

## CSE 378, 06wi – Lecture 5 Main Points

### Cebollita: Compile/Assemble/Link

January 18, 2006

```
[ginger] ~> echo $CLASSPATH
```

```
/u5/zahorjan/cebollita:/u5/zahorjan/cebollita/jlex.jar:/u5/zahorjan/cebollita/cup.jar
```

```
[ginger] ~/cse378/06wi/Lecture5> cat fact.c
```

```
int N = 5;
int result = 1;

int main() {
    while ( N != 0 ) {
        result = result * N;
        N = N - 1;
    }

    printString("The factorial is: ");
    printInt( result);
    printString("\n");
}
```

```
[ginger] ~/cse378/06wi/Lecture5> cebcc fact.c
```

```
main: ([])
```

```
[ginger] ~/cse378/06wi/Lecture5> cat fact.s
```

```
.data
__L1:  .asciiz "The factorial is: "
__L2:  .asciiz "\n"
N:     .word 5
result: .word 1
.text
# -----
#      FuncDef for main([])
#      .global main
main:  addi $sp, $sp, -8
      sw $ra, 0($sp)
      sw $fp, 4($sp)
      add $fp, $0, $sp
#      while ((!= N 0))
#      (!= N 0)
      ori $t0, $0, N
      add $t0, $t0, $gp
      lw $t0, 0($t0)
      addi $t1, $0, 0
      sub $t2, $t0, $t1
      beq $0, $t2, __L5
__L4:  #      result = (* result N)
      ori $t0, $0, result
      add $t0, $t0, $gp
#      (* result N)
      ori $t1, $0, result
      add $t1, $t1, $gp
      lw $t1, 0($t1)
      ori $t3, $0, N
      add $t3, $t3, $gp
      lw $t3, 0($t3)
      mult $t4, $t1, $t3
      sw $t4, 0($t0)
#      N = (- N 1)
```

```

        ori $t0, $0, N
        add $t0, $t0, $gp
#       (- N 1)
        ori $t1, $0, N
        add $t1, $t1, $gp
        lw $t1, 0($t1)
        addi $t3, $0, 1
        sub $t4, $t1, $t3
#       (!= N 0)
        ori $t0, $0, N
        add $t0, $t0, $gp
        lw $t0, 0($t0)
        addi $t1, $0, 0
        sub $t3, $t0, $t1
        bne $0, $t3, __L4
__L5:
#       printString(["The factorial is: "])
        addi $sp, $sp, -4
#       ""The factorial is: ""
        ori $t0, $0, __L1
        add $t0, $t0, $gp
        sw $t0, 0($sp)
        jal printString
        addi $sp, $sp, 4
        add $t0, $0, $v0
#       printInt([result])
        addi $sp, $sp, -4
        ori $t0, $0, result
        add $t0, $t0, $gp
        lw $t0, 0($t0)
        sw $t0, 0($sp)
        jal printInt
        addi $sp, $sp, 4
        add $t0, $0, $v0
#       printString(["\n"])
        addi $sp, $sp, -4
#       ""\n""
        ori $t0, $0, __L2
        add $t0, $t0, $gp
        sw $t0, 0($sp)
        jal printString
        addi $sp, $sp, 4
        add $t0, $0, $v0
__L3:
        lw $ra, 0($fp)
        lw $fp, 4($fp)
        addi $sp, $sp, 8
        jr $ra

```

**[ginger] ~/cse378/06wi/Lecture5> cebasm fact.s**

**[ginger] ~/cse378/06wi/Lecture5> cebumpm fact.o**

fact.o

```

SymTabSize: 44
  {N:= [0], __L1:= [4], __L2:= [24], main:= [0], result:= [28]}
RefTabSize: 96
  {N:= [16, 60, 80, 88, 112], __L1:= [140], __L2:= [200], printInt:= [184],
printString:= [152, 212], result:= [40, 48, 168]}
DataSize: 32
TextSize: 240
00000000 0x23bdfff8: addi    $sp, $sp, -8
00000004 0xafbf0000: sw      $ra, 0($sp)
00000008 0xafbe0004: sw      $fp, 4($sp)
0000000c 0x001df020: add     $fp, $0, $sp

