**📖 MTH2008** Scientific Computing Logbook

School of Engineering and Physical Sciences, University of Lincoln

Semester A, 2024

*“I confirm that this logbook is entirely my own work and that all references and quotations, from both primary and secondary sources, have been fully identified and properly acknowledged.”* - William Fayers (27378661).

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## **Week 1** – 2024-09-30 to 2024-10-07

**What did you learn in the lab tasks this week?**

In the lab session this week we focused on outputting to a data stream and handling special characters. In order to output to a data stream, I learned we use cout to declare console output and insert data into this with the insertion operator, << - this differs from Python’s print function, but is essentially how it works. This is because C++ is a lower level language, just above assembly code, and is thus more lightweight and efficient, e.g. you don’t need input/output capabilities with all programs, as not all programs need a command-line interface, hence we include the line #include <iostream>to access these stream commands.

Additionally, we explored special characters (\n, \a, \b, \f, \r, and \t), escape sequences (\\, \', \", and \?), and the line terminator (endl). The special characters and escape sequences are similar to those used in Python, but the line terminator was completely new for me. Functionally, it seems to act the same as a newline character, but works by ending the data stream started by cout.

**How well did I learn it?**

I learned everything pretty quickly, making parallels with Python quite often. It’s been really fun learning a completely new, more low-level language and deepening my understanding of programming in general. I did some extra work outside of my lab session, too, which definitely helped me reinforce any new knowledge and understand C++ even quicker.

**How does my solution compare with the official solution?**

The official solution for Task 3 adds an additional explanation of how Pascal’s triangle is obtained, as well as uses a simplified solution using spaces rather than tab characters.

**How can I extend the concepts used in the tasks to form a new project**

In my extra work this week, I’ve extended the concepts used to make Pascal’s triangle by changing the logic to a more loop-based system so that I can use render any number of rows. I also tried an alternative to using the tab characters, setd::setw. Not only this, but I decided to take this number of rows as a user input with std::cin and validated the input, throwing an exception if invalid.

I also researched C++ best practices and styling guidelines, referencing documents like Google Style Guides [[1]](#references) and Doxygen [[2]](#references). The main points are learned from this were: consistent comment style (I opted for /\* and /\*\*), function return rationale (i.e. when to use void), explicitly returning 0 in a main function (to tell the console it ran correctly), docstring placement (before a function, contrasting with Python), and function declaration (placing the opening curly bracket on the same line).

Finally, with the project I already explained, I explored functions, for loops, conditional statements, exception handling, and some basic libraries: cmath, stdexcept, and iomanip.

**Lesson Review Question Answers**

1. Facilitates complex simulations; differs by enabling exploration beyond physical limits.
2. Climate modeling, drug discovery, astrophysics simulations.
3. First computer-assisted proof; raises questions about proof validity.
4. Cost/feasibility issues; safety concerns.
5. From serial to parallel computing; enhances computational power for complex problems.
6. Serial: sequential processing; Parallel: simultaneous processing.
7. Physical limits in miniaturization; heat dissipation, quantum effects.
8. FLOPS: Floating Point Operations Per Second; measures computational performance.
9. Binary: two digits (0, 1); used for electronic circuitry efficiency.
10. Encapsulation, inheritance, polymorphism.

Multiple choice: BCCBCCBBBA

### Basic Use: Using Cout

#### Task Task.1

5

cout << "Welcome to C++ Programming\n";

### Basic Use: Special Characters

#### Task Task.2

3

cout << "With bell character: Welcome to C++ Programming\a" << "---\n";

3

cout << "With backspace character: Welcome to C++ Programming\b" << "---\n";

3

cout << "With return character: Welcome to C++ Programming\r" << "---\n";

3

cout << "With tab character: Welcome to C++ Programming\t" << "---\n";

4

cout << "Escaped characters: Is the symbol \\n called \' Newline \' \? \n";

5

cout << "A rose by any other name would smell as sweet";  
cout << endl;

### Basic Use: Pascals Triangle

/\*\*  
 \* @file l03-basic\_use-pascals\_triangle.cpp  
 \* @author William Fayers (william@fayers.com)  
 \* @brief Exploring cout and special characters to print Pascal's Triangle.  
 \* @version 0.1.0  
 \* @date 2024-09-30  
 \*   
 \* @copyright Copyright (c) 2024  
 \*   
 \*/  
#include <iostream>  
  
using namespace std;  
  
