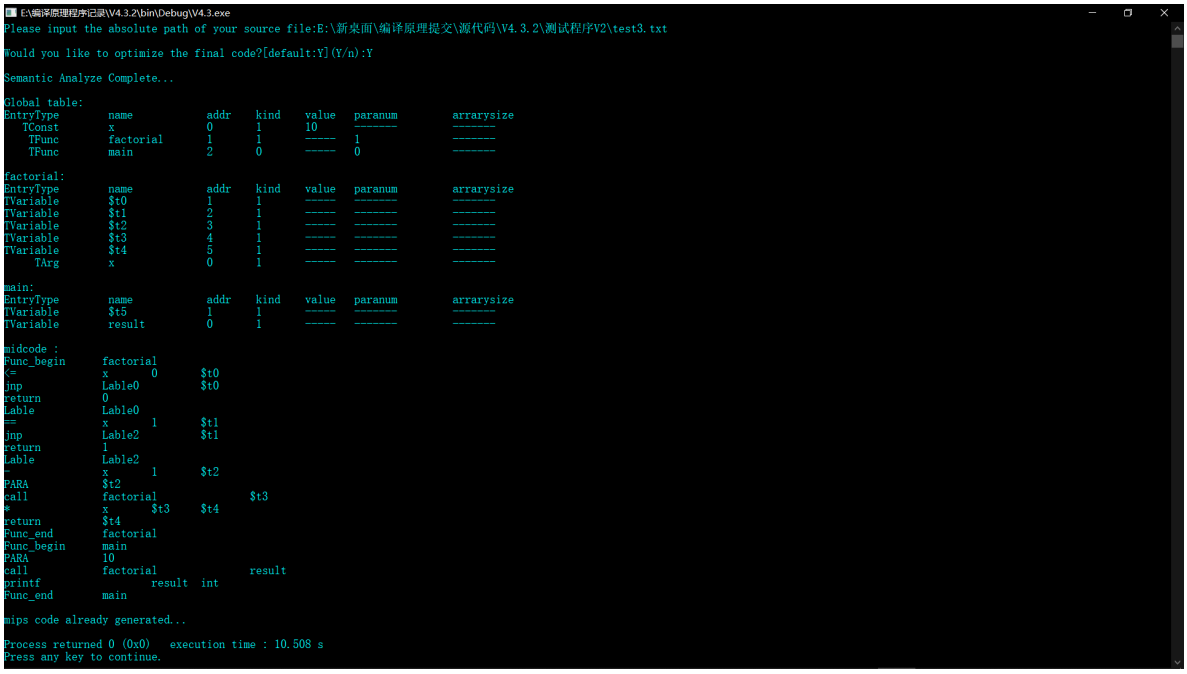
此文档选取一些有代表性的测试程序进行详细说明

1.斐波那契数列

- 源程序

```
const int x = 10;
int factorial(int x)
{
    if(x<=0) return (0);
    if(x==1) return (1);
    return (x*factorial(x - 1));
}

void main()
{
    int result;
    result = factorial(x);
    printf(result);
}
```

- 中间产物



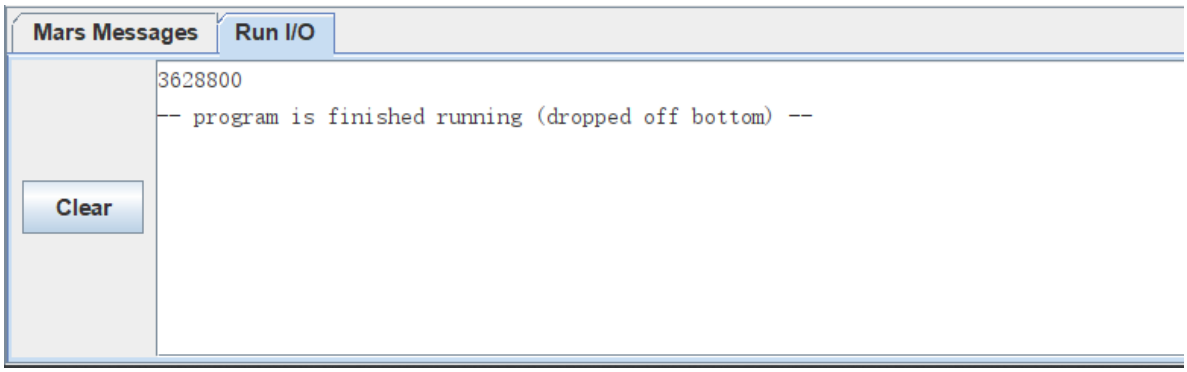
- 经过优化后的汇编代码

```
.data
    x:  .word 10
.text
    j   main
factorial:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,24
    lw  $s0,36($fp)
```

```
    li  $t2,0
    bgt $s0,$t2,Lable0
    li  $v1,0
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
Lable0:
    li  $t2,1
    bne $s0,$t2,Lable2
    li  $v1,1
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
Lable2:
    li  $t2,1
    sub $s1,$s0,$t2
    subi    $sp,$sp,4
    sw  $s1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal factorial
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,4
    add $sp,$sp,$t1
    move    $s2,$v1
    mul $s3,$s0,$s2
    move    $v1,$s3
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
main:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,12
    subi    $sp,$sp,4
```

```
    li  $t1,10
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal factorial
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,4
    add $sp,$sp,$t1
    move    $s0,$v1
    move    $a0,$s0
    li  $v0,1
    syscall
```

