Introduction to IoT

School Year 2023-2024

Valsalice

Course Structure

1	Introduction and Basics	
2	Basic Data Types and Operators	
3	Control Structures Pt. 1	
4	Control Structures Pt. 2	NOV 7
5	Functions and Scope	NOV 14
6	Arrays and Strings	NOV 21
10	Preprocessor and Macros	DEC 19
11	Custom Data Types	JAN 9
7	Introduction to Contiki-NG and nRF52840	NOV 28
8	Sensing and Actuating with Contiki-NG	DEC 5
9	Basic Communication and Networking	DEC 12
12	Introduction to RPL and Network Routing	JAN 16
13	Challenges in Wireless Communication	JAN 23
14	Advanced Protocols: TSCH and 6TiSCH	JAN 30
15	Advanced Topics in Wireless Communication	FEB 6
16	Reliable Data Transfer Challenge	FEB 20, FEB 27, MAR 5

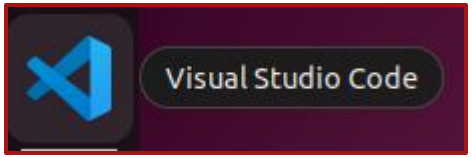
= Core Topics = Optional Topics

Open your Virtual Machines

1. Turn on your Laptops
2. Login using “User”
3. Open the **Virtual Box** program
4. Add the Virtual Machine (**Ctrl + A**)
5. Open the **VirtualBox** folder
6. Select the **nRF52840LAB** file
7. Click **Start**

Prepare the Coding Environment

1. Start the Virtual Machine **nRF52840LAB**
2. Open **Visual Studio Code**



3. From the Terminal:

```
make setup
```

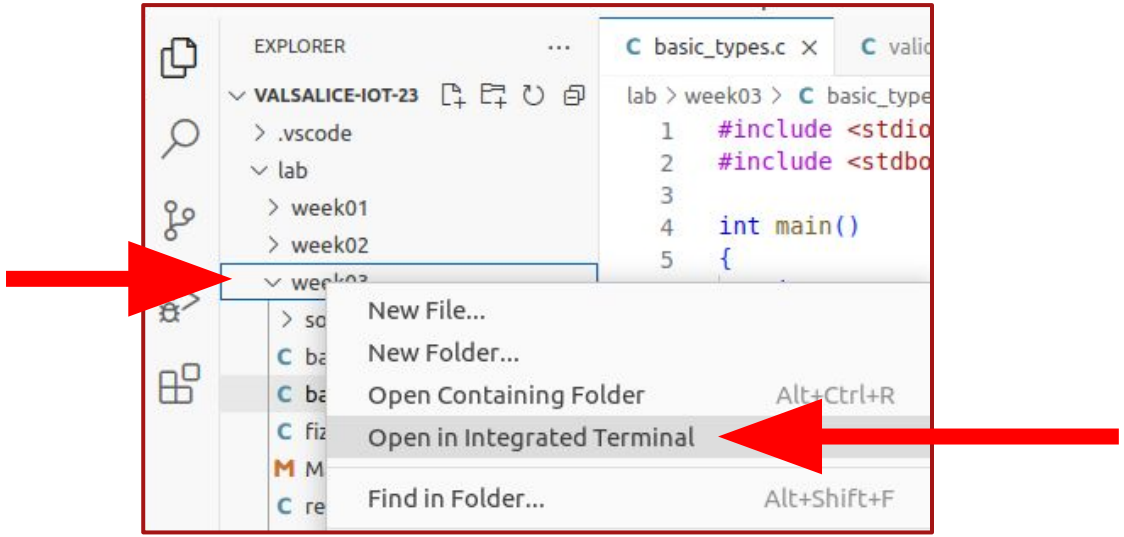
4.
```
valsalice-iot-23 git:(master) make setup
Enter your username:
```

5.
```
Password
```

6.
```
✅ Repository setup complete!
```

Prepare the Coding Environment

7. Open the **`week04`** folder in the terminal



8. You should see the following in the terminal:

```
week04 git:(master)
```

Recap: Basic Input/Output Functions

- **`printf`**: C function for formatted output

```c
printf("Hello, World!\n");
```

