Semester HS2020

C++ Zusammenfassung

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1 Introduction to C++

In C++ gibt es keinen Garbage Collector, wie man es aus anderen Sprachen, wie Java oder C# kennt. Warnung: Wenn Code "falsch"geschrieben wurde, kann Undefined Behavior auftreten.

1.1 C++ Compilation Process

*.cpp Files

- Also called Implementation File
- For function implementations (can be in .h as well)
- Source of compilation

*.h File

- Also called Header File
- Declarations and definitions to be used in other implementation files

3 Phases of compilation

- Preprocessor Textual replacement of preprocessor directives (include)
- Compiler Translation of C++ code into machine code (source file to object file)
- Linker Combination of object files and libraries into libraries and executables

1.2 Declarations and Definitions

All things with a name that you use in a C++ program must be declared before you can do so.

One Definition Rule

While a program element can be declared several times without problem there can be only one definition of it. This is called the **One Definition Rule** (ODR)!

Include Guard

Include guards ensure that a header file is only included once. Multiple inclusions could violate the One Definition Rule when the header contains definitions.

```
#ifndef SAYHELLO_H_
#define SAYHELLO_H_

#include <iosfwd>
struct Greeter { /* Some Code */ };

#endif /* SAYHELLO_H_ */
```

2 Values and Streams

2.1 Variable Definitions

- Defining a variable consists of specifying its type, its variable name and its initial value. E.g. int x{42};
- Empty braces mean default initialization. E.g. double x{};
- Using = for initialization we can have the compiler determine its type. E.g. auto const i = 5;

Constants

- Adding the const keyword in front of the name makes the variable a single assignment variable, aka a constant. E.g. int const x{42};
  - Must be initialized and immutable
- Use the keyword constexpr if the variable is required to be fixed at compile time. E.g. double constexpr pi{3.14159};

Why shoud I use const?

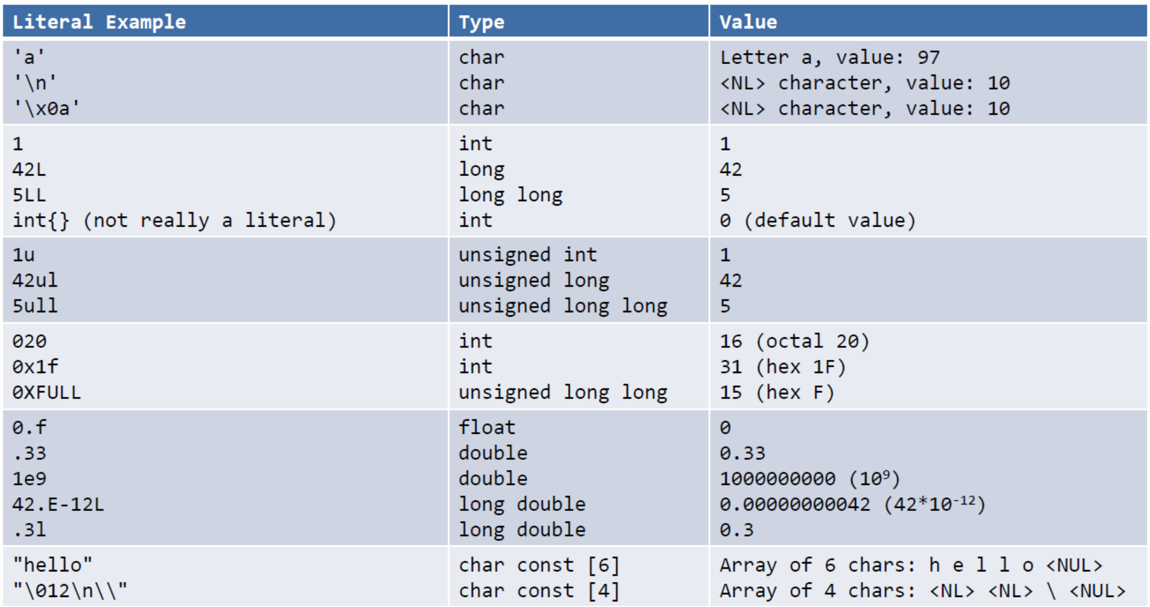
- A lot of code needs names for values, but often does not intend to change it
- It helps to avoid reusing the same variable for different purposes (code smell)
- It creates safer code, because a const variable cannot be inadvertently changed
- It makes reasoning about code easier
- Constness is checked by the compiler
- It improves optimization and parallelization (shared mutable state is dangerous)

Important types for Variable

- short, int, long, long long - each also available as unsigned version
- bool, char, unsigned char, signed char
- float, double, long double
- void is special, it is the type with no values
- class defined: E.g. std::string, std::vector

2.2 Values and Expressions

Integer to boolean: 0 = False, every other value = True
if (a < b < c) → zuerst wird a < b ausgewertet (true oder false). Dann wird der Boolean mit einem int (c) verglichen. Der Bool wird dafür implizit in 0 oder 1 gecastet.



