Fundamental Computer Programming- C++ Lab(I)

LAB 3

Distribution of BMI Levels

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Purposes

- Get familiar with the basic structure of a C++ program
- Get familiar with some control statements such as while (..) { ….}, for (…) {…}, etc.

A typical while loop

```
while (condition) {
                  …
                  …
                  …
}
```

← **Loop body:** the statements inside while loop

Concept of "iteration": One iteration consists of statements executed from the beginning to the end of a loop.

- Develop problem solving skills

while Statement

- Typically used when we do not know how many times a task should be repeatedly executed. Certainly, it can also be used when the number of times of a loop body executed is known.
  - Sentinel-controlled *while*
  - Counter-controlled *while*

Sentinel Controlled *while*

- A condition is evaluated every time to determine whether a *while* loop should be terminated. This condition serves as a sentinel (哨兵). If the value of the sentinel is evaluated to be true, the *while* loop continues and the loop body is executed. Otherwise, the while loop stops.

Example

```
// Determine class average of grades
int main()
{
  int total; // sum of grades entered by user
  int gradeCounter; // number of grades
entered
  int grade; // grade value
  double average;
// number with decimal point for average

  // initialization phase
  total = 0; // initialize total
  gradeCounter = 0; // initialize loop counter

  // processing phase
  // prompt for input and read grade from
user
  cout << "Enter grade or -1 to quit: ";
  cin >> grade; // input grade or sentinel
value
```

```
  // loop until sentinel value read from user
  while ( grade != -1 ) // while grade is not -1
  {
    total = total + grade; // add grade to total
    gradeCounter = gradeCounter + 1;
    // increment counter

    // prompt for input and read next grade
    cout << "Enter grade or -1 to quit: ";
    // input grade or sentinel value
      cin >> grade;
  } // end while

    …
   …
}
```

Counter-Controlled *while*

```
#include <iostream>
using namespace std;

int main ()
{
   int total; // sum of grades entered by user
   // number of the grade to be entered next
   int gradeCounter;
   int grade; // grade value entered by user
   int average; // average of grades

   // initialization phase
   total = 0; // initialize total
   // initialize loop counter
   gradeCounter = 1;
```

```
   // processing phase, looping 10 times
   while ( gradeCounter <= 10 ) {
     cout << "Enter grade: ";
     cin >> grade; // input next grade
     total = total + grade; // add grade to total
     // increment counter by 1
     gradeCounter = gradeCounter + 1;
    } // end while


   // termination phase
   average = total / 10;
   // display total and average of grades
   cout << "\nTotal of all 10 grades is " << total <<
endl;
   cout << "Class average is " << average << endl;
} // end main
```

do {…} *while* (…)

```
// Will execute the loop body at least once
#include <iostream>
using namespace std;

int main()
{
   int counter = 1; // initialize counter

   do
   {
      cout << counter << " "; // display counter
      counter++; // increment counter
   } while ( counter <= 10 ); // end do...while

   cout << endl; // output a newline
} // end main
```

for Statement

- Best used when the number of times a task that repeats is known in advance. It is typically counter-controlled.

```
// Counter-controlled repetition with the for statement.
#include <iostream>
using namespace std;

int main()
{
  Int sum = 0;
 // for statement header includes initialization,
 // loop-continuation condition and increment.
 for ( int counter = 1; counter <= 10; counter++ ){
   sum = sum + counter;
   cout << counter << " " << sum << endl;
  } // end for
} // end main
```

Yet another Multiple Selection Statement: switch

Must be evaluated into a constant integer value

```
switch ( grade ) {
    case 'A': // grade was uppercase A
    case 'a': // or lowercase a
      aCount++; // increment aCount
      break; // necessary to exit switch

    case 'B': // grade was uppercase B
    case 'b': // or lowercase b
      bCount++; // increment bCount
      break; // exit switch

    case 'C': // grade was uppercase C
    case 'c': // or lowercase c
      cCount++; // increment cCount
      break; // exit switch

    case 'D': // grade was uppercase D
    case 'd': // or lowercase d
      dCount++; // increment dCount
      break; // exit switch

    case 'F': // grade was uppercase F
    case 'f': // or lowercase f
      fCount++; // increment fCount
      break; // exit switch

    case '\n': // ignore newlines,
    case '\t': // tabs,
    case ' ': // and spaces in input
      break; // exit switch

    default: // catch all other characters
      cout << "Incorrect letter grade entered."
        << " Enter a new grade." << endl;
      break; // optional; will exit switch anyway
} // end switch
```

