School of Engineering and Information Sciences

MIDDLESEX UNIVERSITY

EXAMINATION PAPER

2010/2011 Summer Exam

MODULE TITLE Advanced Topics in Games Development

MODULE NUMBER CMT 3325

MODULE LEADER'S NAME Chris Huyck

Time allowed: 3 hours

Total number of questions: 4 questions

Instructions to candidates: Answer all questions. Each question carries 25 marks.

Materials provided: The book Programming Game AI by Example (by Buckland) is allowed, along with one A4 page marked as notes on the top. Please submit that page with the exam (it will not be marked).

Equipment permitted: none

Total number of pages: 3

No books, papers or electronic devise is to be brought into the examination room other than any specified above.

Candidates are warned that illegible scripts will not be marked

1. AI

(a) The game of chess is played on an 8x8 board, and both players have 16 pieces. There can be at most one piece on each board position. Estimate the size of the state space for chess. Explain your reasoning of the size.

(6 marks)

Marking scheme:
2 points reasonable estimate
2 points for good estimate
2 points for reasoning

Sample answer:

Each of the 32 pieces can be on any of the squares without replacement. So, the size is 64!/32!. Of course there is some redundancy (pawns are equivalent), and impossible positions (e.g. a knight on white stays on white), and some unusual states (you can get two queens), but this is on the right order. It is bigger than 10^32 which is a really vast number.

(b) Why is exhaustive search not applicable to the game of chess? What method would be a good method for playing chess?

(10 marks)

Marking scheme:
3 points the search space is too big for exhaustive search
3 points evaluation function
2 points search several moves ahead.
2 points for additional techniques (like minimax).

Sample answer:

The search space is so big, that exhaustive search can not be run on modern computers (including the Cloud). It's not clear if computers will ever be fast enough for exhaustive search of chess. Instead, a good technique is to use an evaluation function which gives a value to each possible board. For example, boards where white wins get a value of infinity, non-winning boards might get more points for having more white pieces than black pieces (it's all inverted for black), and having control of parts of the board. Now the space can be searched by a breadth first search. All moves are expanded for the next move, and this is done for several moves (or plies) in advance. It's assumed that black will minimize and white maximize (Minimax). At the end of the search, you choose the move that will give you the best future board (as far as you've searched). Other techniques like iterative deepening, and alpha beta pruning can help.

(c) Many techniques that can be used for chess can be used in modern video games. Explain a game where some of the techniques could be used and how they'd be used.

(9 marks)

Marking scheme:
3 points evaluation function
2 points reasonable game
2 points for search

2 points for other techniques

Sample answer:
The evaluation function can be used broadly in games that take advantage of search techniques. For instance, a resource allocation game, like Command and Conquer, could use an evaluation function to show how good various positions would be. Many of the other chess techniques would also work. Breadth first search could be used to move plies forward. As it's adversarial, minimax could also be used as well as iterative deepening, and other techniques.

2. Physics

(a) The earth's rotation around the sun is caused largely by the sun's gravitational effect on the earth. What is the relation between the sun's gravitational effect on the earth, and the earth's gravitational effect on the sun? The earth has an equal gravitational effect on the sun. Paraphrase (or quote) Newton's law that gives you the answer.

(8 marks)

Marking scheme
2 marks for equality
6 marks for the paraphrase
Sample answer:
The gravitational effects are equal. This is due to Newton's law that states the mutual actions of two bodies up each other are always equal.

(b) A bowling ball that weighs 5 kg sits on a ramp that is 1 metre tall. How much potential energy does it have?

(6 marks)

Marking scheme
2 marks for the formula
2 marks for good answer
2 marks for the right answer
Sample answer:
E = mass *g * height
E = 5kg*9.8*1 = 4.9 J ~= 5 J

(c) When small children bowl, they often use ramps. What forces are involved in the game?

(6 marks)

Marking scheme
1 mark potential energy of ball
2 marks motion of ball
2 marks motion of pins
1 mark energy from the push.
Sample answer:
Potential energy from the ball sitting on the ramp is translated into motion when the ball is pushed down the ramp. If it hits the bowling pins, they will knock into each other. An additional bit of energy is added to the ball when the bowler pushes it down the ramp.

(d) What additional forces are available to a person bowler not using a ramp, but throwing with their hand?

(5 marks)

Marking scheme
3 marks spin
2 marks other

Sample answer:

A bowler using his hand can make the ball spin. This can cause it to hook at the end enabling the ball to hit the right triangle of pins along one of the sides; that's why good bowlers use spin. Of course, a bowler using his body has his motion of walking translated to the ball along with his full arm motion, so the ball will usually go faster than one coming down a ramp.

