03 Condition Codes, Jumps, Function Calls

Register Numbers assigned

Registers	r0	r1	r2	r3	r4	r5	r6	r7
Reg_Num	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7

Registers	r8	r9	r10	r11	r12	r13	r14	r15
Reg_Num	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF

Instruction Opcodes

Operation	**Load**	**Store**	**Add**	**Sub**	**Mult**	**Division**	**Modulo**	**Load Imm**
Instruction	lw	sw	add	sub	mul	div	mod	lw
Opcode	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07

Operation	**Move**	**Load EA**	**Push**	**Pop**	**Set Less Than**	**Jump**	**Jump Reg**	**Branch If Eq**
Instruction	mov	lea	push	pop	slt	jmp	jr	beq
Opcode	0x08	0x09	0x0A	0x0B	0x0C	0x0D	0x0E	0x0F

Operation	**Branch If N.Eq**	**Invalid**
Instruction	bne	x
Opcode	0x10	0xFF

Instruction Format

1. **lea reg1,regb,regi, S,D**
   e.g. lea r5, r4,r1,1,4

   "lea" is Load Effective Address which will load the memory address in the destination register where

   Reg1: Destination Register
   Regb: Base register
   Regi: Index Register

S: Scaling Factor
D: Offset to be added

Reg1= [Regb+Regi*S+D]

2. **beq reg1,reg2,label**
   e.g. beq r1,r2,lb0

   The "beq" is Branch Equal Instruction which compares the 2 register values and if they are equal then jumps to label given. The beq instruction finds the difference between reg1 and reg2 to find equality. If difference is zero then the values are equal otherwise not equal

   - Reg1: Register1
   - Reg2: Register2
   - Label: label to jump to

3. **bne reg1,reg2,label**
   e.g. bne r1,r2,lb0

   The "bne" is Branch Not Equal Instruction which compares the 2 register values and if they are not equal then jumps to label given. The bne instruction finds the difference between reg1 and reg2 to find non-equality. If difference is zero then the values are equal otherwise not equal.

   - Reg1: Register1
   - Reg2: Register2
   - Label: label to jump to

4. **slt reg1,reg2,reg3**
   e.g. slt r1,r2,r3

   The "slt" instruction is known as Set Less Than. The instruction will compare 2 register values and if second register value is less than third register value then it will store 1 in the destination register otherwise 0 is set in the destination register.
   - Reg1: Destination Register which is set to 0 or 1
   - Reg2: First Register to be compared
   - Reg3: Second Register to be compared

5. **jmp label**
   e.g. jmp lb0

   "jmp" Instruction jumps to the assigned label name. Prior to jumping it checks at which point the label resides. The labels are given the instruction pointer value during which time it appears in the code such as
   lb0: add r1,r2
   - Label: label address to which the jump should be forwarded.

6. **jr reg1**

e.g. jr r13

"jr" Instruction jumps to the assigned register memory address. Prior to jumping it checks at which point the register resides.

- Reg1: Register address to jump to

7. **push reg1**
   e.g. push r11

   Push instruction pushes the register value at that point of time into the stack.
   - Reg1: Register number to push into the stack.
8. **pop reg1**
   e.g. pop r12

   Pop instruction pops the latest value in stack to the register address.
   - Reg1: Register number where stack value is popped.

Flags

A 16-bit flag register has lower 4 bits defined as follows:

- 0^{th} bit as Zero flag: Is set whenever the result of any ALU operation is zero.
- 1^{st} bit as Sign Flag: A sign flag is set whenever the result is negative.
- 2^{nd} bit as Overflow flag: A overflow is set whenever the result goes out of range or the answer is negative as we are dealing with unsigned numbers.
- 3^{rd} bit as Carry flag: A carry flag is set whenever the addition is out of range

Examples:

```
Memory loaded with initial values.
Registers loaded with initial values.

Press Enter Key to Continue...


Enter an instruction number 1. Input 2. Display 3. Exit
1

Load or Store Instruction can be of the format-lw/sw/lea reg,reg,reg,S,D

Load Immediate can be of the format- lw reg,$immediate

Arithmetic/Move Instruction can be of the format- add/sub/mul/div/mod/mov reg,reg

Jump Instruction can be of the format- jmp lbl_name

Jump Register Instruction can be of the format- jr reg

Stack Operation's Instruction can be of the format- push/pop reg
Set Less than Operation Instruction can be of the format- slt reg,reg,reg
Branch Operation's Instruction can be of the format- beq/bne reg,reg,lbl_name
Please find the acceptable range values:
        Reg: r0-r15
        S:1,2,4,8
        D:0,1,2,3,4

Enter 'End' to start execution

Program Loaded
```

Examples:

Zero flag:

1. Mod operation
   lw r0,$4294967295
   lw r1,$144
   lw r2,$2
   lw r3,$2
   mod r1,r2
   End
   Output: The zero flag is set since the result is zero

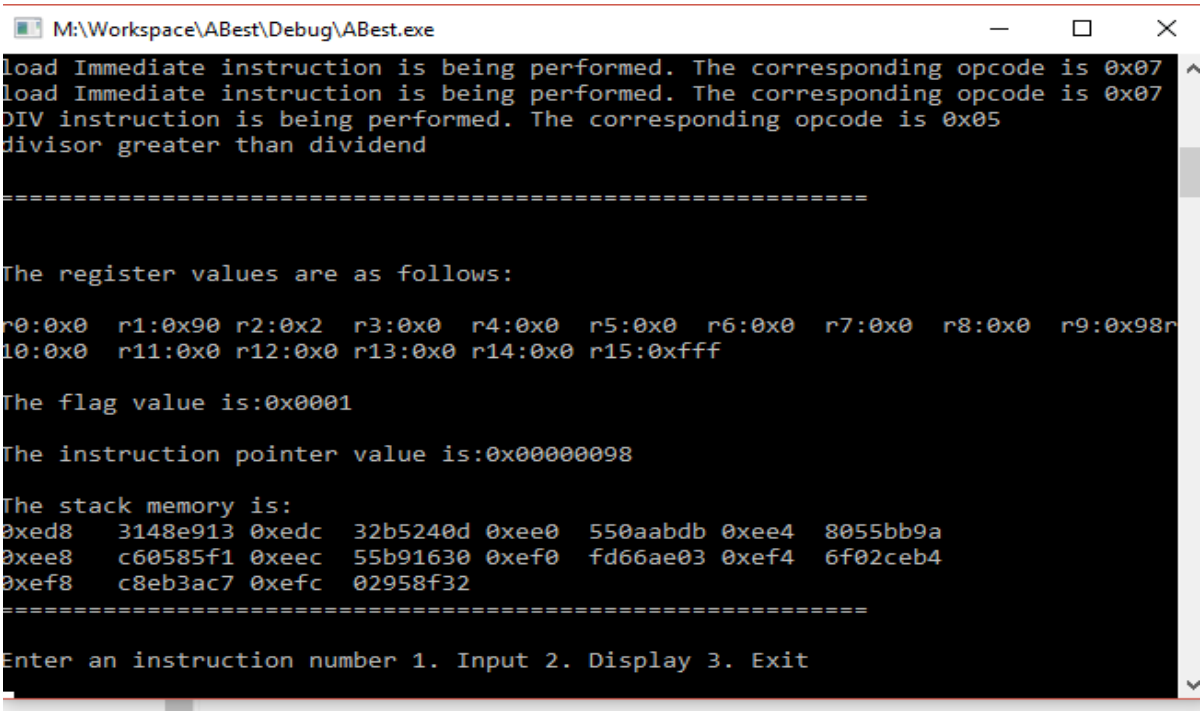
```
============================================================


The register values are as follows:

r0:0x0  r1:0x0  r2:0x2  r3:0x2  r4:0x0  r5:0x0  r6:0x0  r7:0x0  r8:0x0  r9:0x98r10:0x0  r11:0x0 r12:0x0 r13:0x0 r14:0x0 r15:0xfff

The flag value is:0x0001

The instruction pointer value is:0x00000098

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

2. Beq operation:
   lw r0,$4294967295

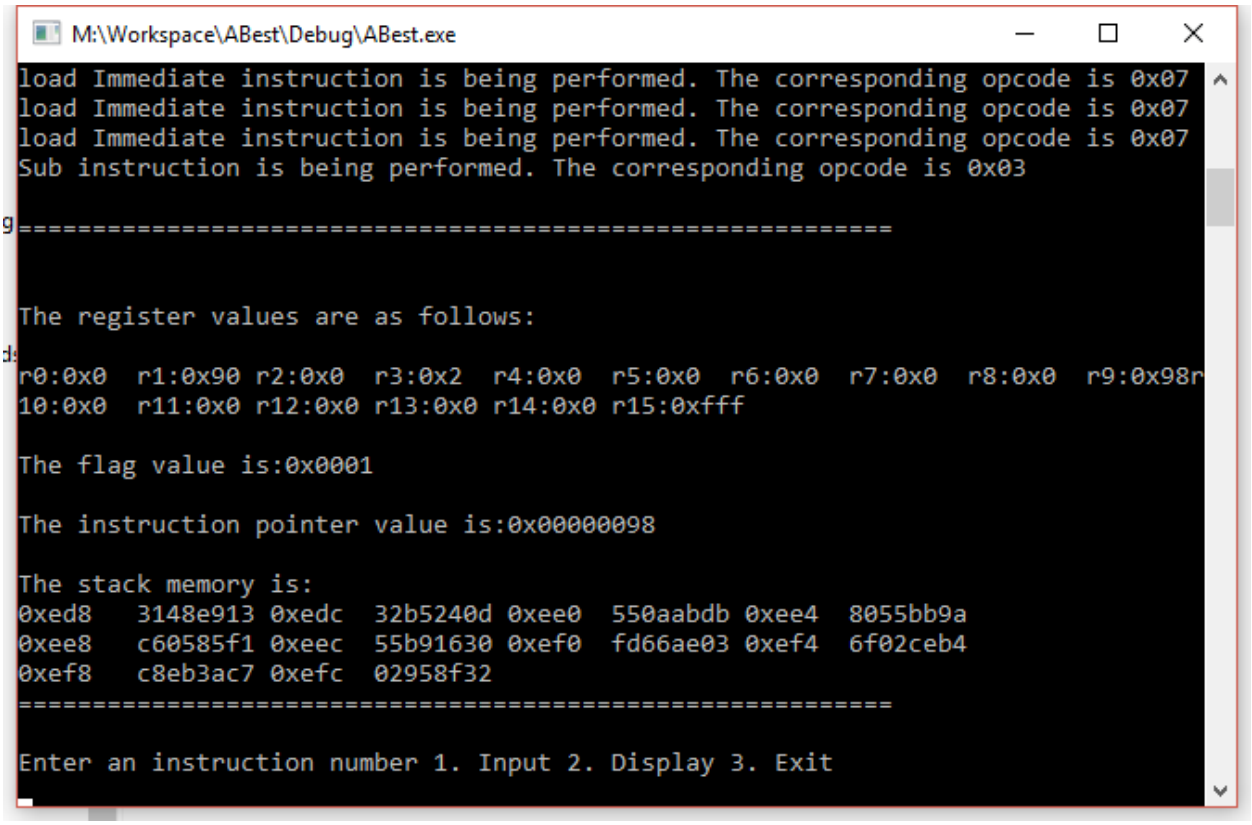
lw r1,$144
lw r2,$2
lw r3,$2
beq r3,r2,lb1
lb1:End
Output: The zero flag is set since beq operation results in zero.

