COMP37111

Two hours - online

UNIVERSITY OF MANCHESTER
DEPARTMENT OF COMPUTER SCIENCE

Advanced Computer Graphics

Date: Friday 17th January 2020

Time: 14:00 - 16:00

This is an online examination. Please answer ALL Questions.
The examination is worth a total of 45 marks

This is a CLOSED book examination

The use of electronic calculators is NOT permitted

1. What is the principal characteristic of “generative modelling”? (1 mark)

2. a) Figure 1 shows a bamboo forest in summer sunlight. Suggest how you might use a generative modelling approach to create a geometrical model of this scene. (3 marks)

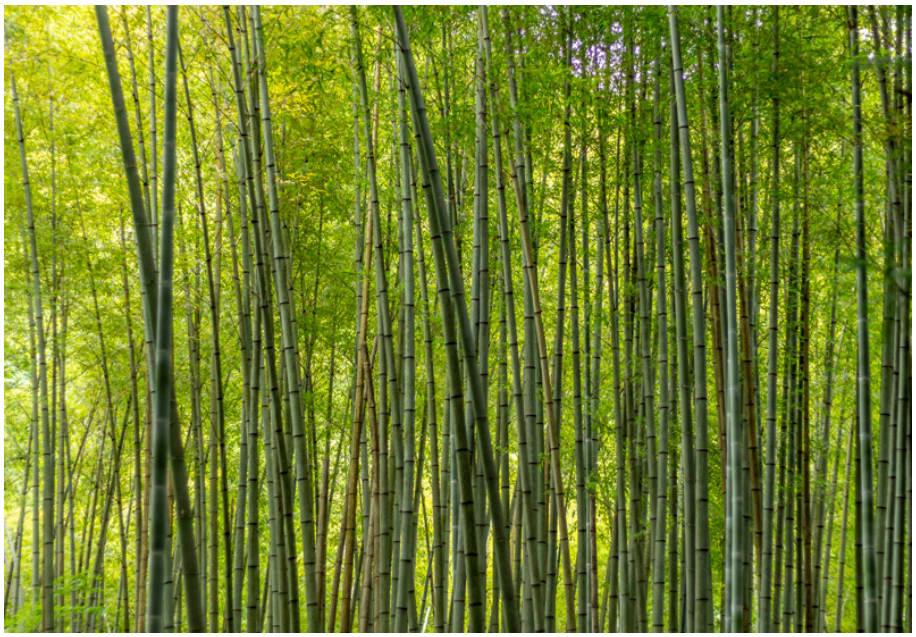

Figure 1.

b) Suggest techniques suitable for rendering real-time images of the scene which look realistic (2 marks)

3. Describe a process that, starting with a single quadrilateral, can create the kind of approximation to terrain shown in Figure 2. Your answer should include discussion of any relevant issues of time/space complexity. How could you ensure that, if required, the exact same terrain could be generated each time the process runs? (5 marks)

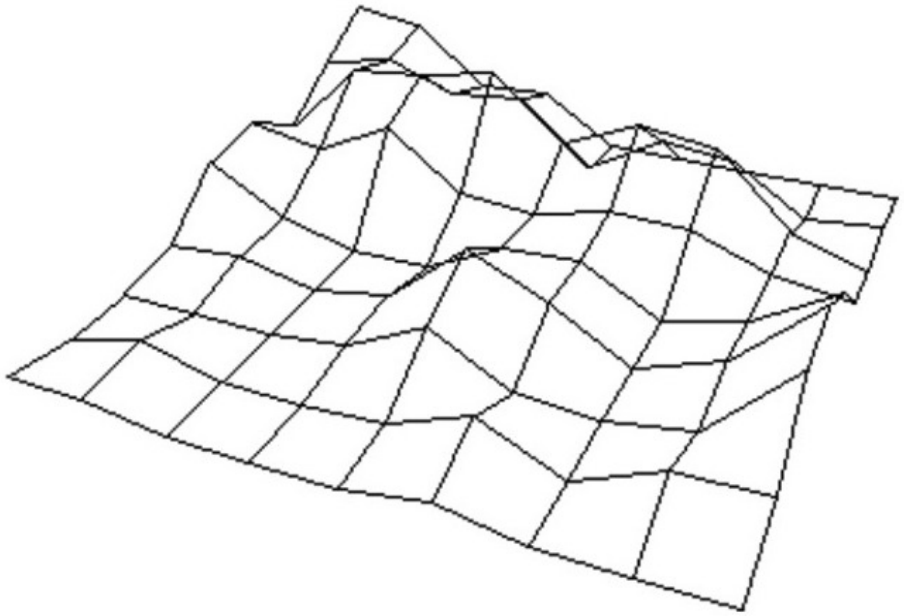

Figure 2.

4. You have a laser scanner which for each separate scan from a fixed position produces a text file for the point cloud captured. Your task is to use this scanner to create a realistic 3D model of the sculpture of Alan Turing shown in Figure 3. As far as possible, your model should not have any holes or missing detail. Describe a workflow for doing this, naming and describing any specific algorithms you would use. You may assume that you have access to a software library which can perform a suitable triangulation on a set of 3D points. (6 marks)

Figure 3.

