ECE 220

Lecture x000A - 10/01

Slides based on material originally by: Yuting Chen & Thomas Moon

Recap + reminders

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  - Introduction to pointers & arrays, `sizeof` function, etc.

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  - Strings & multidimensional arrays
  - Problem solving examples
  - Quiz #2

Recap

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#include <stdio.h>

int my_first_sum(int arr[]){
  int sum=0, i=0;
  for (i=0; i<5; i++)
    sum += arr[i];
  return sum;
}

int main(void){
  int i, arr[5];
  for (i=0; i<5; i++){
    printf("Enter an integer:\t");
    scanf("%d", &arr[i]);
  }
  printf("\nThe sum is %d", my_first_sum(arr));
}
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Fact: The name of the array is *pointer* to the array!

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int my_third_sum(int *arr){
  int i, sum=0;
  for (i=0; i<5; i++)
    sum += *(arr + i);
  return sum;
}
```

would also work just fine!

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Pointer arithmetic	Pointer arithmetic	Array notation

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`cptr` is defined as a variable. The compiler allows it to be redefined.

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cptr = cptr + 1;
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- Try doing:

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cptr = cptr + 1;
arr = arr + 1;
```

`arr` without the `[]` *decays* to a pointer but once declared is not assignable *sans* subscript.

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```c
#include <stdio.h>

int main(){
    int *arrp;
    int (*arrpw)[5];
    int arr[5]={5,2,3,1,4};

    arrp = arr;
    arrpw = &arr;

    printf("arrp= %p, arrpw= %p\n", arrp, arrpw);
    arrp++;
    arrpw++;
    printf("arrp= %p, arrpw= %p\n", arrp, arrpw);
}
```

Pointers - subtle points

- What is the difference between `arrp`, `arrpw` in the code snippet on the right?
- **Hint**: Consider the output.

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int main(){
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```c
#include <stdio.h>

int main(void){
  int arr[5] = {1, 2, 3, 4, 5};
  int (*arrpw)[5] ;
  int *parr[5];

  arrpw = &arr;

  for (int i=0; i<5; i++){
    printf("*(*arrpw + %d): %d\n", i, *(*arrpw + i));
    printf("*parr[%d]: %d\n", i, *parr[i]);
  }
}
```

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Same as before.

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  arrpw = &arr;

  for (int i=0; i<5; i++){
    printf("*(*arrpw + %d): %d\n", i, *(*arrpw + i));
    printf("*parr[%d]: %d\n", i, *parr[i]);
  }
}
```

Same as before.

`parr` is now an *array* of five pointers.

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```c
#include <stdio.h>

int *printx(void){
    static int x = 0;
    printf("value of x is %d \n",x++);
    return (&x);
}

int main(){
    int *x_ptr;
    x_ptr = printx();
    x_ptr = printx();
    *x_ptr = (*x_ptr) + 1;
    printx();
}
```

More bewares …

- Pointers can be used to modify *static* variables defined inside functions.
- Actually, pointers can also modify `const` variables.

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int *printx(void){
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- Actually, pointers can also modify `const` variables.

```c
int main(void){
    const int var = 10;
    int *ptr = &var;

    *ptr = 12;
    printf("var = %d\n", var);
}
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int main(void){
    const int var = 10;
    int *ptr = &var;

    *ptr = 12;
    printf("var = %d\n", var);
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```

Yes there are things called `const` pointers - but we will only go there when we have to.

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Summary: pointers & arrays

- Pointer
  - Stores the address of a variable in memory
  - Allows us to indirectly access/change variables
- Arrays
  - A list of values arranged sequentially in memory
  - Array name without index is the same as pointer to the array
  - Therefore in C, all arrays are ***passed by reference,*** i.e., if you change array passed to a function, change will be reflected outside!

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  - Write the *function* so that it accepts the array length as a *parameter*.

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- When using arrays we need to know the size or *dimensions* of the arrays.
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```c
# include<stdio.h>

int any_sum(int arr[], int arr_len){
int i, sum = 0;
  for (i=0; i < arr_len; i++)
    sum += arr[i];
return sum;
}

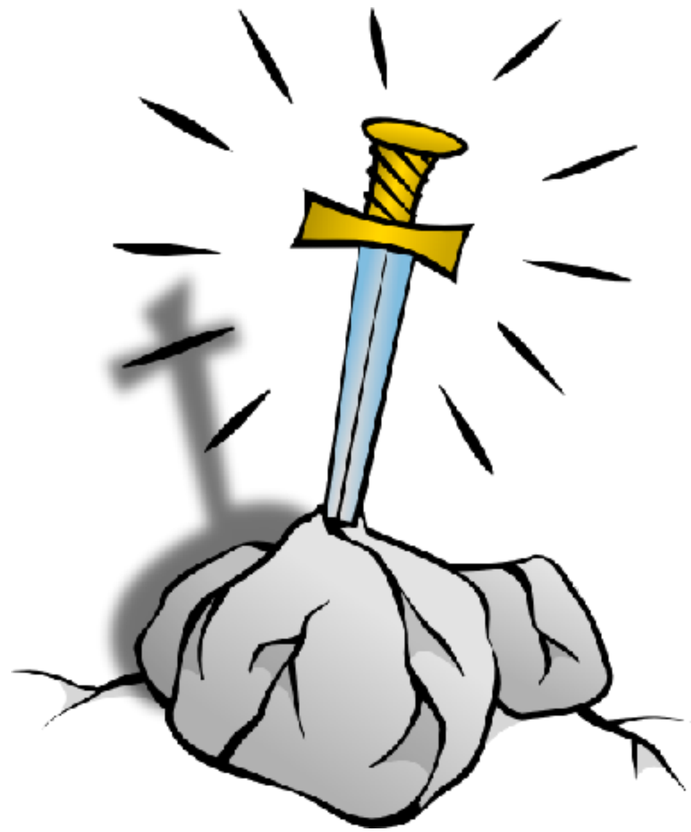
int main(void){
  int arr1[] = {1, 2, 3, 4, 5};
  int arr2[] = {1, 2, 3, 4, 5, 6, 7, 8, 9};

  printf("sum(arr1): %d\n", any_sum(arr1, 5));
  printf("sum(arr2): %d\n", any_sum(arr2, 9));
}
```

Using arrays

- **Challenge:** Can the function be modified so `any_sum` can determine the size of the array *itself* (without passing in the value)?