- Mars运行结果



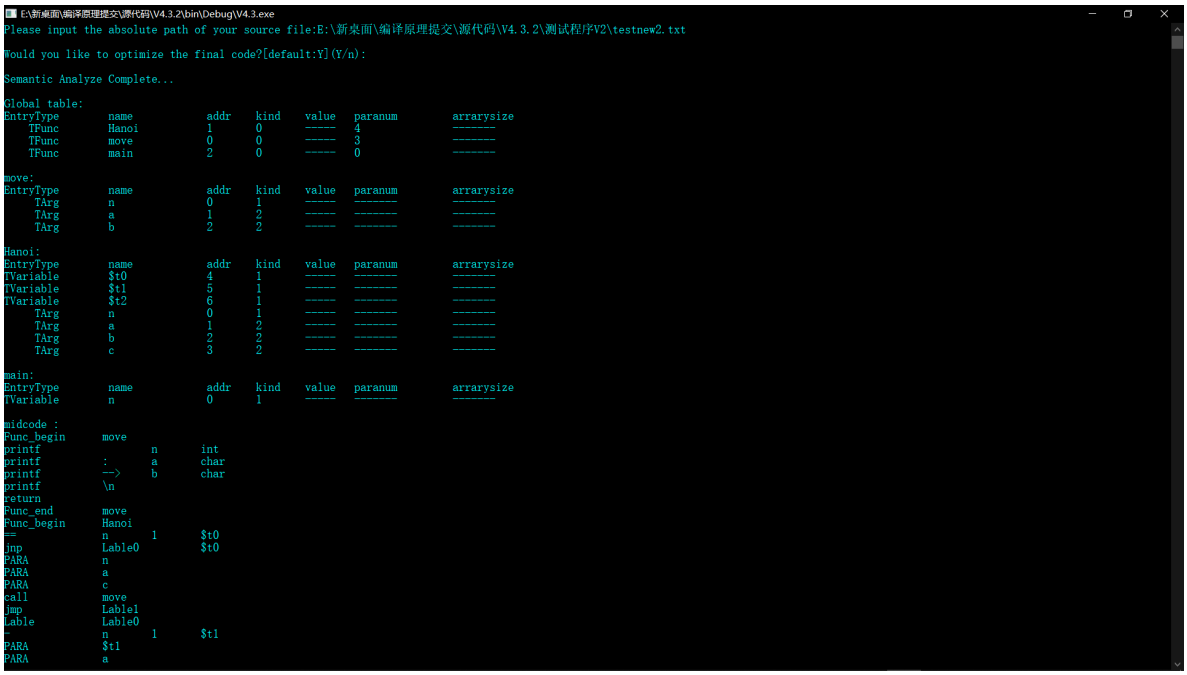
2.汉诺塔问题

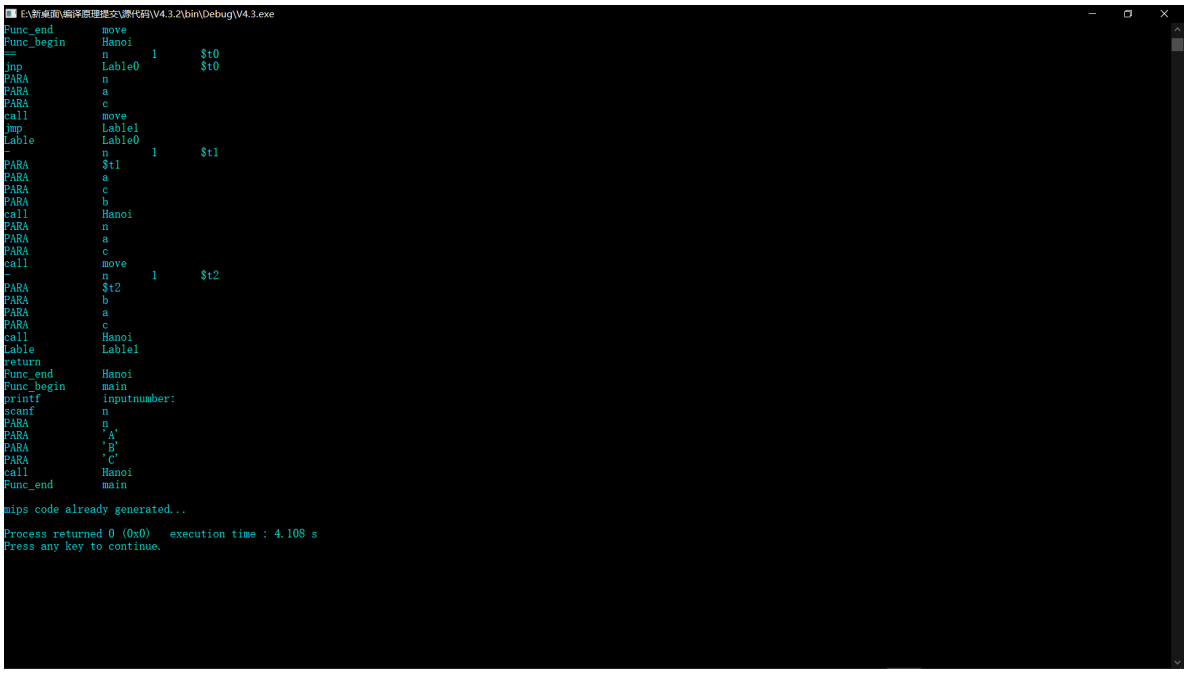
- 源代码

```
void move(int n,char a,char b)
{
        printf(n);
    printf(":",a);
    printf("-->",b);
    printf("\n");
        return;
}
void Hanoi(int n,char a,char b,char c)
{
    if(n==1)
        move(n,a,c);
```

```
    else
    {
        Hanoi(n - 1,a,c,b);
        move(n,a,c);
        Hanoi(n - 1,b,a,c);
    }
   return;
 }
 void main()
{
   int n;
   printf("inputnumber:");
   scanf(n);
   Hanoi(n,'A','B','C');
}
```