```
beq instruction is being performed. The corresponding opcode is 0x0F

============================================================


The register values are as follows:

r0:0x0  r1:0x90 r2:0x2  r3:0x0  r4:0x0  r5:0x0  r6:0x0  r7:0x0  r8:0x0  r9:0x98r10:0x0  r11:0x0 r12:0x0 r13:0x0 r14:0x0 r15:0xfff

The flag value is:0x0001

The instruction pointer value is:0x00000098

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

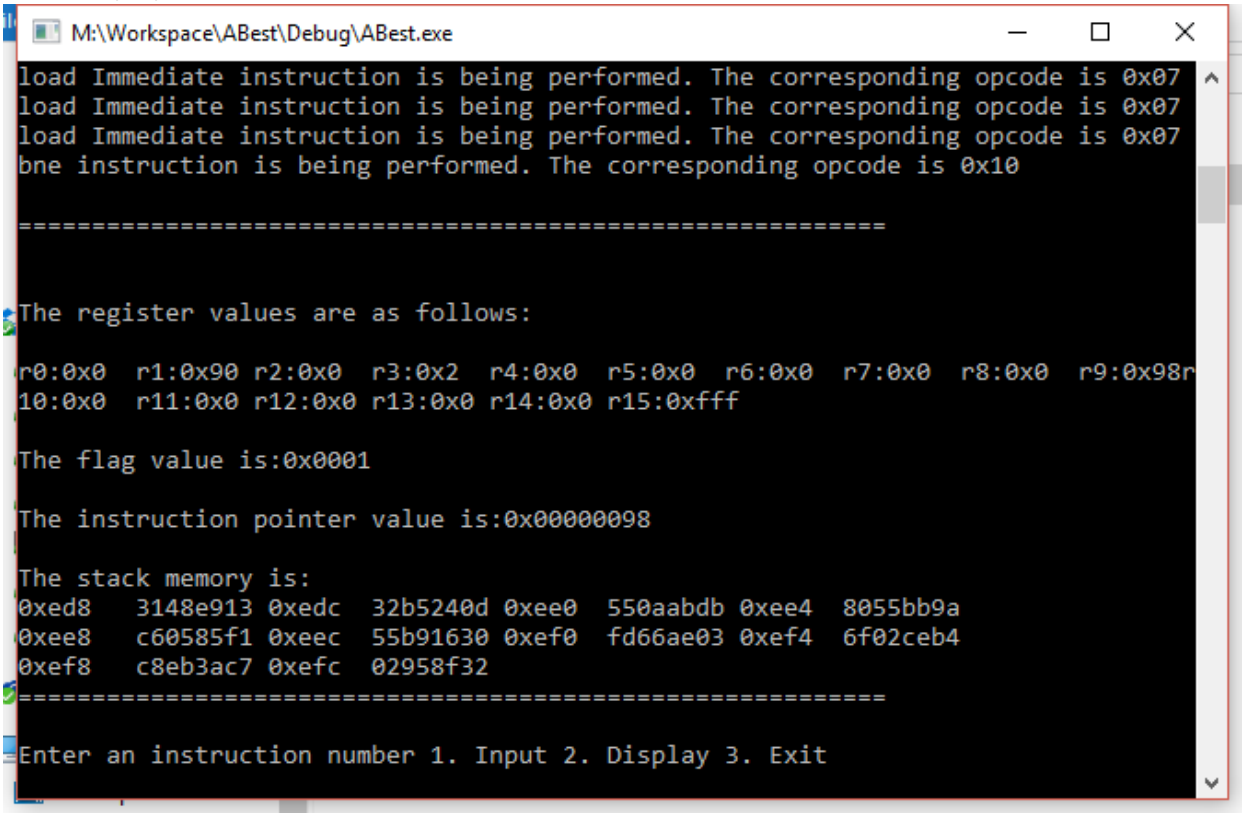
3. Division operation
   lw r0,$4294967295
   lw r1,$144
   lw r2,$0
   lw r3,$2
   div r2,r1,lb1
   lb1:End



4. Subtraction operation: sub r2,r2



5. bne r2, r2, lb1



6. Multiplication with 0.
lw r0,$0
lw r1,$144
mul r0,r1
End
Output:

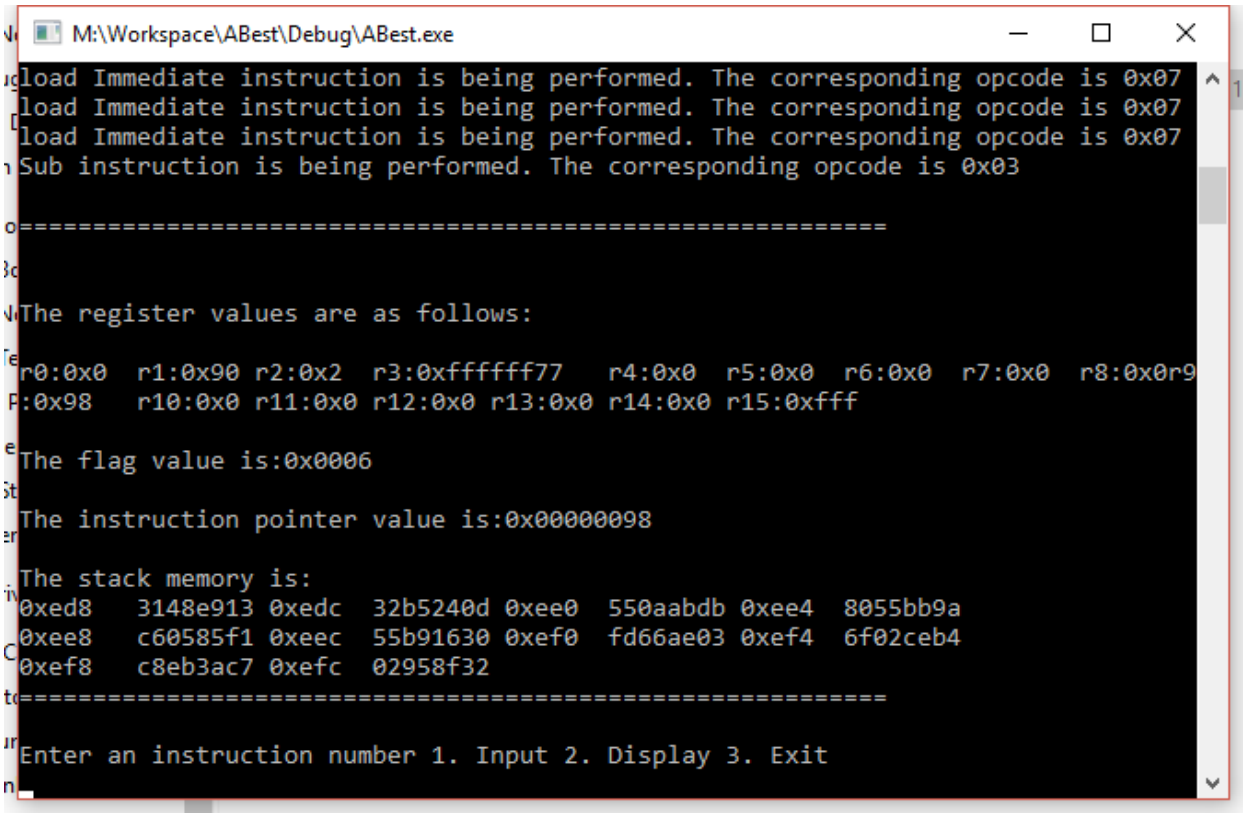
```
Mul instruction is being performed. The corresponding opcode is 0x04

============================================================


The register values are as follows:

r0:0x0  r1:0x90 r2:0x2  r3:0x2  r4:0x0  r5:0x0  r6:0x0  r7:0x0  r8:0x0  r9:0x98r10:0x0  r11:0x0 r12:0x0 r13:0x0 r14:0x0 r15:0xfff

The flag value is:0x0001

The instruction pointer value is:0x00000098

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

Sign flag:

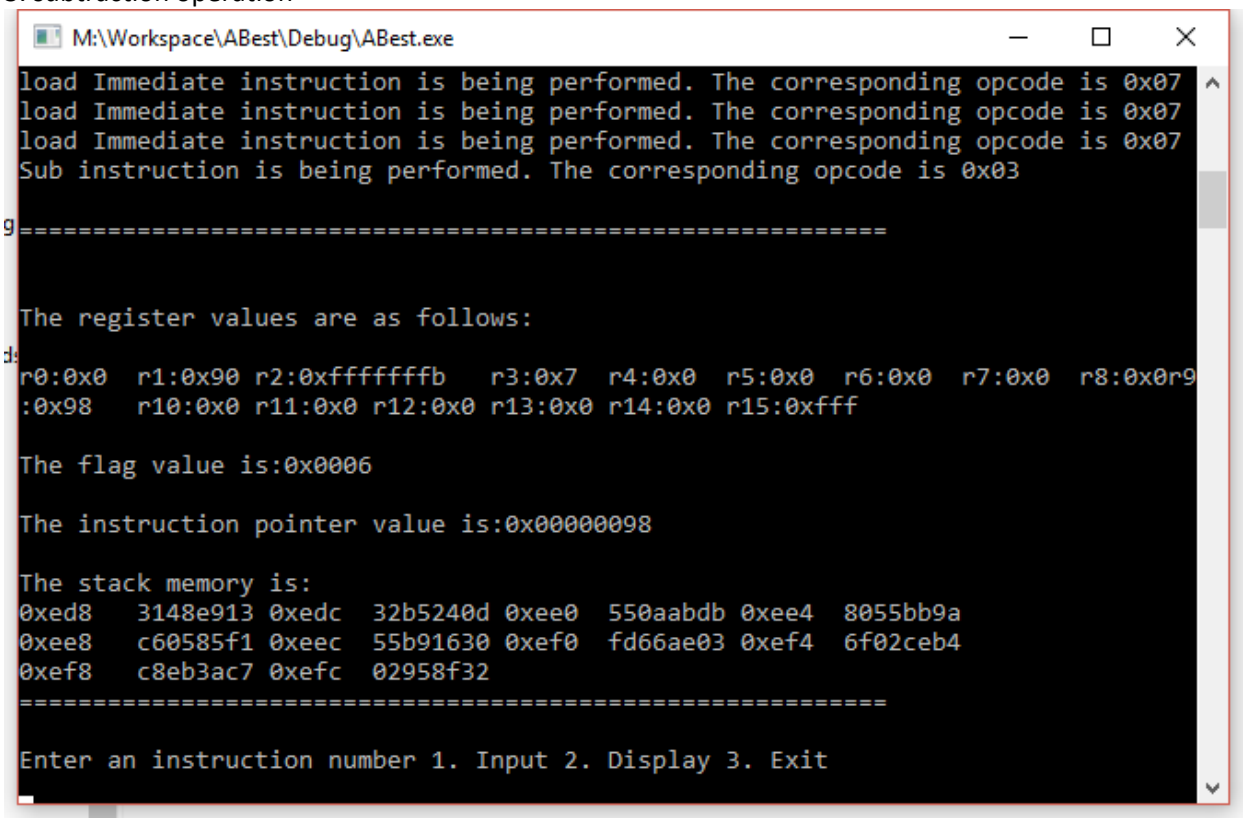
1. Subtraction of big number from small number
lw r0,$4294967295
lw r1,$144
lw r2,$2
lw r3,$2
sub r2,r1
End
Ouput: the sign and overflow are set since the result is negative

