

Create a Program in C (Last Class)

- Input:
 - three floating point numbers
- Output:
 - the average of those three numbers
- Use:
 - `scanf` to get the input
 - `printf` to show the result
 - a function to calculate the average

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printf, scanf Syntax

```
printf(char *format, ...)
```

```
scanf(char *format, ...)
```

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Format String

- `%d` – decimal integer
- `%s` – string
- `%c` – character
- `%f` – floating-point number

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Example

```
int x;
```

```
scanf("Enter an integer: ", &i);
```

```
printf("The integer you entered is: ", i);
```

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C/Java Syntax – Arrays and Strings

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Lecture 03 Summary

- Arrays
- In-class Exercises
- Strings

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By the end of this lecture, you will be able to write C code that uses and manipulates arrays and/or strings.

You will also be able to describe what happens in the computer's memory when this code is executed.

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In Python, how would you write a function that takes the average of a set of numbers?

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Example

```
def average(list):
    sum = 0.0
    size = 0
    for num in list:
        sum = sum + num
        size = size + 1

    return sum / size
```

- What would you pass into this function?

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Example

```
avg = average([3,5,10,4,1,6])
```

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In C, there are no lists, only arrays

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Arrays vs. Lists

Arrays in C

- Have a fixed size that never changes
 - once full, will not grow
- All elements are of the same type (int, float, etc.)
- Has no insert or append operations
 - must write these yourself

Lists in Python

- Can add/remove elements at will
- Elements can be of different types
- Has special operations to insert, append, get the size, etc.

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Array Declaration Syntax

```
<type> array_name[<# elements>];
```

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Examples

```
int test_scores[10];
char student_name[50];
short avg_rainfall[31];
float observations[10000];
double temperatures[100];
unsigned int no_negatives[25];
long long big_numbers[3000];
```

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Array Access Syntax

```
array_name[<element-index>]
```

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Example

```
main()
{
    int test_scores[100];
    int i;

    /* initialize all array elements to 0 */
    for (i = 0; i < 100; i++)
        test_scores[i] = 0;

    /* Print out array elements */
    for (i = 0; i < 100; i++)
        printf("test_scores[%d] = %d\n", i, test_scores[i]);

    /* modify some array elements */
    test_scores[30] = 89;
    test_scores[25] = 37;
    test_scores[98] = 56;
    test_scores[33] = 21;

    /* print out array elements */
    for (i = 0; i < 100; i++)
        printf("test_scores[%d] = %d\n", i, test_scores[i]);
}
```

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Array Initialization Syntax

```
<array-declaration> = { <element1>,  
    <element2>, <element3>, ... };
```

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Example

```
main ()  
{  
    int my_array[] = {50, 25, 31, 22, 16};  
    int i;  
  
    for (i = 0; i < 5; i++)  
    {  
        printf("my_array[%d] = %d\n", i, my_array[i]);  
    }  
}
```

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Arrays as Function Parameters

```
void print_int_array(int array[])
```

- Write this function

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Write a C function that computes the average of an array of numbers.

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Exercises: Arrays in Memory

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Exercise 1: Draw a Diagram

```
main()
{
    char array1[5];
    short array2[5];
    int array3[5];
    long array4[5];
    long long array5[5];
    float array6[5];
    double array7[5];

    unsigned char array8[5];
    unsigned short array9[5];
    unsigned int array10[5];
    unsigned long array11[5];
    unsigned long long array12[5];
}
```

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Exercise 2

- Compute the size (in bytes) of each array.
- How did you compute the size?
- What information do you need to know to compute the amount of memory taken by an array?

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Exercise 3

- Assume all of the arrays start at location 1000 (decimal).
- Compute the address (in memory) for each array element for each array.

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Exercise 4

- What is the relationship between the index of an array element and its actual address? (express your answer in the form of an equation)

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Exercise 5: Explain the output

<code>main ()</code>	Output:
<code>{</code>	
<code> int x = 1000;</code>	x = 1000
<code> int my_array[100];</code>	y = 1000
<code> int y = 1000;</code>	
<code> int i;</code>	
<code> printf("x = %d\n", x);</code>	x = 1000
<code> printf("y = %d\n\n", y);</code>	y = 5000
<code> my_array[-1] = 5000;</code>	
<code> printf("x = %d\n", x);</code>	
<code> printf("y = %d\n", y);</code>	
<code>}</code>	

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Consider the following

```
void function(float[] array)
{
    ...
}
```

- What is the maximum size of the array?
- How many elements are in the array?
- What happens if you try to access an element outside the array's bounds?
- How would you insert an element in the middle?

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```
array[89]
```

- When the compiler sees this bit of code, what does it do?

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Strings

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In C, there is no “string” type

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What is a string made up of?

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Example

```
char student_name[30];
```

- Can I store the string “Wolfeschlegelsteinhausenbergerdorff” (35 chars)?
- Can I store the string “Matthew” (7 chars)?
- How does `printf` know to stop after the ‘w’?

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Null-terminated

- A string does not have to take up all of the allocated space.
- Must end with the null character:
 - `'\0'`
 - ascii value 0

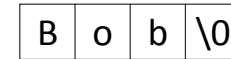
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Example

```
char name[] = "Bob";
```



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What happens if you forget to end a string with `'\0'`?

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C String Functions

Name	Syntax	Purpose
<code>strcpy</code>	<code>strcpy(char *s1, const char *s2)</code>	Copies the string pointed to by s2 into the character array pointed to by s1 (including the null terminator byte). s2 must be null-terminated and the programmer must ensure that the character array pointed to by s1 is large enough to accommodate the string in s2.
<code>strncpy</code>	<code>strncpy(char *s1, const char *s2, int n)</code>	Copies at most n characters from s2 into the character array s1. The null byte will be included in the copy.
<code>strcat</code>	<code>strcat(char *s1, const char *s2)</code>	appends string s2 to the end of character array s1. The first character of s2 overwrites the null character at the end of s1.

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Name	Syntax	Purpose
strncat	<code>strncat(char *s1, const char *s2, int n)</code>	appends at most n characters of the string s2 to the end of character array s1. The first character of s2 overwrites the null character at the end of s1.
strcmp	<code>int strcmp(const char *s1, const char *s2)</code>	compares the string s1 to the string s2. If the strings are identical, the function returns 0. If s1 is <i>lexically less than</i> s2, then a number < 0 is returned. If s1 is <i>lexically greater than</i> s2, then a value > 0 is returned.
strncmp	<code>int strncmp(const char *s1, const char *s2, int n)</code>	same as strcmp except than only up to n characters are compared.
strlen	<code>int strlen(const char *s)</code>	returns the number of characters in the string (not including the null character)

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Example

```
strcat(char *s1, const char *s2)
{
    int i = 0;
    int j = 0;

    /* Find the end of the first string */
    while (s1[i] != '\0')
    {
        i++;
    }

    /* Starting there, add the contents of the second */
    while (s2[j] != '\0')
    {
        s1[i] = s2[j];
        i++;
        j++;
    }

    /* Make sure the string is null-terminated */
    s1[i] = '\0';
}
```

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Exercise

- Create a function called `ninjify` that adds an extra space character in between each word.
 - “Is there a ninja in my program?” would become:
“Is there a ninja in my program?”
- The function signature should be:


```
void ninjify(char *s1, const char *s2)
```

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Next Class

- Pointers and Indirection

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