- **`scanf`**: C function for formatted input

```c
char name[50];
scanf("%s", name);
```

Recap: Data Types

C has a number of primitive data types:

int `42` `1200` `1_200` `-3`

float `3.14` `0.00001` `-2.1`

char `'A'` `'@'` `'\n'`

bool `true` `false`

Strings are *NOT* a primitive data type, and have special syntax.

strings `"Hello"` `"A"` `"I am a full sentence!"`

Recap: Variables

A variable is a named container that stores data or values.

```
int x = 42;
float y = -0.12;
char w = 'A';
char z[50] = "Full sentence";
```

Booleans require a custom include statement:

```
#include <stdbool.h>
bool hello = true;
```

Recap: Comparisons

Values and variables can be compared.

```
int x = 10;
int y = 4;

bool w = x > y;
printf("W: %d\n", w);

bool z = x <= y;
printf("Z: %d\n", z);
```

Recap: Boolean Operators

Greater than	>
Greater or equal than	>=
Less than	<
Less or equal than	<=
Equals	==
Not equals	!=
Not	!

Recap: Chaining Comparisons

- **and** (both must be true)

```
true && false
```

```
(5 < 6) && (5 < 10)
```

- **or** (either must be true)

```
true || false
```

```
(5 < 3) || (5 < 10)
```

- **not** (negation)

```
!true
```

```
!(5 < 3)
```

Recap: If-Statements

Allow for branches in your code!

```c
int x = 5;

if (x < 10) {
    printf("X is small \n");
} else {
    printf("X is large \n");
}
```

```c
int x = 20;

if (x < 10) {
    printf("X is small \n");
} else {
    printf("X is large \n");
}
```

NOTE: You **do not** need an else block, it's optional.

Exercise

Write a program (**even_odd.c**) that, given a variable **num**:

- Prints “EVEN” if the number is even.
- Prints “ODD” if the number is odd.

```
if (false) {
    printf("......");
} else {
    printf("......");
}
```

To execute:

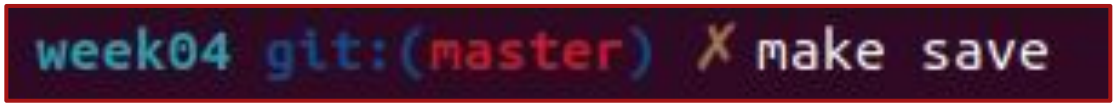
```
make even_odd.run
```

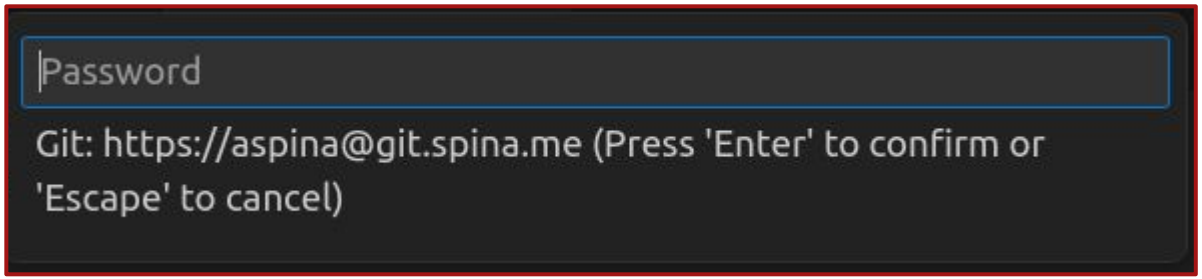
Exercise - Solution

```
if (num % 2 == 0) {
    printf("EVEN\n");
} else {
    printf("ODD\n");
}
```

Save remotely your Changes

1. `make save`

2. 

3. 

4. 

If-Statement chaining

You can chain multiple conditions with **`else if`**.

