BigInteger Library in MIPS-32 Assembly

CS321/CS322 Mini-Project

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Introduction

- Primitive integer data type - 32-bits or 64-bits in C, C++, Java, etc.
- Calculations involving very large integers cannot be directly handled
- Eg.: Factorial of 100, which contains 158 characters
- Several programming languages big-integer libraries to handle such big integer operations (Java - BigInteger, C++ - Boost MultiPrecision, python - ‘bignum’).
- In this project, several basic functions have been implemented in the in the MIPS-32 instruction set.

Description

- The big-integer ‘struct’:
  First 4-bytes stores size in bytes of the integer array. The rest is an integer array of a given size. The least-significant-bit is stored first (little-endian).
- This code currently supports a big integer of a maximum size of 2^32 bytes. All operations work on arbitrary length big integers.
- The code currently only supports unsigned operations, which can easily be extended to support signed big-integers if needed.

Functions implemented - Utilities

- make_bi
- make_bi_100
- ascii_to_int
- make_bi_from_str
- add_3_words
- print_bi
- set_bi_zero

Functions implemented - Utilities

- add_bi_bi
- sub_bi_bi
- mult_bi_bi
- comp_bi_bi

add_bi_bi

- Function that adds 2 big integers
- Unsigned addition is done word-by-word
- Returns $v0 - address of new big integer
- The function first makes a new big integer to store the result of size max(l1, l2) + 4 bytes where l1, l2 are the sizes in bytes of the input big integers
- The addition is done word-by-word, and the carry is stored. The function calls the add_3_words subroutine for adding the two words and the carry word.

sub_bi_bi

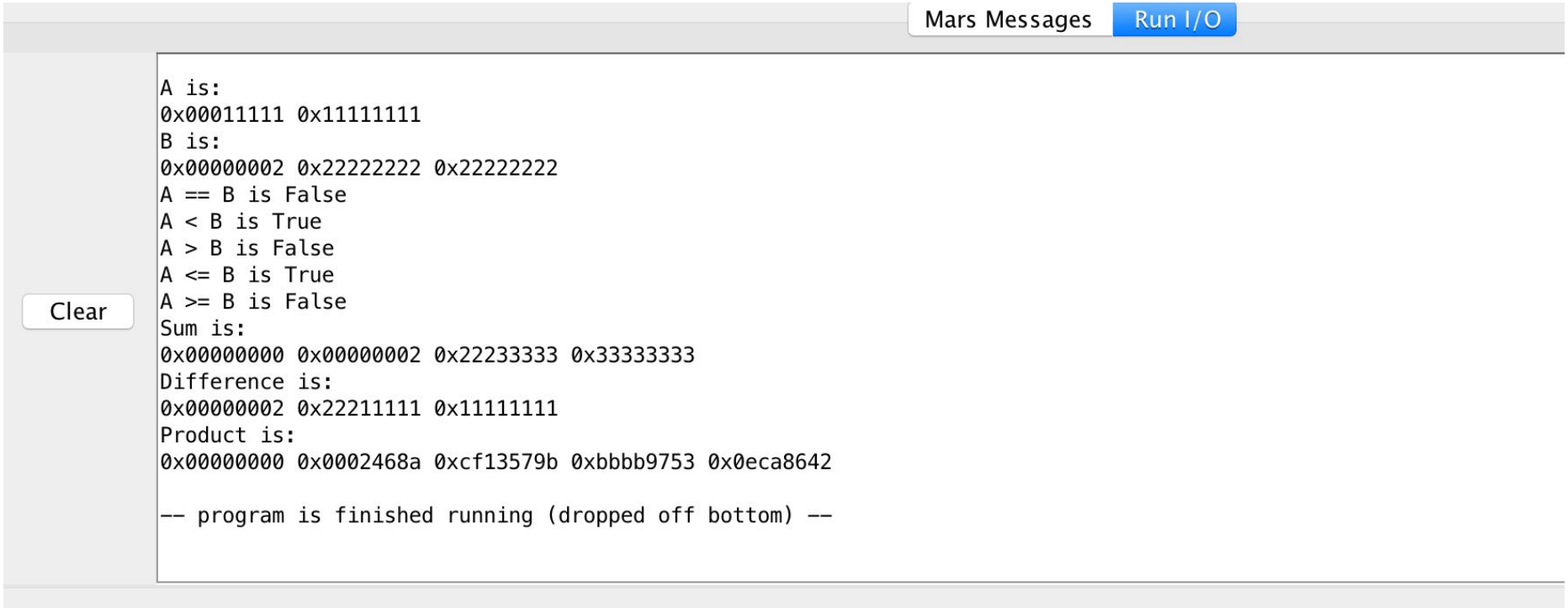
- Function that finds the difference of 2 big-integers
- Smaller big-integer is subtracted from the bigger big-integer - comparison function is used to determine if the big integers need to be swapped.
- Returns $v0 - address of new big-integer
- New big-integer made to store the result of size max(l1, l2)
- When doing the subtraction, the previous borrow is added to the subtrahend and then this sum is subtracted from the minuend
  (minuend - (subtrahend+borrow) = difference)
- This is done byte-by-byte since the sum of the subtrahend and the borrow might not fit in a 32-bit register if done word-by-word.

mult_bi_bi

- This is a function that multiplies 2 big integers.
- Unsigned multiplication is done word-by-word.
- Returns $v0 - address of new big integer.
- A new big integer of size l1 + l2 is made and initialized to 0.
- An outer_loop loops through the first big integer. An inner_loop loops through the second.
- Each word from the first big integer gets multiplied to the whole second big integer, with the carry handled.
- The add_3_words subroutine is used to add the carry, the accumulated sum in the result, and the product of the words.
- This is then put in the right position in the result.

comp_bi_bi

- This is a function that compares two big integers. It returns boolean flags for ‘equal’, ‘less-than’, ‘greater-than’, ‘less-than-or-equal’, and ‘greater-than-or-equal’.
- Values passed - $a0 - first bi, $a1 - second bi.
- Returns: $v0 - Equal, $a0 - LT, $a1 - GT, $a2 - LTE, $a3 - GTE.
- First, the lengths of the two big integers are compared. If they’re equal, the integers are compared word-by-word, and the flags are set depending on the comparison.



Output showing comparisons, sum, difference, and product

Thank you!