Department Of Computer Engineering

Project1

Computer Organization

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Programming Language : MIPS

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Q.1 ARRAYS USING FOR LOOP

1.INTRODUCTİON / AIM

In this experiment, , we will learn how to write and simulate MIPS code.

2.PROBLEM

We have 2 arrays which are A[n] and B[n]. İf A[i] > B[i] we must swap the elements of each array.

3.SUMMARY OF CODE(Labels)

3.1 main:

```
main:
        addi $sp, $sp, -4 #open stack
        addi $t3, $0, 0   #define i for foorloop
        la $t1, A
        la $t2, B
        addi $t0, $0, 4   #constant for byteset(use for adding 4 byte on array address
        addi $a1, $t1, 0  #argüment of Adrees A
        addi $a2, $t2, 0  #argümen of Adress B
        addi $t5, $0, 5   #constant for forloop
        j foorloop
```

On main label firstly I open the stack frame and I define $t3 variable for forloop. I get addresses of A[0] and B[0] with variables which are $t1, $t2. I define $a1, $a2 for using in function which equals $t1, $t2. I define $t5 for using like a constant=5 for forloop. On main label I define this variables and jump to foorloop label.

3.2 forloop:

```
foorloop:
        slt $t4, $t3, $t5  #check foorloop
        beq $t4, 1, compare #if i<5 it goes compare
        j finish
```

On foorlop label it compares $t3 (i) and $t5(constant) if $t3 less than $t5 it define $t4=1 otherwise 0. On second line if $t4 equals 1 it jump to compare label otherwise goes to finish label. Arrays lengths are 5 so I used static code below.

3.3 Compare:

```
compare:
        addi $t3, $t3, 1   #i=i+1
        lw $s1, 0($a1)     #get s1=A[i]
        lw $s2, 0($a2)     #get s2= B[i]
        slt $s0, $s1, $s2  #check A[i]<B[i]
        beq $s0, 0, swap   #if A[i]< B[i]  go swap
        add $a1, $a1, $t0  #get adrees A[i]+4
        add $a2, $a2, $t0  #get addres B[i]+4
        j foorloop
```

On compare label I increase i then define variables $s1, $s2 for values of A[i], B[i]. On 4. line I checked A[i] is less than B[i]. If A[i] < B[i] define $s0 =1 . Then checking if $s0 equals 0 It goings to swap label otherwise it won't be swap the elements of each array and it increase the addresses of each arrays 4 byte and jump to foorloop.

3.4 Swap:

```
swap:
        sw $s1, 0($sp)     #stack[0]= A[i]
        sw $s2, 0($a1)     #A[i]= B[i]
        lw $s1, 0($sp)     #A[i]= stack[0]
        sw $s1, 0($a2)     #B[i]=A[i]
        add $a1, $a1, $t0  #get adrees A[i]+4
        add $a2, $a2, $t0  #get adess B[i]+4
        j foorloop
```

I store the value of A[i] on stack frame. Than Update A[i] value equals B[i]. Then I get value of A[i] on stack. After that update B[i] value equals A[i]. And increase adresses of each array 4 byte.

3.5 Finish:

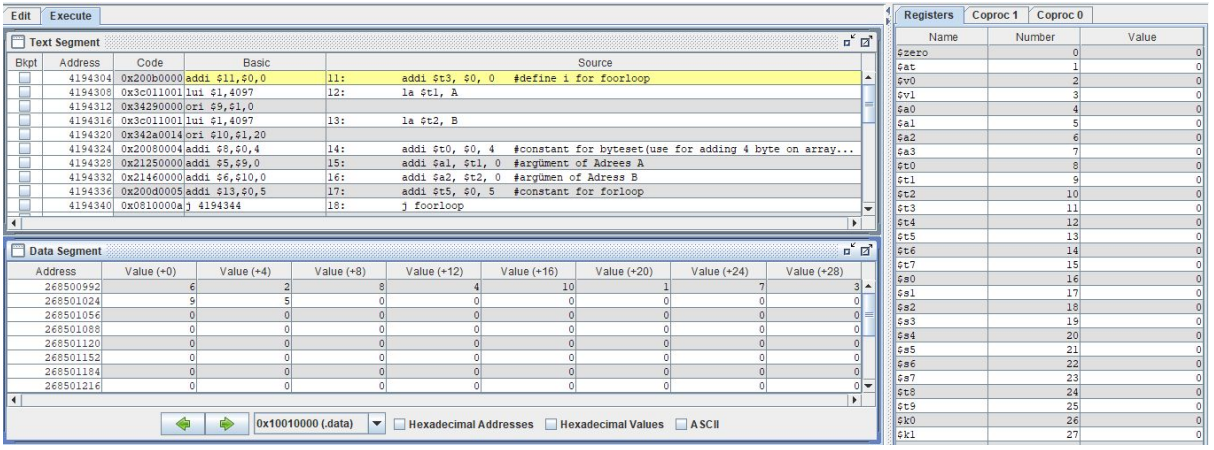
I closed stack frame and the code below was executed and program was finished.

