

# **Development Of Computer Program on Pascal's Triangle using Combination**

A Research presented to  
the College of Information and Computer Science  
Cagayan State University – Carig Campus, Tuguegarao City,  
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In fulfillment  
of the academic requirements for the degree  
BACHELOR OF SCIENCE IN COMPUTER SCIENCE

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## **ACKNOWLEDGEMENT**

Writing this research had been a challenging and at the same time fulfilling journey for the researchers. It's completion would not have been possible without the encouragement, guidance and support of the people who guided them from the beginning al, the way to its success.

Accordingly, the researchers personally express their deepest gratitude to the following individuals:

First and foremost, praises and thanks to Almighty God for his blessings throughout the completion of the research.

Dr. Mario Oli, their subject teacher for his consistent and patience he extended in providing answers to all the concerns and inquiries of the researchers as he attended to their need.

Parents of the researchers, for their unwavering support, emotionally and financially. Also, this achievement wouldn't be possible without their loving upbringing and nurturing. They would not have been where and what they are today.

To their friends and classmates who openly gave their suggestions and opinions in the process.

To each member of the group who keep eye on the study looking for detail by detail improvement especially when there were errors and revisions to the research paper.

The Researchers

## **DEDICATION**

This study is wholeheartedly dedicated to their beloved parents, who have been their source of inspiration and gave them strength when they thought of giving up, who continually provide their moral, spiritual, emotional, and financial support.

To their classmates, friends, and teachers who shared their words of advice and encouragement to finish this study.

And lastly, they dedicated this book to the Almighty God, thank you for the guidance, strength, power of mind, protection and skills and for giving them a healthy life. All of these, they offer to you.

The Researchers

## TABLE OF CONTENTS

TITLE PAGE .....	i
ACKNOWLEDGEMENT.....	ii
DEDICATION .....	iii
TABLE OF CONTENTS .....	iv

### CHAPTER 1

<b>I. INTRODUCTION .....</b>	<b>1</b>
------------------------------	----------

### CHAPTER 2

<b>II. BODY .....</b>	<b>3</b>
<b>A. METHOD.....</b>	<b>3</b>
<b>B. DESIGN.....</b>	<b>4</b>
<b>C. INTERFACE .....</b>	<b>4</b>
• Home Section .....	5
• Tutorial Section .....	6
• Pascal's Triangle Section .....	7
• Combination.....	8
• Members .....	9
<b>D. CODING STRUCTURE .....</b>	<b>10</b>
• Pascal's Triangle Coding Structure... ..	10
• Combination Coding Structure... ..	12
<b>E. PROBLEMS    ENCOUNTERED    BEFORE, DURING AND AFTER THE         DEVELOPMENT OF THE PROGRAM         .....</b>	<b>13</b>

<b>III. CONCLUSION .....</b>	<b>15</b>
<b>IV. RECOMMENDATION .....</b>	<b>15</b>
<b>V. REFERENCES.....</b>	<b>16</b>
<b>VI. APPENDIX .....</b>	<b>17</b>

## Chapter 1 INTRODUCTION

Pascal's Triangle are numbers in triangular arrangement in which numbers are organized in staggered order. The triangle can be filled out from the top by adding together the two numbers just above to the left and right of each position in the triangle.

Before Blaise Pascal studied the pattern of numbers that forms the triangle, it was already known centuries earlier. The first known individual to study the triangle was the Persian mathematician Al-Karaji who lived from 953 to 1029. He wrote the now-lost book that provided the first description of Pascal's Triangle. In the 11<sup>th</sup> century, Omar Khayyam, a Persian poet, mathematician, and astronomer, recreated Al-Karaji's work by using the well-known binomial theorem in order to reproduce the triangle. As a result, the triangle was called Khayyam's Triangle in Iran. Also in the 11<sup>th</sup> century, the triangle was known to the Chinese. Jia Xian, a Chinese mathematician, produced a triangular representation of the binomial theorem coefficients. Later, it was known as Yang Hui's Triangle after Yang Hui presented the triangle in the 13<sup>th</sup> century. The triangle first appeared in Europe in 1527 after it was featured in Petrus Apianus' frontispiece of his books about business calculations. In Italy, the triangle was known as Tartaglia's Triangle, after the Italian Algebraist Niccolo Fontana Tartaglia wherein he published the triangle with six rows. In 1570, Gerolamo Cardano analyzed the triangle and published the additive and multiplicative rules for generating the triangle. In 1665, Blaise Pascal published "*Traite du Triangle Arithmetique*" (Treatise on Arithmetical Triangle). Pascal collected and used the features of the triangle that is already known to solve probability problems. Other qualities were discovered by Pascal and proofs for them were developed. Pierre Raymond de Montmort and Abraham de Moivre name the triangle after Pascal, which is now widely used in the western world.

