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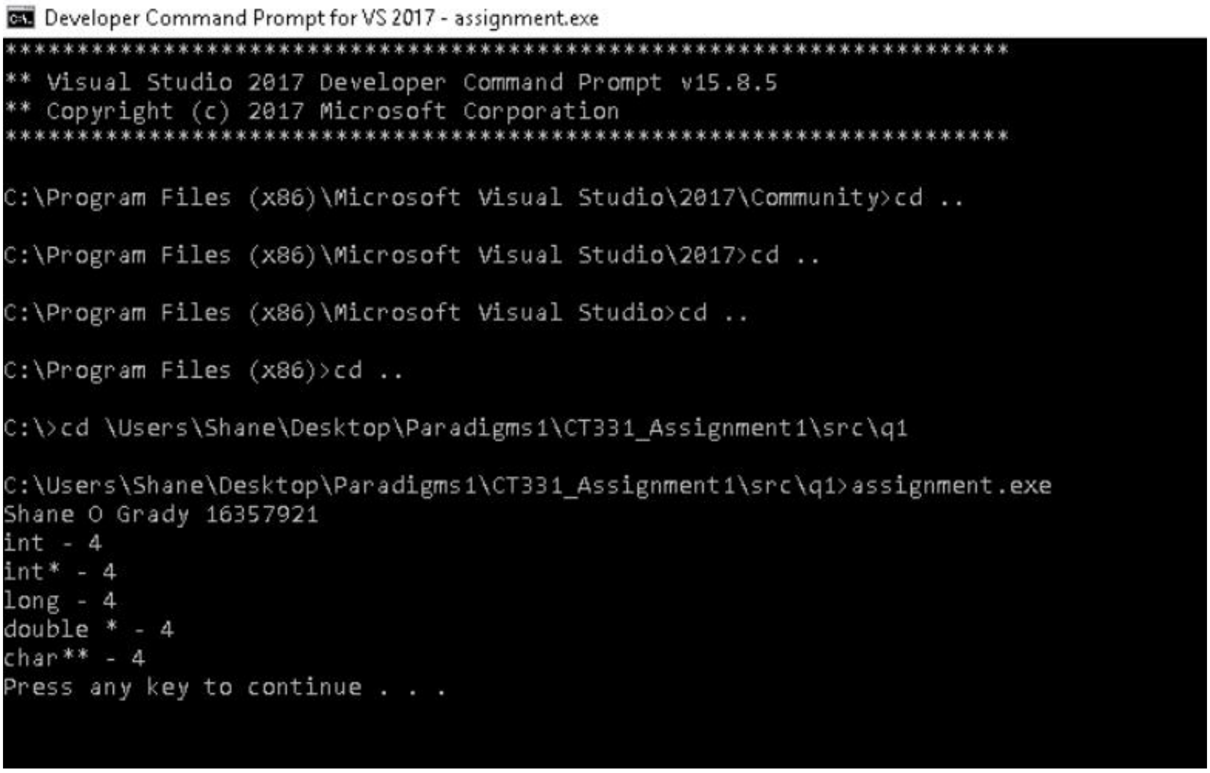
CT331 Assignment 1

Question 1(A):

```c
#include <stdio.h>
#include <stdlib.h>

int main(int arg, char* argc[]) {
	int a = 0;
	int* b = 0;
	long c = 0;
	double * d = 0;
	char** e = 0;

	printf("Shane O Grady 16357921 \n");
	printf("int - %d \n", sizeof(a));
	printf("int* - %d \n", sizeof(b));
	printf("long - %d \n", sizeof(c));
	printf("double * - %d \n", sizeof(d));
	printf("char** - %d \n", sizeof(e));

	system("pause");

}
```



Developer Command Prompt for VS 2017 - assignment.exe

```
**********************************************************************
** Visual Studio 2017 Developer Command Prompt v15.8.5
** Copyright (c) 2017 Microsoft Corporation
**********************************************************************

C:\Program Files (x86)\Microsoft Visual Studio\2017\Community>cd ..

C:\Program Files (x86)\Microsoft Visual Studio\2017>cd ..

C:\Program Files (x86)\Microsoft Visual Studio>cd ..

C:\Program Files (x86)>cd ..

C:\>cd \Users\Shane\Desktop\Paradigms1\CT331_Assignment1\src\q1

C:\Users\Shane\Desktop\Paradigms1\CT331_Assignment1\src\q1>assignment.exe
Shane O Grady 16357921
int - 4
int* - 4
long - 4
double * - 4
char** - 4
Press any key to continue . . .
```