About writing if (…) else if (…) else

```
if (sGrade >= 80) {
   cout << “A”;
   countA = countA + 1;
}
else if (sGrade >= 70) {
   cout << “B”;
   countB = countB + 1;
}
else if (sGrade >= 60) {
   cout << “C”;
   countC = countC + 1;
}
else {
   cout << “F”;
   countF = countF + 1;
}
```

```
if (sGrade >= 80) {
   cout << “A”;
   countA = countA + 1;
}
else if (sGrade < 80 && sGrade >= 70) {
   cout << “B”;
   countB = countB + 1;
}
else if (sGrade < 70 && sGrade >= 60) {
   cout << “C”;
   countC = countC + 1;
}
else if (sGrade < 60 ){
   cout << “F”;
   countF = countF + 1;
}
```

Which is better?

Body Mass Index (BMI)

- Based on the materials of Lab 2, we can calculate a person’s BMI (Body Mass Index) using the following formula.

$$\boldsymbol{BMI = Weight/Height^2}$$

- A BMI value can be categorized into one of the following levels according to the BMI ranges specified in the following table.

BMI level	**BMI range(kg/m²)**
Unreasonably small BMI (USL)	BMI <=10
Highly severely underweight (HSUW)	10 <BMI <= 15
Severely underweight (SUW)	15 < BMI <= 16
Underweight (UW)	16 < BMI <= 18.5
Normal (NW)	18.5 < BMI <= 25
Overweight (OW)	25 < BMI <= 40
Obese (OB)	40 < BMI <= 50
Severely obese (SOB)	50 < BMI <= 60
Highly severely obese (HSOB)	60 < BMI <= 70
Unreasonably large BMI (ULL)	BMI > 70

LAB 3: BMI Level Distribution

- **Input**
  - Your program should accept weight and height values repeatedly until a weight or height value is smaller than or equal to 0. If a weight or height value is not valid, their BMI calculation should be canceled and the program should proceed to handle next data set. That is, the program should ignore an invalid data set. A data set consists of the weight and height of a person.
  - Some input data sets are shown on the right. In each data set, the first member is weight and the second member is height. Note that the 11-th data set is not valid.

```
56 1.5
27 0.93
44 1.3
56 1.65
60 1.8
200 2.4
160 2.1
23 1.6
34 1.3
54 1.8
10 1.6
56 1.3
77 1.75
0 0
```

Input Format

- A data set is input from keyboard as shown below.

  65.2 1.73

  The first number is weight and the second number is height. They are both placed on the same line.
- Your program should continue reading data sets until a weight or height value smaller than or equal to 0 is read.

Constraints on Input Data

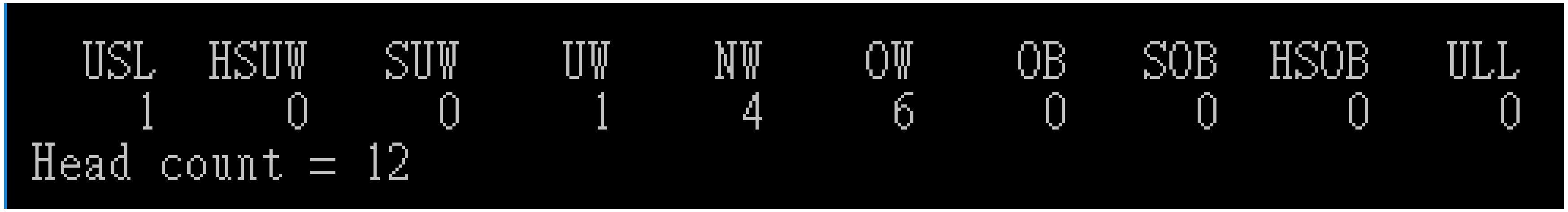
- Weight should be greater than or equal to 20kg and less than or equal to 200kg.
- Height should be greater than or equal to 0.9m and less than or equal to 2.5m.
- If weight or height is not in the defined range, the data set is invalid and should be ignored.