The binomial theorem is used to discover the value of the binomial coefficients in the expansion using the formula for combinations. In this case, the combinations are the various methods for selecting  $r$  variables from the available  $n$  variables. The formula  $n C_r = \frac{n!}{r!(n-r)!}$  is used for finding combinations of  $r$  objects from

$n$  different objects. The following are the properties of the coefficients in this case.

- $n C_0 = n C_n = 1$
- $n C_1 = n C_{n-1} = n$
- $n C_r = n C_{n-r}$

By simply substituting simple numeric values of  $x=1$  and  $y=1$  in the binomial expansion of  $(x+y)^n$ , the following binomial expansion properties can be obtained.

The calculation of combinations is a second useful application of Pascal's Triangle. The entries in Pascal's triangle, which is basically a stack of binomial coefficients, are the numbers of combination of  $N$  taken  $n$ , where  $N$  is the row starting with  $N=0$  for the top row and  $n$  is the  $n$ th number in row proceeding from left to right, with  $n=0$  being the first number.

The Pascal's Triangle is significant because it has a variety of patterns that can be utilized to simplify complicated calculations.

Objective:

The aim of the program is for Pascal's Triangle to display the triangle with a given number of rows and can be converted into a whole number using Combination. The combination is for it to display the formula and the answer to the given problem and also to see its relationship in applying Pascal's Triangle.

## **Chapter 2**

### **BODY**

Pascal's Triangle and Combination are two separate but are complementary topics in the field of Computer Science. Pascal's triangle is a triangular arrangement of numbers that produces the coefficients of the expansion of binomial expressions. On the other hand, combination is one of the counting techniques where arrangement or order of objects is insignificant. Combination can be used to generate the coefficients in the expansion of a binomial expression.

This paper aims to produce an application that contains both a feature to generate the Pascal's Triangle given the number of rows entered by the user, and at the same time, a Combination calculator feature that will solve the coefficient of a  $r$  position element given the  $n$  number of rows.

#### **A. METHOD**

The problem that is addressed in this paper is the addition of Combination calculator to the Pascal's Triangle application. As mentioned earlier, the use of combination to generate the coefficients in the expansion of a binomial expression is very helpful in verifying the elements of the Pascal's Triangle. In the same way, Pascal's Triangle helps in verifying the output in getting the coefficients of expansion of binomial expression using Combination. In this paper, the researchers developed an application that will address this problem. The application was developed using C# language, and Visual Basic or .NET as compiler.

First, the researchers created a code for the Pascal's Triangle. Then, using the Combination formula in solving for the coefficients in expansion of binomial expression, the researchers produced the code for the Combination calculator of the app. After the code was written for the two formula, the researchers made the code for the application. In this process, the code for the other features of the app namely the Home, Tutorials, Members and other action buttons were written. The last part is the designing process where the Graphical User Interface (GUI) is implemented for the code.

## B. DESIGN



The application was designed using C# Windows Forms App. The researchers named the application "**Pascal's App**". A logo was designed, having a triangular shape and a blaze effect.

The theme color of the app is a combination of majenta and red. The font used is Calibri with a font color of white. In the left side, the tabs are placed, having a background of majenta, and corresponding logo for every tab were put beside the labels. The headings are located at the top with a red background. The main contents are placed below the headings, having a gray background.