What is the difference between these two snippets of code?

```c
int num;
scanf("%d", &num);

if (num < 3) {
    printf("Small number\n");
} else if (num < 10) {
    printf("Medium number\n");
}
```

```c
int num;
scanf("%d", &num);

if (num < 3) {
    printf("Small number\n");
}
if (num < 10) {
    printf("Medium number\n");
}
```

Exercise

Write a program (**`comparison.c`**) that, given a variable **`num`**:

- Prints “ZERO” if the number is equal to 0.
- Prints “POSITIVE” if the number is greater than 0.
- Prints “NEGATIVE” if the number is less than 0.

To execute:

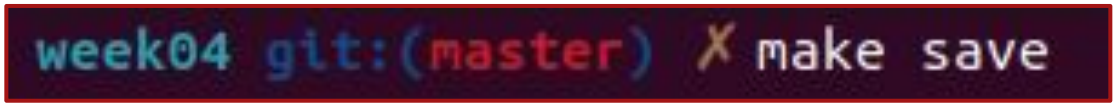
```
make comparison.run
```

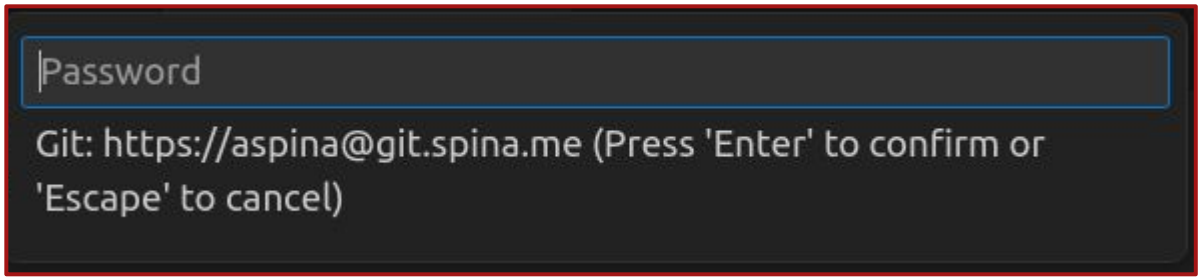
Exercise - Solution

```
if (num < 0) {
    printf("NEGATIVE\n");
} else if (num > 0) {
    printf("POSITIVE\n");
} else {
    printf("ZERO\n");
}
```

Save remotely your Changes

1. `make save`

2. 

3. 

4. 

If-Statement nesting

You can nest multiple if-statements within each other.

```
int x = 8;

if (x < 10) {
     if (x < 5) {
          printf("X is less than 5\n");
     } else {
          printf("X is between 5 and 10\n");
     }
} else {
     printf("X is between greater than 15\n");
}
```

Exercise

Write a program (**`fizz_buzz.c`**) that given a variable **`num`**.

- If **`num`** is divisible by 2 it prints “Fizz”.
- If **`num`** is divisible by 3 it prints “Buzz”.
- If **`num`** is divisible by both 2 and 3 it prints “FizzBuzz”.

```
Insert a number: 20
Fizz
```

```
Insert a number: 9
Buzz
```

```
Insert a number: 6
FizzBuzz
```

To execute: `make fizz_buzz.run`

Exercise Solution 1

```
// Implementation:
if ((num % 2 == 0) && (num % 3 == 0)) {
    printf("FizzBuzz\n");
} else if (num % 2 == 0) {
    printf("Fizz\n");
} else if (num % 3 == 0) {
    printf("Buzz\n");
}
```

Exercise Solution 2

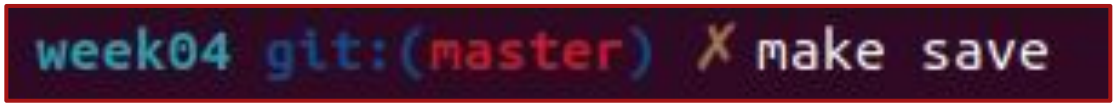
```
bool is_div_2 = num % 2 == 0;
bool is_div_3 = num % 3 == 0;

if (is_div_2 && is_div_3) {
    printf("FizzBuzz\n");
} else if (is_div_2) {
    printf("Fizz\n");
} else if (is_div_3) {
    printf("Buzz\n");
}
```

