

Zach Dubinsky

CSC-270

Prof.Rieffel

2/7/22

## Lab 5

I affirm that all included work is my own in accordance with the class syllabus and the Union College Honor Code. [Signed: Zachary Dubinsky, 2/7/22]

1. The first image shows QtSpim with my sum.asm code loaded. All eight breakpoints are marked on this image, and screenshots of the register at each one are included below. The console output was 258.

```
QtSpim
File Simulator Registers Text Segment Data Segment Window Help

FP Regs Int Regs [16] Data Text
Int Regs [16] Text
PC = 0
EPC = 0
Cause = 0
BadVAddr = 0
Status = 3000fff10
HI = 0
LO = 0
R0 [r0] = 0
R1 [at] = 0
R2 [v0] = 0
R3 [v1] = 0
R4 [a0] = 0
R5 [a1] = 0
R6 [a2] = 0
R7 [a3] = 0
R8 [t0] = 0
R9 [t1] = 0
R10 [t2] = 0
R11 [t3] = 0
R12 [t4] = 0
R13 [t5] = 0
R14 [t6] = 0
R15 [t7] = 0
R16 [s0] = 0
R17 [s1] = 0
R18 [s2] = 0
R19 [s3] = 0
R20 [s4] = 0
R21 [s5] = 0

User Text Segment [00400000]..[00440000]
* [00400000] 8fa40000 lw $4, 0($29) ; 183: lw $a0 0($sp) # argc
[00400004] 27a50004 addiu $5, $29, 4 ; 184: addiu $a1 $sp 4 # argv
[00400008] 24a60004 addiu $6, $5, 4 ; 185: addiu $a2 $a1 4 # envp
[0040000c] 00041080 sll $2, $4, 2 ; 186: sll $v0 $a0 2
[00400010] 00c23021 addu $6, $6, $2 ; 187: addu $a2 $a2 $v0
[00400014] 0c100009 jal 0x00400024 [main] ; 188: jal main
[00400018] 00000000 nop ; 189: nop
[0040001c] 3402000a ori $2, $0, 10 ; 191: li $v0 10
[00400020] 0000000c syscall ; 192: syscall # syscall 10
(exit)
[00400024] 3c011001 lui $1, 4097 ; 18: lw $t0, num1 # temp = num1
* [00400028] 8c280000 lw $8, 0($1) ; 19: add $t1, $0, $t0 # accum
* [0040002c] 00084820 add $9, $0, $8 ; 20: lw $t0, num2 # temp = num2
= temp ; 21: add $t1, $t1, $t0 #
[00400030] 3c011001 lui $1, 4097 ; 22: lw $t0, num3 # temp = num3
* [00400034] 8c280004 lw $8, 4($1) ; 23: add $t1, $t1, $t0 #
* [00400038] 01284820 add $9, $9, $8 ; 24: sw $t1, sum # sum = accum
accum = accum + temp ; 25: addi $v0, $0, 1 # $v0 =
[0040003c] 3c011001 lui $1, 4097 ; 26: add $a0, $0, $t1 # $a0 =
* [00400040] 8c280008 lw $8, 8($1) ; 27: syscall # syscall($v0=1)
* [00400044] 01284820 add $9, $9, $8 ;
accum = accum + temp ;
[00400048] 3c011001 lui $1, 4097 ;
[0040004c] ac29000c sw $9, 12($1) ;
[00400050] 20020001 addi $2, $0, 1 ;
code for 'print-int' ;
* [00400054] 00092020 add $4, $0, $9 ;
accum ;
[00400058] 0000000c syscall ;
prints $a0 ;
```

