CS270 Computer Organization Factorial in C and LC3 Assembly

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Factorial – C and Intel assembly

```c
int main() {
  unsigned int n = 7;
  unsigned int f = 1;
  for ( ; n>0; n--)
    f = f * n;
  return f;
}
```

```
; optimized intel code
main:
movl    $1, %eax
movl    $7, %edx
.L2:
    imull  %edx, %eax
    subl   $1, %edx
    jne.L2
    rep ret
```

Factorial w/o * – C and Intel assembly

```c
int main() {
  unsigned int n = 7;
  unsigned int f = 1;
  for ( ; n>0; n--) {
    unsigned int res = 0;
    unsigned int i = n;
    for ( ; i>0 ; i-- )
      res += f;
    f = res;
  }
  return f;
}
```

```
main:
    pushq %rbp
    movq %rsp, %rbp
    movl $7, -4(%rbp)
    movl $1, -8(%rbp)
    jmp .L2
.L5: movl $0, -12(%rbp)
    movl -4(%rbp), %eax
    movl %eax, -16(%rbp)
    jmp .L3
.L4: movl -8(%rbp), %eax
    addl %eax, -12(%rbp)
    subl $1, -16(%rbp)
.L3: cmpl $0, -16(%rbp)
    jne .L4
    movl -12(%rbp), %eax
    movl %eax, -8(%rbp)
    subl $1, -4(%rbp)
.L2: cmpl $0, -4(%rbp)
    jne .L5
    movl -8(%rbp), %eax
    popq %rbp
    ret
```

Factorial w/o * – C and LC3 assembly

```c
int main() {
  unsigned int n = 7;
  unsigned int f = 1;
  for ( ; n>0; n-- ) {
    unsigned int r = 0;
    unsigned int i = n;
    for (; i>0; i-- )
      r += f;
    f = r;
  }
  return f;
}
```

```
        .ORIG x3000
        AND R1,R1,#0      ; R1=0
        ADD R1,R1,#7      ; R1=7  n=7
        AND R2,R2,#0      ; R2=0
        ADD R2,R2,#1      ; R2=1  f=1
FACT                      ; loop
        AND R4,R4,#0      ; R4=0   r=0
        AND R3,R3,#0      ; R3=0
        ADD R3,R3,R1      ; R3=R1 i=n
MULT                      ; loop
        ADD R4,R4,R2      ; R4+=R2 r+=f
        ADD R3,R3,#-1     ; R3--    i--
        BRp MULT          ; R3>0?   i>0
        AND R2,R2         ; R2=0
        ADD R2,R2,R4      ; R2=R4   f=r
        ADD R1,R1,#-1     ; R1--    n--
        BRp FACT          ; R1>0?   n>0
        HALT              ; CATCH FIRE
        .END
```

Factorial w/o * – C with LC3 assembly

```
;int main() {
.ORIG x3000
;  unsigned int n = 7;
     AND R1,R1,#0          ; R1=0
     ADD R1,R1,#7          ; R1=7
;  unsigned int f = 1;
     AND R2,R2,#0          ; R2=0
     ADD R2,R2,#1          ; R2=1


;  for ( ; n>0; n-- )
FACT                       ; loop
;    unsigned int r = 0;
     AND R4,R4,#0          ; R4=0
;    unsigned int i = n;
     AND R3,R3,#0          ; R3=0
     ADD R3,R3,R1          ; R3=R

;    for ( ; i>0; i-- )
MULT                       ; loop
```

```
;        r += f;
     ADD R4,R4,R2          ; R4+=R2
;        i-- for loop
     ADD R3,R3,#-1         ; R3--
;        continue MULT loop while i>0
     BRp MULT              ; R3>0?


;    f = r
     AND R2,R2,#0          ; R2=0
     ADD R2,R2,R4          ; R2=R4
;    n-- for loop
     ADD R1,R1,#-1         ; R1--
;    continue FACT loop while n>0
     BRp FACT              ; R1>0?

;  return f;
     HALT                  ; CATCH FIRE
.END
```