```
Sub instruction is being performed. The corresponding opcode is 0x03

============================================================


The register values are as follows:

r0:0x0  r1:0x90 r2:0xffffff72   r3:0x2  r4:0x0  r5:0x0  r6:0x0  r7:0x0  r8:0x0r9:0x98   r10:0x0 r11:0x0 r12:0x0 r13:0x0 r14:0x0 r15:0xfff

The flag value is:0x0006

The instruction pointer value is:0x00000098

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

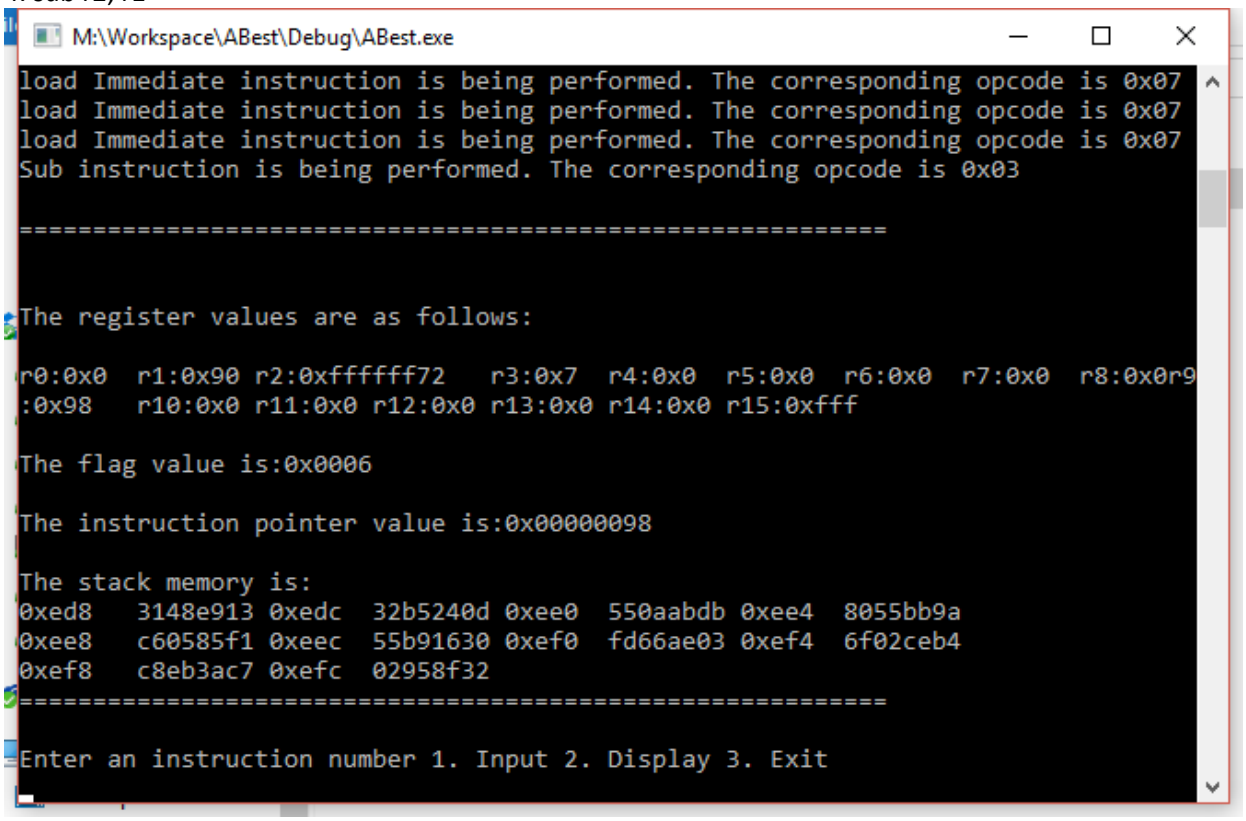
2. subtraction operation



