Técnicas de Inteligencia Artificial

EVOLUCION GENETICA

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1-. AI

Artificial intelligence (AI) is rapidly transforming our world, permeating various sectors from entertainment to medicine. It empowers machines to exhibit intelligent behaviours, including learning, problem-solving, and decision-making, often exceeding human capabilities in specific tasks. This essay delves into the multifaceted nature of AI, exploring its applications, ethical considerations, security risks, advantages and disadvantages, and the legal framework necessary for its responsible development. By understanding the vast potential and inherent challenges of AI, we can navigate its integration into our lives with foresight and ensure its benefits reach all of humanity.

1.1.- Applications of AI

Artificial Intelligence (AI) is revolutionizing diverse sectors, from the creation of virtual worlds in video games to the diagnosis of diseases in medicine. Its impact is palpable in everyday life, and its potential to improve it is even greater.

In the world of entertainment, AI enables the creation of more intelligent and realistic non-playable characters (NPCs) in video games. These NPCs make complex decisions, interact with the player in a natural way, and learn from their experiences, creating a more immersive and exciting gaming experience. AI also enables the creation of dynamic game worlds that change based on the player's actions, offering a unique and unparalleled experience. In addition, adaptive game design thanks to AI adjusts the difficulty to the level of the player, creating a challenging and rewarding challenge for all.

In the medical field, AI is transforming disease diagnosis. AI is enabling faster and more accurate diagnosis thanks to the analysis of medical images such as X-rays or CT scans. In addition, AI is accelerating the development of new drugs by identifying chemical compounds with therapeutic potential. In terms of treatments, AI allows the creation of personalized and more effective plans for each patient by analyzing their data.

In the financial sector, AI is increasing security and efficiency. Fraud detection by analyzing patterns of financial transactions makes it possible to identify unusual behaviour and protect financial institutions. AI also offers personalized financial advice with recommendations on investments, savings and financial planning to achieve each individual's goals. In addition, financial market

analysis can identify trends, predict market movements and generate more effective investment strategies.

In agriculture, AI is driving productivity and sustainability. Optimizing irrigation with analysis of climate data and soil information enables efficient water use and increases crop productivity. Crop health monitoring using AI allows the identification of pests, diseases and other threats, enabling timely actions to protect crops. And forecasting future yields helps farmers better plan the production and marketing of their products.

In transportation, AI is revolutionising the way we get around. Autonomous vehicles, which navigate without a human driver, have the potential to make transportation safer, more efficient, and more accessible. Real-time traffic optimization reduces congestion, improves vehicle flow, and reduces travel times and pollution. Efficient fleet management with route optimization, maintenance scheduling, and driver performance monitoring improves efficiency and reduces costs in transportation operations.

On the environmental front, AI is helping to protect and conserve our planet. Monitoring climate change by analyzing satellite data and information allows us to understand its causes, predict impacts and develop strategies to mitigate and adapt to its effects. Biodiversity protection through the identification and monitoring of endangered species, habitat mapping and combating poaching contributes to the conservation of natural wealth. Optimized natural resource management for sustainable water and energy use, pollution reduction and the promotion of sustainable practices bring us closer to a greener future.

In short, AI is present in various sectors and has enormous potential to improve our lives. It is important to follow its development and harness its benefits responsibly.

1.2.- Ethical Issues of AI

The development of Artificial Intelligence (AI) brings with it endless opportunities to improve our lives. However, this technological advance also raises several ethical questions that we cannot ignore.

Algorithmic bias: AI systems are trained on large amounts of data, and if this data contains bias, the AI will perpetuate and amplify it. This can lead to discrimination in areas such as hiring, lending, or criminal justice, disproportionately affecting minority and vulnerable groups.

Loss of human control: AI-driven automation may lead to a decrease in human control over critical systems, such as autonomous vehicles, automated weapons, or financial decision-making systems. This raises serious concerns about liability in the event of failures or errors and the potential for these systems to be used for malicious purposes.

