CSC1048 Computability and Complexity

Functional Programming Lab 3: Lists

Aim

The aim of this class is to help you learn to define your own functions on lists, especially using recursion and list patterns.

1. Palindromes

Write a function `isPalindrome :: [a] -> Bool` that takes a list and checks if it is a palindrome. For example:

```
> isPalindrome [1,7,5,7,1]
True
> isPalindrome "madam"
True
```

2. Shortest list

Write a function `shortest :: [[a]] -> [a]` that takes a list of lists and returns the shortest list in the list (and returns [] if the list of lists is empty). For example:

```
> shortest [[1,2,3],[1,2],[1,2,3,4,5],[4,3,2,1]]
[1,2]
```

3. Adding Two Polynomials

A polynomial in a single variable can be represented rather simply by a list of its coefficients. For example:

`[1,7,5,2]`	represents	$2x^3 + 5x^2 + 7x + 1$
`[42,2,1]`	represents	$x^2 + 2x + 42$
`[-3,0,0,0,1]`	represents	$x^4 - 3$
`[0,-2,0,4]`	represents	$4x^3 - 2x$

Notice how the list index for each element corresponds to the exponent of the term.

Define a type synonym `Poly` for this representation. Two polynomials can be summed by adding the coefficients of corresponding terms. For example, the sum of $2x^3 + x^2 + 1$ and $3x^4 + 4x^2 - 7$ is $3x^4 + 2x^3 + 5x^2 - 6$.

Define a Haskell function `sumPoly :: Poly -> Poly -> Poly` that sums two polynomials that are represented as above. Take care with the case of polynomials with different degrees. For example:

```
> sumPoly [1,7,5,2] [42,2,1]
[43,9,6,2]
> sumPoly [-3,0,0,0,1] [1,7,5,2]
[-2,7,5,2,1]
> sumPoly [0,-2,0,4] [1,7,5,2]
[1,5,5,6]
```

4. Evaluating a Polynomial

Define a Haskell function `evalPoly :: Int -> [Int] -> Int` which, given a polynomial and a value for `x`, will calculate the value of the polynomial for that value of `x`. For example:

```
> evalPoly 3 [1,7,5,2]
121
> evalPoly (-2) [0,-2,0,4]
-28
> evalPoly 4 (sumPoly [0,-2,0,4] [1,7,5,2])
485
```

There are many ways to do this, but an identity that you may find helpful is the following:

$a_n x^n + \ldots + a_2 x^2 + a_1 x + a_0 = a_0 + x(a_1 + x(a_2 + x(\ldots a_n) \ldots))$