3. subtraction operation

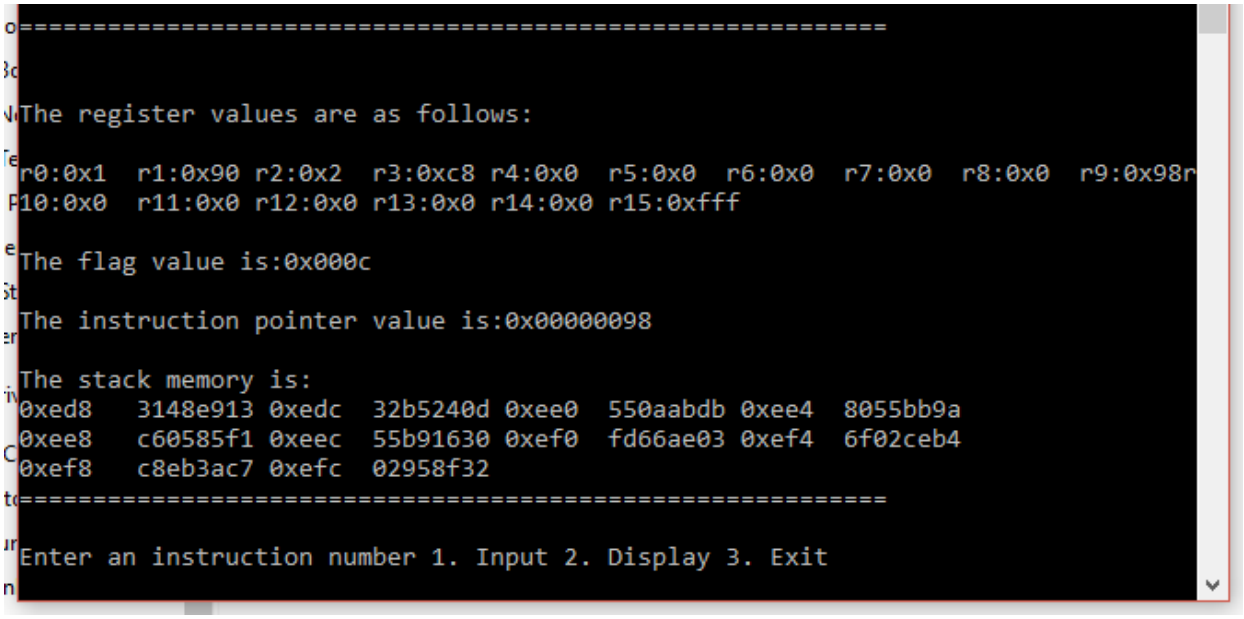


4. sub r2, r1

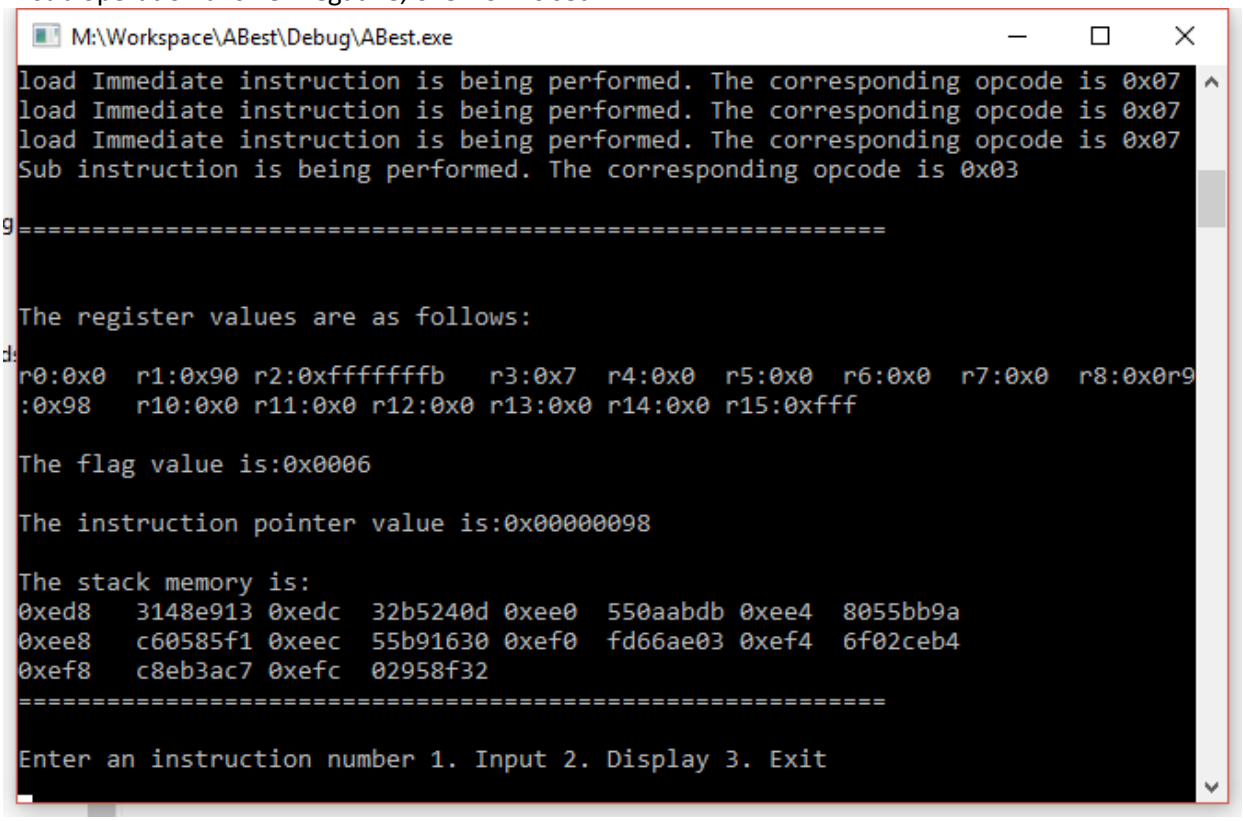


Overflow Flag:

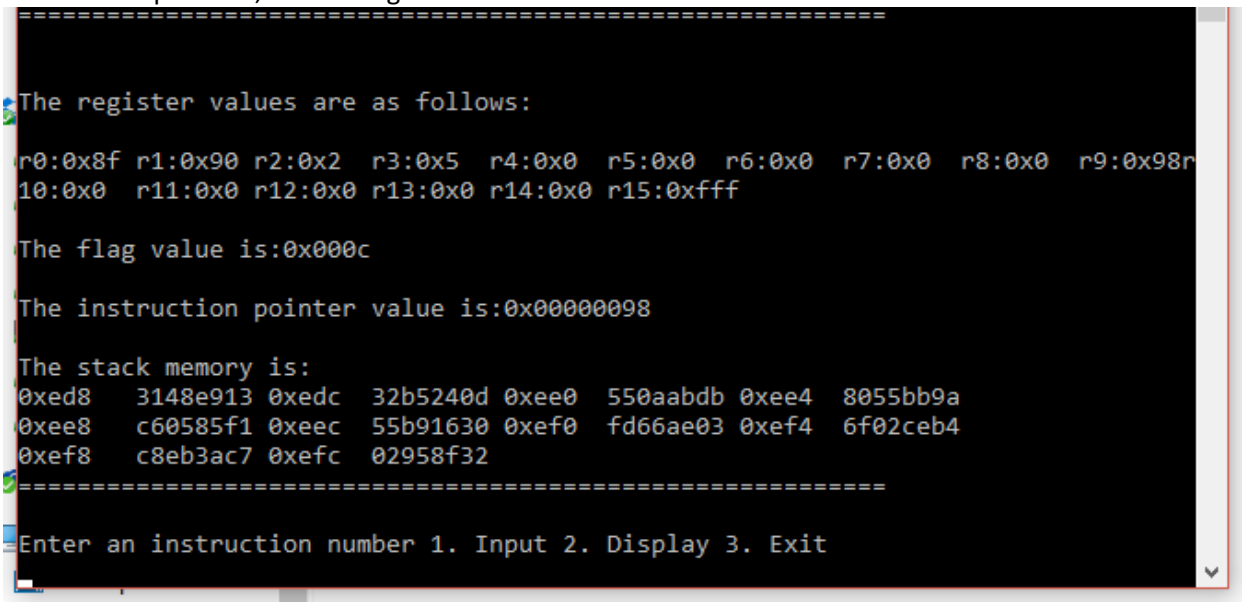
1. addition operation out of range.



2. sub operation answer negative, overflow is set

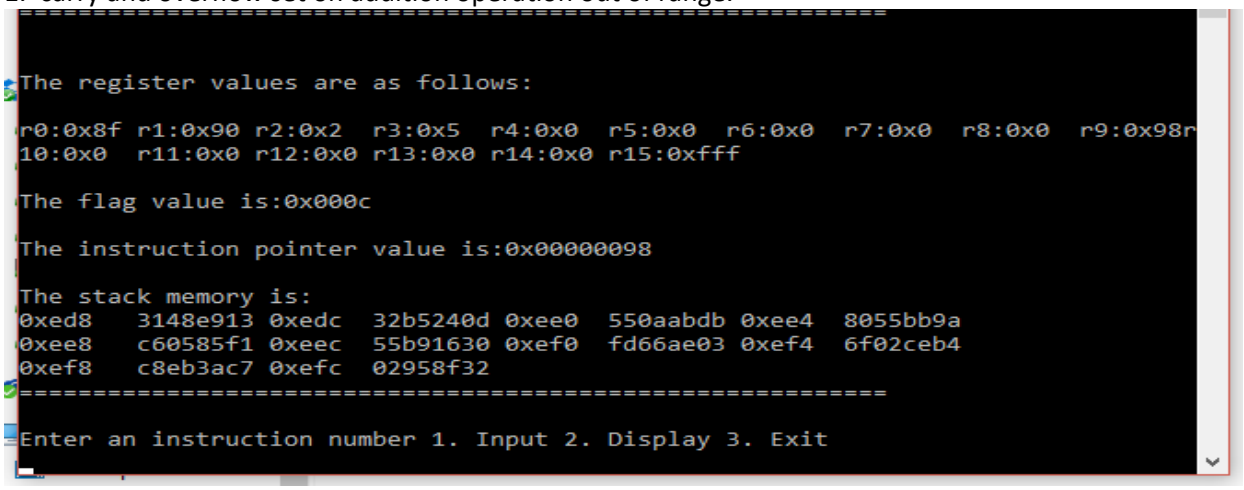


3. addition operation, out of range

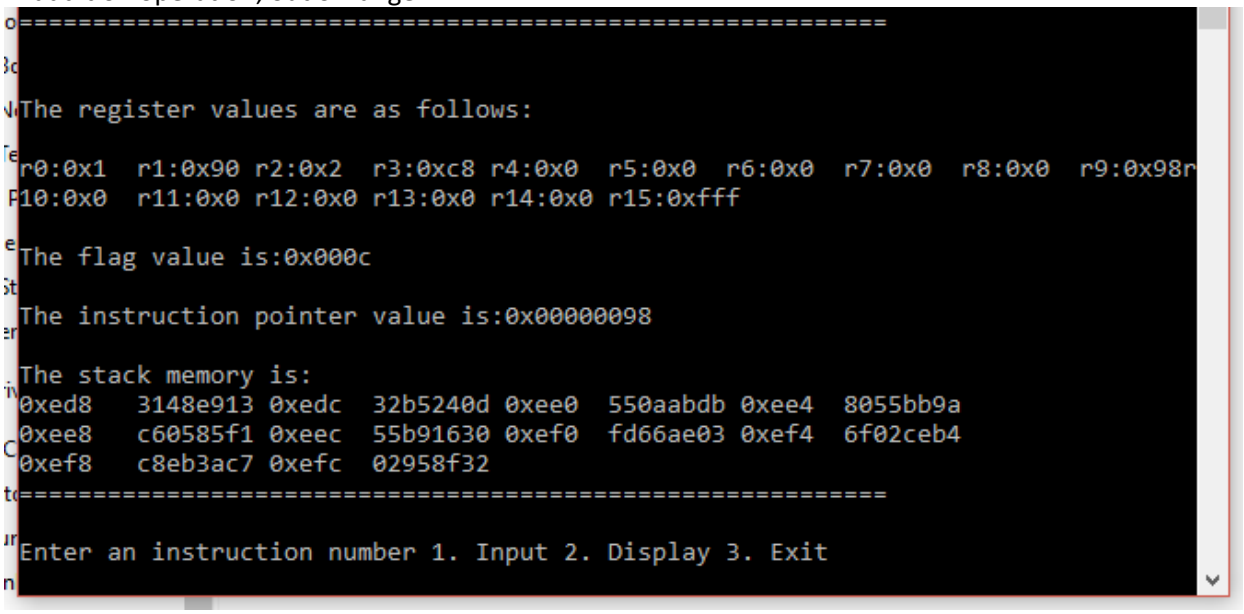


Carry flag:

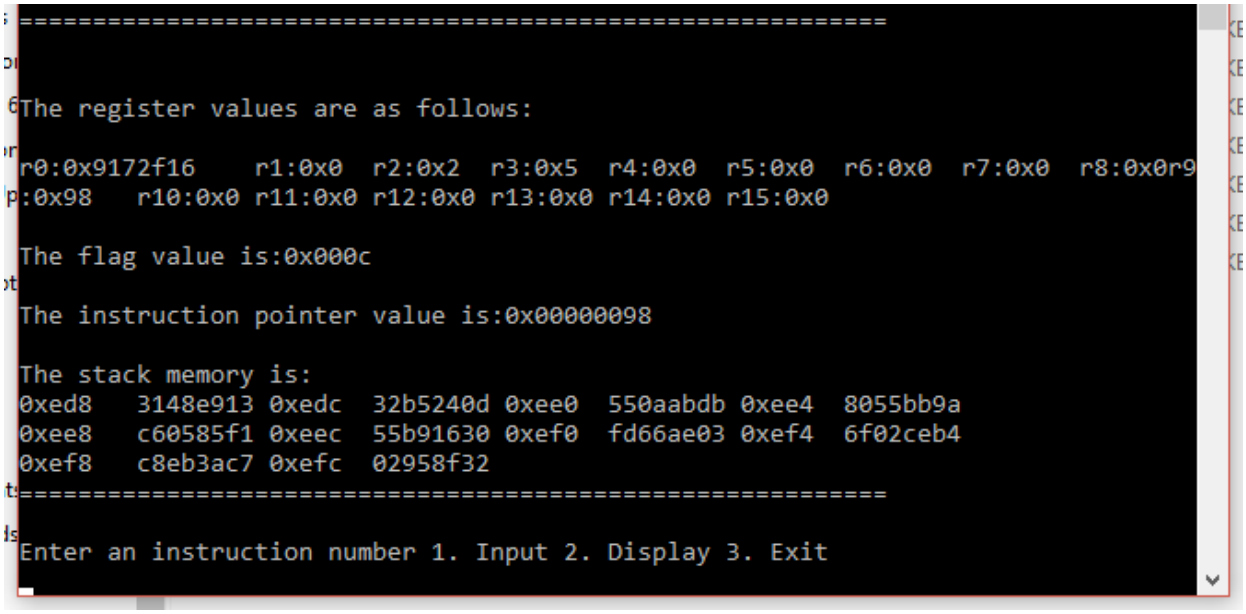
1. carry and overflow set on addition operation out of range.