Privacy and surveillance: AI makes it possible to collect and analyze personal data on a large scale, which poses a risk to privacy and individual freedom. AI-driven mass surveillance could be used to control and manipulate individuals, eroding freedom of expression and individual autonomy.

Inequality and exclusion: Access to and adoption of AI could exacerbate existing inequalities in society. Those with access to the technology and the resources to develop and apply it could benefit disproportionately, while marginalized groups could be left behind.

Impact on labour: AI-driven automation could lead to job losses in some sectors, especially those involving repetitive and routine tasks. This could generate mass unemployment and social disruption, requiring policies and support programs to retrain and reintegrate displaced workers.

Manipulation and misinformation: AI can be used to create false or misleading content, such as deepfakes or fake news, which can be spread through social networks and other channels to manipulate public opinion, influence elections or sow social discord.

These are just some of the ethical challenges we must address as AI continues to develop and integrate into our lives. We must have open and honest conversations about these issues to ensure that AI is used responsibly and ethically, for the benefit of all humanity.

1.3.- Security issues

Artificial Intelligence (AI) is revolutionizing our world, but along with its undeniable benefits come security risks that we cannot ignore. It is crucial to analyze these challenges in depth to understand their complexities and develop effective mitigation strategies.

1. Cyber-attacks: AI in the hackers' sights

AI systems, like any computer system, are vulnerable to cyber-attacks. Malicious actors could exploit these breaches to manipulate them, steal confidential information or take control of critical infrastructures. A chilling example: a cyberattack on an AI system for air traffic control could lead to accidents with terrible consequences.

2. Autonomous weapons: ethical dilemmas and uncontrolled risks

The development of autonomous AI-controlled weapons raises serious ethical and security concerns. These weapons could select and attack targets without human intervention, increasing the risk of errors, accidents and violations of international humanitarian law. A frightening scenario: an autonomous weapon programmed to attack enemies could mistake civilians for combatants, resulting in civilian casualties and war crimes.

3. AI in the wrong hands: a power for malicious purposes.

AI could be used for malicious purposes by state or non-state actors. One example: is the creation of fake news and propaganda to manipulate public opinion, destabilize governments or even conduct large-scale cyberattacks. A state actor could use AI to sow discord among the population of an enemy country.

4. Sabotage and Disruption: Chaos as a Weapon

AI could be used to sabotage critical infrastructure, such as power grids or transportation systems, causing widespread economic damage and jeopardizing public safety. A terrorist group could hack into a power grid and cause a widespread blackout in a city.

5. Mass surveillance: privacy under threat

AI could implement mass surveillance systems that monitor people's movements and activities, eroding privacy and individual freedom. A government could use AI to monitor social networks and suppress political dissent.

6. Arms race: a dangerous escalation

The development of autonomous AI-controlled weapons could spark an arms race between countries, increasing the risk of conflict and war. If one country develops advanced autonomous weapons, others could be pressured to follow suit, leading to an escalation in tension and the risk of war.

In conclusion, AI presents enormous potential to improve our lives, but it also carries considerable security risks. It is critical to address these challenges proactively by developing robust ethical and legal frameworks, fostering international cooperation, and promoting the responsible use of AI. Only in this way can we reap the benefits of this technology while mitigating its risks and building a secure future for all.

1.4.- Advantages and disadvantages

Artificial Intelligence (AI) presents a panorama of opportunities and challenges that we must analyze comprehensively. Exploring its various implications allows us to better understand both its advantages and disadvantages.

In terms of advantages, AI offers several significant benefits. On the one hand, it provides greater efficiency and productivity by automating repetitive, tedious and dangerous tasks, thus freeing human workers to focus on more creative and strategic activities. It also optimizes processes by analyzing data and patterns, leading to reduced cycle times and improved product and service quality.

In the field of decision-making, AI plays a crucial role in analyzing large volumes of data, identifying patterns and trends, and providing valuable information for decision-making. This translates into better planning and resource management, as well as the ability to anticipate future events, such as product demand or the risk of equipment failure.