4.TEST CASES

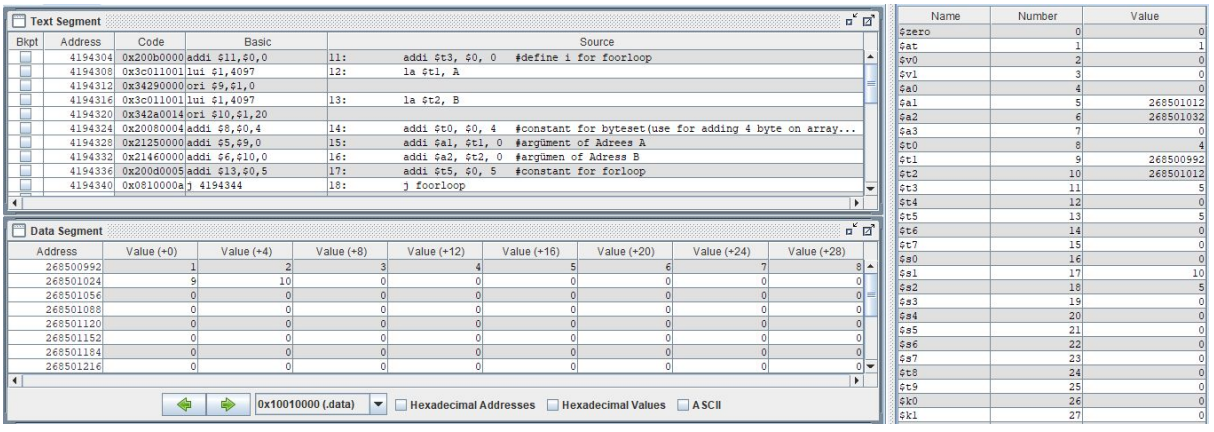
4.1 Test Case:

A={6,2,8,4,10}, B={1,7,3,9,5}

Before Executed



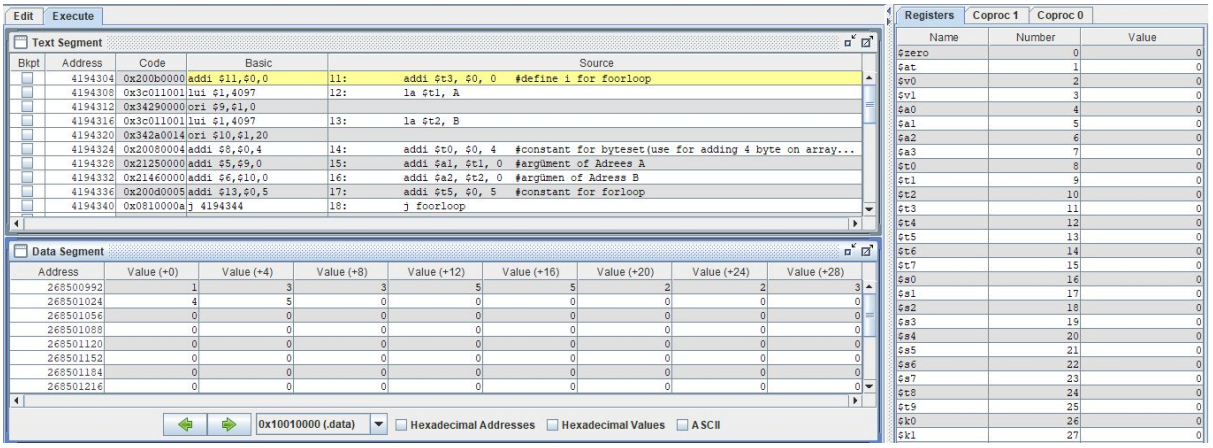
After Executed



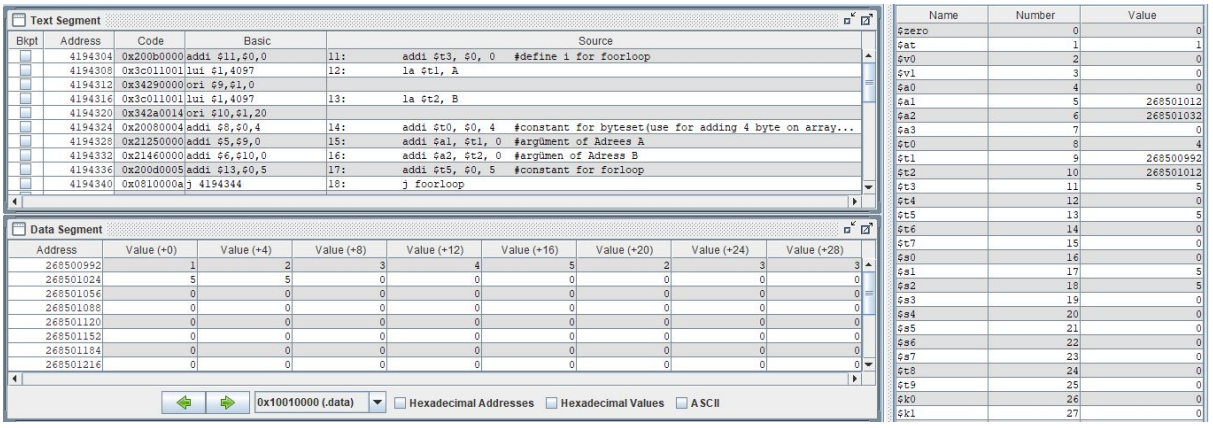
4.2 Test Case:

A={1,3,3,5,5}, B={2,2,3,4,5}

Before Executed



After Executed



Q.2 FUNCTİON CALLS

1.INTRODUCTİON / AIM

In this experiment, , we will learn how to write and simulate MIPS code.

2.PROBLEM

Compare two integer and return values with functions. In code, we are not allowed to use multiplication instructions .

3.SUMMARY OF CODE(Labels)

3.1 Main:

```
main:   addi $s0, $0, 3          #a=3
        addi $s1, $0, 3          #b=5
        addi $s2, $0, 0          #result=0
        addi $a0, $s0, 0         #argümentA=a
        addi $a1, $s1, 0         #argümentB=b
        bne $s0, $s1, compare    #if a!=b go compare
        add $s2, $s0,$s1         #else result=a+b
        addi $v0, $s2, 0         #returnValue=result
```

On this label I defined integers which are $s0,$s1 equals to a and b. Then defined $s2 equals result. I defined argüments for using on functions which are $a0,$a1 equals to a and b. Then if a is not equal to b it goes to compare label. Otherwise adding $s0 and $s1 and define $s2. Then return the value of $s2 for $v0.

3.2 Compare:

```
compare: slt $t1, $a0, $a1       #if a<b go punish else go award
        beq $t1, 1, punish
        beq $t1, 0, award
```

On this label if $a0 less than $a1 it defines $t1 1 otherwise it defines $t1 0. İf $t1 equals 1 it goes to punish label, if $t1 equals 0 it goes to award label.

3.3 Award:

```
award:  add $t0, $a0, $a1        #t0=a+b
        sll $t0, $t0, 1          #t0=t0*2
        addi $v0, $t0, 0         #returnValue=t0
        j finish
```

On this label it's add $a0 and $a1 and define $t0 the result of adding. Then I used shift left logical for multiply the $t0 with 2. Then define the result value $v0 equals to $t0. Then jump the finish label.