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PC = 0	PC = 4194308	PC = 4194348	PC = 4194352
EPC = 0	EPC = 4194304	EPC = 4194344	EPC = 4194348
Cause = 0	Cause = 36	Cause = 36	Cause = 36
BadVAddr = 0	BadVAddr = 0	BadVAddr = 0	BadVAddr = 0
Status = 3000ff10	Status = 805371664	Status = 805371664	Status = 805371664
HI = 0	HI = 0	HI = 0	HI = 0
LO = 0	LO = 0	LO = 0	LO = 0
R0 [r0] = 0	R0 [r0] = 0	R0 [r0] = 0	R0 [r0] = 0
R1 [at] = 0	R1 [at] = 0	R1 [at] = 268500992	R1 [at] = 268500992
R2 [v0] = 0	R2 [v0] = 0	R2 [v0] = 4	R2 [v0] = 4
R3 [v1] = 0	R3 [v1] = 0	R3 [v1] = 0	R3 [v1] = 0
R4 [a0] = 0	R4 [a0] = 1	R4 [a0] = 1	R4 [a0] = 1
R5 [a1] = 0	R5 [a1] = 2147481692	R5 [a1] = 2147481692	R5 [a1] = 2147481692
R6 [a2] = 0	R6 [a2] = 2147481700	R6 [a2] = 2147481700	R6 [a2] = 2147481700
R7 [a3] = 0	R7 [a3] = 0	R7 [a3] = 0	R7 [a3] = 0
R8 [t0] = 0	R8 [t0] = 0	R8 [t0] = 17	R8 [t0] = 17
R9 [t1] = 0	R9 [t1] = 0	R9 [t1] = 0	R9 [t1] = 17
R10 [t2] = 0	R10 [t2] = 0	R10 [t2] = 0	R10 [t2] = 0
R11 [t3] = 0	R11 [t3] = 0	R11 [t3] = 0	R11 [t3] = 0
R12 [t4] = 0	R12 [t4] = 0	R12 [t4] = 0	R12 [t4] = 0
R13 [t5] = 0	R13 [t5] = 0	R13 [t5] = 0	R13 [t5] = 0
R14 [t6] = 0	R14 [t6] = 0	R14 [t6] = 0	R14 [t6] = 0
R15 [t7] = 0	R15 [t7] = 0	R15 [t7] = 0	R15 [t7] = 0
R16 [s0] = 0	R16 [s0] = 0	R16 [s0] = 0	R16 [s0] = 0
R17 [s1] = 0	R17 [s1] = 0	R17 [s1] = 0	R17 [s1] = 0
R18 [s2] = 0	R18 [s2] = 0	R18 [s2] = 0	R18 [s2] = 0
R19 [s3] = 0	R19 [s3] = 0	R19 [s3] = 0	R19 [s3] = 0
R20 [s4] = 0	R20 [s4] = 0	R20 [s4] = 0	R20 [s4] = 0
R21 [s5] = 0	R21 [s5] = 0	R21 [s5] = 0	R21 [s5] = 0

PC = 4194360	PC = 4194364	PC = 4194372	PC = 4194376
EPC = 4194356	EPC = 4194360	EPC = 4194368	EPC = 4194372
Cause = 36	Cause = 36	Cause = 36	Cause = 36
BadVAddr = 0	BadVAddr = 0	BadVAddr = 0	BadVAddr = 0
Status = 805371664	Status = 805371664	Status = 805371664	Status = 805371664
HI = 0	HI = 0	HI = 0	HI = 0
LO = 0	LO = 0	LO = 0	LO = 0
R0 [r0] = 0	R0 [r0] = 0	R0 [r0] = 0	R0 [r0] = 0
R1 [at] = 268500992	R1 [at] = 268500992	R1 [at] = 268500992	R1 [at] = 268500992
R2 [v0] = 4	R2 [v0] = 4	R2 [v0] = 4	R2 [v0] = 4
R3 [v1] = 0	R3 [v1] = 0	R3 [v1] = 0	R3 [v1] = 0
R4 [a0] = 1	R4 [a0] = 1	R4 [a0] = 1	R4 [a0] = 1
R5 [a1] = 2147481692	R5 [a1] = 2147481692	R5 [a1] = 2147481692	R5 [a1] = 2147481692
R6 [a2] = 2147481700	R6 [a2] = 2147481700	R6 [a2] = 2147481700	R6 [a2] = 2147481700
R7 [a3] = 0	R7 [a3] = 0	R7 [a3] = 0	R7 [a3] = 0
R8 [t0] = -35	R8 [t0] = -35	R8 [t0] = 276	R8 [t0] = 276
R9 [t1] = 17	R9 [t1] = -18	R9 [t1] = -18	R9 [t1] = 258
R10 [t2] = 0	R10 [t2] = 0	R10 [t2] = 0	R10 [t2] = 0
R11 [t3] = 0	R11 [t3] = 0	R11 [t3] = 0	R11 [t3] = 0
R12 [t4] = 0	R12 [t4] = 0	R12 [t4] = 0	R12 [t4] = 0
R13 [t5] = 0	R13 [t5] = 0	R13 [t5] = 0	R13 [t5] = 0
R14 [t6] = 0	R14 [t6] = 0	R14 [t6] = 0	R14 [t6] = 0
R15 [t7] = 0	R15 [t7] = 0	R15 [t7] = 0	R15 [t7] = 0
R16 [s0] = 0	R16 [s0] = 0	R16 [s0] = 0	R16 [s0] = 0
R17 [s1] = 0	R17 [s1] = 0	R17 [s1] = 0	R17 [s1] = 0
R18 [s2] = 0	R18 [s2] = 0	R18 [s2] = 0	R18 [s2] = 0
R19 [s3] = 0	R19 [s3] = 0	R19 [s3] = 0	R19 [s3] = 0
R20 [s4] = 0	R20 [s4] = 0	R20 [s4] = 0	R20 [s4] = 0
R21 [s5] = 0	R21 [s5] = 0	R21 [s5] = 0	R21 [s5] = 0

2. The first image shows QtSpim with my sum2.asm code loaded. All eight breakpoints are marked on this image, and screenshots of the register at each one are included below. The console output was 60.

