

**Recitation 3, Wed, February 14**

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**Substitution, Recursion Problems**

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**1. Substitution**

Consider the example below. Notice that  $x$  is used in multiple places. When do we substitute for  $x$  and when don't we?

```
(define x-y*y  
  (lambda (x y)  
    (- x ((lambda (x) (* x x)) y))))
```

Use the substitution model to evaluate the following expression, and write each substitution step.

```
(x-y*y 11 3)
```

Value: \_\_\_\_\_

**2. Recursion**

2.1. a. Implement addition as a recursive procedure that employs repeated successor. In Scheme, this is the `inc` function, which increases its argument by 1; `dec` decreases its argument by 1. (Hint: check for base case, then recursive case.)

```
(define (add x y)
```

b. Write the first 4 substitution steps for `(add 3 2)`

2.2. Implement subtraction as a recursive procedure that employs the `dec` function, which decreases its argument by 1.

```
(define (sub x y)
```

2.3 Implement exponentiation through repeated multiplication.

```
(define (expt x n)  
  <your code will go here>  
)
```

a. recursive algorithm

b. iterative algorithm (Hint: Define a helper function.)