

Advanced Reconfigurable Computing DLX Assembler Requirements

Introduction

Your task is to design an assembler that translates DLX assembly language programs into Intel .mif files (one file for data segment and one for code segment).

Requirements

1. You can use any programming language you prefer to write your assembler. Suggested languages are C, C++, or Python. Write good, maintainable code as we are going to use the assembler throughout the semester.
2. The assembler should handle the entire DLX instruction set described in the class lecture notes. Remember that we are implementing a super-sub-set of DLX, so be careful when looking at 3rd party references. The assembler should also be able to identify code and data segments, variables (remember all variables are arrays), and labels.
3. Executing the compiler from the command line should follow this format:

```
$ ./dlx_asm <source_file>.dlx <data_file>.mif <code_file>.mif
```
4. Embedding comments in the .mif files may be useful, but is not required.

Pass-off

This is a complex assignment, thus there is a two-part pass-off.

1. 10 points – Demonstrate that your tool can successfully ingest example1.dlx, example2.dlx, and example3.dlx, and produce the appropriate output files for each input.
2. 10 points – Write your own DLX program, using at least one function call, that computes a factorial. You should have two scalar variables, one named `n` that contains the original number and one named `f`, in which the result of the factorial computation is stored. Demonstrate your source code and your successful .mif outputs.

The following pages contain the source code (.dlx) for the three examples plus data segment and code segment outputs for each.

example1.dlx

```
;This is a comment
;Comments always consume entire lines

.data
n      1      10
result 1      0

.text
    ADDI R1, R0, 0
    ADDI R2, R0, 1
    LW    R10, n(R0)

top
    SLEI R11, R10, 1
    BNEZ R11, exit
    ADD  R3, R1, R2
    ADDI R1, R2, 0
    ADDI R2, R3, 0
    SUBI R10, R10, 1
    J    top

exit
    SW    result(R0), R3

done
    J    done
```

data1.mif

```
DEPTH = 1024;
WIDTH = 32;
ADDRESS_RADIX = HEX;
DATA_RADIX = HEX;
CONTENT
BEGIN

000 : 0000000A; --n[0]
001 : 00000000; --result[0]

END;
```

code1.mif

```
DEPTH = 1024;
WIDTH = 32;
ADDRESS_RADIX = HEX;
DATA_RADIX = HEX;
CONTENT
BEGIN

000 : 10200000; --ADDI      R1, R0, 0
001 : 10400001; --ADDI      R2, R0, 1
002 : 05400000; --LW       R10, n(R0)
003 : 816A0001; --SLEI      R11, R10, 1
004 : B160000A; --BNEZ     R11, 00A
005 : 0C611000; --ADD       R3, R1, R2
006 : 10220000; --ADDI      R1, R2, 0
007 : 10430000; --ADDI      R2, R3, 0
008 : 214A0001; --SUBI     R10, R10, 1
009 : B4000003; --J        003
00A : 08600001; --SW       result(R0), R3
00B : B400000B; --J       00B

END;
```

example2.dlx

```
.data
m      1      10
n      1      5
a      1      0

.text
LW    R5, m(R0)
LW    R6, n(R0)
ADDI R1, R5, 0
ADDI R2, R6, 0
JAL   func
SW    a(R0), R1

done
J     done

func
;R7 is loop counter
;R8 is sum
ADDI R7, R0, 0
ADDI R8, R0, 0

loop
ADDI R9, R0, 0
SLTI R9, R7, 32
BEQZ R9, loop_done
ANDI R10, R2, 1
BEQZ R10, if_done
ADDI R8, R8, 1

if_done
SLLI R1, R1, 1
SRLI R2, R2, 1
J     loop

loop_done
JR   R31
```

data2.mif

```
DEPTH = 1024;
WIDTH = 32;
ADDRESS_RADIX = HEX;
DATA_RADIX = HEX;
CONTENT
BEGIN

000 : 0000000A; --m[0]
001 : 00000005; --n[0]
002 : 00000000; --a[0]

END;
```