Definitely let me know if you find a way. 😉



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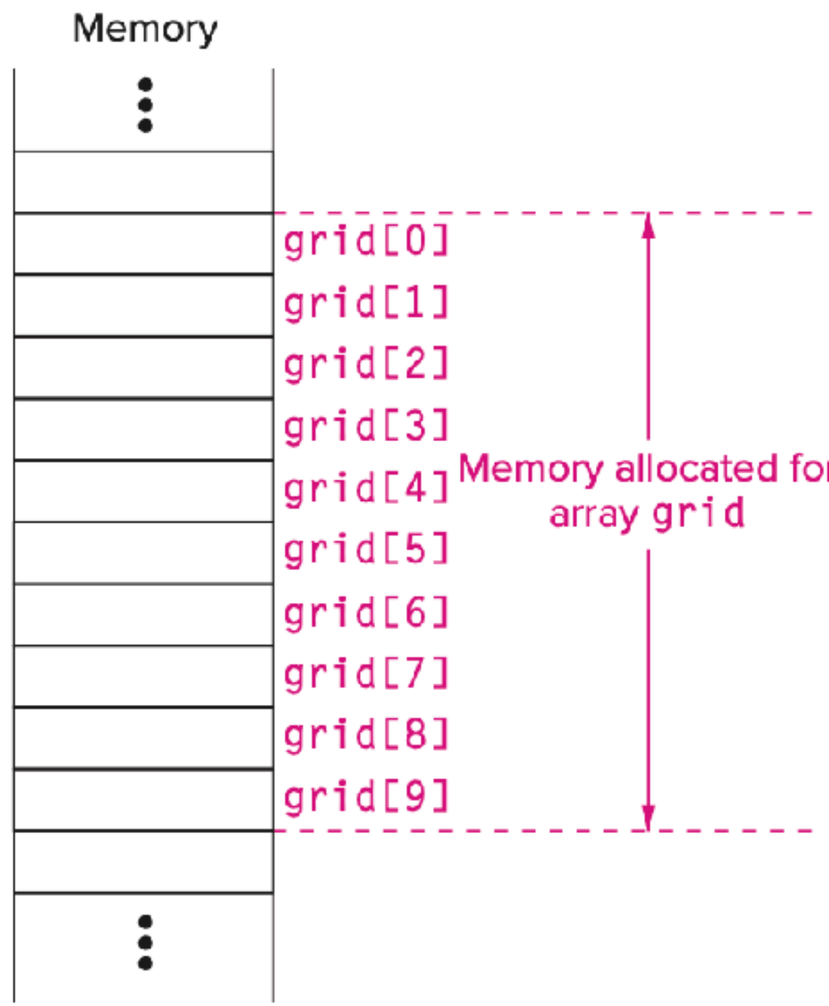

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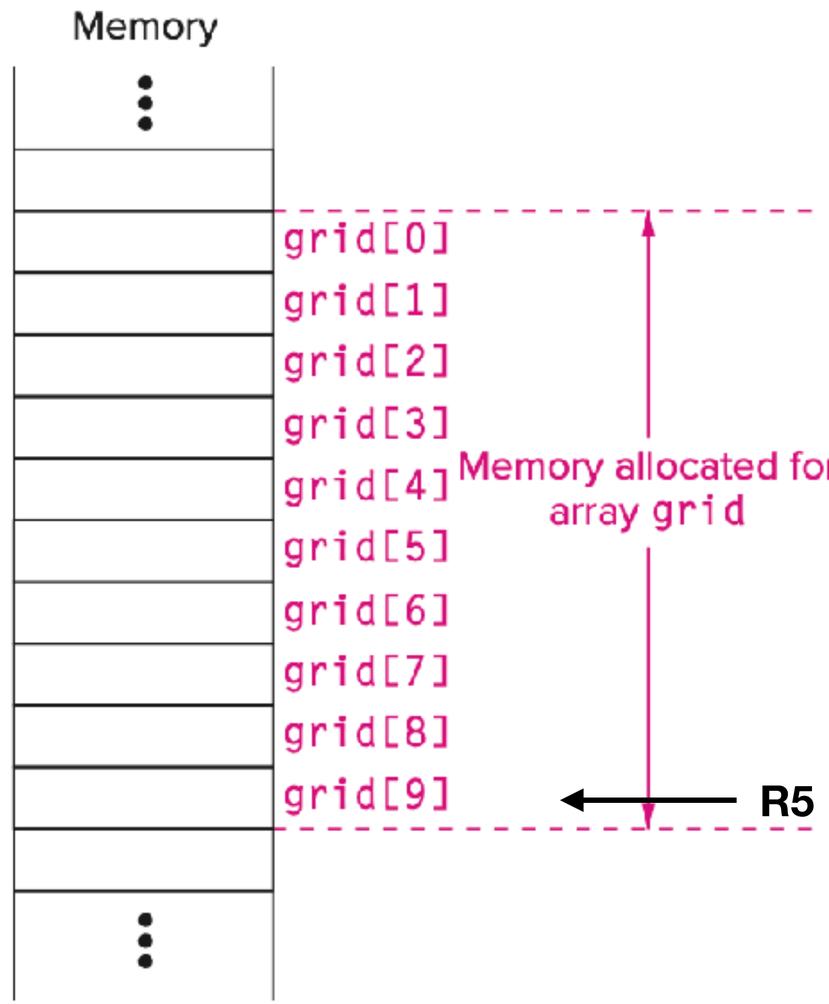

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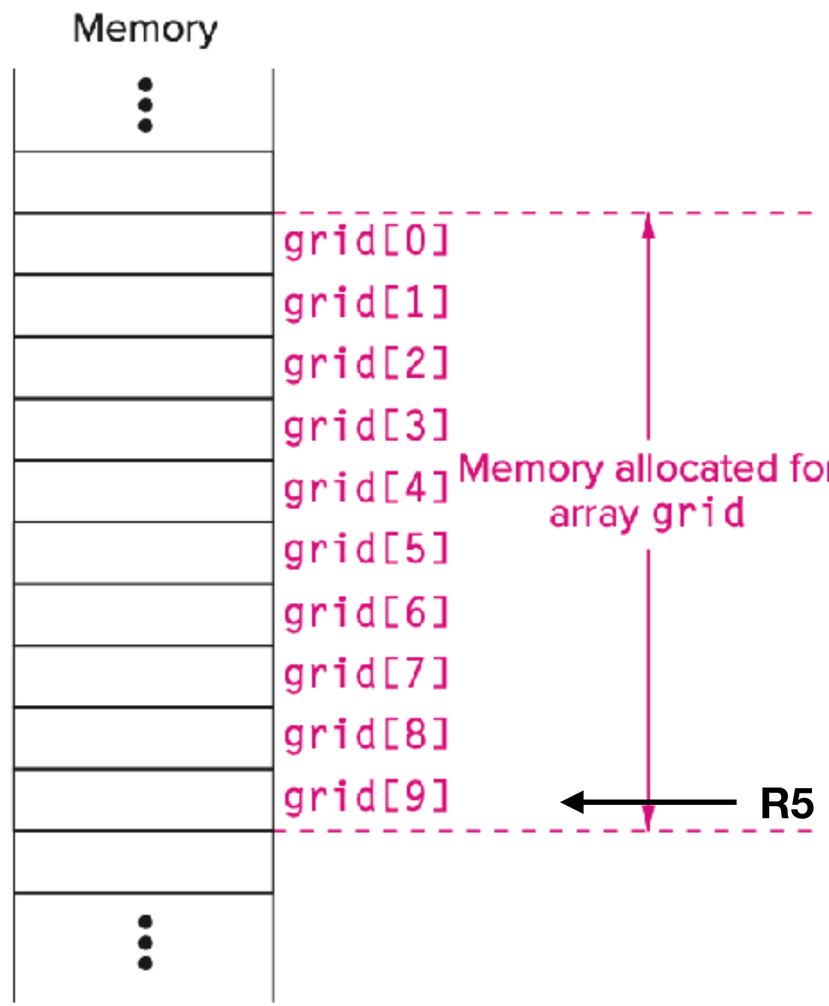

