2 Foundations of Computer Science (asp45)

(a) We are interested in performing operations on nested lists of integers in ML. A nested list is a list that can contain further nested lists, or integers. For example:

\[[3, 4], 5, [6, [7], 8], []\]

We will use the datatype:

\[
\text{datatype nested_list} = \text{Atom of int} \\
| \text{Nest of nested_list list};
\]

Write the code that creates a value of the type \text{nested_list} above. [1 mark]

(b) Write the function \text{flatten} that flattens a nested list to return a list of integers. [3 marks]

(c) Write the function \text{nested_map f n} that applies a function \(f\) to every \text{Atom} in \(n\). [4 marks]

(d) What is the type of \(f\) in Part (c)? [1 mark]

(e) Write a function \text{pack as xs n} that takes a list of integers and a \text{nested_list}; the function should return a new \text{nested_list} with the same structure as \(n\), with integers that correspond to the integers in list \(xs\). Note: It is acceptable for the function to fail when the number of elements differ. Example:

\[
> \text{pack as [1, 2, 3] (Nest [Atom 9, Nest [Atom 8, Atom 7]]); } \\
\text{val it = Nest [Atom 1, Nest [Atom 2, Atom 3]]: nested_list } \\
\]

[6 marks]

(f) What does the data type \text{nested_zlist} correspond to? [2 marks]

\[
\text{datatype nested_zlist} = \text{ZAtom of int} \\
| \text{ZNest of (unit -> nested_zlist list)};
\]

(g) Write the function that converts a \text{nested_zlist} to a \text{nested_list}. [3 marks]