Zach Dubinsky

CSC-270

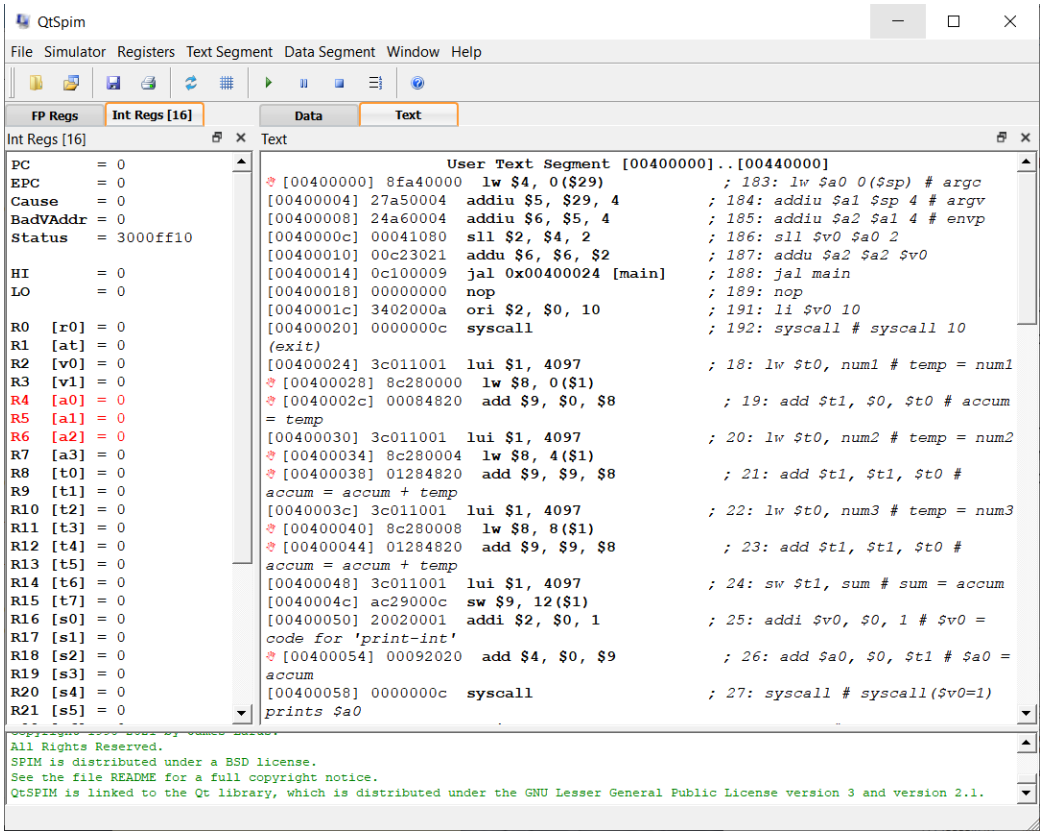
Prof.Rieffel

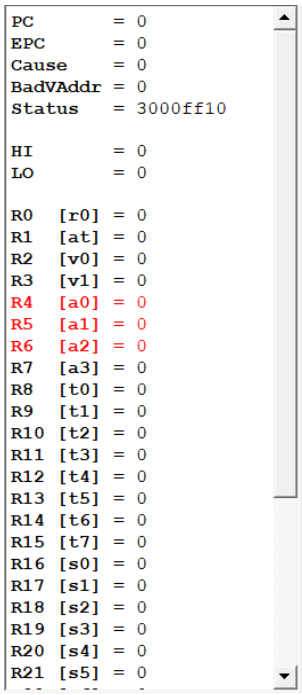
2/7/22

Lab 5

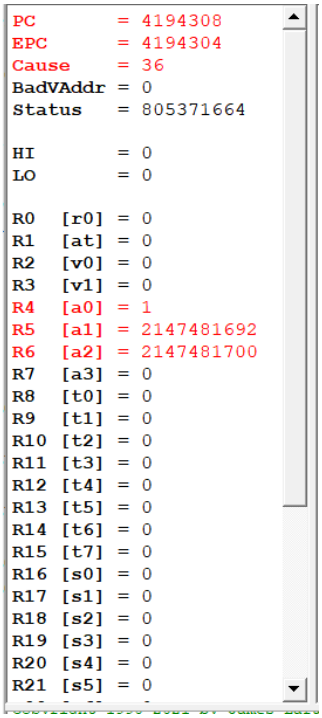
I affirm that all included work is my own in accordance with the class syllabus and the Union College Honor Code. [Signed: Zachary Dubinsky, 2/7/22]

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.