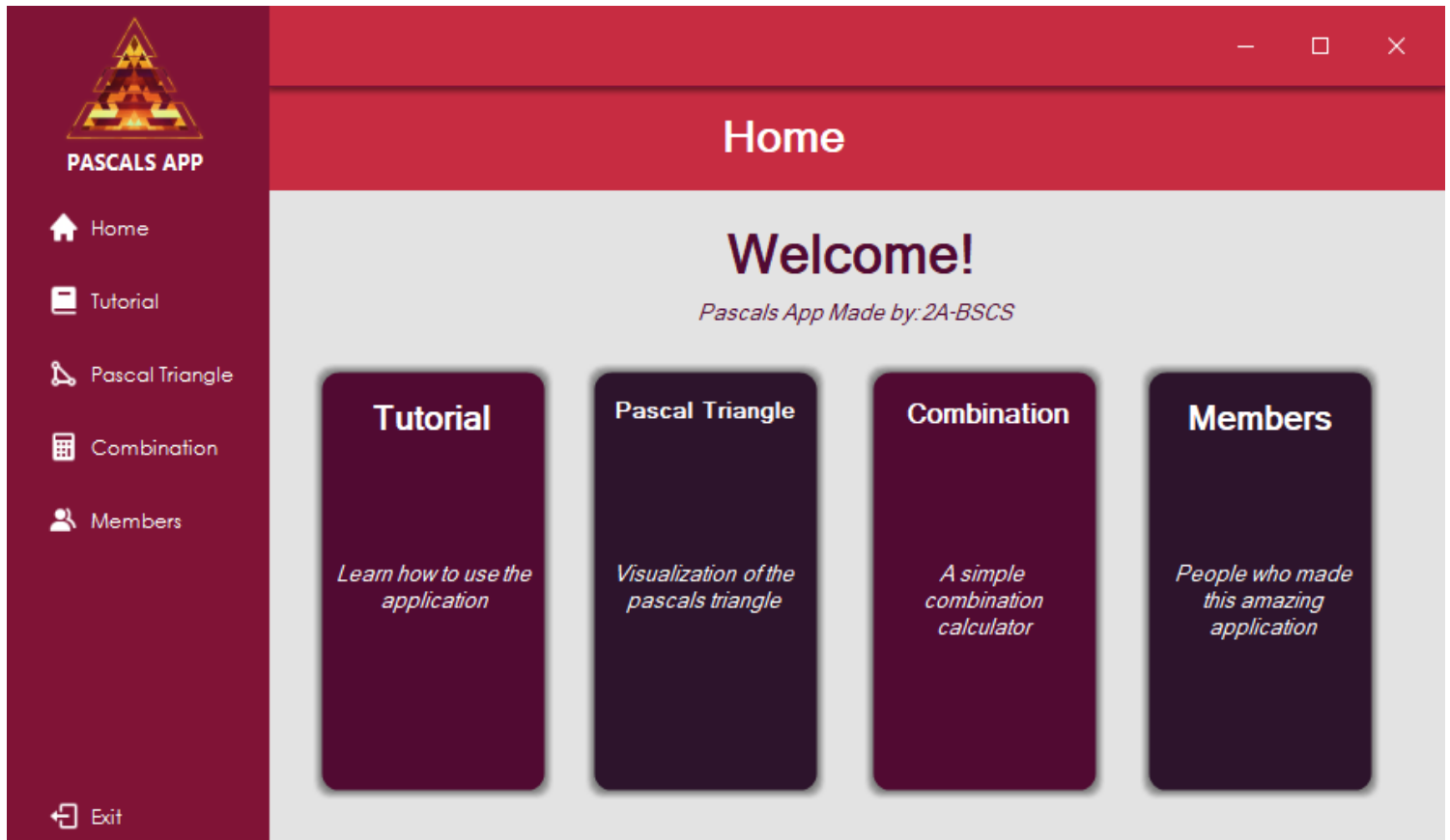
## C. INTERFACE

Upon opening the application, a loading screen will be displayed. After the app is loaded, the Home section will be displayed. The logo was placed in the upper-left part of the application. There are three action buttons in the app namely the minimize, maximize and exit button. These buttons were placed at the upper-right part of the app. Another exit button is placed at the lower-left part of the app, but the label "Exit" is displayed instead of an exit logo. There are five (5) tabs in the app and were placed at the left side namely Home, Tutorial, Pascal's Triangle, Combination and Members tab arranged respectively from top to bottom.



## Home Section

The Home section displays the features of the application presented above in the column format, each feature having a container where each title and short description of the features are located. Also, included in the Home section is a welcome greeting, the name of the app and its developers.