Question 1(B) :

The size of every primitive value turned out to be 4 which surprised me. However, I discovered that a pointer has 4 bytes which explains why the char and double have a result of 4. As well as this I discovered that both the int and long have a size of 4 bytes through research carried out online

Question 2:

Linkedlist.h

```
#ifndef CT331_ASSIGNMENT_LINKED_LIST

#define CT331_ASSIGNMENT_LINKED_LIST


typedef struct listElementStruct listElement;
```

```
//Creates a new linked list element with given content of size

//Returns a pointer to the element

listElement* createEl(char* data, size_t size);


//Prints out each element in the list

void traverse(listElement* start);


//Inserts a new element after the given el

//Returns the pointer to the new element

listElement* insertAfter(listElement* after, char* data, size_t size);


//Delete the element after the given el

void deleteAfter(listElement* after);


//Returns the number of elements in a linked list

int length(listElement* list);


//Push a new element onto the head of a list.

void push(listElement** list, char* data, size_t size);


//Pop an element from the head of a list.

listElement* pop(listElement** list);


//Enqueue a new element onto the head of the list.

void enqueue(listElement** list, char *data, size_t size);


//Dequeue an element from the tail of the list.
```

```
listElement* dequeue(listElement* list);



#endif
```

Linkedlist.c

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "linkedList.h"

typedef struct listElementStruct{
  char* data;
  size_t size;
  struct listElementStruct* next;
} listElement;

//Creates a new linked list element with given content of size
//Returns a pointer to the element
listElement* createEl(char* data, size_t size){
  listElement* e = malloc(sizeof(listElement));
  if(e == NULL){
    //malloc has had an error
    return NULL; //return NULL to indicate an error.
  }
  char* dataPointer = malloc(sizeof(char)*size);
  if(dataPointer == NULL){
    //malloc has had an error
    free(e); //release the previously allocated memory
    return NULL; //return NULL to indicate an error.
  }
  strcpy(dataPointer, data);
  e->data = dataPointer;
  e->size = size;
  e->next = NULL;
  return e;
}

//Prints out each element in the list
void traverse(listElement* start){
  listElement* current = start;
  while(current != NULL){
    printf("%s\n", current->data);
    current = current->next;
  }
}

//Inserts a new element after the given el
//Returns the pointer to the new element
listElement* insertAfter(listElement* el, char* data, size_t size){
  listElement* newEl = createEl(data, size);
  listElement* next = el->next;
  newEl->next = next;
  el->next = newEl;
  return newEl;
}


//Delete the element after the given el
void deleteAfter(listElement* after){
  listElement* delete = after->next;
  listElement* newNext = delete->next;
  after->next = newNext;
  //need to free the memory because we used malloc
  free(delete->data);
  free(delete);
}

// Returns the number of elements in a linked list.
int length(listElement* list) {
       int counter = 0;
       listElement* temp = list;
       while (temp != NULL) {
              temp = temp->next;
              counter++;
       }
       return counter;
}
```

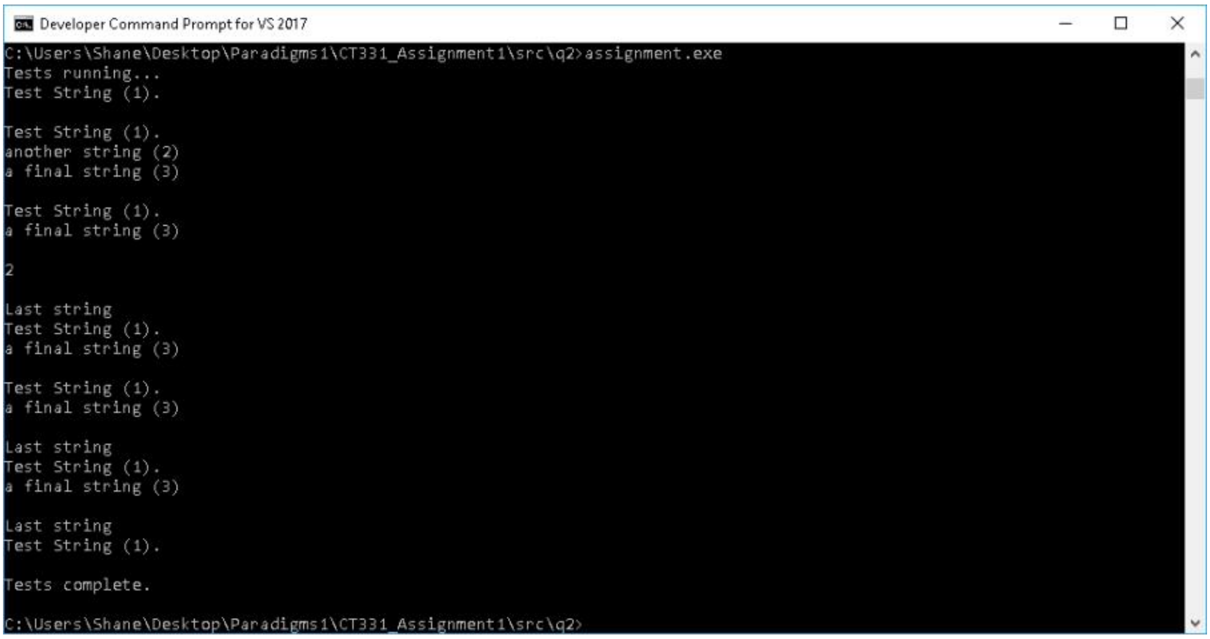
```
// Push a new element onto the head of a list.
void push(listElement** list, char *data, size_t size) {
        listElement* node = createEl(data, size);
        node->next = *list;
        *list = node;
}

