Arrays and Strings
Arrays and Pointers

• In C, array names are just aliases that can be used as pointers

  ```c
  int y[] = {2, 3, 4, 5};  // these two are
  int *y = {2, 3, 4, 5};   // roughly equivalent
  ```

• Indexing and dereferencing pointers are equivalent

  Side note: you can do arithmetic with pointers!
  ```c
  *y ≡ y[0]           *(y+1) ≡ y[1]
  ```
Arrays and Pointers

- Pointer types are important!
  - If $x$ is an `int8_t*`, $x[3]$ accesses element at byte offset $3 \times 1 = 3$
  - If $y$ is an `int32_t*`, $y[3]$ accesses element at byte offset $3 \times 4 = 12$
Pointers

```c
int x = 1;
int y[4] = {2, 3, 4, 5};
int *p = &x;
*p = 6;
p = y;
*p = 7;
```

What are the values of x and y at the end?
Pointers

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int *p = &x;
*p = 6;
p = y;
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```
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int *p = &x;
*p = 6;
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int *p = &x;
*p = 6;
p = y;
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Pointers

int x = 1;
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What about this?
p++;  
*p = 9;
Arrays and Pointers

• The same is (roughly) true for C "strings" (arrays of chars)

```c
char text[] = "hello";   // read-write
char *text = "hello";    // read-only
```
C Strings

- C strings are a sequence of ASCII chars **terminated with null char (‘\0’)**
  - Declare and initialize (static/stack, no explicit size needed):
    - char *name   = "John Smith";
    - char name[] = "John Smith";
  - Declare only (static/stack, size needed):
    - char name[11];
  - Declare only (heap, size needed):
    - char *name = (char*) malloc (sizeof(char) * 11);

- Useful functions (need to **#include <string.h>**)
  - Find length: **strlen**
  - Copy string or convert / format data into string: **snprintf**
  - Convert to long / float: **strtol / strtof**
  - Compare strings: **strncmp**
  - Search for substring: **strstr**
Information = Bits + Context

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Copying strings

- In Java: `dest = str1 + str2;` // copy strings
  - What does this code do in C?

```
  hello
  // str1
  dave
  // str2
```

- Need to copy all characters from one string to another
  - First for `str1` and then for `str2`
Copying strings

• Old solution: `strcpy`
  - Basically:  
    ```
    void strcpy (char *dest, char *src) {
        for (int i = 0; src[i] != '\0'; i++) {
            dest[i] = src[i];
        }
    }
    ```
  - What happens if `src` isn't null-terminated?

OUT OF BOUNDS!!!
Copying strings

• Using `strcpy` is now considered **unsafe**
  – You are **not permitted** to use it in CS 261
• Solution: specify a maximum length that is safe to copy
  – This is usually the allocated length of the destination
• Older alternative: `strncpy`
  – Requires a maximum length
  – However, it does not guarantee the result is null-terminated
• Newer alternative: `strcpy_s`
  – However, it is not in the C99 standard
• **Better alternative:** `snprintf`
  – Safe, C99-standard, and more powerful than the other two
Output and string conversion

- `printf` and `snprintf` are conceptually similar
  - The former prints to standard out
  - The latter "prints" to a string (character array)
  - The latter can also copy strings and convert to strings

- `snprintf(dest_str, max_size, "%s", src_str);` // copy string
- `snprintf(dest_str, max_size, "%d", int_var);` // int -> string
- `snprintf(dest_str, max_size, "%f", float_var);` // float -> string

```c
int printf (                            char *format, ...)
int snprintf (char *buffer, int bufsize, char *format, ...)
```
Question

• How do we declare an array of strings?
Arrays of arrays

- Array of string (char*) pointers
  - Two (roughly) equivalent syntax choices
    - char *name[];
    - char **name;
  - Must allocate/initialize each sub-array separately

- Command-line parameters
  - int main (int argc, char *argv[])
  - Example: "./program -a myfile.txt"
    - argc = 3
    - argv[0] = "./program"
    - argv[1] = "-a"
    - argv[2] = "myfile.txt"
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#define STR_LEN 8

int main(int argc, char **argv)
{
    // check parameters
    if (argc != 3) {
        fprintf(stderr, "Usage: ./hello2 <fname> <lname>

        exit(EXIT_FAILURE);
    }

    // convert name to "First L." format
    char fullname[STR_LEN];
    snprintf(fullname, STR_LEN, "%s %c.", argv[1], argv[2][0]);

    // output new full name
    printf("Hello, %s!\n", fullname);

    return EXIT_SUCCESS;
}