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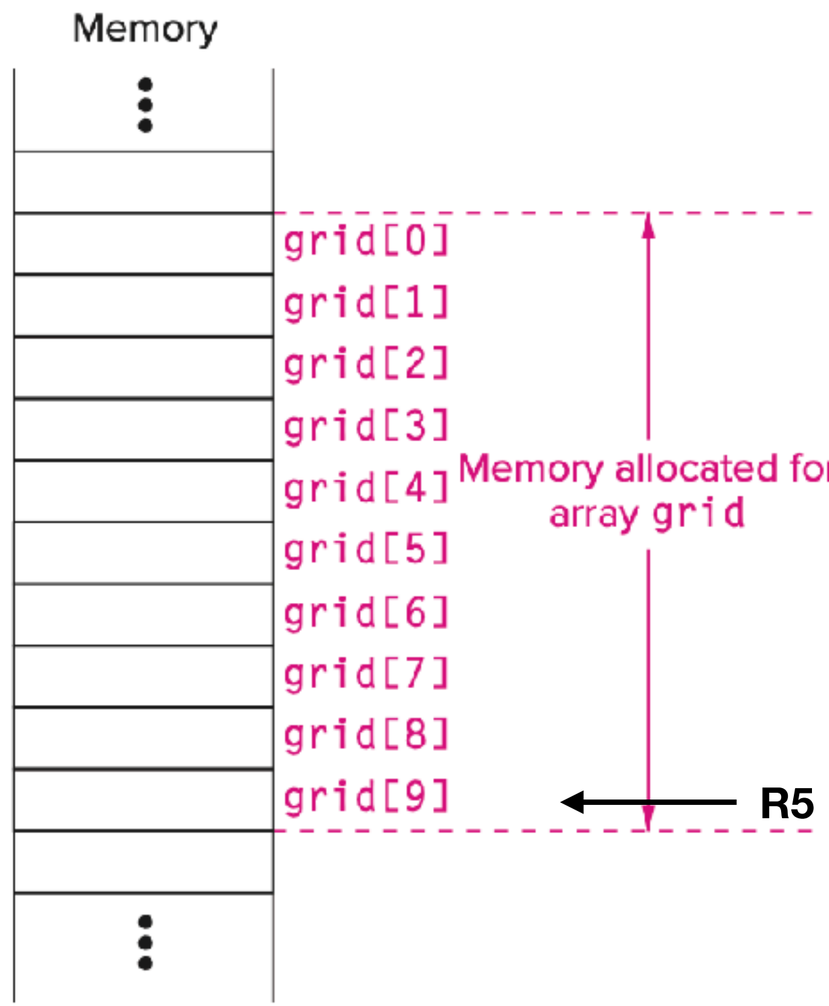

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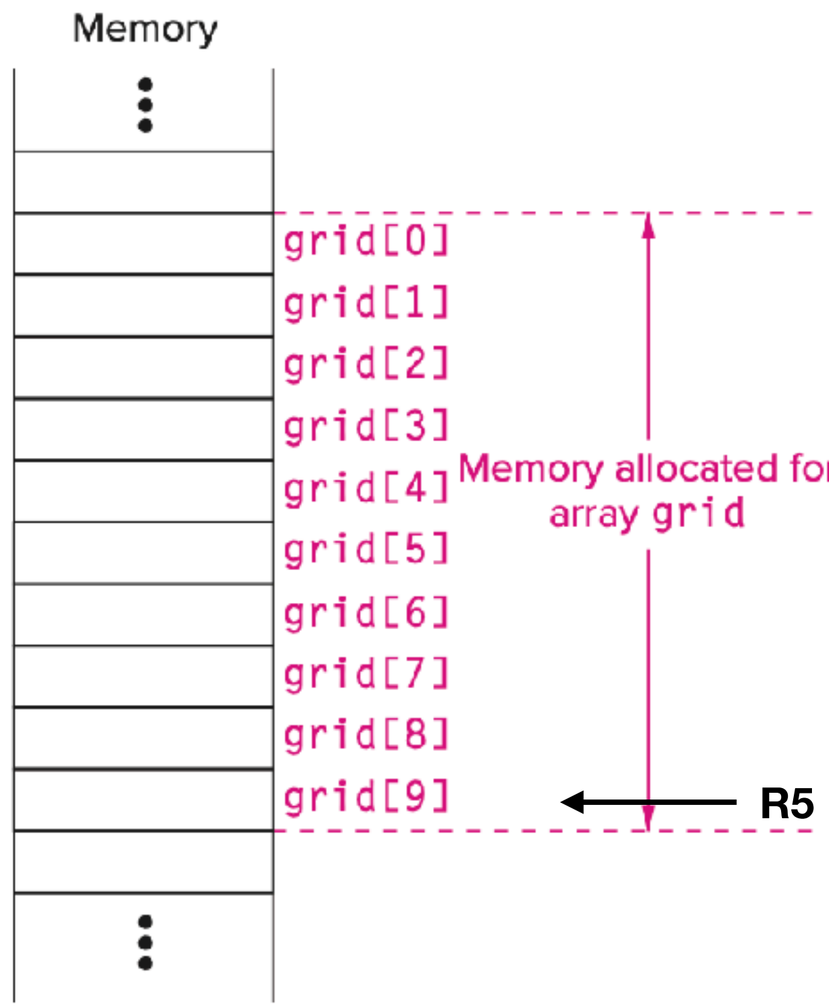

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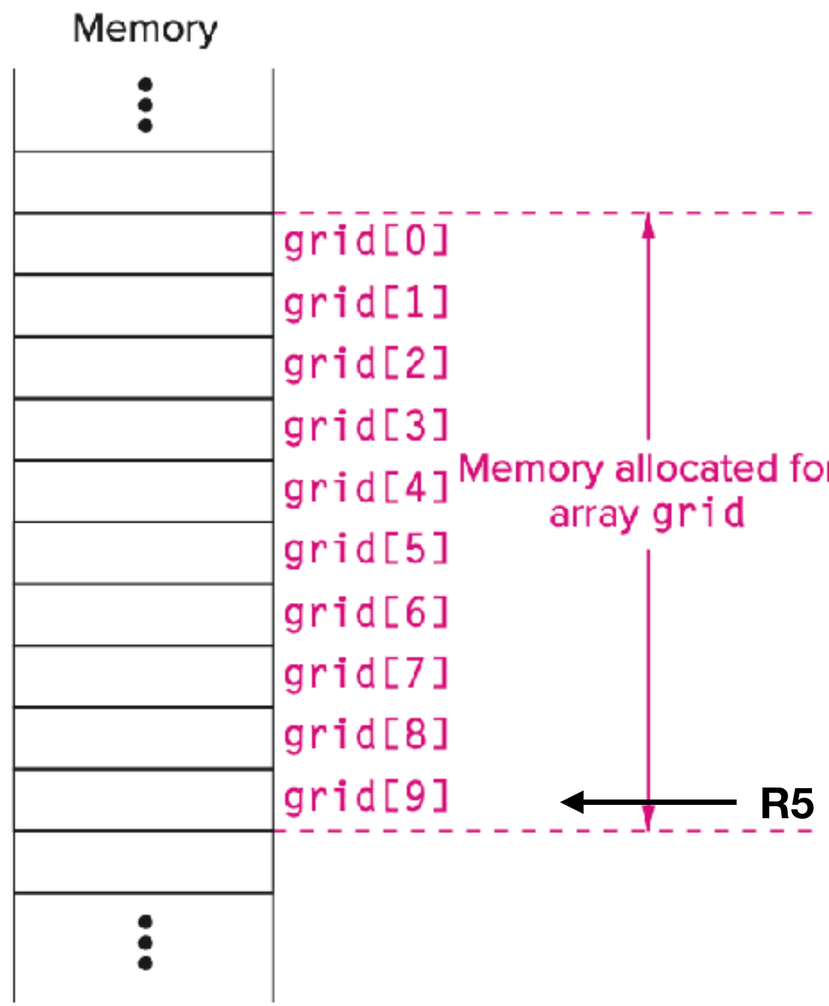

