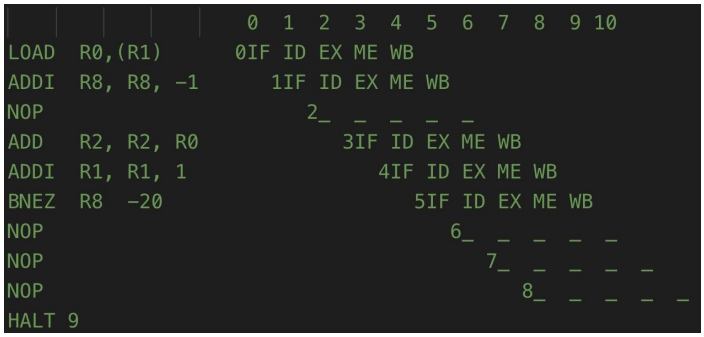
Project 1A Part I - cq4

d. Change the programs (one at-a-time) to ...

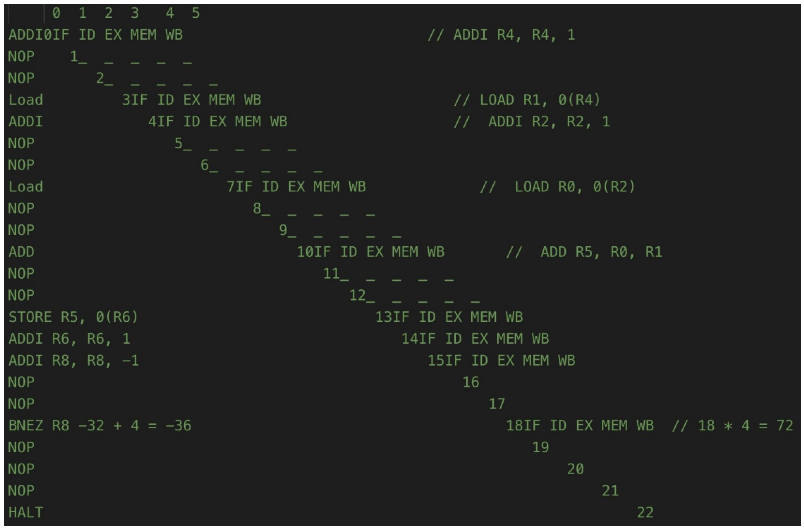
program1.c

```
insMEM[0] = 0x10200000;       // LOAD  R0,(R1)       top:  R0 = MEM[R1];
insMEM[1] = 0x1508FFFF;       // ADDI  R8, R8, -1           count = count - 1;
insMEM[3] = 0X04401000;       // ADD   R2, R2, R0           sum = sum + R0;
insMEM[4] = 0x14210001;       // ADDI  R1, R1, 1            R1 = R1 + 1;
insMEM[5] = 0x2500FFE8;       // BNEZ  R8  -24  = 6 * 4 = 16 + 8 if (count != 0) goto top
insMEM[6] = 0x00000000;       //  Do not remove. Needed to make HALT work correctly
insMEM[9] = 0x28000000;       // HALT
```



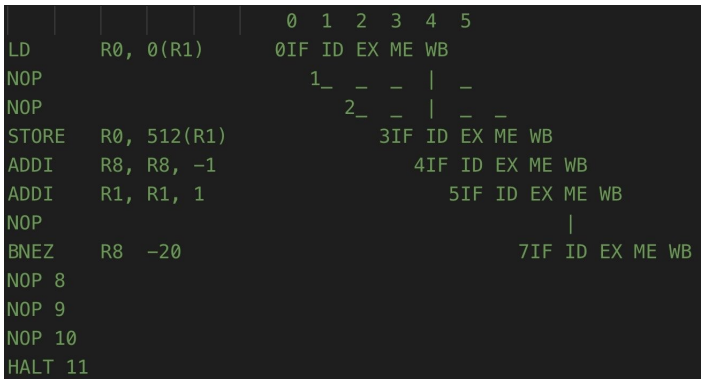
program2.c

```
insMEM[0] = 0x14840001; //  ADDI R4, R4, 1   top1: index2++
insMEM[3] = 0x10810000; //  LOAD R1, 0(R4)         element2 = MEM[index2]
insMEM[4] = 0x14420001; //  ADDI R2, R2, 1         index1++
insMEM[7] = 0x10400000; //  LOAD R0, 0(R2)         element1 = MEM[index1]
insMEM[10] = 0x04012800; //  ADD R5, R0, R1         temp = element1 + element2
insMEM[13] = 0x18C50000; //  STORE R5, 0(R6)        MEM[index3] = temp
insMEM[14] = 0x14C60001; //  ADDI R6, R6, 1         index3++
insMEM[15] = 0x1508FFFF; //  ADDI R8, R8, -1        count--
insMEM[18] = 0x2500FFB4; //  BNEZ R8 -16*5 + 4 = -76          if (count != 0) goto top
insMEM[19] = 0x00000000; //  NOP
insMEM[22] = 0x28000000; // HALT
```

