CSCA48 - Intro to CS II

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Week 2 - Jan 20th

Memory Model in C

* It's like a locker room! All locker boxes are numbered in increasing order, and only can be accessed by the right user.

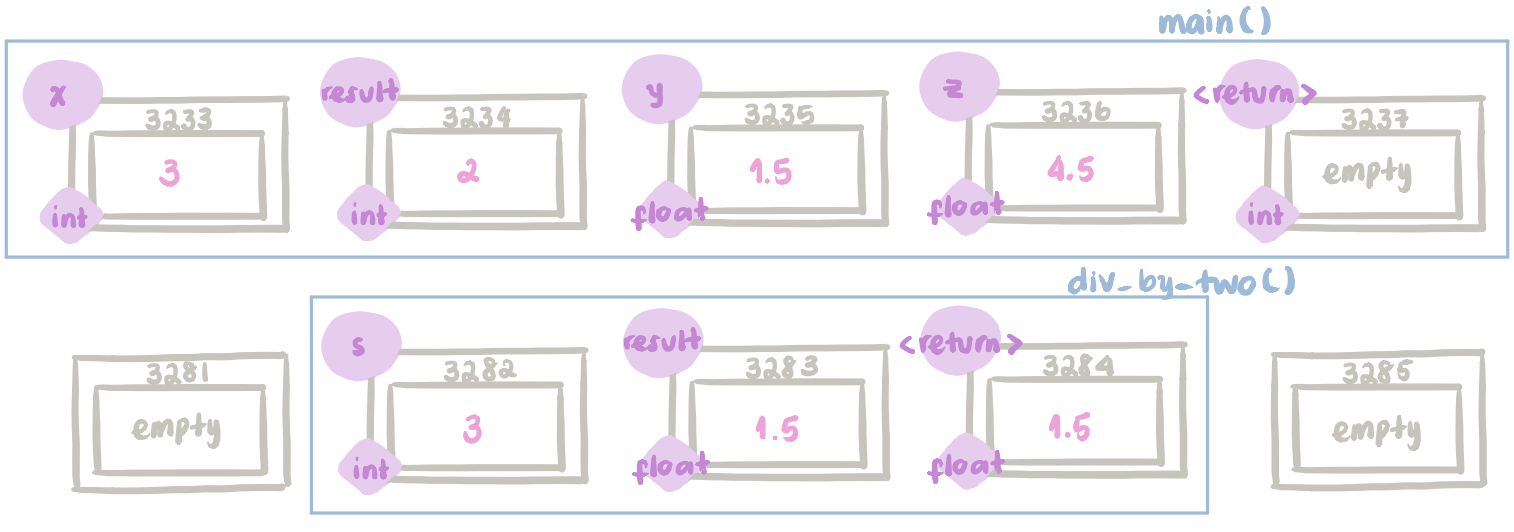
* There are 3 different ways in which a program can get a box in memory:
  - Declaring a variable (each variable gets a box)
  - Input parameters to functions (each gets a box)
  - Return value (gets one box)

Ex1: Draw the diagram of the memory model right at the point where the result is returned (before the space reserved for the function is released) for the following program.

```c
#include<stdio.h>

float div_by_two(int s){
    float result;
    result = s / 2;
    return result;
}

int main(){
    int x, result;
    float y, z;
    x = 3;
    y = div_by_two(x);
    z = y + 3;
    result = z / 2;
    printf("The result is: %d\n",result);
}
```



Arrays and Strings

* Arrays:
  - Collections of contiguous boxes of the same data type. (contiguous in memory)
  - Fixed size
  - Wrong indexes? You are screwed...

* Strings:
  - Arrays of chars.
  - End-of-string delimeter '\0'
  - Strings are passed to functions by telling it is location in memory, so the function can modify the original input.

Ex2: What do you think this prints out?

```c
#include<stdio.h>

int main(){
    char original[1024]="This is the original string!";
    char unoriginal[1024]="And this is another string!";

    original = unoriginal;

    printf("%s\n",original);
}
```

does this even work?! Why?!