3.4 Punish:

```
punish: sub $t0, $a0, $a1        #t0=a-b
        sll $t0, $t0, 1          #t0=t0*2
        addi $v0, $t0, 0         #returnValue=t0
        j finish
```

On this label it's subtract $a0 and $a1 and define $t0 the result of subtraction. Then I used shift left logical for multiply the $t0 with 2. Then define the result value $v0 equals to $t0. Then jump the finish label.

3.5 Finish:

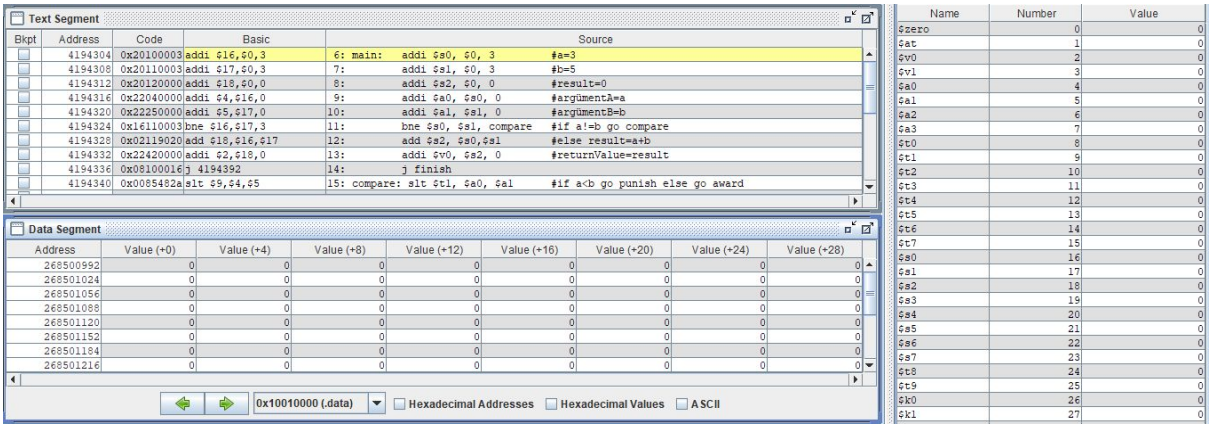
The code below was executed and program was finished.

4.TEST CASES

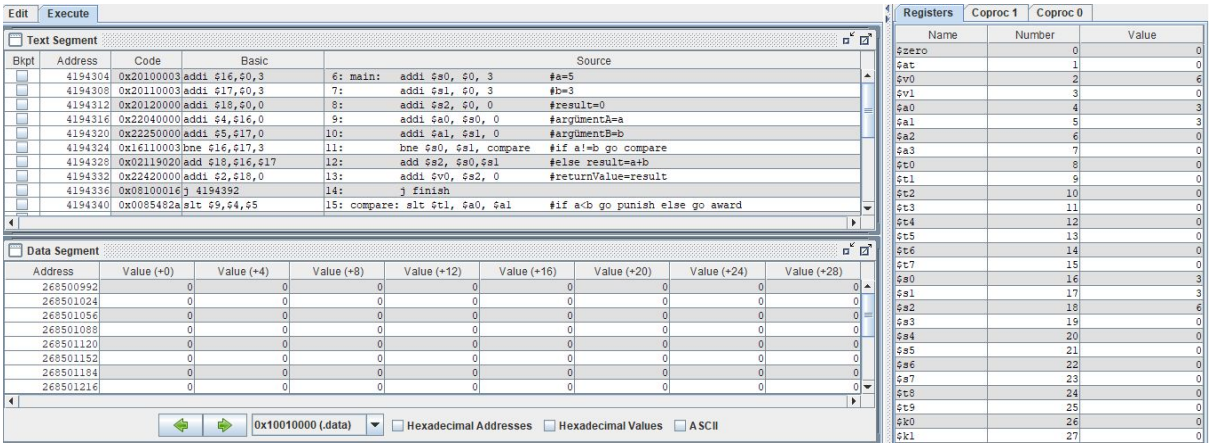
4.1 Test Case:

a=3, b=3

Before Executed



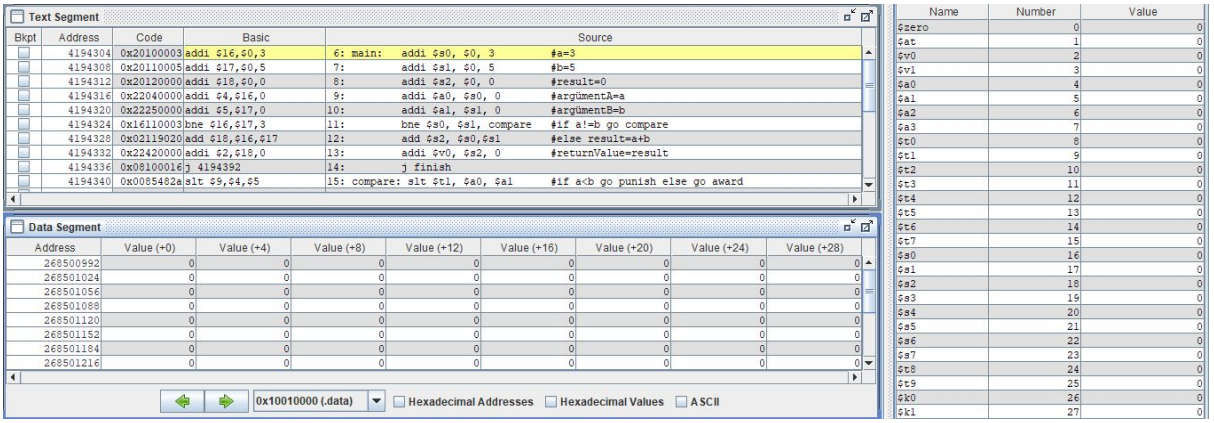
After Executed



4.2 Test Case:

a=3, b=5

Before Executed



Text Segment

Bkpt	Address	Code	Basic	Source
	4194304	0x20100003	addi $16,$0,3	6: main: addi $s0, $0, 3 #a=3
	4194308	0x20110005	addi $17,$0,5	7: addi $s1, $0, 5 #b=5
	4194312	0x20120000	addi $18,$0,0	8: addi $s2, $0, 0 #result=0
	4194316	0x22040000	addi $4,$16,0	9: addi $a0, $s0, 0 #argümentA=a
	4194320	0x22250000	addi $5,$17,0	10: addi $a1, $s1, 0 #argümentB=b
	4194324	0x16110003	bne $16,$17,3	11: bne $s0, $s1, compare #if a!=b go compare
	4194328	0x02119020	add $18,$16,$17	12: add $s2, $s0,$s1 #else result=a+b
	4194332	0x22420000	addi $2,$18,0	13: addi $v0, $s2, 0 #returnValue=result
	4194336	0x08100016	j 4194392	14: j finish
	4194340	0x0085482a	slt $9,$4,$5	15: compare: slt $t1, $a0, $a1 #if a<b go punish else go award