- 中间产物





- 经过优化后的汇编代码

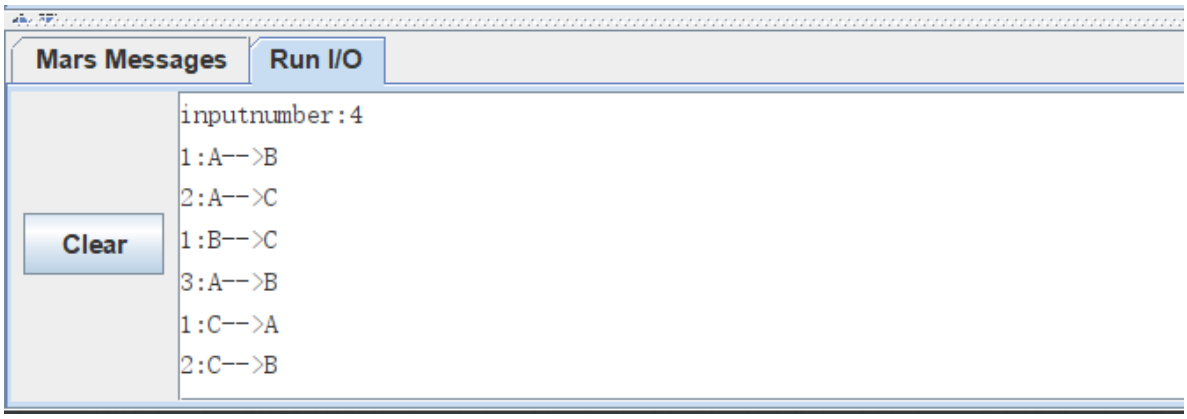
```
.data
    msg1:   .asciiz ":"
    msg2:   .asciiz "-->"
    msg3:   .asciiz "\n"
    msg4:   .asciiz "inputnumber:"
.text
    j   main
move:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,4
    lw  $s0,44($fp)
    lw  $s1,40($fp)
    lw  $s2,36($fp)
    move    $a0,$s0
    li  $v0,1
    syscall
    li  $v0,4
    la  $a0,msg1
    syscall
    move    $a0,$s1
    li  $v0,11
    syscall
    li  $v0,4
    la  $a0,msg2
    syscall
    move    $a0,$s2
    li  $v0,11
    syscall
    li  $v0,4
    la  $a0,msg3
    syscall
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
Hanoi:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,16
    lw  $s0,48($fp)
    lw  $s1,44($fp)
    lw  $s2,36($fp)
    lw  $s4,40($fp)
    li  $t2,1
    bne $s0,$t2,Lable0
    subi    $sp,$sp,4
    sw  $s0,0($sp)
    subi    $sp,$sp,4
```

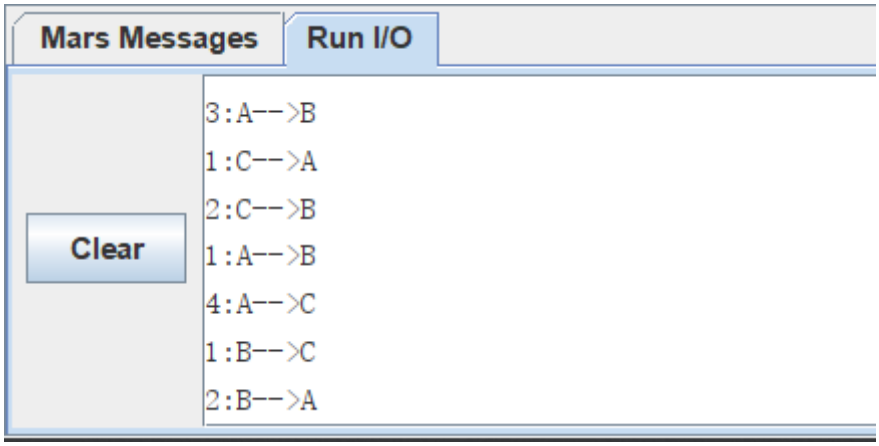
```
    sw  $s1,0($sp)
    subi    $sp,$sp,4
    sw  $s2,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal move
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    j   Lable1
Lable0:
    li  $t2,1
    sub $s3,$s0,$t2
    subi    $sp,$sp,4
    sw  $s3,0($sp)
    subi    $sp,$sp,4
    sw  $s1,0($sp)
    subi    $sp,$sp,4
    sw  $s2,0($sp)
    subi    $sp,$sp,4
    sw  $s4,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal Hanoi
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,16
```

