**Assignment Number**

**Problem Statement**

Program in C to convert a number between two bases.

**Theory**

The base of a number system is defined as the number of individual digits present in the system. For example, in decimal system, there are total 10 digits, from 0-9. Hence the base of decimal number system is 10. Similarly, there are only 0 and 1 in binary number system, hence the base is 2. Defining base is important to evaluate the value of a number in an weighted number system. For example, consider the following number in base B :

(d2d1d0)B

The equivalent decimal value for this number will be :

(d2d1d0)B = (B2 x d2 + B1 x d1 + B0 x d0)10

Hence to convert between any to arbitrary bases, we first need to convert it to decimal, and then convert the decimal value to the desired base. To convert any number from decimal to a desired base B, we divide the number by B, until a quotient of 0 is obtained. Then we collect the remainder of each step reversely, to get the final output.

**Examples :**

1. **Binary to octal :** (1111)2 = (15)10 = (17)8
2. **Hexadecimal to binary :** (ffff)16 = (65535)10 = (1111111111111111)2
3. **Octal to hexadecimal :** (77)8 = (63)10 = (3f)16

**Algorithms**

**Variable Listing**

|  |  |  |
| --- | --- | --- |
| **Name** | **Datatype** | **Purpose** |
| inputBase | Integer | To store the base of the input number |
| number | Integer | To store the input, if the inputBase is less than or equal to 10 |
| hex | Character array | To store the input, if the inputBase is greater than 10 |
| outputBase | Integer | To store the base of the output number |
| hasBadChar | Integer | To denote if the input has some invalid characters in it |
| toDecimal | Integer | To store the converted decimal value of the given input |
| final | Integer array | To store the converted outputBase value of the given input |

**1. Algorithm for Get\_Cval(character, inputBase)**

// returns the equivalent decimal value of a character in given inputBase

1. If(ascii(c) >= ascii(0) and ascii(c) <= ascii(9))

// ascii() is a function which returns the ascii value of a character

Then

* 1. Return ascii(c) - ascii(0)

1. Else If(ascii(c) >= ascii(a) and ascii(c) <= (ascii(a) + inputBase - 11))

Then

* 1. Return ascii(c) - ascii(a) + 10

1. Else If(ascii(c) >= ascii(A) and ascii(c) <= (ascii(A) + inputBase - 11))

Then

* 1. Return ascii(c) - ascii(A) + 10

1. Else
   1. Return -1 // the character should not be present in given base

[End of if structure]

**2. Algorithm for Con\_Lt10(number, inputBase)**

// to convert a number from a base less than 10 to decimal

1. Set i = 0
2. Repeat through step 2.a to 2.c while(n >= 1)

Begin

* 1. Set digit[i] = number % 10
  2. Set number = number / 10 // '/' denotes integer division operation
  3. Set i = i + 1

[End of While loop]

1. Set bak = i - 1
2. Set i = 0
3. Set sum = 0
4. Repeat through step 6.a to 6.b while(i <= bak)

Begin

* 1. Set sum = sum + (digit[i] \* inputBasei)
  2. Set i = i + 1

[End of While loop]

1. Return sum

**3. Algorithm for Con\_Gt10(hex, inputBase)**

// to convert a number from a base greater than 10 to decimal

1. Set len = length\_of(hex) - 1 // length\_of is a function which returns

// the length of an array

1. Set dec = 0
2. Set i = 0
3. Set val = 0
4. Repeat through step 5.a to 5.d while (hex[i] != Null)

Begin

* 1. Set val = Get\_Cval(hex[i], inputBase)
  2. If(val = -1) // The character should not be present in this inputBase

Then

* + 1. Print "Invalid character" hex[i] "for base" inputBase
    2. Set hasBadChar = 1 // Flag to denote a bad character in input

[End of if structure]

* 1. Set dec = dec + (val \* inputBaselen)
  2. Set len = len-1

[End of while loop]

1. Return dec

**4. Algorithm for Main()**

1. Set choice = y
2. Repeat through step 2.a to 2.o while (choice = y)

Begin

* 1. Print "Enter the input base : "
  2. Read inputBase
  3. Print "Enter the number : "
  4. If(inputBase < 2 or inputBase > 16)

Then

* + 1. Print "Input base must fall within the range [2,16]
    2. Exit

[End of if structure]

* 1. If(inputBase = 16)

Then

* + 1. Read hex
  1. Else
     1. Read number

[End of if structure]

* 1. Print "Enter the output base : "
  2. Read outputBase
  3. If(outputBase < 2 or outputBase > 16)

Then

* + 1. Print "Output base must fall within the range [2,16]"
    2. Exit

[End of if structure]

* 1. If(inputBase = 10)

Then

* + 1. Set toDecimal = number
  1. Else
     1. If(inputBase < 10)

Then

* + - 1. Set toDecimal = Con\_Lt10(number, inputBase)
    1. Else
       1. Set toDecimal = Con\_Gt10(hex, inputBase)

[End of if structure]

* + 1. If(hasBadChar = 1) // Bad character in source

Then

* + - 1. Exit

[End of if structure]

[End of if structure]

* 1. If(outputBase = 10)

Then

* + 1. Print "Converted number : " toDecimal
  1. Else
     1. Set i = 0
     2. Repeat through step 2.i to step 2.iii while(toDecimal >= 1)
        1. Set final[i] = toDecimal % outputBase
        2. Set number = number / outputBase
        3. Set i = i + 1

