МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ
РОССИЙСКОЙ ФЕДЕРАЦИИ

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ БЮДЖЕТНОЕ ОБРАЗОВАТЕЛЬНОЕ
УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ

**«БЕЛГОРОДСКИЙ ГОСУДАРСТВЕННЫЙ
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Кафедра программного обеспечения вычислительной техники и
автоматизированных систем

Лабораторная работа №5
по дисциплине: Объектно-ориентированное программирование
Тема: Классы, виды отношений. Наследование.

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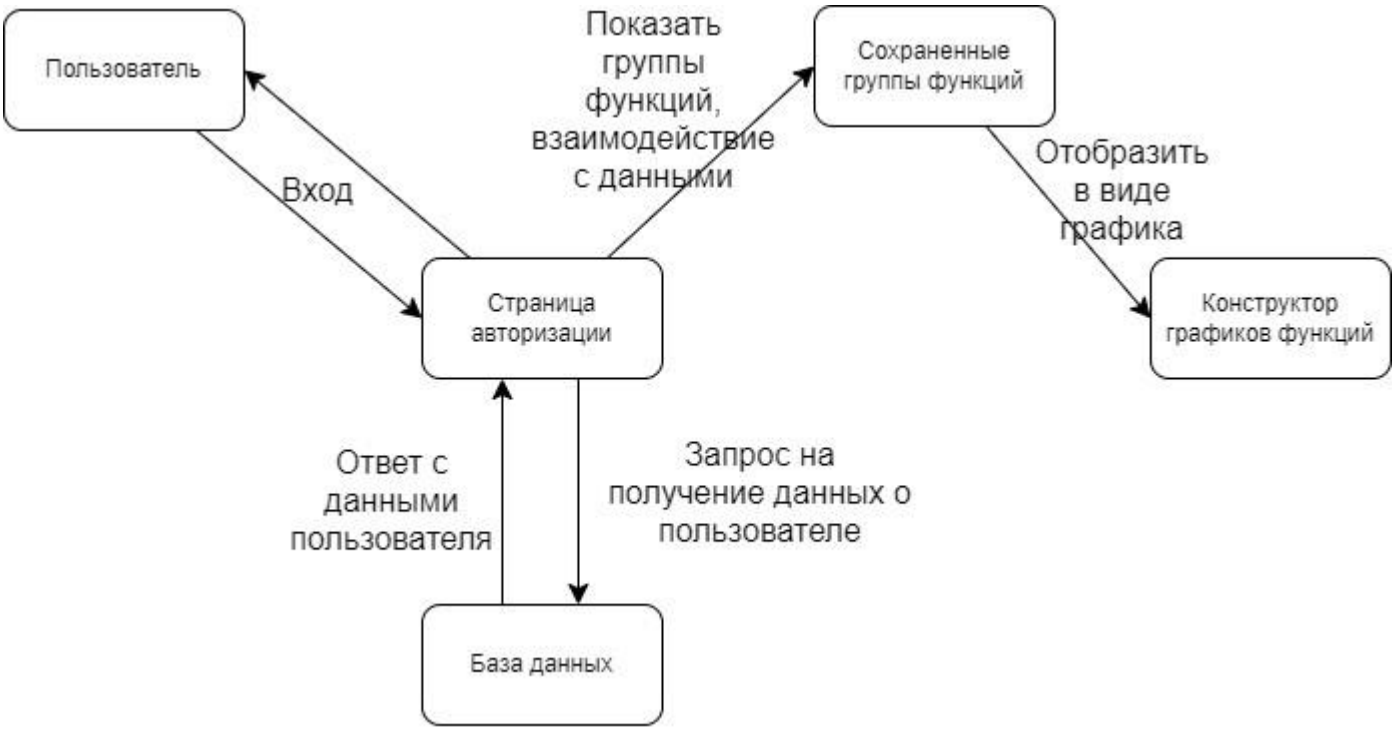
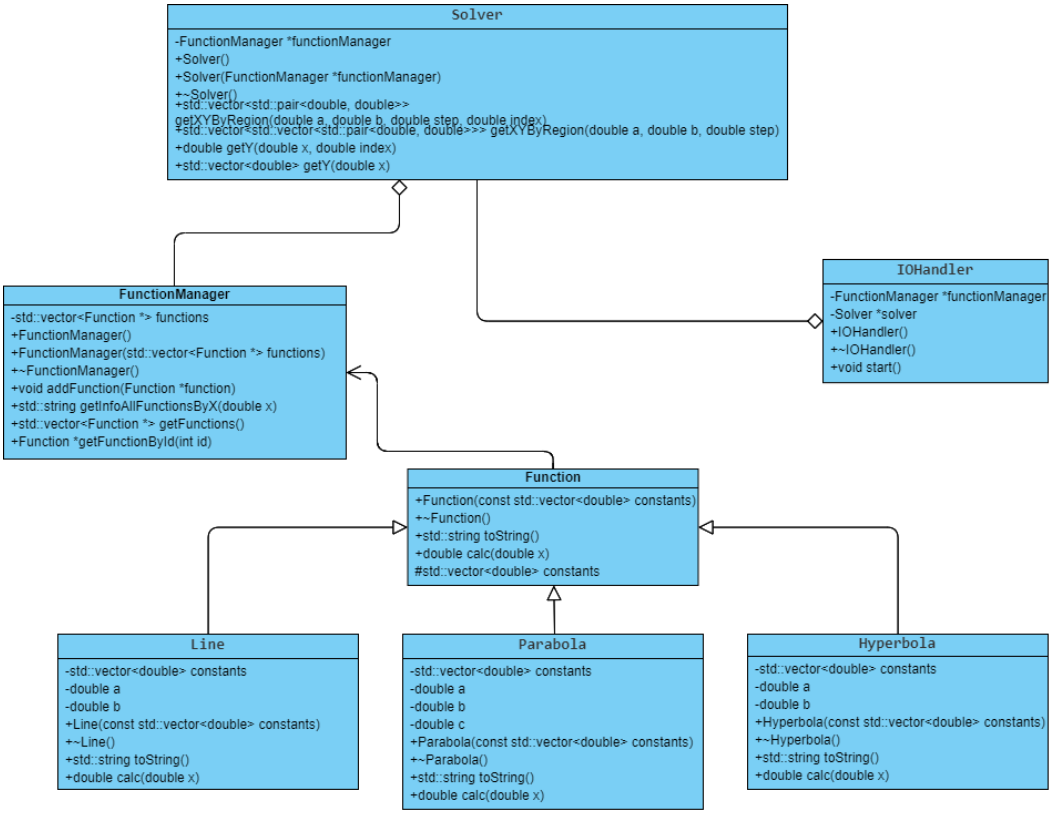
Цель работы: Получение теоретических знаний в области разработки классов, получение практических навыков реализаций классов и отношений между ними.