2. addition operation, out of range



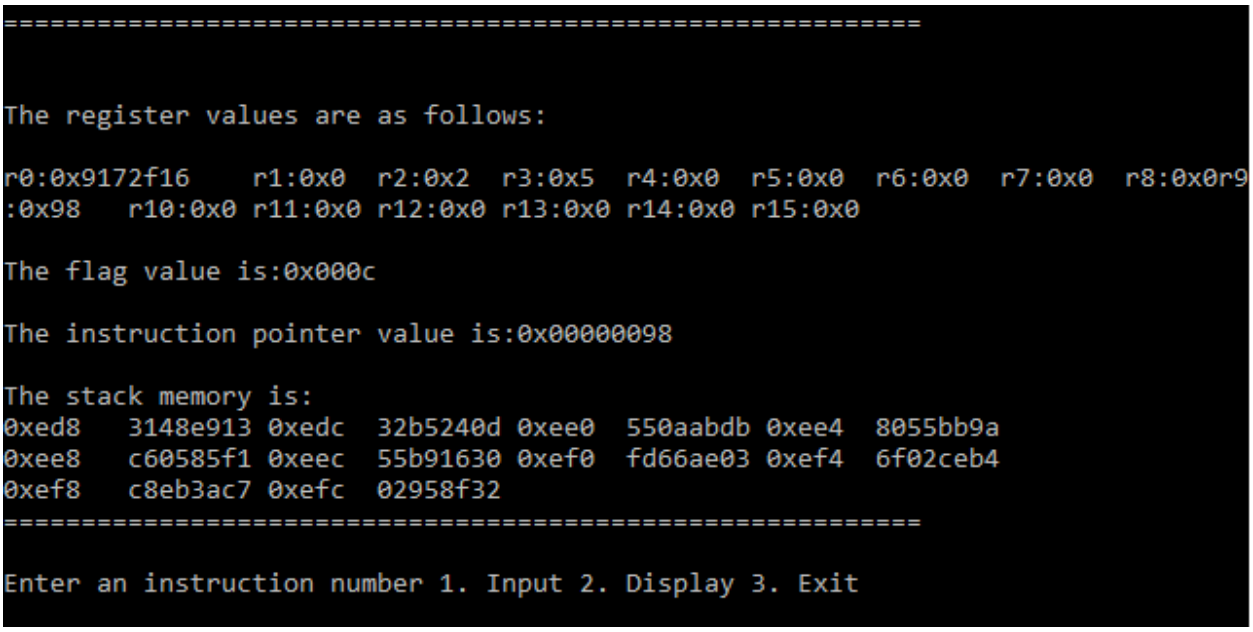
4. Addition Operation Carry and Overflow



5. lw r0,$3300000000

   lw r1,$1147481622

   add r0,r1



6. lw r0,$4000000000

   lw r1,$2147481622

   add r0,r1

```
============================================================


The register values are as follows:

r0:0x6e6b2016   r1:0x0  r2:0x2  r3:0x5  r4:0x0  r5:0x0  r6:0x0  r7:0x0  r8:0x0r9
:0x98   r10:0x0 r11:0x0 r12:0x0 r13:0x0 r14:0x0 r15:0x0

The flag value is:0x000c

The instruction pointer value is:0x00000098

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================

Enter an instruction number 1. Input 2. Display 3. Exit
```

Loops

The loops are implemented using the instructions as explained above. Implementation of while loop, do while loop and for loop is as given below. The C code and the corresponding assembly code is provided.

The **Jump label** and the **LEA** operation is demonstrated using the loops.

Note:

- The instructions in our program are read through a file, hence the default file included in Line 170 of the code is “binary_search.txt”. If you want to see the demonstration of loops, then replace the file name as “whileloop.txt” OR “dowhileloop.txt” OR “forloop.txt” in line 170 of the code and rerun the program.
- The text files to be run should be placed in the folder where executable is present.

1. While Loop

We have implemented a program that takes number 1 to 5 and calculates the sum.

C	Assembly

int x=5;
int cnt=1;
int sum=0;
while(cnt<=x){
sum=sum+cnt;
cnt++;
}
	lw r1,$0005
	lw r2,$0001
	lw r3,$0001
	lb2:slt r0,r1,r2
	beq r0,r3,lb1
	add r4,r2
	add r2,r3
	jmp lb2
	lb1:lw r9,$3832
	lea r11,r15,r9,1,
	End

Explanation:

- The sentinel value is loaded into the register r1.
- The counter is loaded into r2 and the register is incremented using register r3
- The while loop starts at lb2 label and checks for the condition that r2 does not exceed 5.
- If it exceeds then beq transfers the execution to label lb1 else the current value in r2 in added to r4 thus giving addition of numbers 1-5.

Register/Stack Values before Operation

```
============================================================


The register values are as follows:

r0:0x0  r1:0x0  r2:0x0  r3:0x0  r4:0x0  r5:0x0  r6:0x0  r7:0x0  r8:0x0  r9:0x0r10:0x0   r11:0x0 r12:0x0 r13:0x0 r14:0x0 r15:0x0

The flag value is:0x0000

The instruction pointer value is:0x00000080

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

While loop loaded from "whileloop.txt"

```
Memory loaded with initial values.
Registers loaded with initial values.

Press Enter Key to Continue...


Enter an instruction number 1. Input 2. Display 3. Exit
1

Load or Store Instruction can be of the format-lw/sw/lea reg,reg,reg,S,D

Load Immediate can be of the format- lw reg,$immediate

Arithmetic/Move Instruction can be of the format- add/sub/mul/div/mod/mov reg,reg

Jump Instruction can be of the format- jmp lbl_name

Jump Register Instruction can be of the format- jr reg

Stack Operation's Instruction can be of the format- push/pop reg
Set Less than Operation Instruction can be of the format- slt reg,reg,reg
Branch Operation's Instruction can be of the format- beq/bne reg,reg,lbl_name
Please find the acceptable range values:
        Reg: r0-r15
        S:1,2,4,8
        D:0,1,2,3,4

Enter 'End' to start execution

Program Loaded
```

Operations Performed:

```
load Immediate instruction is being performed. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
```

Register values after operation:

```
============================================================


The register values are as follows:

r0:0x0  r1:0x5  r2:0x6  r3:0x1  r4:0xf  r5:0x0  r6:0x0  r7:0x0  r8:0x0  r9:0xac r10:0x0 r11:0xa4       r12:0x0 r13:0x0 r14:0x0 r15:0x0

The flag value is:0x0000

The instruction pointer value is:0x000000ac

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

As you can see the r1 is loaded with sentinel value, r2 is incremented till 6 and the summation of first five numbers is stored in r4. (0xf => 15_{10})

2. Do While Loop

We have implemented a program that takes number 1 to 6 and calculates the sum.

C	Assembly

int x=6;
int cnt=1;
int sum=0;
do{
sum=sum+cnt;
cnt++;
}while(cnt<=x);
	lw r1,$0005
	lw r2,$0001
	lw r3,$0001
	lb2:add r4,r2
	slt r0,r1,r2
	add r2,r3
	beq r0,r3,lb1
	jmp lb2
	lb1:lw r9,$100
	End

Explanation:

- The sentinel value is loaded into the register r1.
- The counter is loaded into r2 and the register is incremented using register r3
- The while loop starts at lb2 label and addition is performed between current value in r2 and r4.
- Then check is performed. If it exceeds then beq transfers the execution to label lb1 else the execution is transferred to label2.
- Since the do while loop executes one time before checking for condition it adds 6 as well to the sum.

