CH-230-A

Programming in C and C++

C/C++

Tutorial 2

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Type Conversions

- When data of different types are combined (via operators) some rules are applied
- Types are converted to a common type
  - Usually, to the larger one (called promotion)
  - **Example:** while summing an `int` and a `float`, the `int` is converted into a `float` and then the sum is performed
- A demotion is performed when a type is converted to a smaller one
  - **Example:** a function takes an `int` parameter and you provide a `float`
- A demotion implies possible loss of information
- Therefore, be careful with what to expect
  - In the above example, the fractional part will be lost

Casting

- It is possible to overcome standard conversions (casting)
- To force to a different data type, put the desired data type before the expression to be converted
  (type name) expression
- Casting is a unary operator with high precedence

Casting: An Example

```
1       int a;
2       float f1 = 3.456;
3       float f2 = 1.22;
4       /* these operations imply demotions */
5       a = (int) f1 * f2;     /* a is now 3 */
6       a = (int) (f1 * f2);   /* a is now 4 */
```

Incrementing and Decrementing

- The unary operators ++ and -- can be applied to increase or decrease a variable by 1

```
1  int a, b;
2  a = b = 0;
3  a++; b-- ; ++a ; --b;
```

- Note that they can be both prefix and postfix operators
  - The two versions are different

Prefix and Postfix Modes

- Prefix means that first you modify and then you use the value
- Postfix means that first you use and then you modify the value
- `int a = 10, b;`

Expression	New value of `a`	New value of `b`
`b = ++a;`	11	11
`b = a++;`	11	10
`b = --a;`	9	9
`b = a--;`	9	10

The `sizeof()` Operator

- `sizeof()` returns the number of bytes needed to store a specific object
- Useful for determining the sizes of the different data types on your system

```
1 int a;
2 printf("size int %lu\n", sizeof(a));
3 printf("size float %lu\n", sizeof(float));
4 printf("size double %lu\n", sizeof(double));
```

- For strings do not confuse `sizeof()` with `strlen()`
- Compile-time operator, will not work for dynamically allocated memory

Boolean Variables

- A boolean variable can assume only two logic values: **true** or **false**
- Boolean variables and expressions are widely used in computer languages to control branching and looping
- Some operators return boolean values
- A boolean expression is an expression whose value is **true** or **false**

Boolean Operators

- Boolean operators can be applied to boolean variables
  - AND, OR, NOT

A	NOT A	A	B	A AND B	A	B	A OR B
false	true	false	false	false	false	false	false
true	false	false	true	false	false	true	true
		true	false	false	true	false	true
		true	true	true	true	true	true

Booleans in C

- Originally, C did not provide an ad-hoc boolean type but uses rather the `int` type
- 0 is false, everything different from 0 is true
- In C99 the type `_Bool` was introduced, example: `_Bool b = 0;`
- Additionally, the library `stdbool.h` defines the type `bool`, example: `bool b = false;`
- C also provides the three Boolean operators
  - `&&` for AND,
  - `||` for OR,
  - `!` for NOT
- Applied to booleans they return booleans

Boolean Operators: Example

```
1   int main() {
2     int a, b, c;
3     a = 0;              /* a is false */
4     b = 57;             /* b is true */
5     c = a || b;         /* c is true */
6     c = a && b;         /* c is false */
7     a = !a;             /* a is now true */
8     c = a && b;         /* c is now true */
9     c = (a && !b) && (a || b);
10    return 0;
11  }
```

Relational Operators

- Relational operators are applied to other data types (numeric, character, etc.) and produce boolean values

  `(b > 5) --> true`
- Relational operators with boolean operators produce boolean expressions

  `(b > 5) && (a < 1) --> true && false --> false`

Relational operator	Meaning
==	Equality test
!=	Inequality test
>	Greater
<	Smaller
>=	Greater or equal
<=	Smaller or equal

Relational Operators: Example

```
1   int main() {
2     int a = 2, b, c;
3     float f1 = 1.34;
4     float f2 = 3.56;
5     char ch = 'D';
6     b = f1 >= f2;
7     c = !b;
8     b = c == b;
9     b = b != c;
10    c = f2 > a;
11    c = ch > a;
12    return 0;
13  }
```

Branching

- Up to now programs seem to execute all the instructions in sequence, from the first to the last (a linear program)
- Change the control flow of a program with branching statements
- Branching allows to execute (or not to execute) certain parts of a program depending on boolean expressions or conditions

Selection: `if ... else`

- In general selection constructs allow to choose a way in a binary bifurcation
- De facto you can use it in three ways
  - `if ()` single selection
  - `if ()`
    `else` double selection
  - `if ()`
    `else if ()`
    `else if ()`
    `...`
    `else` multiple selection

The `if` Syntax (1)

