This Lecture: Functions

- Motivation: reading dates
- Functions formally
- Scoping
- (Time allowing) live coding

Summary of Lecture 6

- The while statement.
- The for statement.
- fibonacci.c

Read a day and a month.

Day Between 1 and 31
Month Between 1 and 12

Months have different numbers of days, but we’ll ignore that.
#include <stdio.h>
#include <stdlib.h>

int main() {
    /* Read a Day */
    int day = 0;
    while (day < 1 || day > 31) { /* Ask until day is valid */
        printf("Enter a value between 1 and 31: ");
        scanf("%d", &day);
    }
    /* Read a Month */
    int month = 0;
    while (month < 1 || month > 12) {
        printf("Enter a value between 1 and 12: ");
        scanf("%d", &month);
    }
    printf("You entered %d of %d\n", day, month);
    return EXIT_SUCCESS;
}

These are very similar. Write it once?
Always Have a Return Statement

Bad Code:
```c
int AddTwo(int to) {
    to + 2;
}
```

Good Code:
```c
int AddTwo(int to) {
    return to + 2;
}
```

Returning Nothing

void means there is nothing to return. return can be omitted for void.

Bad Code:
```c
int SayHello() {
    printf("Hello\n");
}
```

Good Code:
```c
void SayHello() {
    printf("Hello\n");
}
```

Multiple Inputs

Functions can have any number of arguments (inputs).

```c
int Sum0() { return 0; }
int Sum1(int first) { return first; }
int Sum2(int first, int second) { return first + second; }
```

Return Happens Immediately

Bad Code:
```c
/* Actually returns value */
int AddTwo(int value) {
    return value;
    /* Never reached */
    value = value + 2;
}
```

Good Code:
```c
int AddTwo(int value) {
    value = value + 2;
    return value;
}
```
Returning Early

return's immediate effect can be useful:

/* Take the absolute value of the number */
int AbsoluteValue(int number) {
    if (number >= 0) {
        /* All non-negative numbers will return here. */
        return number;
    }
    /* Now we know that number < 0 */
    return -number;
}

Names Change

Good Code:

void PrintTwo(int start) {
    printf("%d\n", start + 2);
}
int main() {
    int alice = 0, bob = 1;
    PrintTwo(alice); /* Run PrintTwo with start = 0 */
    PrintTwo(bob); /* Run PrintTwo with start = 1 */
    return EXIT_SUCCESS;
}

Value of alice or bob becomes start

Scoping

Functions do not share variables.

Bad Code:

int AddTwo() { return value + 2; }
void Print() {
    int value = 0;
    printf("%d", AddTwo());
}

Good Code:

int AddTwo(int value) { return value + 2; }
void Print() {
    int value = 0;
    printf("%d", AddTwo(value));
}

Formalizing Function Calls

Functions run in an environment.

When we call a function:

1. Create a new environment.
2. Copy the arguments to their new names.
3. Run the function.
4. Save the return value.
5. Clean up the environment.

This is why functions can’t see variables outside their environment.
Call Example

```c
int AddTwo(int value) {
    return value + 2;
}
int main() {
    int alice = 0;
    int bob = AddTwo(alice);
    printf("%d", bob);
    return EXIT_SUCCESS;
}
```

1. Make an environment for AddTwo.
2. Copy 0 to value (since alice is 0).
3. Run value + 2.
4. Save the return value.
5. Restore main's environment.
6. Continue running main, which will copy return to bob.

Arguments Are Copies

Changes do not impact callers:

```c
void FailsToIncrement(int value) {
    /* Increments a copy in its own environment */
    value = value + 1;
}
void Fail() {
    int number = 0;
    /* Send a copy of number */
    FailsToIncrement(number);
    /* Prints 0 */
    printf("%d", number);
}
```

Declare Before Use

**Bad Code:**

```c
int AddFour(int to) {
    /* AddTwo not yet declared */
    return AddTwo(AddTwo(to));
}
int AddTwo(int to) {
    return to + 2;
}
```

**Good Code:**

```c
int AddTwo(int to) {
    return to + 2;
}
int AddFour(int to) {
    return AddTwo(AddTwo(to));
}
```

Declaring Separately

**Good Code:*

```c
/* Tell the compiler that AddTwo is a function taking an int
    and returning an int. No need to name variables. */
int AddTwo(int);
int AddFour(int to) {
    return AddTwo(AddTwo(to));
}
int AddTwo(int to) {
    return to + 2;
}
```
**Summarizing Functions**

Functions let you encapsulate code.

Use functions to:
- Reduce repetition
- Group functionality together
- Explain what a chunk of code does (by naming it)

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**Learning more**

**Reading Assignment:**
Chapter 5 (sections 5.1-5.5) of “A book on C”.

**Lecture 8:**
We will continue the “Functions” theme in Lecture 8.