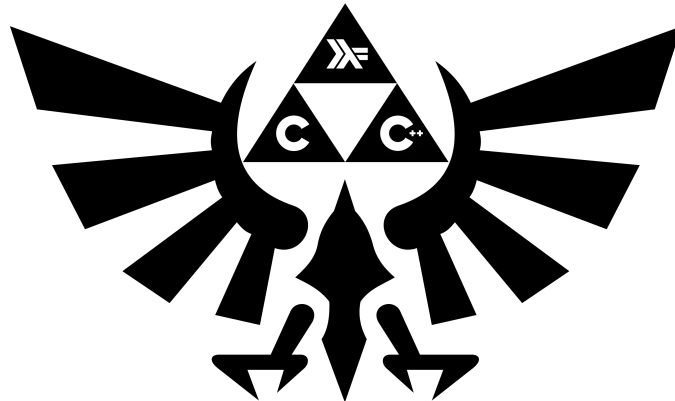


B3 - Paradigms Seminar

B-PDG-300

Day 07 - Morning

Resistance is Futile





Day 07 - Morning

language: C++



- The totality of your source files, except all useless files (binary, temp files, obj files,...), must be included in your delivery.

All your exercises will be compiled with `g++` **and the** `-std=c++20 -Wall -Wextra -Werror` **flags**, unless specified otherwise.

All output goes to the standard output, and must be ended by a newline, unless specified otherwise.



None of your files must contain a `main` function, unless specified otherwise. We will use our own `main` functions to compile and test your code. It will include your header files.

For each exercise, the files to turn-in are path relative to the root of the directory. So you **don't** have to put everything in an `exXX` folder.



Read the examples **CAREFULLY**. They might require things that weren't mentioned in the subject...



The `*alloc`, `free`, `*printf`, `open` and `fopen` functions, as well as the `using namespace` keyword, are forbidden in C++. By the way, `friend` is forbidden too, as well as any library except the standard one.



UNIT TESTS

It is highly recommended to test your functions as you implement them. It is common practice to create and use what are called **unit tests**.

From now on, we expect you to write unit tests for your functions (when possible). To do so, please follow the instructions in the “**How to write Unit Tests**” document on the intranet, available [here](#).

For them to be executed and evaluated, put a `Makefile` at the root of your directory with the `tests_run` rule as mentionned in the documentation linked above.



EXERCISE 0 - THE FEDERATION

Turn in: Federation.hpp, Federation.cpp, WarpSystem.hpp, WarpSystem.cpp

The **United Planets Federation** is an alliance of people able to travel through space. They all possess the distortion speed – or warp – technology, letting them travel through subspace, and all share common values.

Starfleet is an organization tightly coupled to the **Federation**.

Its primary mission is to collect as much information as possible about the **Universe** (and life and everything).

The fleet also has a defensive purpose (which is why all their vessels are prepped and armed), which can turn offensive if need be.

You must create a `Federation` namespace, which contains all the elements that allow the **Federation** to exist. Within the `Federation` namespace, create a nested `Starfleet` namespace. It contains a `Ship` class, which will be used to create spaceships.

Each `Ship` must have the following attributes:

```
int _length;  
int _width;  
std::string _name;  
short _maxWarp;
```



These properties must all be provided during the `Ship`'s construction, and cannot be later modified by a method or by directly accessing them.

The class' constructor must have the following prototype:

```
Ship(int length, int width, std::string name, short maxWarp);
```

Upon creation, each `Ship` prints the following to the standard output:

```
The ship USS [NAME] has been finished.  
It is [LENGTH] m in length and [WIDTH] m in width.  
It can go to Warp [MAXWARP]!
```



You must of course replace `[NAME]`, `[LENGTH]`, `[WIDTH]` and `[MAXWARP]` with the appropriate values.

Each `Ship` requires a complex system to navigate through space, which you must have to provide. As this system is not exclusive to the **Federation's** Ships, you must create a new `WarpSystem` namespace. This namespace will house the `QuantumReactor` class, with a single attribute:

```
bool _stability;
```

which will not be provided during the object's construction, but will instead be set to `true` by default.