  
/\*\*  
 \* @brief Main function to run the program.  
 \*   
 \* @return int Success or failure (0 or 1).  
 \*/  
int main() {  
 /\* Print Pascal's Triangle up to n=5 with cout and the tab character to center the numbers \*/  
 cout << "n\t\t\t\t Pascal's Triangle up to n=5\n";  
 cout << "0\t\t\t\t\t\t1\n";  
 cout << "1\t\t\t\t\t1\t\t1\n";  
 cout << "2\t\t\t\t1\t\t2\t\t1\n";  
 cout << "3\t\t\t1\t\t3\t\t3\t\t1\n";  
 cout << "4\t\t1\t\t4\t\t6\t\t4\t\t1\n";  
 cout << "5\t1\t\t5\t\t10\t\t10\t\t5\t\t1\n";  
  
 cout << "\t\t\t\t Made by William Fayers\n";  
 /\*\*  
 \* ANSWER (Task 3.1):  
 \* I used the tab character, `\t` to center the numbers in the Pascal's Triangle, along with  
 \* `cout` to print the numbers. This ended up with a fairly nice looking Pascal's Triangle.  
 \*/  
  
 /\* Return 0 to indicate the program ran successfully \*/  
 return 0;  
}

### Pascal Triangle: Extended Project

/\*\*  
 \* @file e01-pascal\_triangle-extended\_project.cpp  
 \* @author William Fayers (william@fayers.com)  
 \* @brief Outputs Pascal's triangle to the console, extending the concepts from lab 1.  
 \* @version 0.1.0  
 \* @date 2024-10-01  
 \*   
 \* @copyright Copyright (c) 2024  
 \*   
 \*/  
  
#include <iostream> /\* For std::cout, std::cin \*/  
#include <cmath> /\* For std::ceil, std::pow \*/  
#include <stdexcept> /\* For std::invalid\_argument \*/  
#include <iomanip> /\* For std::setw \*/  
  
  
const int MAX\_ROWS = 29;  
const std::string ERROR\_MESSAGE = "Error: rows must be between 0 and "  
 + std::to\_string(MAX\_ROWS) + "!";  
  
/\*\*  
 \* @brief Outputs Pascal's triangle to the console.  
 \*   
 \* @details Calculates Pascal's triangle iteratively using the formula:  
 \* \f[  
 \* C(n, k+1) = C(n, k) \times \frac{n - k}{k + 1}  
 \* \f]  
 \* where \f$C(n, k)\f$ is the coefficient at row \f$n\f$ and column \f$k\f$.  
 \* Ensures the triangle is centered in the console by calculating the maximum  
 \* width of the triangle and the maximum width of the coefficients, using the  
 \* power of 2 to estimate the width of the largest coefficient.  
 \*   
 \* @note Designed to test the use of output streams, loops, error handling, libraries,  
 \* and functions in C++. Extends the concepts from lab 1, exploring new concepts  
 \* like using the `std::setw` function to set the width of the output instead of  
 \* using the tab character.  
 \*   
 \* @param rows The number of rows to output in Pascal's triangle. Must be non-negative  
 \* and less than or equal to MAX\_ROWS.  
 \*  
 \* @throw std::invalid\_argument Throws an error if rows is less than 0 or greater than MAX\_ROWS.  
 \*  
 \* @warning Since the coefficients in Pascal's triangle can grow very large, this  
 \* function may not work as expected for rows greater than 29.  
 \*  
 \* @example  
 \* \code{.cpp}  
 \* output\_pascals\_triangle(4);  
 \* \endcode  
 \*  
 \* Expected Output:  
 \* \code{.plaintext}  
 \* 1  
 \* 1 1  
 \* 1 2 1  
 \* 1 3 3 1  
 \* 1 4 6 4 1  
 \* \endcode  
 \*/  
void output\_pascals\_triangle(int rows) {  
 /\* Throw an error if rows is less than 0 or greater than MAX\_ROWS. \*/  
 if (rows < 0 || rows > MAX\_ROWS) {  
 throw std::invalid\_argument(ERROR\_MESSAGE);  
 }  
  
