

CS 218

Homework, MIPS Asst. #4

Purpose: Become familiar with the MIPS Instruction Set, and the MIPS standard calling convention, and basic recursion.

Due: Thursday (7/07)

Points: 75

Assignment:

The Collatz conjecture¹ is an unsolved conjecture in mathematics named after Lothar Collatz, who first proposed it in 1937. Take any natural number n . If n is even, divide it by 2 to get $n / 2$, if n is odd multiply it by 3 and add 1 to obtain $3n + 1$. Repeat the process indefinitely. The conjecture is that no matter what number you start with, you will always eventually reach 1.

More precisely, the problem can be stated as:

$$\text{collatz}(n) = \begin{cases} 1 & \text{if } n=1 \\ n / 2 & \text{if } n \text{ is even} \\ 3n+1 & \text{if } n \text{ is odd} \end{cases}$$

Write the following assembly language functions.

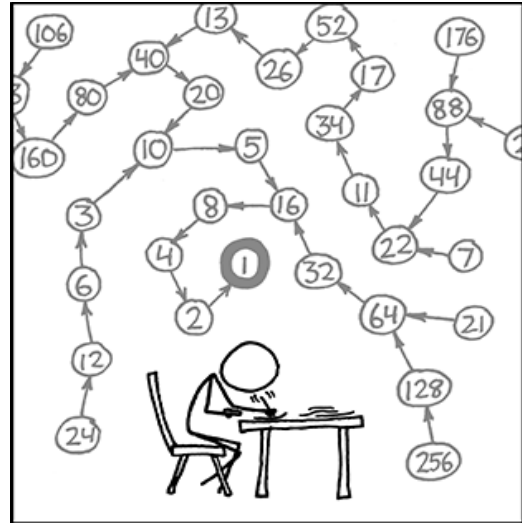
- Write a recursive MIPS assembly language procedure, **collatz()**, to display n and then compute the Collatz operation (above) for a positive integer. Includes returning a count for each call to **collatz()** procedure.
- Write a MIPS assembly language function, **readn()**, to read the initial n value and verify the range is between 1 and 715,000,001.
- Write a MIPS assembly language function, **continue()**, to prompt the user ("Enter another number (Y/y/N/n)? ") if they want to continue or exit the program.

Refer to the example for input/output formatting. Do not change the data types of the provided data. You may define additional variables as required.

Submission:

When complete, submit:

- A copy of the **source file** via the class web page by class time.
- A copy of the log file (Including the "Console" and "Text Segment" options). Include the inputs and testing shown in the example (which includes showing the n range checks and "Y/y/N/n" handling and error handling. In addition, execute the program using integers (42, 41, 715000000, 715000001, 255, and 257).



THE COLLATZ CONJECTURE STATES THAT IF YOU PICK A NUMBER, AND IF IT'S EVEN DIVIDE IT BY TWO AND IF IT'S ODD MULTIPLY IT BY THREE AND ADD ONE, AND YOU REPEAT THIS PROCEDURE LONG ENOUGH, EVENTUALLY YOUR FRIENDS WILL STOP CALLING TO SEE IF YOU WANT TO HANG OUT.

Source: <http://xkcd.com/710/>

¹ For more information, refer to: http://en.wikipedia.org/wiki/Collatz_conjecture

Example Output: (See PDF file for additional examples)

Console

MIPS Assignment #5
Collatz Conjecture Program

Integer value for Collatz Conjecture:

Enter n (1 - 715,000,001): 25

Collatz() sequence:

collatz() = 25
collatz() = 76
collatz() = 38
collatz() = 19
collatz() = 58
collatz() = 29
collatz() = 88
collatz() = 44
collatz() = 22
collatz() = 11
collatz() = 34
collatz() = 17
collatz() = 52
collatz() = 26
collatz() = 13
collatz() = 40
collatz() = 20
collatz() = 10
collatz() = 5
collatz() = 16
collatz() = 8
collatz() = 4
collatz() = 2
collatz() = 1

Collatz() Steps: 24

Enter another number (Y/y/N/n)? g
Error, must answer with (Y/y/N/n).
Enter another number (Y/y/N/n)? z
Error, must answer with (Y/y/N/n).
Enter another number (Y/y/N/n)? y

Integer value for Collatz Conjecture:

Enter n (1 - 715,000,001): 26

Collatz() sequence:

collatz() = 26
collatz() = 13
collatz() = 40
collatz() = 20
collatz() = 10
collatz() = 5
collatz() = 16
collatz() = 8
collatz() = 4
collatz() = 2
collatz() = 1

Collatz() Steps: 11

Enter another number (Y/y/N/n)? y

Integer value for Collatz Conjecture:

Enter n (1 - 715,000,001): 1

Collatz() Sequence:

collatz() = 1

Collatz() Steps: 1

Enter another number (Y/y/N/n)? y

Integer value for Collatz Conjecture:

Enter n (1 - 715,000,001): -3

Error, n value must be between 1 and
715,000,001

Please re-enter data.

Integer value for Collatz Conjecture:

Enter n (1 - 715,000,001): 715000002

Error, n value must be between 1 and
715,000,001

Please re-enter data.

Integer value for Collatz Conjecture:

Enter n (1 - 715,000,001): 245

Collatz() sequence:

collatz() = 245
collatz() = 736
collatz() = 368
collatz() = 184
collatz() = 92
collatz() = 46
collatz() = 23
collatz() = 70
collatz() = 35
collatz() = 106
collatz() = 53
collatz() = 160
collatz() = 80
collatz() = 40
collatz() = 20
collatz() = 10
collatz() = 5
collatz() = 16
collatz() = 8
collatz() = 4
collatz() = 2
collatz() = 1

Collatz() Steps: 22

Enter another number (Y/y/N/n)? n

Program Terminated.