C Bootcamp

CI Computer Girls

April 30, 2016

Hello World

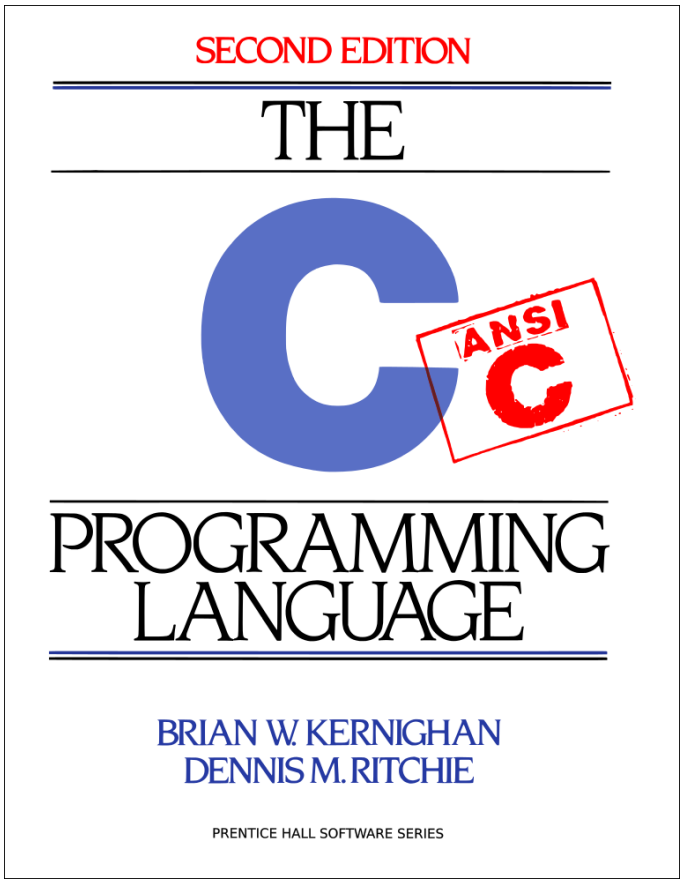

Figure 1: The bible.

- A C program consists of *functions* and *variables*.

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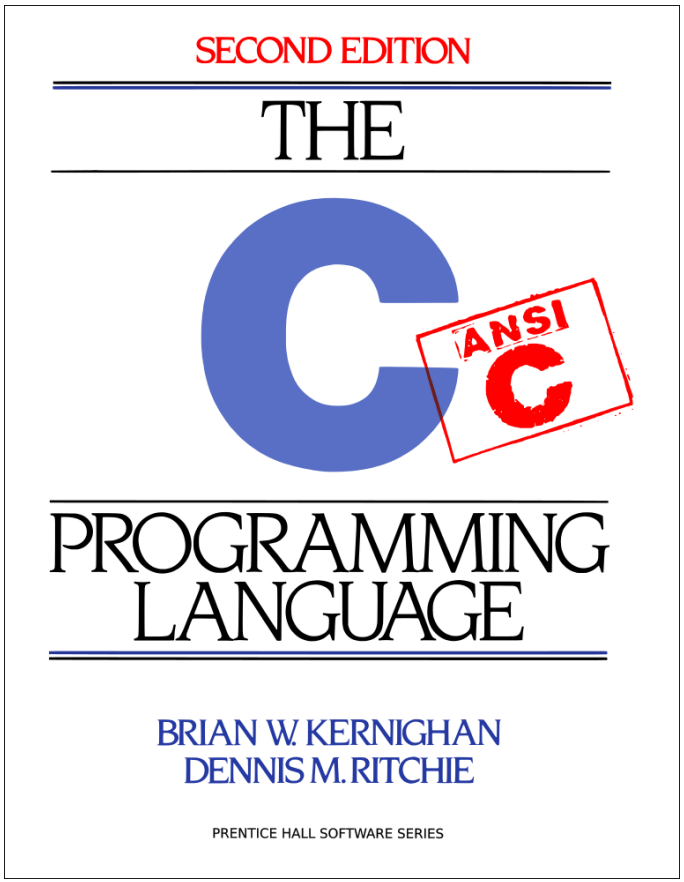

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- A function contains *statements* that specify the computing operations to be done.