How can we copy elements from an array?

Ex3: Does the following code compile? If not, what would you change?

```c
#include<stdio.h>

int main(){
    int  array_one[10];
    int  array_two[5];

    for (int i=0; i<5; i++){
       array_two[i]=i;
    }

    array_one=array_two;
}
```

Nope! C does not allow assignment between arrays like this.

If we need to copy values we need to do it manually.

Ex4: Write a function that takes two input strings (size 1024) and swaps their content.

Hmm... Interesting!

Week 3 - Jan 27th

Pointers

* They are just a variable! With a locker and all, that have the memory address of another variable (which we can decide)

* When we create a pointer, its type has to match the variable type.

E.g. if you want to initialize a pointer to an int variable: `int *p = NULL;`

* But hold on, how do we use pointers ?!

  - We first need to assign a variable to our pointer, so we can use `&`.

    E.g. Store the address of x in p: `p = &x;`

  - We can also use them to access the value from the locker that they are pointing to.

    E.g. Copy the contents of locker (p) into x: `x = *(p);`
    Remember (p) stands for the locker # stored in p.

    How about if we want to access the locker next to (p)? `x = *(p+1);`
    ↳ offset.

  - Now that we can access contents of the locker stored in the pointer, we can also modify its content.

    E.g. Let's change the value of (p) to 5 : `*(p) = 5;`

* Don't forget the equivalence between arrays and pointers.

  E.g. Store the address of the first element of the array in pointer p:
  `p = &my_string[0];` or `p = my_string;`

  - Also, you can use the offset to access the other values of the array.

    E.g. If I have an array of 5 elements `p = my_array;`
    I can initialize all its values to 0. `*(p) = 0;`
    `*(p+1) = 0;` ... and so on.

Ex1 Let's review the 'reverse' function we did in lecture.

`void reverse(char *input, char *output)` make the output be the reverse of the input strings.

Ex2 Create the function 'reverse_inplace' that reverses a string in place (don't use a temp array)

`void reverse_inplace (char *input)` can you modify the existing one? Hint: use pointers + offset.

Ex3 Given the starter file ex3.c, implement the function 'pokeAround' to print the values stored in the other variables around it.

`void pokeAround (char *p)` Hint: use pointers and offsets again ☺

Week 4 - Feb 3rd

c - c - d - a - b - c
d - e - d - b - b - b

Compound Data Types (CDT)

* Useful to represent information about entites that have multiple properties.

  E.g. A student record needs to have fields like name, student number, age, etc.

* We want to keep all these information together and bundle it up in a single package.

* How can you define it?

```
typedef struct struct_name
{
   int field_name;
   // More data
} new_type_name;
```

* How to use them?

  - Declare a variable:
    `new_type_name v;`
  - Access a field:
    `v.field_name = 5;`
  - Pass them or return them from a function:
    `new_type_name update_func(new_type_name v, int value1, ..,)`

* How does it look in memory?

  - A variable of a CDT gets one locker only!
  - Passing or returning a CDT creates a copy
  - Using it with pointers.

```
new_type_name v;
new_type_name *vp;
vp = &v;
vp -> field_name = 5;
```

Week 5 - Feb 10th

Office Hours Change! Now: Fridays 4-5pm in 1C402

Dynamic memory management

Using built-in functions, you can ask for some memory that persists even when the function returns. This memory given to you is stored in a separate area

in memory called the heap.

* To use: call the calloc() function to allocate memory, it will return a pointer to the block of memory, which is the only way to access this block in memory.

* Don't forget to empty the memory once you are done using it.

To allocate enough space for N elements of type T:

```
T *allocatedPtr = (T*) calloc(sizeof(T), N);
```

To free the memory:

```
free(allocatedPtr)
```

Ex: Implement a dynamic array for restaurant reviews like you did in lecture with Linked Lists.