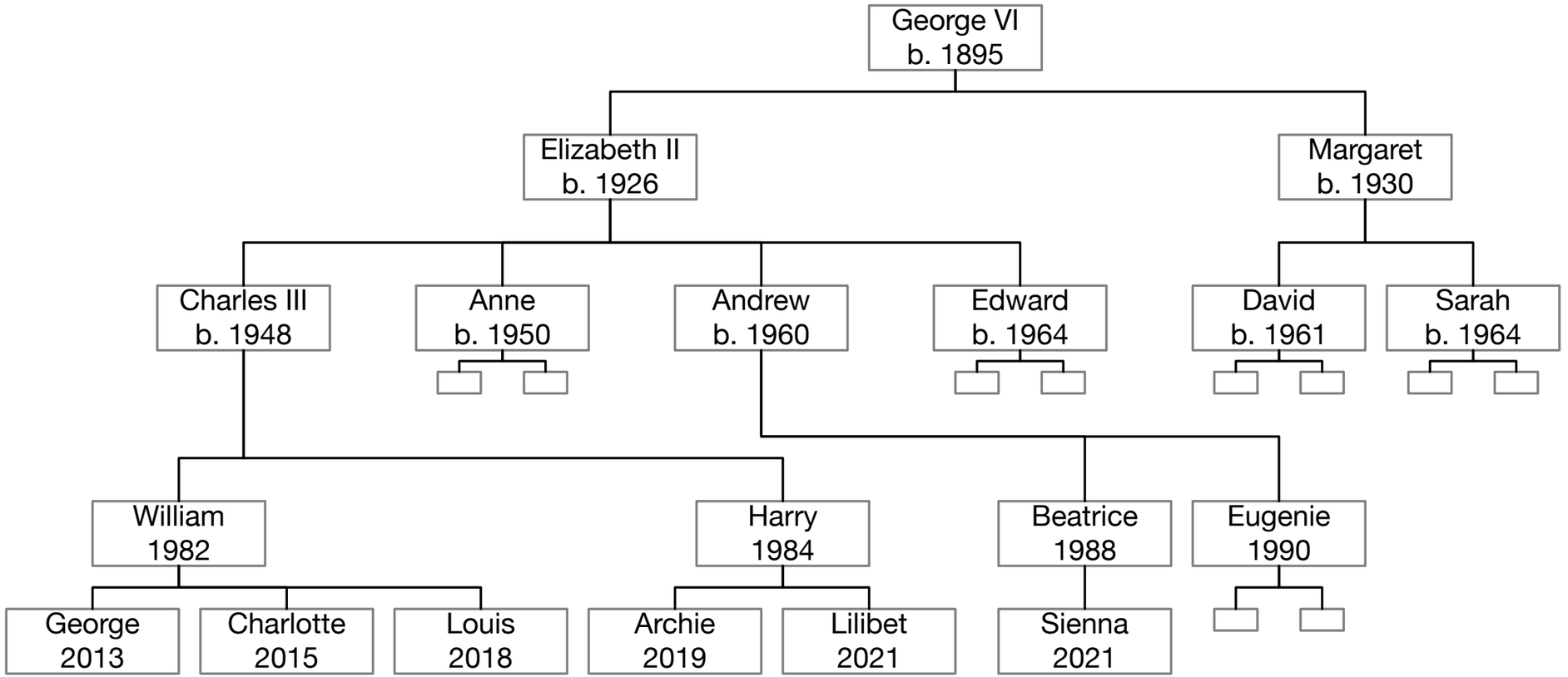
CS135 T09

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 `(birthdate name p)`, which finds the descendant of `p` with the given `name` and produces their birthdate or `false` if not found.

```
(define george
  (make-person "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

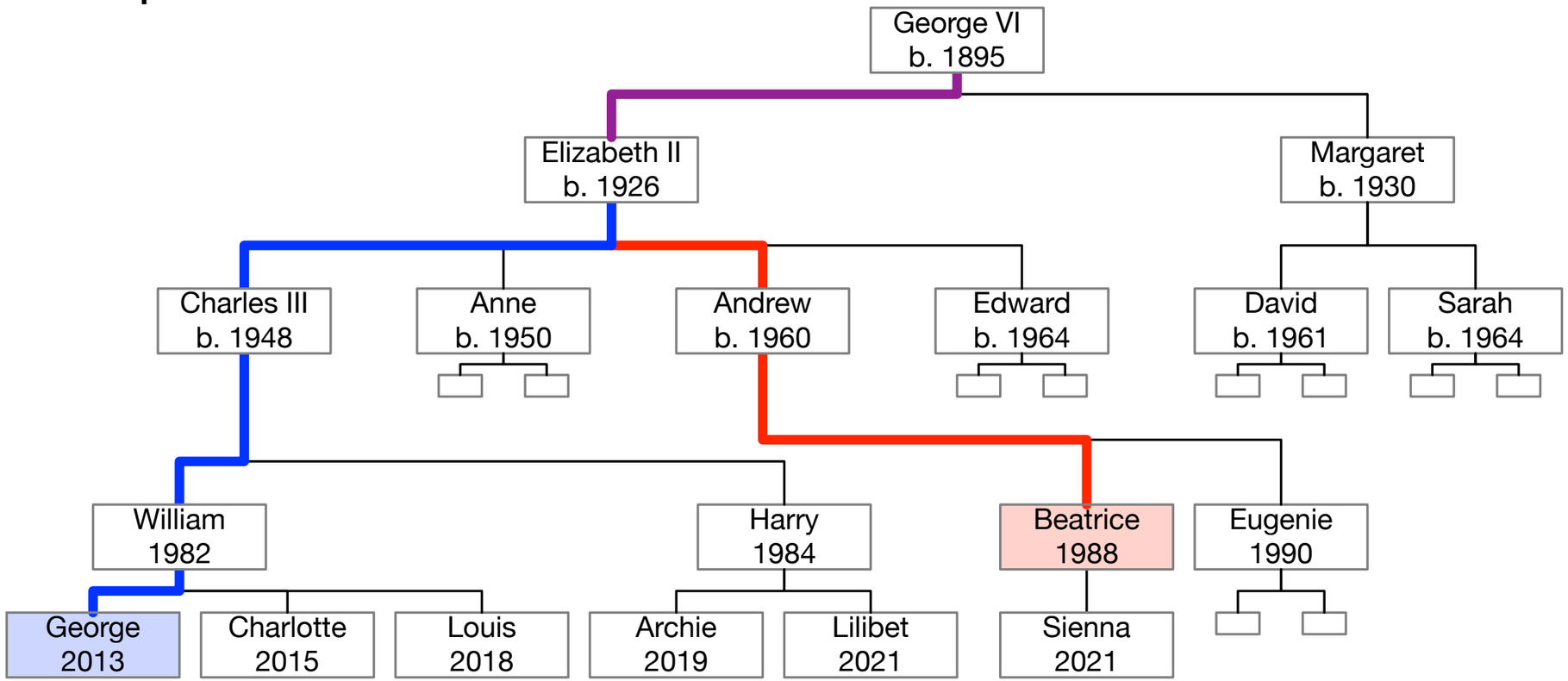
```
;; (born-after year p) produces a list of all the names in p and
;; p's descendants that were born after the specified year.

;; 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 `name1` (but not including `name1`).
- Find the “path” – the list of people – that lead from `p` to `name2` (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)
```