- General syntax:

```
1 if (condition)
2   statement 1;
3 else
4   statement 2;
5 other_statement; /* always executed */
```

- The else part can be omitted
- Statement: single statement or multiple statements
- Multiple statements need to be surrounded by braces { }

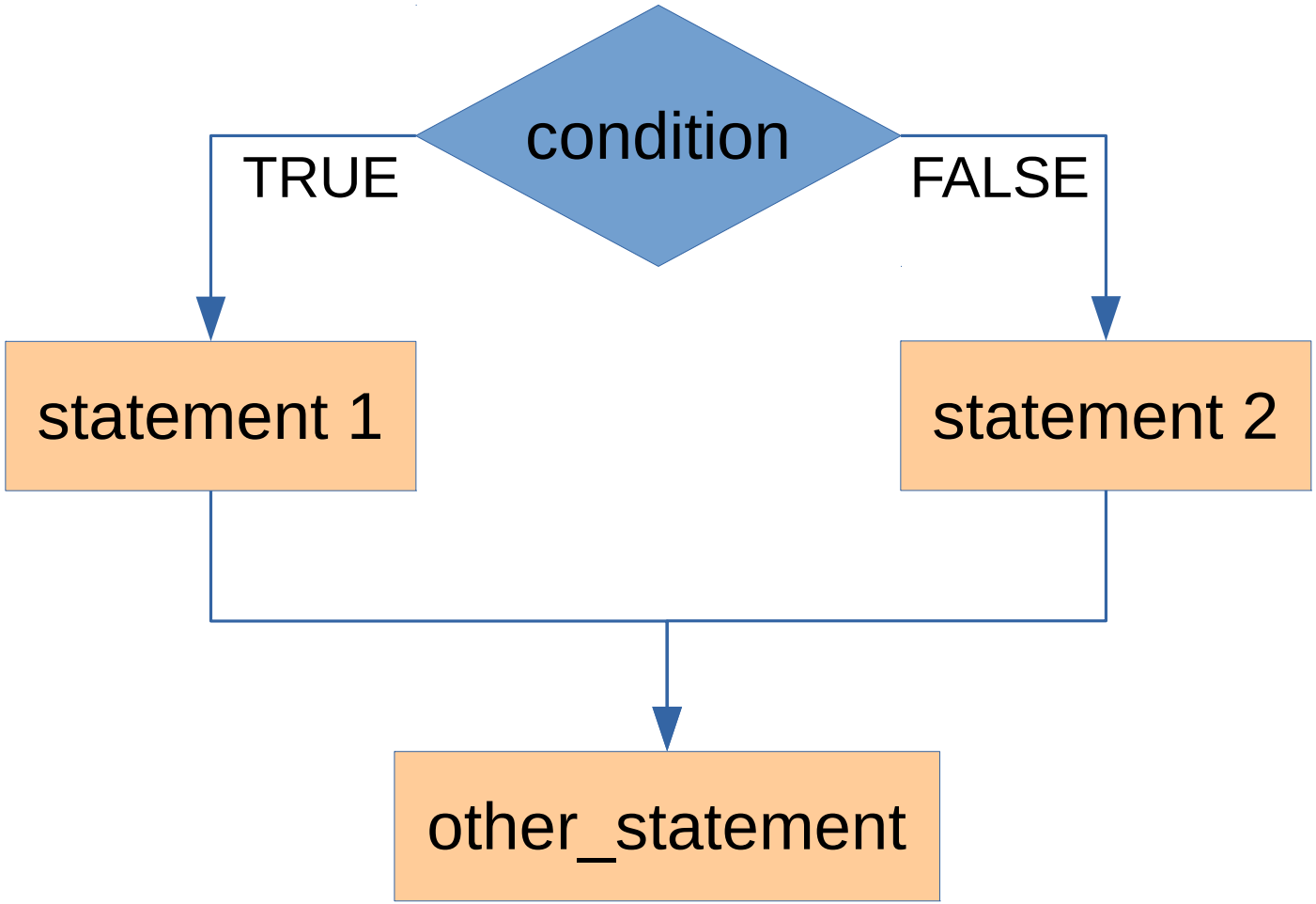
The `if` Syntax (2)

- Preferred syntax (always use braces)

```
1 if (condition) {
2   statements;
3 }
4 else {
5   statements;
6 }
```

- If you add statements, program flow is not changed (less errors)
- Using indentation, you can easily see where block starts and ends

`if`: Flow Chart



if: Example

```
1  #include <stdio.h>
2  int main() {
3    int first, second;
4    printf("Type the first number:\n");
5    scanf("%d", &first);
6    printf("Type the second number:\n");
7    scanf("%d", &second);
8    if (first > second) {
9      printf("The larger one is %d\n", first);
10   }
11   else {
12     printf("The larger one is %d\n", second);
13   }
14   printf("Can you see the logical error?\n");
15   return 0;
16 }
```