```

```

00000010 0x34080000: ori    $t0, $0, 0
00000014 0x011c4020: add   $t0, $t0, $gp
00000018 0x8d080000: lw    $t0, 0($t0)
0000001c 0x20090000: addi  $t1, $0, 0
00000020 0x01095022: sub   $t2, $t0, $t1
00000024 0x11400018: beq   $0, $t2, 24
00000028 0x34080000: ori    $t0, $0, 0
0000002c 0x011c4020: add   $t0, $t0, $gp
00000030 0x34090000: ori    $t1, $0, 0
00000034 0x013c4820: add   $t1, $t1, $gp
00000038 0x8d290000: lw    $t1, 0($t1)
0000003c 0x340b0000: ori    $t3, $0, 0
00000040 0x017c5820: add   $t3, $t3, $gp
00000044 0x8d6b0000: lw    $t3, 0($t3)
00000048 0x012b6018: mult  $t4, $t1, $t3
0000004c 0xad0c0000: sw    $t4, 0($t0)
00000050 0x34080000: ori    $t0, $0, 0
00000054 0x011c4020: add   $t0, $t0, $gp
00000058 0x34090000: ori    $t1, $0, 0
0000005c 0x013c4820: add   $t1, $t1, $gp
00000060 0x8d290000: lw    $t1, 0($t1)
00000064 0x200b0001: addi  $t3, $0, 1
00000068 0x012b6022: sub   $t4, $t1, $t3
0000006c 0xad0c0000: sw    $t4, 0($t0)
00000070 0x34080000: ori    $t0, $0, 0
00000074 0x011c4020: add   $t0, $t0, $gp
00000078 0x8d080000: lw    $t0, 0($t0)
0000007c 0x20090000: addi  $t1, $0, 0
00000080 0x01095822: sub   $t3, $t0, $t1
00000084 0x1560ffe8: bne   $0, $t3, -24
00000088 0x23bdfffc: addi  $sp, $sp, -4
0000008c 0x34080000: ori    $t0, $0, 0
00000090 0x011c4020: add   $t0, $t0, $gp
00000094 0xafa80000: sw    $t0, 0($sp)
00000098 0x0c000000: jal   0x0
0000009c 0x23bd0004: addi  $sp, $sp, 4
000000a0 0x00024020: add   $t0, $0, $v0
000000a4 0x23bdfffc: addi  $sp, $sp, -4
000000a8 0x34080000: ori    $t0, $0, 0
000000ac 0x011c4020: add   $t0, $t0, $gp
000000b0 0x8d080000: lw    $t0, 0($t0)
000000b4 0xafa80000: sw    $t0, 0($sp)
000000b8 0x0c000000: jal   0x0
000000bc 0x23bd0004: addi  $sp, $sp, 4
000000c0 0x00024020: add   $t0, $0, $v0
000000c4 0x23bdfffc: addi  $sp, $sp, -4
000000c8 0x34080000: ori    $t0, $0, 0
000000cc 0x011c4020: add   $t0, $t0, $gp
000000d0 0xafa80000: sw    $t0, 0($sp)
000000d4 0x0c000000: jal   0x0
000000d8 0x23bd0004: addi  $sp, $sp, 4
000000dc 0x00024020: add   $t0, $0, $v0
000000e0 0x8fdf0000: lw    $ra, 0($fp)
000000e4 0x8fde0004: lw    $fp, 4($fp)
000000e8 0x23bd0008: addi  $sp, $sp, 8
000000ec 0x03e00008: jr    $0, $ra, $0