QtSpim

File Simulator Registers Text Segment Data Segment Window Help

FP Regs Int Regs [10] Data Text

Int Regs [10]

PC = 0  
EPC = 0  
Cause = 0  
BadVAddr = 0  
Status = 80537166  
4  
HI = 0  
LO = 0  
R0 [r0] = 0  
R1 [at] = 0  
R2 [v0] = 0  
R3 [v1] = 0  
R4 [a0] = 0  
R5 [a1] = 0  
R6 [a2] = 0  
R7 [a3] = 0  
R8 [t0] = 0  
R9 [t1] = 0  
R10 [t2] = 0  
R11 [t3] = 0  
R12 [t4] = 0  
R13 [t5] = 0  
R14 [t6] = 0  
R15 [t7] = 0  
R16 [s0] = 0  
R17 [s1] = 0  
R18 [s2] = 0  
R19 [s3] = 0  
R20 [s4] = 0

User Text Segment [00400000]..[00440000]

```
[00400000] 8fa40000 lw $4, 0($29) ; 183: lw $a0 0($sp) # argc
[00400004] 27a50004 addiu $5, $29, 4 ; 184: addiu $a1 $sp 4 # argv
[00400008] 24a60004 addiu $6, $5, 4 ; 185: addiu $a2 $a1 4 # envp
[0040000c] 00041080 sll $2, $4, 2 ; 186: sll $v0 $a0 2
[00400010] 00c23021 addu $6, $6, $2 ; 187: addu $a2 $a2 $v0
[00400014] 0c100009 jal 0x00400024 [main] ; 188: jal main
[00400018] 00000000 nop ; 189: nop
[0040001c] 3402000a ori $2, $0, 10 ; 191: li $v0 10
[00400020] 0000000c syscall ; 192: syscall # syscall 10 (exit)
[00400024] 3c011001 lui $1, 4097 ; 18: lw $t0, num1 # temp = num1
[00400028] 8c280000 lw $8, 0($1) ; 19: add $t1, $0, $t0 # accum =
[0040002c] 00084820 add $9, $0, $8 temp
[00400030] 3c011001 lui $1, 4097 ; 20: lw $t0, num2 # temp = num2
[00400034] 8c280004 lw $8, 4($1) ; 21: add $t1, $t1, $t0 # accum =
[00400038] 01284820 add $9, $9, $8 accum + temp
[0040003c] 3c011001 lui $1, 4097 ; 22: lw $t0, num3 # temp = num3
[00400040] 8c280008 lw $8, 8($1) ; 23: add $t1, $t1, $t0 # accum =
[00400044] 01284820 add $9, $9, $8 accum + temp
[00400048] 3c011001 lui $1, 4097 ; 24: sw $t1, sum # sum = accum
[0040004c] ac29000c sw $9, 12($1) ; 25: addi $v0, $0, 1 # $v0 = code
[00400050] 20020001 addi $2, $0, 1 for 'print-int'
[00400054] 00092020 add $4, $0, $9 ; 26: add $a0, $0, $t1 # $a0 =
[00400058] 0000000c syscall ; 27: syscall # syscall($v0=1)
[0040005c] 03e00008 jr $31 ; 28: jr $ra # return control to
```

