

Two hours

The exam will be taken on line.
This paper version is made available as a backup
In this event please use a separate answerbook for each section.

**UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE**

Advanced Computer Graphics

Date: Tuesday 17th January 2017

Time: 09:45 - 11:45

Please answer BOTH Questions

This is a CLOSED book examination

The use of electronic calculators is NOT permitted

[PTO]

Section A

1. a) Figure 1 shows a possible triangulation of 8 points A-H. What are three undesirable properties of this triangulation, and why are they undesirable? (3 marks)

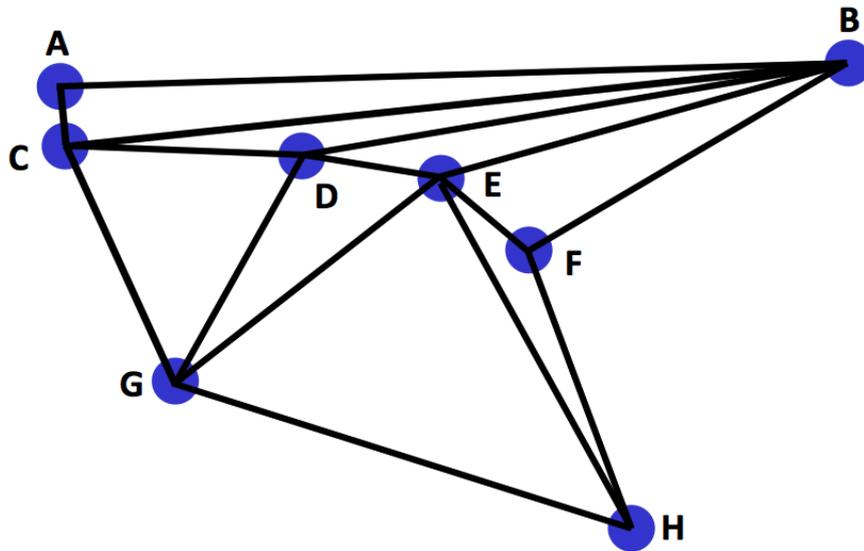


Figure 1.

- b) Describe the basic principles of a technique for creating a triangulation of a point cloud that helps to eliminate the properties you described in the previous question. (2 marks)
- c) What is the 'occlusion problem' in laser scanning? (1 mark)
- d) Describe two different techniques for attempting to solve the occlusion problem. (4 marks)
- e) You are building a real-time computer graphics simulation of lightning hitting a tree. Describe suitable techniques for modelling and rendering the scene. (4 marks)
- f) What is meant by the term 'calibrated camera' in the context of estimating 3D geometry from photographs? (3 marks)
- g) Explain how automatic feature detection is used in the estimation of 3D geometry from a video sequence. (3 marks)

Section B

2. a) In classical Whitted Ray Tracing, why is it common to trace rays by starting from the eyepoint and ending at light-sources and not the other way round? (1 mark)
- b) What is the role of shadow feelers in Whitted Ray Tracing? (1 mark)
- c) In a scene that is lit by a single spotlight facing towards all the objects, describe what happens when a primary ray encounters a silver mirror. (2 marks)
- d) In the same scene, what happens when a ray encounters a sphere made of green glass? (2 marks)
- e) In the same scene, what happens when a ray encounters a cube covered in a matt material such as velvet? (2 marks)
- f) Why is it difficult to render velvet effectively using Ray Tracing? Which alternative photo-realistic rendering technique might be used to give a better result? Briefly explain why. (3 marks)
- g) Select and name one of the data structures from Figure 2, and explain how it could be used to accelerate the process of Ray Tracing. (2 marks)
- h) Which two of the data structures in Figure 2 would be appropriate for storing volumetric data to be used for Direct Volume Rendering? Explain which would work best for dense data resulting from a geological scan, and which for more sparse data such as a CT scan of an archeological object inside a locked box. In each case, name the data structure and explain its use. (3 marks)