Statements and Compound Statements

- Statements can be grouped together to form compound statements
- A compound statement is a set of statements surrounded by braces

```
1 int a = 3;
2 if (a > 0) {
3   printf("a is positive %d\n", a);
4   a = a - 2 * a;
5   printf("now a is negative %d\n", a)
6 }
```

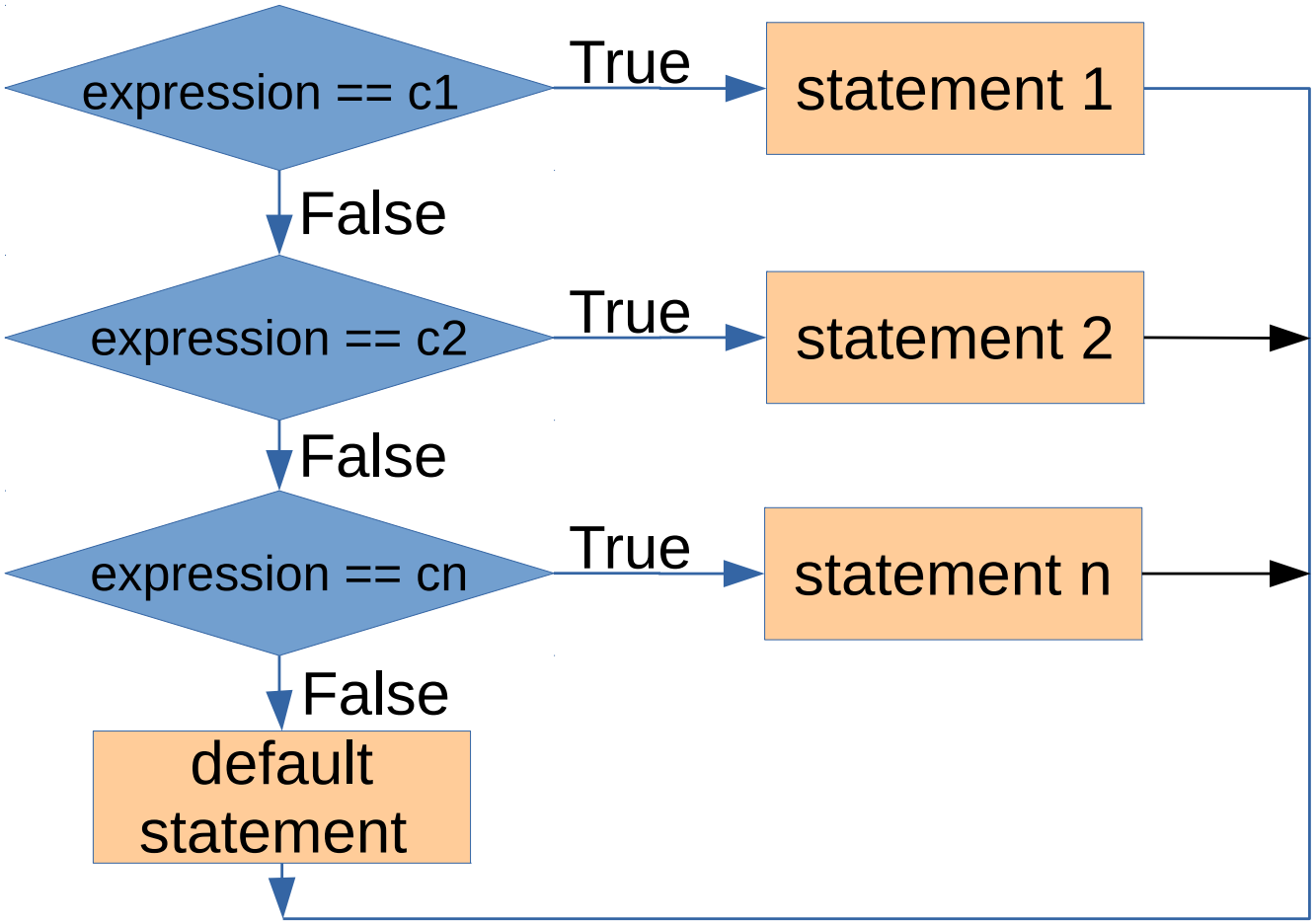
Multiple Choices: `switch`

- `switch` can be used when an expression should be compared with many values
- The same goal can be obtained with multiple `if`'s
- The expression must return an integer value

switch: The Syntax

```
1  switch (expression)  {
2    case c1:
3      statement1;
4      break;
5
6    case c2:
7      statement2;
8      break;
9
10   ...
11
12   default:
13     default_statement;
14 }
```