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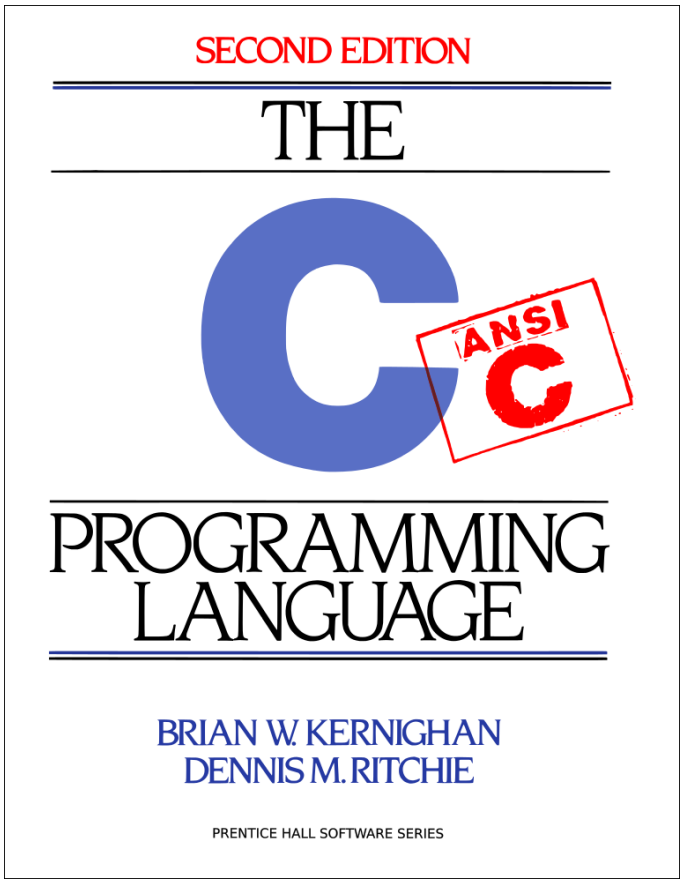

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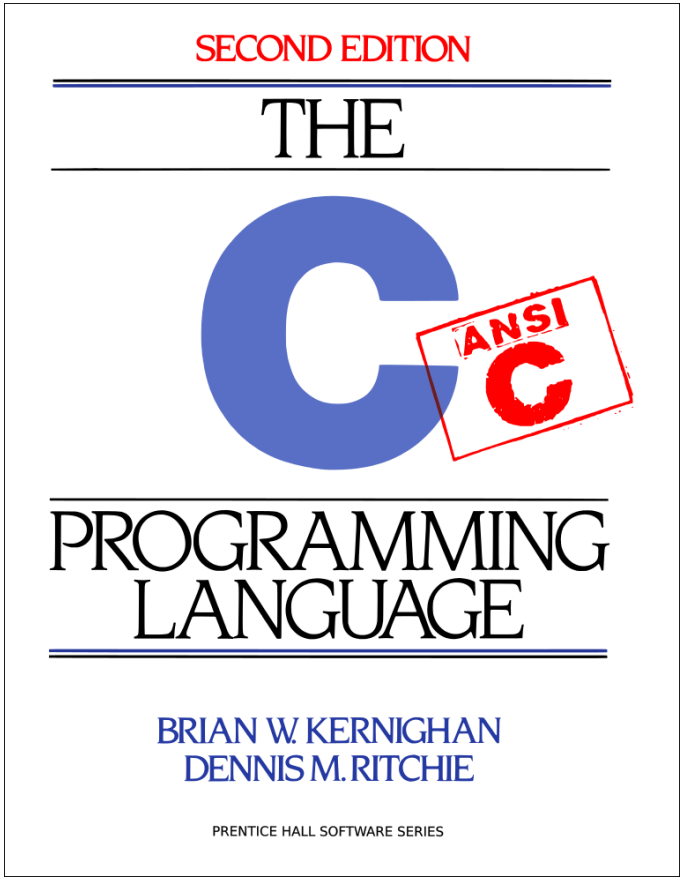

Figure 1: The bible.

- A C program consists of *functions* and *variables*.
- A function contains *statements* that specify the computing operations to be done.
- Variables store values to be used during computation.
- Normally you can name functions whatever you like, but every program must contain a function named `main`.

Hello World

```c
#include <stdio.h>

main() {
  printf("Hello, world!\n");
}
```

- In this example `printf` is a function that takes a *character string* as its argument.