You must also provide an `isStable` member function which verifies the stability of the `QuantumReactor`, as well as a `setStability` member function which can modify it. The method `setStability` should be the only way to modify the attribute `_stability`.

```
bool isStable();  
void setStability(bool stability);
```

`WarpSystem` will also contain a `Core` class with a single attribute:

```
QuantumReactor *_coreReactor;
```

This pointer to `QuantumReactor` must be provided when constructing the object. A `checkReactor()` member function will provide access to the reactor, by returning the pointer to the `QuantumReactor`.

The `Ship` class can now have a `setupCore` member function, taking a pointer to a `Core` as a parameter and returning nothing.

This function will hold the `Core` in the `Ship` and print the following to the standard output:

```
USS [NAME]: The core is set.
```

`Ship` should also have a `checkCore` member function taking no parameters and printing the following to the standard output:

```
USS [NAME]: The core is [STABILITY] at the time.
```



[STABILITY] must be replaced by “stable” if `_stability` is true and by “unstable” otherwise.

It must also be possible to create `Ship` objects that do not belong to the `Starfleet`.

These objects have the same functions and attributes as the other `Ships`, but the building process is slightly different.

An independent ship has a maximum warp speed of 1. Upon creation, it prints the following:

```
The independent ship [NAME] just finished its construction.  
It is [LENGTH] m in length and [WIDTH] m in width.
```

The other functions' output may also be different, as you will see in the example.



The following code must compile and print out what follows:

```
int main()
{
    Federation::Starfleet::Ship UssJanissary(289, 132, "Janissary", 6);
    Federation::Ship Independent(150, 230, "Nomad");
    WarpSystem::QuantumReactor QR;
    WarpSystem::QuantumReactor QR2;
    WarpSystem::Core core(&QR);
    WarpSystem::Core core2(&QR2);

    UssJanissary.setupCore(&core);
    UssJanissary.checkCore();
    Independent.setupCore(&core2);
    Independent.checkCore();

    QR.setStability(false);
    QR2.setStability(false);
    UssJanissary.checkCore();
    Independent.checkCore();

    return 0;
}
```

```
~/B-PDG-300> g++ -W -Wall -Werror -Wextra *.cpp
~/B-PDG-300> ./a.out | cat -e
The ship USS Janissary has been finished.$
It is 289 m in length and 132 m in width.$
It can go to Warp 6!$
The independent ship Nomad just finished its construction.$
It is 150 m in length and 230 m in width.$
USS Janissary: The core is set.$
USS Janissary: The core is stable at the time.$
Nomad: The core is set.$
Nomad: The core is stable at the time.$
USS Janissary: The core is unstable at the time.$
Nomad: The core is unstable at the time.$
```



EXERCISE 1 - THE BORGS

Turn in: `Federation.hpp/cpp`, `WarpSystem.hpp/cpp`, `Borg.hpp/cpp`



You must reuse the `Federation` and `WarpSystem` files from the previous exercise.

The universe is a big place.

Spreading their influence from the Delta quadrant, the Borgs are a dangerous race and have incredible technology in their possession, thanks to their power of assimilation.

Create a `Borg` namespace containing a `Ship` class.

The Borg's Ships are different from the Federation's in many aspects:

- first and foremost, they have the shape of a cube. Thus, they have no width and height, but a single side length;
- they have no name either.

Their attributes must be:

```
int _side;  
short _maxWarp;
```

The Borg vessels are built from a unique model: their side is 300 meters long, and their maximum speed is Warp 9.

These values are not provided upon construction.

When a Borg `Ship` is built, it prints the following to the standard output:

```
We are the Borgs. Lower your shields and surrender yourselves unconditionally.  
Your biological characteristics and technologies will be assimilated.  
Resistance is futile.
```

A Borg vessel does not print anything when installing a `Core`.

