + 10*8 = 1080, 1000 + 10*1 = 1010, 1000 + 10*4 = 1040

(b) `HELLOWORIAMREADYTOPARTY`

Because the buggy code mixes up sizes and levels of indirection, it copies sizeof(char*) bytes into the returned strings. In other words, it copies the first 8 bytes of a string, which are the first 8 characters. So HELLOWORLD gets shortened to HELLOWOR, and because TOPARTY's null terminator is the 7th character, that is copied in, and the entire string print in printf ends there, even though more characters were in fact copied after that.

(c) The key conceptual error in original code is thinking that sizeoof on a char* variable is the same as strlen of a char* variable. This must be corrected in the first for loop and in the subsequent concatenation loop.

Here is one solution that corrects the arguments to memcpy:

```
char *multi_concatenate(const char *strs[], size_t num_strs) {
      size_t len = 1;
      for (size_t i = 0; i< num_strs; i++) {
            ~~len += sizeof(strs[i]);~~ len += strlen(strs[i]);
      }
      char *result = malloc(len);
      int curr_len = 0;
      for (size_t i = 0; i< num_strs; i++) {
            ~~memcpy(result + sizeof(strs[i]) * i, strs[i],~~
                  ~~sizeof(strs[i]));~~
            memcpy(result + curr_len, strs[i], strlen(strs[i]));
            curr_len += strlen(strs[i]);
      }
      ~~result[sizeof(strs[0]) * num_strs] = '\0';~~
      result[curr_len] = '\0'; //need to add null terminator
      return result;
}
```

Here is another solution that replaces memcpy with the more appropriate strcat:

```
char *multi_concatenate(const char *strs[], size_t num_strs) {
      size_t len = 1;
      for (size_t i = 0; i< num_strs; i++) {
            ~~len += sizeof(strs[i]);~~ len += strlen(strs[i]);
      }
      char *result = malloc(len);
      result[0] = '\0'; //need to start with null terminator before strcat
      for (size_t i = 0; i< num_strs; i++) {
            ~~memcpy(result + sizeof(strs[i]) * i, strs[i],~~
                  ~~sizeof(strs[i]));~~
            strcat(result, strs[i]);
      }
      ~~result[sizeof(strs[0]) * num_strs] = '\0';~~
      return result;
}
```

Problem 6: The `accumulate` generic

a) *This first part was designed to expose basic memory and pointer errors very early on—e.g. to confirm that weren't dropping* **&***'s and* ******'s where they weren't needed.*

```
void accumulate(const void *base, size_t n, size_t elem_size,
                BinaryFunc fn, const void *init, void *result) {
  memcpy(result, init, elem_size);
  for (size_t i = 0; i < n; i++) {
    const void *next = (char *) base + i * elem_size;
    fn(result, next, result);
  }
}
```

b)

```
static void multiply_two_numbers(void *partial, const void *next, void *result) {
   *(int *)result = *(int *)partial * *(const int *)next;
} // preserving the constness in the casts wasn't necessary


int int_array_product(const int array[], size_t n) {
   int identity = 1, product;
   accumulate(array, n, sizeof(int),
              multiply_two_numbers, &identity, &product);
   return product;
}
```

Problem 7: Integer Representation

```
a) B3A
b) -19
c) 13
d) 10101001011111011101111
e) 0011100
f) 1C
g) 11011111
```

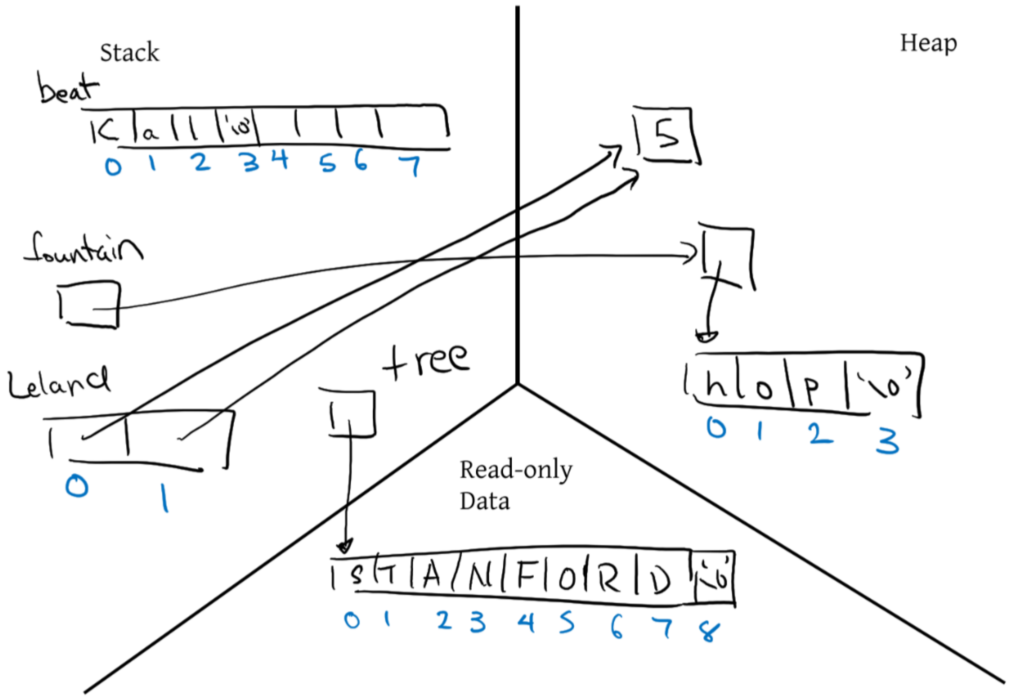
Problem 8: Integer Representation

```
        (a)     0xCAFE
        (b)     00110111
        (c)     -86
        (d)     11110011
```

Problem 9: Pointers and strings

```
'I'
'E'
*first_key = strdup(cmap_first(cmap));
*values = malloc(nelems * sizeof(int));
(*values)[index++] = *(int*)cmap_get(cmap, cur))
      Rubric Notes: (*values)[++ index] is not an acceptable answer
```

Problem 10: Memory Diagram



Text description of the diagram above:

tree is a char * on the stack, which points to the index 0 element (the 'S') of an array of 9 characters in the read-only data segment (a string literal) containing the characters "STANFORD" and a null terminator. In this data segment array, the character 'S' is at index 0, 'T' at index 1, 'A' at index 2, 'N' at index 3, 'F' at index 4, 'O' at index 5, 'R' at index 6, 'D' at index 7, and '\0' at index 8.

beat is an array of characters of length 8 on the stack. The character 'C' is at index 0, 'a' at index 1, 'l' at index 2, and '\0' at index 3. Indices 4-7 are uninitialized.

fountain is a char ** on the stack, which points to a char * allocated on the heap. This heap-allocated char * points to the index 0 element (the 'h') of a heap-allocated string of length 4 (elsewhere on the heap) containing the characters "hop" and a null terminator. In this heap-allocated character array, the character 'h' is at index 0, 'o' at index 1, 'p' at index 2, and '\0' at index 3.

leland is an array of 2 int *s on the stack. The index 0 element of this array points to a heap-allocated int containing the value 5. The index 1 element of this **leland** array also points to this same heap-allocated int containing the value 5 (in other words, the index 0 and 1 elements in **leland** point to the same location, which is of the heap allocated int with value 5).