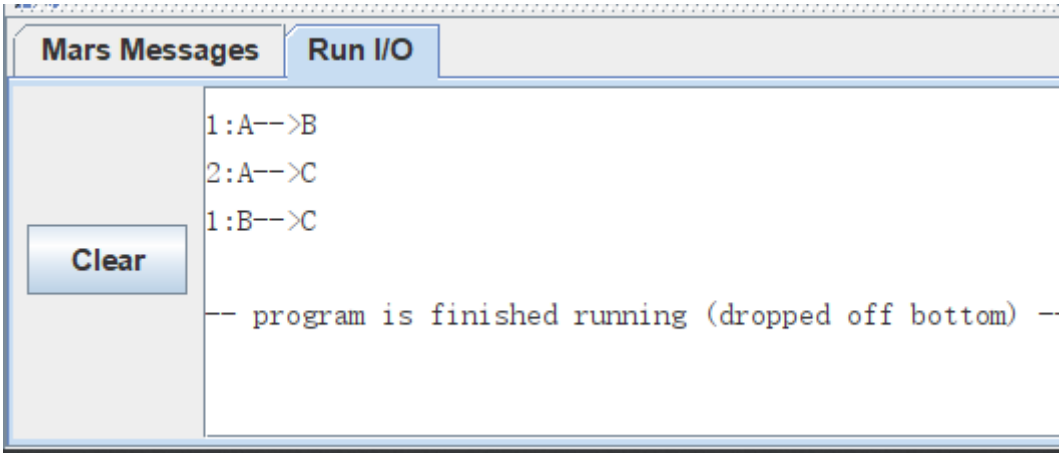
```
    add $sp,$sp,$t1
    subi    $sp,$sp,4
    sw  $s0,0($sp)
    subi    $sp,$sp,4
    sw  $s1,0($sp)
    subi    $sp,$sp,4
    sw  $s2,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal move
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    li  $t2,1
    sub $s5,$s0,$t2
    subi    $sp,$sp,4
    sw  $s5,0($sp)
    subi    $sp,$sp,4
    sw  $s4,0($sp)
    subi    $sp,$sp,4
    sw  $s1,0($sp)
    subi    $sp,$sp,4
    sw  $s2,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal Hanoi
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
```

```
    addi    $sp,$sp,32
    li  $t1,16
    add $sp,$sp,$t1
Lable1:
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
main:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,8
    li  $v0,4
    la  $a0,msg4
    syscall
    li  $v0,5
    syscall
    move    $s0,$v0
    subi    $sp,$sp,4
    sw  $s0,0($sp)
    subi    $sp,$sp,4
    li  $t1,'A'
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,'B'
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,'C'
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal Hanoi
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,16
    add $sp,$sp,$t1
```

