

# Clicker

I thought the midterm was:

- A. Easier than expected
- B. About as hard as expected
- C. Harder than expected

# Clicker

I should have:

- A. Completed fewer practice exams than I did
- B. Completed the same number of practice exams as I did
- C. Completed more practice exams than I did

atomic  
compound  
lists  
trees  
graphs

search  
trees  
graphs

| Core Recipes  | Template Origin  |                                      | Abstraction  |
|---|--|--------------------------------------|--|
|   | Data Driven  | Control Driven                       |  |
| <a href="#">How to Design Functions (HtDF).</a><br>Design any function.   | <a href="#">Data Driven Templates</a><br>Produce template for a data definition based on the form of the type comment. | <a href="#">Function Composition</a> | <a href="#">From Examples</a><br>Produce an abstract function given two similar functions. |
| <a href="#">How to Design Data (HtDD).</a><br>Produce data definitions based on structure of the information to be represented. | <a href="#">2 One-of Data</a><br>Functions where 2 arguments have a one-of in their type comments.                     | <a href="#">Failure Handling</a>     | <a href="#">From Type Comments</a><br>Produce a fold function given type comments.         |
| <a href="#">How to Design Worlds (HtDW).</a><br>Produce interactive programs that use big-bang.                                 |  | <a href="#">Backtracking Search</a>  |  |
|   |  | <a href="#">Generative Recursion</a> | <a href="#">Using Abstract Functions</a>   |
|   |  | <a href="#">Accumulators</a>         |  |
|   |  | <a href="#">Template Blending</a>    |  |

L20 L21 L22

L18 L19 L20

# Accumulators

- accumulate information from prior recursive calls
- three categories
  - preserve context from prior recursive calls
  - result so far