Register/Stack Values before Operation

```
============================================================


The register values are as follows:

r0:0x0  r1:0x0  r2:0x0  r3:0x0  r4:0x0  r5:0x0  r6:0x0  r7:0x0  r8:0x0  r9:0x0r10:0x0   r11:0x0 r12:0x0 r13:0x0 r14:0x0 r15:0x0

The flag value is:0x0000

The instruction pointer value is:0x00000080

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

Operations Performed

```
load Immediate instruction is being performed. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Add instruction is being performed. The corresponding opcode is 0x02
SLT instruction is being performed. The corresponding opcode is 0x0C
Add instruction is being performed. The corresponding opcode is 0x02
beq instruction is being performed. The corresponding opcode is 0x0F
jump instruction is being performed. The corresponding opcode is 0x0D
Add instruction is being performed. The corresponding opcode is 0x02
SLT instruction is being performed. The corresponding opcode is 0x0C
Add instruction is being performed. The corresponding opcode is 0x02
beq instruction is being performed. The corresponding opcode is 0x0F
jump instruction is being performed. The corresponding opcode is 0x0D
Add instruction is being performed. The corresponding opcode is 0x02
SLT instruction is being performed. The corresponding opcode is 0x0C
Add instruction is being performed. The corresponding opcode is 0x02
beq instruction is being performed. The corresponding opcode is 0x0F
jump instruction is being performed. The corresponding opcode is 0x0D
Add instruction is being performed. The corresponding opcode is 0x02
SLT instruction is being performed. The corresponding opcode is 0x0C
Add instruction is being performed. The corresponding opcode is 0x02
beq instruction is being performed. The corresponding opcode is 0x0F
jump instruction is being performed. The corresponding opcode is 0x0D
Add instruction is being performed. The corresponding opcode is 0x02
SLT instruction is being performed. The corresponding opcode is 0x0C
Add instruction is being performed. The corresponding opcode is 0x02
beq instruction is being performed. The corresponding opcode is 0x0F
jump instruction is being performed. The corresponding opcode is 0x0D
Add instruction is being performed. The corresponding opcode is 0x02
SLT instruction is being performed. The corresponding opcode is 0x0C
Add instruction is being performed. The corresponding opcode is 0x02
beq instruction is being performed. The corresponding opcode is 0x0F
load Immediate instruction is being performed. The corresponding opcode is 0x07
```

Register values after operation

```
============================================================


The register values are as follows:

r0:0x0  r1:0x5  r2:0x7  r3:0x1  r4:0x15 r5:0x0  r6:0x0  r7:0x0  r8:0x0  r9:0xa8 r10:0x0 r11:0x0 r12:0x0 r13:0x0 r14:0x0 r15:0x0

The flag value is:0x0000

The instruction pointer value is:0x000000a8

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

As you can see the r1 is loaded with sentinel value, r2 is incremented till 6 and the summation of first six numbers is stored in r4 (0x15 => 21_{10})

3. For Loop

We have implemented a program that takes number 1 to 5 and calculates the sum.

C	Assembly

int x=5;
int cnt;
int sum=0;
for(cnt=1;cnt<=x;cnt++){
sum=sum+cnt;
}
	lw r1,$0005
	lw r2,$0001
	lw r3,$0001
	lb2:slt r0,r1,r2
	beq r0,r3,lb1
	add r4,r2
	add r2,r3
	jmp lb2
	lb1:lw r9,$3832
	lea r11,r15,r9,1,
	End

Explanation:

- The FOR loop is similar to While loop in execution as the “for” operation is broken down into multiple simple operations
- The sentinel value is loaded into the register r1.
- The counter is loaded into r2 and the register is incremented using register r3
- The for loop starts at lb2 label and checks for the condition that r2 does not exceed 5.
- If it exceeds then beq transfers the execution to label lb1 else the current value in r2 in added to r4 thus giving addition of numbers 1-5.

Register/Stack Values before Operation

```
============================================================


The register values are as follows:

r0:0x0  r1:0x0  r2:0x0  r3:0x0  r4:0x0  r5:0x0  r6:0x0  r7:0x0  r8:0x0  r9:0x0r10:0x0   r11:0x0 r12:0x0 r13:0x0 r14:0x0 r15:0x0

The flag value is:0x0000

The instruction pointer value is:0x00000080

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

Operations Performed

```
load Immediate instruction is being performed. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
Add instruction is being performed. The corresponding opcode is 0x02
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
beq instruction is being performed. The corresponding opcode is 0x0F
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
```

Register values after operation

```
=============================================================


The register values are as follows:

r0:0x0  r1:0x5  r2:0x6  r3:0x1  r4:0xf  r5:0x0  r6:0x0  r7:0x0  r8:0x0  r9:0xacr10:0x0  r11:0xa4       r12:0x0 r13:0x0 r14:0x0 r15:0x0

The flag value is:0x0000

The instruction pointer value is:0x000000ac

The stack memory is:
0xed8   3148e913 0xedc  32b5240d 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
=============================================================
```

As you can see the r1 is loaded with sentinel value, r2 is incremented till 6 and the summation of first five numbers is stored in r4. (0xf => 15_{10})

Binary Search using Recursive Function Call

Explanation

Once the program is loaded in instruction memory, the program asks the user for the array size, the elements in the array and the element to be searched in the array. The program is loaded in "binary_search.txt".

C	Assembly

int binarySearch(int arr[], int l, int r, int x)
{
  if (r >= l)
  {
  int mid = l + (r - l)/2;
 	
  // If the element is present at the middle itself
  if (arr[mid] == x) return mid;
 	
  // If element is smaller than mid, then it can only be present
  // in left subarray
  if (arr[mid] > x) return binarySearch(arr, l, mid-1, x);
 	
  // Else the element can only be present in right subarray
  return binarySearch(arr, mid+1, r, x);
  }
 	
  // We reach here when element is not present in array
  return -1;
}
	lw r0,$0
	lw r1,$144
	push r1
	jmp lb0
	jmp lb2
	lb0:slt r1,r12,r11
	lw r2,$1
	beq r1,r2,lb1
	mov r3,r11
	add r3,r12
	lw r2,$2
	div r3,r2
	lw r5,$4000
	lea r5,r5,r3,4,0
	lw r7,r0,r5,1,0
	mov r15,r7
	bne r15,r10,lb4
	mov r14,r3
	pop r13
	jr r13
	lb4:slt r1,r10,r7
	lw r2,$1
	beq r1,r2,lb3
	mov r11,r3
	add r11,r2
	jmp lb0
	lb3:mov r12,r3
	sub r12,r2
	jmp lb0
	lb1:sub r14,r2
	pop r13
	jr r13
	lb2:End

The screenshots for the recursive function call with all the test cases are as follows

Loading the Program

```
Memory loaded with initial values.
Registers loaded with initial values.

Press Enter Key to Continue...


Enter an instruction number 1. Input 2. Display 3. Exit
1

Load or Store Instruction can be of the format-lw/sw/lea reg,reg,reg,S,D

Load Immediate can be of the format- lw reg,$immediate

Arithmetic/Move Instruction can be of the format- add/sub/mul/div/mod/mov reg,re
g

Jump Instruction can be of the format- jmp lbl_name

Jump Register Instruction can be of the format- jr reg

Stack Operation's Instruction can be of the format- push/pop reg
Set Less than Operation Instruction can be of the format- slt reg,reg,reg
Branch Operation's Instruction can be of the format- beq/bne reg,reg,lbl_name
Please find the acceptable range values:
        Reg: r0-r15
        S:1,2,4,8
        D:0,1,2,3,4

Enter 'End' to start execution

Program Loaded
```

Iteration 1

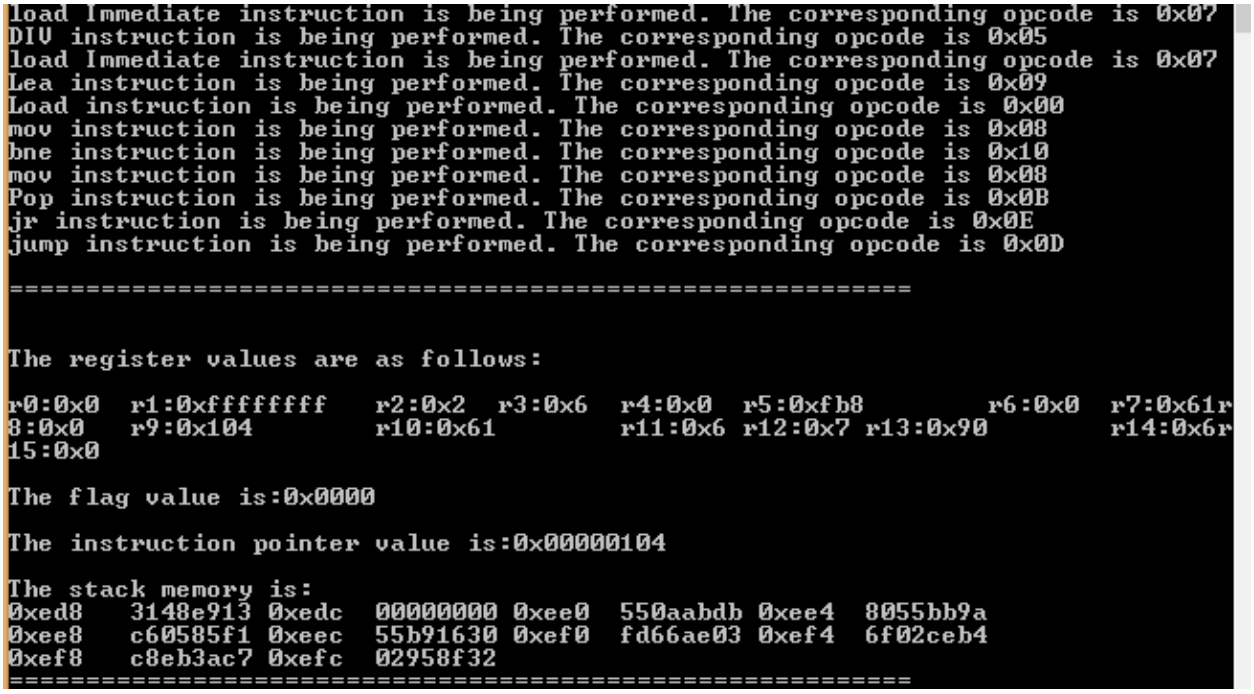
No of Elements: 10

Elements: 10 12 24 29 66 94 97 151 163 522

1. **Case 1:** Element to be searched: 97

   Result is in r14: 06(index value for 97 in the array)

```
Program Loaded

*** Binary search ***
Enter number of elements: 10

Enter 10 elements in ascending order: 10 12 24 29 66 94 97 151 163 522

Enter 'key' element you need to find: 97

Binary search function will find 97 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
```



2. **Case 2:** Element to be searched: 12
   Result is in r14: 01(index value for 12 in the array)
   Elements: 10 12 24 29 66 94 97 151 163 522

```
Program Loaded

*** Binary search ***
Enter number of elements: 10

Enter 10 elements in ascending order: 10 12 24 29 66 94 97 151 163 522

Enter 'key' element you need to find: 12

Binary search function will find 12 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
```

```
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
divisor greater than dividend
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

============================================================


The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x1  r4:0x0  r5:0xfa4        r6:0x0  r7:0xcr8
:0x0    r9:0x104        r10:0xc r11:0x1 r12:0x1 r13:0x90        r14:0x1 r15:0x0

