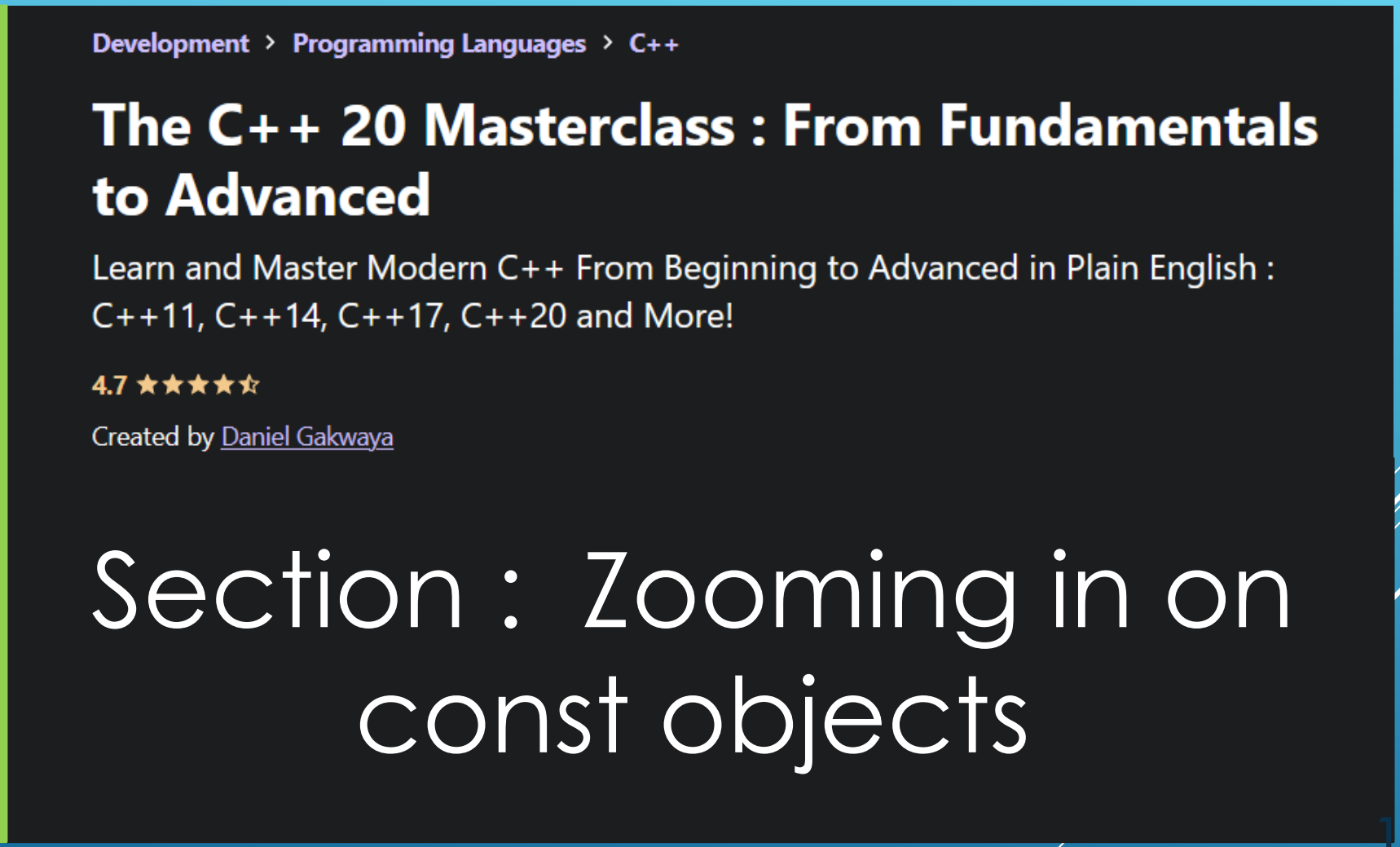
Slides



Section : Zooming in on const objects

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Objects and the const keyword : Introduction

```
class Dog
{
public:
    Dog();
    Dog(const std::string& name_param,const std::string& breed_param, int age_param);
    ~Dog();
    void set_name(const std::string& dog_name) ;
    void set_dog_breed(const std::string& breed) ;
    void set_dog_age(int age) ;
    std::string get_name() ;
    std::string get_breed() ;
    int get_age() ;
    void print_info() ;
private :
    std::string dog_name;
    std::string dog_breed;
    int * dog_age;
};
```

Declaring const object

```
const Dog dog1("Flatcher","Shepherd",3);
```

PROBLEM

We can't modify const objects. That's fine and it's what we want. But we can't read from them either. Which makes the kind of useless.