```

[ginger] ~/cse378/06wi/Lecture5> ceblink prologue-os.o fact.o iolib-os.o

Linking:

```

  prologue-os.o
  fact.o
  iolib-os.o

```

Setting entry to : 0x0

[ginger] ~/cse378/06wi/Lecture5> cebdumpe a.out

```

Text size: 0x00000168
Data size: 0x00000028
Stack size: 0x00000800
Heap size: 0x00000200
Entry point: 0x00000000
00000000 0x0c000003: jal      0x3
00000004 0x3402000a: ori      $v0, $0, 10
00000008 0x0000000c: syscall $0, $0, $0
0000000c 0x23bdfff8: addi    $sp, $sp, -8
00000010 0xafbf0000: sw      $ra, 0($sp)
00000014 0xafbe0004: sw      $fp, 4($sp)
00000018 0x001df020: add     $fp, $0, $sp
0000001c 0x34080000: ori     $t0, $0, 0
00000020 0x011c4020: add     $t0, $t0, $gp
00000024 0x8d080000: lw      $t0, 0($t0)
00000028 0x20090000: addi    $t1, $0, 0
0000002c 0x01095022: sub     $t2, $t0, $t1
00000030 0x11400018: beq     $0, $t2, 24
00000034 0x3408001c: ori     $t0, $0, 28
00000038 0x011c4020: add     $t0, $t0, $gp
0000003c 0x3409001c: ori     $t1, $0, 28
00000040 0x013c4820: add     $t1, $t1, $gp
00000044 0x8d290000: lw      $t1, 0($t1)
00000048 0x340b0000: ori     $t3, $0, 0
0000004c 0x017c5820: add     $t3, $t3, $gp
00000050 0x8d6b0000: lw      $t3, 0($t3)
00000054 0x012b6018: mult   $t4, $t1, $t3
00000058 0xad0c0000: sw      $t4, 0($t0)
0000005c 0x34080000: ori     $t0, $0, 0
00000060 0x011c4020: add     $t0, $t0, $gp
00000064 0x34090000: ori     $t1, $0, 0
00000068 0x013c4820: add     $t1, $t1, $gp
0000006c 0x8d290000: lw      $t1, 0($t1)
00000070 0x200b0001: addi    $t3, $0, 1
00000074 0x012b6022: sub     $t4, $t1, $t3
00000078 0xad0c0000: sw      $t4, 0($t0)
0000007c 0x34080000: ori     $t0, $0, 0
00000080 0x011c4020: add     $t0, $t0, $gp
00000084 0x8d080000: lw      $t0, 0($t0)
00000088 0x20090000: addi    $t1, $0, 0
0000008c 0x01095822: sub     $t3, $t0, $t1
00000090 0x1560ffe8: bne    $0, $t3, -24
00000094 0x23bdfffc: addi    $sp, $sp, -4
00000098 0x34080004: ori     $t0, $0, 4
0000009c 0x011c4020: add     $t0, $t0, $gp
000000a0 0xaf800000: sw      $t0, 0($sp)
000000a4 0x0c000046: jal     0x46
000000a8 0x23bd0004: addi    $sp, $sp, 4
000000ac 0x00024020: add     $t0, $0, $v0
000000b0 0x23bdfffc: addi    $sp, $sp, -4
000000b4 0x3408001c: ori     $t0, $0, 28
000000b8 0x011c4020: add     $t0, $t0, $gp
000000bc 0x8d080000: lw      $t0, 0($t0)
000000c0 0xaf800000: sw      $t0, 0($sp)
000000c4 0x0c000042: jal     0x42
000000c8 0x23bd0004: addi    $sp, $sp, 4
000000cc 0x00024020: add     $t0, $0, $v0
000000d0 0x23bdfffc: addi    $sp, $sp, -4
000000d4 0x34080018: ori     $t0, $0, 24
000000d8 0x011c4020: add     $t0, $t0, $gp
000000dc 0xaf800000: sw      $t0, 0($sp)
000000e0 0x0c000046: jal     0x46
000000e4 0x23bd0004: addi    $sp, $sp, 4

```

```
000000e8      0x00024020: add      $t0, $0, $v0
000000ec      0x8fdf0000: lw        $ra, 0($fp)
000000f0      0x8fde0004: lw        $fp, 4($fp)
000000f4      0x23bd0008: addi     $sp, $sp, 8
000000f8      0x03e00008: jr       $0, $ra, $0
000000fc      0x34020005: ori      $v0, $0, 5
00000100      0x0000000c: syscall  $0, $0, $0
00000104      0x03e00008: jr       $0, $ra, $0
00000108      0x34020001: ori      $v0, $0, 1
0000010c      0x8fa40000: lw        $a0, 0($sp)
00000110      0x0000000c: syscall  $0, $0, $0
00000114      0x03e00008: jr       $0, $ra, $0
00000118      0x34020004: ori      $v0, $0, 4
0000011c      0x8fa40000: lw        $a0, 0($sp)
00000120      0x0000000c: syscall  $0, $0, $0
00000124      0x03e00008: jr       $0, $ra, $0
00000128      0x34020007: ori      $v0, $0, 7
0000012c      0x0000000c: syscall  $0, $0, $0
00000130      0x03e00008: jr       $0, $ra, $0
00000134      0x34020008: ori      $v0, $0, 8
00000138      0x8fa40000: lw        $a0, 0($sp)
0000013c      0x8fa50004: lw        $a1, 4($sp)
00000140      0x0000000c: syscall  $0, $0, $0
00000144      0x03e00008: jr       $0, $ra, $0
00000148      0x3402000a: ori      $v0, $0, 10
0000014c      0x8fa40000: lw        $a0, 0($sp)
00000150      0x0000000c: syscall  $0, $0, $0
00000154      0x03e00008: jr       $0, $ra, $0
00000158      0x3402000b: ori      $v0, $0, 11
0000015c      0x8fa40000: lw        $a0, 0($sp)
00000160      0x0000000c: syscall  $0, $0, $0
00000164      0x03e00008: jr       $0, $ra, $0
```