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PC = 4194308	PC = 4194348	PC = 4194352	PC = 4194360
EPC = 4194304	EPC = 4194344	EPC = 4194348	EPC = 4194356
Cause = 36	Cause = 36	Cause = 36	Cause = 36
BadVAddr = 0	BadVAddr = 0	BadVAddr = 0	BadVAddr = 0
Status = 805371664	Status = 805371664	Status = 805371664	Status = 805371664
HI = 0	HI = 0	HI = 0	HI = 0
LO = 0	LO = 0	LO = 0	LO = 0
R0 [r0] = 0	R0 [r0] = 0	R0 [r0] = 0	R0 [r0] = 0
R1 [at] = 0	R1 [at] = 268500992	R1 [at] = 268500992	R1 [at] = 268500992
R2 [v0] = 0	R2 [v0] = 4	R2 [v0] = 4	R2 [v0] = 4
R3 [v1] = 0	R3 [v1] = 0	R3 [v1] = 0	R3 [v1] = 0
R4 [a0] = 1	R4 [a0] = 1	R4 [a0] = 1	R4 [a0] = 1
R5 [a1] = 2147481692	R5 [a1] = 2147481692	R5 [a1] = 2147481692	R5 [a1] = 2147481692
R6 [a2] = 2147481700	R6 [a2] = 2147481700	R6 [a2] = 2147481700	R6 [a2] = 2147481700
R7 [a3] = 0	R7 [a3] = 0	R7 [a3] = 0	R7 [a3] = 0
R8 [t0] = 0	R8 [t0] = 10	R8 [t0] = 10	R8 [t0] = 20
R9 [t1] = 0	R9 [t1] = 0	R9 [t1] = 10	R9 [t1] = 10
R10 [t2] = 0	R10 [t2] = 0	R10 [t2] = 0	R10 [t2] = 0
R11 [t3] = 0	R11 [t3] = 0	R11 [t3] = 0	R11 [t3] = 0
R12 [t4] = 0	R12 [t4] = 0	R12 [t4] = 0	R12 [t4] = 0
R13 [t5] = 0	R13 [t5] = 0	R13 [t5] = 0	R13 [t5] = 0
R14 [t6] = 0	R14 [t6] = 0	R14 [t6] = 0	R14 [t6] = 0
R15 [t7] = 0	R15 [t7] = 0	R15 [t7] = 0	R15 [t7] = 0
R16 [s0] = 0	R16 [s0] = 0	R16 [s0] = 0	R16 [s0] = 0
R17 [s1] = 0	R17 [s1] = 0	R17 [s1] = 0	R17 [s1] = 0
R18 [s2] = 0	R18 [s2] = 0	R18 [s2] = 0	R18 [s2] = 0
R19 [s3] = 0	R19 [s3] = 0	R19 [s3] = 0	R19 [s3] = 0

PC = 4194364	PC = 4194372	PC = 4194376	PC = 4194388
EPC = 4194360	EPC = 4194368	EPC = 4194372	EPC = 4194388
Cause = 36	Cause = 36	Cause = 36	Cause = 36
BadVAddr = 0	BadVAddr = 0	BadVAddr = 0	BadVAddr = 0
Status = 805371664	Status = 805371664	Status = 805371664	Status = 805371664
HI = 0	HI = 0	HI = 0	HI = 0
LO = 0	LO = 0	LO = 0	LO = 0
R0 [r0] = 0	R0 [r0] = 0	R0 [r0] = 0	R0 [r0] = 0
R1 [at] = 268500992	R1 [at] = 268500992	R1 [at] = 268500992	R1 [at] = 268500992
R2 [v0] = 4	R2 [v0] = 4	R2 [v0] = 4	R2 [v0] = 10
R3 [v1] = 0	R3 [v1] = 0	R3 [v1] = 0	R3 [v1] = 0
R4 [a0] = 1	R4 [a0] = 1	R4 [a0] = 1	R4 [a0] = 60
R5 [a1] = 2147481692	R5 [a1] = 2147481692	R5 [a1] = 2147481692	R5 [a1] = 2147481692
R6 [a2] = 2147481700	R6 [a2] = 2147481700	R6 [a2] = 2147481700	R6 [a2] = 2147481700
R7 [a3] = 0	R7 [a3] = 0	R7 [a3] = 0	R7 [a3] = 0
R8 [t0] = 30	R8 [t0] = 30	R8 [t0] = 30	R8 [t0] = 30
R9 [t1] = 30	R9 [t1] = 30	R9 [t1] = 60	R9 [t1] = 60
R10 [t2] = 0	R10 [t2] = 0	R10 [t2] = 0	R10 [t2] = 0
R11 [t3] = 0	R11 [t3] = 0	R11 [t3] = 0	R11 [t3] = 0
R12 [t4] = 0	R12 [t4] = 0	R12 [t4] = 0	R12 [t4] = 0
R13 [t5] = 0	R13 [t5] = 0	R13 [t5] = 0	R13 [t5] = 0
R14 [t6] = 0	R14 [t6] = 0	R14 [t6] = 0	R14 [t6] = 0
R15 [t7] = 0	R15 [t7] = 0	R15 [t7] = 0	R15 [t7] = 0
R16 [s0] = 0	R16 [s0] = 0	R16 [s0] = 0	R16 [s0] = 0
R17 [s1] = 0	R17 [s1] = 0	R17 [s1] = 0	R17 [s1] = 0
R18 [s2] = 0	R18 [s2] = 0	R18 [s2] = 0	R18 [s2] = 0
R19 [s3] = 0	R19 [s3] = 0	R19 [s3] = 0	R19 [s3] = 0

- shows the contents of data memory after execution. The elements of the array are underlined in blue, the elements that were swapped in the second image have been outlined in red.