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- Copy the code above into an empty file `hello.c` in your `task1` directory (We'll help you find it.), and then from your terminal:

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- In this example `printf` is a function that takes a *character string* as its argument.
- Copy the code above into an empty file `hello.c` in your `task1` directory (We'll help you find it.), and then from your terminal:

```
# cd ~/Desktop/bootcamp/task1
# gcc hello.c
# ./a.out
```

Prompts

From your terminal,

```
# cd ../task2
```

then open the file `prompt.c` in your text editor. You should see the following:

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```c
#include <stdio.h>

main() {
  char name[40];
  printf("Enter your name:\n");

  // YOUR TASK: Prompt the user for their name say hello.

}
```

Prompts

```c
#include <stdio.h>

main() {
  char name[40];
  printf("Enter your name:\n");

  // YOUR TASK: Prompt the user for their name say hello.

}
```

- For this task, we'll make use of a new function

```c
scanf(char* format, ...)
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- `scanf` reads characters from your terminal, interprets them according to the `format` you provide (consult your cheatsheet), and stores the results in the remaining arguments.

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- `scanf` reads characters from your terminal, interprets them according to the `format` you provide (consult your cheatsheet), and stores the results in the remaining arguments.
- For example, to store a user-given string in `name`,

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scanf("%s", name);
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- Similarly, `printf` can be given format specifiers in its first argument and will print the rest of its arguments accordingly.

```c
printf("Goodbye %s", name);
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Prompts

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  char name[40];
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scanf("%s", name);
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- Similarly, `printf` can be given format specifiers in its first argument and will print the rest of its arguments accordingly.

```c
printf("Goodbye %s", name);
```

- Complete your task (Ask for your help if you're stuck!), and run your program.

Arguments

From your terminal,

```
# cd ../task3
```

then open the file `arguments.c` in your text editor. You should see the following:

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```
# cd ../task3
```

then open the file `arguments.c` in your text editor. You should see the following:

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

int main(int argc, char* argv[]) {
  if (argc < 3) {
    printf("Usage: %s <name> <integer>\n", argv[0]);
    return -1;
  }

  // YOUR TASK: Read the user's name and an integer
  // from command line arguments, then say hello
  // to the user as many times as given by the integer.

}
```

Arguments

```
1  int main(int argc, char* argv[]) {
2    ...
3  }
```

- Note that our `main` has grown a little.

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- The first `int` tells us that this function will return an integer.

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1  int main(int argc, char* argv[]) {
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- The first `int` tells us that this function will return an integer.
- `int argc` and `char* argv[]` are parameters to `main`.

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- The first `int` tells us that this function will return an integer.
- `int argc` and `char* argv[]` are parameters to `main`.
  - `char* argv[]` is an array of strings containing all the arguments we'll pass when we run our program. (More on that later.)

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1  int main(int argc, char* argv[]) {
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- Note that our `main` has grown a little.
- The first `int` tells us that this function will return an integer.
- `int argc` and `char* argv[]` are parameters to `main`.
  - `char* argv[]` is an array of strings containing all the arguments we'll pass when we run our program. (More on that later.)
  - `int argc` is an integer indicating the length of `argv` or the number of strings contained within.

Arguments

```
1  int main(int argc, char* argv[]) {
2    ...
3  }
```

For example, if we invoke our program as follows:

```
# ./a.out CiComputerGirls 5
```

Arguments

```
1  int main(int argc, char* argv[]) {
2    ...
3  }
```

For example, if we invoke our program as follows:

```
# ./a.out CiComputerGirls 5
```

- Then `argc` contains the integer 3.

Arguments

```
1  int main(int argc, char* argv[]) {
2    ...
3  }
```

For example, if we invoke our program as follows:

```
# ./a.out CiComputerGirls 5
```

- Then `argc` contains the integer 3.
- `argv[0]` contains the string `"a.out"`.

Arguments

```
1  int main(int argc, char* argv[]) {
2    ...
3  }
```

For example, if we invoke our program as follows:

```
# ./a.out CiComputerGirls 5
```

- Then `argc` contains the integer 3.
- `argv[0]` contains the string `"a.out"`.
- `argv[1]` contains the string `"CiComputerGirls"`.

Arguments

