Midterm exam of Principles of Programming Languages, 2016.11.21

Notes:
- Total available time: 1h.
- You may use any written material you need, and write in Italian, if you prefer.
- You cannot use electronic devices during the exam.

Exercise 1 (6 points)
The fold operations are very general, and can be used to implement many higher order functions.
1) Define map as a fold (left or right, your choice).
2) Define filter as a fold (left or right, your choice).

Exercise 2 (6 points)
The function \((cos\text{-}min \ i\ j)\), given below, returns the integer in the range \([i,j]\) with the smallest cosine.
\[
\begin{align*}
\text{(define } (\text{cos}\text{-}\text{min} \ i \ j) \text{)} \\
\quad \text{(if } (= \ i \ j) \\
\quad \quad \ j \\
\quad \quad \text{(let } (((k \ (\text{cos}\text{-}\text{min} \ (+ \ i \ 1) \ j)))) \\
\quad \quad \quad \text{(if } (< \ (\cos \ i) \ (\cos \ k)) \\
\quad \quad \quad \quad \ i \\
\quad \quad \quad \quad \ k))))
\end{align*}
\]
Implement a tail-recursive version of \( cos\text{-}min \).
Solutions

Es 1
(define (fmap f l)
  (foldr (lambda (x y)
      (cons (f x) y))
    '()
    l))

(define (ffilter p l)
  (foldr (lambda (x y)
      (if (p x)
        (cons x y)
        y))
    '()
    l))

Es 2
(define (cos-min-tail i j)
  (define (helper i j k)
    (if (= i j)
        k
        (helper (+ 1 i) j
            (if (< (cos i) (cos k)) i k))))
    (helper (+ 1 i) j i))