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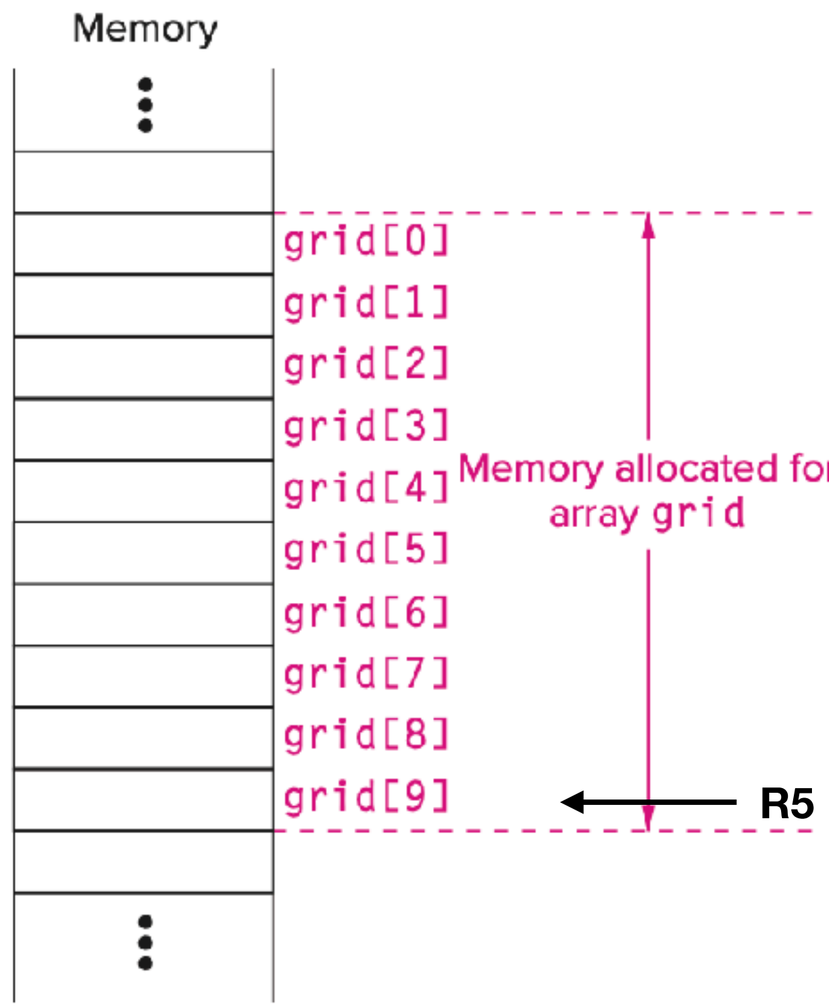

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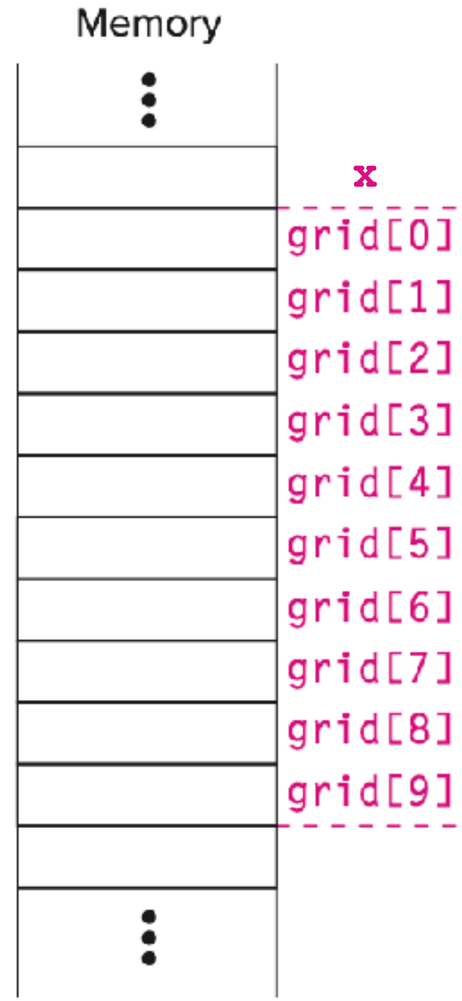

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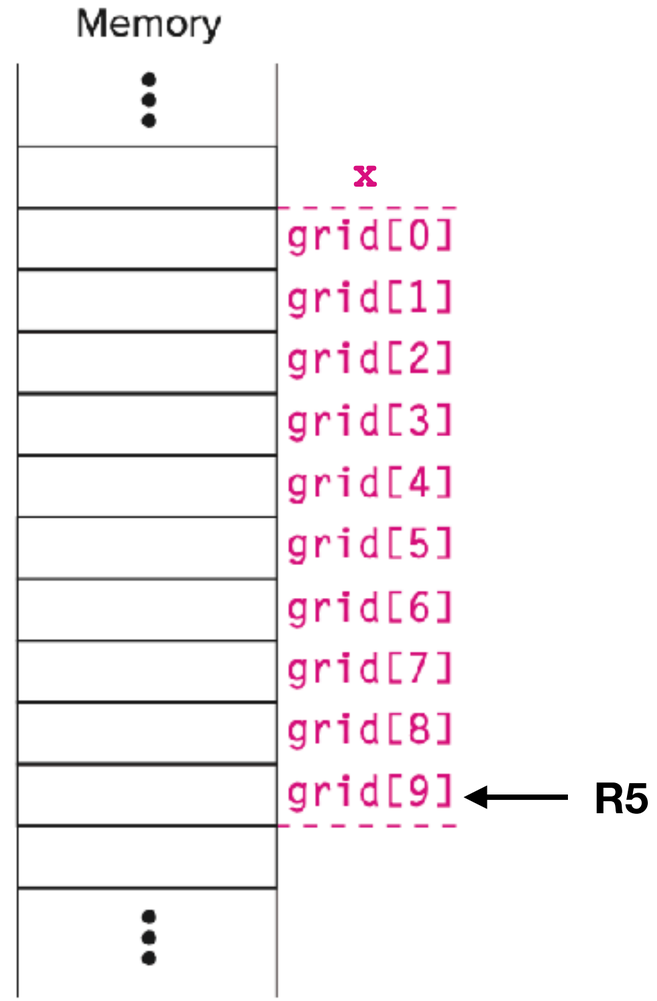