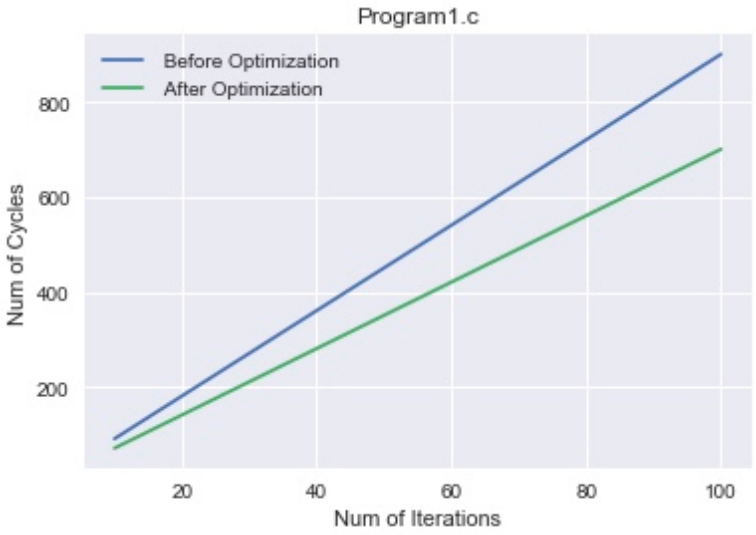


program3.c

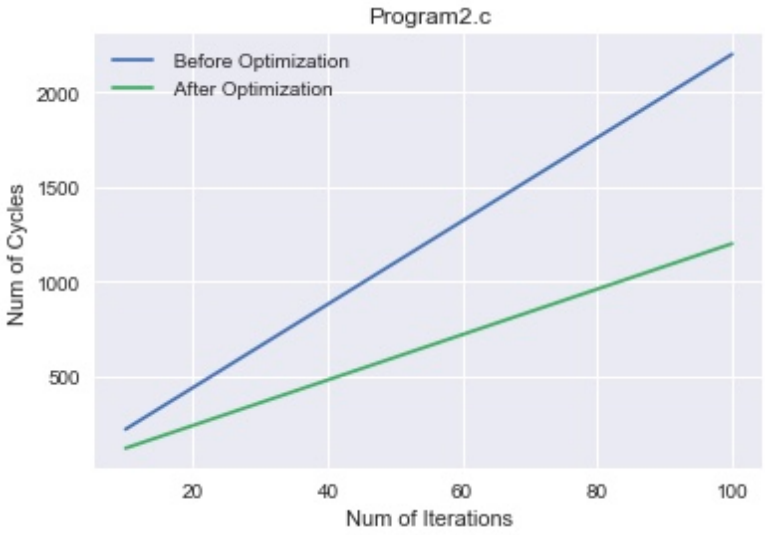
```
insMEM[0] = 0x10200000;        // LD   R0, 0(R1)         COPY: value = MEM[index]
insMEM[3] = 0x18200200;        // STORE  R0, 512(R1)           MEM[index+512] = value
insMEM[4] = 0x1508FFFF;       // ADDI  R8, R8, -1              count--
insMEM[5] = 0x14210001;       // ADDI  R1, R1, 1               index++
insMEM[7] = 0x2500FFE0;       // BNEZ R8  -20   (7+1)*4 = 32               if (count != 0)
goto COPY
insMEM[8] = 0x00000000;       // NOP
insMEM[11] = 0x28000000;       // HALT
```



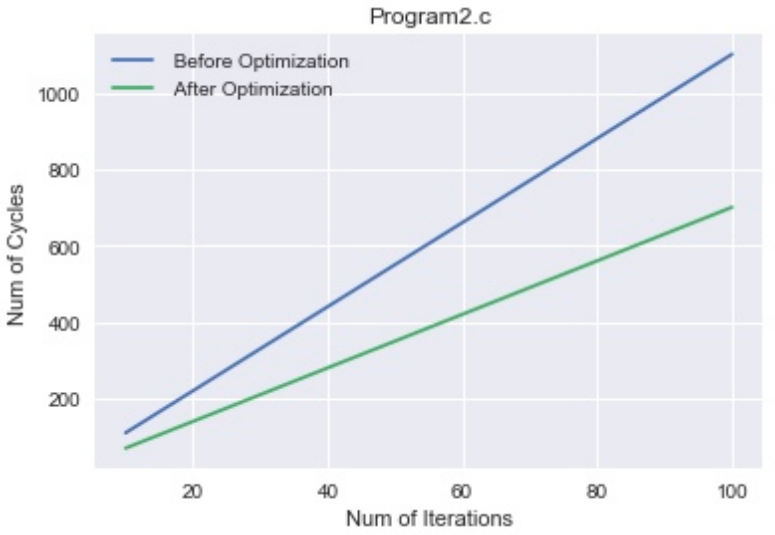
e. Run each program for NUM_ITERATIONS equal ...




```
x =  [10,  20,  40,  80, 100]
y =  [91, 181, 361, 721, 901]
y2 = [71, 141, 281, 561, 701]
```




```
x =  [ 10,  20,  40,  80,   100]
y =  [221, 441, 881, 1761, 2201]
y2 = [121, 241, 481,  961, 1201]
```




```
x =  [ 10,  20,  40,  80,  100]
y =  [111, 221, 441, 881, 1101]
y2 = [ 71, 141, 281, 561,  701]
```