When verifying it however, it prints, if `stability` is true:

```
Everything is in order.
```

or, if `stability` is not true:

```
Critical failure imminent.
```

Starfleet needs outstanding crewmen and captains to face this threat.

Create a `Captain` class inside the `Starfleet` namespace, with the following attributes:

```
std::string _name;           // provided during construction  
int _age;                    // not provided during construction
```



In addition to these attributes, add functions that let you query the captain's name and age, as well as a function that modifies their age:

```
std::string getName();  
int getAge();  
void setAge(int age);
```

Modify Starfleet's Ship class so that it can be led by a captain.

It must contains a pointer to a Captain, that can be modified using the following function:

```
void promote(Captain *captain);
```

This function must print the following to the standard output:

```
[CAPTAIN NAME]: I'm glad to be the captain of the USS [SHIP NAME].
```



Of course, replace the names by the appropriate values.

Create an Ensign class, with the following attribute:

```
std::string _name;
```

The only way to create an Ensign is the following:

```
int main()  
{  
    Federation::Starfleet::Ensign Ensign("Pavel Chekov");  
}
```



These two methods to create an Ensign must NOT compile:

```
Ensign Chekov;  
Ensign Chekov = (std::string)"Pavel Andreievich Chekov";
```

Upon construction, an Ensign prints:

```
Ensign [NAME], awaiting orders.
```




The following code will compile and display what follows:

```
int main()
{
    Federation::Starfleet::Ship UssJanissary(289, 132, "Janissary", 6);
    Federation::Starfleet::Captain James("James T. Kirk");
    Federation::Starfleet::Ensign Ensign("Pavel Chekov");
    WarpSystem::QuantumReactor QR;
    WarpSystem::QuantumReactor QR2;
    WarpSystem::Core core(&QR);
    WarpSystem::Core core2(&QR2);

    UssJanissary.setupCore(&core);
    UssJanissary.checkCore();
    UssJanissary.promote(&James);

    Borg::Ship Cube;
    Cube.setupCore(&core2);
    Cube.checkCore();

    return 0;
}
```

```
Terminal
~/B-PDG-300> g++ -std=c++20 -Wall -Werror -Wextra *.cpp
~/B-PDG-300> ./a.out | cat -e
The ship USS Janissary has been finished.$
It is 289 m in length and 132 m in width.$
It can go to Warp 6!$
Ensign Pavel Chekov, awaiting orders.$
USS Janissary: The core is set.$
USS Janissary: The core is stable at the time.$
James T. Kirk: I'm glad to be the captain of the USS Janissary.$
We are the Borgs. Lower your shields and surrender yourselves unconditionally.$
Your biological characteristics and technologies will be assimilated.$
Resistance is futile.$
Everything is in order.$
```



EXERCISE 2 - GET MOVING!

Turn in: Federation.hpp/cpp, WarpSystem.hpp/cpp, Borg.hpp/cpp

At some point, your Ships will need to move.

Add the following attributes to your Ship classes:

```
Destination _location;  
Destination _home;
```

Destination is an enumeration defined in the Destination.hpp file.

_home is set to:

```
EARTH           // for Ships of Federation::Starfleet  
VULCAN          // for Ships of Federation  
UNICOMPLEX      // for Ships of Borg
```

Upon construction, _location = _home.

Add the following member functions to your ships:

```
bool move(int warp, Destination d);    // set _location to d  
bool move(int warp);                  // set _location to _home  
bool move(Destination d);              // set _location to d  
bool move();                           // set _location to _home
```

These functions must return true if these 3 assertions are true:

1. warp <= _maxWarp,
2. d != _location,
3. QuantumReactor::_stability == true.

They return false otherwise.



These 3 assertions cannot always be checked depending on the member functions.



Of course, if the function does not return true, the ship does not move.



