

2011 Paper 3 Question 2

Algorithms II

- (a) Explain, with prose and no more than 15 lines of pseudocode, the “Jarvis’s march” algorithm for finding the convex hull of a set of points. Marks awarded for: clarity of explanation, legibility of pseudocode, correctness of algorithm. [5 marks]
- (b) Consider the following claim: “The cross-product trick can be used as a plug-in substitution for the comparison operation between two arguments that gives a three-way result (namely $<$, $>$ or $=$). Therefore, given an arbitrary set of 2D vectors all starting from the origin, I can sort them in order of increasing polar angle, from 0 to 2π , without computing any angles, merely by applying a standard sort algorithm with the comparison operation replaced by the cross-product trick”.
- (i) Explain the “cross-product trick”. [3 marks]
- (ii) Prove the correctness of the above claim or refute it with a clearly explained graphical or numerical counterexample. [7 marks]
- (c) Traditionally, Jarvis’s march handles the left side and the right side of the hull separately. Clearly explain why a single pass would not work as desired and then describe a variant implementation to handle the problem in one pass, highlighting its advantages and disadvantages. [5 marks]
- [Hint: see part (b)(ii).]