code2.mif

```
DEPTH = 1024;
WIDTH = 32;
ADDRESS_RADIX = HEX;
DATA_RADIX = HEX;
CONTENT
BEGIN

000 : 04A00000; --LW      R5, m(R0)
001 : 04C00001; --LW      R6, n(R0)
002 : 10250000; --ADDI    R1, R5, 0
003 : 10460000; --ADDI    R2, R6, 0
004 : BC000007; --JAL    007
005 : 08200002; --SW      a(R0), R1
006 : B4000006; --J      006
007 : 10E00000; --ADDI    R7, R0, 0
008 : 11000000; --ADDI    R8, R0, 0
009 : 11200000; --ADDI    R9, R0, 0
00A : 61270020; --SLTI   R9, R7, 32
00B : AD200012; --BEQZ   R9, 012
00C : 31420001; --ANDI   R10, R2, 1
00D : AD40000F; --BEQZ   R10, 00F
00E : 11080001; --ADDI   R8, R8, 1
00F : 48210001; --SLLI   R1, R1, 1
010 : 50420001; --SRLI   R2, R2, 1
011 : B4000009; --J      009
012 : B800001F; --JR     R31

END;
```

example3.dlx

```
.data
m      10      1 2 3 4 5 6 7 8 9 10
a      10      0 0 0 0 0 0 0 0 0 0

.text
;R12 is loop counter
ADD    R12, R0, R0

m_loop
LW    R5, m(R12)
ADD   R6, R5, R0
ADD   R1, R5, R0
ADD   R2, R6, R0
JAL   func
SW    a(R12), R1
ADDI  R12, R12, 1
SGEI  R13, R12, 10
BEQZ R13, m_loop

done
J     done

func
;R7 is loop counter
;R8 is sum
ADDI  R7, R0, 0
ADDI  R8, R0, 0

f_loop
ADDI  R9, R0, 0
SLTI  R9, R7, 32
BEQZ R9, loop_done
ANDI  R10, R2, 1
BEQZ R10, if_done
ADDI  R8, R8, 1

if_done
SLLI  R1, R1, 1
SRLI  R2, R2, 1
J     f_loop

loop_done
JR   R31
```

data3.mif

```
DEPTH = 1024;
WIDTH = 32;
ADDRESS_RADIX = HEX;
DATA_RADIX = HEX;
CONTENT
BEGIN

000 : 00000001; --m[0]
001 : 00000002; --m[1]
002 : 00000003; --m[2]
003 : 00000004; --m[3]
004 : 00000005; --m[4]
005 : 00000006; --m[5]
006 : 00000007; --m[6]
007 : 00000008; --m[7]
008 : 00000009; --m[8]
009 : 0000000A; --m[9]
00A : 00000000; --a[0]
00B : 00000000; --a[1]
00C : 00000000; --a[2]
00D : 00000000; --a[3]
00E : 00000000; --a[4]
00F : 00000000; --a[5]
010 : 00000000; --a[6]
011 : 00000000; --a[7]
012 : 00000000; --a[8]
013 : 00000000; --a[9]

END;
```

code3.mif

```
DEPTH = 1024;
WIDTH = 32;
ADDRESS_RADIX = HEX;
DATA_RADIX = HEX;
CONTENT
BEGIN

000 : 0D800000; --ADD      R12, R0, R0
001 : 04AC0000; --LW       R5, m(R12)
002 : 0CC50000; --ADD      R6, R5, R0
003 : 0C250000; --ADD      R1, R5, R0
004 : 0C460000; --ADD      R2, R6, R0
005 : BC00000B; --JAL      00B
006 : 082C000A; --SW       a(R12), R1
007 : 118C0001; --ADDI     R12, R12, 1
008 : 91AC000A; --SGEI    R13, R12, 10
009 : ADA00001; --BEQZ    R13, 001
00A : B400000A; --J       00A
00B : 10E00000; --ADDI    R7, R0, 0
00C : 11000000; --ADDI    R8, R0, 0
00D : 11200000; --ADDI    R9, R0, 0
00E : 61270020; --SLTI    R9, R7, 32
00F : AD200016; --BEQZ    R9, 016
010 : 31420001; --ANDI    R10, R2, 1
011 : AD400013; --BEQZ    R10, 013
012 : 11080001; --ADDI    R8, R8, 1
013 : 48210001; --SLLI    R1, R1, 1
014 : 50420001; --SRLI    R2, R2, 1
015 : B400000D; --J       00D
016 : B800001F; --JR      R31

END;
```