 /\* Estimate the width of the largest coefficient using the power of 2 \*/  
 int estimated\_max\_coefficient = std::ceil(std::pow(2, rows));  
 int max\_coefficient\_width = std::to\_string(estimated\_max\_coefficient).length() + 1;  
  
 /\* Calculate the maximum width of the triangle. \*/  
 int max\_triangle\_width = max\_coefficient\_width \* (rows + 1);  
  
 /\* Loop through each row in Pascal's triangle. \*/  
 for (int row = 0; row <= rows; row++) {  
 /\* Set the first coefficient to 1 \*/  
 int coefficient = 1;  
  
 /\* Add leading spaces to center the triangle. \*/  
 int leading\_spaces = (max\_triangle\_width - (max\_coefficient\_width \* (row + 1))) / 2;  
 std::cout << std::string(leading\_spaces, ' ');  
  
 /\* Loop through each column in the current row. \*/  
 for (int column = 0; column <= row; column++) {  
 /\* Output the current coefficient. \*/  
 std::cout << std::setw(max\_coefficient\_width) << coefficient;  
  
 /\* Calculate the next coefficient. \*/  
 coefficient = coefficient \* (row - column) / (column + 1);  
 }  
  
 /\* Move to the next row. \*/  
 std::cout << std::endl;  
 }  
}  
  
/\*\*  
 \* @brief Main function to run the program.  
 \*  
 \* @details This function prompts the user for the number of rows to output  
 \* in Pascal's triangle and calls the output\_pascals\_triangle function.  
 \*  
 \* @return Returns 0 to indicate the program has run successfully.  
 \*/  
int main() {  
 /\* Prompt the user for the number of rows to output. \*/  
 std::cout << "Please enter the number of rows you would like to output (0 to "  
 << MAX\_ROWS << "): ";  
 int rows;  
 std::cin >> rows;  
  
 /\* Output Pascal's triangle to the console. \*/  
 try {  
 output\_pascals\_triangle(rows);  
 } catch (const std::invalid\_argument& e) {  
 std::cout << e.what() << std::endl;  
 }  
  
 /\* Output a goodbye message to the user. \*/  
 std::cout << "Made by William Fayers :)" << std::endl;  
  
 /\* Return 0 to indicate the function has run successfully. \*/  
 return 0;  
}

## **Week 2** – 2024-10-07 to 2024-10-14

**What did you learn in the lab tasks this week?**

This week we explored variables and their data types a bit more, as well as how to use inputs and mathematics to prototype a simple calculator.

**How well did I learn it?**

As I already spent last week diving into C++ a lot more, this week was very simple, so I tried to extend the task solutions slightly with error handling etc.

Making great progress so far!

**How does my solution compare with the official solution?**

Task 2.2’s first offical solution differs the most by inputting the two numbers in one line, rather than separately.

The second official solution to Task 2.2 is a little bit more different, simplifying the programming techniques used. For example, it doesn’t handle any errors and doesn’t use a separate functionto handle any calculations.

**How can I extend the concepts used in the tasks to form a new project**

To extend these concepts, I could create a fully functional calculator with verbose error/input handling, which could even be extended to evaluate simple LaTeX expressions.

### Basic Use: Variables And Data Types

#### Task Task.1

2

int total\_children = 10;  
int candies\_per\_child = 5;  
int extra\_candies = 10;

2

std::cout << "HALLOWEEN CANDY CALCULATOR" << std::endl;  
std::cout << "Total Children: " << total\_children << std::endl;  
std::cout << "Candies per Child: " << candies\_per\_child << std::endl;  
std::cout << "Extra Candies: " << extra\_candies << std::endl;  
std::cout << "---" << std::endl;  
std::cout << "Total Candies: " << total\_candies << std::endl;

2

return 0;

### Basic Use: Input And Math

#### Task Task.2

1

result = number1 / number2;  
std::cout << "Quotient: " << result << std::endl;

3

float mass1, mass2, distance;

3

std::cout << "Enter the mass of the first object (kg): ";  
std::cin >> mass1;  
std::cout << "Enter the mass of the second object (kg): ";  
std::cin >> mass2;  
std::cout << "Enter the distance between the objects (m): ";  
std::cin >> distance;

