Darkwind–War on Wheels: Computer Controlled Cars learn from player behaviour and evolve through the use of Genetic Algorithms

www.dark-wind.com
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Darkwind, the multiplayer on-line turn based strategy war game has continued to push the boundaries of possibilities in on-line gaming with the integration of computer generated players who have improved their skills through cross breeding, natural selection, and learning from human behaviour. The game is one of an extreme minority to implement Genetic Algorithms (GAs) to breed new superior computer generated players who additionally can learn from the strategies of their human adversaries. Artificial Intelligence (AI) techniques can make the behaviour of the computer agent more interesting, varied and believable as it has learned behaviours rather than rules being pre-programmed to determine behaviour.

Genetic algorithms use techniques inspired by Charles Darwin's theory of evolution and survival of the fittest via natural selection: a population of individuals undergo selection in a system where variation inducing operators such as crossover of genes and ongoing mutations are present. The evolution starts from a population of individuals and happens in generations. In each generation the fitness of every individual in the population is evaluated and based on this multiple individuals are randomly selected and modified (recombined and possibly mutated) to form a new population. The new population is then used in the next iteration of the algorithm. A fitness function is used to evaluate individuals, and reproductive success varies with fitness. The results are the average fitness being increased with each generation.

GA evolved computer agents/drivers are being introduced in Darkwind for specific track/car combinations in the racing environment. Effective racing lines for these combinations are being evolved through the use of waypoints. Computer drivers use these waypoints during the game to influence their behaviour as they navigate static and moving obstacles on the racetrack. This provides an evolved understanding of the overall shape of the track.

The GAs have yielded an improvement of up to 30% in computer driver behaviour, but more importantly the use of GAs can make the behaviour of the driver more human like.

Darkwind players are varied, and while some prefer Player-V-Player conflicts, others prefer to team up against computer adversaries. The introduction of GA evolved computer agents benefits all players and increases the challenge for the most effective players.

AI is also being deployed in the wilderness area of the game for efficient path finding, obstacle avoidance and terrain navigation. The routes taken by human players over thousands of journeys per week as they navigate the wilderness are used as a form of route planning consensus by the computer agents in a similar manner to that of how ants use pheromones to mark their trail and guide following ants. If the trail is successful and more cars use it, the guidance becomes more intense and denser, whereas other trails fade out. This is much more effective than doing a cost-surface analysis where the computer agent makes a computational evaluation of the landscape around them as they traverse it, and therefore once again leads to more human like decisions and challenging opponents.

If you have not already signed up go to **dark-wind.com**

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Artificial Intelligence in gaming: Q&A with Dr. Sam Redfern lead developer of Darkwind–War on Wheels:

Question:
What is “Artificial Intelligence” and do all games use it?

Answer:
Artificial Intelligence (AI) is the engineering of seemingly intelligent machines or computer programs. An “intelligent agent” is a computer-controlled entity that perceives its environment and takes actions that maximize its chances of succeeding in that environment. In its broadest sense, AI refers to anything that a computer does which, if done by a human, would require intelligence. So yes, any game that has computer-controlled opponents does have AI at some level.

Question:
What is a “genetic algorithm” and how does this relate to AI?

Answer:
Genetic algorithms are a form of evolutionary computation, which is a branch of artificial intelligence in which evolutionary approaches are used. They use techniques inspired by Charles Darwin's theory of evolution and survival of the fittest via natural selection: a population of individuals undergo selection in a system where variation inducing operators such as crossover of genes and ongoing mutations are present. The evolution starts from a population of individuals and happens in generations. In each generation the fitness of every individual in the population is evaluated and based on this multiple individuals are randomly selected from the population and modified (recombined and possibly randomly mutated) to form a new population. The new population is then used in the next generation of individuals. A “fitness function” is used to evaluate individuals, and reproductive success varies with fitness. The results are the average fitness being increased with each generation.
On the racing circuits in Darkwind, Genetic Algorithm- evolved computer agents/drivers are being introduced for specific track/car combinations. Effective racing lines for these combinations are being evolved through the use of waypoints. Computer drivers use these waypoints during the game to influence their behaviour as they navigate static and moving obstacles on the racetrack. This provides an evolved understanding of the overall shape of the track, which in turn yields behaviour which is both more human-like and effective.

Question:
In addition to the Genetic Algorithms being deployed in racing circuits, you are introducing a different form of AI in the wilderness areas to improve path finding, obstacle avoidance and terrain navigation. Can you explain this?

Answer:
The traditional approach to making a computer agent make a routing or “pathfinding” decision is based on computational evaluation of the landscape, for example the distance to get there by various potential routes. It doesn’t necessarily account for terrain, so for example, a computer agent may decide to drive up a very steep embankment, or around the edge of a cliff which a human player would be less likely to do due to the potential for car damage/death. Many of the subtleties of landscape navigation are computationally very hard to evaluate when you take into consideration factors such as momentum, wheel grip, and terrain types. These type of factors are not relevant in most computer games that require pathfinding, yet in Darkwind they are absolutely critical. Effective combat navigation is as much about mobility as it is about targeting weapons. Rather than making decisions based solely on a computational evaluation of the landscape, what we do is allow the computer agents to make use of the historic data recorded from humans playing the game. The agent doesn’t need to know why a large majority of humans took a certain route across a terrain: it just needs to know that they did so successfully. The computer agent is benefiting from the collective human processing of multiple data forms and is utilising the end results of this human behaviour. The routes taken by human players over thousands of journeys per week as they navigate the wilderness are used as a form of route planning consensus by the computer agents in a similar manner to that of how ants use pheromones to mark their trail and guide following ants. If the trail is successful and more cars use it, the guidance becomes more intense and denser, whereas other trails fade out.

Question:
What makes Darkwind unique?

Answer:
Darkwind really is a unique game overall, there are no other games very similar to it. This is because of a combination of rare and unique factors:

- It is the only turn-based car game that uses realistic physics. Having time to plan your moves actually makes for a more intense and controlled racing/combat experience (and allows for a much more detailed wargame-like combat system);
- It has 'perma-death' as well as long-term and permanent character injuries and ageing. This is very unusual in the MMO model and it is a strong part of the game's flavour since it leads to a gritty, dangerous world where death has real consequences. It also leads to a game where the stakes are very high.
- Persistent-world turn-based strategy games are rare, especially in an MMO model;
- Many aspects of the game (travel, vehicle repair, healing, the economic simulations, character training) run to a real-world time scale. This makes strategic decisions about travel and trading important. You don't just magically appear at a town you're travelling to, you actually have to wait 18 hours in transit.
- Cutting edge computational AI techniques are being deployed which aim to improve the overall game experience for players rather than taking the standard basic approach to computer controlled agents.

These elements all facilitate Darkwind holding the niche position it has as many users look for challenging alternatives to traditional MMOs.

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