- Mars运行结果







3.递归与非递归的折半查找算法

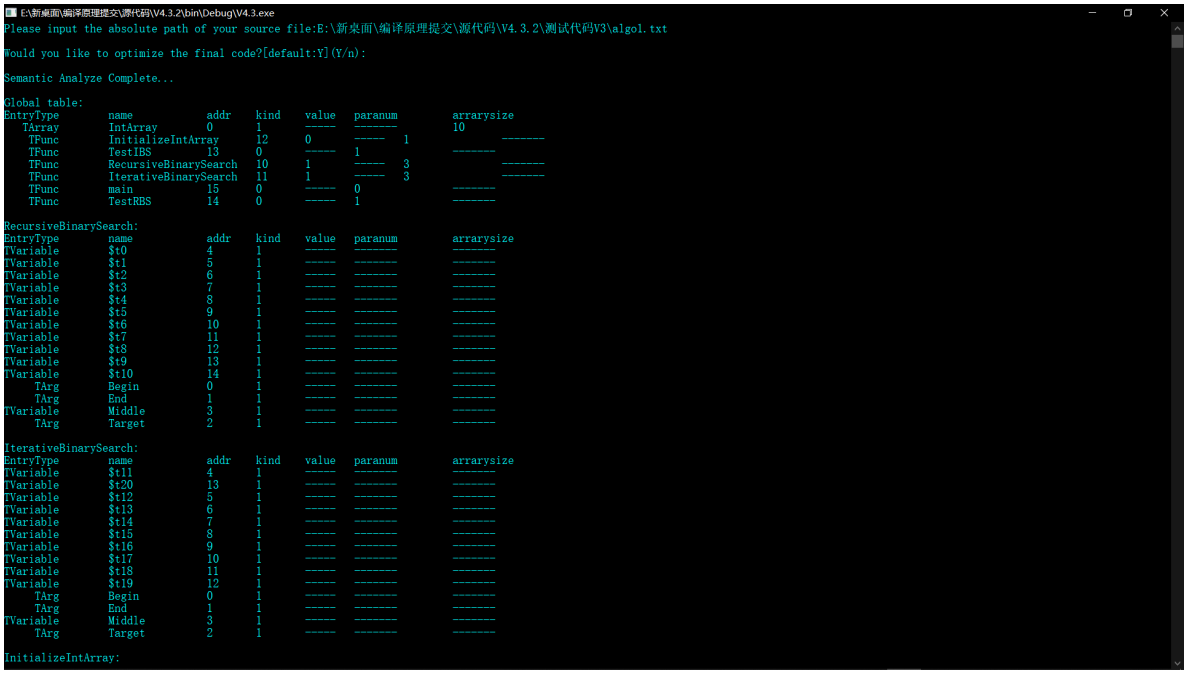
- 源代码

```
int IntArray[10];

int RecursiveBinarySearch(int Begin, int End, int Target) {
  int Middle;

  if (Begin >= End)
    return (-1);

  Middle = Begin + (End - Begin) / 2;
  if (IntArray[Middle] > Target)
    return (RecursiveBinarySearch(Begin, Middle, Target));
  if (IntArray[Middle] < Target)
    return (RecursiveBinarySearch(Middle + 1, End, Target));
```

```
  return (Middle);
}

int IterativeBinarySearch(int Begin, int End, int Target) {
  int Middle;

  if(Begin<End){
  do {
    Middle = Begin + (End - Begin) / 2;
    if (IntArray[Middle] < Target)
      Begin = Middle + 1;
    else if (IntArray[Middle] > Target)
      End = Middle;
    else
      return (Middle);
  }while (Begin < End)
  }

  return (-1);
}

void InitializeIntArray(int a) {
  IntArray[0] = 0;
  IntArray[1] = 1;
  IntArray[2] = 2;
  IntArray[3] = 3;
  IntArray[4] = 4;
  IntArray[5] = 5;
  IntArray[6] = 6;
  IntArray[7] = 7;
  IntArray[8] = 8;
  IntArray[9] = 9;

}

void TestIBS(int a) {
  printf("Test IterativeBinarySearch:");
  printf("Expected 1: ", IterativeBinarySearch(0, 10, 1));
  printf("Expected 5: ", IterativeBinarySearch(0, 10, 5));
  printf("Expected 7: ", IterativeBinarySearch(0, 10, 7));
  printf("Expected -1: ", IterativeBinarySearch(0, 10, 10));

}

void TestRBS(int a) {
  printf("Test RecursiveBinarySearch:");
  printf("Expected 1: ", RecursiveBinarySearch(0, 10, 1));
  printf("Expected 5: ", RecursiveBinarySearch(0, 10, 5));
  printf("Expected 7: ", RecursiveBinarySearch(0, 10, 7));
  printf("Expected -1: ", RecursiveBinarySearch(0, 10, 10));

}

void main() {
  InitializeIntArray(0);
  TestIBS(0);
  TestRBS(0);
```

```
}
```

- 中间产物(部分截图)