3

try {  
float force = calculate\_gravitational\_force(mass1, mass2, distance);  
std::cout << "Gravitational Force: " << force << " N" << std::endl;  
} catch (std::invalid\_argument& error) {  
std::cerr << "Error: " << error.what() << std::endl;  
}

### Coursework: Calculator

#### Task Task.1

1

float radius;  
input\_number(radius, "Enter the radius of the circle: ");

1

float area = M\_PI \* radius \* radius;  
float circumference = 2 \* M\_PI \* radius;  
std::cout << "Area of a circle with radius " << radius << " = " << area << std::endl;  
std::cout << "Circumference of a circle with radius " << radius << " = " << circumference  
<< std::endl;

2

float principal, rate, time;  
input\_number(principal, "Enter the principal amount: ");  
input\_number(rate, "Enter the rate of interest (%): ");  
input\_number(time, "Enter the time period (years): ");

2

float simple\_interest = (principal \* rate \* time) / 100;  
std::cout << "Simple Interest on a principal amount of " << principal << " at a rate of "  
<< rate << "% for " << time << " years = " << simple\_interest << std::endl;

#### Task Task.2

1

return 0;  
}

2

3

4

5

6

7

8

9

10

## **Week 3** – 2024-10-14 to 2024-10-21

**What did you learn in the lab tasks this week?**

We learned more about data types, specifically how they’re handled in memory and their sizes. On top of this, we started using the cmath library for more complex calculations.

**How well did I learn it?**

It was quite simple to learn, and interesting to learn more about the lower-level hardware parts, too. It was slightly confusing answering the questions because of a few minor mistakes in the actual questions and example code, but apart from that I learned it all well!

**How does my solution compare with the official solution?**

The official solutions for Task 2.2 are similar to mine, although handled numbers like 1. instead of 1.0 - this seems very confusing to me. It also wrote each expression in one long line, rather than breaking it across multiple with whitespace. The second expression is also incorrectly evaluated as not a real number in the offical solution.

The final part of this week’s lab also added more than the question asked for, but so did I with error handling!

### Basic Use: Data Size

#### Task Task.1

1

std::cout << "Original number: " << unsigned\_small\_number << std::endl;  
unsigned\_small\_number++;  
std::cout << "Incremented number (1x): " << unsigned\_small\_number << std::endl;  
unsigned\_small\_number++;  
std::cout << "Incremented number (2x): " << unsigned\_small\_number << std::endl;

3

signed\_small\_number = -32768;  
std::cout << "Original number: " << signed\_small\_number << std::endl;  
signed\_small\_number--;  
std::cout << "Decremented number (1x): " << signed\_small\_number << std::endl;  
signed\_small\_number--;  
std::cout << "Decremented number (2x): " << signed\_small\_number << std::endl;

### Libraries: Using Cmath

#### Task Task.2

1

std::cout << sqrt(9.0) << std::endl;

1

std::cout << log(1.1) << std::endl;

1

std::cout << pow(2.5, 3.0) << std::endl;

1

std::cout << ceil(4.1) << std::endl;

1

std::cout << (7 + sqrt(7.0)) / 3.0 << std::endl;

1

std::cout << tanh(0.342) << std::endl;

1

std::cout << fmod(11.0, 4.0) << std::endl;

1

std::cout << abs(-9) << std::endl;

1

std::cout << fabs(-4.5) << std::endl;

1

std::cout << floor(8.8) << std::endl;

1

std::cout << log10(1.0) << std::endl;

1

std::cout << cbrt(10.0) << std::endl;

3

double x;  
std::cout << "Calculation of the hyperbolic cosecant function..." << std::endl;  
std::cout << "Enter a value for x: ";  
std::cin >> x;

3

double y = csch(x);  
if (!std::isnan(y)) {  
std::cout << "Hyperbolic cosecant of " << x << " is: " << y << std::endl;  
} else {  
std::cout << "Hyperbolic cosecant is undefined for x = 0." << std::endl;  
}

### Coursework: Trig Calculator

#### Task Task.3

0

void input\_number(double& number, const std::string& input\_message) {  
while (true) {  
std::cout << input\_message;  
std::cin >> number;  
  
if (std::cin.fail()) {  
std::cerr << "Invalid input. Please enter a valid number." << std::endl;  
std::cin.clear();  
std::cin.ignore(std::numeric\_limits<std::streamsize>::max(), '\n');  
} else {  
std::cin.ignore(std::numeric\_limits<std::streamsize>::max(), '\n');  
return;  
}  
}  
}