// Pop an element from the head of a list.
listElement* pop(listElement** list) {
        if (*list != NULL) {
                listElement* node = (*list)->next;
                *list = (*list)->next;
                return node;
        }
        return *list;
}

//Enqueue a new element onto the head of the list.
void enqueue(listElement** list, char* data, size_t size) {
        push(list, data, size);
}

//Dequeue an element from the tail of the list.
listElement* dequeue(listElement* list) {
        listElement* temp = list;
        while ((temp->next)->next != NULL)
        {
                temp = temp->next;
        }
        listElement* last = temp->next;
        temp->next = NULL;
        return last;
}
```

Tests.c

```
#include <stdio.h>
#include "tests.h"
#include "linkedList.h"

void runTests(){
  printf("Tests running...\n");
  listElement* l = createEl("Test String (1).", 30);
  //printf("%s\n%p\n", l->data, l->next);
  //Test create and traverse
  traverse(l);
  printf("\n");

  //Test insert after
  listElement* l2 = insertAfter(l, "another string (2)", 30);
  insertAfter(l2, "a final string (3)", 30);
  traverse(l);
  printf("\n");

  // Test delete after
```

```c
deleteAfter(l);
traverse(l);
printf("\n");

//Test length
int num = length(l2);
printf("%d\n\n", num);

//Test enqueue
enqueue(&l, "Last string", 30);
traverse(l);
printf("\n");

//Test pop
pop(&l);
traverse(l);
printf("\n");

//Test push
push(&l, "Last string", 30);
traverse(l);
printf("\n");

//Test dequeue
dequeue(l);
traverse(l);
printf("\nTests complete.\n");
```

```
}
```



Developer Command Prompt for VS 2017

```
C:\Users\Shane\Desktop\Paradigms1\CT331_Assignment1\src\q2>assignment.exe
Tests running...
Test String (1).

Test String (1).
another string (2)
a final string (3)

Test String (1).
a final string (3)

2

Last string
Test String (1).
a final string (3)

Test String (1).
a final string (3)

Last string
Test String (1).
a final string (3)

Last string
Test String (1).

Tests complete.

C:\Users\Shane\Desktop\Paradigms1\CT331_Assignment1\src\q2>
```

Question 3:

Genericlinkedlist.h

```
#ifndef CT331_ASSIGNMENT_GENERIC_LINKED_LIST

#define CT331_ASSIGNMENT_GENERIC_LINKED_LIST



typedef void(*printFn)(void* data);



typedef struct genericlistElementStruct {

	void* data;

	size_t size;

	printFn print;

	struct genericlistElementStruct* next;
```

```c
} genericlistElement;

//Creates a new linked list element with given content of size
//Returns a pointer to the element
genericlistElement* createEl(void* data, size_t size, printFn print);

//Prints out each element in the list
void traverse(genericlistElement* start);

//Inserts a new element after the given el
//Returns the pointer to the new element
genericlistElement* insertAfter(genericlistElement* after, void* data, size_t size, printFn print);