- 优化后的汇编代码

```
.data
    IntArray:   .space 40
    msg1:   .asciiz "Test IterativeBinarySearch:"
    msg2:   .asciiz "Expected 1: "
    msg3:   .asciiz "Expected 5: "
    msg4:   .asciiz "Expected 7: "
    msg5:   .asciiz "Expected -1: "
    msg6:   .asciiz "Test RecursiveBinarySearch:"
    msg7:   .asciiz "Expected 1: "
    msg8:   .asciiz "Expected 5: "
    msg9:   .asciiz "Expected 7: "
    msg10:  .asciiz "Expected -1: "
.text
    j   main
RecursiveBinarySearch:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,52
    lw  $s1,44($fp)
    lw  $s2,36($fp)
    lw  $s3,40($fp)
    blt $s1,$s3,Lable0
    li  $v1,-1
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
Lable0:
    sub $s4,$s3,$s1
    li  $t2,2
```

```
    div $s4,$t2
    mflo    $s5
    add $s0,$s1,$s5
    move    $t1,$s0
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    lw  $t2,0($t3)
    move    $s6,$t2
    ble $s6,$s2,Lable2
    subi    $sp,$sp,4
    sw  $s1,0($sp)
    subi    $sp,$sp,4
    sw  $s0,0($sp)
    subi    $sp,$sp,4
    sw  $s2,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal RecursiveBinarySearch
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    move    $s7,$v1
    move    $v1,$s7
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
Lable2:
    move    $t1,$s0
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    lw  $t2,0($t3)
    sw  $t2,-40($fp)
    lw  $t1,-40($fp)
    bge $t1,$s2,Lable4
    li  $t2,1
    lw  $t3,-48($fp)
    add $t3,$s0,$t2
    sw  $t3,-48($fp)
```

```
    subi    $sp,$sp,4
    lw  $t1,-48($fp)
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    sw  $s3,0($sp)
    subi    $sp,$sp,4
    sw  $s2,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal RecursiveBinarySearch
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    sw  $v1,-52($fp)
    lw  $v1,-52($fp)
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
Lable4:
    move    $v1,$s0
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
IterativeBinarySearch:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,48
    lw  $s1,44($fp)
    lw  $s2,40($fp)
    lw  $s6,36($fp)
    bge $s1,$s2,Lable6
Lable7:
    sub $s3,$s2,$s1
    li  $t2,2
    div $s3,$t2
    mflo    $s4
    add $s0,$s1,$s4
```

```
    move    $t1,$s0
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    lw  $t2,0($t3)
    move    $s5,$t2
    bge $s5,$s6,Lable8
    li  $t2,1
    add $s1,$s0,$t2
    j   Lable9
Lable8:
    move    $t1,$s0
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    lw  $t2,0($t3)
    move    $s7,$t2
    ble $s7,$s6,Lable10
    move    $s2,$s0
    j   Lable11
Lable10:
    move    $v1,$s0
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
Lable11:
Lable9:
    blt $s1,$s2,Lable7
Lable6:
    li  $v1,-1
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
InitializeIntArray:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,4
    li  $t1,0
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    li  $t2,0
    sw  $t2,0($t3)
    li  $t1,1
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    li  $t2,1
    sw  $t2,0($t3)
    li  $t1,2
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
```

```
    li  $t2,2
    sw  $t2,0($t3)
    li  $t1,3
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    li  $t2,3
    sw  $t2,0($t3)
    li  $t1,4
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    li  $t2,4
    sw  $t2,0($t3)
    li  $t1,5
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    li  $t2,5
    sw  $t2,0($t3)
    li  $t1,6
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    li  $t2,6
    sw  $t2,0($t3)
    li  $t1,7
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    li  $t2,7
    sw  $t2,0($t3)
    li  $t1,8
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    li  $t2,8
    sw  $t2,0($t3)
    li  $t1,9
    sll $t1,$t1,2
    la  $t2,IntArray
    add $t3,$t2,$t1
    li  $t2,9
    sw  $t2,0($t3)
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
TestIBS:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,20
    li  $v0,4
    la  $a0,msg1
    syscall
    subi    $sp,$sp,4
```

```
    li  $t1,0
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,1
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal IterativeBinarySearch
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    move    $s0,$v1
    li  $v0,4
    la  $a0,msg2
    syscall
    move    $a0,$s0
    li  $v0,1
    syscall
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,5
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal IterativeBinarySearch
    lw  $s7,0($sp)
```

```
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    move    $s1,$v1
    li  $v0,4
    la  $a0,msg3
    syscall
    move    $a0,$s1
    li  $v0,1
    syscall
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,7
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal IterativeBinarySearch
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    move    $s2,$v1
    li  $v0,4
    la  $a0,msg4
    syscall
    move    $a0,$s2
    li  $v0,1
    syscall
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
```

```
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal IterativeBinarySearch
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    move    $s3,$v1
    li  $v0,4
    la  $a0,msg5
    syscall
    move    $a0,$s3
    li  $v0,1
    syscall
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
TestRBS:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,20
    li  $v0,4
    la  $a0,msg6
    syscall
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,1
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
```

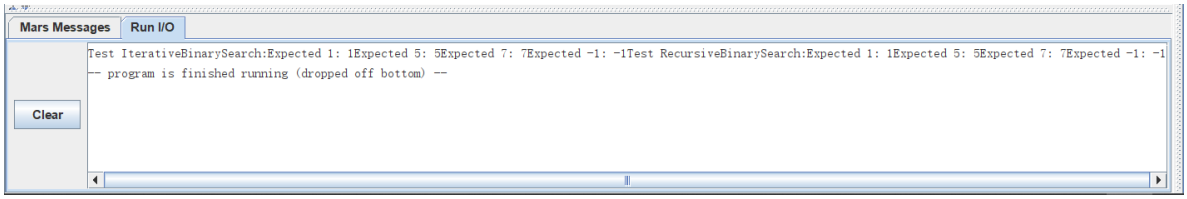
```
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal RecursiveBinarySearch
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    move    $s0,$v1
    li  $v0,4
    la  $a0,msg7
    syscall
    move    $a0,$s0
    li  $v0,1
    syscall
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,5
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal RecursiveBinarySearch
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
```

```
    add $sp,$sp,$t1
    move    $s1,$v1
    li  $v0,4
    la  $a0,msg8
    syscall
    move    $a0,$s1
    li  $v0,1
    syscall
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,7
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal RecursiveBinarySearch
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    move    $s2,$v1
    li  $v0,4
    la  $a0,msg9
    syscall
    move    $a0,$s2
    li  $v0,1
    syscall
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    subi    $sp,$sp,4
    li  $t1,10
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
```

```
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal RecursiveBinarySearch
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,12
    add $sp,$sp,$t1
    move    $s3,$v1
    li  $v0,4
    la  $a0,msg10
    syscall
    move    $a0,$s3
    li  $v0,1
    syscall
    add $sp,$fp,$0
    lw  $ra,0($sp)
    addi    $sp,$sp,4
    lw  $fp,-8($sp)
    jr  $ra
main:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,4
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal InitializeIntArray
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
```

```
    addi    $sp,$sp,32
    li  $t1,4
    add $sp,$sp,$t1
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal TestIBS
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,4
    add $sp,$sp,$t1
    subi    $sp,$sp,4
    li  $t1,0
    sw  $t1,0($sp)
    sw  $s0,-4($sp)
    sw  $s1,-8($sp)
    sw  $s2,-12($sp)
    sw  $s3,-16($sp)
    sw  $s4,-20($sp)
    sw  $s5,-24($sp)
    sw  $s6,-28($sp)
    sw  $s7,-32($sp)
    subi    $sp,$sp,32
    subi    $sp,$sp,4
    jal TestRBS
    lw  $s7,0($sp)
    lw  $s6,4($sp)
    lw  $s5,8($sp)
    lw  $s4,12($sp)
    lw  $s3,16($sp)
    lw  $s2,20($sp)
    lw  $s1,24($sp)
    lw  $s0,28($sp)
    addi    $sp,$sp,32
    li  $t1,4
    add $sp,$sp,$t1
```

