

CSX3004 Programming Languages

Week 4 Worksheet

Write the following functions using pattern matching in ML.

1. Function **exist** of type `'a * 'a list -> bool` so that `exist(e, L)` returns true if and only if `e` is an element of the list `L`.
2. Function **lessthan** of type `int * int list -> int list` so that `lessthan(e, L)` returns a list of all integers in `L` that are less than `e`.
3. Function **repeats** of type `'a list -> bool` that returns true if and only if the given list has two equal elements next to each other.
4. Function **quicksort** of type `int list -> int list` that sorts the given list using the quicksort algorithm.
 Here's a quick review on the algorithm. First, pick an element and call it the pivot. (Note that the head of the list is an easy choice for the pivot.) Then, partition the rest of the list into two sublists: one with all the elements less than the pivot and another with all the elements not less than the pivot. Recursively sort the sublists. Finally, combine two sublists (and the pivot) into a final sorted list. You can read more about the quicksort algorithm at <https://en.wikipedia.org/wiki/Quicksort>.
5. Function to test whether an element is a **member** of a set.
6. Function to construct the **union** of two sets.
7. Function to construct the **intersection** of two sets.
8. Function to construct the **powerset** of any set `A`. A powerset of `A` is the set of all of subsets of `A`. Consider the set `A = { 1, 2, 3 }`. It has 8 subsets which are \emptyset , `{1}`, `{2}`, `{3}`, `{1,2}`, `{1,3}`, `{2,3}`, `{1,2,3}`. In this example, the powerset of `A = { \emptyset , {1}, {2}, {3}, {1,2}, {1,3}, {2,3}, {1,2,3}}`.

Your powerset function should take a list (representing the set) and return a list of lists (representing the set of all subsets of the original set). `powerset [1,2]` should return `[[], [1], [2], [1,2]]` in any order. Your function doesn't need to work on the untyped empty list. It may give an error message when calling `powerset nil`. However, it should work on a typed empty list. Hence, `powerset(nil:int list)` should return the right answer which is `[[]]`.