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const Objects

```
class Dog
{
public:
    Dog();
    Dog(const std::string& name_param,const std::string& breed_param, int age_param);
    ~Dog();
    void set_name(const std::string& dog_name) ;
    void set_dog_breed(const std::string& breed) ;
    void set_dog_age(int age) ;
    std::string get_name() ;
    std::string get_breed() ;
    int get_age() ;
    void print_info() ;
private :
    std::string dog_name;
    std::string dog_breed;
    int * dog_age;
};
```

Declaring const object

```
const Dog dog1("Flatcher","Shepherd",3);
```

Using const objects

```
const Dog dog1("Flatcher","Shepherd",3);

dog1.set_name("Milou");//Setting values on const object won't work

dog1.print_info();//Reading won't work either : Compiler error

std::string name = dog1.get_name(); // Compiler Error
```

PROBLEM

We can't modify const objects. That's fine and it's what we want. But we can't read from them either. Which makes them kind of useless. We'll see a solution to this in a few lectures ahead.

What if we try and go through pointers or references to a const object ?

Going through pointer to non const

```
const Dog dog1("Flatcher","Shepherd",3);
Dog* p_dog = &dog1; // Error : invalid conversion from const Dog* to Dog*
p_dog->set_name("Hillo");
p_dog->print_info();
```

Going through non const reference

```
const Dog dog1("Flatcher","Shepherd",3);
Dog& dog_ref = dog1; // Error : Can't convert from const Dog& to Dog&
dog_ref.set_name("Hillo");
dog_ref.print_info();
```

Going through pointer to const

```
const Dog dog1("Flatcher","Shepherd",3);
const Dog* p_const_dog = &dog1;
p_const_dog->set_name("Hillo"); // Error : expected
p_const_dog->print_info(); // Error : not expected
```

Going through const references

```
const Dog dog1("Flatcher","Shepherd",3);
const Dog& const_dog_ref = dog1;
const_dog_ref.set_name("Hillo"); //Error : Expected
const_dog_ref.print_info();      //Error : Not expected
```

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const Objects as function arguments

```
class Dog
{
public:
    Dog();
    Dog(const std::string& name_param,const std::string& breed_param, int age_param);
    ~Dog();
    void set_name(const std::string& dog_name) ;
    void set_dog_breed(const std::string& breed) ;
    void set_dog_age(int age) ;
    std::string get_name() ;
    std::string get_breed() ;
    int get_age() ;
    void print_info() ;
private :
    std::string dog_name;
    std::string dog_breed;
    int * dog_age;
};
```

Declaring const object

```
const Dog dog1("Flatcher","Shepherd",3);
```

Options

- Pass by value
- Pass by (non const) reference
- Pass by const reference
- Pass by pointer (to non const)
- Pass by pointer to const

Pass by value

```
void function_taking_dog(Dog dog){
    dog.set_name("Internal dog");
    dog.print_info();
}

int main(int argc, char **argv)
{
    const Dog dog1("Flatcher","Shepherd",3);
    //Dog by value
    function_taking_dog(dog1);

    return 0;
}
```

Pass by [non const] reference

```
void function_taking_dog_ref(Dog& dog_ref){
    //Compiler won't allow passing const object as argument
}

int main(int argc, char **argv)
{
    const Dog dog1("Flatcher","Shepherd",3);
    //Dog by ref : Compiler error. Could modify dog1 through non const ref
    function_taking_dog_ref(dog1);
    return 0;
}
```

Pass by const reference

```
void function_taking_const_dog_ref(const Dog& const_dog_ref){
    const_dog_ref.set_name("Hillo");
    const_dog_ref.print_info();
}

int main(int argc, char **argv)
{
    const Dog dog1("Flatcher","Shepherd",3);
    //Dog by const ref
    function_taking_const_dog_ref(dog1);

    return 0;
}
```

Pass by pointer [to non const]

```
void function_taking_dog_p(Dog* p_dog){
    //Compiler won't allow passing const Dog objects as arguments
}

int main(int argc, char **argv)
{
    const Dog dog1("Flatcher","Shepherd",3);
    //Dog by pointer : Compiler error : Could modify dog1 through pointer to non const
    function_taking_dog_p(&dog1);
    return 0;
}
```

Pass by pointer to const

```
void function_taking_pointer_to_const_dog(const Dog* const_p_dog){
    const_p_dog->set_name("Hillo");//Error : Expected
    const_p_dog.print_info(); //Error : Not expected
}


int main(int argc, char **argv)
{
    const Dog dog1("Flatcher","Shepherd",3);
    //Dog by const pointer
    function_taking_pointer_to_const_dog(&dog1);

    return 0;
}
```