1

double atanh(double x) {  
if (x < -1 || x > 1) {  
std::cerr << "\nError: The input value must be between -1 and 1." << std::endl;  
return NAN;  
}  
return 0.5 \* log((1 + x) / (1 - x));  
}

2

double acosh(double x) {  
if (x < 1) {  
std::cerr << "\nError: The input value must be greater than or equal to 1." << std::endl;  
return NAN;  
}  
return log(x + sqrt(x \* x - 1));  
}

0

int main() {  
while (true) {  
double choice;  
std::cout << "Select an operation:\n1. Inverse Hyperbolic Tangent\n"  
<< "2. Inverse Hyperbolic Cosine\n0. Exit\n";  
input\_number(choice, "Enter your choice: ");  
  
if (choice == 0) {  
break;  
}  
  
double x;  
switch (static\_cast<int>(choice)) {  
case 1:  
input\_number(x, "Enter a value for x (between -1 and 1): ");  
std::cout << "The inverse hyperbolic tangent of " << x << " is " << atanh(x)  
<< std::endl;  
break;  
case 2:  
input\_number(x, "Enter a value for x (greater than or equal to 1): ");  
std::cout << "The inverse hyperbolic cosine of " << x << " is " << acosh(x)  
<< std::endl;  
break;  
default:  
std::cerr << "Error: Invalid operation number." << std::endl;  
break;  
}  
}  
  
return 0;  
}

#### Task Task.4

1

2

## **Week 4** – 2024-10-21 to 2024-10-28

**What did you learn in the lab tasks this week?**

This lab we covered conditonal statements, input validation, and how we can apply these topics to a simple calculator.

**How well did I learn it?**

It was quite quick to learn everything because of the extra work I’ve been doing, so yet again, I learned it pretty well!

**How does my solution compare with the official solution?**

Generally, both solutions are the same but mine has more error handling and separates things into more functions. For the final task, the official solution also added another function to be calculated, sech(x), whereas I didn’t.

**How can I extend the concepts used in the tasks to form a new project**

I could extend the trigonometric ideas to make a fully functional trig calculator, with various different trigonometric functions to be evaluated.

### Control Structures: If Else Statements

#### Task Task.1

1

std::tuple<double, double> evaluate\_function1(double x, double &y) {  
if (x >= 2) {  
std::cout << "x is greater than or equal to 2, so \n";  
std::cout << "y = x^3 + sqrt(x) = ";  
y = pow(x, 3) + sqrt(x);  
} else if (x > 0.5 && x < 2) {  
std::cout << "x is between 0.5 and 2, so \n";  
std::cout << "y = 1 - exp(x) = ";  
y = 1 - exp(x);  
} else {  
std::cout << "x is less than or equal to 0.5, so \n";  
std::cout << "y = |x + 5| = ";  
y = fabs(x + 5);  
}  
  
return std::make\_tuple(x, y);  
}

3

std::tuple<double, double> evaluate\_function2(double x, double &y) {  
if (x < -M\_PI/2) {  
std::cout << "x is less than -pi/2, so \n";  
std::cout << "y = -1 - pi/2 = ";  
y = -1 - M\_PI/2;  
} else if (x >= -M\_PI/2 && x <= 0) {  
std::cout << "x is between -pi/2 and 0, so \n";  
std::cout << "y = sin(x) + x = ";  
y = sin(x) + x;  
} else {  
std::cout << "x is greater than 0, so \n";  
std::cout << "y = x = ";  
y = x;  
}  
  
return std::make\_tuple(x, y);  
}

### Control Structures: Input Validation

#### Task Task.2

0

const double banned\_number = 2.0;  
const double small\_number = 10e-12;

0

double x;  
std::cout << "Enter a value for x (other than 2.0): ";  
std::cin >> x;

0

cout << "When x = " << x << ", the function y = 1/(x^2 - 2) is equal to ";  
double y = 1 / (std::pow(x, 2.0) - 2.0);  
cout << y << endl;

