

# 1994 Paper 11 Question 1

## Prolog

Consider the following problem to be solved using a Prolog program:

Given a closed planar polygon chain represented as a list of  $n$  vertices

$$[v(x_1, y_1), v(x_2, y_2), \dots, v(x_n, y_n)]$$

compute the area of the enclosed polygon, and the orientation of the chain. The area is computed by the line integral  $1/2 \int x dy - y dx$  where the integral is over the polygon chain. A naïve solution is given by the following program, which defines the predicate `area`. The goal `area(Chain, Area)` succeeds when `Chain` is the list of vertices, and the magnitude of `Area` is the area of the polygon bounded by the chain. The sign of `Area` is positive if the orientation of the polygon is anticlockwise and negative if it is clockwise:

```
area([X], 0).
area([v(X1, Y1), v(X2, Y2) | VS], Area) :-
    area([v(X2, Y2) | VS], Temp),
    Area is Temp + (X1 * Y2 - Y1 * X2) / 2.
```

Explain how vertices are processed by this procedure. [4 marks]

Why does this program execute inefficiently? [3 marks]

Write an alternative definition that is tail-recursive (iterative) and makes use of accumulator variables. [10 marks]

Explain why your alternative definition executes more efficiently. [3 marks]