---

f. Rewrite the code of each program to minimize ...

program1.c

```
insMEM[0] = 0x1508FFFF;       // ADDI  R8, R8, -1           count = count - 1;
insMEM[1] = 0x10200000;       // LOAD  R0,(R1)       top:  R0 = MEM[R1];
insMEM[2] = 0x14210001;       // ADDI  R1, R1, 1            R1 = R1 + 1;
insMEM[3] = 0x2500FFF0;       // BNEZ  R8  -20              if (count != 0) goto top
insMEM[4] = 0X04401000;       // ADD   R2, R2, R0           sum = sum + R0;
insMEM[5] = 0x00000000;       //  Do not remove. Needed to make HALT work correctly
insMEM[7] = 0x28000000;       // HALT
```

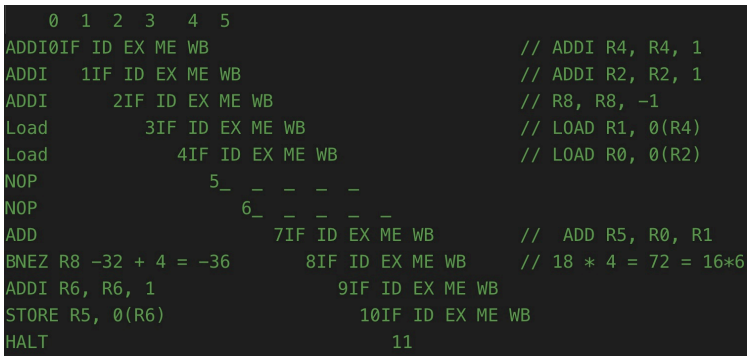
```
After optimization

                    0  1  2  3  4  5  6  7  8  9 10
ADDI  R8, R8, -1   0IF ID EX ME WB
LOAD  R0,(R1)         1IF ID EX ME WB
ADDI  R1, R1, 1          2IF ID EX ME WB
BNEZ  R8  -20               3IF ID EX ME WB
ADD   R2, R2, R0               4IF ID EX ME WB
NOP                               5_  _  _  _  _
NOP                                  6_  _  _  _  _
HALT 7
```

After optimization, each loop there're only 7 steps.

program2.c

```
insMEM[0] = 0x14840001; //  ADDI R4, R4, 1   top1: index2++
insMEM[1] = 0x14420001; //  ADDI R2, R2, 1         index1++
insMEM[2] = 0x1508FFFF; //  ADDI R8, R8, -1        count--
insMEM[3] = 0x10810000; //  LOAD R1, 0(R4)         element2 = MEM[index2]
insMEM[4] = 0x10400000; //  LOAD R0, 0(R2)         element1 = MEM[index1]
```

```
insMEM[7] = 0x04012800; //  ADD R5, R0, R1         temp = element1 + element2
insMEM[8] = 0x2500FFDC; //  BNEZ R8 -16*2 + 4 = -36 = 9 * 4          if (count != 0) goto
top
insMEM[9] = 0x14C60001; //  ADDI R6, R6, 1         index3++
insMEM[10] = 0x18C50000; //  STORE R5, 0(R6)        MEM[index3] = temp
insMEM[11] = 0x00000000; //  NOP
insMEM[12] = 0x28000000; // HALT
```



program3.c

```
insMEM[0] = 0x1508FFFF;       // ADDI  R8, R8, -1             count--
insMEM[1] = 0x10200000;       // LD   R0, 0(R1)         COPY: value = MEM[index]
insMEM[2] = 0x14210001;       // ADDI  R1, R1, 1              index++
insMEM[3] = 0x2500FFF0;       // BNEZ R8  -20   (3+1)*4 = 16  if (count != 0) goto COPY
insMEM[4] = 0x18200200;       // STORE  R0, 512(R1)           MEM[index+512] = value
insMEM[7] = 0x28000000;       // HALT
```