Computer Systems, B1-2 2020

Introduction to C

Troels Henriksen
Based on slides by Michael Kirkedal Thomsen

30. august 2021

Outline

- Syntax - Statements/Expressions/Values
- `main`
- Arrays
- Reading and writing to/from STDIO

Outline

- Syntax - Statements/Expressions/Values
- `main`
- Arrays
- Reading and writing to/from STDIO

Programming is a craft

I will do live coding–feel free to ask questions and make comments.

Recommended compiler flags

Compiler call

```
gcc -Wall -Wextra -pedantic -std=c11 -c [file]
```

-Wall	Turns on (almost) all warnings
-Wextra	Add warnings for unassigned values and more
-pedantic	Makes warnings if you goes outside ISO C
-std=c11	Chooses the latest C standard

Makefile

Tool that makes it easy to build your program.

```
CC=gcc
CFLAGS=-std=c11 -Wall -Werror -Wextra -pedantic

.PHONY: clean all

cmd: updatedfile(s).c
  $(CC) $(CFLAGS) -o $@ -c $<
```

This will be detailed more over time.

C Style Guide – Code is made to be read

Always use curly braces. The opening brace should be on the same line as the declaration.

```
int f() {
  for (int i = 0; i < 100; i++) {
    if (i % 2 == 0) {
      // Do something.
    }
  }
  // Return something.
}
```

- Use 2 spaces for indentation. Indent so as to make the structure of your code clear.
- All functions must return a value. Returning void is not allowed.
- Code must be warning-free.

The `main` function

- Simple main

```
int main() {
   ...
}
```

- Main with arguments

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

Back to reality - Return from `main` function

```
int main(int argc, char* argv[]) {
  ...
  return ???;
}
```

Back to reality - Return from `main` function

```
int main(int argc, char* argv[]) {
  ...
  return ???;
}
```

- Use the `exit` function with returning from `main` function
- Lookup the codes that you need (use `echo $?` to show result.)
- If nothing: `return EXIT_SUCCESS;` is assumed

```
#include <stdlib.h>

int main(int argc, char* argv[]) {
  ...
  return EXIT_SUCCESS;
}
```

Statements: conditional

```
#include <stdlib.h>

int main(int argc, char* argv[]) {
  if (argc == 2) { // 1 argument
    return EXIT_SUCCESS;
  } else if (argc == 4) { // 3 arguments
    return EXIT_SUCCESS;
  } else {
    return EXIT_FAILURE;
  }
}
```

- This is actually a statement with a nested statement

Statements: switch-case

```
#include <stdlib.h>

int main(int argc, char* argv[]) {
  switch (argc) {
    case 2:
      return EXIT_SUCCESS;
      break;
    case 4:
      return EXIT_SUCCESS;
      break;
    default:
      return EXIT_FAILURE;
      break;
  }
}
```

-

Statements: switch-case alternative

```
#include <stdlib.h>

int main(int argc, char* argv[]) {
  switch (argc) {
    case 2:
    case 4:
      return EXIT_SUCCESS;
      break;
    default:
      return EXIT_FAILURE;
      break;
  }
}
```

- Cases only works on constant values (not expressions like conditionals).

Statements: while-loop

```
#include <stdio.h>

int main(int argc, char* argv[]) {
  int i = 1;
  while (i < argc) {
    printf("Argument number %d: %s\n",
           i, argv[i]);
    i = i + 1;
  }
}
```

- Use any expression
- Easy to make it diverge

Statements: for-loop

```
#include <stdio.h>

int main(int argc, char* argv[]) {
  for (int i = 1; i < argc; i++) {
    printf("Argument␣number␣%d:␣%s\n",
           i, argv[i]);
  }
}
```

- Good for iteration
- Keep it simple

Assignments

```
int main(int argc, char* argv[]) {
  int a = 1;
  int b = 2 + a;
  a += b; // a = a + b
  a *= 2;
  a++; // a = a + 1
  a--;
  ++a; // a = a + 1
}
```

- Useful short-hand writing styles.
- Easy to understand when writing simple programs

Watch your side

What is the values of a, b, and c?

```
#include <stdio.h>

int main(int argc, char* argv[]) {
  int a = 3;
  int b = 5;
  int c = a++ + ++b;
  printf("a␣=␣%d\n", a);
  printf("b␣=␣%d\n", b);
  printf("c␣=␣%d\n", c);
}
```

Watch your side

What is the values of a, b, and c?

```
#include <stdio.h>

int main(int argc, char* argv[]) {
  int a = 3;
  int b = 5;
  int c = a++ + ++b;
  printf("a␣=␣%d\n", a);
  printf("b␣=␣%d\n", b);
  printf("c␣=␣%d\n", c);
}
```