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grid[x+1] = grid[x] + 2;
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```
LDR R0, R5, #-10 ; Load the value of x
ADD R1, R5, #-9  ; Base address of grid
ADD R1, R0, R1   ; Calculate address of grid[x]
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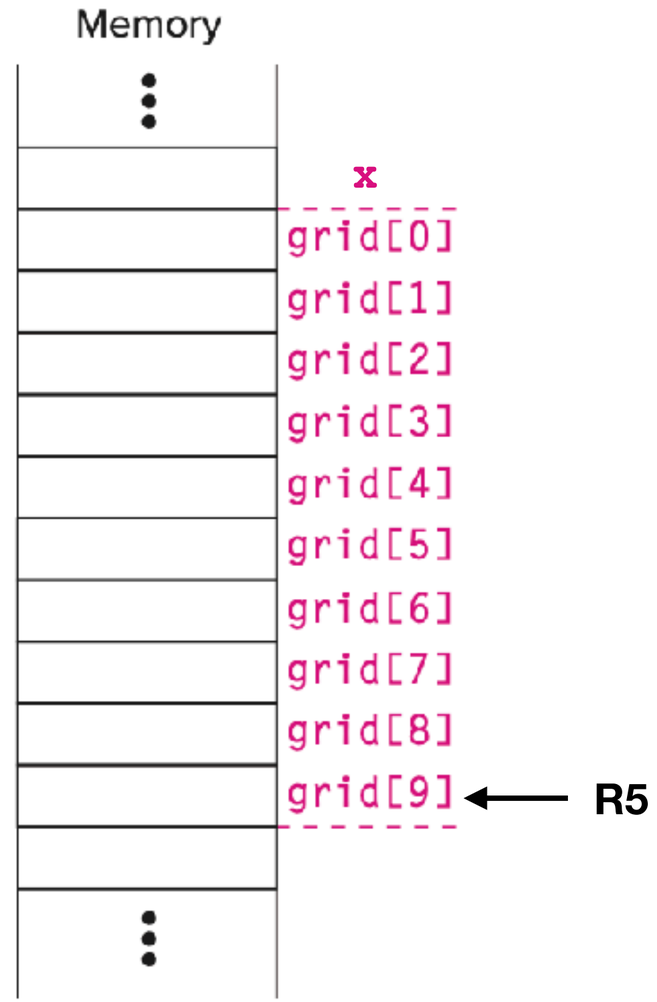