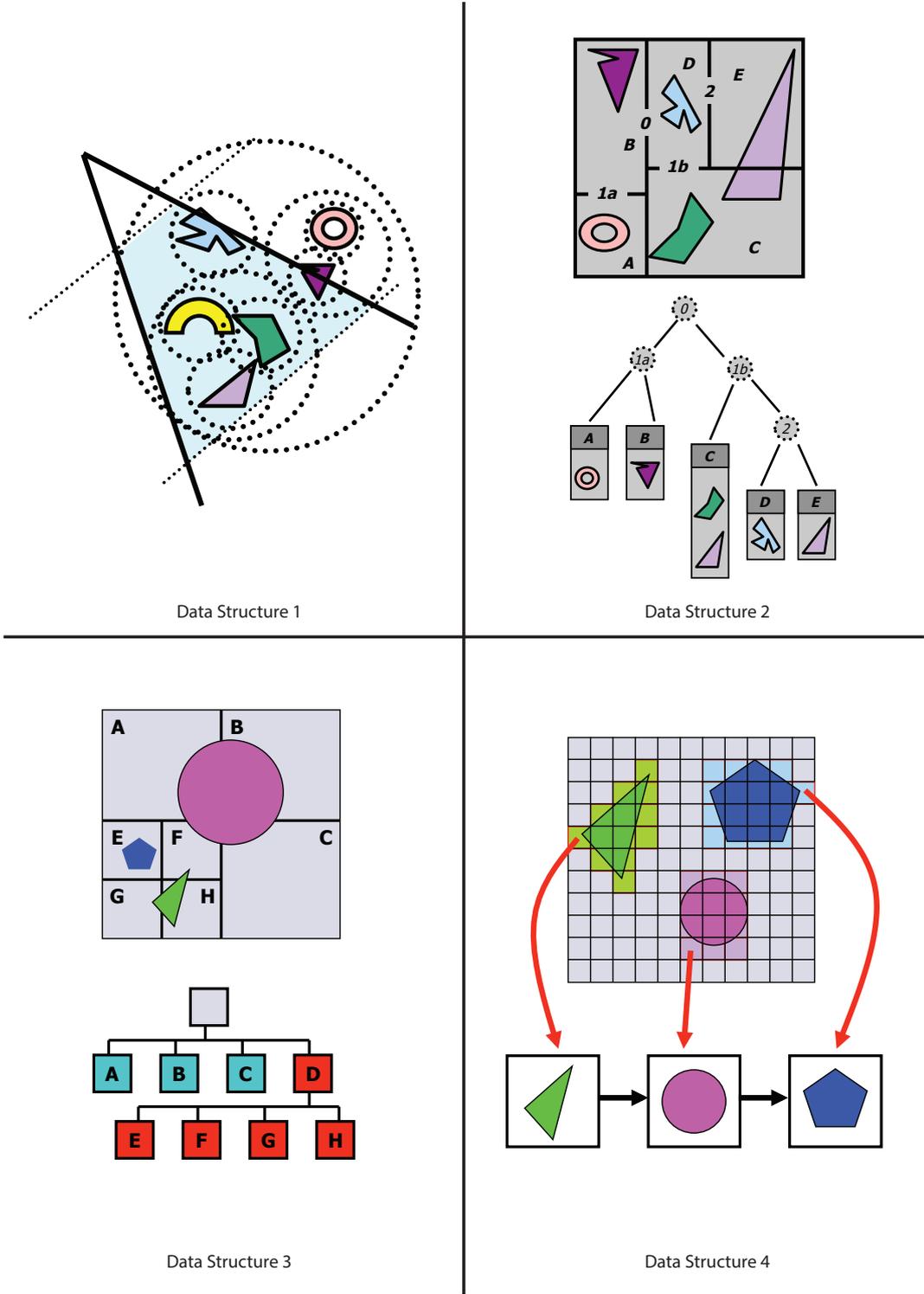


Figure 2.

i) Briefly describe a process of Direct Volume Rendering and a process of Indirect Volume Rendering, then compare and contrast the pros and cons of these approaches when used in the context of a medical application such as the detection of a tumour within healthy tissue. (4 marks)