```
1  int main(int argc, char* argv[]) {
2    ...
3  }
```

For example, if we invoke our program as follows:

```
# ./a.out CiComputerGirls 5
```

- Then `argc` contains the integer 3.
- `argv[0]` contains the string `"a.out"`.
- `argv[1]` contains the string `"CiComputerGirls"`.
- `argv[2]` contains the string `"5"`.

Arguments

```
1  int main(int argc, char* argv[]) {
2    if (argc < 3) {
3      printf("Usage: %s <name> <integer>\n", argv[0]);
4      exit(-1);
5    }
6    ...
7  }
```

- In the given code, we examine `argc` in the condition of our if-statement to ensure our program was passed the correct number of arguments.

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1  int main(int argc, char* argv[]) {
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- And if not, we print a helpful message and exit with an error code.

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- In the given code, we examine `argc` in the condition of our if-statement to ensure our program was passed the correct number of arguments.
- And if not, we print a helpful message and exit with an error code.
- Note that our helpful message prints the value of `argv[0]`. The first string in `argv` will always be the name of your program.

Arguments

```
1  int main(int argc, char* argv[]) {
2    ...
3
4    // YOUR TASK: Read the user's name and an integer
5    // from command line arguments, then say hello
6    // to the user as many times as given by the integer.
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8  }
```

To complete your task,

- Use the function `atoi` to convert the value of `argv[2]` into an `int`.

  ```
  int atoi(char* s)
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  int atoi(char* s)
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- `atoi` converts the string `s` into an `int`. For example,

  ```
  int five = atoi("5");
  ```

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  ```
  int atoi(char* s)
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- `atoi` converts the string `s` into an `int`. For example,
  ```
  int five = atoi("5");
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- Then use a for- or while-loop to print your message as many times as needed.

Functions

From your terminal,

```
# cd ../task4
```

and open the file `functions.c` in your text editor.

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

// YOUR TASK: Implement the function get_population.

int get_population(int generation);

main() {
  ...
}
```

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Each function definition has the form

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return-type function-name(argument declarations) {
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Compare the above with our definition of the function `power` in `functions.c`.

```
1  int power(int base, int exp) {
2    int result = 1;
3
4    int i;
5    for (i = 0; i < exp; i++)
6      result *= base;
7
8    return result;
9  }
```

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  - For a simple implementation consider that if each tribble can breed 2 more tribbles, then after 3 generations you have $2^3 = 8$ tribbles.
  - You can call `power` from within `get_population` to model this relationship.

Pointers

Now `cd` into the `task5` directory and open `pointers.c` in your text editor.

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```c
#include <stdio.h>

main() {
  char *string1 = "This is the first string.";
  char *string2 = "This is the second string.";

  // YOUR TASK: Write a function `swap` that swaps the pointers
  // in its first and second arguments. Then invoke your function
  // with string1 and string2.

  printf("string1 = %s and string2 = %s\n", string1, string2);
}
```

Pointers

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1  main() {
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- A *pointer* is a variable that contains the address in memory of another variable.

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- C has two operators for dealing with pointers:
  - `*` is the *dereferencing* operator. When applied to a pointer, it returns the value to which the pointer points.

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- A *pointer* is a variable that contains the address in memory of another variable.
- C has two operators for dealing with pointers:
  - `*` is the *dereferencing* operator. When applied to a pointer, it returns the value to which the pointer points.
  - `&` does the opposite of `*`. When applied to a variable, it returns the address at which the variable is stored.

Pointers

```
1  main() {
2    char *string1 = "This is the first string.";
3    ...
4  }
```

- Note that the above code declares `string1` to be a pointer. It states that `string1` points to the location in memory of the beginning of the assigned string.

Pointers

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1  main() {
2    char *string1 = "This is the first string.";
3    ...
4  }
```

- Note that the above code declares `string1` to be a pointer. It states that `string1` points to the location in memory of the beginning of the assigned string.
- Now note that `*string1` is a `char`. The `*` applies the dereferencing operator to `string1`, returning the first value at the location to which pointer points. In this case, `'T'`.

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- As in most languages, C passes arguments to functions by value, so there is no way for a called function to alter a variable in the calling function.

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- Consider this function `swap` for swapping two integers:

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1  // WRONG!
2  void swap(int x, int y) {
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5    temp = x;
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```

- Just like Java, this function will not work as intended.
- `x` and `y` are swapped within the scope of our function `swap`, but since they were passed only by value to the function, they will not be swapped in any code that calls our `swap`.