### Control Structures: Simple Calculator

#### Task Task.3

0

void input\_number(const std::string &input\_message, double &number, const double &banned\_number){  
const double float\_error\_resolution = 10e-12;  
  
while (true){  
std::cout << input\_message;  
std::cin >> number;  
  
if (std::cin.fail()){  
std::cerr << "Invalid input. Please enter a valid number." << std::endl;  
std::cin.clear();  
std::cin.ignore(std::numeric\_limits<std::streamsize>::max(), '\n');  
} else if (std::fabs(number - banned\_number) < float\_error\_resolution){  
std::cerr << "Error: x cannot be " << banned\_number << std::endl;  
std::cin.clear();  
std::cin.ignore(std::numeric\_limits<std::streamsize>::max(), '\n');  
} else {  
std::cin.ignore(std::numeric\_limits<std::streamsize>::max(), '\n');  
return;  
}  
}  
}

0

while (true) {  
std::cout << "List of functions:" << std::endl;  
std::cout << "0. Exit" << std::endl;  
std::cout << "1. csch(x)" << std::endl;  
  
int choice;  
std::cout << "Enter the number of the function you would like to use: ";  
std::cin >> choice;  
std::cin.ignore(std::numeric\_limits<std::streamsize>::max(), '\n');  
std::cout << "---" << std::endl;  
  
double x, y;  
switch (choice){  
case 0:  
std::cout << "Exiting..." << std::endl;  
return 0;  
case 1:  
input\_number("Enter x: ", x, 0.0);  
std::cout << "csch(" << x << ") = ";  
y = 1.0 / std::sinh(x);  
break;  
default:  
std::cerr << "Invalid choice. Please enter a valid number." << std::endl;  
y = NAN;  
break;  
}  
  
if (!std::isnan(y)){  
std::cout << y << std::endl;  
}  
}

### Coursework: Quadratic Calculator

#### Task Task.5

0

#include <cmath>  
#include <iostream>  
#include <limits>  
#include <tuple>

0

void input\_number(double& number, const std::string& input\_message) {  
while (true) {  
std::cout << input\_message;  
std::cin >> number;  
  
if (std::cin.fail()) {  
std::cerr << "Invalid input. Please enter a valid number." << std::endl;  
std::cin.clear();  
std::cin.ignore(std::numeric\_limits<std::streamsize>::max(), '\n');  
} else {  
std::cin.ignore(std::numeric\_limits<std::streamsize>::max(), '\n');  
return;  
}  
}  
}

0

std::tuple<double, double> solve\_quadratic(const double a, const double b, const double c) {  
double discriminant = pow(b, 2) - 4 \* a \* c;  
if (discriminant < 0) {  
return std::make\_tuple(NAN, NAN);  
}  
  
double x1 = (-b + sqrt(discriminant)) / (2 \* a);  
double x2 = (-b - sqrt(discriminant)) / (2 \* a);  
  
return std::make\_tuple(x1, x2);  
}

0

int main() {  
while (true) {  
double a, b, c;  
input\_number(a, "Enter the coefficient of x^2: ");  
input\_number(b, "Enter the coefficient of x: ");  
input\_number(c, "Enter the constant term: ");  
  
std::tuple<double, double> x = solve\_quadratic(a, b, c);  
  
std::cout << "The quadratic equation " << a << "x^2 + " << b << "x + " << c << " = 0 has ";  
  
if (std::isnan(std::get<0>(x))) {  
std::cout << "no real solutions." << std::endl;  
} else if (std::get<0>(x) == std::get<1>(x)) {  
std::cout << "one solution: x = " << std::get<0>(x)  
<< std::endl;  
} else {  
std::cout << "two solutions: x = " << std::get<0>(x)  
<< " and x = " << std::get<1>(x) << std::endl;  
}  
  
char response;  
std::cout << "Would you like to solve another quadratic equation? (y/n): ";  
std::cin >> response;  
  
if (response != 'y') {  
break;  
}  
}  
  
return 0;  
}

## **Week 5** – 2024-10-28 to 2024-11-04

**What did you learn in the lab tasks this week?**

This week we extended the statements we know with the switch and while statements, then applied those concepts to making an algorithm to find the Babylonian square root.

**How well did I learn it?**

I think I learned everything quite well, borrowing from my understanding of other programming languages really helped, too.

**How does my solution compare with the official solution?**

The offical solutions aren’t out yet, but I’ll update this when they are - if they are in time for the logbook submission deadline.

