Class introduction

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Class introduction

... done with support of

Figure 1: scheidt&bachmann

Agenda

- Class introduction, class vs struct
- Access specifiers
- Life cycle of class
- Inheritance, Encapsulation, Interface class
- Virtual table
- Additional keywords
- Possible problems, tips and tricks
- Demo, Lessons learned, Q&A, ...

Class introduction, class vs struct

Class introduction, class vs struct

- Class is elementary structure of C++ language designed to represent smallest logical unit
- `Class` uses by default `private` access specifier
- Class is intended to use encapsulation - limiting access to member variables in order to prevent i.e. unintended modifications

```
class Person
{
    std::string name;
    uint8_t age;
};
```

Class introduction, class vs struct

```
class Person
{
    std::string name; // Private by default

public:
    void setName(std::string newName) { name = newName; }
    std::string getName() { return name; }
};

int main() {
    Person john;
    john.setName("John Doe");
    std::cout << john.getName() << std::endl;
    return 0;
}
```

Class introduction, class vs struct

- `Struct` is the same as `class`, but used `public` specifier by default
  - Struct can be inherited, can contain methods, can contain virtual table, ...
- Due to historical reasons it is used mostly for data collection
- "POCO" - **P**lain **O**ld **C** **O**bject

Class introduction, class vs struct

```cpp
struct Person
{
	std::string name;
	uint8_t age;
};

int main()
{
	Person john;
	john.name = "John Doe";
		//This is valid, because all members are public
	john.age = 42;

	return 0;
}
```

Class introduction, class vs struct

- Member variables
- Member functions
- [**WARNING**] Be careful about uninitialized variables
  - https://en.wikipedia.org/wiki/Uninitialized_variable

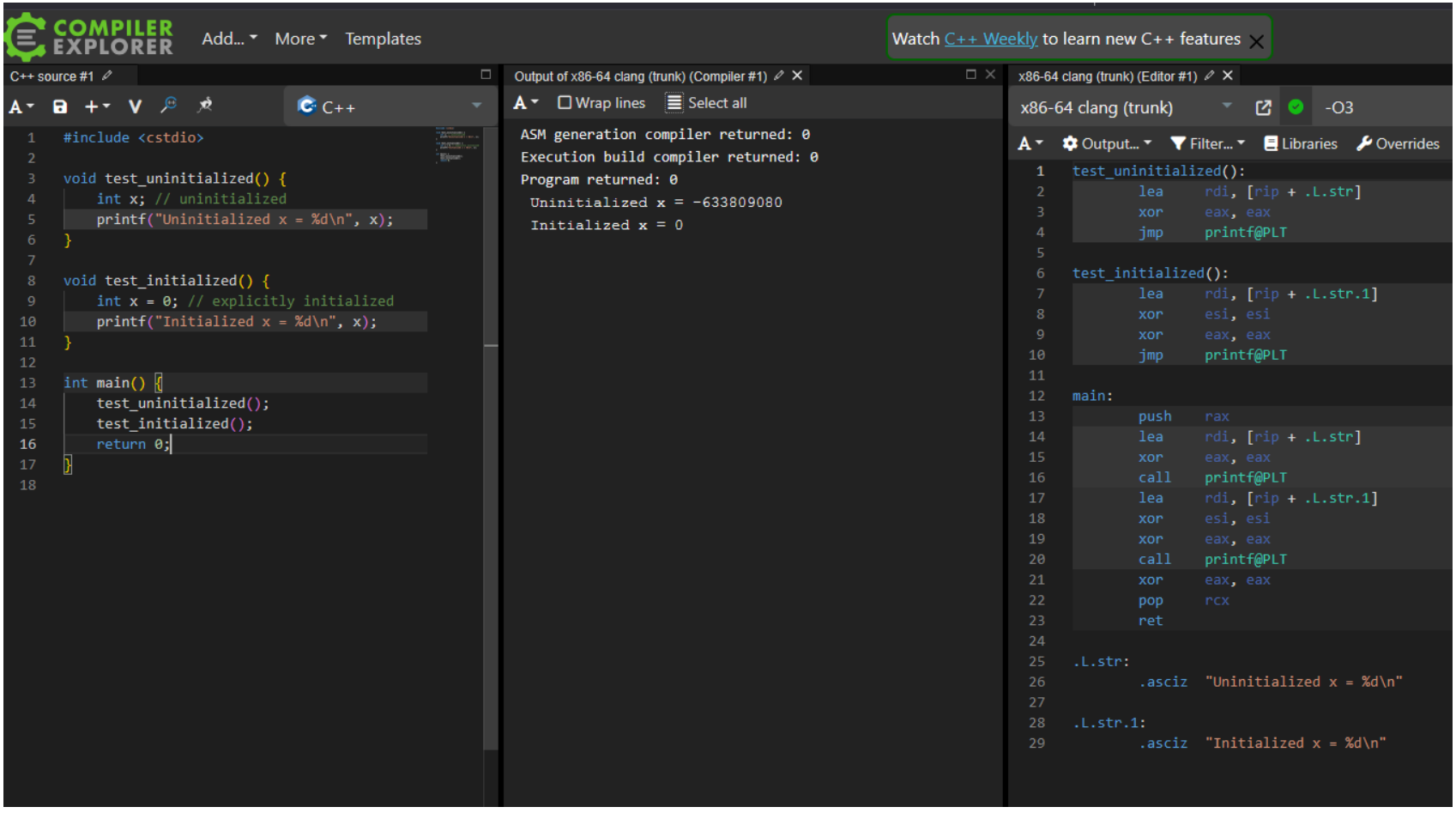

Figure 2: Uninitialized variables

Class introduction

- Demo time

Access specifiers

Access specifiers

- `public`
  - Variable/function can be modified/called from outside of instance
- `protected`
  - Variable/function can be modified/called only from inside of instance or it's child
- `private`
  - Variable/function can be modified/called only from inside of instance.

