THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

The School of Engineering and Applied Science
of The George Washington University

CSCI 6461
Fall 2018
Project 1, Group 9
Floating Point and Vector Operations

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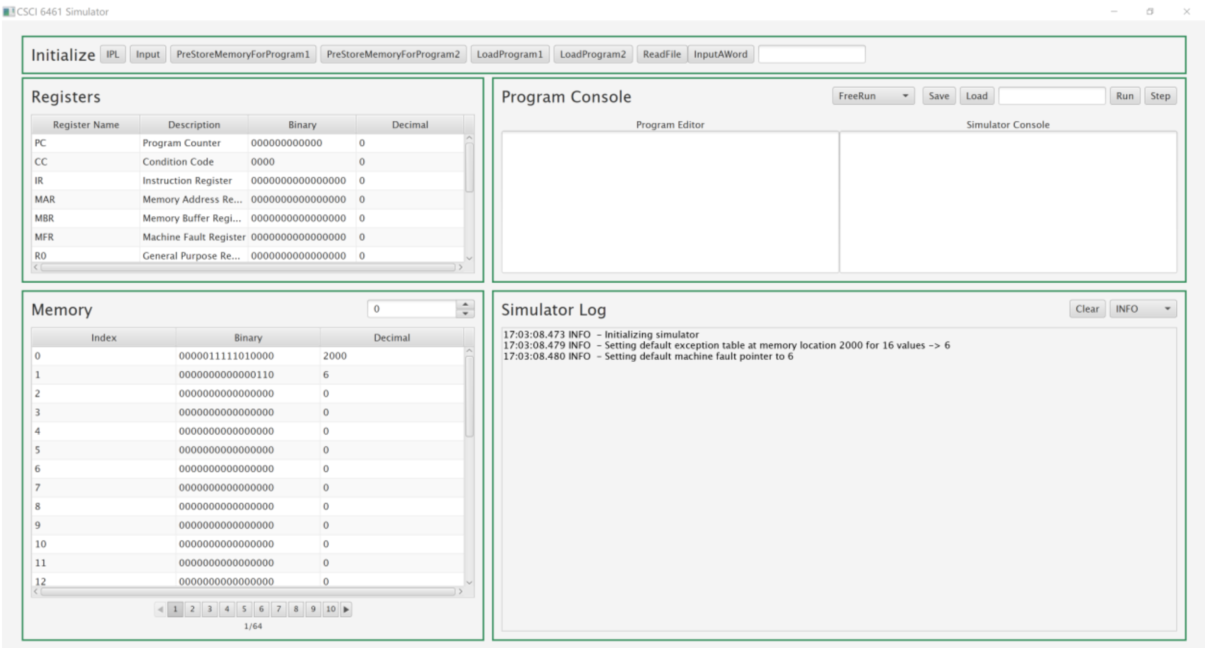
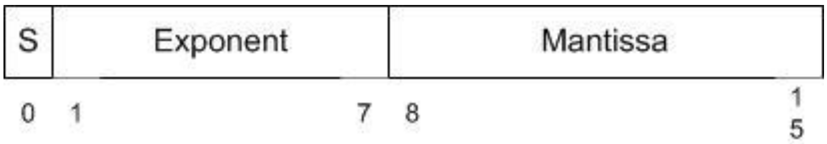
12/01/2018

Design Note



Floating Point Number



Floating point number = (-1)^S * (1.M) * 2^(exponent-bias)

bias = 2^(exponent_bits -1) -1 = 2^6 – 1 =63

For example,

0   1000001   01100000

S = 0, 1+M = 1.375, exponent - bias = 65 - 63 = 2

Value = (-1)^0 * 1.375 * 2^2 = 5.5

Overflow and Underflow:

When the result is normalized by shifting to the right, the result overflows if the exponent overflows.

When the result is normalized by shifting to the left, the result underflows if the exponent overflows.

Pipeline

Floating point addition and subtraction is divided into four steps:

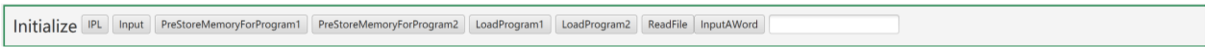
1. Match: Shift the decimal point of the smaller number to the left until the exponents are equal.
2. Calculate: Add the numbers with decimal points aligned.
3. Normalize: Normalize the result to normal form.

