- Exercises

Let's solve a few exercises around CRTP in this lesson.

WE'LL COVER THE FOLLOWING

Problem statement 1

Extend the given piece of code with a `Person` class. A `Person` should have a first and last name.

We need to create two objects of the `Person` class and compare these objects using relational operators.

```
#include <iostream>
#include <string>

template<class Derived>
class Relational{};

// Relational Operators

template <class Derived>
bool operator > (Relational<Derived> const& op1, Relational<Derived> const & op2){
    Derived const& d1 = static_cast<Derived const&>(op1);
    Derived const& d2 = static_cast<Derived const&>(op2);
    return d2 < d1;
}

template <class Derived>
bool operator == (Relational<Derived> const& op1, Relational<Derived> const & op2){
```

```
    Derived const& d1 = static_cast<Derived const&>(op1);
    Derived const& d2 = static_cast<Derived const&>(op2);
    return !(d1 < d2) && !(d2 < d1);
}

template <class Derived>
bool operator != (Relational<Derived> const& op1, Relational<Derived> const & op2){
    Derived const& d1 = static_cast<Derived const&>(op1);
    Derived const& d2 = static_cast<Derived const&>(op2);
    return (d1 < d2) || (d2 < d1);
}

template <class Derived>
bool operator <= (Relational<Derived> const& op1, Relational<Derived> const & op2){
    Derived const& d1 = static_cast<Derived const&>(op1);
    Derived const& d2 = static_cast<Derived const&>(op2);
    return (d1 < d2) || (d1 == d2);
}

template <class Derived>
bool operator >= (Relational<Derived> const& op1, Relational<Derived> const & op2){
    Derived const& d1 = static_cast<Derived const&>(op1);
    Derived const& d2 = static_cast<Derived const&>(op2);
    return (d1 > d2) || (d1 == d2);
}

// Implement a person class here

// Person

// Apple

class Apple:public Relational<Apple>{
public:
    explicit Apple(int s): size{s}{};
    friend bool operator < (Apple const& a1, Apple const& a2){
        return a1.size < a2.size;
    }
private:
    int size;
};

// Man

class Man:public Relational<Man>{
public:
    explicit Man(const std::string& n): name{n}{}
    friend bool operator < (Man const& m1, Man const& m2){
        return m1.name < m2.name;
    }
private:
    std::string name;
};

int main(){

  std::cout << std::boolalpha << std::endl;

  // Call Person class object here checks them for all relational operaotrs

  std::cout << std::endl;
```

```
}
```




Problem statement 2

In example 2, how can we prevent a derived class, which has the wrong template parameter: `Derived4: Base<Derived3>`

```
// templateCRTP.cpp

#include <iostream>

template <typename Derived>
struct Base{
  void interface(){
    static_cast<Derived*>(this)->implementation();
  }
  void implementation(){
    std::cout << "Implementation Base" << std::endl;
  }
};

struct Derived1: Base<Derived1>{
  void implementation(){
    std::cout << "Implementation Derived1" << std::endl;
  }
};

struct Derived2: Base<Derived2>{
  void implementation(){
    std::cout << "Implementation Derived2" << std::endl;
  }
};

struct Derived3: Base<Derived3>{};

template <typename T>
void execute(T& base){
    base.interface();
}

// Write the struct here

int main(){

  std::cout << std::endl;

  // call the function here

  std::cout << std::endl;

}
```


Problem statement 3

The functionality of the program in example 2 of the previous lesson can be implemented in various ways. Implement each variant.

Case 1:

Object-oriented with dynamic polymorphism.

```
#include <iostream>

// Implement the functionality here

int main() {
  // call the function here
  return 0;
}
```

Case 2:

Just a function template.

```
#include <iostream>

// write your function template here

int main() {
  // Call the function here
}
```

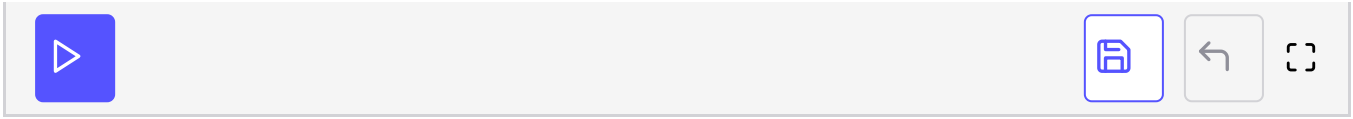
Case 3:

To solve this exercise with **Concepts**, peek into the last chapter of this course. **Concepts** are a valid and elegant method.

Concepts with C++20:

```
#include <iostream>
```

```
// Implement it using C++20 concept

int main() {
  // your code goes here
}
```

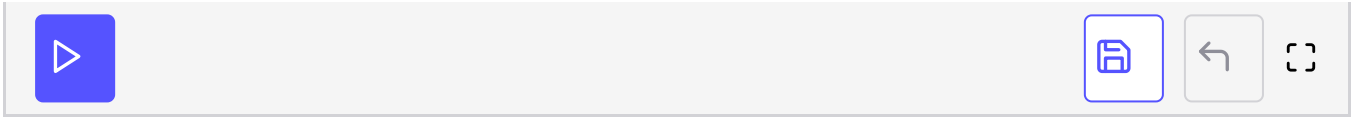


Problem statement 4

Implement the class `ShareMe` and use it.

- Objects of the class `ShareMe` should return an `std::shared_ptr` to themselves.

```
#include <iostream>

// Implement the class here

int main() {
  // After implementing the shareMe class uncomment the code given below

  /*
  std::cout << std::endl;

  // share the same ShareMe object
  std::shared_ptr<ShareMe> shareMe(new ShareMe);
  std::shared_ptr<ShareMe> shareMe1= shareMe->getShared();

  // both resources have the same address
  std::cout << "Address of resource of shareMe "<< (void*)shareMe.get() << " " << std::endl;
  std::cout << "Address of resource of shareMe1 "<< (void*)shareMe1.get() << " " << std::endl

  // the use_count is 2
  std::cout << "shareMe.use_count(): "<< shareMe.use_count() << std::endl;
  std::cout << std::endl;
  */
}
```



In the next lesson, we'll look at solutions to these exercises.