Foundations of Computer Science

What does $O(g(n))$ mean, and what is its relevance to programming? (Describe both advantages and limitations.) [5 marks]

Consider the following ML declarations, for tree-like expressions:

```ml
datatype 'a expr = Join of 'a expr * 'a expr
  | Tip of 'a;

fun flatten (Tip x) = [x]
| flatten (Join (e1,e2)) = flatten e1 @ flatten e2;
```

The size of an expression is the number of Tips it contains. State the complexity of $\text{flatten}(e)$, measured in cons operations, as a function of the size of $e$:

(a) in the worst case [3 marks]
(b) in the average case [4 marks]
(c) in the best case [3 marks]

Code a function flat such that flat($e$) = flatten($e$) for all $e$, justifying this claim. Show that flat’s worst-case complexity is linear. [5 marks]