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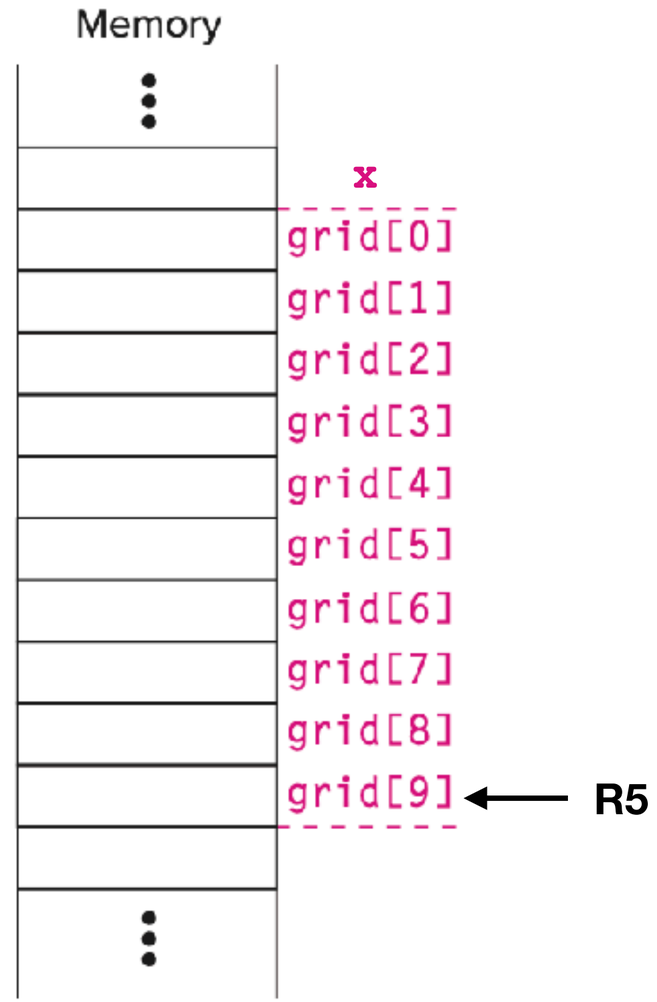
LDR R2, R1, #0   ; R2 <-- grid[x]
ADD R2, R2, #2   ; R2 <-- grid[x] + 2
```



Arrays in LC-3

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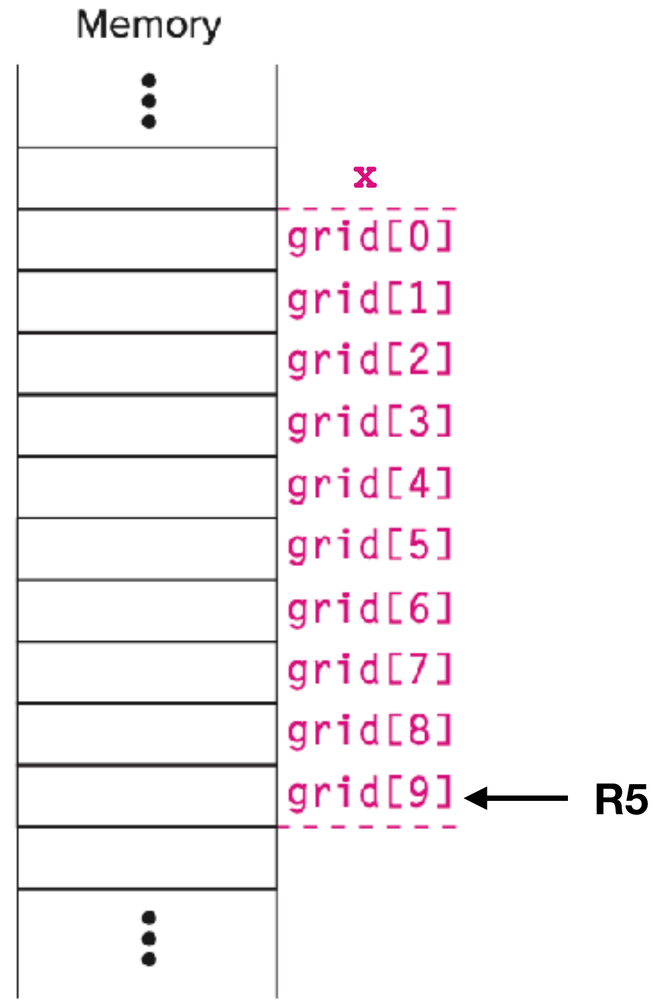

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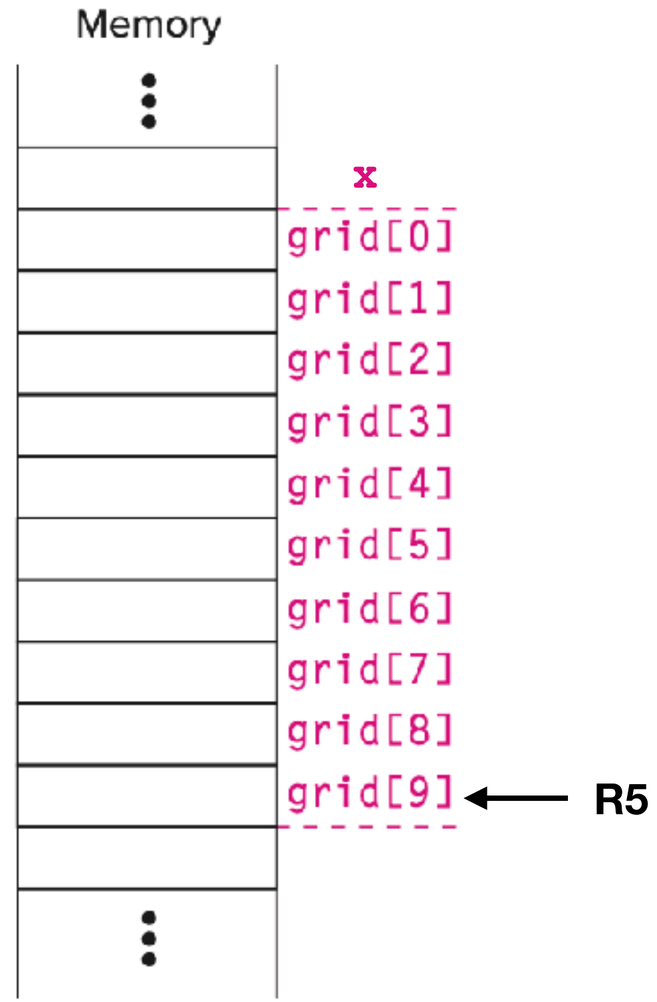

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Note “ vs. ‘

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Note “ vs. ‘

Did not use all 10 characters - some are unused

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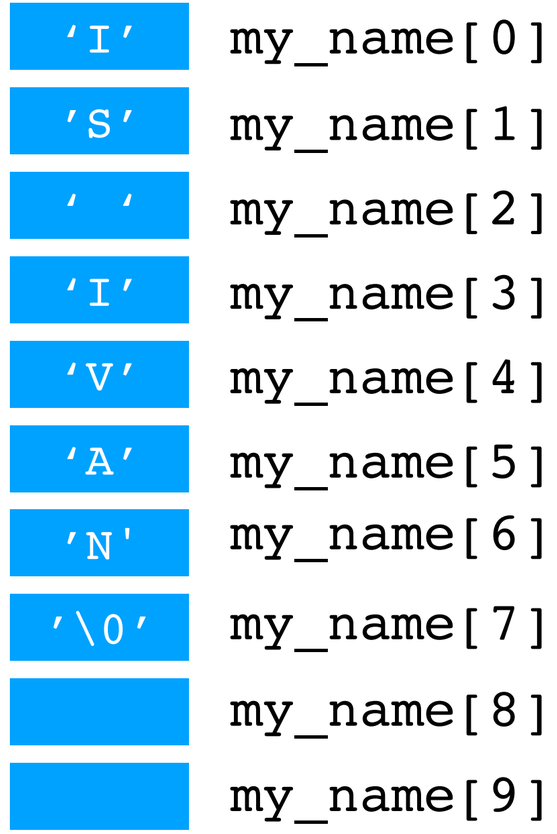

Strings in C

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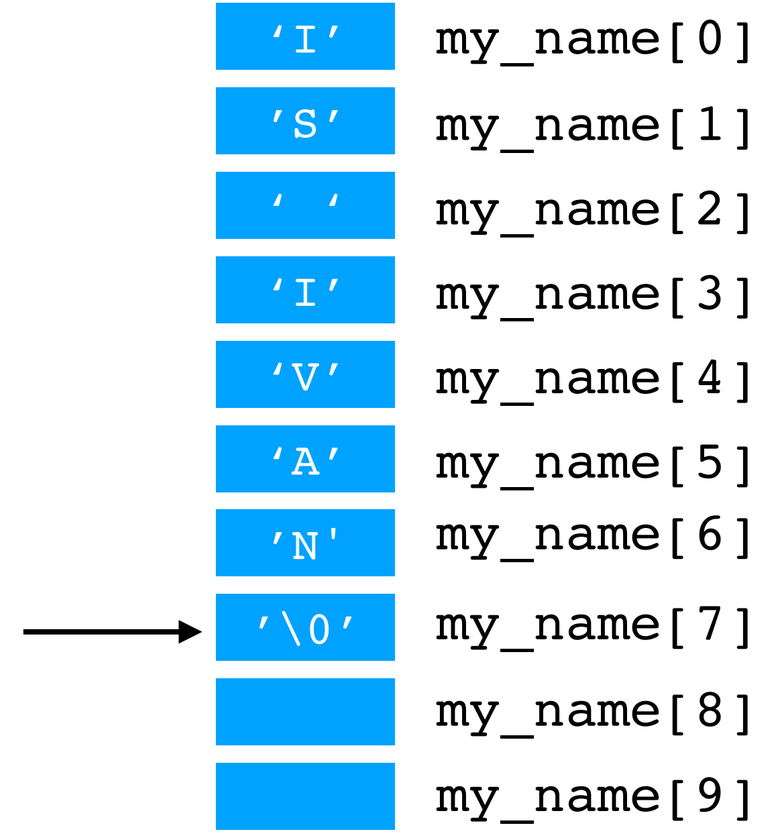
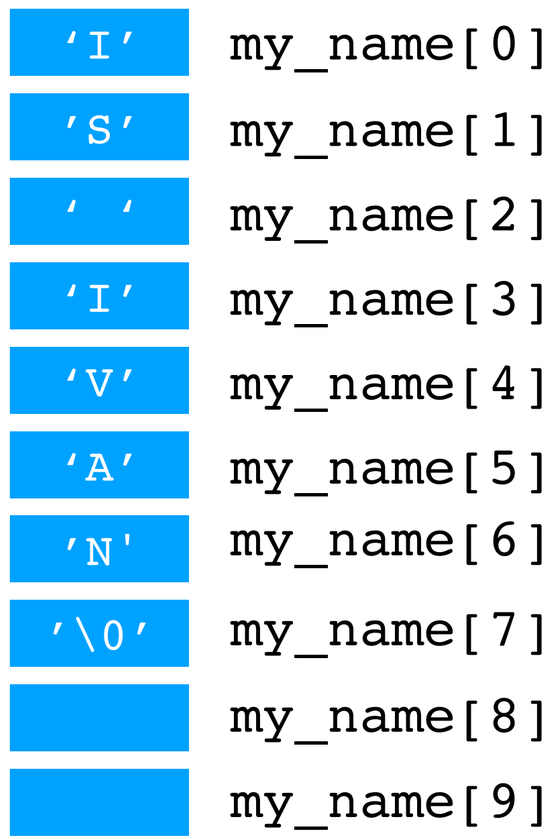
  - *Null-termination* for strings.



Strings in C


'I'
my_name[0]
'S'
my_name[1]
' '
my_name[2]
'I'
my_name[3]
'V'
my_name[4]
'A'
my_name[5]
'N'
my_name[6]
'\0'
my_name[7]
my_name[8]
my_name[9]

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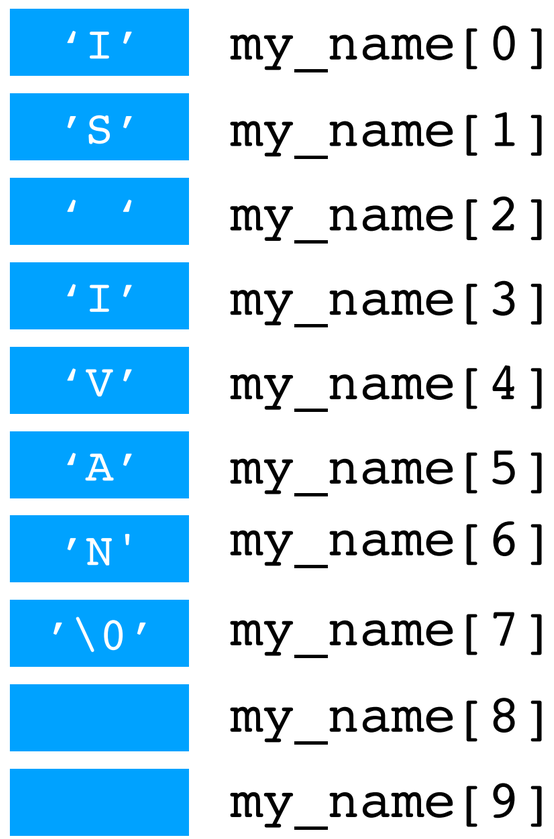