Access specifiers

- Demo time

Life cycle of class

Life cycle of class

- Compiler creates several function for you (*"Special member functions"*)
  - **Default constructor**
  - **Destructor**
  - Copy constructor
  - Move constructor
  - Copy assignment operator
  - Move assignment operator

Life cycle of class

- Constructor
  - Function that is called upon instance creation
  - User can alter it in order to set initial values to variables or force user to set them
  - “Parametrized” vs “default” constructor

Life cycle of class

- Destructor
  - Called at the end of class lifetime (i.e. when object goes out of scope. Warning, this mechanism is not guaranteed!)
  - Can be used to cleanup resources (free allocated memory, end connection, close sockets, free handles, unsubscribe to messages, . . .)
  - [WARNING] Always declare destructor as virtual!

Life cycle of class

- Rule of three
  - Copy constructor
  - Copy assignment operator
  - Move semantics was introduced in C++11 standard
- Rule of five
  - Move constructor
  - Move assignment operator
- https://en.cppreference.com/w/cpp/language/rule_of_three.html

Life cycle of class

- Demo time

Encapsulation, Inheritance, Interface class

Encapsulation, Inheritance, Interface class

Encapsulation

- Limiting access to member variables
- Creating “read-only” variables
- Validating input/output of variables

Encapsulation

```
class Person
{
      int age;
public:
      void setAge(int newAge)
      {
            if ((newAge > 0) && (newAge < 100))
            {
                  age = newAge;
            } else
            throw std::exception("Invalid age");
      }
};
```

Inheritance

```
class Animal
{
protected:
     unsigned int legs;

public:
     virtual void setLegs(unsigned int newLegs) {
          legs = newLegs;
     }

     virtual unsigned int getLegs() const {
          return legs;
     }

}
```

Inheritance

```
class Dog : public Animal
{
}

int main()
{
     Dog lassie;
     lassie.setLegs(4);

     return 0;
}
```

Inheritance

```
class Dog : public Animal
{
}

int main()
{
      Animal lassie = new Dog;
      lassie->setLegs(4);

      return 0;
}
```

Interface class (Abstract class)

- Defining interface, forcing user to fulfill requirements
- You can't instantiate it

```
class NoisyAnimal{
      virtual void makeNoise() = 0;
      //this enforces us to implement makeNoise function
}

class NoisyDog : public NoisyAnimal
{
      void makeNoise() {
            std::cout << "HAF HAF!" << std::endl;
      }
}
```

```cpp
int main()
{
    NoisyAnimal animal; //Compilation error
    NoisyDog dog;       //This is fine
    dog.makeNoise();
    return 0;
}
```

Encapsulation, Inheritance, Interface class

- Demo time

Virtual table

Virtual table

- Table that is containing relationship between parents/children and calls proper functions
- Created by using keyword `virtual` somewhere in class (or eventually others that imply `virtual`, i.e. `final`, `override`)
- Used for runtime polymorphism
  - Polymorphism -> instance of class behaving like other type
  - Remember `Animal lassie = new Dog;`
- https://en.wikipedia.org/wiki/Virtual_method_table

Virtual table

- Demo time

Additional keywords

Additional keywords

- `this`
  - Returns address of current instance. Useful when I am registering myself to some publisher.
- `override` (vs overload)
  - Overrides method in parent
  - Checks whether method I am trying to override truly exists in parent
  - Prevents unintended overloading (functions of same name but with different parameters)

Additional keywords

- `final`
  - If used on class, prevents further inheritance
  - If used on method, prevents overriding this method
- `const`
  - Prevents modification of given variable
  - If used on function, prevents any member variable modification
- `explicit`
  - Prevents unintended conversion of input parameters

Additional keywords

- Demo time

Possible problems, tips and tricks

Possible problems, tips and tricks

- Always initialize your member variables (at least with `{}`);
  - Otherwise in `Release` or `-O3` build these values will obtain random values!
- Size of empty class is not zero. It is at least 1 byte in order to allocate some memory (to be capable of using `this` keyword)
  - Read more here

Possible problems, tips and tricks

- Diamond inheritance problem

```
class Parent {
     void foo() = 0;
}

class ChildA : public Parent{
     void foo() {
          std::cout << "Foo from A"; }
}

class ChildB : public Parent{
     void foo() {
          std::cout << "Foo from B"; }
}
```

```
class Grandchild : public ChildA, ChildB
{
}

int main()
{
      Grandchild joe;
      joe.foo();      //Which "foo" override is called? From
                      //This results in compilation error
      return 0;
}
```

Possible problems, tips and tricks

- Demo time
  - C uninitialized variables
  - Simple class, encapsulation
  - Abstract class
  - Examining default constructor, parametrized constructor, destructor
  - Virtual destructor issue
  - final, const, override

Lessons learned

- Initialize your variables, otherwise they **WILL** get random values (at least with `{}`)
  - Otherwise in `Release` or `-O3` they are not implicitly zeroed
- Declare your destructor as **virtual**
- If possible, use as many keywords as possible (`const`, `override`, `final`, `explicit`, ...)
  - Compilers are very smart and thus performance optimization is not goal of using i.e. `const` keyword. Readability and maintainability is your goal.

Q&A