cs61c, Spring 1998
Midterm #1
Professor Clancy

Problem #1 (7 points, 14 minutes)

In lab assignment 4, you wrote a function that returned the contents of the various fields of a MIPS I-format instruction. In this problem we consider a similar task for the Prune 100 computer. The Prune, like the MIPS, has 32-bit instructions. The Prune has only 16 registers. In an I-format Prune instruction, the meaning of the bits is as follows.

```
     The first 8 bits are the op code.
     The next 4 bits are the register to be modified by the instruction.
     The last 20 bits are the immediate operand, in 1's complement.

Thus the equivalent to the MAL instruction, addi $10,-2 might appear in hexadecimal
as
      94 af ff fd
if the op code for the addi instruction were 94 base 16.
```

On the next page, write a MAL function SplitIFormat that returns the contents of the register and immediate fields of a Prune 100 I-format instruction. If written in C, its prototype would be

```
        void SplitIFormat (int instr, int *register, int *immediate);

If written in C++, its prototype would be
        void SplitIFormat (int instr, int &register, int &immediate);
```

Follow the conventions described in class and in lab and homework assignment 6 for passing arguments and managing registers and the system stadck. Provide comments sufficient for the graders to understand your work.

Problem #2 (7 points, 13 minutes)

Part a Translate the following MAL program segment to TAL. You may use either names or numbers for the registers.

```
                li      $t1,-5
        loop:   sub     $t1,$t1,3
                bgt     $t1,$a1,loop

Equivalent TAL segment:
```

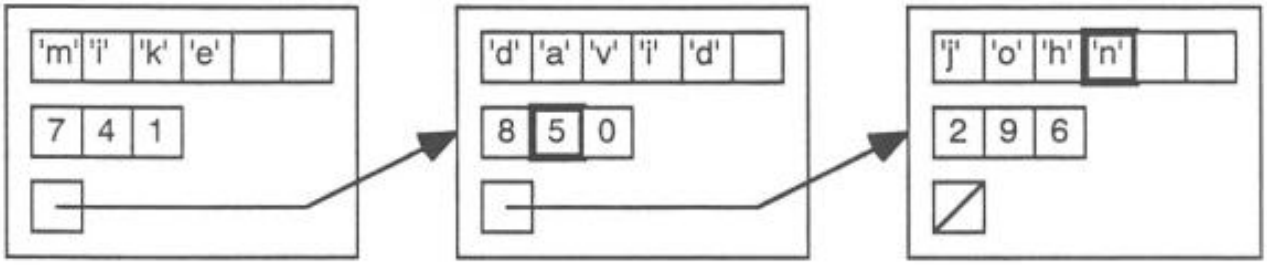
```
Part b
```

Your answer to part a should include a branch instruction. Translate this branch instruction to machine language by filling in the boxes below with 0's and 1's.

Problem #3 (7 points, 10 minutes)

```
Consider a list with nodes defined in C or C++ as follows.
        struct ListNode {
                char name[6];
                int code[3];
                struct ListNode* next;     /* ListNode* next in C++ */
        };
```

The diagram below, not drawn to scale, gives an example of such a list.



Part a

Assume that register $a1 contains a pointer to the first node of the list. Write MAL code that loads $s2 with the second integer in the second node in the list (with the list pictured above, this will load a 5 into $s2).

Part b

Again, assume that register $a1 contains a points to the first node of the list. Write MAL code that loads $s2 with the fourth character in the third node in the list (with the list pictured above, this will load 'n' into $s2.)

Problem #4 (7 points, 12 minutes)

```
Consider the following C functions that check if one string contains another as a
substring.  The terms "string 1" and "string 2" are used in the comments to mean the
strings represented by s1 and s2 respectively.

        int ContainsAsSubstring (char *s1, char *s2) {
                if (*s2 == '\0') {              /* if string 2 has run out, */
                        return 1;               /* it's a substring of string 1. */
                } else if (*s1 == '\0') {       /* if string 1 has run out, */
                        return 0;               /* string 2 isn't a substring of
string 1. */
                } else if (StartsWith (s1, s2)) {
                        return 1;
                } else {
                        return ContainsAsSubstring (s1+1, s2);
                }
        }
        int StartsWith (char *s1, char *s2) {
```

```
                if (*s2 == '\0') {              /* any string starts with the empty
string */
                        return 1;
                } else if (*s1== '\0') {        /* if string 1 has run out, */
                        return 0;
                } else if (*s1 != *s2) {
                        return 0;
                } else {
                        return ContainsAsString (s1+1, s2+1);
                }
        }
```

Some examples of how ContainsAsSubstring behaves are listed below.

String 1	String 2	result of ContainsAsSubstring
"abcde"	"abc"	1
"xyabc"	"abc"	1
"axbc"	"ab"	0
"xy"	"abc"	0

Fill in the missing code in the MAL implementation of ContainsAsSubstring below. (Don't worry about StartsWith.) Yous code should perform as described in the accompanying comments, and should follow conventions described in class and in lab and homework assignment 6 for passing arguments and managing registers and the system stack. You may assume that neither argument pointer is null.

```
ContainsAsSubstring:
        # save registers on the stack









        #check base cases



        beqz  $t1,returnTrue
        beqz  $t0,returnFalse

        move  $s0,$a0           #does string 1 start with string 2?
        move $s1,$a1
        jal   StartsWith
        bnez  $v0,returnTrue

        add    $a0,$s0,1                #no match; make recursive call
        move $a1,$s1
        jal     ContainsAsSubstring
        j        return
```

```
returnTrue:
        #prepare to return 1



        j     return
returnFalse:
        #prepare to return 0



return:
        # restore registers and return
```

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