The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

3. **Case 3:** Element to be searched: 121
   Result is in r14: -1(-1 as not found in the array)
   Elements: 10 12 24 29 66 94 97 151 163 522

```
Program Loaded

*** Binary search ***
Enter number of elements: 10

Enter 10 elements in ascending order: 10 12 24 29 66 94 97 151 163 522

Enter 'key' element you need to find: 121

Binary search function will find 121 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
```

```
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
Sub instruction is being performed. The corresponding opcode is 0x03
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

============================================================


The register values are as follows:

r0:0x0  r1:0x0  r2:0x1  r3:0x7  r4:0x0  r5:0xfbc        r6:0x0  r7:0x97 r8:0x0r9
:0x104  r10:0x79        r11:0x7 r12:0x6 r13:0x90        r14:0xffffffff  r15:0x1e


The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

Iteration 2

No of Elements: 9

1. **Case 1:** Element to be searched: 9
   Result is in r14: 08(index value for 9 in the array)
   Elements: 1 2 3 4 5 6 7 8 9

```
Program Loaded

*** Binary search ***
Enter number of elements: 9

Enter 9 elements in ascending order: 1 2 3 4 5 6 7 8 9

Enter 'key' element you need to find: 9

Binary search function will find 9 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
```

```
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

============================================================


The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x8  r4:0x0  r5:0xfc0        r6:0x0  r7:0x9r8
:0x0    r9:0x104        r10:0x9 r11:0x8 r12:0x9 r13:0x90        r14:0x8 r15:0x0

The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

2. **Case 2:** Element to be searched: 1
   Result is in r14: 00(index value for 1 in the array)
   Elements: 1 2 3 4 5 6 7 8 9

```
Program Loaded

*** Binary search ***
Enter number of elements: 9

Enter 9 elements in ascending order: 1 2 3 4 5 6 7 8 9

Enter 'key' element you need to find: 1

Binary search function will find 1 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
```

```
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
divisor greater than dividend
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

============================================================


The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x0  r4:0x0  r5:0xfa0        r6:0x0  r7:0x1r8
:0x0    r9:0x104        r10:0x1 r11:0x0 r12:0x0 r13:0x90        r14:0x0 r15:0x0

The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

3. **Case 3:** Element to be searched: 56
   Result is in r14: -1(-1 as not found in the array)
   Elements: 1 2 3 4 5 6 7 8 9

```
Program Loaded

*** Binary search ***
Enter number of elements: 9

Enter 9 elements in ascending order: 1 2 3 4 5 6 7 8 9

Enter 'key' element you need to find: 56

Binary search function will find 56 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
```

```
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
one instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
one instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
Sub instruction is being performed. The corresponding opcode is 0x03
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

============================================================


The register values are as follows:

r0:0x0  r1:0x0  r2:0x1  r3:0x9  r4:0x0  r5:0xfc4        r6:0x0  r7:0x234e1f06r8:
0x0     r9:0x104        r10:0x38        r11:0x9 r12:0x8 r13:0x90        r14:0xff
ffffff  r15:0x234e1ece

The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

Iteration 3

No of Elements: 11

1. **Case 1:** Element to be searched: 39
   Result is in r14: 02(index value for 39 in the array)
   Elements: 10 27 39 44 52 88 120 156 212 300 314

```
Program Loaded

*** Binary search ***
Enter number of elements: 11

Enter 11 elements in ascending order: 10 27 39 44 52 88 120 156 212 300 314

Enter 'key' element you need to find: 39

Binary search function will find 39 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

=========================================================


The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x2  r4:0x0  r5:0xfa8        r6:0x0  r7:0x27r
8:0x0   r9:0x104        r10:0x27        r11:0x0 r12:0x4 r13:0x90        r14:0x2r
```

2. **Case 2:** Element to be searched: 212
   Result is in r14: 08(index value for 212 in the array)
   Elements: 10 27 39 44 52 88 120 156 212 300 314

```
Program Loaded

*** Binary search ***
Enter number of elements: 11

Enter 11 elements in ascending order: 10 27 39 44 52 88 120 156 212 300 314

Enter 'key' element you need to find: 212

Binary search function will find 212 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

============================================================


The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x8  r4:0x0  r5:0xfc0        r6:0x0  r7:0xd4r
8:0x0   r9:0x104        r10:0xd4        r11:0x6 r12:0xb r13:0x90        r14:0x8r
```

3. **Case 3:** Element to be searched: 254
   Result is in r14: -1(-1 as not found in the array)
   Elements: 10 27 39 44 52 88 120 156 212 300 314

```
Program Loaded

*** Binary search ***
Enter number of elements: 11

Enter 11 elements in ascending order: 10 27 39 44 52 88 120 156 212 300 314

Enter 'key' element you need to find: 254

Binary search function will find 254 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
```

```
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
Sub instruction is being performed. The corresponding opcode is 0x03
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

==========================================================


The register values are as follows:

r0:0x0  r1:0x0  r2:0x1  r3:0x9  r4:0x0  r5:0xfc4        r6:0x0  r7:0x12cr8:0x0r9
:0x104  r10:0xfe        r11:0x9 r12:0x8 r13:0x90        r14:0xffffffff  r15:0x2e


The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc   00000000 0xee0   550aabdb 0xee4   8055bb9a
```

Iteration 4

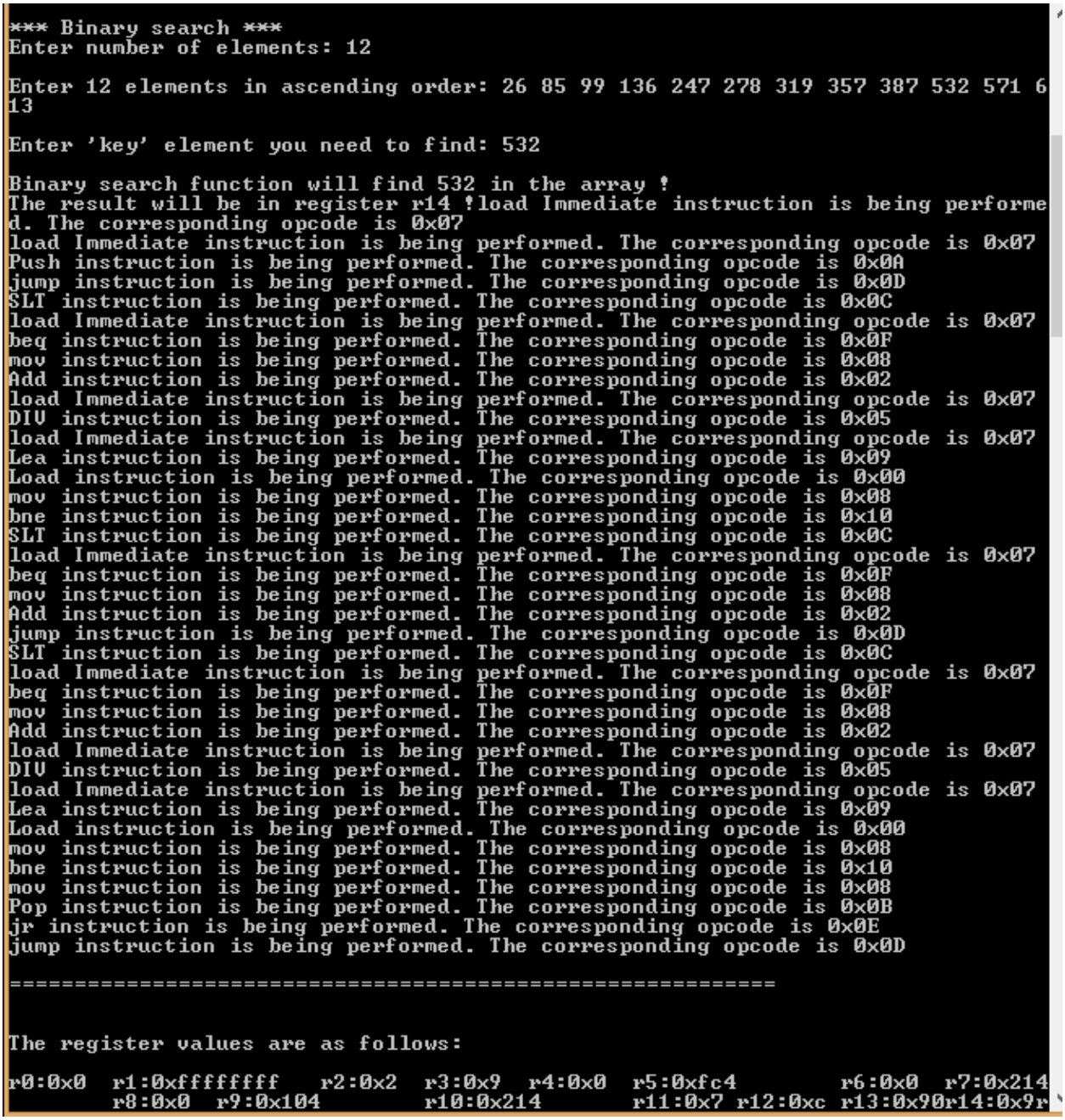
No of Elements: 12 elements

1. **Case 1:** Element to be searched: 136
   Result is in r14: 03(index value for 136 in the array)
   Elements: 26 85 99 136 247 278 319 357 387 532 571 613

```
Program Loaded

*** Binary search ***
Enter number of elements: 12

Enter 12 elements in ascending order: 26 85 99 136 247 278 319 357 387 532 571 6
13

Enter 'key' element you need to find: 136

Binary search function will find 136 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
```

```
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

============================================================


The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x3  r4:0x0  r5:0xfac        r6:0x0  r7:0x88r
8:0x0   r9:0x104        r10:0x88        r11:0x3 r12:0x3 r13:0x90        r14:0x3r
15:0x0

The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

2. **Case 2:** Element to be searched: 532
   Result is in r14: 09(index value for 532 in the array)
   Elements: 26 85 99 136 247 278 319 357 387 532 571 613



3. **Case 3:** Element to be searched: 322
   Result is in r14: -1(-1 as not found in the array)
   Elements: 26 85 99 136 247 278 319 357 387 532 571 613

```
Program Loaded

*** Binary search ***
Enter number of elements: 12

Enter 12 elements in ascending order: 26 85 99 136 247 278 319 357 387 532 571 6
13

Enter 'key' element you need to find: 322

Binary search function will find 322 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
```

```
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
Sub instruction is being performed. The corresponding opcode is 0x03
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