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4    temp = *px;    // temp gets the value to which px points.
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6    *py = temp;    // The value to which py points gets temp.
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We can invoke this `swap` like so:

```
1  int a = 5;
2  int b = 10;
3  swap(&a, &b);
4  // Now a == 10, and b == 5.
```

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7  }
8
9  int a = 5;
10 int b = 10;
11 swap(&a, &b);
12 // Now a == 10, and b == 5.
```

- Note that to swap two `int` our function accepts two `int*`.

Pointers

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1  void swap(int *px, int *py) {
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10 int b = 10;
11 swap(&a, &b);
12 // Now a == 10, and b == 5.
```

- Note that to swap two `int` our function accepts two `int*`.
- We use `&` to access the address at which our values are stored. In other words, to access *pointers* to our variables `a` and `b`.

Pointers

```
1  main() {
2    char* string1 = "This is the first string.";
3    char* string2 = "This is the second string.";
4
5    // YOUR TASK: Write a function `swap` that swaps the pointers
6    // in its first and second arguments. Then invoke your function
7    // with string1 and string2.
8
9    printf("string1 = %s and string2 = %s\n", string1, string2);
10 }
```

- Since a string is already a pointer to a `char` (or a `char*`), your `swap` should take two pointers to `char` pointers (or two `char**`).

Pointers

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9    printf("string1 = %s and string2 = %s\n", string1, string2);
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- Since a string is already a pointer to a `char` (or a `char*`), your `swap` should take two pointers to `char` pointers (or two `char**`).
- Implement `swap` and test your program. (And ask for help if you're stuck!)

Structs

Now `cd` into the `task6` directory and open `structs.c` in your text editor.

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```c
typedef struct {
  char* name;
  int health;
  int* weapon_statuses; // An array whose elements indicate the
                        // status of each weapon.
                        // A value >= 100 indicates the weapon is
                        // ready to fire.
  int num_weapons;
} Spaceship;

// YOUR TASK: Implement charge_weapons and attack_ship.
void charge_weapons(Spaceship* ship);
void attack_ship(Spaceship* from, Spaceship* to);
```

Structs

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1  typedef struct {
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- A struct is simply a collection of one or more variables, grouped together under a single name.

Structs

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1  typedef struct {
2    char* name;
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```

- A struct is simply a collection of one or more variables, grouped together under a single name.
- As defined, our `Spaceship` struct contains the variables `name`, `health`, `weapon_statuses`, and `num_weapons`.

Structs

C defines two operators for dealing with structs. A member of a struct is referred to with the `.` operator, as shown below:

```
1  Spaceship starship = ...
2  printf("The name of our ship is %s", starship.name);
```

Structs

C defines two operators for dealing with structs. A member of a struct is referred to with the `.` operator, as shown below:

```
1  Spaceship starship = ...
2  printf("The name of our ship is %s", starship.name);
```

However as you can see from the function declarations in `structs.c`, dealing with a pointer to a struct instead of structs themselves is quite common. To refer to a member of a struct from a pointer, use the `->` operator.

```
1  Spaceship *ship = ...
2  printf("The name of our ship is %s", ship->name);
```

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  char* name;
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```

- Implement the two functions and test your program.
- Note that to `weapon_statuses` is an array, so to access an element you apply an index like so: `ship->weapon_statuses[0]`.

Headers

Now `cd` into the `task7` directory and open `headers.c` in your text editor.

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You'll find an incomplete implementation of a linked-list struct.

```
1  // headers.c
2
3  // YOUR TASK: Write a header file for the linked-list
4  // implementation below, exposing list_append(), list_prepend(),
5  // and the struct itself.
6
7  #include "headers.h"
8
9  struct List {
10   void* data;
11   struct List* next;
12 };
13
14 ...
```

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- Think of header files as the public documentation of any program or library you write.
- I.e., declarations for any functions we would consider "public" in an OOP language go in our header file. Declarations of functions we would consider "private" can remain in our source file.
- Anyone using the provided linked-list library would probably want the ability to declare instances of `struct List` and append and prepend to it, so we declare those in the header.

Further Work

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- Familiarizing yourself with the command line through online courses such as those at Codecademy.com.