4. Result: Get the result.

Here is an example to execute six floating point addition/subtraction operations in pipeline:

Result				R1	R2	R3	R4	R5	R6
Normalize			N1	N2	N3	N4	N5	N6	
Calculate		C1	C2	C3	C4	C5	C6		
Match	M1	M2	M3	M4	M5	M6			
Clock	1	2	3	4	5	6	7	8	9

Initialize Button



Button [IPL]

By Clicking IPL, registers, memory and CPU will be set initially.

Button [Input]

By Clicking Input, the number in the Simulator Console will be input to CPU.

Button [PreStoreMemoryForProgram1]

By Clicking PreStoreMemoryForProgram1, it will store some values into memory, which helps run the program1:

memory[8]	0000000001000000	64	for X1
memory[9]	0000000010101010	170	for X2
memory[85]	0111111111111111	32767	for compare
memory[86]	0000000001000000	64	
memory[87]	0000000001010100	84	

Button [PreStoreMemoryForProgram2]

By Clicking PreStoreMemoryForProgram2, it will store some values into memory, which helps run the program2:

memory[12]	0000001000000000	512	Word store start
memory[13]	0000000001000000	64	for X1
memory[14]	0000000001100000	96	for X2
memory[15]	0000000000000001	1	sentence number
memory[16]	0000000000000001	1	word number

Button [LoadProgram1]

That will load instructions used in program1and store them into memory[126-185]. Set the PC =126.

Button [LoadProgram2]

That will load instructions used in program2 and store them into memory[64-10]. Set the PC =64.

Button [ReadFile]

That will read “**program2_paragraph.txt**” and store each word into memory.

Button [InputAWord]

This is the word you want to find in paragraph. The word will be stored in CPU.

Registers

Registers

Register Name	Description	Binary	Decimal
PC	Program Counter	000000000000	0
CC	Condition Code	0000	0
IR	Instruction Register	0000000000000000	0
MAR	Memory Address Re...	0000000000000000	0
MBR	Memory Buffer Regi...	0000000000000000	0
MFR	Machine Fault Register	0000000000000000	0
R0	General Purpose Re...	0000000000000000	0

1.We have implemented the following registers:

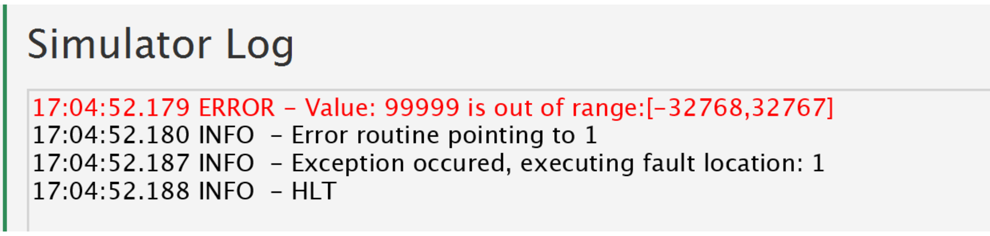
Mnemonic	Size
PC	12 bits
CC	4 bits
IR	16 bits
MAR	16 bits
MBR	16 bits
MFR	4 bits
R0…R3	16bits
X1…X3	16 bits
FR0…FR1	16bits

2. You can deposit a value to the register directly by double clicking a cell in “Binary” or “Decimal” column and setting a value.