- Mars运行结果

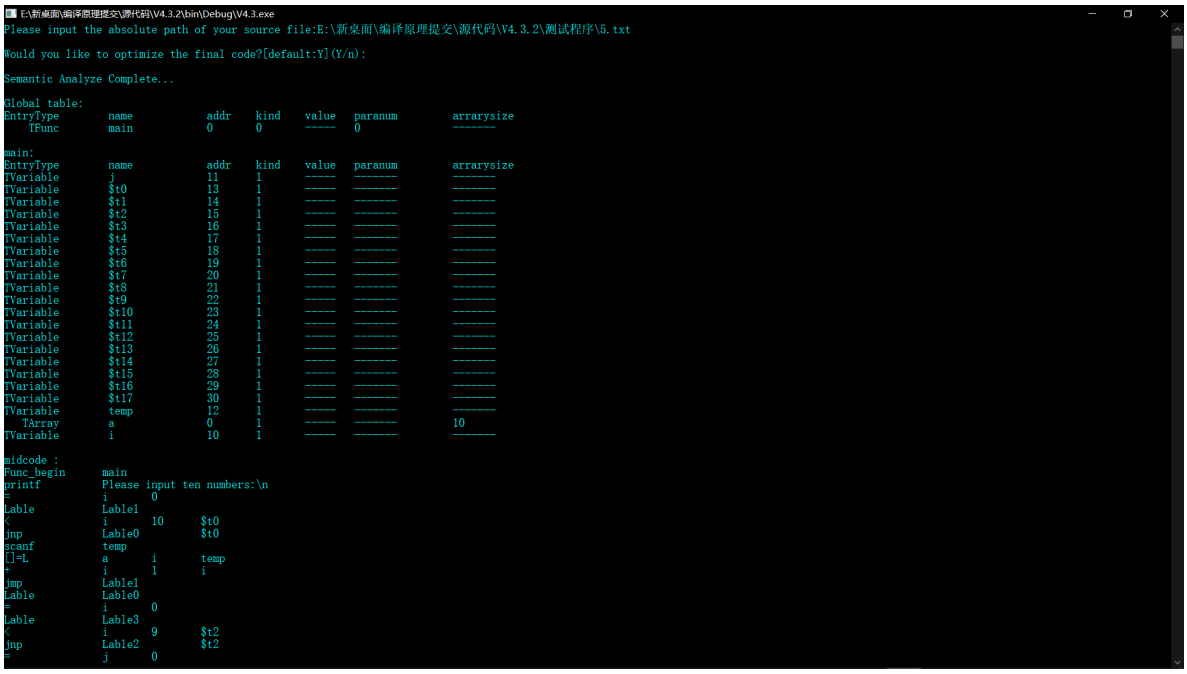


4.冒泡排序

- 源代码

```
void main()
{
	int a[10];
	int i, j, temp;
	printf("Please input ten numbers:\n");
	for (i = 0; i < 10; i=i + 1) {
		scanf(temp);
	  a[i]=temp;
	}
	for (i = 0; i < 9; i=i + 1) {

		for (j = 0; j < 9 - i; j=j + 1)
		if (a[j] > a[j + 1])
		{
			temp = a[j];
			a[j] = a[j + 1];
			a[j + 1] = temp;
		 }
	}


	for (i = 0; i < 10; i=i + 1)
		printf(a[i]);

	return ;
}
```

- 中间产物(部分截图)