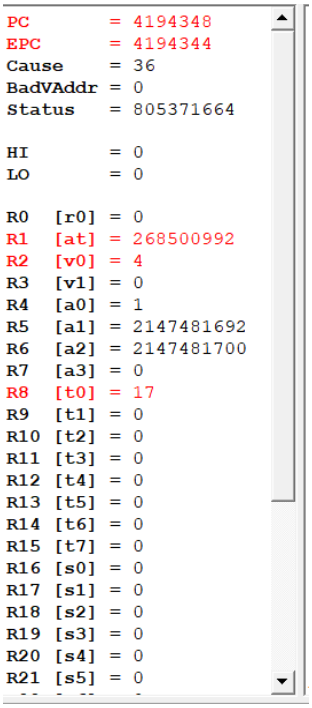




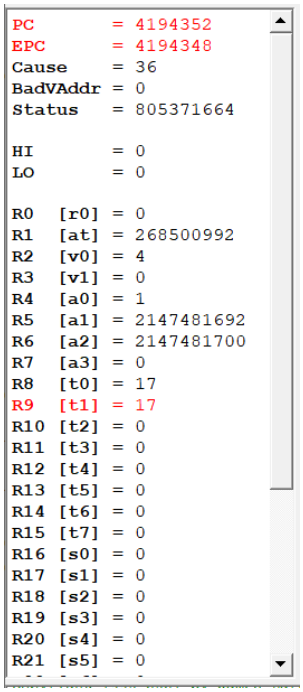
```
PC        = 0
EPC       = 0
Cause     = 0
BadVAddr  = 0
Status    = 3000ff10

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
```



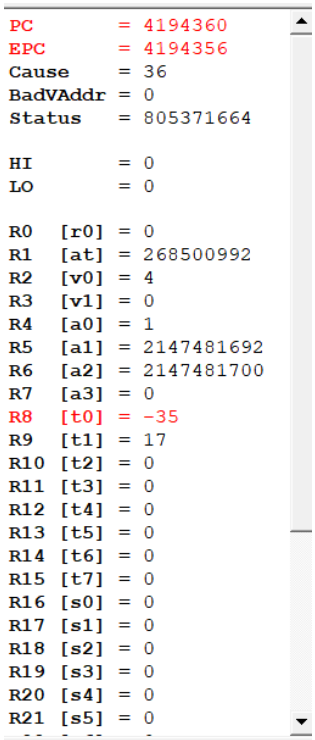
```
PC        = 4194308
EPC       = 4194304
Cause     = 36
BadVAddr  = 0
Status    = 805371664

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 0
R2   [v0] = 0
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 2147481692
R6   [a2] = 2147481700
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
```



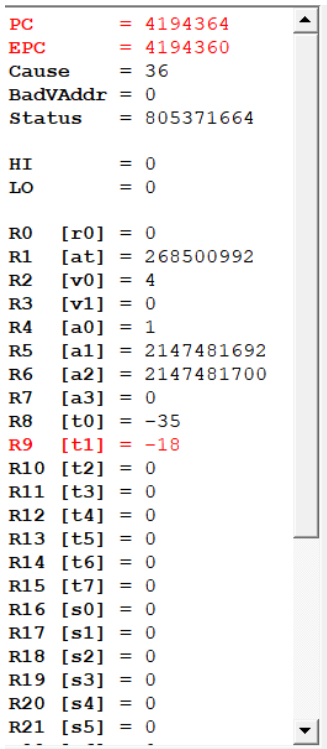
```
PC        = 4194348
EPC       = 4194344
Cause     = 36
BadVAddr  = 0
Status    = 805371664

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 268500992
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 2147481692
R6   [a2] = 2147481700
R7   [a3] = 0
R8   [t0] = 17
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
```



