

Exercise 1.9. Each of the following two procedures defines a method for adding two positive integers in terms of the procedures `inc`, which increments its argument by 1, and `dec`, which decrements its argument by 1.

```
(define (+ a b)
  (if (= a 0)
      b
      (inc (+ (dec a) b))))
```

```
(define (+ a b)
  (if (= a 0)
      b
      (+ (dec a) (inc b))))
```

Using the substitution model, illustrate the process generated by each procedure in evaluating `(+ 4 5)`. Are these processes iterative or recursive?

Answer. Consider the process generated by the first procedure,

```
(+ 4 5)
;;(inc (+ (dec 4) 5))
(inc (+ 3 5))
;;(inc (inc (+ (dec 3) 5)))
(inc (inc (+ 2 5)))
;;(inc (inc (inc (+ (dec 2) 5))))
(inc (inc (inc (+ 1 5))))
;;(inc (inc (inc (inc (+ (dec 1) 5)))))
(inc (inc (inc (inc (+ 0 5)))))
(inc (inc (inc (inc 5))))
(inc (inc (inc 6)))
(inc (inc 7))
(inc 8)
9
```

we can intuitively conclude that the process above is recursive.

Generated by the second procedure is the following process,

```
(+ 4 5)
;;(+ (dec 4) (inc 5))
(+ 3 6)
;;(+ (dec 3) (inc 6))
(+ 2 7)
;;(+ (dec 2) (inc 7))
(+ 1 8)
;;(+ (dec 1) (inc 8))
(+ 0 9)
9
```

undoubtedly, this process is iterative.