- Informally, ++a first increments a, then returns its value
- Informally, b++ first returns the value of b, then increments
- Be very careful of side-effects

Watch you side – lets try again

What is the values of a, b, and c?

```
#include <stdio.h>

int main(int argc, char* argv[]) {
  int a = 3;
  int b = 5;
  int c = -2;
  a += (c = a++ - (b += --c)) + ++b;
  printf("a␣=␣%d\n", a);
  printf("b␣=␣%d\n", b);
  printf("c␣=␣%d\n", c);
}
```

Watch you side – lets try again

What is the values of a, b, and c?

```
#include <stdio.h>

int main(int argc, char* argv[]) {
  int a = 3;
  int b = 5;
  int c = -2;
  a += (c = a++ - (b += --c)) + ++b;
  printf("a = %d\n", a);
  printf("b = %d\n", b);
  printf("c = %d\n", c);
}
```

- Assignments are expressions with side-effects that return the value that is assigned to a variable.
- **Order of evaluation in expression is unspecified.**

Arrays

```
#include <stdio.h>

int main(int argc, char* argv[]) {
  int a[16];
  a[0] = 1;
  for (int i = 1; i < 16; i++) {
    a[i] = a[i-1] + 1;
  }
  printf("final␣=␣%d\n", a[15]);
}
```

- No check for out-of-bounds
- Arrays cannot be assigned to
- Arrays cannot be compared
- Do it element wise

Writing to stdout

```
int result = fprint("Show␣%s␣of␣value␣%d␣", ...);
```

c	Character
d or i	Signed decimal integer
e	Scientific notation (mantissa/exponent) using e character
E	Scientific notation (mantissa/exponent) using E character
f	Decimal floating point
g	Uses the shorter of %e or %f
G	Uses the shorter of %E or %f
o	Signed octal
s	String of characters
u	Unsigned decimal integer
x	Unsigned hexadecimal integer
X	Unsigned hexadecimal integer (capital letters)
p	Pointer address
n	Nothing printed
%	Character

Reading from stdin

```
#include <stdio.h>

int main(int argc, char* argv[]) {
   char input[20];
   printf ("Give␣me␣a␣string\n");
   scanf("%s", input);
   printf ("You␣wrote:␣%s\n", input);
}
```

- Reading value from stdin

Reading from stdin

```
#include <stdio.h>

int main(int argc, char* argv[]) {
   char input[20];
   printf ("Give␣me␣a␣string\n");
   scanf("%s", input);
   printf ("You␣wrote:␣%s\n", input);
}
```

- Reading value from stdin
- Problem with writing outside buffer

Reading a string

```
#include <stdio.h>

int main(int argc, char* argv[]) {
  char input[20];
  printf ("Give␣me␣a␣string\n");
  fgets(input, sizeof(input), stdin);
  printf ("You␣wrote:␣%s\n", input);
}
```

- Use `fgets`
- Can limit the number of values read
- Made for reading from files
- stdin is just a file (somewhere)

Reading values

```
#include <stdio.h>

int main(int argc, char* argv[]) {
  int input;
  printf ("Give␣me␣a␣integer\n");
  scanf("%d", input);
  printf ("You␣wrote:␣%d\n", input);
}
```

- Reading value from stdin

Reading values

```
#include <stdio.h>

int main(int argc, char* argv[]) {
   int input;
   printf ("Give␣me␣a␣integer\n");
   scanf("%d", input);
   printf ("You␣wrote:␣%d\n", input);
}
```

- Reading value from stdin
- Does not work

Reading values – correct

```
#include <stdio.h>

int main(int argc, char* argv[]) {
   int input;
   printf ("Give␣me␣a␣integer\n");
   scanf("%d", &input);
   printf ("You␣wrote:␣%d\n", input);
}
```

- Reading value from stdin

Reading values – correct

```
#include <stdio.h>

int main(int argc, char* argv[]) {
   int input;
   printf ("Give␣me␣a␣integer\n");
   scanf("%d", &input);
   printf ("You␣wrote:␣%d\n", input);
}
```

- Reading value from stdin
- Does not work

Getting values from arguments

```
#include <stdio.h>

int main(int argc, char *argv[]) {
  int input;
  if(argc == 2) {
    int res = sscanf(argv[1],"%d", &input);
    if (res == 0) {
      printf("Bad value\n");
    } else {
      printf("Input was: %d\n", input);
    }
  }
}
```

You now know enough to get in troube

Questions?