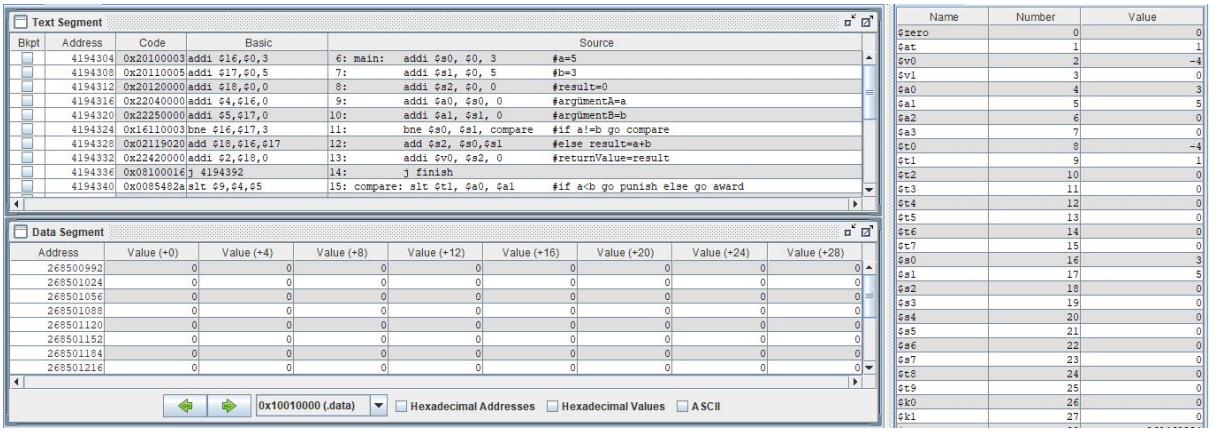
Data Segment

Address	Value (+0)	Value (+4)	Value (+8)	Value (+12)	Value (+16)	Value (+20)	Value (+24)	Value (+28)
268500992	0	0	0	0	0	0	0	0
268501024	0	0	0	0	0	0	0	0
268501056	0	0	0	0	0	0	0	0
268501088	0	0	0	0	0	0	0	0
268501120	0	0	0	0	0	0	0	0
268501152	0	0	0	0	0	0	0	0
268501184	0	0	0	0	0	0	0	0
268501216	0	0	0	0	0	0	0	0

0x10010000 (.data) Hexadecimal Addresses Hexadecimal Values ASCII

Name	Number	Value
$zero	0	0
$at	1	0
$v0	2	0
$v1	3	0
$a0	4	0
$a1	5	0
$a2	6	0
$a3	7	0
$t0	8	0
$t1	9	0
$t2	10	0
$t3	11	0
$t4	12	0
$t5	13	0
$t6	14	0
$t7	15	0
$s0	16	0
$s1	17	0
$s2	18	0
$s3	19	0
$s4	20	0
$s5	21	0
$s6	22	0
$s7	23	0
$t8	24	0
$t9	25	0
$k0	26	0
$k1	27	0

After Executed



Text Segment

Bkpt	Address	Code	Basic	Source
	4194304	0x20100003	addi $16,$0,3	6: main: addi $s0, $0, 3 #a=5
	4194308	0x20110005	addi $17,$0,5	7: addi $s1, $0, 5 #b=3
	4194312	0x20120000	addi $18,$0,0	8: addi $s2, $0, 0 #result=0
	4194316	0x22040000	addi $4,$16,0	9: addi $a0, $s0, 0 #argümentA=a
	4194320	0x22250000	addi $5,$17,0	10: addi $a1, $s1, 0 #argümentB=b
	4194324	0x16110003	bne $16,$17,3	11: bne $s0, $s1, compare #if a!=b go compare
	4194328	0x02119020	add $18,$16,$17	12: add $s2, $s0,$s1 #else result=a+b
	4194332	0x22420000	addi $2,$18,0	13: addi $v0, $s2, 0 #returnValue=result
	4194336	0x08100016	j 4194392	14: j finish
	4194340	0x0085482a	slt $9,$4,$5	15: compare: slt $t1, $a0, $a1 #if a<b go punish else go award

Data Segment

Address	Value (+0)	Value (+4)	Value (+8)	Value (+12)	Value (+16)	Value (+20)	Value (+24)	Value (+28)
268500992	0	0	0	0	0	0	0	0
268501024	0	0	0	0	0	0	0	0
268501056	0	0	0	0	0	0	0	0
268501088	0	0	0	0	0	0	0	0
268501120	0	0	0	0	0	0	0	0
268501152	0	0	0	0	0	0	0	0
268501184	0	0	0	0	0	0	0	0
268501216	0	0	0	0	0	0	0	0