EXERCISE 3 - THIS IS WAR

Turn in: Federation.hpp/cpp, WarpSystem.hpp/cpp, Borg.hpp/cpp

Now that the ships can move, they need a way to attack and defend themselves.
Provide Starfleet's Ships with these new attributes:

```
int _shield;  
int _photonTorpedo;
```

With these getters and setters:

```
int getShield();  
void setShield(int shield);  
int getTorpedo();  
void setTorpedo(int torpedo);
```

Upon construction, `_shield` is initialized to 100.

Modify the `Starfleet::Ship`'s constructor to allow it to take a number of torpedo as parameter. Make the following code compile but not by adding new constructors:

```
int main()  
{  
    Federation::Starfleet::Ship UssJanissary(289, 132, "Janissary", 6);  
    Federation::Starfleet::Ship BiggerShip(345, 219, "Pathfinder", 6, 5);  
    Federation::Starfleet::Ship DefaultShip;  
}
```

The new version of the constructor must produce the following output:

```
The ship USS [name] has been finished.  
It is [length] m in length and [width] m in width.  
It can go to Warp [maxWarp]!  
Weapons are set: [Torpedo] torpedoes ready.
```

Or, if no information is given:

```
The ship USS Enterprise has been finished.  
It is 289 m in length and 132 m in width.  
It can go to Warp 6!
```

Calling the constructor with no parameters will give all attributes their default value, as shown above.



If torpedo is set to 0 don't print the line about weapons. Meaning the calls and outputs from exercise 0 must still work and be the same.

Implement the following member functions for the `Starfleet's Ships`:

```
void fire(Borg::Ship *target);  
void fire(int torpedoes, Borg::Ship *target);
```

Every call to the `fire` function reduces by 1 or torpedoes the value of `_photonTorpedo`, and prints:

```
[SHIP NAME]: Firing on target. [TORPEDO] torpedoes remaining.
```

The function then reduces by $50 * \text{torpedoes}$ the target's `_shield` attribute.

If the `Ship` runs out of torpedoes, it prints:

```
[SHIP NAME]: No more torpedo to fire, [CAPTAIN NAME]!
```



Of course, the ship can't fire more torpedoes than it has in store.

If it tries to do so, it should print the following message:

```
[SHIP NAME]: Not enough torpedoes to fire, [CAPTAIN NAME]!
```

Add a `getCore` member function to the `Federation::Ship` class.

It takes no parameter and returns a pointer to the `Federation::Ship`'s Core.

Add the following attributes to the Borg's vessels:

```
int _shield;           // set to 100 upon construction
int _weaponFrequency;  // can be provided upon construction
short _repair;         // can be provided upon construction
```

As well as the following getters and setters:

```
int getShield();
void setShield(int shield);
int getWeaponFrequency();
void setWeaponFrequency(int frequency);
short getRepair();
void setRepair(short repair);
```

Change the `Borg::Ship`'s constructor so it can take two optional parameters: `weaponFrequency` and `repair`. The following code must compile and create two identical ships:

```
int main()
{
    Borg::Ship Cube;
    Borg::Ship AnotherCube(20, 3);
}
```

Add the following member functions to the Borg's Ship class:

```
// reduces the `target`'s `_shield` attribute by `_weaponFrequency`
void fire(Federation::Starfleet::Ship *target);

// makes the `target`'s `QuantumReactor` unstable
void fire(Federation::Ship *target);

// reduces `_repair` by 1 and resets `_shield` to 100 (if `_repair` > 0, otherwise
// does nothing)
void repair();
```

The `Borg::Ship`'s fire functions must print the following:

```
Firing on target with [WEAPONFREQUENCY]GW frequency.
```



Once again, replace `[WEAPONFREQUENCY]` with the appropriate value.

The `repair` function prints the following, if repair is possible:

```
Begin shield re-initialisation... Done. Awaiting further instructions.
```

If not, it prints:

```
Energy cells depleted, shield weakening.
```



By now, you don't need us to provide a `main` function to test your code, do you?



EXERCISE 4 - COMMANDERS

Turn in: `Admiral.hpp/cpp`, `BorgQueen.hpp/cpp`

Now that your fleets can move around and shoot at stuff, you need some way to command them. Two classes are required to meet this requirement.