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const Member functions

```
class Dog
{
public:
    Dog();
    Dog(const std::string& name_param,const std::string& breed_param, int age_param);
    ~Dog();
    void set_name(const std::string& dog_name) ;
    void set_dog_breed(const std::string& breed) ;
    void set_dog_age(int age) ;
    std::string get_name() ;
    std::string get_breed() ;
    int get_age() ;
    void print_info() ;
private :
    std::string dog_name;
    std::string dog_breed;
    int * dog_age;
};
```

Declaring const object

```
const Dog dog1("Flatcher","Shepherd",3);
```

PROBLEMS

- Can't read from const objects
- At this point they are just useless objects

Goals

```
std::cout << "const Dog object" << std::endl;
const Dog dog1("Fletcher","Shepherd",3);

std::cout << "name : " << dog1.get_name() << std::endl;
dog1.print_info();
//dog1.set_name("Snowy"); // Compiler error : Expected.


std::cout << std::endl;
std::cout << "non const Dog object" << std::endl;
Dog dog2("Soluk","Shepherd",2);
dog2.set_name("Haluk");
std::cout << "dog2.get_name() : " << dog2.get_name() << std::endl;
dog2.print_info();
```

const methods

```
std::string get_name() const {
    return dog_name;
}

std::string get_breed() const {
    return dog_breed;
}

int get_age() const;     // Can split code into declaration
                         // and implementation.
```

Outside implementation

```
int Dog::get_age() const
{
    return *dog_age; // Dereference and return
}
```

non const overloads for methods

```
void print_info() const{

    std::cout << "print_info const version called" << std::endl;
    std::cout << "Dog name : " << dog_name <<
            ", dog breed : " << dog_breed << " , dog age : " << *dog_age << std::endl;
    //++info_print_count; //Error
}

void print_info(){
    std::cout << "print_info non const version called" << std::endl;
    std::cout << "Dog name : " << dog_name <<
            ", dog breed : " << dog_breed << " , dog age : " << *dog_age << std::endl;

    ++info_print_count;
}
```

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Getters that double as setters

```
class Dog
{
public:
    Dog();
    Dog(const std::string& name_param,const std::string& breed_param, int age_param);
    ~Dog();
     std::string& get_name() /*const*/  { //The const is removed because we want this
                                          // method to be used to modify the object
                                          // through the returned reference
        return dog_name;
    }
     std::string& get_breed() /*const*/ {
        return dog_breed;
    }
    int& get_age(){
        return dog_age;
    }
private :
    std::string dog_name;
    std::string dog_breed;
    int dog_age;
};
```

```
Dog dog1("Fluffy","Shepherd",3);

dog1.print_info();

std::cout << "dog name : " << dog1.get_name() << std::endl;

std::cout << "Changing the name of the dog" << std::endl;
dog1.get_name() = "Dandio";
dog1.print_info();

dog1.get_age() = 5;
dog1.print_info();
```

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Dangling pointers and references

A pointer or reference is said to be dangling if it's pointing to or referencing invalid data. A simple example for pointers is a pointer pointing to a deleted piece of memory.


pointer
object


pointer
delete
object


pointer
object


pointer
nullptr

Dangling reference

```
const std::string& Dog::compile_dog_info() const{
    std::string info = "Dog name : " + dog_name
                     + " dog breed : " + dog_breed
                     + "dog age : " + std::to_string(dog_age);
    return info;
}
```

Dangling pointer

```
int * Dog::return_int_pointer() const{
    int jumps_per_minute {50};
    return &jumps_per_minute;
}
```

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Zooming in on const

main function

```
const Dog dog1("Fletcher","Shepherd",3);
```

const methods

```
std::string get_breed() const {
    return dog_breed;
}
```

Const correctness

- For const objects you can only call const member functions
- const objects are completely non-modifiable(immutable), the compiler won't allow calling a member function that modifies the const object in any way
- We are not allowed to modify the object in any way inside const member functions
- Just as we're not allowed to directly modify the object inside a const member function, we're not allowed to call a method that modifies the object indirectly either
- Any attempt to modify an object's member variable (direct or indirect) from within a const member functions will result in a compiler error
- You cannot call any non-const member functions from within a const member function

