Machine Learning for Game AI

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What is Machine Learning?

A branch of Artificial Intelligence.

Learn a model of the world by statistical analysis of observations.

The model allows us to do:
- Simulation
- Prediction
- Classification/Clustering

The model can also be used to decide on actions to take in the world. The actions are based on models and data, not rules and conditions.

What Can Machine Learning do for Games?

We can create a model of human game play.

Game agents can be created that learn to play like an individual human player, which could be used in online worlds in which a player's avatar persists even when the player is not online.

ML analysis of logs from online games could automatically find and close exploits, or adjust the attributes of items or characters to keep competitive play balanced.

Games that learn from human behavior could anticipate the actions of players to adjust the difficulty or type of challenges, or change the game world to keep the game interesting and fun.

The 'Touring' Test: Modeling Human Play

In Touring, a human player explores a dungeon, battling monsters and collecting treasure.

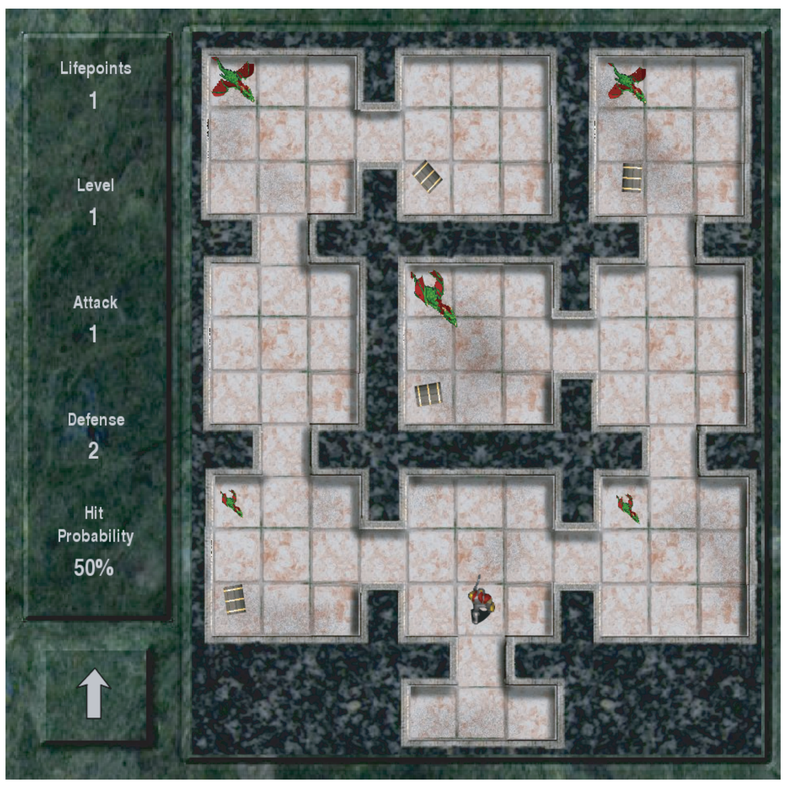
From recorded player logs, our program then learns a model of player behaviour. Our approach groups similar games together into sub-models to capture different styles of play.

The computer can then play in a human-like way by selecting one of the styles of human play and looking at the statistical model of what humans in that cluster did in each situation.

Because the model is constructed automatically and actions performed by probabilistic processes, there is no need to explictly program any action on the part of the agent. The game AI doesn't require a single if-then statement or any hard-coded actions.

If the game changes, all that is required is that the model be retrained using a new data set -- the game AI doesn't need to be touched.

The game Black & White made extensive use of Machine Learning techniques such as Neural Networks to create creatures that learned from experience and could be trained by the player.



'Touring' is a very simple game we have developed to test ML techniques and demonstrate the potential of ML in games.

Results

	Humans	Trained agent	Random agent
Experiment 1	90% (39)	83% (40)	0 (-)
Experiment 2	73% (41)	75% (50)	0 (-)

Performance by humans, a trained agent and a randomly acting agent. The numbers are the average winning percentages. In brackets, we show the average number of steps taken to win a game.

about us

http://www.cs.ubc.ca/sml

The University of British Columbia Statistical Multimedia Learning Group was founded in 2002 as a research group devoted to applying Machine Learning to media data sets: audio, text, musical scores, photographs, paintings, and, of course, games. Our members come from engineering, AI, graphics, game development, computer vision and statistics backgrounds.

Our non-game research projects include
- computer vision software that learns to identify object in pictures based on examples
- image restoration software for damaged photographs
- search engines that allow searches based on combinations of images, music and text
- software that learns to identify the moods of music
- a browsing program for exploring the archives of the Vancouver Art Gallery

The head of the UBC SML group is Dr Nando de Freitas, a leader in the Machine Learning and Statistical Multimedia research communities.

Touring demonstrates our group's solutions to several common ML problems.

Modeling styles of play

As new games are recorded, the sub-models representing different styles of play are adapted to reflect the new information using Online Expectation Maximization techniques (Bao 2003, thesis)

What is done when a situation is encountered that never occured in the recorded games?

Techniques from Bayesian stats allow us to incorporate subjective belief about unseen events.
(Barnard & de Freitas, UBC Tech Report, 2001)

How can we determine what data needs to be collected?

The importance of different data items to the quality of results can be determined with feature weighting. (Carbonetto, de Freitas, Gustafson & Thompson, AI-Stats 2003)

Basing actions on data without storing all data in memory

Data is represented in our model as statistics, using techniques from Statistics and Natural Language Processing, which we adapted for our work on multimedia databases (Brochu & de Freitas, NIPS 2003; Brochu, de Freitas & Bao, AI-Stats 2003)