**How can I extend the concepts used in the tasks to form a new project**

As similarly suggested in previous weeks, I could extend these concepts to make a fully functional calculator - maybe I will between semesters!

### Control Structures: Switch Statements

#### Task Task.1

1

void example\_switch\_function() {  
unsigned int incrementor = 3;  
unsigned int number;  
  
switch (incrementor) {  
case 1:  
number = 1;  
break;  
case 2:  
number = 1;  
break;  
case 3:  
number = 2;  
break;  
case 4:  
number = 6;  
break;  
case 5:  
number = 24;  
break;  
default:  
number = 0;  
break;  
}  
  
std::cout << "The number is: " << number << std::endl;  
}

1

// example\_switch\_function(); // uncomment this line to run the example

2

const double small\_number = 10e-12;  
double x, y;  
int selection;  
  
std::cout << "FUNCTION LIST" << std::endl;  
std::cout << "1. csch(x)" << std::endl;  
std::cout << "2. sech(x)" << std::endl;  
std::cout << "3. coth(x)" << std::endl;  
  
std::cout << "Select a function (1-3): ";  
std::cin >> selection;  
if (selection > 0 && selection < 4) {  
std::cout << "Enter a value for x: ";  
std::cin >> x;  
std::cout << "For x = " << x << ", ";  
}  
  
switch (selection) {  
case 1:  
if (std::abs(x) < small\_number) {  
std::cout << "csch(x) is undefined for x = 0." << std::endl;  
return 1;  
}  
y = 1/sinh(x);  
std::cout << "csch(x) ";  
break;  
case 2:  
y = 1/cosh(x);  
std::cout << "sech(x) ";  
break;  
case 3:  
if (std::abs(x) < small\_number) {  
std::cout << "coth(x) is undefined for x = 0." << std::endl;  
return 1;  
}  
y = 1/tanh(x);  
std::cout << "coth(x) ";  
break;  
default:  
std::cout << "Invalid selection." << std::endl;  
return 1;  
}  
  
std::cout << "= " << y << std::endl;

### Control Structures: While Loops

#### Task Task.2

1

std::setprecision(10);

1

double mean = sum / 6;

1

double variance = ((sum\_of\_squares / 6) - (mean \* mean)) \* 6 / 5;  
double standard\_deviation = std::sqrt(variance);

1

std::cout << "The minimum value is: " << min << std::endl;  
std::cout << "The maximum value is: " << max << std::endl;  
std::cout << "The mean value is: " << mean << std::endl;  
std::cout << "The standard deviation is: " << standard\_deviation << std::endl;

2

do {  
factorial\_result \*= current\_number;  
current\_number++;  
} while (current\_number <= input\_number);

2

std::cout << "The factorial of " << input\_number << " is: " << factorial\_result << std::endl;

### Algorithms: Babylonian Square Root

#### Task Task.3

1

double number = 0;  
std::cout << "Enter a number: ";  
std::cin >> number;

1

double square\_root = babylonian\_square\_root(number);  
std::cout << "The square root of " << number << " is " << square\_root << std::endl;

### Coursework: Variable Manipulation

#### Task Task.6

0

#include <cmath>  
#include <iostream>

1

int x = 25;  
int y = 18;  
double pay\_rate = 12.50;  
int first\_number = 10;  
int temporary\_number = first\_number;

2

int temporary\_x = x;  
x = y;  
y = temporary\_x;

3

std::cout << "The value of x is: " << x << std::endl;  
std::cout << "The value of y is: " << y << std::endl;  
double evaluated\_expression = (x + 12) / (y - 18 + pow(x, 3)); // Unsure if correct expression  
std::cout << "Substituting these values into the expression (x + 12) / (y - 18 + x^3) gives: "  
<< evaluated\_expression << std::endl;

## 📓 References

[1] “A comprehensive guide to C++ coding standards and best practices,” *C++ Style Guide*, 2024. [Online] Available: https://google.github.io/styleguide/cppguide.html (accessed 2024-10-05).

[2] “Official documentation for Doxygen’s documentation blocks and usage,” *Doxygen Manual - Documentation Blocks*, 2024. [Online] Available: https://www.doxygen.nl/manual/docblocks.html (accessed 2024-10-05).