3. Software

(a) Distributed games like World of Warcraft raise complex software issues. Discuss software development, and algorithmic issues that arise from games that have large numbers of users playing on different machines.

(12 marks)

Marking Scheme:
2 marks versioning
2 marks platform support
2 marks shared data
2 marks communication
2 marks distribution of process
2 marks client server
Other points are possible

Sample Answer:

Some simple issues involving games that are played by a large number of people involve traditional software engineering issues like versioning, and running on multiple platforms. It is unlikely that everyone will be playing with the same version of the software, so how can different versions be kept compatible? Similarly, it is unlikely that everyone will have the same platform or even operating system. So, what different platforms are supported, and how are they supported?

Another issue is distribution of process and data, and updates of data. If each player has a different view of the world, when one player changes the world, others must see the change. This leads to client server questions. Does the server do all the work, and the clients merely act as input and output devices, or is there more processing done on the clients, and thus do they retain more data? These light vs. heavy client issues are also effected by communication bandwidth. If the server needs to communicate a lot of data (e.g. streaming video) , there will need to be a lot of bandwidth.

(b) What mechanisms could be used to test such a massively distributed game?

(7 marks)

Marking Scheme:
2 marks test suite
2 marks bug reporting
2 marks other

Sample Answer:

Its really a complex environment to test, and the state of the game is likely to always be unique, so a wide range of techniques should be used. It is essential that automated test suites should be running around the clock. An update policy for software needs to be enforced, and this update policy needs to incorporate test suites. Similarly, users should be included in the testing and should be encouraged to report bugs (particularly reproducible bugs). It is important to compartmentalize tests and code so that unforeseen code interactions are avoided.

(c) Would it be useful to have chatbots in such a game? Why? Assuming yes, what would be a good way to implement them?

(6 marks)

Marking Scheme:
2 marks yes (or good reason for no)
2 marks object oriented
2 marks data driven

Sample Answer:

Yes chatbots would be good agents. Assuming users don't play every role, chatbots can go a long way to making the game interesting. A good way would be to use OO techniques. Some base classes (using possibly FSAs) could lead to simple chatbots. It would be good to have these data driven, so that agents can be easily specialised. Subclassing could also lead to more complex agents that specialise in certain conversations. It might even be possible to allow users to make agents like these.

4. Theory, software and AI

(a) A semantic net is a type of graph. What do the nodes and arcs mean?

(6 marks)

Marking Scheme:
2 marks nodes
2 marks arcs
2 marks arc restriction

Sample Answer:

The nodes in semantic nets usually refer to objects or classes of objects, though they may also refer to values. Arcs refer to relationships between nodes, with ISA and instance of being the most typical arcs. There is typically a restricted number of type of arcs (relations) in a semantic net language.

(b) How might an agent learn a semantic net for a game while playing in the game?
(7 marks)

Marking Scheme:
2 marks some form of learning
2 marks a rational way of doing learning (Isa in my answer).
2 marks a way of expanding (adding extra attributes in my answer)
1 mark for exploration.
Sample Answer:
It really depends on how the objects are presented to the agent. Typically this can be done symbolically, and the agent can start to categorise instances that it expeiences. As it categorises instances, it can start to build an is-a instance (subcategorisation) hierarchy. It might also try to classify situations, and give attributes to objects. If it sees an object, it might try to learn more about it by using it.

(c) What use might that agent make of its learned semantic net in the game?
(6 marks)

Marking Scheme:
2 marks knowledge makes agents more useful
2 marks specific and general
2 marks other
Sample Answer:
As the agent knows more about its environment, it will know more things that it can do, and the effects of such actions. Thus an agent that learned a semantic net from an environment could function better. It would know about specific items (instances) and could use its categories to guess how novel objects would behave. Note, this is probably not very useful when there are only a few objects as the agent could just be programmed with knowledge of them. However, when there are lots of objects, new objects are introduced (say by mods), and the combination of objects results in novel objects, this learning approach can be useful.

(d) How might goaling interact with an agent that learned semantic nets?
(6 marks)

Marking Scheme:
2 marks something with reasonable goals
2 marks some interaction between goals and the net
2 marks for sound interaction
Note another reasonable answer here is that the goals can evolve through the semantic net, and other answers must exist.
Sample Answer:
One simple goal that an agent the could learn semantic nets might have would be to increase the size of its semantic net, and a second might be to improve the accuracy of the net. This could lead to an agent that would explore on its own to improve its knowledge.