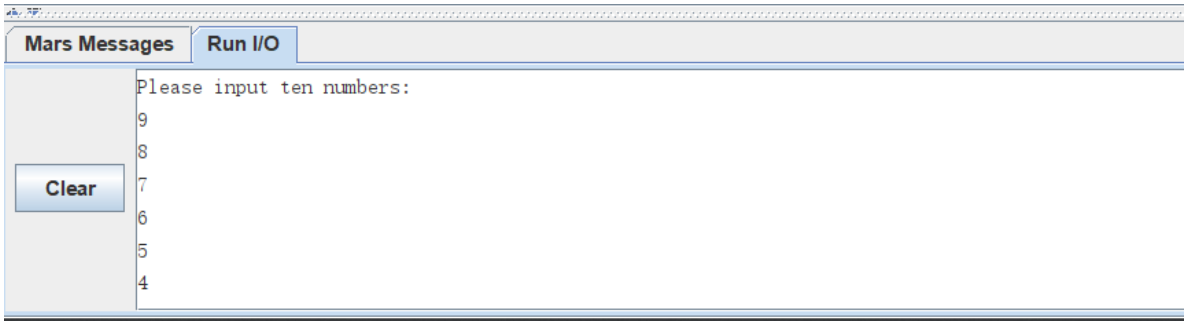


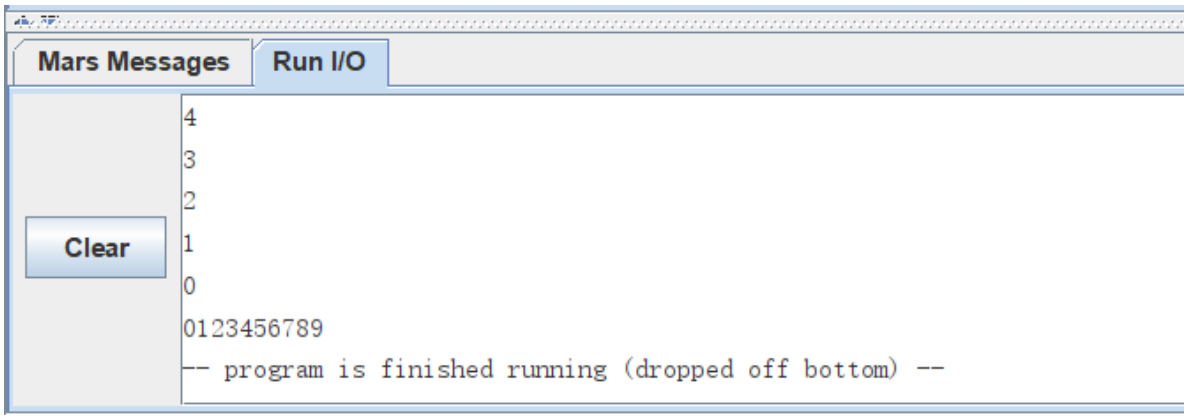
- 优化后的汇编

```
.data
    msg1:   .asciiz "Please input ten numbers:\n"
.text
    j   main
main:
    sw  $ra,0($sp)
    sw  $fp,-4($sp)
    add $fp,$sp,$0
    subi    $sp,$sp,128
    li  $v0,4
    la  $a0,msg1
    syscall
    li  $t2,0
    move    $s0,$t2
Lable1:
    li  $t2,10
    bge $s0,$t2,Lable0
    li  $v0,5
    syscall
    move    $s2,$v0
    move    $t1,$s0
    sll $t1,$t1,2
    la  $t2,-8($fp)
    sub $t3,$t2,$t1
    sw  $s2,0($t3)
    li  $t2,1
    add $s0,$s0,$t2
    j   Lable1
Lable0:
    li  $t2,0
    move    $s0,$t2
Lable3:
    li  $t2,9
    bge $s0,$t2,Lable2
    li  $t2,0
    move    $s1,$t2
Lable5:
    li  $t1,9
    sub $s4,$t1,$s0
    bge $s1,$s4,Lable4
    move    $t1,$s1
    sll $t1,$t1,2
    la  $t2,-8($fp)
    sub $t3,$t2,$t1
    lw  $t2,0($t3)
    move    $s5,$t2
    li  $t2,1
    add $s6,$s1,$t2
    move    $t1,$s6
    sll $t1,$t1,2
    la  $t2,-8($fp)
    sub $t3,$t2,$t1
    lw  $t2,0($t3)
    move    $s7,$t2
    ble $s5,$s7,Lable6
```

```
    move    $t1,$s1
    sll $t1,$t1,2
    la  $t2,-8($fp)
    sub $t3,$t2,$t1
    lw  $t2,0($t3)
    sw  $t2,-96($fp)
    lw  $t2,-96($fp)
    move    $s2,$t2
    li  $t2,1
    add $s3,$s1,$t2
    move    $t1,$s3
    sll $t1,$t1,2
    la  $t2,-8($fp)
    sub $t3,$t2,$t1
    lw  $t2,0($t3)
    sw  $t2,-104($fp)
    move    $t1,$s1
    sll $t1,$t1,2
    la  $t2,-8($fp)
    sub $t3,$t2,$t1
    lw  $t2,-104($fp)
    sw  $t2,0($t3)
    sw  $s3,-108($fp)
    lw  $t1,-108($fp)
    sll $t1,$t1,2
    la  $t2,-8($fp)
    sub $t3,$t2,$t1
    sw  $s2,0($t3)
Lable6:
    li  $t2,1
    add $s1,$s1,$t2
    j   Lable5
Lable4:
    li  $t2,1
    add $s0,$s0,$t2
    j   Lable3
Lable2:
    li  $t2,0
    move    $s0,$t2
Lable9:
    li  $t2,10
    bge $s0,$t2,Lable8
    move    $t1,$s0
    sll $t1,$t1,2
    la  $t2,-8($fp)
    sub $t3,$t2,$t1
    lw  $t2,0($t3)
    sw  $t2,-124($fp)
    lw  $a0,-124($fp)
    li  $v0,1
    syscall
    li  $t2,1
    add $s0,$s0,$t2
    j   Lable9
Lable8:
```

- Mars运行结果


Mars Messages
Run I/O
Clear
Please input ten numbers:
9
8
7
6
5
4


Mars Messages
Run I/O
Clear
4
3
2
1
0
0123456789
-- program is finished running (dropped off bottom) --