Задание: Программа решения заданных произвольных уравнений.
1. Создать абстрактный класс Function с методом вычисления значения функции y=f(x) в заданной точке.
2. Создать производные классы:
Line (y=ax+b),
Parabola (y=ax 2 +bx +c),
Hyperbola (y=a/x+b)
со своими методами вычисления значения в заданной точке.
3. Создать массив n функций и вывести полную информацию о значении данных функций в точке x.






```cpp
class Function
{
private:
public:
    Function(const std::vector<double> constants);
    ~Function();
    virtual std::string toString();
    virtual double calc(double x) = 0;

protected:
    std::vector<double> constants;

};
class Hyperbola : public Function
{
private:
    std::vector<double> constants;
    double a;
    double b;
public:
    Hyperbola(std::vector<double> constants);
    ~Hyperbola();
    double calc(double x) override;
    std::string toString() override;
};
```

```cpp
class Line : public Function
{
private:
    std::vector<double> constants;
```

```
public:
    Line(std::vector<double> constants);
    ~Line();
    double calc(double x) override;
    std::string toString() override;

protected:
    double a;
    double b;
};
```

```
class Parabola : public Function
{
private:
    std::vector<double> constants;
public:
    Parabola(std::vector<double> constants);
    ~Parabola();
    double calc(double x) override;
    std::string toString() override;

protected:
    double a;
    double b;
    double c;
};
```

```
class FunctionManager
{
private:
    std::vector<Function *> functions;

public:
    FunctionManager();
    FunctionManager(std::vector<Function *> functions);
    ~FunctionManager();

    Function *getFunctionById(int id);
    std::vector<Function *> getFunctions();
    void addFunction(Function *function);
    size_t size();
};
```

```
class IOHandler
{
private:
    FunctionManager *functionManager;
    Solver *solver;
public:
    IOHandler();
    ~IOHandler();
```

```
    void start();
};
```

```
class Solver
{
private:
    FunctionManager *functionManager;

public:
    Solver();
    Solver(FunctionManager *functionManager);
    ~Solver();

    std::vector<std::pair<double, double>> getXYByRegion(double a, double b, double step,
double index);
    std::vector<std::vector<std::pair<double, double>>> getXYByRegion(double a, double b,
double step);
    double getY(double x, double index);
    std::vector<double> getY(double x);
};
```

```
Function::Function(std::vector<double> constants) {
    this->constants = constants;
}

Function::~Function() {
    delete this;
}

std::string Function::toString() {
    std::string res;
    for (double constant : constants)
        res += std::to_string(constant) + " ";

    return res;
}
```

```
Hyperbola::Hyperbola(std::vector<double> constants) : Function::Function(constants)
{
    if (constants.size() != 2)
        throw std::invalid_argument("num of constants not equal 2");

    a = constants[0];
    b = constants[1];
}

Hyperbola::~Hyperbola() { delete this; }

double Hyperbola::calc(double x)
{
    return a / x + b;
}
```

```
std::string Hyperbola::toString() {
    return std::to_string(a) + " / x + " + std::to_string(b);
}
```

```
Line::Line(std::vector<double> constants) : Function::Function(constants)
{
    if (constants.size() != 2)
        throw std::invalid_argument("num of constants not equal 2");

    a = constants[0];
    b = constants[1];
}

Line::~Line() {
    delete this;
}

double Line::calc(double x)
{
    return a * x + b;
}

std::string Line::toString() {
    return std::to_string(a) + " * x + " + std::to_string(b);
}
```

```
Parabola::Parabola(std::vector<double> constants) : Function::Function(constants)
{
    if (constants.size() != 3)
        throw std::invalid_argument("num of constants not equal 3");

    a = constants[0];
    b = constants[1];
    c = constants[2];
}

Parabola::~Parabola()
{
    delete this;
}

double Parabola::calc(double x)
{
    return a * x * x + b * x + c;
}

std::string Parabola::toString() {
    return std::to_string(a) + " * x2 + " + std::to_string(b) + " x + " +
std::to_string(c);
}
```

```
FunctionManager::FunctionManager()
{
```

```
}

FunctionManager::FunctionManager(std::vector<Function *> functions)
{
    this->functions = functions;
}

FunctionManager::~FunctionManager()
{
    delete this;
}

void FunctionManager::addFunction(Function *function)
{
    functions.push_back(function);
}

std::vector<Function *> FunctionManager::getFunctions()
{
    return functions;
}

Function *FunctionManager::getFunctionById(int id)
{
    return functions[id];
}

size_t FunctionManager::size()
{
    return functions.size();
}
```

```
#include "../../headers/function/IOHandler.h"
#include "../../headers/function/Solver.h"
#include "../../headers/function/specific/Line.h"
#include "../../headers/function/specific/Hyperbola.h"
#include "../../headers/function/specific/Parabola.h"

#include <iostream>

IOHandler::IOHandler()
{
    this->functionManager = new FunctionManager();
    this->solver = new Solver(functionManager);
}

IOHandler::~IOHandler()
{
    delete this;
}

void IOHandler::start()
{
    int command_index;
```

```
    while (true)
    {
        std::cout << "1- add function\n2- calc functions\n";