//Delete the element after the given el
void deleteAfter(genericlistElement* after);

//Returns the number of elements in a linked list
int length(genericlistElement* list);

//Push a new element onto the head of a list.
void push(genericlistElement** list, void* data, size_t size, printFn print);

//Pop an element from the head of a list.
genericlistElement* pop(genericlistElement** head);

//Enqueue a new element onto the head of the list.
void enqueue(genericlistElement** list, void* data, size_t size, printFn print);
```

```c
//Dequeue an element from the tail of the list.

genericlistElement* dequeue(genericlistElement* list);


//Prints out an integer element

void printInt(void* data);


//Prints out a float element

void printFloat(void* data);


//Prints out a char element

void printChar(void* data);


//Prints out a string element

void printStr(void* data);




#endif
```

Genericlinkedlist.c

```c
#include <stdio.h>

#include <stdlib.h>

#include <string.h>

#include "genericLinkedList.h"


//Creates a new linked list element with given content of size

//Returns a pointer to the element
```

```c
genericlistElement* createEl(void* data, size_t size, printFn print) {
        genericlistElement* e = malloc(sizeof(genericlistElement));
        if (e == NULL) {
                //malloc has had an error
                return NULL; //return NULL to indicate an error.
        }
        void* dataPointer = malloc(size);
        if (dataPointer == NULL) {
                //malloc has had an error
                free(e); //release the previously allocated memory
                return NULL; //return NULL to indicate an error.
        }
        memmove(dataPointer, data, size);
        e->data = dataPointer;
        e->size = size;
        e->print = print;
        e->next = NULL;
        return e;
}

//Prints out each element in the list
void traverse(genericlistElement* head) {
        genericlistElement* current = head;
        while (current != NULL) {
                current->print(current->data);
                current = current->next;
        }
```

```
}

//Inserts a new element after the given el
//Returns the pointer to the new element
genericlistElement* insertAfter(genericlistElement* el, void* data,
       size_t size, printFn print) {
       genericlistElement* newEl = createEl(data, size, print);
       genericlistElement* next = el->next;
       newEl->next = next;
       el->next = newEl;
       return newEl;
}

//Delete the element after the given el
void deleteAfter(genericlistElement* after) {
       genericlistElement* delete = after->next;
       genericlistElement* newNext = delete->next;
       after->next = newNext;
       //need to free the memory because we used malloc
       free(delete->data);
       free(delete);
}

// Returns the number of elements in a linked list.
int length(genericlistElement* list) {
       int counter = 0;
       genericlistElement* temp = list;
```

```
        while (temp != NULL) {
                temp = temp->next;
                counter++;
        }
        return counter;
}


// Push a new element onto the head of a list.
void push(genericlistElement** list, void* data, size_t size, printFn print) {
        genericlistElement* node = createEl(data, size, print);
        node->next = *list;
        *list = node;
}


// Pop an element from the head of a list.
genericlistElement* pop(genericlistElement** list) {
        if (*list != NULL) {
                genericlistElement* node = (*list)->next;
                *list = (*list)->next;
                return node;
        }
        return *list;
}


//Enqueue a new element onto the head of the list.
void enqueue(genericlistElement** list, void* data, size_t size, printFn print) {
        push(list, data, size, print);
```

```
}

//Dequeue an element from the tail of the list.
genericlistElement* dequeue(genericlistElement* list) {
	genericlistElement* temp = list;

	while (temp->next->next != NULL) {
		temp = temp->next;
	}
	genericlistElement* last = temp->next;
	temp->next = NULL;
	return last;
}

void printChar(void* data){
  printf("%c\n", *(char*)data);
}

//Print an integer element
void printInt(void* data){
  printf("%d\n", *(int*)data);
}

