CS135 T09

General Trees, Mutual Recursion, and Local
Descendants

- Develop a data definition to store descendants of King George VI.
- Write templates for functions to process the descendants.
Descendants Data Definition

(define-struct person (name birth children))
;; A Person is a (make-person Str Nat (listof Person))
;; Requires: names are unique

;; person-template: Person -> Any
(define (person-template p)
  (... (person-name p)
       (person-birth p)
       (listof-person-template (person-children p)))))

;; listof-person-template: (listof Person) -> Any
(define (listof-person-template lop)
  (cond [(empty? lop) ...]
        [else (... (person-template (first lop))
                  (listof-person-template (rest lop)))]))
Birthdate

Write \((\text{birthdate name } p)\), which finds the descendant of \(p\) with the given name and produces their birthdate or \text{false} if not found.

```scheme
(define george "George VI" 1895
  (list (make-person "Elizabeth II" 1926
    (list (make-person "Charles III" 1948
      (list (make-person "William" 1982
        (list (make-person "George" 2013 (list))
          (make-person "Charlotte" 2015 (list))
          (make-person "Louis" 2018 (list))))))
      (make-person "Harry" 1984
        (list (make-person "Archie" 2019 (list))
          (make-person "Lilibet" 2021 (list))))))
  (make-person "Andrew" 1960
    (list (make-person "Beatrice" 1988
      (list (make-person "Sienna" 2021 (list))))
    (make-person "Eugenie" 1990 (list)))
  (make-person "Edward" 1964 (list))
  (make-person "Anne" 1950 (list))
))

(make-person "Margaret" 1930
  (list (make-person "David" 1961 (list))
    (make-person "Sarah" 1964 (list)))))
```
Birthdate tests

(check-expect (birthdate "George VI" george) 1895)
(check-expect (birthdate "Anne" george) 1950)
(check-expect (birthdate "Sarah" george) 1964)
(check-expect (birthdate "Justin" george) false)

;; (birthdate name p) finds the birthdate of the named person.
;; birthdate: Str Person -> (anyof false Nat)
(define (birthdate name p) ...)
Born After

;; (born-after year p) produces a list of all the names in p and p’s descendants that were born after the specified year.

;; born-after: Nat Person -> (listof Str)
(define (born-after year p) ...)

(check-expect (born-after-v1 2023 george) empty)
(check-expect (born-after-v1 2018 george)
 (list "Sienna" "Lilibet" "Archie" "Louis"))

We’ll solve this problem two different ways:
  ➢ with append
  ➢ with an accumulator
Nearest common ancestor

(nearest-common-ancestor name1 name2 p) finds the nearest common ancestor, within p and p’s descendants, of name1 and name2. We assume the names are unique within the descendants tree.
Nearest common ancestor – strategy

- Find the “path” – the list of people – that lead from $p$ to $name_1$ (but not including $name_1$).
- Find the “path” – the list of people – that lead from $p$ to $name_2$ (but not …).
- Produce the last item on the common prefix.

Considerations

- The paths might be different lengths.
- What if one or both of the names are not found?
- Who is the nearest common ancestor of George VI?
- Who is the nearest common ancestor of “Beatrice” and “Beatrice”?
Nearest common ancestor – design recipe

;;; (nearest name1 name2 p) finds the name of the nearest common ancestor
;;; of name1 and name2 within the descendants of p.

;;; nearest: Str Str Person -> (anyof Str false)
(define (nearest name1 name2 p) ...)

(check-expect (nearest "Elizabeth II" "Margaret" george) "George VI")
(check-expect (nearest "Charles III" "Edward" george) "Elizabeth II")
(check-expect (nearest "George" "Charlotte" george) "William")
(check-expect (nearest "Archie" "Bilbo Baggins" george) false)
(check-expect (nearest "Beatrice" "Beatrice" george) "Andrew")
(check-expect (nearest "George VI" "Beatrice" george) false)