        std::cin >> command_index;
        switch (command_index)
        {
        case 1:
            std::cout << "\nChange type of function\n1- Line\n2- Hyperbola\n3-
Parabola\n";
            std::cin >> command_index;

            double a;
            std::cout << "input a: ";
            std::cin >> a;

            double b;
            std::cout << "input b: ";
            std::cin >> b;

            switch (command_index)
            {
            case 1:
                functionManager->addFunction(new Line({a, b}));
                break;
            case 2:
                functionManager->addFunction(new Hyperbola({a, b}));
                break;
            case 3:
                double c;
                std::cout << "input c: ";
                std::cin >> c;
                functionManager->addFunction(new Parabola({a, b, c}));
                break;

            default:
                std::cerr << "Incorrect command index\n";
                break;
            }

            break;

        case 2:
            std::cout << "\nHow much function wou want calculate\n1- One\n2- Many\n";
            std::cin >> command_index;
            switch (command_index)
            {
            case 1:
                for (size_t i = 0; i < functionManager->size(); i++)
                {
                    std::cout << i + 1 << ' ' << functionManager->getFunctionById(i)-
>toString() << '\n';
                }
                int index;
                std::cout << "Change function:\n";
```

```
            std::cin >> index;

            std::cout << "1- By X\n2- By range\n";
            std::cin >> command_index;
            switch (command_index)
            {
            case 1:
                double x;
                std::cout << "Write X\n";
                std::cin >> x;

                std::cout << "Result: "
                          << "f(" << x << ") = " << solver->getY(x, index-1) << '\n';

                break;
            case 2:
                double a;
                std::cout << "Write A\n";
                std::cin >> a;

                double b;
                std::cout << "Write B\n";
                std::cin >> b;

                double step;
                std::cout << "Write step\n";
                std::cin >> step;

                for (auto result : solver->getXYByRegion(a, b, step, index-1))
                    std::cout << result.first << "\t| " << result.second << '\n';

                break;

            default:
                std::cerr << "Incorrect command index\n";

                break;
            }

            break;
        case 2:
            std::cout << "1- By X\n2- By range\n";
            std::cin >> command_index;
            switch (command_index)
            {
            case 1:
                double x;
                std::cout << "Write X\n";
                std::cin >> x;

                std::cout << "Result:\n";
                for (size_t i = 0; i < functionManager->size(); i++)
                    std::cout << "f(" << x << ") = " << solver->getY(x, i) << '\n';
```

```
                    break;
                case 2:
                    double a;
                    std::cout << "Write A\n";
                    std::cin >> a;

                    double b;
                    std::cout << "Write B\n";
                    std::cin >> b;

                    double step;
                    std::cout << "Write step\n";
                    std::cin >> step;

                    for (auto table : solver->getXYByRegion(a, b, step))
                    {
                        for (auto result : table)
                            std::cout << result.first << " | " << result.second << '\n';

                        std::cout << "------\n";
                    }

                    break;

                default:
                    std::cerr << "Incorrect command index\n";
                    break;
                }

                break;
            default:
                std::cerr << "Incorrect command index\n";
                break;
            }
        }
    }
}
```

```
Solver::Solver()
{
}

Solver::Solver(FunctionManager *functionManager)
{
    this->functionManager = functionManager;
}

Solver::~Solver()
{
    delete this;
}

std::vector<std::pair<double, double>> Solver::getXYByRegion(double a, double b, double
step, double index)
```

```
{
    auto res = std::vector<std::pair<double, double>>();
    while (a < b)
    {
        res.push_back({a, getY(a, index)});

        a += step;
    }

    return res;
}
std::vector<std::vector<std::pair<double, double>>> Solver::getXYByRegion(double a, double
b, double step)
{
    auto res = std::vector<std::vector<std::pair<double, double>>>();
    for (size_t i = 0; i < functionManager->size(); i++)
    {
        res.push_back(getXYByRegion(a, b, step, i));
    }

    return res;
}
double Solver::getY(double x, double index)
{
    return functionManager->getFunctionById(index)->calc(x);
}

std::vector<double> Solver::getY(double x)
{
    auto res = std::vector<double>();
    for (size_t i = 0; i < functionManager->size(); i++)
    {
        res.push_back(getY(x, i));
    }

    return res;
}
```