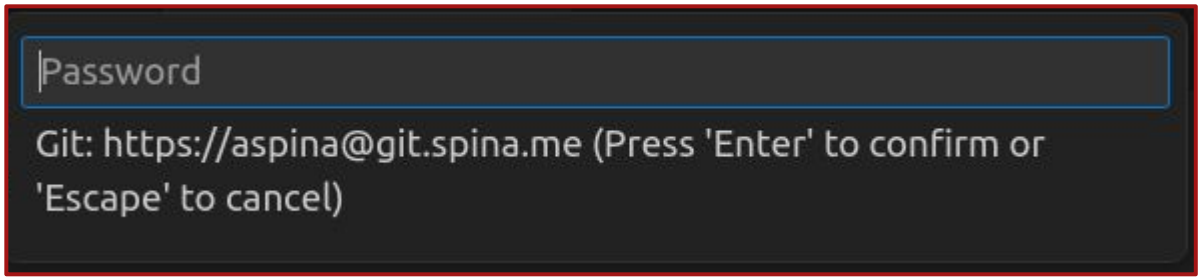
Exercise Solution 3

```
// Implementation:
if (num % 2 == 0) {
    printf("Fizz");
}

if (num % 3 == 0) {
    printf("Buzz");
}

printf("\n");
```

Save remotely your Changes

1. `make save`

2. 

3. 

4. 

While-Loops

Repeat parts of your code!

To execute:

```
make loop.run
```

```c
int num;
printf("Input a number greater than 100: ");
scanf("%d", &num);

while (num <= 100) {
    printf("Wrong number, try again: ");
    scanf("%d", &num);
}

printf("Well done!\n");
```

While-Loops

Anatomy of a while-loop:

1. Uses the **`while`** keyword
2. The condition is between brackets:

   `( )`
3. The body is between curly brackets:

   `{ }`

```
int x = 5;


while (x < 10) {
    x += 1;
    printf("Incr\n");
}
```

Exercise

Write a program (**`hello.c`**) that prints “`Hello`” five times.

Hint (1): use `x += 1` to increment variables

Hint (2): if the program is stuck use **`Ctrl + C`** from terminal

To execute:

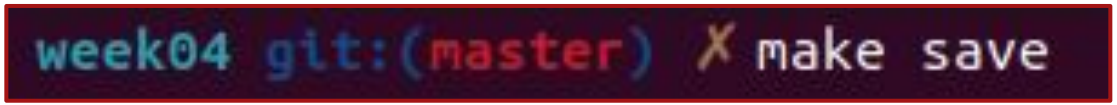
```
make hello.run
```

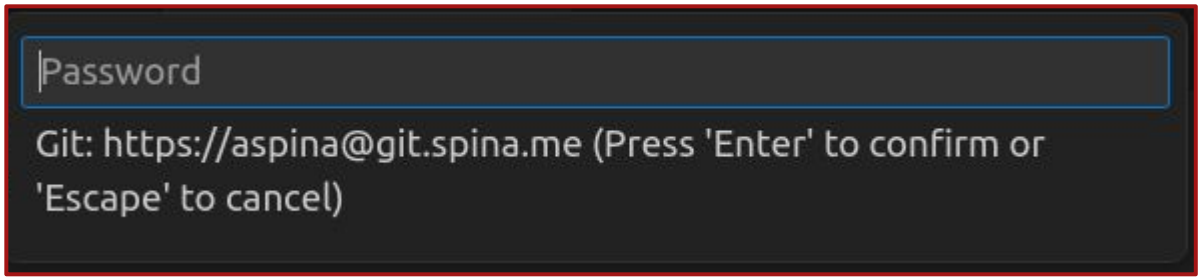
Exercise - Solution

```
int x = 0;


while (x < 5)
{
    x += 1;
    printf("Hello %d\n", x);
}
```

Save remotely your Changes

1. `make save`

2. 