In addition, AI fosters innovation and development by discovering new knowledge, facilitating the development of new customized products and services, and enhancing human creativity by stimulating the generation of new ideas and concepts.

However, these advantages also come with significant challenges that need to be addressed. For example, AI-driven automation may lead to job losses in sectors where tasks are repetitive and routine. This could generate increased unemployment and exacerbate social inequalities if adequate public policies are not implemented to mitigate these negative impacts.

In addition, there is a risk that AI will exacerbate existing inequalities in society, especially in terms of unequal access to technology and the concentration of power and wealth in the hands of a few. This could marginalize vulnerable groups and perpetuate discriminatory biases if measures are not taken to ensure the inclusion and protection of all sectors of society.

In summary, while AI offers numerous advantages in terms of efficiency, productivity and innovation, it is essential to address its challenges, such as job losses and the exacerbation of inequalities, to ensure that its impact is beneficial to society as a whole.

1.5.- Legal aspects

The implementation and expansion of Artificial Intelligence (AI) brings with it several legal challenges that must be addressed comprehensively to ensure its responsible development and use. These challenges cover various areas, from liability to data protection and other relevant legal aspects.

First of all, the question of liability is fundamental. When faced with possible damage caused by AI systems, the question arises as to who should take responsibility: the developers, the owners, the users or the companies that use these systems? To resolve this dilemma, it is crucial to establish clear standards and legal mechanisms that define responsibilities in different scenarios, considering factors such as the level of autonomy of the system and the security measures implemented.

Regarding intellectual property, the complexity of determining who owns the copyright on works created by AI, such as text, images or music, arises. There is a need to develop legal frameworks that protect human creativity and prevent plagiarism or undue imitation of existing works while encouraging innovation and finding an appropriate balance between intellectual property protection and AI development.

Data protection is another crucial aspect to consider. The use of large amounts of personal data to train and operate AI systems poses risks to individual privacy, so it is imperative to ensure that this data is handled securely and responsibly, complying with regulations such as the GDPR in Europe or the California Consumer Privacy Act in the United States.

In addition, other relevant legal aspects must be addressed, such as algorithmic bias in AI systems to avoid discrimination, transparency and explainability of such systems, security against cyber-attacks, impact on employment and regulation of autonomous AI-controlled weapons.

In short, it is essential to develop a robust and adaptable legal framework that regulates AI responsibly and ethically, maximizing its benefits and minimizing its risks. Collaboration at the international level is crucial to establishing standards and regulations that ensure AI is used for the benefit of all humanity.

2.- Implemented technique

This work explores the implementation of a genetic algorithm to simulate the evolution of animals in a virtual ecosystem. The main objective is to observe how animal characteristics, such as speed, recklessness and efficiency in searching for food and water, adapt and improve over generations.

For this purpose, a simulation has been developed in which several emulated deer try to survive with a limited food and water source, to achieve an environment as similar as possible to real life.

2.1.- Simulation

The simulation was planned to take place in a virtual environment where two types of animals coexist: carnivores and herbivores. Each animal will have a set of genes that will determine its characteristics and behaviour. As the animals interact with the environment, searching for food, and water and reproducing, their "success" will be evaluated. The more successful animals will be more likely to reproduce, passing on their genes to the next generation. Over time, animal populations are expected to adapt to the environment, developing characteristics that allow them to survive and thrive.

However, due to developmental time constraints, the final version only has the presence of one herbivore. The carnivore animal will be delegated to a future development.