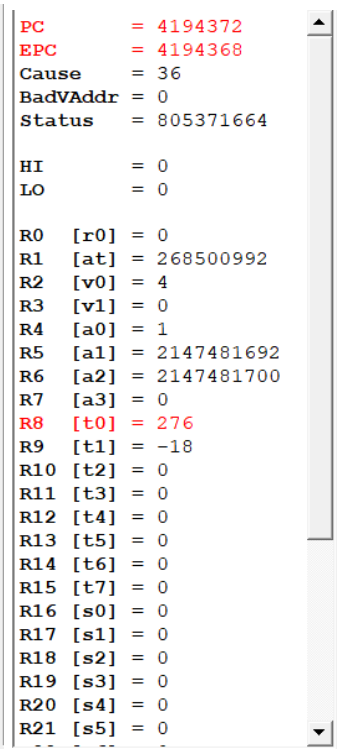
```
PC        = 4194352
EPC       = 4194348
Cause     = 36
BadVAddr  = 0
Status    = 805371664

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 268500992
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 2147481692
R6   [a2] = 2147481700
R7   [a3] = 0
R8   [t0] = 17
R9   [t1] = 17
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
```



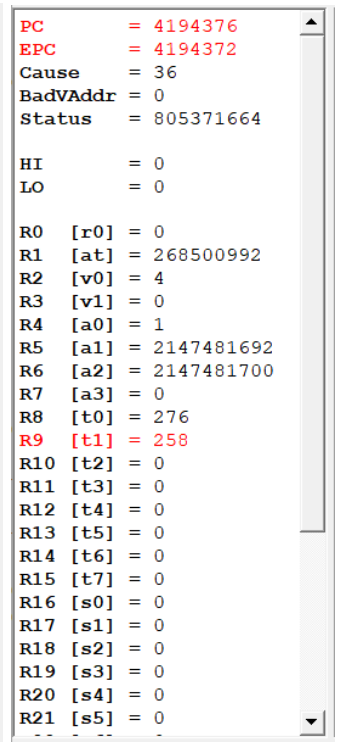
```
PC        = 4194360
EPC       = 4194356
Cause     = 36
BadVAddr  = 0
Status    = 805371664

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 268500992
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 2147481692
R6   [a2] = 2147481700
R7   [a3] = 0
R8   [t0] = -35
R9   [t1] = 17
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
```



```
PC        = 4194364
EPC       = 4194360
Cause     = 36
BadVAddr  = 0
Status    = 805371664

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 268500992
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 2147481692
R6   [a2] = 2147481700
R7   [a3] = 0
R8   [t0] = -35
R9   [t1] = -18
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
```