- worklist      **next lecture**

these overlap some

# accumulator design recipe (htdf + this)

- templating:
  - recursive template wrapped in local and top-level function
  - add acc(umulator) parameter(s) to inner function
    - add acc after all ... (can use better name)
    - add (... acc) in recursive call
    - add ... in trampoline
- work out example progression of recursive calls
- wish for what the accumulator should be at the end
- work backward through progression to get accumulator at each step
- design type and invariant (may need a new data definition)
- initialize invariant, preserve invariant, exploit invariant
- test and debug

```

(@htdf sequence?)
(@signature (listof Natural) -> Boolean)
;; produces true if every element of lon is 1 greater than prior element
(check-expect (sequence? (list))      true)
(check-expect (sequence? (list 2))     true)
(check-expect (sequence? (list 2 3 4)) true)
(check-expect (sequence? (list 3 5 6)) false)
(check-expect (sequence? (list 2 3 4 7 5)) false)

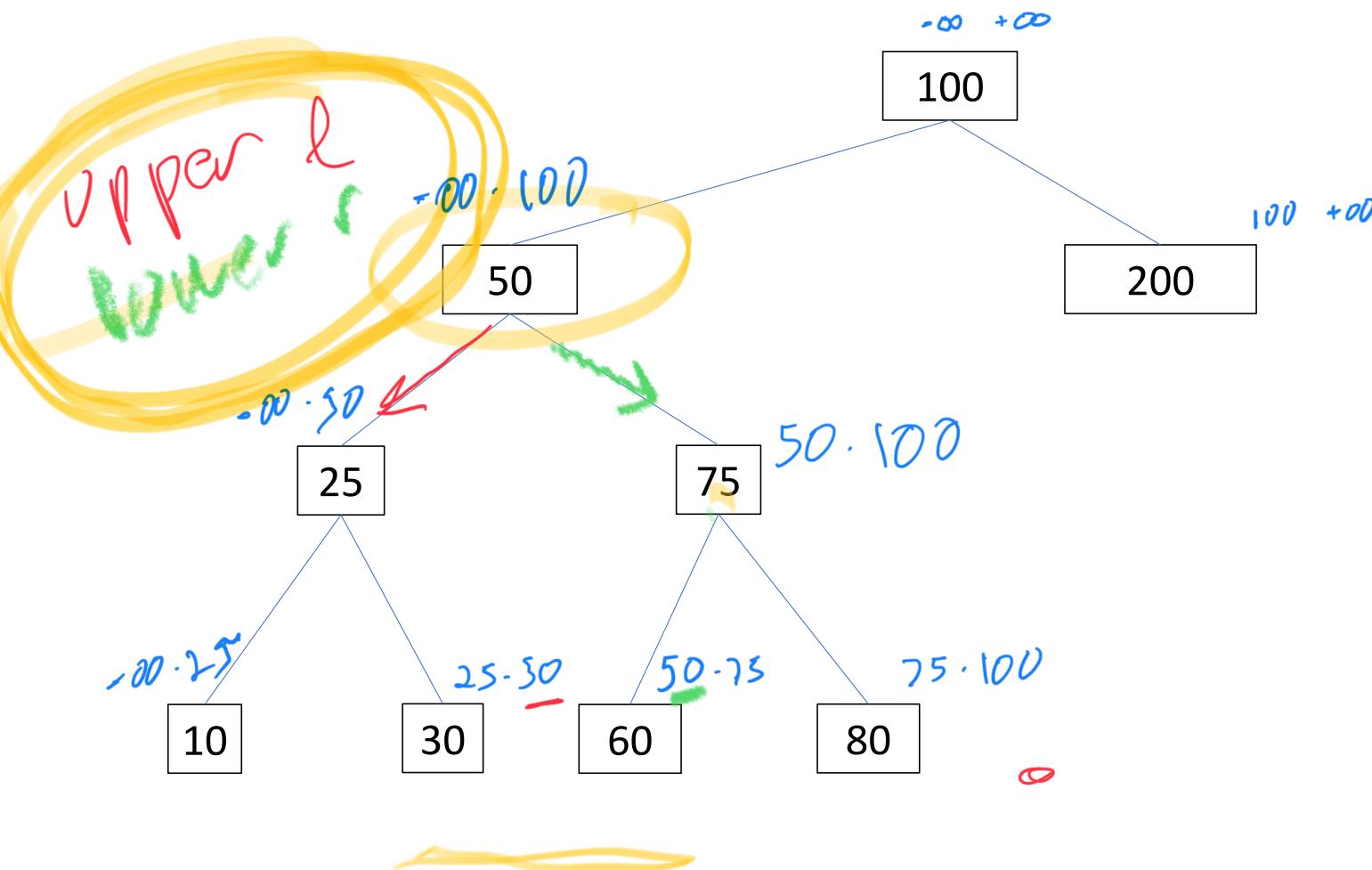
(@template-origin (listof Natural) accumulator)

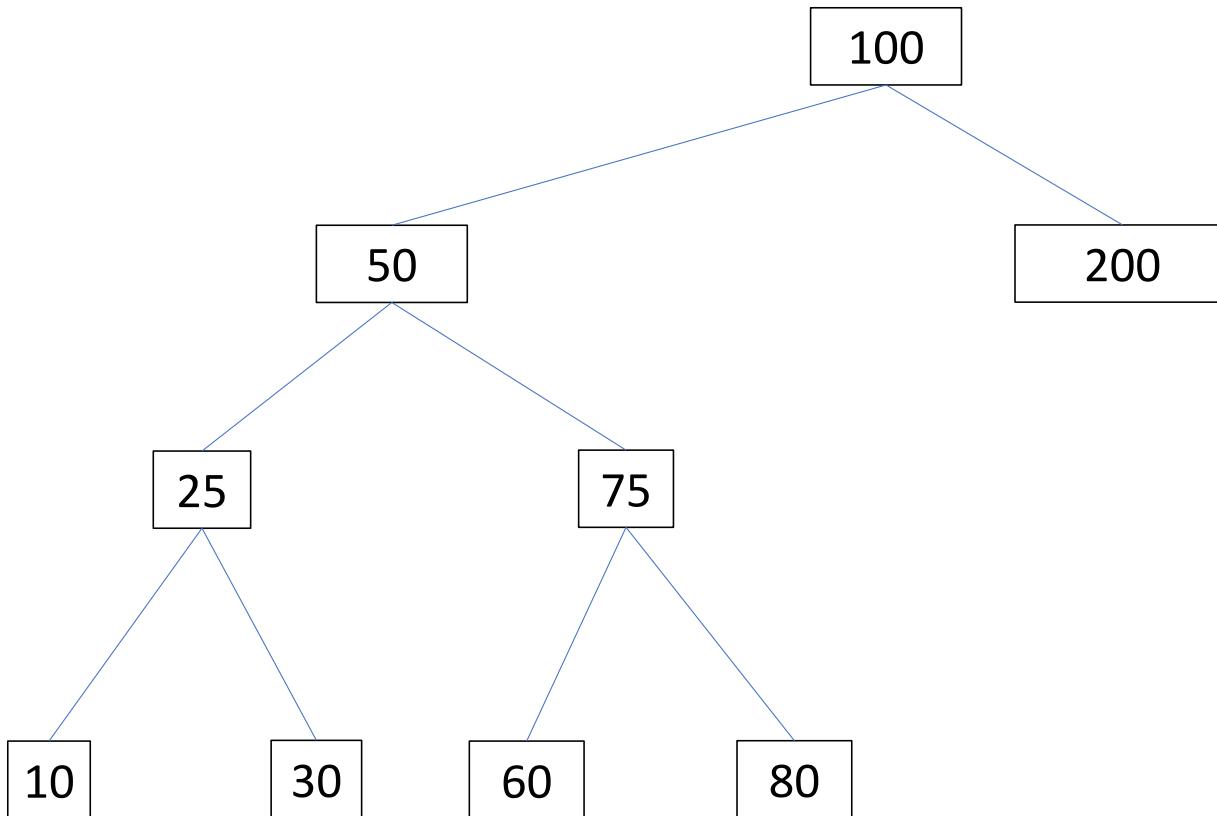
(define (sequence? lon0)
  ;; prev is Natural
  ;; invariant: the element of lon0 immediately before (first lon)
  ;; (sequence? (list 2 3 4 7 5))
  ;; (sequence? (list 3 4 7 5) 2)
  ;; (sequence? (list 4 7 5) 3)
  ;; (sequence? (list 7 5) 4) ==> false
  (local [(define (sequence? lon prev)
            (cond [(empty? lon) true]
                  [else
                    (if (= (first lon) (+ 1 prev)) ;exploit (use)
                        (sequence? (rest lon)
                                  (first lon)) ;preserve
                        false)]))]
    (if (empty? lon0)                      ;if original list is empty, we can't
        true                            ;initialize accumulator, so special case
        (sequence? (rest lon0)
                  (first lon0)))))) ;initialize