The animal has the following states:

1. Eating
2. Foraging
3. Searching for water
4. Drinking
5. Sleeping
6. Reproduce

This is the state in which the animals spend the most time. While searching for food, the animals will detect, using their sense of smell, points of interest that they will have to investigate to discern if they are valid or not. A point of interest may consist of the following:

● A viable food source

- A viable water source
- A contaminated water source
- A contaminated food source
- *A new resting place
- Nothing of interest

As long as it is not detected, the point of interest will be known by different fractions that change depending on how close the animal gets.
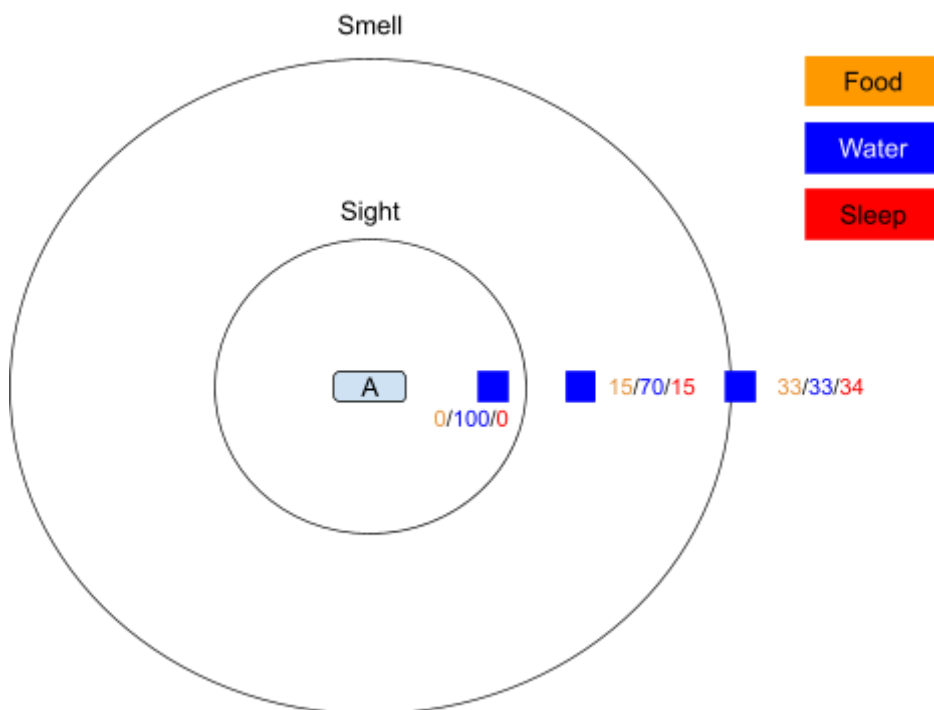
The animal is not aware of what the point of interest is until it can see it. At this point, it can detect whether it is a source of food, water or something else but is not able to differentiate whether it is contaminated or not until it gets very close. As the animal gets closer, it can deduce more accurately the type of point of interest it is approaching. In addition, if several points of interest are within range, the animal will have to decide which point of interest it is best to approach. This depends on several parameters, which when put together in an algorithm, will decide which direction is the most interesting.

The parameters to be taken into account are the following:

- Food
- Water
- Detected points of interest
- Known points of interest
- Distance to the points of interest
- Level of knowledge of the point of interest.
- Fatigue
- Recklessness of the animal

Taking all this into account, the animal will move around the world map trying to survive.

Reproduction

Animals can reproduce and thus create new generations of animals, which also inherit behaviours from their progenitors and thus evolve.

To have the opportunity to reproduce, the animal must meet several specific requirements:

Age: The animal must exceed a minimum age of a couple of years. In addition, the difficulties of very old age also set limits.

Feeding: An animal is only able to reproduce in the case that in a few days before it has achieved a complete feeding, giving it strength to be able to reproduce.

Genetic algorithms are used to manage the creation of new generations.

Sleep

The animal has a fatigue bar, when this bar reaches the set limit at which the animal has to sleep it has to return to its nearest safe resting area.

If on this trip back to the zone the bar rises to 100% although it has not reached the zone the animal will fall asleep and will fall asleep on the spot. Since it will not have slept in the destined zone, it will wake up tired.