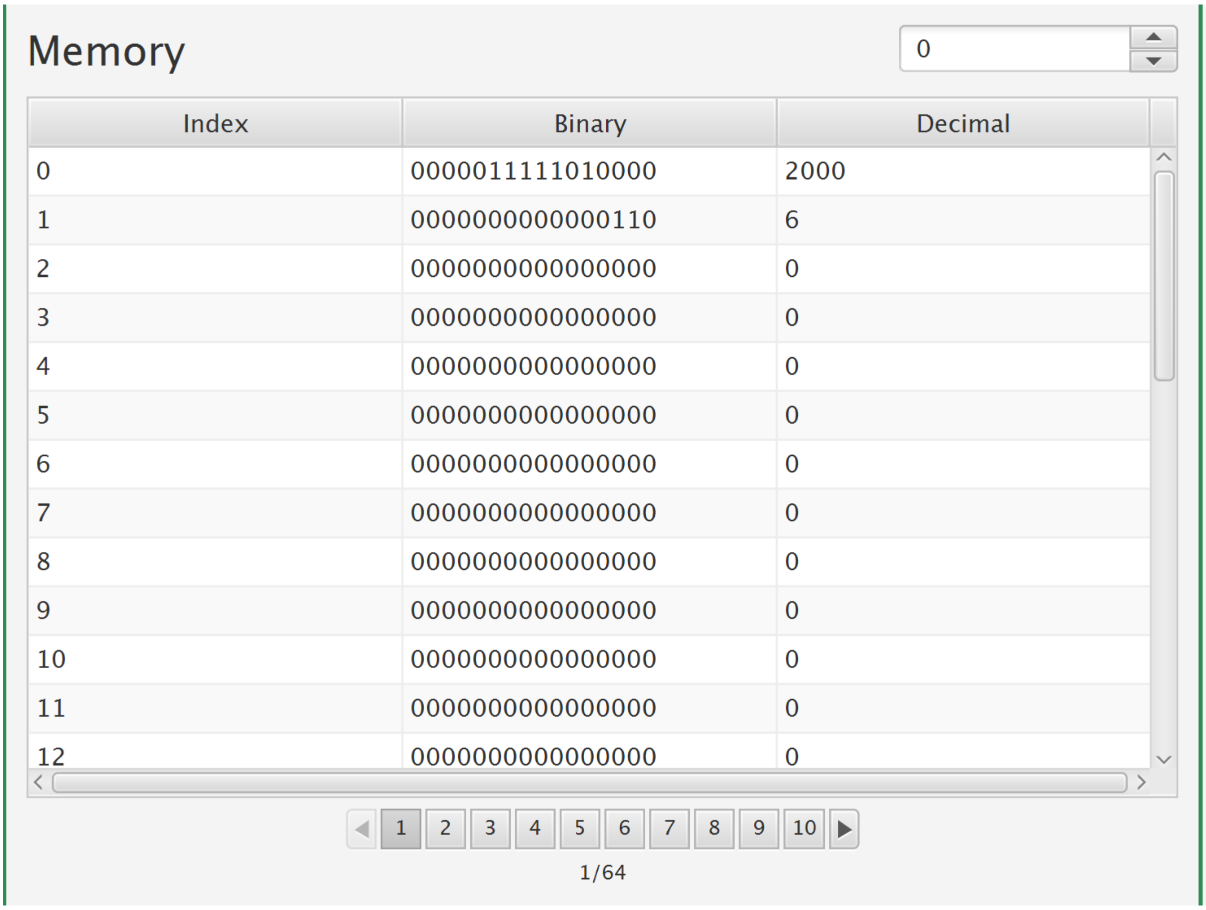
Register Name	Description	Binary	Decimal
PC	Program Counter	000000000001	1

17:04:07.190 INFO – Setting register PC to 1

3.If the value is out of range, the simulator will throw Illegal Value Exception.



Memory and Cache



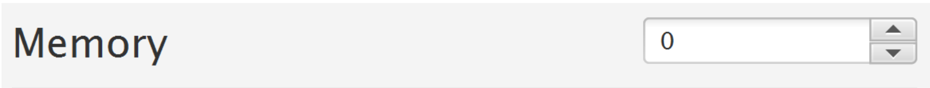
Index	Binary	Decimal
0	0000011111010000	2000
1	0000000000000110	6
2	0000000000000000	0
3	0000000000000000	0
4	0000000000000000	0
5	0000000000000000	0
6	0000000000000000	0
7	0000000000000000	0
8	0000000000000000	0
9	0000000000000000	0
10	0000000000000000	0
11	0000000000000000	0
12	0000000000000000	0

