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LAB REPORT

CET 3510 – OL71

(MICROCOMPUTER SYSTEMS TECHNOLOGY LABORATORY)

LAB #3

Data Formats and Data Conversion

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Table of Contents

Objective.....	3
Materials.....	3
Procedure.....	3
Code.....	3-7
Conclusion.....	7

Objective:

The objective of this lab is to find the integer storage size in bytes and the maximum and minimum values for different data types. This lab requires C++ programming with Assembly in Visual Studio Community 2019. The programs used in this lab are programmed in C++ and Assembly to automate the conversion process for decimal, hexadecimal, and binary numbers. Most importantly, this lab will allow to understand data formats of signed and unsigned numbers which is meant to test information in a computer architecture.

Materials:

- Microsoft Visual Studio C++ Community Edition 2019

Procedure:

1. First, open Microsoft Visual Studio C++ Community Edition 2019
2. Then, type program#1, compile and run the program.
3. After that, explain each line of the code by writing comments
4. Modify program#2 by writing C++ code of signed int, unsigned short int and unsigned int
5. Then, find the maximum and minimum values in decimal and binary format
6. After that, convert a hexadecimal number to a binary value and decimal value for signed char, signed short int, signed int, unsigned short int and unsigned int
7. Compile and run the program to analyze the output

Program#1

```
#include "stdio.h"
#include <bitset>
#include <iostream>

using namespace std;

int main(void)
{
    char c1;
    unsigned char ucl;
    short int i1;

    //more variavble to declare

    //Data type of char
    cout << "The minimum value of a char is " << CHAR_MIN << endl;
    cout << "The maximum value of a char is " << CHAR_MAX << endl;
    cout << "The storage size in byte(s) of a char is " << sizeof(c1) << endl;

    cout << "Input a hexadecimal number in the data type of char, for example 8a" <<
endl;
    scanf_s("%x", &c1);

    //bitset stores the number of bits in 8*sizeof(c1)
```

```

bitset<8 * sizeof(cl)>charBits(cl);
cout << "The converted binary value is " << charBits << endl;
printf("The converted binary value is %i \n", cl);
printf("-----\n");

//Data type of unsigned char
cout << "The maximum value of an unsigned char is " << UCHAR_MAX << endl;
cout << "The storage size in byte(s) of an unsigned char is " << sizeof(ucl) <<
endl;

cout << "Input a hexadecimal number in the data type of unsigned char, for example
8a" << endl;
scanf_s("%x", &ucl);

//bitset stores the number of bits in 8*sizeof(ucl)
bitset<8 * sizeof(ucl)> ucharBits(ucl);
cout << "The converted binary value is " << ucharBits << endl;
printf("The converted decimal values is %i \n", ucl);
printf("-----\n");

// Data type of short int
cout << "The minimum value of a short int is " << SHRT_MIN << endl;
cout << "The maximum value of a short int is " << SHRT_MAX << endl;
cout << "The storage size in byte(s) of a short int is " << sizeof(i1) << endl;

cout << "Input a hexadecimal number in the data type of short int, for example
8fff" << endl;
scanf_s("%x", &i1);

//bitset stores the number of bits in 8*sizeof(i1)
bitset<8 * sizeof(i1)>shortBits(i1);
cout << "The converted binary value is " << shortBits << endl;
printf("The converted decimal value is %i \n", i1);
printf("-----\n");
system("pause");
exit(0);
return 0;
}

```

Output:

```

The minimum value of a char is -128
The maximum value of a char is 127
The storage size in byte(s) of a char is 1
Input a hexadecimal number in the data type of char, for example 8a
ff
The converted binary value is 11111111
The converted binary value is -1
-----
The maximum value of an unsigned char is 255
The storage size in byte(s) of an unsigned char is 1
Input a hexadecimal number in the data type of unsigned char, for example 8a
ff
The converted binary value is 11111111
The converted decimal values is 255
-----
The minimum value of a short int is -32768
The maximum value of a short int is 32767
The storage size in byte(s) of a short int is 2
Input a hexadecimal number in the data type of short int, for example 8fff

```

Program#2

```

#include "stdio.h"
#include <bitset>
#include <iostream>

using namespace std;

int main(void)
{
    char c1;
    unsigned char ucl;
    short int i1;
    unsigned short int us_shrt_int;
    signed int signedInt = 0;
    unsigned int us_int = 0;

    //more variavble to declare

    //Data type of char
    cout << "The minimum value of a char is " << CHAR_MIN << endl;
    cout << "The maximum value of a char is " << CHAR_MAX << endl;
    cout << "The storage size in byte(s) of a char is " << sizeof(c1) << endl;

    cout << "Input a hexadecimal number in the data type of char, for example 8a" <<
endl;
    scanf_s("%x", &c1);

    //bitset stores the number of bits in 8*sizeof(c1)
    bitset<8 * sizeof(c1)>charBits(c1);
    cout << "The converted binary value is " << charBits << endl;