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The register values are as follows:

r0:0x0  r1:0x0  r2:0x1  r3:0x7  r4:0x0  r5:0xfbc        r6:0x0  r7:0x165r8:0x0r9
:0x104  r10:0x142       r11:0x7 r12:0x6 r13:0x90        r14:0xffffffff  r15:0x23


The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```
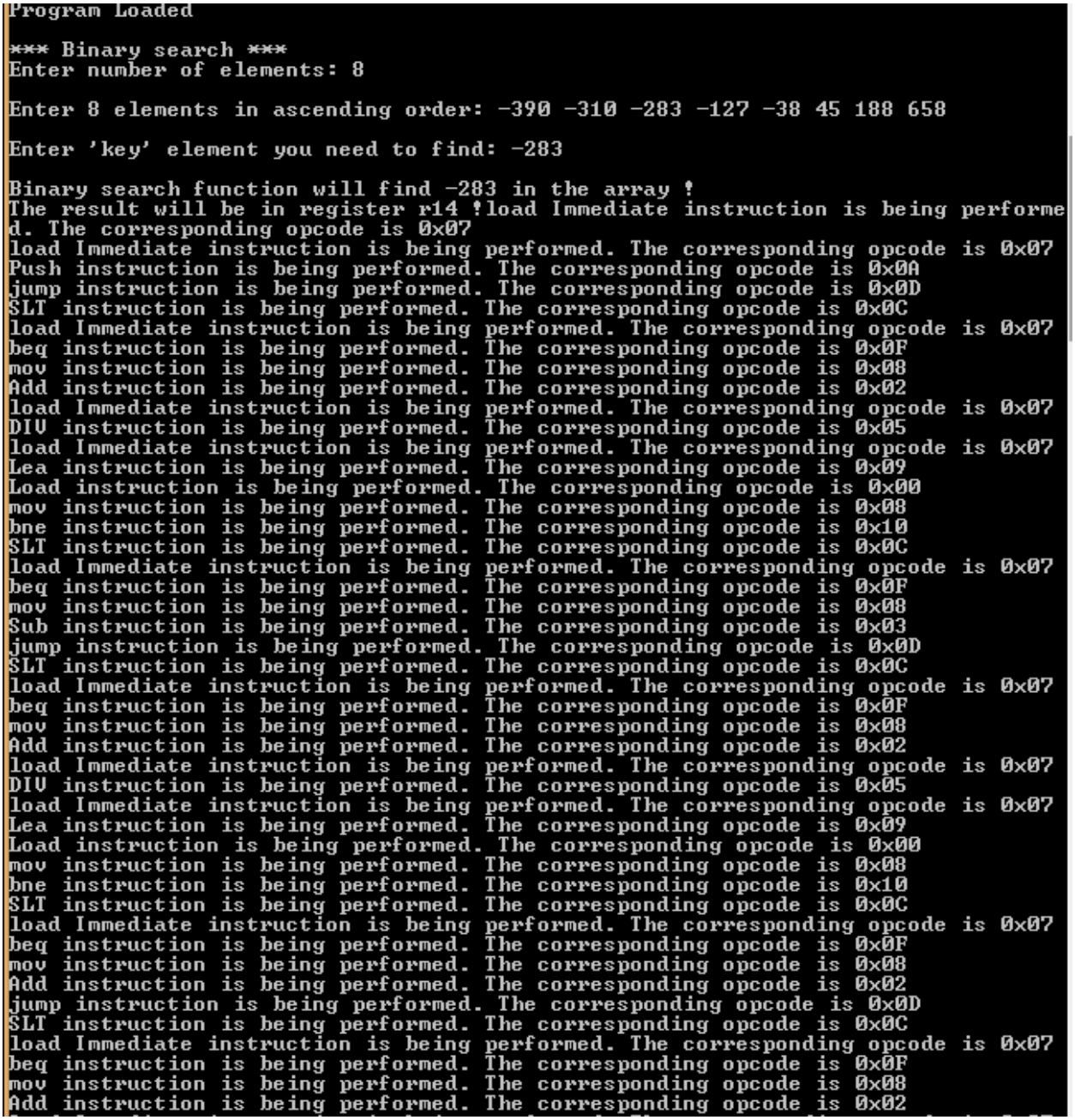

Iteration 5

No of Elements: 8 elements

1. **Case 1:** Element to be searched: -283
   Result is in r14: 02(index value for -283 in the array)
   Elements: -390 -310 -283 -127 -38 45 188 658


Program Loaded
*** Binary search ***
Enter number of elements: 8
Enter 8 elements in ascending order: -390 -310 -283 -127 -38 45 188 658
Enter 'key' element you need to find: -283
Binary search function will find -283 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02

```
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

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The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x2  r4:0x0  r5:0xfa8        r6:0x0  r7:0xfff
ffee5   r8:0x0  r9:0x104        r10:0xffffee5  r11:0x2 r12:0x3 r13:0x90r14:0x2
15:0x0

The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

2. **Case 2:** Element to be searched: 188
   Result is in r14: 06(index value for 188 in the array)
   Elements: -390 -310 -283 -127 -38 45 188 658

```
Program Loaded

*** Binary search ***
Enter number of elements: 8

Enter 8 elements in ascending order: -390 -310 -283 -127 -38 45 188 658

Enter 'key' element you need to find: 188

Binary search function will find 188 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

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The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x6  r4:0x0  r5:0xfb8        r6:0x0  r7:0xbcr
8:0x0   r9:0x104        r10:0xbc        r11:0x5 r12:0x8 r13:0x90        r14:0x6r
```

3. **Case 3:** Element to be searched: 540
   Result is in r14: -1(-1 as not found in the array)
   Elements: -390 -310 -283 -127 -38 45 188 658

```
Program Loaded

*** Binary search ***
Enter number of elements: 8

Enter 8 elements in ascending order: -390 -310 -283 -127 -38 45 188 658

Enter 'key' element you need to find: 540

Binary search function will find 540 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
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beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
Sub instruction is being performed. The corresponding opcode is 0x03
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

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The register values are as follows:

r0:0x0  r1:0x0  r2:0x1  r3:0x7  r4:0x0  r5:0xfbc        r6:0x0  r7:0x292r8:0x0r9
:0x104  r10:0x21c       r11:0x7 r12:0x6 r13:0x90        r14:0xffffffff  r15:0x76


The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

Iteration 6

No of Elements: 9 elements

1. **Case 1:** Element to be searched: -455
   Result is in r14: 01(index value for -455 in the array)
   Elements: -670 -455 -308 -111 244 351 493 555 850

```
Program Loaded

*** Binary search ***
Enter number of elements: 9

Enter 9 elements in ascending order: -670 -455 -308 -111 244 351 493 555 850

Enter 'key' element you need to find: -455

Binary search function will find -455 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

============================================================


The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x1  r4:0x0  r5:0xfa4        r6:0x0  r7:0xfff
ffe39   r8:0x0  r9:0x104        r10:0xfffffe39  r11:0x0 r12:0x3 r13:0x90r14:0x1r
```

2. **Case 2:** Element to be searched: 850
   Result is in r14: 08(index value for 850 in the array)
   Elements: -670 -455 -308 -111 244 351 493 555 850

```
Program Loaded

*** Binary search ***
Enter number of elements: 9

Enter 9 elements in ascending order: -670 -455 -308 -111 244 351 493 555 850

Enter 'key' element you need to find: 850

Binary search function will find 850 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
```

```
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
mov instruction is being performed. The corresponding opcode is 0x08
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

============================================================


The register values are as follows:

r0:0x0  r1:0xffffffff   r2:0x2  r3:0x8  r4:0x0  r5:0xfc0        r6:0x0  r7:0x352
        r8:0x0  r9:0x104        r10:0x352       r11:0x8 r12:0x9 r13:0x90r14:0x8r
15:0x0

The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
============================================================
```

3. **Case 3:** Element to be searched: 86
   Result is in r14: -1(-1 as not found in the array)
   Elements: -670 -455 -308 -111 244 351 493 555 850

```
Program Loaded

*** Binary search ***
Enter number of elements: 9

Enter 9 elements in ascending order: -670 -455 -308 -111 244 351 493 555 850

Enter 'key' element you need to find: 86

Binary search function will find 86 in the array !
The result will be in register r14 !load Immediate instruction is being performe
d. The corresponding opcode is 0x07
load Immediate instruction is being performed. The corresponding opcode is 0x07
Push instruction is being performed. The corresponding opcode is 0x0A
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Sub instruction is being performed. The corresponding opcode is 0x03
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
```

```
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
load Immediate instruction is being performed. The corresponding opcode is 0x07
DIV instruction is being performed. The corresponding opcode is 0x05
load Immediate instruction is being performed. The corresponding opcode is 0x07
Lea instruction is being performed. The corresponding opcode is 0x09
Load instruction is being performed. The corresponding opcode is 0x00
mov instruction is being performed. The corresponding opcode is 0x08
bne instruction is being performed. The corresponding opcode is 0x10
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
mov instruction is being performed. The corresponding opcode is 0x08
Add instruction is being performed. The corresponding opcode is 0x02
jump instruction is being performed. The corresponding opcode is 0x0D
SLT instruction is being performed. The corresponding opcode is 0x0C
load Immediate instruction is being performed. The corresponding opcode is 0x07
beq instruction is being performed. The corresponding opcode is 0x0F
Sub instruction is being performed. The corresponding opcode is 0x03
Pop instruction is being performed. The corresponding opcode is 0x0B
jr instruction is being performed. The corresponding opcode is 0x0E
jump instruction is being performed. The corresponding opcode is 0x0D

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The register values are as follows:

r0:0x0  r1:0x0  r2:0x1  r3:0x3  r4:0x0  r5:0xfac        r6:0x0  r7:0xffffff91r8:
0x0     r9:0x104        r10:0x56        r11:0x4 r12:0x3 r13:0x90        r14:0xff
ffffff  r15:0xffffff3b

The flag value is:0x0000

The instruction pointer value is:0x00000104

The stack memory is:
0xed8   3148e913 0xedc  00000000 0xee0  550aabdb 0xee4  8055bb9a
0xee8   c60585f1 0xeec  55b91630 0xef0  fd66ae03 0xef4  6f02ceb4
0xef8   c8eb3ac7 0xefc  02958f32
```