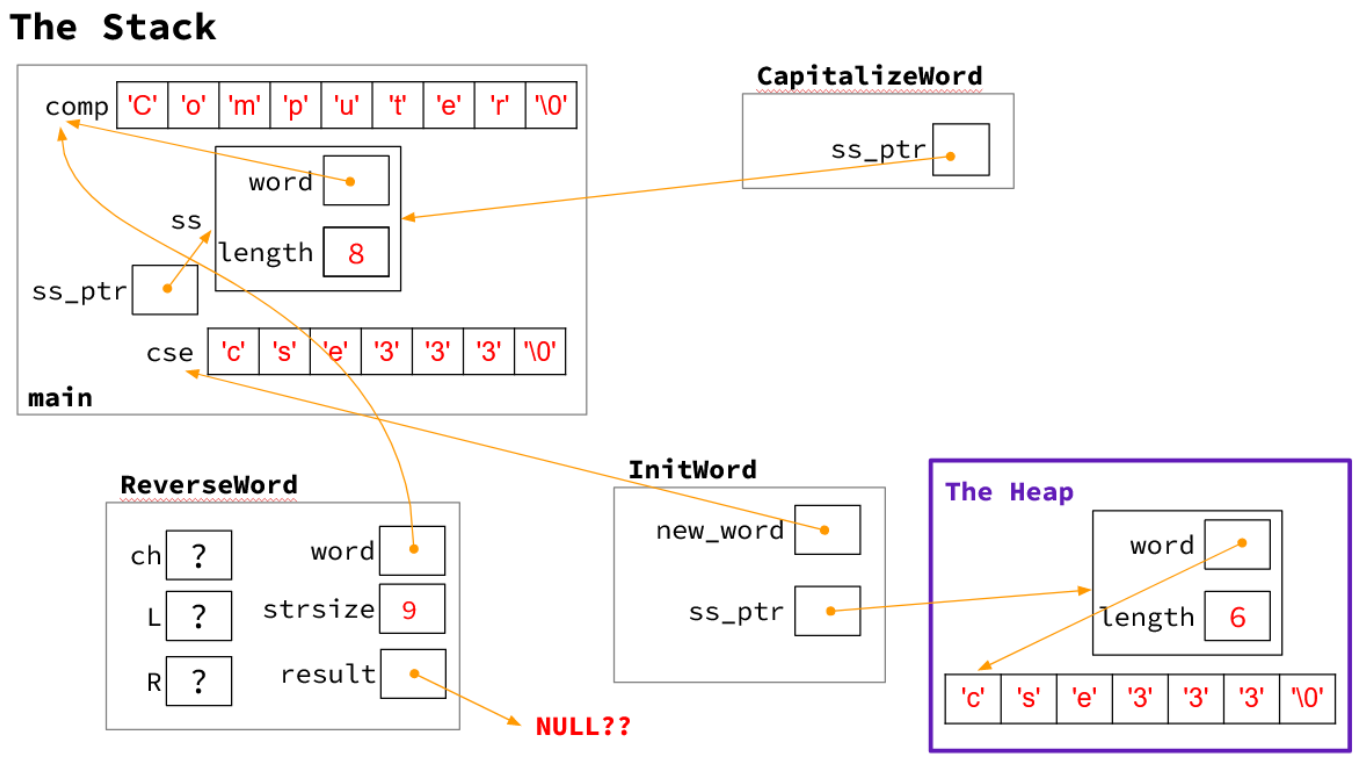
CSE 333 – Section 2: Structs and Debugging Solutions

Exercise 1

Below is the state of memory up to the call to `strncpy()` in `ReverseWord()`. Functions whose stack frames have been popped are shown for completion.



Exercise 2

Note: To see the full solution with proper use of function declarations on the course website.

```c
/* Fixed code for CSE 333 Section 2
 * 1. Draw a memory diagram for the execution to identify errors.
 * 2. Use gdb and valgrind to identify sources of runtime, logical,
 *    and memory errors.
 * 3. Clean up the code style.
 */

#include <string.h>  // strncpy, strlen
#include <stdio.h>   // printf
#include <stdlib.h>  // malloc, NULL, free, EXIT_FAILURE, EXIT_SUCCESS
#include <ctype.h>   // toupper

// A SimpleString stores a C-string and its current length
typedef struct simplestring_st {
  char* word;
  int   length;
} SimpleString;

// Capitalize the first letter in the word
void CapitalizeWord(SimpleString* ss_ptr);

/*
* FIXED: Returning a pointer as an output parameter requires a double pointer
*/
// Allocate a new SimpleString on the heap initialized with word
// and return pointer to the new SimpleString in dest
void InitWord(char* word, SimpleString** dest);

// Return a new string with the characters in word in reverse order.
char* ReverseWord(char* word);

int main(int argc, char* argv[]) {
  char comp[] = "computer";
  SimpleString ss = {comp, strlen(comp)};
  SimpleString* ss_ptr = &ss;

  // expecting "1. computer, 8"
  printf("1. %s, %d\n", ss_ptr->word, ss_ptr->length);

  char cse[] = "cse333";
  InitWord(cse, &ss_ptr);
  // expecting "2. cse333, 6"
  printf("2. %s, %d\n", ss_ptr->word, ss_ptr->length);

  CapitalizeWord(ss_ptr);
  // expecting "3. Cse333, 6"
  printf("3. %s, %d\n", ss_ptr->word, ss_ptr->length);
```

```c
  char* reversed = ReverseWord(ss_ptr->word);
  /*
  * FIXED: Use free to fix memory leaks from InitWord
  * (Use valgrind to find this leak)
  */
  free(ss_ptr->word);
  free(ss_ptr);
  InitWord(reversed, &ss_ptr);
  // expecting "4. 333esC, 6"
  printf("4. %s, %d\n", ss_ptr->word, ss_ptr->length);

  /*
  * FIXED: Use free to fix memory leaks from heap-allocated reversed string
  * (Use valgrind to find this leak)
  */
  free(reversed);
  free(ss_ptr->word);
  free(ss_ptr);
  return EXIT_SUCCESS;
}

void InitWord(char* word, SimpleString** dest) {
  *dest = (SimpleString*) malloc(sizeof(SimpleString));
  if (*dest == NULL) {
    exit(EXIT_FAILURE);
  }
  (*dest)->length = strlen(word);
  (*dest)->word = (char*) malloc(sizeof(char) * ((*dest)->length + 1));
  if (((*dest)->word) == NULL) {
    exit(EXIT_FAILURE);
  }
  strncpy((*dest)->word, word, (*dest)->length + 1);
}

void CapitalizeWord(SimpleString* ss_ptr) {
  ss_ptr->word[0] = toupper(ss_ptr->word[0]);
}

char* ReverseWord(char* word) {
  char* result = NULL;  // the reversed string
  int L, R;
  char ch;

  // copy original string then reverse and return the copy
  int strsize = strlen(word) + 1;
  /*
  * FIXED: Return string is heap-allocated and responsibility to free passed to
  * the caller
  */
  result = (char*) malloc(strsize);
  if (result == NULL) {
    exit(EXIT_FAILURE);
```

```
  }
  strncpy(result, word, strsize);

  L = 0;
  /*
  * FIXED: Decrement length of result by 1 to avoid copying null terminator
  */
  R = strlen(result) - 1;
  while (L < R) {
    ch = result[L];
    result[L] = result[R];
    result[R] = ch;
    L++;
    R--;
  }

  return result;
}
```

Exercise 3

Style Issues

1. Should error check any call to malloc()

```
if (rev == NULL) {
  return NULL;
}
if (rev->word == NULL) {
  return NULL;
}
```