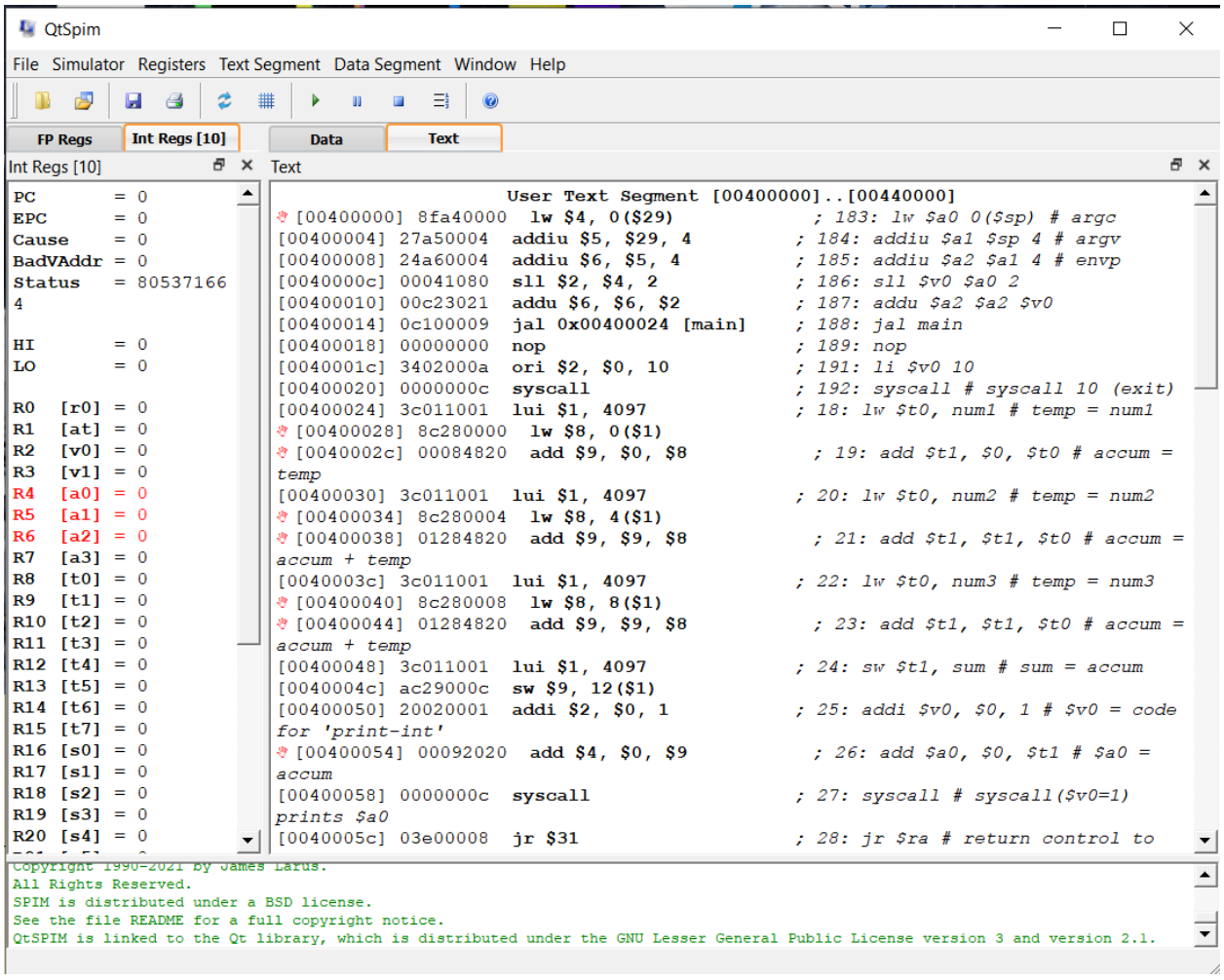


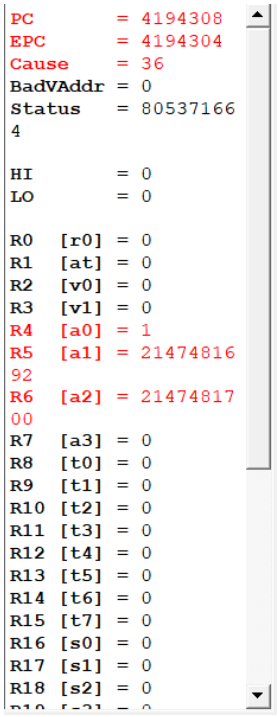
```
PC        = 4194372
EPC       = 4194368
Cause     = 36
BadVAddr  = 0
Status    = 805371664

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 268500992
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 2147481692
R6   [a2] = 2147481700
R7   [a3] = 0
R8   [t0] = 276
R9   [t1] = -18
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
```



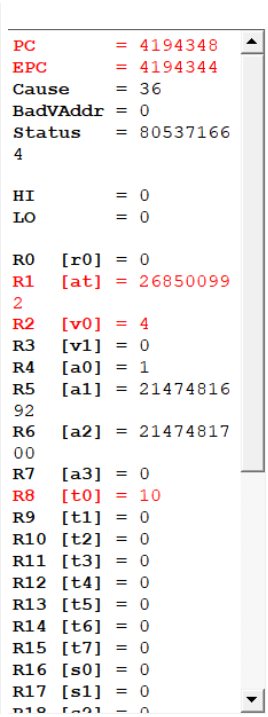
```
PC        = 4194376
EPC       = 4194372
Cause     = 36
BadVAddr  = 0
Status    = 805371664

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 268500992
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 2147481692
R6   [a2] = 2147481700
R7   [a3] = 0
R8   [t0] = 276
R9   [t1] = 258
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
```

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.