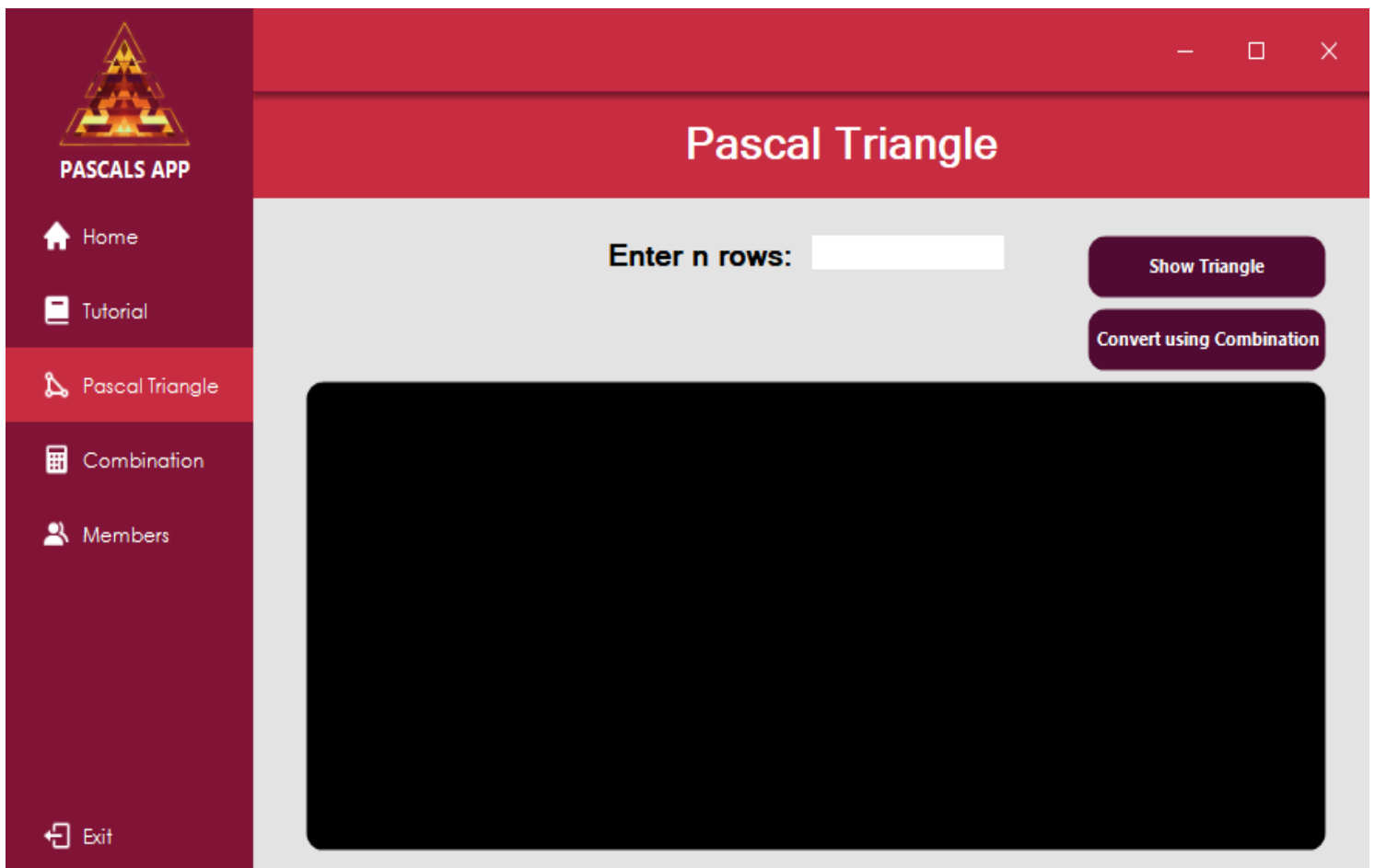
## Tutorial Section

In the Tutorials section, a simple visual tutorial on how to use the application is presented. A previous (prev) and next button are placed in the left and right part, respectively, to navigate the tutorial section.



