Computer Architecture — Course: IT089IU

International University – VNU HCM — Date: March 2023

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Laboratory Session 2

Testing and Branching

1. MIPS assembler directives

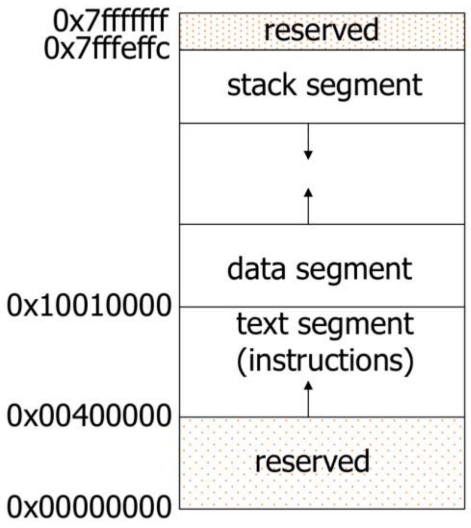


Figure 1 MIPS Memory Usage as viewed in SPIM

.text

indicates that following items are stored in the user text segment, typically instructions

.data

indicates that following data items are stored in the data segment

.globl sym

declare that symbol sym is global and can be referenced from other files

Common data definitions

.word w1, ..., wn

store n 32-bit quantities in successive memory words

.half h1, ..., hn

store n 16-bit quantities in successive memory halfword

.byte b1, ..., bn

store n 8-bit quantities in successive memory bytes

.ascii str

store the string in memory but do not null-terminate it

- strings are represented in double-quotes “str”
- special characters, eg. \n, \t, follow C convention

.asciiz str

store the string in memory and null-terminate it

.float f1, ..., fn

store n floating point single precision numbers in successive memory locations

.double d1, ..., dn

store n floating point double precision numbers in successive memory locations

.**space** n

reserves n successive bytes of space

.**align** n

align the next datum on a 2^n byte boundary.

For example, **.align 2** aligns next value on a word boundary.

.**align 0** turns off automatic alignment of **.half**, **.word**, etc. till next **.data** directive

2. Pseudo-instructions (20pts)

Pseudo-instructions do not correspond to real MIPS instructions. Assembler would translate pseudo-instructions to real instructions (one or more instructions). Pseudo-instructions not only make it easier to program, it can also add clarity to the program, by making the intention of the programmer clearer.

Change the pseudo-instruction “**li $t0, 5**” in **Lab2_2.s** to “**li $t0, -5**”. What are the real MIPS instructions for “**li $t0, -5**”. Explain how the real instructions work.

Change the pseudo-instruction “**li $t0, 5**” in **Lab2_2.s** to “**li $t0, 0xaabbccdd**”. What are the real instructions for “**li $t0, 0xaabbccdd**”. Explain how the real instructions work.

3. Branching (40pts)

3.1 Load the assembly file **Lab2_3.s** into qtSpim and run. Try to win the game. What is the **secret number**?

3.2 Result (Source Code): Why win and lose in the same time? -> BNE = Branch if NOT EQUAL

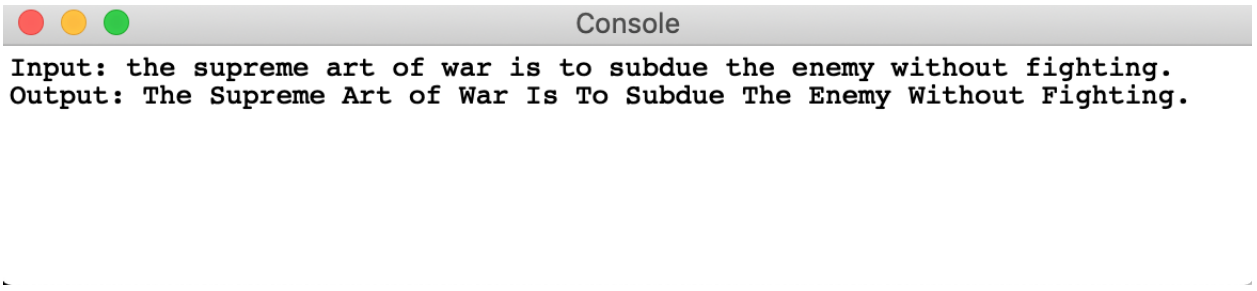
3.3 Modify the game so that it will print out as follow (no iteration) using the instructions **bgt,** or **bge,** or **blt,** or **ble**: Save your file as **Lab2_3.3.s**

3.4 Modify the game so that player can keep guessing until he finds the secret number. Save your assembly as **Lab2_3.4.s**

3.5 Modify previous version so that player can decide to stop the game by input a **flag**. Save your assembly as **Lab2_3.5.s**

4. String (20pts)

Write an assembly that convert an input string as follow:



```
Input: the supreme art of war is to subdue the enemy without fighting.
Output: The Supreme Art of War Is To Subdue The Enemy Without Fighting.
```

The first letter of every word is capitalized. Save your assembly as **Lab2_4.s**

5. hidden problem (20pts)

Reference:

1. https://en.wikibooks.org/wiki/MIPS_Assembly/Pseudoinstructions
2. https://courses.missouristate.edu/KenVollmar/MARS/Help/SyscallHelp.html
3. https://www.assemblylanguagetuts.com/mips-assembly-programming-tutorials/#MIPS_Data_Types
4. https://en.wikibooks.org/wiki/MIPS_Assembly/Arithmetic_Instructions
5. https://gab.wallawalla.edu/~curt.nelson/cptr280/lecture/mips%20arithmetic%20instructions.pdf