1. Prove that the expected space requirement of a skip list constructed on \( n \) numbers is \( O(n) \).

2. Let \( S \) be a set of \( n \) points in the plane. A point \( p \) in \( S \) is called maximal (or Pareto-optimal) if no other point in \( S \) is both above and to the right of \( p \). If each point in \( S \) is chosen independently and uniformly at random from the unit square \([0, 1] \times [0, 1]\) what is the exact expected number of Pareto-optimal points in \( S \).

3. A data stream is an extremely long sequence of items that you can read only once. A data stream algorithm looks roughly like this:

```plaintext
DoSomethingInteresting(stream S):
  repeat
    x ← next item in S
    ⟨⟨ do something fast with x ⟩⟩
  until S ends
  return ⟨⟨ something ⟩⟩
```

Describe and analyze an algorithm that chooses one element uniformly at random from a data stream, without knowing the length of the stream in advance. Your algorithm should spend \( O(1) \) time per stream element and use \( O(1) \) space (not counting the stream itself).