[End of while loop]

* + 1. Set i = i - 1
    2. Print "Converted number : "
    3. Repeat through step 5.i to step 5.iii while (i > 0)

Begin

* + - 1. If(final[i] > 9) // we need to print some characters

Then

* + - * 1. Set character = final[i] - 10 + ascii(A)
        2. Print character
      1. Else
         1. Print final[i]

[End of if structure]

* + - 1. Set i = i - 1

[End of while loop]

[End of if structure]

* 1. Print "Do you want to continue (y/n) ? "
  2. Read choice

[End of while loop]

1. End

**Source Code**

#include <stdio.h> // printf(), scanf()

#include <math.h> // pow()

#include <string.h> // strlen()

// ===================================================

// Bookkeeping methods

// ===================================================

// Returns the decimal value of a character

int get\_cval(char c, int ib){

if(c >= '0' && c <= '9') // It is a numeric digit

return c - '0';

if(c >= 'a' && c <= 'a' + (ib - 11)) // It is something between a - f

return c - 'a' + 10;

if(c >= 'A' && c <= 'A' + (ib - 11)) // It is something between A - F

return c - 'A' + 10;

return -1; // It is impossible to have a digit like this in present base!

}

// ======================================================

// Conversion methods

// ======================================================

static short hasBadChar = 0; // Flag to denote if received string has an invalid character

// Convert a number in a base > 10 to base 10

long int con\_gt10(char hex[20], long int ib){

long int len, val, dec = 0, i = 0;

len = strlen(hex) - 1;

for(i=0; hex[i]!='\0'; i++){

val = get\_cval(hex[i], ib);

if(val == -1){

printf("\n[Error] Bad character %c for input base %ld!", hex[i], ib);

hasBadChar = 1;

}

dec += val \* pow(ib, len);

len--;

}

return dec;

}

// Convert a number in a base < 10 to base 10

long int con\_lt10(long int n, long int ib){

long int b[20], i=0, s=0, p;

while(n >= 1){

b[i] = n%10;

n = n/10;

p = i;

i++;

}

for (i=0; i<=p; i++){

s += (b[i] \* pow(ib,i));

}

return s;

}

// =====================================================

// Driver

// =====================================================

int main(){

char ch = 'Y';

do{

long int n, a[20], ib, ob, i = 1, p, c;

char hex[20]; // String to store if the input base is > 10

printf("\n[Input] Enter the input base : ");

scanf("%ld",&ib);

if(ib < 2 || ib > 16){ // Hey man, behave yourself!

printf("\n[Error] Input base must be fall in the range [2,16]!");

return 1;

}

if (ib < 11){ // Thank god! The input is going to be pure decimal

printf("\n[Input] Enter the number : ");

scanf("%ld",&n);

}

else { // There is going to be some nasty chars in it

printf("[Input] Enter the number : ");

scanf("%s", hex);

}

printf("\n[Input] Enter the output base : ");

scanf("%ld",&ob);

if(ob < 2 || ob > 16){ // Whoops!

printf("\n[Error] Output base must fall in the range [2,16]!");

}

if(ib != 10){ // We can't really convert a decimal to decimal, can we?

if(ib < 10)

c = con\_lt10(n, ib);// A function to convert all < 10 bases to decimal

else{

c = con\_gt10(hex, ib); // A function to convert all > 10 bases to

// decimal

if(hasBadChar == 1) // Don't play dumb with me!

return 1;

}

}

else

c = n;

if(ob == 10){ // We have the converted decimal by now

printf("\n[Output] Converted number : %ld",c);

}

else { // Converting to the output base, when will this day end?

// You know this, right?

while(c >= 1){

a[i] = c%ob;

c = c/ob;

p = i;

i++;

}

printf("\n[Output] Converted number : ");

for (i=p;i>=1;i--){ // Let's desugar it

if(a[i] > 9) // Duh! I can handle it too!

printf("%c", (char)(a[i] + 87));

else

printf("%ld",a[i]);

}

}

printf("\n[Input] Do you want to continue (y/n) ? ");

scanf(" %c",&ch);

} while(ch=='y' || ch=='Y'); // I can keep it up, can you?

return 0;

}

**Input and Output**

**Set 1**

[Input] Enter the input base : 2

[Input] Enter the number : 101011

[Input] Enter the output base : 10

[Output] Converted number : 43

[Input] Do you want to continue (y/n) ? n

**Set 2**

[Input] Enter the input base : 16

[Input] Enter the number : qwe12

[Input] Enter the output base : 10

[Error] Bad character q for input base 16!

[Error] Bad character w for input base 16!

**Set 3**

[Input] Enter the input base : -2

[Error] Input base must be fall in the range [2,16]!

**Set 4**

[Input] Enter the input base : 16

[Input] Enter the number : ffff

[Input] Enter the output base : 10

[Output] Converted number : 65535

[Input] Do you want to continue (y/n) ? n

**Discussion**

1. To convert a number from one base to another one must enter two different bases.
2. If the entered bases are same then the output will be same as like the input. So for better programming one must check at first whether the bases are same or not.
3. If one enters the negative number for bases and also for number of that corresponding base, then user cannot get the desired output. So to get the desired output one must enter the positive number for bases and for numbers.