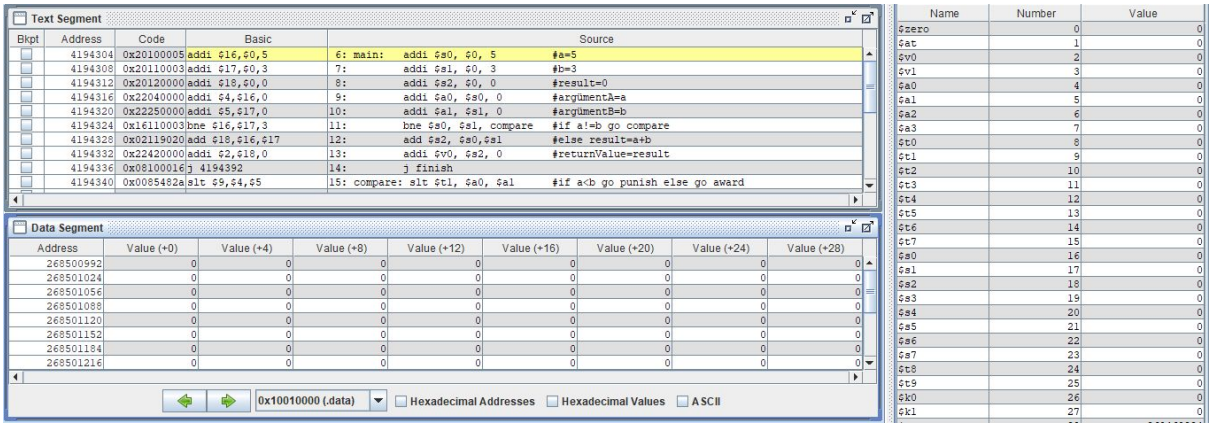
0x10010000 (.data) Hexadecimal Addresses Hexadecimal Values ASCII

Name	Number	Value
$zero	0	0
$at	1	1
$v0	2	-4
$v1	3	0
$a0	4	3
$a1	5	5
$a2	6	0
$a3	7	0
$t0	8	-4
$t1	9	1
$t2	10	0
$t3	11	0
$t4	12	0
$t5	13	0
$t6	14	0
$t7	15	0
$s0	16	3
$s1	17	5
$s2	18	0
$s3	19	0
$s4	20	0
$s5	21	0
$s6	22	0
$s7	23	0
$t8	24	0
$t9	25	0
$k0	26	0
$k1	27	0

4.3 Test Case:

a=5, b=3

Before Executed



Text Segment

Bkpt	Address	Code	Basic	Source
	4194304	0x20100005	addi $16,$0,5	6: main: addi $s0, $0, 5 #a=5
	4194308	0x20110003	addi $17,$0,3	7: addi $s1, $0, 3 #b=3
	4194312	0x20120000	addi $18,$0,0	8: addi $s2, $0, 0 #result=0
	4194316	0x22040000	addi $4,$16,0	9: addi $a0, $s0, 0 #argümentA=a
	4194320	0x22250000	addi $5,$17,0	10: addi $a1, $s1, 0 #argümentB=b
	4194324	0x16110003	bne $16,$17,3	11: bne $s0, $s1, compare #if a!=b go compare
	4194328	0x02119020	add $18,$16,$17	12: add $s2, $s0,$s1 #else result=a+b
	4194332	0x22420000	addi $2,$18,0	13: addi $v0, $s2, 0 #returnValue=result
	4194336	0x08100016	j 4194392	14: j finish
	4194340	0x0085482a	slt $9,$4,$5	15: compare: slt $t1, $a0, $a1 #if a<b go punish else go award