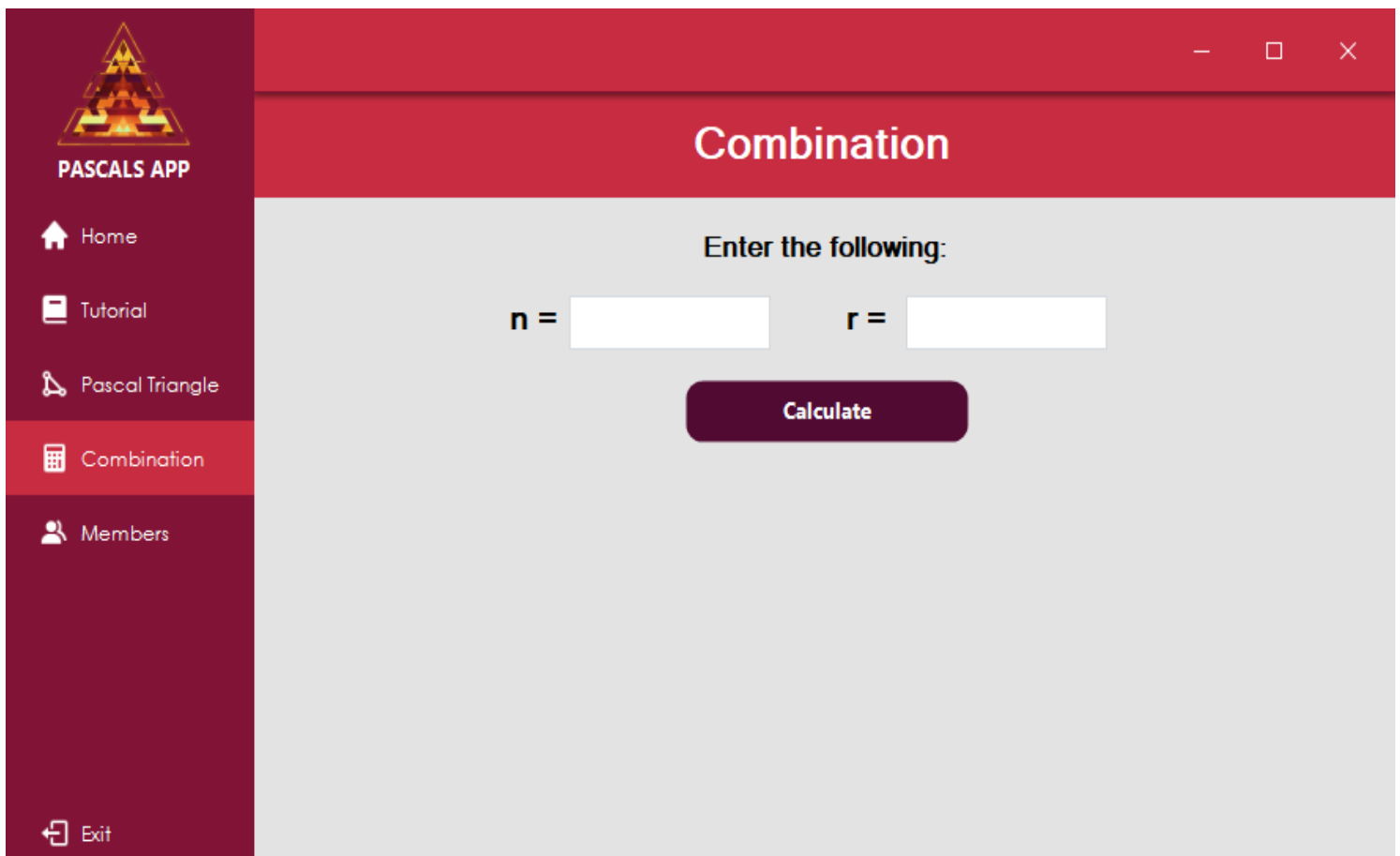
## Pascal's Triangle Section

In the Pascal's Triangle section, there are two textboxes with different sizes, and two buttons. The smaller textbox is used for the user input (the number of rows to be entered) and the other textbox is to display the output of the Pascal's Triangle generated. For the buttons, the first button is to display the elements of the Pascal's Triangle in the form of Combination format, and the second button is to display the Pascal's Triangle in the simplified form (numerical values).



