CSCI1300 - Introduction to Computer Programming
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Recitation 7: Parsing and 2D array

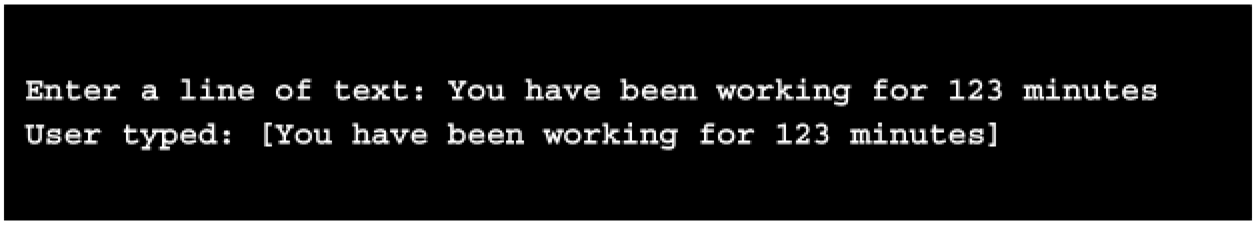
Computers can store information in many different formats. We have used integers, floating point values, strings and characters. When we print information to the console for a user to read, we convert the integer and floating point values to characters that can be displayed on the screen. When we get data from the user, they type individual characters and press the return key to send the data to our program.

The ***cin*** object has been interpreting the characters from the user and converting them into integer and floating point values for use in our programs. We are going to control the parsing of the string of characters typed in by the user. We will get data from the user in whole lines of text, that is a sequence of characters up to the end of line character. The ***getline*** function will allow us to read the sequence into a string variable.

The example below will read a line of text from the user (***cin*** specifies where to read from) and will echo the string back to the console.

```
string strX;
cout << "Enter a line of text: ";
getline(cin, strX);
cout << "User typed: [" << strX << "]" << endl;
```

Here is an example of the interaction when the program is run:



```
Enter a line of text: You have been working for 123 minutes
User typed: [You have been working for 123 minutes]
```

The numbers typed are just characters in the string, they have not been converted to an integer value in the program. However, we can parse out the numbers (get the sub-string with only the numbers) and convert them from string to integer or floating point values. In this case, we need to find the number within the string and then we can convert that substring into an integer.

You have learned many ways to search through a string and find substrings. One that will be very useful in the near future is to break a string up into words (an array of strings made up of the contiguous non-space characters) . If you performed that task on the string above, you could search the words for a string that was all digits and be able to convert it.

If we were to *chop* this sentence into words, we would end up with each of these strings:

You
have
been
working
for
123
minutes

Only one of these values is all digits and could be converted into an integer value.

In our examples, we will be using data that will come from text files. Data within files can be organized in many ways. Frequently consecutive values on the same line are separated by some specific character called a delimiter. In CSV (Comma Separated Values) files the delimiter is a comma. In TSV (Tab Separated Values) the delimiter is a tab (the escape character for a tab is '\t'). We can use the same type of function to break up a line of text into fields that are separated by a specific character. In our example above, we used a space character (' ') to delimit the words. Generically, we want to collect the characters until we encounter the delimiter.

Once the strings have be separated, we need to convert the values from the string into an integer or floating point value. We could write the code to interpret the individual digits and generate the correct value, but there are already functions to do this for us.

For example:

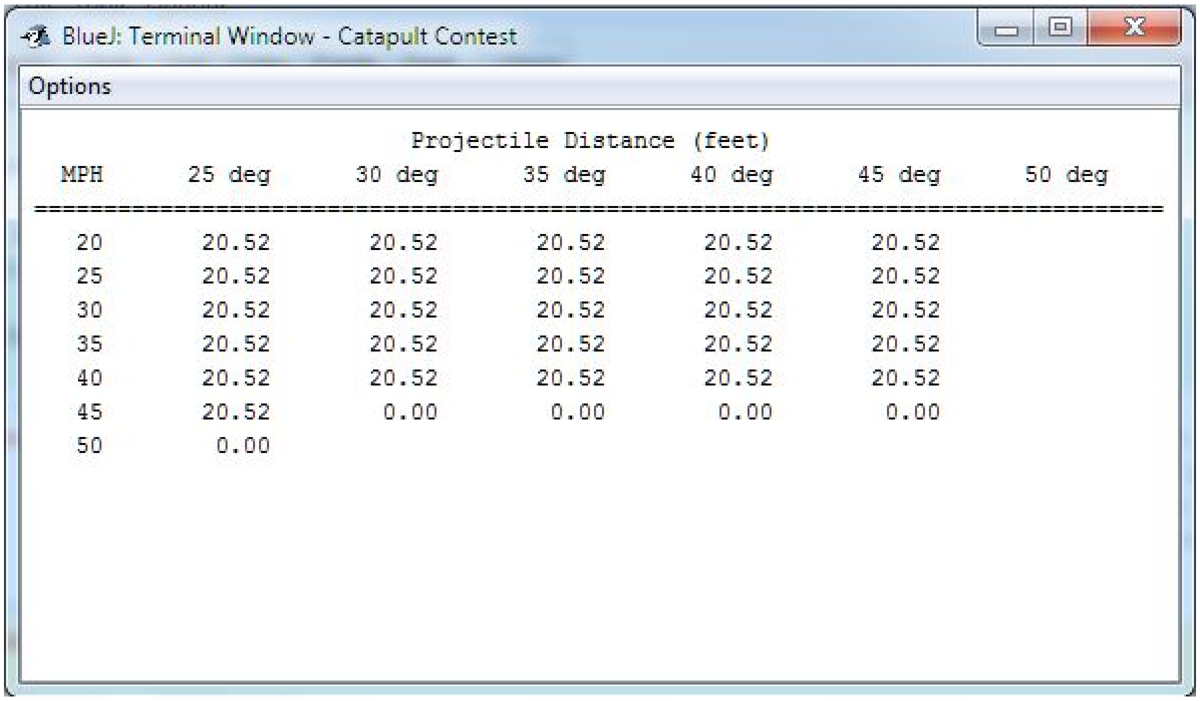
```
     string str = "123";
     int x = stoi(str);       //Converts   the   string   into   an
integer.

     string strPi = "3.14159";
     float pi = stof(strPi);  //Converts the string into a float.
```