Пример работы:

```
int main()
{
    Line l1({2, 2});
    Line l2({2, 2});
    Parabola p1({3, 2, 1});
    Line l3({2, 2});
    Hyperbola h1({2, 2});

    FunctionManager fm({&l1, &l2, &l3});
    fm.addFunction(&p1);
    fm.addFunction(&h1);

    std::cout << fm.getInfoAllFunctionsByX(4);
```

```
    return 0;
}
```

Выходные данные:

```
1- add function
2- calc functions
1

Change type of function
1- Line
2- Hyperbola
3- Parabola
1
input a: 7
input b: 6
1- add function
2- calc functions
1

Change type of function
1- Line
2- Hyperbola
3- Parabola
3
input a: 4
input b: 5
input c: 6
1- add function
2- calc functions
2

How much function wou want calculate
1- One
2- Many
1
1 7.000000 * x + 6.000000
2 4.000000 * x2 + 5.000000 x + 6.000000
Change function:
1
1- By X
2- By range
1
Write X
8
Result: f(8) = 62
1- add function
2- calc functions
2

How much function wou want calculate
1- One
2- Many
2
```

```
1- By X
2- By range
1
Write X
4
Result:
f(4) = 34
f(4) = 90
1- add function
2- calc functions
2

How much function wou want calculate
1- One
2- Many
2
1- By X
2- By range
2
Write A
0
Write B
4
Write step
0.5
0 | 6
0.5 | 9.5
1 | 13
1.5 | 16.5
2 | 20
2.5 | 23.5
3 | 27
3.5 | 30.5
------
0 | 6
0.5 | 9.5
1 | 15
1.5 | 22.5
2 | 32
2.5 | 43.5
3 | 57
3.5 | 72.5
------
1- add function
2- calc functions
```

Вывод: В ходе лабораторной работы получили теоретические знания в области разработки классов, получили практические навыки реализации классов и отношений между ними.