5. In methods for capturing 3D geometry from the world using only cameras,

   a) describe how multiple images can be analysed to estimate scene geometry. (4 marks)

   b) why is the use of a video camera generally preferable to using a still camera? (2 marks)

6. You have used image-based methods to create a geometrical model of a real scene. You now wish to add objects to this scene created synthetically with a computer graphics modelling system. Explain how to add the objects such that they appear to sit realistically in the scene geometrically, and blend in correctly when the entire scene is rendered. (2 marks)

7. We see in the real world because light enters the eye after being emitted from light sources and interacting with objects; why is this not the model used in classical Whitted Ray tracing? What model approach is used instead and why?
(2 marks)

8. In ray tracing, explain what happens when a primary ray encounters a sphere made of a shiny semi-transparent blue material. (3 marks)

9. Explain how light behaves when it encounters a highly diffuse material such as velvet, and describe why this presents challenges for ray tracing (2 marks)

10. You have joined a team developing a new interactive first-person video game in which the player explores a dimly-lit haunted house. There are objects such as beds, curtains, sofas, cupboards and various rusted metal items throughout the house, and various dim lights can be switched on and off by the player (though none provide bright lighting). Ray Tracing, Radiosity and Volume Rendering are being considered as alternative ways for creating a realistic-looking environment. Which approach would you select, and why? Justify your choice with respect to the alternatives. (3 marks)

11. Explain how the process you chose in the previous question could deal with different combinations of lights being switched on and off during gameplay while still providing real-time behaviour. (2 marks)

12. With reference to the data structures illustrated in Figure 4, name and describe an approach to spatial enumeration that could be used to optimise the rendering of the haunted house and the various objects within. (2 marks)

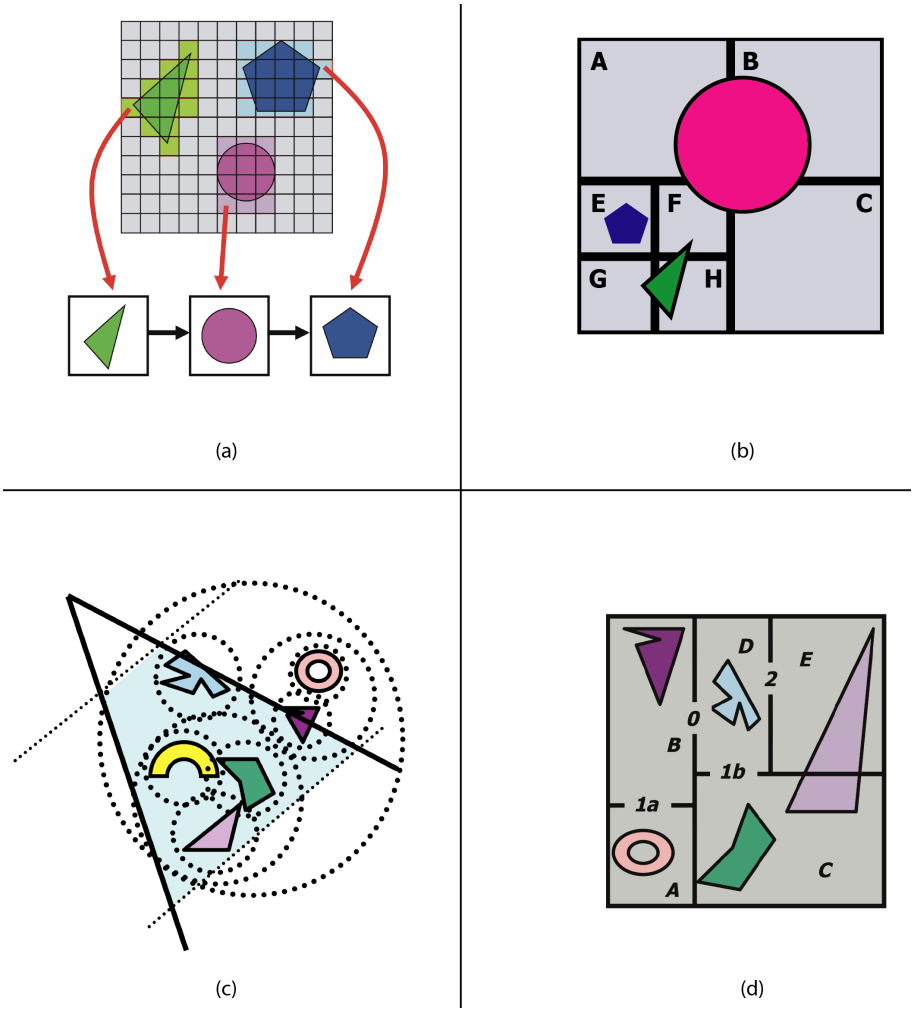

Figure 4.

13. Describe an optimisation to the spatial enumeration approach you chose previously that exploits the fact that the house consists of rooms and corridors. (2 marks)

14. Towards the end of the game's development, the lead designer decides that the player has a torch that can be used to illuminate small areas of the house at a time and also that there are a number of ceramic, slightly-shiny objects in the game. What implications does this have for the rendering approach you chose previously, and how might you implement these effects? (2 marks)

15. A final last-minute change is introduced in which swarms of flying insects that scatter throughout the house can be released by the player disturbing various objects. Explain how you might need to modify/augment the approach to spatial enumeration you chose previously. (2 marks)

END OF EXAMINATION