You should get to know how these functions will work on different strings. Test these functions out on your own. What happens when the string argument to ***stoi*** or ***stof*** is not directly representable as an ***int*** or ***float***? For instance, what do ***stoi("123.45")*** and ***stoi("123abcd")*** return? Do they work at all?

Challenge problem: create a program to convert the sequence of digit characters into an integer or floating point value.

2D arrays

Often it is useful to have lots of data associated with each index. Consider a table with data, such as wind chill values or the catapult data shown below. We may want to store multiple values for each row of information. If we consider the catapult data as a 2D array, the speed will specify which row we want to look at and the angle will determine which column to look at for that row. In this case, the speed and angle are the index values used to find the resulting distance.



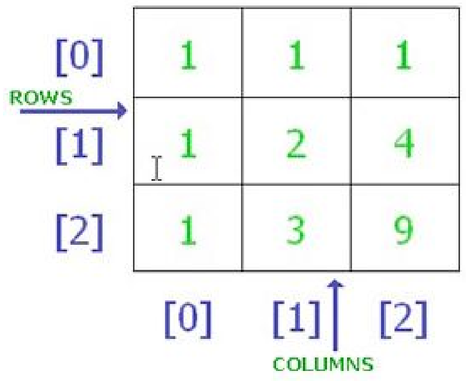
```
                         Projectile Distance (feet)
  MPH      25 deg      30 deg      35 deg      40 deg      45 deg      50 deg
==================================================================================
   20       20.52       20.52       20.52       20.52       20.52
   25       20.52       20.52       20.52       20.52       20.52
   30       20.52       20.52       20.52       20.52       20.52
   35       20.52       20.52       20.52       20.52       20.52
   40       20.52       20.52       20.52       20.52       20.52
   45       20.52        0.00        0.00        0.00        0.00
   50        0.00
```

We can create multiple dimensional data in C++ using arrays.
To create a 3 by 3 array shown below, we must tell the C++ compiler that we are creating a number of rows in an array AND that each row will have three elements in that row. We specify each dimension in its own set of brackets.

```
int table[3][3];
cout << table[0][0] << endl;
cout < table[2][1] << endl;
```

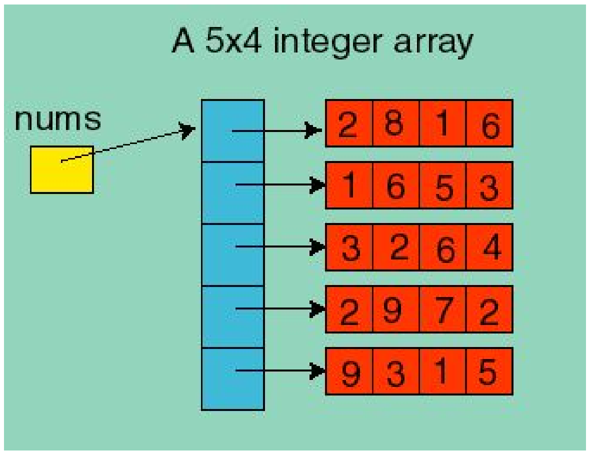
Output:

```
1
3
```



Multiple dimensional arrays are actually built as an array of arrays. In our two dimensional example, the program will build an array of three elements, where each element is an array of three integers.
For a 5x4 array example where *nums* is a multiple dimensional array, the layout of the memory will look like the figure below.

```
int nums[5][4];
```



To access the array we will need to use nested loops, one for indexing through each array:

```
int nums[5][4];
for (int row = 0 ; row < 5 ; row++)
{
    for (int col = 0 ; col < 4 ; col++)
    {
            cout << setw(4) << nums[row][col];
     }
    cout << endl;
}
```

When passing a multi-dimensional array as a parameter, *you must specify the size of the all dimensions except the first.* In our case, we have a two dimensional array, we can pass the array to a function, but we must specify the number of columns in each row.

```
float CalcAverage(int array[][4], int n_rows)
{
}
```

The function above is told it is a two dimensional array with 4 integer elements per row. The array itself could be any number of rows. Therefore we also send another parameter that specifies how many rows to process.