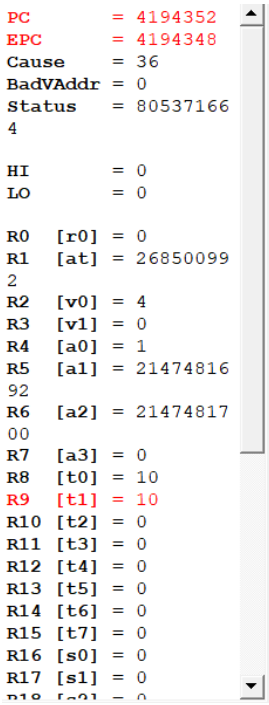




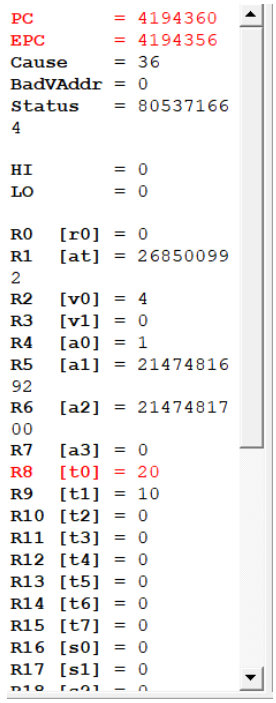
```
PC        = 4194308
EPC       = 4194304
Cause     = 36
BadVAddr  = 0
Status    = 80537166
4

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 0
R2   [v0] = 0
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 21474816
92
R6   [a2] = 21474817
00
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
```



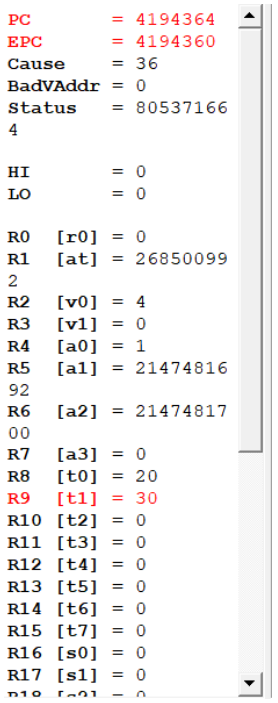
```
PC        = 4194348
EPC       = 4194344
Cause     = 36
BadVAddr  = 0
Status    = 80537166
4

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 26850099
2
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 21474816
92
R6   [a2] = 21474817
00
R7   [a3] = 0
R8   [t0] = 10
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
```



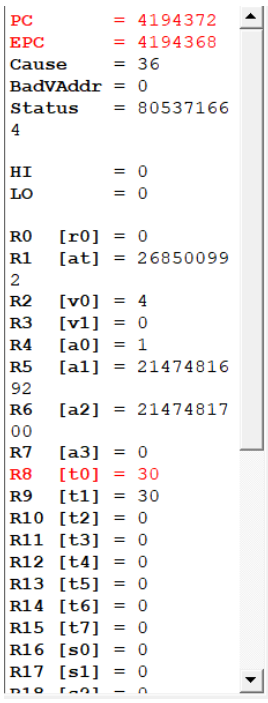
```
PC        = 4194352
EPC       = 4194348
Cause     = 36
BadVAddr  = 0
Status    = 80537166
4

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 26850099
2
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 21474816
92
R6   [a2] = 21474817
00
R7   [a3] = 0
R8   [t0] = 10
R9   [t1] = 10
R10  [t2] = 0
R11  [t3] = 0
R12  [t4] = 0
R13  [t5] = 0
R14  [t6] = 0
R15  [t7] = 0
R16  [s0] = 0
R17  [s1] = 0
```