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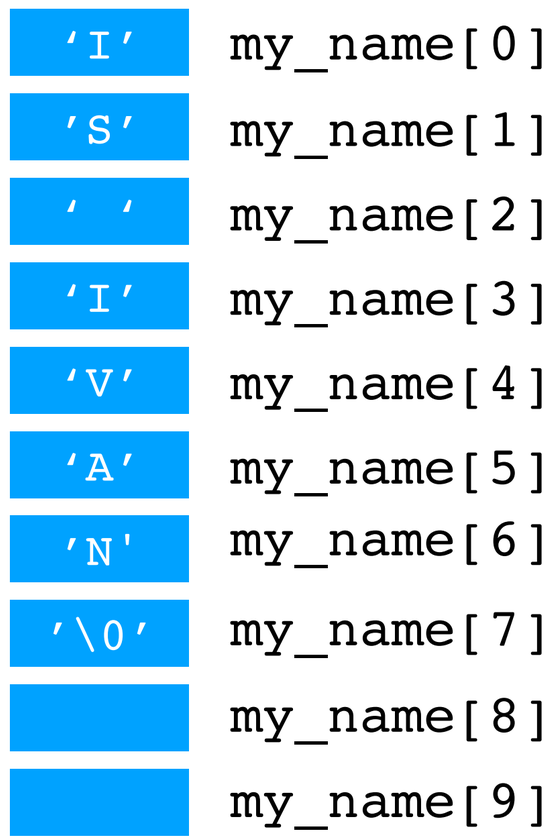

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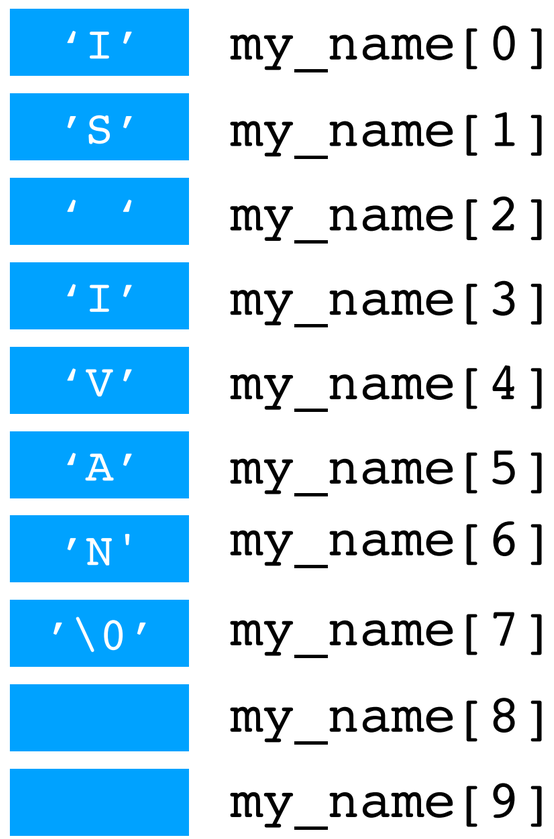

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my_name[2] = '_';
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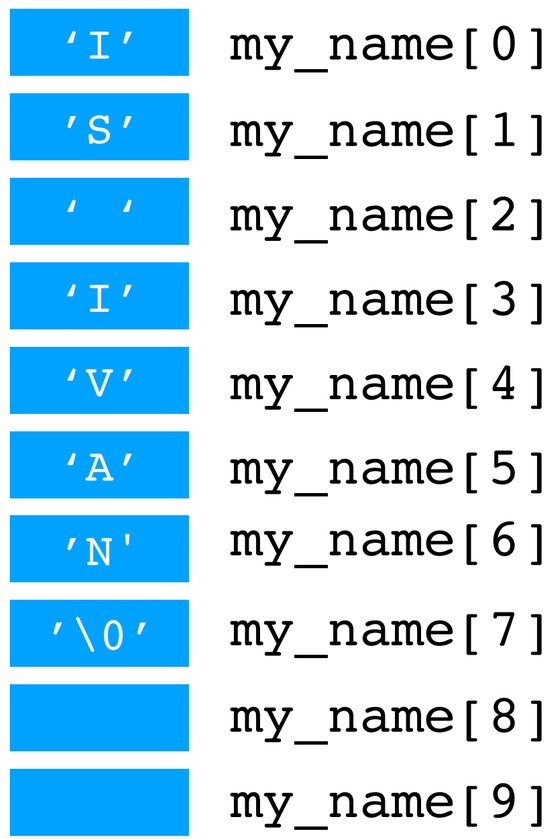

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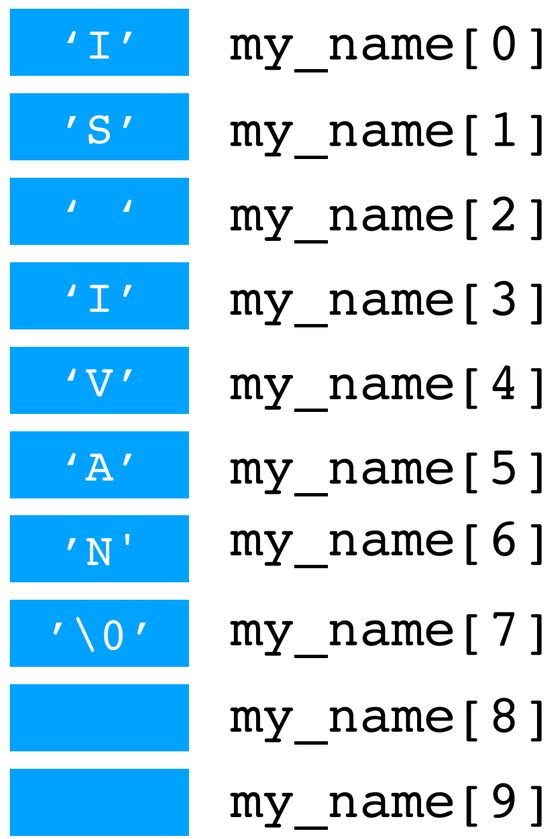

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Single quote

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- Run code on right with input “ECE 220” typed in from the console.

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#include <stdio.h>

int main(void){
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  char mychar;
  printf("Enter a string:\t");
  scanf("%s", mystr);
  printf("\nYou entered: %s", mystr);
  printf("\nEnter a character:\t");
  scanf("%c", &mychar);
  printf("\nYou entered: %c\n", mychar);
  return 0;
}
```