`switch`: Flow Chart



switch: Example

```c
#include <stdio.h>
int main() {
  int c;
  for (c = 0; c <= 3; c++) {
    printf("c: %d\n", c);

    switch (c) {
      case 1:
        printf("Here is 1\n");
        break;
      case 2:
        printf("Here is 2\n");
        /* Fall through */
      case 3:
      case 4:
        printf("Here is 3, 4\n");
        break;
      default:
        printf("Here is default\n");
    }
  }
  return 0;
}
```

Iterations

- In many cases it is necessary to repeat a set of operations many times
- Example: compute the average grade of the exam
  - Read all the grades, and sum them
  - Divide the sum by the number of grades
- C provides three constructs

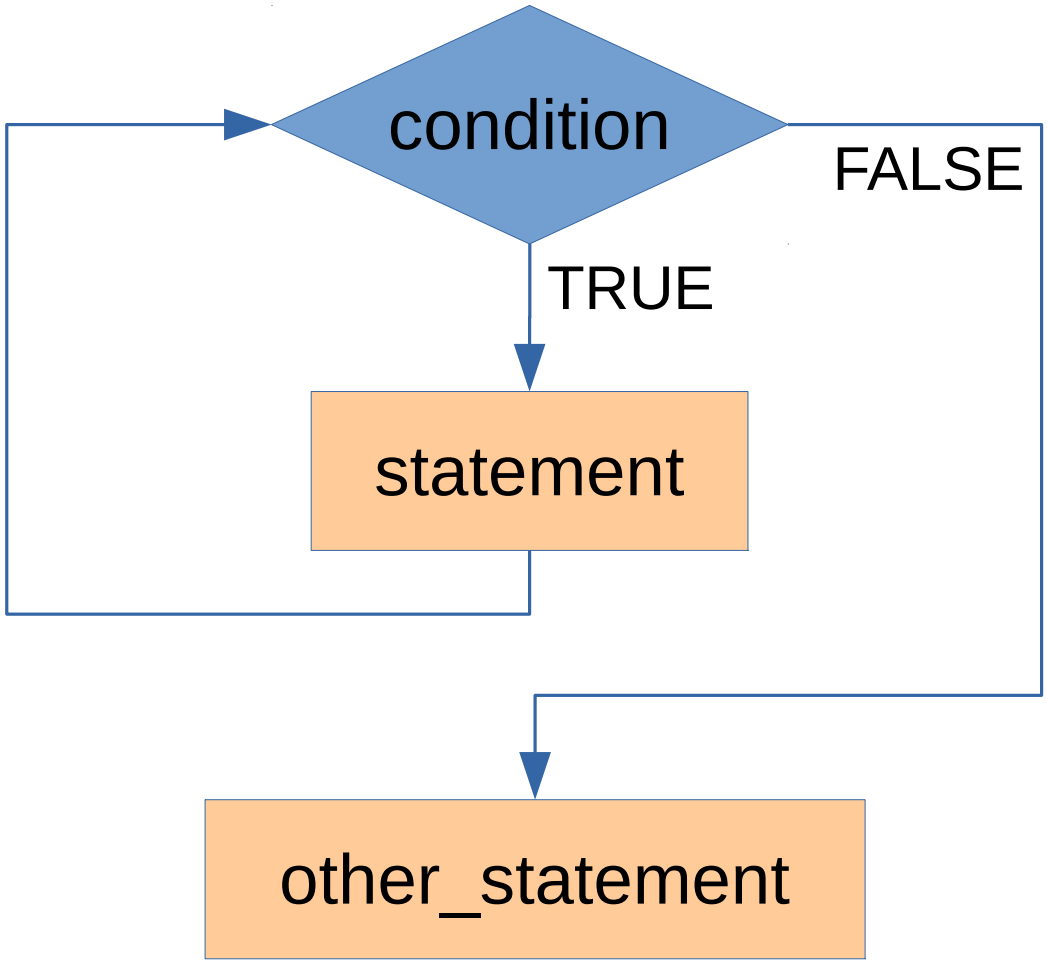
Iterations: `while`

- General syntax:

```
1 while (condition) {
2   statement;
3 }
```

- Keep executing the statement as long as the condition is true

`while`: Flow Chart



Example:
Compute the Sum of the First n Natural Numbers

```
1  #include <stdio.h>
2  int main() {
3     int idx, n, sum = 0;
4     printf("Enter a positive number ");
5     scanf("%d", &n);
6     idx = 1;
7     while (idx <= n) {
8        sum += idx;
9        idx++;
10    }
11    printf("The sum is %d\n",sum);
12    return 0;
13 }
```

Iterations: `for`

- General syntax:

```
for (initial-statement; condition; iteration-
    statement)
  statement;
```

- Example:

```
for (n = 0; n <= 10; n++)
  printf("%d\n", n);
```

- The `for` and `while` loops can be made interchangeable

`for`: Flow Chart