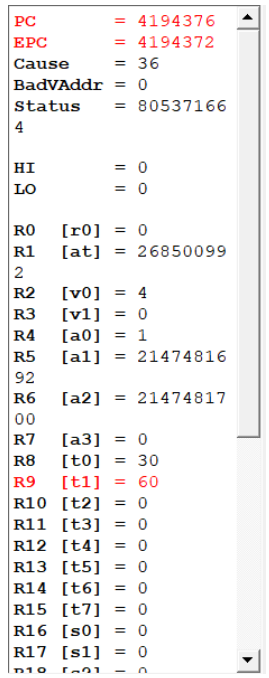
```
PC        = 4194360
EPC       = 4194356
Cause     = 36
BadVAddr  = 0
Status    = 80537166
4

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 26850099
2
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 21474816
92
R6   [a2] = 21474817
00
R7   [a3] = 0
R8   [t0] = 20
R9   [t1] = 10
R10  [t2] = 0
R11  [t3] = 0
R12  [t4] = 0
R13  [t5] = 0
R14  [t6] = 0
R15  [t7] = 0
R16  [s0] = 0
R17  [s1] = 0
```



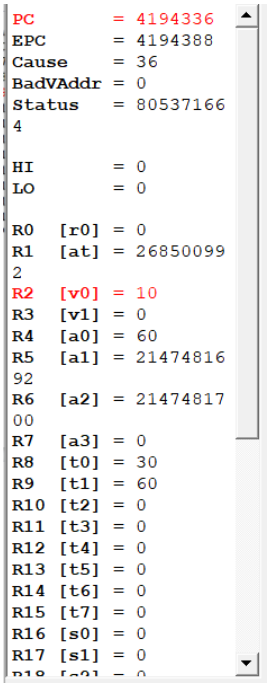
```
PC        = 4194364
EPC       = 4194360
Cause     = 36
BadVAddr  = 0
Status    = 80537166
4

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 26850099
2
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 21474816
92
R6   [a2] = 21474817
00
R7   [a3] = 0
R8   [t0] = 20
R9   [t1] = 30
R10  [t2] = 0
R11  [t3] = 0
R12  [t4] = 0
R13  [t5] = 0
R14  [t6] = 0
R15  [t7] = 0
R16  [s0] = 0
R17  [s1] = 0
```



```
PC        = 4194372
EPC       = 4194368
Cause     = 36
BadVAddr  = 0
Status    = 80537166
4

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 26850099
2
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 21474816
92
R6   [a2] = 21474817
00
R7   [a3] = 0
R8   [t0] = 30
R9   [t1] = 30
R10  [t2] = 0
R11  [t3] = 0
R12  [t4] = 0
R13  [t5] = 0
R14  [t6] = 0
R15  [t7] = 0
R16  [s0] = 0
R17  [s1] = 0
```



```
PC        = 4194376
EPC       = 4194372
Cause     = 36
BadVAddr  = 0
Status    = 80537166
4

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 26850099
2
R2   [v0] = 4
R3   [v1] = 0
R4   [a0] = 1
R5   [a1] = 21474816
92
R6   [a2] = 21474817
00
R7   [a3] = 0
R8   [t0] = 30
R9   [t1] = 60
R10  [t2] = 0
R11  [t3] = 0
R12  [t4] = 0
R13  [t5] = 0
R14  [t6] = 0
R15  [t7] = 0
R16  [s0] = 0
R17  [s1] = 0
```



```
PC        = 4194336
EPC       = 4194388
Cause     = 36
BadVAddr  = 0
Status    = 80537166
4

HI        = 0
LO        = 0

R0   [r0] = 0
R1   [at] = 26850099
2
R2   [v0] = 10
R3   [v1] = 0
R4   [a0] = 60
R5   [a1] = 21474816
92
R6   [a2] = 21474817
00
R7   [a3] = 0
R8   [t0] = 30
R9   [t1] = 60
R10  [t2] = 0
R11  [t3] = 0
R12  [t4] = 0
R13  [t5] = 0
R14  [t6] = 0
R15  [t7] = 0
R16  [s0] = 0
R17  [s1] = 0
```

3. The first screenshot shows the contents of data memory before execution. The second 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.