//Print a float element
void printFloat(void* data){
  printf("%f\n", *(float*)data);
}
```

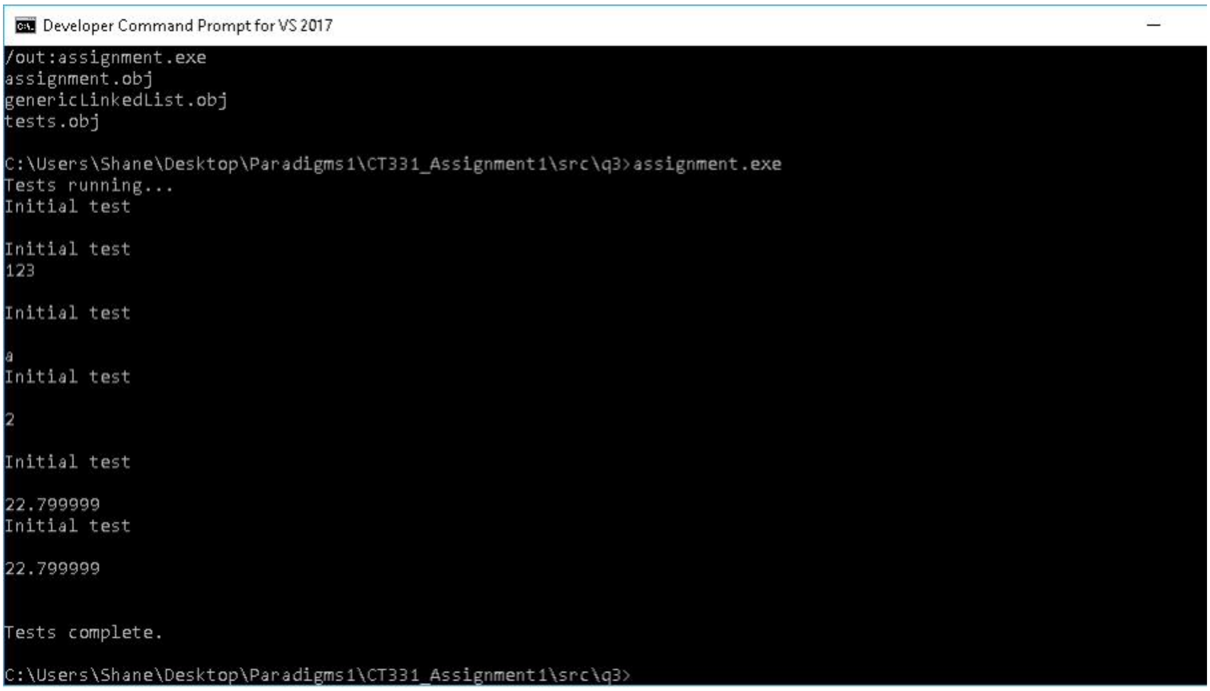
```c
//Print a string element
void printStr(void* data){
  printf("%s\n", data);
}
```

tests.c

```c
#include <stdio.h>
#include "tests.h"
#include "genericLinkedList.h"

void runTests(){
        printf("Tests running...\n");
        genericlistElement* l = createEl("Initial test", 30, printStr);
        //Test for create and traverse
        traverse(l);
        printf("\n");

        //Test for insert after
        int num = 123;
        insertAfter(l, &num, sizeof(int), &printInt);
        traverse(l);
        printf("\n");

        // Test for delete after
        deleteAfter(l);
```

```c
traverse(l);
printf("\n");

//Test for push
char a = 'a';
push(&l, &a, sizeof(char), &printChar);
traverse(l);
printf("\n");

//Test for length
printf("%d\n\n", length(l));

//Test for pop
pop(&l);
traverse(l);
printf("\n");

//Test for enqueue
float i = 22.8;
enqueue(&l, &i, sizeof(float), &printFloat);
traverse(l);
printf("\n");

//Test for dequeue
dequeue(l);
traverse(l);
printf("\n");
```

```
        printf("\nTests complete.\n");

}
```



```
/out:assignment.exe
assignment.obj
genericLinkedList.obj
tests.obj

C:\Users\Shane\Desktop\Paradigms1\CT331_Assignment1\src\q3>assignment.exe
Tests running...
Initial test

Initial test
123

Initial test

a
Initial test

2

Initial test

22.799999
Initial test

22.799999


Tests complete.

C:\Users\Shane\Desktop\Paradigms1\CT331_Assignment1\src\q3>
```

Question 4:

i)

Traversing a linked list in reverse will have high memory intensity as singly linked lists cannot be reversed directly. Once you reach the last node which is now the head you can traverse backwards. In order to traverse the linked list in reverse it is required to iterate one position back each time. This requires a lot of memory as a result.

ii)

To reduce memory intensity, the structure should be changed to a doubly linked list. Unlike the singly linked list, it can travel in two directions, next and previous. Depending on the size of the list, this can make a major impact when traversing in reverse as it would require much more memory to do so in a singly linked list.