```

```

printf("The converted binary value is %i \n", cl);
printf("-----\n");

//Data type of unsigned char
cout << "The maximum value of an unsigned char is " << UCHAR_MAX << endl;
cout << "The storage size in byte(s) of an unsigned char is " << sizeof(uc1) <<
endl;

cout << "Input a hexadecimal number in the data type of unsigned char, for example
8a" << endl;
scanf_s("%x", &uc1);

//bitset stores the number of bits in 8*sizeof(uc1)
bitset<8 * sizeof(uc1)> ucharBits(uc1);
cout << "The converted binary value is " << ucharBits << endl;
printf("The converted decimal values is %i \n", uc1);
printf("-----\n");

// Data type of short int
cout << "The minimum value of a short int is " << SHRT_MIN << endl;
cout << "The maximum value of a short int is " << SHRT_MAX << endl;
cout << "The storage size in byte(s) of a short int is " << sizeof(i1) << endl;

cout << "Input a hexadecimal number in the data type of short int, for example
8fff" << endl;
scanf_s("%x", &i1);

//bitset stores the number of bits in 8*sizeof(i1)
bitset<8 * sizeof(i1)> shortBits(i1);
cout << "The converted binary value is " << shortBits << endl;
printf("The converted decimal value is %i \n", i1);
printf("-----\n");

//Data unsigned short int
cout << "The maximum value of a unsigned short int is " << USHRT_MAX << endl;
cout << "The storage size in byte(s) of a unsigned short int is " <<
sizeof(us_shrt_int) << endl;
cout << "Input a hexadecimal number in the data type of unsigned short int, for
example BFFF" << endl;
scanf_s("%x", &us_shrt_int);

//bitset stores the number of bits in 8*size(us_shrt_int)
bitset<8 * sizeof(us_shrt_int)> us_shrt_Bits(us_shrt_int);
cout << "The converted binary value is " << us_shrt_int << endl;
printf("The converted decimal value is %i \n", us_shrt_int);
printf("-----\n");

//Data signed int
cout << "The minimum value of a int is " << INT_MIN << endl;
cout << "The maximum value of a int is " << INT_MAX << endl;
cout << "The storage size in byte(s) of a signed int is " << sizeof(signedInt) <<
endl;

//bitset stores the number of bits in 8*size(signedInt)
bitset<8 * sizeof(signedInt)> us_shrt_Bits(signedInt);
cout << "The converted binary value is " << signedInt << endl;
printf("The converted decimal value is %i \n", signedInt);
printf("-----\n");

```

```

//Data unsigned int
cout << "The maximum value of a unsigned int is " << INT_MAX << endl;
cout << "The storage size in byte(s) of a signed int is " << sizeof(us_int) <<
endl;
    cout << "Input a hexadecimal number in the data type of unsigned int, for example
8FFF8FFF" << endl;

    //bitset stores the number of bits in 8*size(us_int)
    bitset <8 * sizeof(us_int)> us_shrt_Bits(us_int);
    cout << "The converted binary value is " << us_int << endl;
    printf("The converted decimal value is %i \n", us_int);
    printf("-----\n");

    system("pause");
    exit(0);
    return 0;
}

```

Output:

```

The minimum value of a char is -128
The maximum value of a char is 127
The storage size in byte(s) of a char is 1
Input a hexadecimal number in the data type of char, for example 8a
8a
The converted binary value is 10001010
The converted binary value is -118
-----
The maximum value of an unsigned char is 255
The storage size in byte(s) of an unsigned char is 1
Input a hexadecimal number in the data type of unsigned char, for example 8a
ff
The converted binary value is 11111111
The converted decimal values is 255
-----
The minimum value of a short int is -32768
The maximum value of a short int is 32767
The storage size in byte(s) of a short int is 2
Input a hexadecimal number in the data type of short int, for example 8fff
8fff
The converted binary value is 1000111111111111
The converted decimal value is -28673
-----
Press any key to continue . . .

```

Conclusion:

Throughout this lab, I learned how to interpret and write programs to obtain and analyze decimal, hexadecimal, and binary numbers. I was also able to figure out the integer's storage size in bytes and the maximum/minimum values for various data types to analyze information in computer architecture. I used a variety of variables and learned in depth about C++ programming.