

Concepts of Conversion of Base-2 Floating Point Binary Number to a Base-10 Decimal Number

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Introduction

The following worksheet illustrates how to convert a base-2 floating point binary number to a base-10 decimal number using loops and various conditional statements. The user inputs total number of bits, decimal sign bit value, exponent sign bit value, mantissa bits entry, and exponent bits entry in the *Input* section of the program. The program will then convert the floating point binary number into a decimal number.

Initialization

[> *restart; with(MTM) :*

Section 1: Input

This is the only section where the user interacts with the program.

The generalized formula for floating point format is given by $y = \sigma \cdot m \cdot 10^e$

Enter the total number of bits

> *tot_bits := 9*

tot_bits := 9 (3.1)

Enter the sign of the number: '0' if the number is positive, '1' if the number is negative.

> *dec_sign := "0"*

dec_sign := "0" (3.2)

Enter the sign of the exponent: '0' if the number is positive, '1' if the number is negative.

> *exp_sign := "0"*

exp_sign := "0" (3.3)

Enter the mantissa bits

> *Mant_bits := "1011"*

Mant_bits := "1011" (3.4)

Enter the exponent bits

> *Exp_bits := "101"*

Exp_bits := "101" (3.5)

This is the end of the user section. All information must be entered before proceeding to the next section. **RE-EXECUTE THE PROGRAM.**

Section 2: Procedure

We must first check to see if the number of bits entered by the user corresponds with the total number of bits specified.

```
> a := length(dec_sign) :
  b := length(exp_sign) :
  c := length(Mant_bits) :
  d := length(Exp_bits) :

Totalbits := a + b + c + d :

if tot_bits ≠ Totalbits then
  printf("\nThere is an error in the number of bits entered. The total number of bits counted
  does not correspond with the total number of bits entered by the user. Please make sure
  the addition of all the bits specified equals the total number of bits specified.")
else
  printf("\nThe total number of counted bits is equal to the number of total number of bits
  entered by the user. The simulation will now begin");
end if;
```

The total number of counted bits is equal to the number of total number of bits entered by the user. The simulation will now begin

Using *if* statements to designate the signs of both the decimal number to be approximated and the exponent.

```
> if dec_sign = "0" then
  Dec_sign := 1;
elif dec_sign = "1" then
  Dec_sign := -1;
end if;

if exp_sign = "0" then
  Exp_sign := 1;
elif exp_sign = "1" then
  Exp_sign := -1;
end if;
```

Here we initialize the *Mant_sum* value at one to account for the $1 \cdot 2^0$ term that always exists in the floating point approximations.

```
> Mant_sum := 1 :
for i to c do
  Mant_sum := Mant_sum + (parse(Mant_bits[i]) * 2(-i));
end do;
```

Using the loop to create a number array from the exponent character array.

```
> Exp_sum := 0 :
for i to d do
  Exp_sum := Exp_sum + (parse(Exp_bits[i]) * 2(d-i));
```

end do:

Determining the final base-10 number.

```
> Final_Dec_Num := Dec_sign * Mant_sum * 2 ^ (Exp_sign * Exp_sum);  
Final_Dec_Num := 54
```

(4.1)

▼ Conclusion

This worksheet illustrates the use of Maple to convert a floating point binary representation to a base-10 number. Recall that floating point representation is used more often than fixed point representation due to two primary advantages: floating point representation supports a much larger range of values while maintaining a relative error of similar magnitude for all numbers.

▼ References

Floating Point Representation:

See: http://numericalmethods.eng.usf.edu/mws/gen/01aae/mws_gen_aae_txt_floatingpoint.pdf

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