McGill

April 2017

PRACTICE Examination

Modern Computer Games

COMP-521

A Non-exhaustive Set of Practice Exam Questions

EXAMINER:		ASSOC. EXAMINER:	

STUDENT NAME:		**McGILL ID:**									

INSTRUCTIONS

EXAM:	CLOSED BOOK ☐ OPEN BOOK ☒
	SINGLE-SIDED ☒ PRINTED ON BOTH SIDES OF THE PAGE ☐
	MULTIPLE CHOICE ☐ Note: The Examination Security Monitor Program detects pairs of students with unusually similar answer patterns on multiple-choice exams. Data generated by this program can be used as admissible evidence, either to initiate or corroborate an investigation or a charge of cheating under Section 16 of the Code of Student Conduct and Disciplinary Procedures. ANSWER IN BOOKLET ☐ EXTRA BOOKLETS PERMITTED: YES ☐ NO ☐ ANSWER ON EXAM ☒
	SHOULD THE EXAM BE: RETURNED ☒ KEPT BY STUDENT ☐
CRIB SHEETS:	NOT PERMITTED ☐ PERMITTED ☒ e.g. one 8 1/2X11 handwritten double-sided sheet Specifications:
DICTIONARIES:	TRANSLATION ONLY ☐ REGULAR ☒ NONE ☐
CALCULATORS:	NOT PERMITTED ☒ PERMITTED (Non-Programmable) ☐
ANY SPECIAL INSTRUCTIONS:	

1	2	3	4	5	6	7	**Total**
/2	/5	/2	/7	/7	/5	/6	**/40**

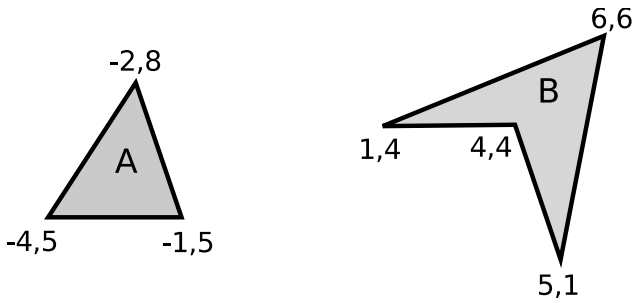
1. Consider possible triangulations of the interior of a simple polygon P. If P is not convex, does there always exist a triangulation with the Delaunay property? Explain why or show and describe a counter-example. **2**

2. In analyzing the Hertel-Melhorn algorithm for constructing navigation meshes, you saw a lower-bound of proof for convex partitioning arguing that at least $\lceil \frac{r}{2} \rceil + 1$ convex regions are required if you have r reflex vertices.

   (a) Demonstrate that this lower bound can in fact be achieved: describe an infinite family of n-vertex polygons with $r \in O(n)$ reflex vertices for which a convex partitioning exists that reaches the lower bound. **2**

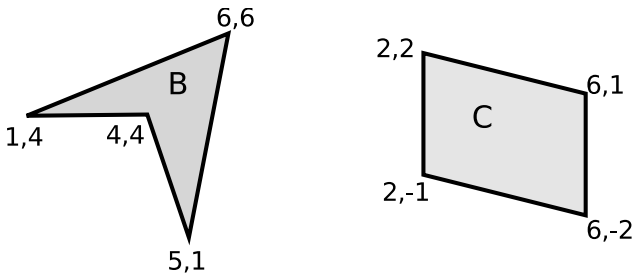
   (b) Now, draw a polygon (and its convex partitioning) with 2 reflex vertices that cannot be partitioned into less than 5 convex regions by drawing lines diagonals between polygon vertices. **3**

3. Consider the following polygons: **2**



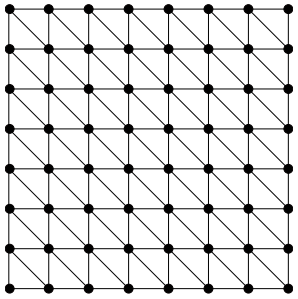
Draw and show coordinates of the convex hull of the Minkowski sum of A and B.

4. Consider the following polygons: **7**



Using the Gilbert-Johnson-Keerthi (GJK) algorithm, determine whether (B, C) intersect. Show all work—you do not need to show each dot-product or calculation, but every major step of your computation should be indicated and clearly justified.

