University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

SEMESTER II EXAMINATION – 2016/2017

COMP 30540

Game Development

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Time Allowed: 2 Hours

Instructions for Candidates

Answer three questions. Each question carries 100 marks.

Instructions for Invigilators

Written materials and electronic devices are prohibited.

1. (Shape collision)

1a. What are *voronoi regions*? Illustrate by discussing Voronoi regions surrounding a rectangle in an infinite plane.

[10 marks]

1b. What is the *Minkowski sum* of two 2D shapes, and similarly, of two 3D shapes? Illustrate with an example of two off-origin non-identical triangles.

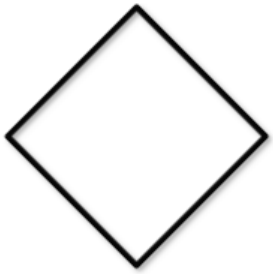
[25 marks]

1c. Give an algorithm for cheaply computing whether a circle of given radius and centre position overlaps a coplanar axis-aligned rectangle of given size and position.

[15 marks]

1d. Compose and explain a similar algorithm for cheaply computing whether a given axis-aligned rectangle overlaps a given coplanar square tilted at 45°. Refer to the diagram below:

[30 marks]



centre_x	left	
centre_y	right	(right > left)
side_length	bottom	
	top	(top > bottom)

1e. Explain why testing for intersection of two 3D convex shapes may make use of the Minkowski sum of one shape and the reflection-through-the-origin of the other.

[20 marks]

2. (Less common AI techniques)

2a. Why might the Sense-Think-Act cycle of a NPC AI be extended to use some learning?

[20 marks]

2b. Describe two simple forms of learning that might be incorporated into NPC AI.

[30 marks]

2c. Why would AAA development teams choose to avoid more sophisticated learning methods?

[10 marks]

2d. Outline an algorithm for processing a 2D map in which passable and impassable pixels are easily distinguished or even labelled, to find choke points where movement might be difficult or impossible.

[40 marks]

3. (Behaviour Trees)

3a. What are behaviour trees? What may a leaf node of a behaviour tree consist of?

[20 marks]

3b. Describe the most common types of behaviour tree interior node, in their simplest forms.

[20 marks]

3c. Why are less simple forms of those interior node types sometimes used?

[20 marks]

3d. So-called *Decorator nodes* are also sometimes used. Give examples of their role in a behaviour tree.

[20 marks]

3e. Why may errors arise in using behaviour trees, and how are they accommodated?

[20 marks]

4. (Physics)

4a. How does a physics-based approach help in modelling the behaviours of non-rigid 3D bodies and of colliding rigid bodies?

[30 marks]

4b. Discuss how modelling two distinct types of non-rigid 3D bodies may be done using *particles* and *links*, describing any properties that should be associated with particles and links.

[40 marks]

4c. Why does physics simulation rest on numerical integration? What dangers attend the use of numerical integration?

[30 marks]

5. (BSP)

5a. What is a *Binary Space Partitioning* (BSP) of a set of polygons representing surfaces in a 3D scene?

[20 marks]

5b. Explain how a BSP allows realistic rendering of such polygons without sorting polygons by distance from a camera and without Z-buffering.

[25 marks]

5c. Give two reasons why forming a BSP is facilitated if only triangles are used, and not general polygons.

[20 marks]

5d. It is desirable that each distinct object should have its surface polygons represented in its own BSP tree. Why is this so? When, and how often, should a BSP for an entire scene be created?

[20 marks]

5e. Why is it useful to associate bounding boxes with BSP tree nodes, in addition to the polygons they contain?

[15 marks]