```

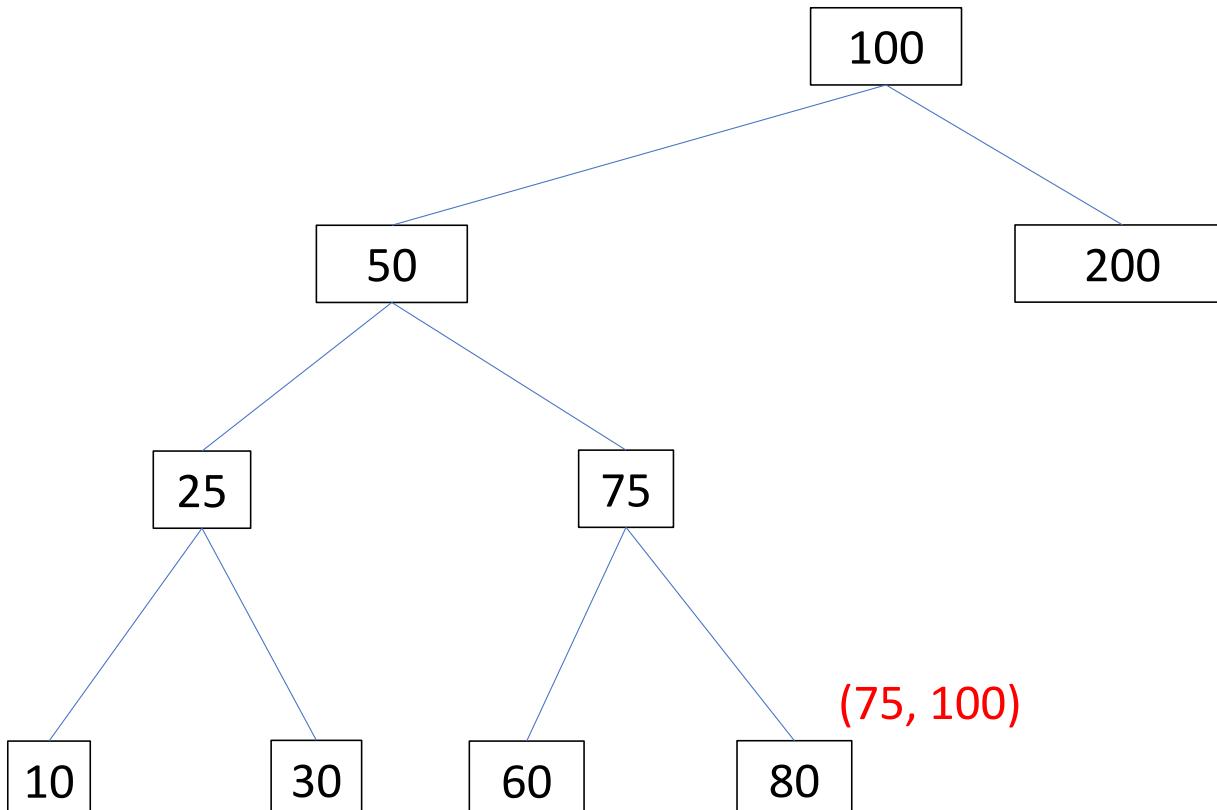
what does no  
change

lower  
upper





Why is 80 OK here?  
What range of numbers is OK here?



(75, 100)

Why is 80 OK here?  
What range of numbers is OK here?

```

(@htdf bst?)
(@signature BinaryTree -> Boolean)
;; produce true if bt satisfies binary search tree invariants
(check-expect (bst? BT1) true)
(check-expect (bst? BT2) false)
(check-expect (bst? BT3) false)
(check-expect (bst? BT4) false)
(check-expect (bst? BT5) false)

(@template-origin BinaryTree accumulator)

(define (bst? bt0)
  ; lower is Integer
  ; lower bound of key at current node
  ; initially -inf.0 is reset on recursions down a right branch
  ; upper is Integer
  ; upper bound of key at current node
  ; initially +inf.0 is reset on recursions down a left branch
  ;;
  ;;
  (local [(define (bst? bt lower upper)
    (cond [(false? bt) true]
          [else
            (and (< lower (node-k bt) upper)
                 (bst? (node-l bt) lower
                       (node-k bt)) ;exploit
                 (bst? (node-r bt) (node-k bt) upper))))]) ;preserve
    (bst? bt0 -inf.0 +inf.0)));
  ;;
  ;NOTE that we would never expect you to have
  ;already known about these two constants!
)

```