3. 

4. 

For-Loops

Repeat a **specific** amount of times!

```c
int x;

for (x = 1; x <= 5; x++) {
    printf("Hello %d\n", x);
}
```

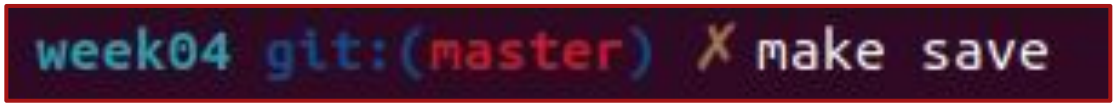
```c
int x = 0;

while (x < 5) {
    x += 1;
    printf("Hello %d\n", x);
}
```

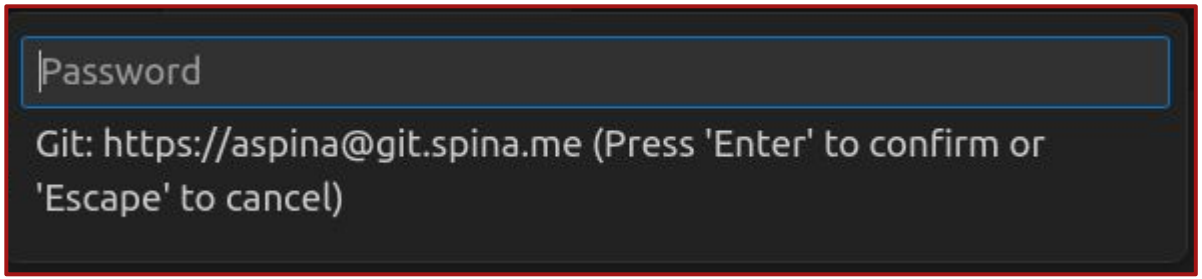
To execute:

```
make for_loop.run
```

Save remotely your Changes

1. `make save`

2. 

3. 

4. 

Exercise

Write a program (**`table.c`**) that prints the first five multiples of 6:

```
6
12
18
24
30
```

or

```
6 x 1 = 6
6 x 2 = 12
6 x 3 = 18
6 x 4 = 24
6 x 5 = 30
```

To execute:

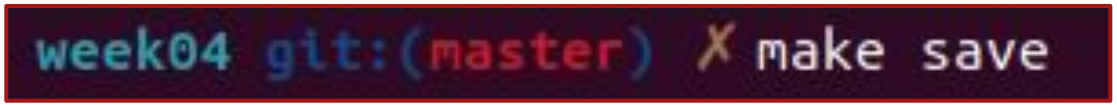
```
make table.run
```

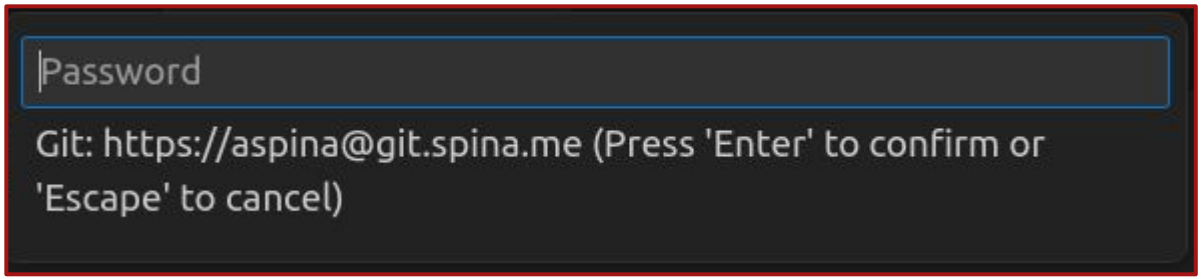
Exercise - Solution

```c
int x;


for (x = 1; x <= 5; x++)
{
    int product = x * 6;
    printf("6 x %d = %d\n", x, product);
}
```

Save remotely your Changes

1. `make save`

2. 

3. 

4. 

End of Class

See you all next week!