5. Given a regular, triangular grid of points as a game space, as shown below, you need to define a coordinate system and come up with a metric for calculating the distance between any two locations. Note that only a finite patch of the space is shown; assume it is an infinite grid.



In this grid characters occupy the points themselves rather than the grid cells, and can move to any adjacent point as a unit-cost, discrete step.

(a) Describe how to give coordinates to each point and give a distance function that you can use to easily compute the distance between two points. **5**

Your distance function should trivially satisfy the positivity (non-negative) and symmetry properties. Clearly explain why the following two other properties hold:

- *translation invariance:* Given two integers v, w, the distance from A to B is the same as the distance from $A + (v, w)$ to $B + (v, w)$.

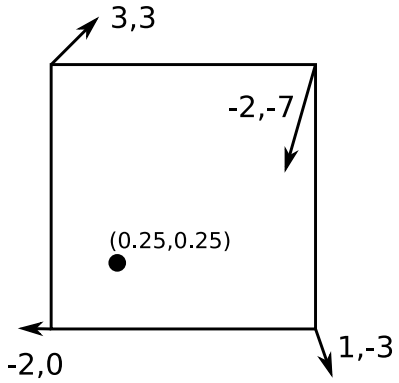
- *triangle inequality:* The distance from A to B is never more than the distance from A to C plus the distance from C to B.

(b) Suppose a single point was removed in the grid (along with its attached edges). Argue whether or not the two above properties still hold under your coordinate system and distance function: **2**

- *translation invariance:*

- *triangle inequality:*

6. As part of a Perlin noise computation, noise vectors are applied at the corners of the unit square as shown below. What is the Perlin noise value computed at the given dot? You should use an 'S'-curve for interpolation: $s(a) = 3a^2 - 2a^3$. **5**



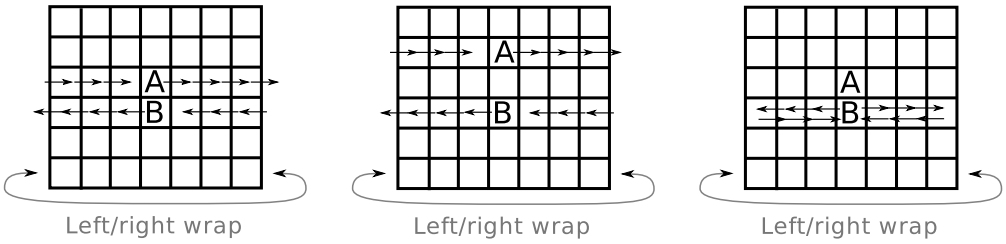
7. Suppose you need to implement an AI modeling the behaviour of a typical student attending a lecture in a classroom. You have the following animations available: **6**

   - a) Look forward attentively
   - b) Write something on a piece of paper
   - c) Look forward puzzled
   - d) Type on a laptop
   - e) Use a mouse attached to a laptop
   - f) Open a laptop
   - g) Close a laptop
   - h) Laugh while looking at a laptop
   - i) Look forward and speak
   - j) Look surprised
   - k) Get up and leave

   The student has the ability to detect his/her state (eg laptop open or not), and at arbitrary points the student may be asked a question, or a bell may ring signifying the end of class (after which no further external events will occur). Draw an appropriate behaviour-tree AI for the student. Use all of the animations, ensure a sensible order to the student actions, and also ensure your student is responsive to external events.

8. Characters move on a 7×6 square grid with 8-way distance; assume discrete, unit-distance movement and cylindrical topology—ie wrapping left/right but not top/bottom. Suppose two game characters, A and B, each have a 1×1 nimbus (ie a single cell) and a 3×3 focus, centered on the character. Each character must receive a notification every time something enters, leaves, or moves within their interest. **6**

Compare the use of nimbus+focus with the use of a plain aura for interest management in terms of communication cost. In each of the cases below consider one full cycle of movement (ie up to, but not including the point at which A and B have returned to their starting position and intended movement direction) and give the total number of messages sent by A and by B for nimbus+focus and for aura. Assume A and B alternate moves, with A moving first.



(a) A and B are 1 unit apart vertically. Both A and B move in opposite but parallel directions.

(b) A and B are 2 units apart vertically. Both A and B move in opposite but parallel directions.

(c) A and B are 1 unit apart vertically. Character A stays still, while B moves to the right 3 units, then to the left 6 units, then to the right 2 units.