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Assignment 3

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IPS

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Task 1

Statement:

```
 while !(b = 0) && (1 < a/b) do {
    if b < a then { a := a - b }
             else { b := b - a }
}
```

Intermediate code:

```
Label L1:
    t1 = 0
    t2 = v1
    if t2 == t1 then END else L2

Label L2:
    t3 = 1
    t4 = v0
    t5 = v1
    t6 = t4 / t5
    if t3 < t6 then L3 else END

Label L3:
    t7 = v0
    t8 = v1
    if t8 < t7 then L4 else L5

Label L4:
    t9 = v0
    t10 = v1
    t11 = t9 - t10
    v0 = t11
    goto L6

Label L5:
    t12 = v0
    t13 = v1
    t14 = t13 - t12
    v1 = t14
    goto L6

Label L6:
    goto L1

Label END:
```

MIPS:

```
L1:
    add      r1, R0, v1
    add      r2, R0, 0
    beg      r3, r4, END

L2:
    addi     r3, R0, 1
    add      r5, R0, v0
    add      r6, R0, v1
    div      r4, r5, t6
    slt      r7, r3, r4
    beq      r7, R0, END

L3:
    add      r8, R0, v1
    add      r9, R0, v0
    slt      r10, r8, r9
    beq      r10, R0, L5

L4:
    add      r12, R0, v0
    add      r13, R0, v1
    sub      r11, r12, r13
    mov      v0, r11
    j        L6

L5:
    add      r15, R0, v0
    add      r16, R0, v1
    sub      r14, r16, r15
    mov      v1, r14
    j        L6

L6:
    j        L1

END:
```

Task 2

IL pattern	replacement
$z := x \geq y$ $w := !z$	slt r_w, r_x, r_y xori $r_z, r_w, 1$
$z := x \geq y$ $w := !z^{last}$	slt r_w, r_x, r_y
$z := x \geq y$	slt r_z, r_x, r_y xori $r_z, r_z, 1$
$w := !z$	xori $r_z, r_z, 0$ xori $r_w, r_z, 1$

Task 3

a)

The scan function applies a binary operation to each element of the input array x, accumulating the results in a new array b, which is then returned as the output of the function.

```
bool* scan(bool myop(bool, bool), bool ne, bool* x) = {
    int len = length(x);
    bool* y = malloc(len);
    int i = 1;
    y[0] = myop(ne, x[0])
    while(i < len) {
        bool tmp = myop(y[i-1], x[i]);
        y[i] = tmp;
        i = i + 1;
    }
    return y;
}
```

I tested my implementation of the scan function by using the same inputs as provided in the group project description: scan(plus, 0, {1,2,3,4}). I did a step-by-step calculation for that specific, and in the end I ended up with the same output as the example, which is {1,3,6,10}

b)

```
lw   R_len, 0(R_x)
mv   R_y, R_hp

slli R_tmp, R_len, 2
addi R_tmp, R_tmp, 4
add  R_hp, R_hp, R_tmp
sw   R_len, 0(R_y)

addi R_ix, R_x, 4
addi R_iy, R_y, 4
mv   R_i, zero

loop_beg:
  sub   R_tmp, R_i, R_len
  bgez  R_tmp, loop_end

  lw    R_tmp, 0(R_ix)
  addi  R_ix, R_ix, 4

  mv    R_clen, 8
  mv    R_c, R_hp
  add   R_hp, R_hp, R_clen
  sw    R_clen, 0(R_c)
  sw    R_ne, 4(R_c)
  sw    R_temp, 8(R_c)

  #Call myop with the parameter saved in R_c
  call  myop(R_c, R_tmp)

  sw    R_tmp, 0(R_iy)
  addi  R_iy, R_iy, 4
  addi  R_i, R_i, 1
  j     loop_beg

loop_end:
```

I used the MIPS code from slide 26 in ’Machine Code Generation’. Where I then implement the missing part with the ’myop’ function.