COMPUTER SCIENCE TRIPOS Part IA – 2019 – Paper 1

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:

```
datatype nested_list = Atom of int
                     | Nest of nested_list list;
```

Write the code that creates a value of the type **nested_list** above.   [1 mark]

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

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

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

(e) Write a function `pack_as xs n` that takes a list of integers and a `nested_list`; the function should return a new `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:

```
> pack_as [1, 2, 3] (Nest [Atom 9, Nest [Atom 8, Atom 7]]);
val it = Nest [Atom 1, Nest [Atom 2, Atom 3]]: nested_list
```

[6 marks]

(f) What does the data type `nested_zlist` correspond to?   [2 marks]

```
datatype nested_zlist  = ZAtom of int
                       | ZNest of (unit -> nested_zlist list);
```

(g) Write the function that converts a `nested_zlist` to a `nested_list`.   [3 marks]