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- Run code on right with input “ECE 220” typed in from the console.

- What happened?

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Syntax: `fgets(charbuf, buf_size, source)`

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- Is that the only way to fix the issue?

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scanf("%10[0-9a-zA-Z ]", mystr);
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- We use the `sscanf` function.

```
sscanf(char_buffer, format_string, variables…)
```

Example

- Write a C program that will parse user input of a sequence of digits in the format `xxx-xxx-xxxx` as 10 digit phone number. In other words into an area code, prefix and a local identifying number. Print each out to the console separately.

Example

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```c
#include <stdio.h>

int main(void){
  int area_code, prefix, pnum;
  char mystr[13];

  printf("Enter a 10-digit phone number.\n");
  printf("Format: xxx-xxx-xxxx\n");

  fgets(mystr, 13, stdin);
  sscanf(mystr, "%d-%d-%d", &area_code, &prefix, &pnum);

  printf("\nArea code: %d", area_code);
  printf("\nPrefix: %d", prefix);
  printf("\nLocal: %d", pnum);

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Example

Why 13?

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What if input did not fit given format?

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  return 0;
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`sscanf` will return number of values correctly parsed

Entering multiple strings?

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```
#include <stdio.h>

int main(void){
char arr[][6] = {"cat",
                 "horse",
                 "golf"};

int i;
printf("Elements are:\n");
for (i = 0; i < 3; i++)
   printf("%s\n", arr[i]);
}

arr[1] = "cat";
}
```

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→ Compiler error! Cannot assign to array.

To modify character arrays after declaration use `strcpy` from `<string.h>` (which also houses a `strlen` function just FYI).

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arr[1] = "dog";
}
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Strings - subtle points

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- You will often see the code from the previous slide written this way.

- But they are **NOT** equivalent.

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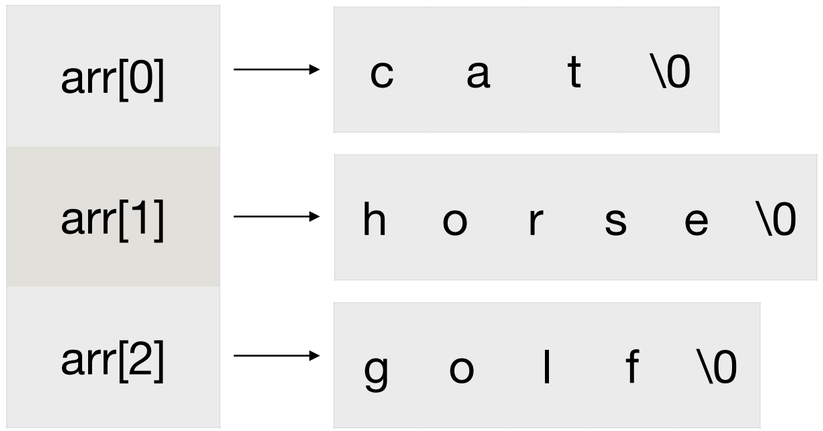


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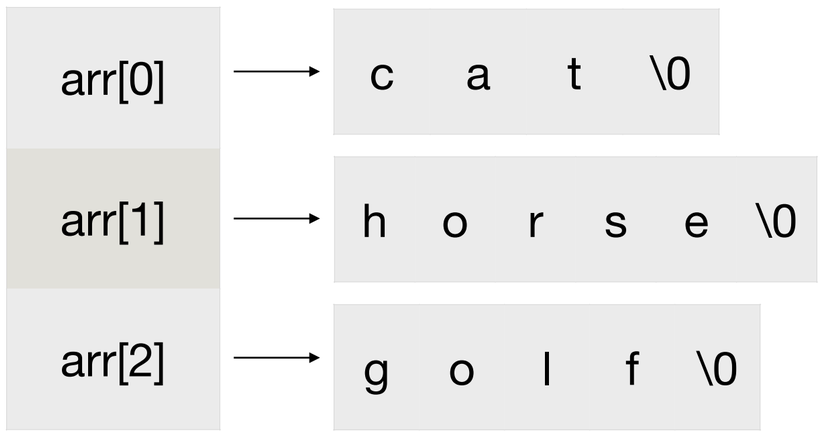


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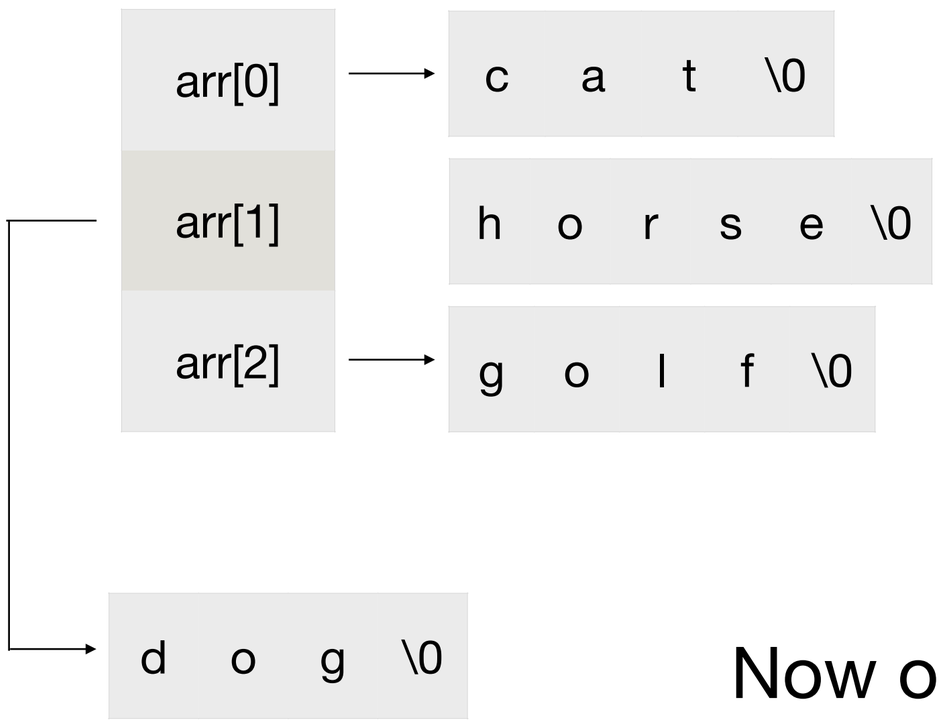
Now okay!

Strings - subtle points

Memory allocation

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printf("Elements are:\n");
for (int i = 0; i < 3; i++)
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}

arr[0][1] = 'o';
}
```

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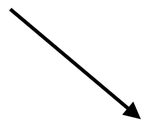

Undefined behavior!

Strings - subtle points

```c
#include <stdio.h>

int main(void){
char arr[3][6] = {"cat",
                  "horse",
                  "golf"};

printf("Elements are:\n");
for (int i = 0; i < 3; i++)
   printf("%s\n", arr[i]);
}

arr[0][1] = 'o';
}
```

Okay.

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Okay.

These are stored as *string literals*, often in read-only memory. `arr` just points to them.

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These are allocated on the stack and so `arr` remains modifiable.

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