Literal Example	Type	Value
'a' '\n' '\x0a'	char char char	Letter a, value: 97 <NL> character, value: 10 <NL> character, value: 10
1 42L 5LL int{} (not really a literal)	int long long long int	1 42 5 0 (default value)
1u 42ul 5ull	unsigned int unsigned long unsigned long long	1 42 5
020 0x1f 0XFULL	int int unsigned long long	16 (octal 20) 31 (hex 1F) 15 (hex F)
0.f .33 1e9 42.E-12L .3l	float double double long double long double	0 0.33 1000000000 (10^9) 0.00000000042 ($42*10^{-12}$) 0.3
"hello" "\012\n\\"	char const [6] char const [4]	Array of 6 chars: h e l l o <NUL> Array of 4 chars: <NL> <NL> \ <NUL>

2.3 Strings and Sequences

std::string is C++'s type for representing sequences of char (which is often only 8 bit) and are mutable. That means, we can modify the content. (Vergleich zu Java: Dort würde ein neues String Objekt erstellt werden)
Grundsätzlich werden Strings also als char const[ ] abgespeichert. Mit dem namespace std::literals hat man die Option hinter dem String eine 's' anzufügen, um das Objekt effektiv als String zu speichern. z.B. "ab"s

toUpper Iterator

```cpp
void toUpper(std::string & value) {
    transform(cbegin(value), cend(value), begin(value), ::toupper);
}
```

2.4 Input and Output Streams

Functions taking a stream object must take it as a reference, because they provide a side effect to the stream (i.e., output characters).

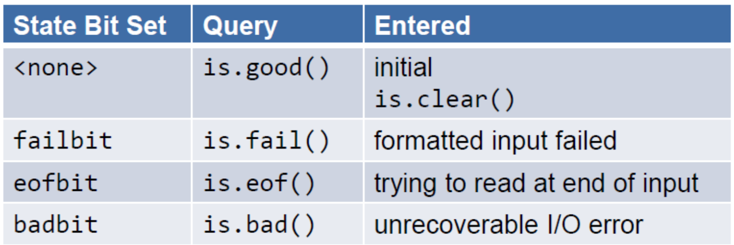
Reading from Input

- Reading into a std::string always works. Unless the stream is already !good() → Spaces werden übersprungen (neues String-Objekt)!
- Reading into other types (e.g. int) has no error recovery. A wrong input puts the stream into status fail and the characters remain in the input.
- Post-read check: if (in » age) { ... }
- Multiple subsequent reads are possible: if (in » symbol » count) { ... }
- Remove fail flag: in.clear()
- Ignore one char: in.ignore();
- Helpfull for reading: while (in.good()) um die Leseoperationen setzen.

Robust reading of an int value

```cpp
// Use an std::istringstream as intermediate stream
int inputAge(std::istream & in)
    std::string line{}
    while (getline(in, line)) {
        std::istringstream is{line};
        int age{-1};
        if (is >> age) {
            return age;
        }
    }
    return -1;
}
```

Stream States



State Bit Set	Query	Entered
<none>	is.good()	initial is.clear()
failbit	is.fail()	formatted input failed
eofbit	is.eof()	trying to read at end of input
badbit	is.bad()	unrecoverable I/O error

3 Woche03

4 Woche04

5 Woche05

6 Woche06

7 Woche07

8 Woche08

9 Woche09

10 Woche10

11 Woche11

12 Woche12

13 Woche13

14 Anhang

14.1 Übungen Woche XX

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Includes

```cpp
// Only the declaration for input and output streams
#include <iosfwd>

// Implementation of input stream
#include <istream>

// Implementation of output stream
#include <ostream>

// Declaration of both streams and additionally std::cout, std::cin, std::cerr
#include <iostream>

// Functions: std::tolower(c), std::isupper(c)
#include <cctype>

// Strings
#include <string>
```