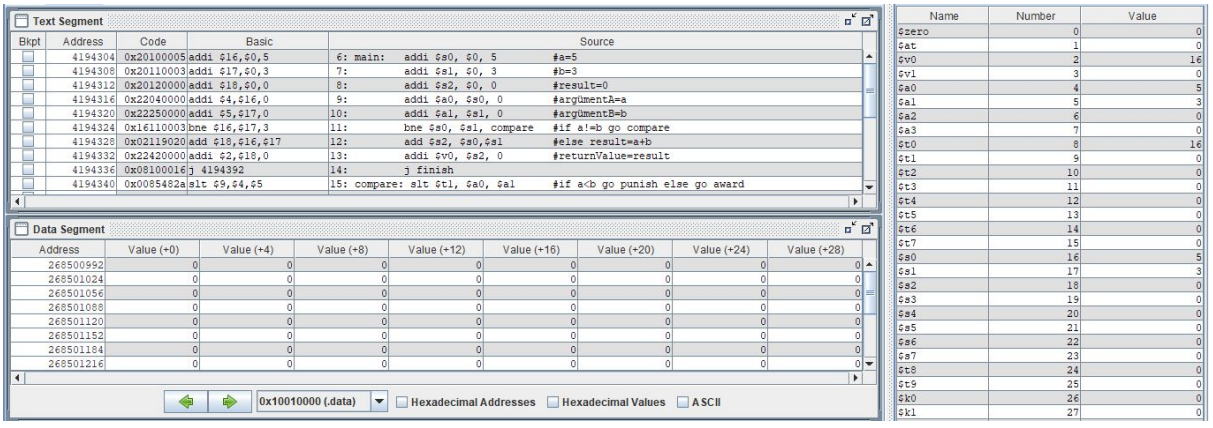
Data Segment

Address	Value (+0)	Value (+4)	Value (+8)	Value (+12)	Value (+16)	Value (+20)	Value (+24)	Value (+28)
268500992	0	0	0	0	0	0	0	0
268501024	0	0	0	0	0	0	0	0
268501056	0	0	0	0	0	0	0	0
268501088	0	0	0	0	0	0	0	0
268501120	0	0	0	0	0	0	0	0
268501152	0	0	0	0	0	0	0	0
268501184	0	0	0	0	0	0	0	0
268501216	0	0	0	0	0	0	0	0

0x10010000 (.data) Hexadecimal Addresses Hexadecimal Values ASCII

Name	Number	Value
$zero	0	0
$at	1	0
$v0	2	0
$v1	3	0
$a0	4	0
$a1	5	0
$a2	6	0
$a3	7	0
$t0	8	0
$t1	9	0
$t2	10	0
$t3	11	0
$t4	12	0
$t5	13	0
$t6	14	0
$t7	15	0
$s0	16	0
$s1	17	0
$s2	18	0
$s3	19	0
$s4	20	0
$s5	21	0
$s6	22	0
$s7	23	0
$t8	24	0
$t9	25	0
$k0	26	0
$k1	27	0

After Executed



Text Segment

Bkpt	Address	Code	Basic	Source
	4194304	0x20100005	addi $16,$0,5	6: main: addi $s0, $0, 5 #a=5
	4194308	0x20110003	addi $17,$0,3	7: addi $s1, $0, 3 #b=3
	4194312	0x20120000	addi $18,$0,0	8: addi $s2, $0, 0 #result=0
	4194316	0x22040000	addi $4,$16,0	9: addi $a0, $s0, 0 #argUmentA=a
	4194320	0x22250000	addi $5,$17,0	10: addi $a1, $s1, 0 #argUmentB=b
	4194324	0x16110003	bne $16,$17,3	11: bne $s0, $s1, compare #if a!=b go compare
	4194328	0x02119020	add $18,$16,$17	12: add $s2, $s0,$s1 #else result=a+b
	4194332	0x22420000	addi $2,$18,0	13: addi $v0, $s2, 0 #returnValue=result
	4194336	0x08100016	j 4194392	14: j finish
	4194340	0x0085482a	slt $9,$4,$5	15: compare: slt $t1, $a0, $a1 #if a<b go punish else go award

Data Segment

Address	Value (+0)	Value (+4)	Value (+8)	Value (+12)	Value (+16)	Value (+20)	Value (+24)	Value (+28)
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268501024	0	0	0	0	0	0	0	0
268501056	0	0	0	0	0	0	0	0
268501088	0	0	0	0	0	0	0	0
268501120	0	0	0	0	0	0	0	0
268501152	0	0	0	0	0	0	0	0
268501184	0	0	0	0	0	0	0	0
268501216	0	0	0	0	0	0	0	0

0x10010000 (.data) Hexadecimal Addresses Hexadecimal Values ASCII

Name	Number	Value
$zero	0	0
$at	1	0
$v0	2	16
$v1	3	0
$a0	4	5
$a1	5	3
$a2	6	0
$a3	7	0
$t0	8	16
$t1	9	0
$t2	10	0
$t3	11	0
$t4	12	0
$t5	13	0
$t6	14	0
$t7	15	0
$s0	16	5
$s1	17	3
$s2	18	0
$s3	19	0
$s4	20	0
$s5	21	0
$s6	22	0
$s7	23	0
$t8	24	0
$t9	25	0
$k0	26	0
$k1	27	0