1. Memory is 2048 words size, 16-bit words.
2. Use **"BitSet"** to store data.
3. Set **MAR**, **MBR** when store and fetch.
4. Cache is implemented in **"src.Memory.MemoryCache.Java"**. For every store and fetch, we search the cache first. If the corresponding index is found in the cache, then simulator will logger "hit cache". If the corresponding index is not found in the cache, put the index to the cache. When the cache is full, we use FIFO and remove the first.
5. We have stored some value in memory for **TRAP** and **Machine Fault**

memory[0]	0000000000000111	2000	Trap table start

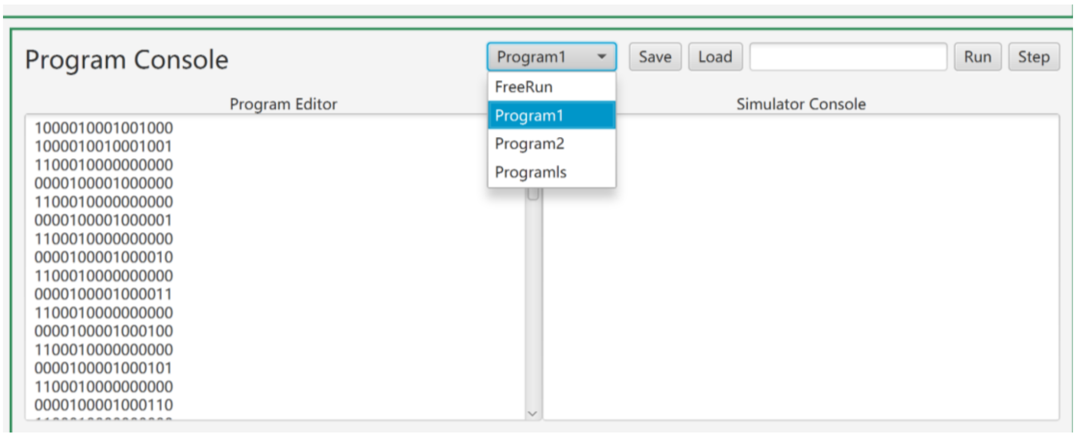
memory[1]	0000000000000110	6	Machine Fault Trap instruction location
memory[6]	0000000000000000	0	HLT
memory[2000]	0000000000010100	6	Routine 0
memory[2001]	0000000000010100	6	Routine 1 IllegalMemoryAccess
memory[2002]	0000000000010100	6	Routine 2 IllegalTrapCode
memory[2003]	0000000000010100	6	Routine 3 IllegalValue
memory[2004]	0000000000010100	6	Routine 4 IllegalOpcode
memory[2005]	0000000000010100	6	Routine 5 IllegalRegisterAccess
memory[2006]	0000000000010100	6	Routine 6
memory[2007]	0000000000010100	6	Routine 7
memory[2008]	0000000000010100	6	Routine 8 MemoryOutOfBounds
memory[2009]	0000000000010100	6	Routine 9
memory[2010]	0000000000010100	6	Routine 10
memory[2011]	0000000000010100	6	Routine 11
memory[2012]	0000000000010100	6	Routine 12
memory[2013]	0000000000010100	6	Routine 13
memory[2014]	0000000000010100	6	Routine 14
memory[2015]	0000000000010100	6	Routine 15

6. Memory can be changed directly by double clicking cells and setting a different value, which is analogous to what we have done with registers
7. You can go to any location in memory by inputting an index here.



Program Console

ComboBox [programNameSelector]



You can select some programs that are already stored. And it will automatically set instructions in Program Editor (***TextArea [programContents])***.

Button [Save]

By clicking Save, it will save the current instructions of the selected program in our Program Editor.

Button [Load]

By clicking Load, it will load the instructions of selected program and store them into memory.

If ***TextField [StartIndex]*** is empty, the default location is memory[32], the program will be load to memory start from 32 and set PC = 32;

If you input a number in ***TextField [StartIndex]***, the program will be load to memory start from the input number and set PC = input number.

Button [Run]

Run the program until HLT.

Button [Step]

Run single Step.

TextArea [console]

If the simulator executes instruction OUT, the output will show in the ***TextArea [console].***

Simulator Log

Button [Clear]

Clear the contents in the log.

ComboBox [logLevels]

Select different level of log to show.