## Combination

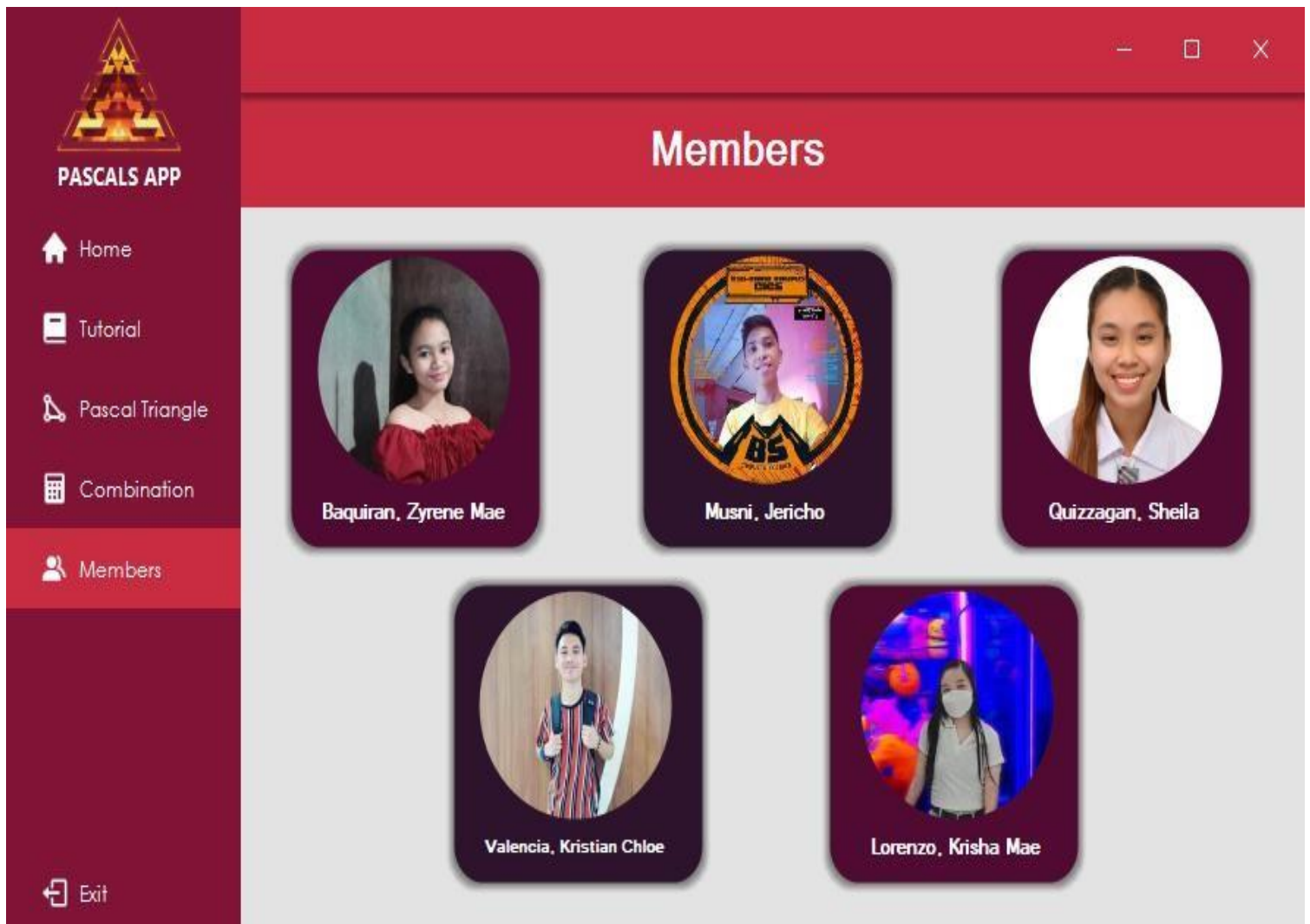
In this section, users can solve for the coefficients in an expansion of a binomial expression. The user will only need to input the degree (highest exponent) of the binomial expression to be expanded and the position of the coefficient in the expansion. There are two textboxes in this feature. One is used to get the degree of binomial expression, and the other textbox is to get the position of the coefficient the user wants to solve. After clicking the Calculate button, the solution to get the coefficient using Combination will be displayed.



The screenshot displays the 'PASCALS APP' interface. On the left is a dark red sidebar with a logo at the top and a list of menu items: Home, Tutorial, Pascal Triangle, Combination (highlighted in a lighter red), Members, and Exit. The main area has a red header with the title 'Combination' and window control buttons. Below the header, the text 'Enter the following:' is centered. Underneath, there are two input fields: 'n =' followed by a white text box, and 'r =' followed by another white text box. A dark red 'Calculate' button is positioned below these inputs. The background of the main area is a light gray.

## Members

In this section, the names of the members who developed the application “**Pascal's App**” can be found. The names with the corresponding pictures of the members are separated with corresponding boxes.



## D. CODING STRUCTURES

### Pascals Triangle Coding Structure

```
string print = "";  
string a = nTxt.Text;  
if(a.All(char.IsDigit) && a!="")
```

First, we declare two string variables named “*print*” and “*a*”. “*print*” variable will hold the Pascal's data and “*a*” variable will hold the user input. After the user inputs some real numbers, it will validate first if it is a digit or null.

```
n = int.Parse(a);  
if(n > -1)  
for(int r = 0; r <= n; r++)  
{  
    print += Spaces(n, r);  
    for(int  
        c = 0; c <= r; c++)  
    {  
        print += (" "+r+"/" + c + "\t\t");  
    }  
    print += "\r\n";  
}  
triangleTxt.Text = print;  
}
```

After it verifies that the user input is a real number, the “a” string variable will convert it into an int data type and store it in the “n” variable. Now, the program will check if the data is greater than -1, if it is true, it will continue to store all the generated data into the “print” variable and display it in the “triangleTxt” textbox.

else

```
{
    MessageBox.Show("n must be greater than -1", "Error", MessageBoxButtons.OK, MessageBoxIcon.Exclamation);
}
```

else

```
{
    MessageBox.Show("Input must only be a numeric number!", "Error", MessageBoxButtons.OK, MessageBoxIcon.Exclamation);
}
```

We also added some breaking points if the user input is less than 0 or not a numeric number.

```
static string Spaces(int spaces, int r)
```

```
{
    string sp = "";
    for(int space=spaces; space>r; space--)
    {
        sp+="\t";
    }
    return sp;
}
```

This method is used for creating number of spaces in order for the data to look like a triangle in the GUI. It uses the current data to count all the needed spaces.