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Mutable objects

```
class Dog
{
public:
    Dog();
    /* ...

    void print_info() const{
        ++info_print_count;
        std::cout << "Dog name : " << dog_name <<
                ", dog breed : " << dog_breed << " , dog age : " << *dog_age
                    << "print_count : " << info_print_count << std::endl;
    }
    /* ...
private :

    /* ...

    std::string dog_name;
    std::string dog_breed;
    int * dog_age;
    size_t info_print_count{0};
};
```

Mutable member vars

```
class Dog
{
public:
    Dog();
    /* ...

    void print_info() const{
        ++info_print_count;
        std::cout << "Dog name : " << dog_name <<
                ", dog breed : " << dog_breed << " , dog age : " << *dog_age
                    << "print_count : " << info_print_count << std::endl;
    }
    /* ...
private :

    /* ...

    std::string dog_name;
    std::string dog_breed;
    int * dog_age;
    mutable size_t info_print_count{0};
};
```

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Structured bindings

```cpp
struct Point{
    double x;
    double y;
};
int main(int argc, char **argv)
{
    Point point1 {4.4,5.9};

    auto [a,b] = point1;

    std::cout << "a : " << a << std::endl;
    std::cout << "b : " << b << std::endl;

    //a and b are just copies
    point1.x = 10.1;
    point1.y = 66.2;

    std::cout << std::endl;
    std::cout << "point1 has changed : " << std::endl;
    std::cout << "a : " << a << std::endl;
    std::cout << "b : " << b << std::endl;
    return 0;
}
```

```cpp
struct Point{
    double x;
    double y;
};

int main(int argc, char **argv)
{
    Point point1 {4.4,5.9};

    auto [a,b] = point1;

    //Capturing a structured binding in a lambda function
    //This was only possible in C++20.
    auto f = [a](){
        std::cout << "Have captured : " << a << std::endl;
    };
    f();

    return 0;
}
```

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Objects and the const keyword : Summary

```
class Dog
{
public:
    Dog();
    Dog(const std::string& name_param,const std::string& breed_param, int age_param);
    ~Dog();
    void set_name(const std::string& dog_name) ;
    void set_dog_breed(const std::string& breed) ;
    void set_dog_age(int age) ;
    std::string get_name() ;
    std::string get_breed() ;
    int get_age() ;
    void print_info() ;
private :
    std::string dog_name;
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Declaring const object

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We can't modify const objects. That's fine and it's what we want. But we can't read from them either. Which makes the kind of useless.

const member functions

```
std::string get_name() const {
    return dog_name;
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std::string get_breed() const {
    return dog_breed;
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int get_age() const;     // Can split code into declaration
                         // and implementation.
```

Getters that double as setters

```
class Dog
{
public:
    Dog();
    Dog(const std::string& name_param,const std::string& breed_param, int age_param);
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     std::string& get_name() /*const*/  { //The const is removed because we want this
                                          // method to be used to modify the object
                                          // through the returned reference
        return dog_name;
    }
     std::string& get_breed() /*const*/ {
        return dog_breed;
    }
    int& get_age(){
        return dog_age;
    }
private :
    std::string dog_name;
    std::string dog_breed;
    int dog_age;
};
```

Dangling reference

```
const std::string& Dog::compile_dog_info() const{
    std::string info = "Dog name : " + dog_name
                     + " dog breed : " + dog_breed
                     + "dog age : " + std::to_string(dog_age);
    return info;
}
```

Dangling pointer

```
int * Dog::return_int_pointer() const{
    int jumps_per_minute {50};
    return &jumps_per_minute;
}
```

Const correctness

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- Any attempt to modify an object's member variable (direct or indirect) from within a const member functions will result in a compiler error
- You cannot call any non-const member functions from within a const member function

Mutable member vars

```
class Dog
{
public:
    Dog();
    /* ...

    void print_info() const{
        ++info_print_count;
        std::cout << "Dog name : " << dog_name <<
                ", dog breed : " << dog_breed << " , dog age : " << *dog_age
                    << "print_count : " << info_print_count << std::endl;
    }
    /* ...
private :

    /* ...

    std::string dog_name;
    std::string dog_breed;
    int * dog_age;
    mutable size_t info_print_count{0};
};
```

Structured bindings

```
struct Point{
    double x;
    double y;
};
int main(int argc, char **argv)
{
    Point point1 {4.4,5.9};

    auto [a,b] = point1;

    std::cout << "a : " << a << std::endl;
    std::cout << "b : " << b << std::endl;

    //a and b are just copies
    point1.x = 10.1;
    point1.y = 66.2;

    std::cout << std::endl;
    std::cout << "point1 has changed : " << std::endl;
    std::cout << "a : " << a << std::endl;
    std::cout << "b : " << b << std::endl;
    return 0;
}
```

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