First, an `Admiral` class, belonging to the `Starfleet` namespace (don't forget this namespace is nested in another `Federation` namespace).

This class must have the following private attribute:

```
std::string _name; // provided upon construction
```

Upon construction, the `Admiral` displays:

```
Admiral [NAME] ready for action.
```

The class must hold two public method pointers:

- `movePtr`: points to the `move(Destination)` method of the `Ship` class from the `Federation::Starfleet` namespace
- `firePtr`: points to the `fire(Borg::Ship *)` method of the `Ship` class from the `Federation::Starfleet` namespace



Method pointer ? You 'member function pointer ? Well, almost the same but not really...

Add the two following member functions to the `Admiral` class:

```
void fire(Federation::Starfleet::Ship *ship, Borg::Ship *target);  
bool move(Federation::Starfleet::Ship *ship, Destination dest);
```

When called, the `fire` method prints the following message:

```
On order from Admiral [NAME]:
```

This should be displayed before calling the `fire` function of the `Ship`.



You must not directly call the `move` or `fire` methods of `Ship`.

Create the `BorgQueen` class (within the `Borg` namespace), holding 3 method pointers:

- `movePtr`: points to the `move(Destination)` method of the `Borg::Ship` class
- `firePtr`: points to the `fire(Federation::Starfleet::Ship *)` method of the same class
- `destroyPtr`: points to the `fire(Federation::Ship *)` method of the same class



Add the following member functions, which will use the method pointers described above:

```
bool move(Borg::Ship *ship, Destination dest);
void fire(Borg::Ship *ship, Federation::Starfleet::Ship *target);
void destroy(Borg::Ship *ship, Federation::Ship *target);
```

Each method pointer will be initialized in the classes' constructors.

Here is a quick example of how it must work with the `Admiral` class but it's similar with the `BorgQueen` class:

```
int main()
{
    Federation::Starfleet::Ship UssJanissary(289, 132, "Janissary", 6, 20);
    Federation::Starfleet::Admiral Pierce("Pierce");
    Borg::Ship Cube(25);

    Pierce.fire(&UssJanissary, &Cube);
    Pierce.fire(&UssJanissary, &Cube);

    return 0;
}
```

And it must output:

```
Terminal
~/B-PDG-300> g++ -std=c++20 -Wall -Werror -Wextra *.cpp
~/B-PDG-300> ./a.out | cat -e
The ship USS Janissary has been finished.$
It is 289 m in length and 132 m in width.$
It can go to Warp 6!$
Weapons are set: 20 torpedoes ready.$
Admiral Pierce ready for action.$
We are the Borgs. Lower your shields and surrender yourselves unconditionally.$
Your biological characteristics and technologies will be assimilated.$
Resistance is futile.$
On order from Admiral Pierce:$
Janissary: Firing on target. 19 torpedoes remaining.$
On order from Admiral Pierce:$
Janissary: Firing on target. 18 torpedoes remaining.$
```



EXERCISE 5 - EXAM

Turn in: Exam.hpp, Exam.cpp

Create an Exam class that makes this code compile:

```
int main()
{
    Exam e = Exam(&Exam::cheat);

    e.kobayashiMaru = &Exam::start;
    (e.*e.kobayashiMaru)(3);
    Exam::cheat = true;
    if (e.isCheating())
        (e.*e.kobayashiMaru)(4);
}
```

and output the following:

```
Terminal
~/B-PDG-300> g++ -std=c++20 -Wall -Werror -Wextra Exam.cpp main.cpp
~/B-PDG-300> ./a.out | cat -e
[The exam is starting]$
3 Klingon vessels appeared out of nowhere.$
they are fully armed and shielded$
This exam is hard... you lost again.$
[The exam is starting]$
4 Klingon vessels appeared out of nowhere.$
they are fully armed and shielded$
What the... someone changed the parameters of the exam !
```