### Combination Coding Structure

```
string a=nTb.Text,b=rTb.Text;  
if(a.All(char.IsDigit) && b.All(char.IsDigit) && a!=""&&b!="")
```

We specifically used C# as our language and Visual Basic or .Net as our compiler on this project. In our program, we used data type string for the storage of the output and to get the input of the user since the textboxes data in default are strings and converted into data type uint after the validation if the user input is a digit or null.

```
uint quotient=0,dividend=1,divisor=0,divisor1=1,divisor2=1; uint n =  
uint.Parse(nTb.Text),r=uint.Parse(rTb.Text);
```

After the program validates the user input as a digit, we then proceed to converting the string input into a uint data type and prepare some other storage for the computation.

```
if(n > 12)  
{  
    MessageBox.Show("This calculator can only factor up to numeric  
    12","Error",MessageBoxButtons.OK,MessageBoxIcon.Exclamation);  
}
```

What is a Uint C#?

uint is a keyword that is used to declare a variable which can store an integral type of value (unsigned integer) from the range of 0 to 4,294,967,295 which can store more data than int data type. However, this is still not enough to use factorial greater than 12.

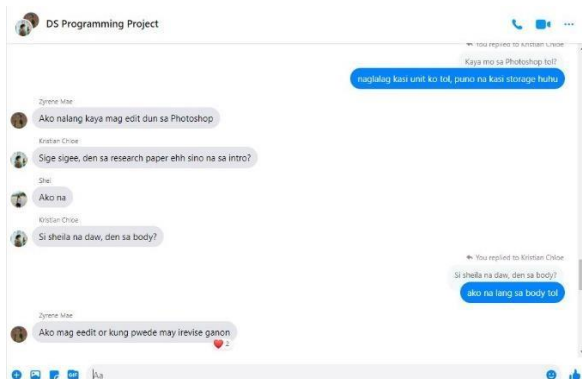
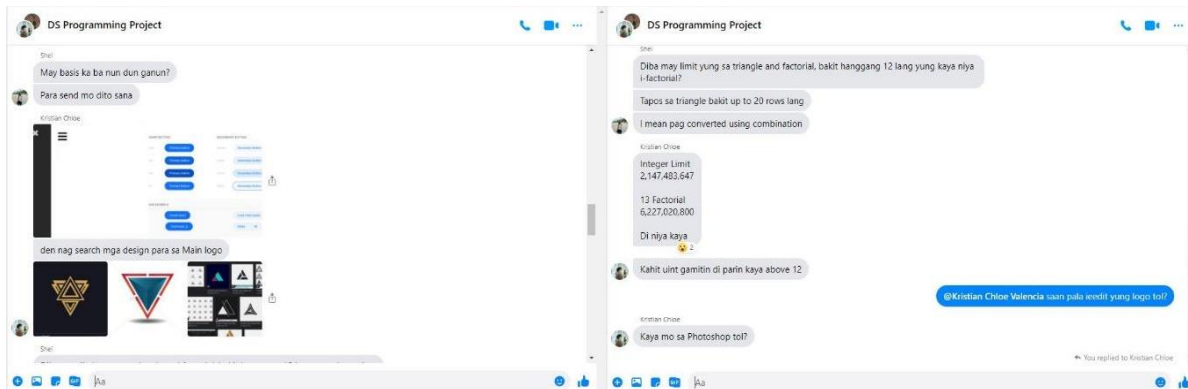


## E. PROBLEMS ENCOUNTERED BEFORE, DURING AND AFTER THE DEVELOPMENT OF THE PROGRAM

Starting from the planning stage up to the development of the program, the researchers encountered several problems. These problems occurred before, during and after the development of the program. Fortunately, the researchers took several steps to solve these problems.

### Before the development of the program

Before the development of the program, the researchers needed to conceptualize the design of the app. This challenges the researchers to think for a design that will be appropriate to the initial concept to design an app having multiple tabs.



### **During the development of the program**

During the program development, the researchers dealt with the problem of making the multiple tabs be compiled into one form. Since this concept is new for the researchers, they searched for a solution in the Internet to fix the problem. Fortunately, the researchers found a solution to solve the problem.