To Do

- Calculate the BMI value for each data set.
- Categorize a BMI value into its corresponding level based on the table shown in a previous slide.
- Count the number of data sets that a BMI level has. The invalid data sets should not be included.
- Print out the requested output.

Output

- **After processing all the input data sets,**
  - print out the number of valid data sets for each BMI level.
    - The first line should be the BMI levels, starting from the level name USL, then the names of the levels with increasing BMI values. Proper separation between the names of two adjacent levels should be set.
    - The second line should be the numbers of the data sets whose BMI levels are classified as the levels being presented in the first line.
      - Place the first digit of the number of a BMI level right just below the last character of the level name. For example, if there are 13 data sets belonging to SUW level, the digit 3 of 13 should be placed right just below the character W of SUW.
  - print out the total number of valid data sets (denoted by "Head count"), i.e., number of persons whose weight and height are valid, as shown below.



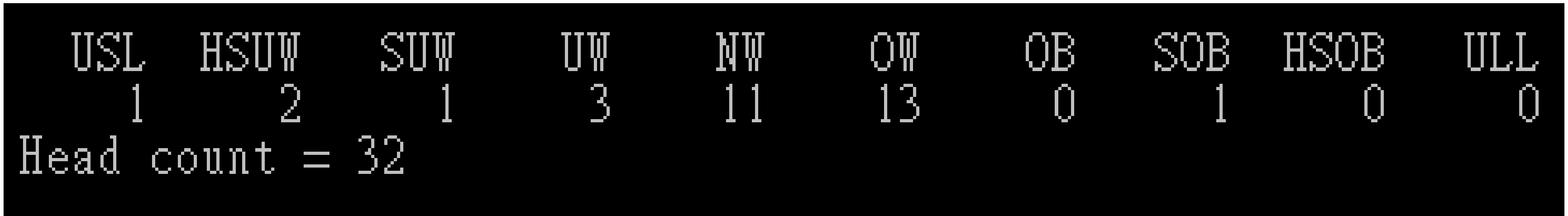
```
  USL   HSUW     SUW      UW       NW       OW       OB      SOB    HSOB     ULL
    1      0       0       1        4        6        0        0       0        0
Head count = 12
```

Another Example

Adding the following data sets to the previous ones.

65 1.79	65.4 1.66
56 1.9	39.6 1.45
89 1.6	66.6 1.76
48 1.8	140 1.6
65 1.9	120 1.77
56 2.7	110 1.9
88 1.7	135.8 1.87
96 1.85	67.8 1.68
38 1.65	63 1.7
84 1.6	55.5 1.58
78 2.15	

We should get the following output:



```
   USL  HSUW    SUW     UW     NW     OW     OB    SOB   HSOB    ULL
     1     2      1      3     11     13      0      1      0      0
Head count = 32
```

Follow All Requirements

- Input formats
- Output formats
- All constraints on input data, especially not accepting invalid inputs
- Coding styles
  - Avoiding using variables which do not have expressive power. That is, a variable name should carry the meaning of the matter in which the variable intends to represent.

If you don't follow the requirements, up to 30% of the points for your lab will be deduced.

Rules for Program Submission

- Put all the relevant files in the same folder.
- Name your folder SID_LabX, where ID is your student ID number and X is the number assigned to the lab. If a lab has N parts, N>1, then create N sub-folders with their names SID_LabX_N in the the folder SID_LabX.
  - ➢ For example, for Lab 2 with only one part and with student ID number 1041544, the name of the folder must be S1041544_Lab2. N is omitted if there is only one part.
  - ➢ Another example, similar to the above but Lab 2 has two parts. Then, you have to create a folder S1041544_Lab2 and two sub-folders S1041544_Lab2_1 and S1041544_Lab2_2
- Compress the folder into a file named SID_LabX.zip, for example, S1041533_Lab2.zip. Then, submit the compressed file
- If you violate this rule, your lab will not be graded. If graded other penalty will be applied.