### **After the development of the program**

After the development of the program and the code was tested, the researchers discovered several errors. First error occurred when displaying the Pascal's Triangle in the Graphic User Interface (GUI). Since there is the possibility to generate a Pascal's Triangle of infinite size, depending on the value of the rows entered by the user, the researchers looked for a way to solve this error.

Second error occurred when solving for the factorial of a number greater than 12 for the Combination calculator of the app. To address this error, the researchers added a breaking point.

This part of the code will throw a message to inform the user that the input to be entered for the row should not be greater than 20.

## **CONCLUSION**

To sum it up, our program Pascal's Triangle and Combination do have a connection with each other. The Pascal's Triangle will need positive integers from the user in order to produce numbers in the form of a triangle, which can later be converted using Combination. On the other hand, combination will be able to provide answers with solution from the numbers given by the user which serve as the values of  $n$  and  $r$ .

## **RECOMMENDATION**

Based on the findings and conclusions, the following recommendation are derived:

Increase the number of applications in computing for finding a techniques to enhance the knowledge and understanding of students in solving Pascal's Triangle and Combination. The researchers recommend that this study will benefit to those future researchers who want to expand or use this as guide in conducting their study.

## REFERENCES

Pascal's Triangle:

[https://en.m.wikipedia.org/wiki/Pascal%27s\\_triangle](https://en.m.wikipedia.org/wiki/Pascal%27s_triangle)

<https://mathworld.wolfram.com/PascalsTriangle.html>

History of Pascal's Triangle:

<http://5010.mathed.usu.edu/Fall2018/HWheeler/main2.html>

The Relationship Between Pascal's Triangle and Combinations:

<https://study.com/academy/lesson/the-relationship-between-pascals-triangle-combinations.html>

<https://www.statisticshowto.com/pascals-triangle/>

## APPENDIX


### INTRODUCTION

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Pascal's Triangle are numbers in triangular arrangement in which numbers are organized in staggered order. The triangle can be filled out from the top by adding together the two numbers just above to the left and right of each position in the triangle.

Before Blaise Pascal studied the pattern of numbers that forms the triangle, it was already known centuries earlier. The first known individual to study the triangle was the Persian mathematician Al-Karaji who lived from 953 to 1029.

He wrote the now-lost book that provided the first description of Pascal's Triangle.

In the 11th century, Omar Khayyam, a Persian poet, mathematician,




### BODY

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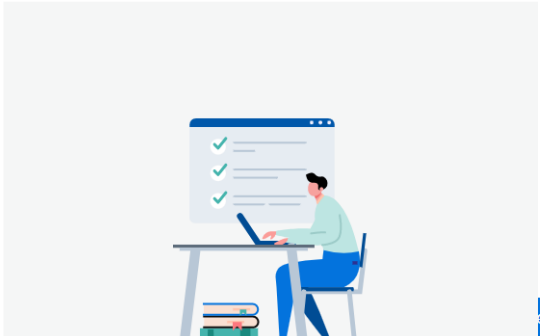
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
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Combination can be used to generate the coefficients in the expansion of a binomial expression.

This paper aims to produce an application that contains both a feature to generate the Pascal's Triangle given the n number of rows entered by





## BODY (CODING STRUCTURE)

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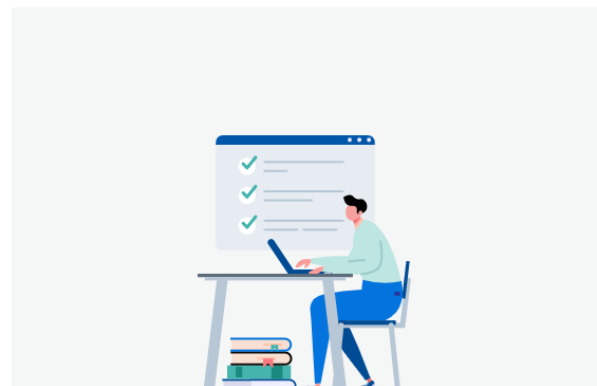


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will continue to store all the generated data into the "print" variable and display it in the
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We also added some breaking points if the user input is less than 0 or not a numeric number.
static string Spaces(int spaces, int n) { string sp = ""; for(int space=spaces; space>n; space--) {
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```

## CONCLUSION



Increase the number of applications in computing for finding a techniques to enhance the knowledge and understanding of students in solving Pascal's Triangle and Combination. The researchers recommend that this study will benefit to those future researchers who want to expand or use this as guide in conducting their study.




## RECOMMENDATION

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