2.2.- Evolutionary Algorithms

The genetic algorithm will be based on natural selection, where animals with higher "success" (survival, reproduction) will be more likely to pass on their genes to the next generation. The genes, or parameters, that will be considered are:

1. Population and Genes:

- Each animal is considered an individual within a population.
- Their behaviour is determined by "genes" like:
    - Priorities (importance given to needs like hunger, thirst, etc.)
    - Sensory Acuity (how well they sense food, water, dangers)
    - Decision Thresholds (when to prioritize one action over another)

2. Selection:

- Animals with higher survival rates and successful reproduction are "fitter".
- During breeding, selection algorithms choose parents:
    - Roulette Wheel Selection: Assigns probabilities based on fitness, fitter animals have a higher chance of being chosen.
    - Tournament Selection: Small groups compete, and the winner from each group gets selected for breeding.
    - In this case, selection happens before mating, when choosing a partner.

3. Crossover:

- Genes from two selected parents are combined to create offspring.
    - One-Point Crossover: A random point on the "chromosome" is chosen, and the "tails" are swapped between parents to create two new offspring.
    - Multi-Point Crossover: Similar to one-point, but with multiple crossover points, leading to more diverse offspring.
    - This case uses a one-point crossover determined by a random number generator.

4. Mutation:

- During reproduction, a small chance of mutations can happen in the offspring's genes.
- This helps maintain diversity and avoid getting stuck in ineffective solutions.
- Mutations can slightly alter priorities, sensory acuity, or decision thresholds.

Benefits of Evolutionary Algorithms:

- Adaptation: Over generations, animals with gene combinations leading to better survival and reproduction become more common.
- Emergent Behaviors: Complex and diverse behaviours arise from individual traits, leading to more realistic animal interactions and group dynamics.
- Open-ended Evolution: The simulation can continuously adapt as the animal population evolves and the environment changes

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Optimizing the EA is crucial. Here are some key considerations:

- **Selection Techniques**: Different selection methods (e.g., roulette wheel selection, tournament selection) prioritize different solution characteristics. Choosing the right technique can significantly impact convergence speed and solution quality.

- **Mutation Rate**: The mutation rate controls the introduction of new variations. Too low a rate limits exploration, while too high a rate can disrupt convergence.

- **Crossover Rate**: The crossover rate determines the frequency of combining solutions. Finding the optimal balance is essential for effective exploration and exploitation of the search space.

- **Hybridization:** Combining EAs with other techniques (e.g., machine learning) can leverage the strengths of each approach for even better performance.

2.3.- Evolutionary Algorithms Implementation

During the implementation of this project, several problems have arisen and I have had to deal with them. With varying success in each of them.

Food foraging algorithm

The foraging algorithm, as previously discussed, is the main pillar on which this project is based. It is critically necessary that the animals behave as closely as possible to reality, otherwise, all the work that takes this part as a basis could not be carried out satisfactorily.

During the development I have encountered several problems derived from this, the main one being poor decision making once all the data has been received. The way this algorithm works, each point of interest provides a direction in which the animal is going to move. This direction is also assigned a value that indicates how important this point is. Once all the values are calculated and the directions are added up, there is a final direction that should be the most interesting for the animal.

This approach works very well with a limited number of interest points, since it computes all directions, and moves naturally from one point to another without looking like a robot. But, once a large number of interest points come into play, the force is equalized to all directions, and due to the large number of vectors "pulling" the animal, it is left unable to decide a direction completely. It ends up circling itself.

One way to try to solve this problem was to limit the distance at which the points of interest affected the animal. In this way, you limit the amount of points pulling more than necessary. This solution works relatively well and is worthy of consideration in the future, but, due to the limited time available, it was set aside for future development.

The final solution, in order not to waste the work done, was to use the calculated values of the points of interest, but instead of deciding on a specific direction, a specific point of interest to go to is decided.

This solution solves all the problems of the previous algorithm with the drawback of also limiting the naturalness of the movement, but it is the most feasible solution in the short term.

Points of interest management

The management of points of interest also created several not-inconsiderable problems, especially on the part of Unreal and its way of calling each function in order. The main problem was that the moment an animal consumed a point of interest, it disappeared, but as all animals have a memory where they store known points of interest, the reference to this point of interest was kept stored in them. Once the point is deleted, it takes a few cycles to delete itself from the references of the other animals as well, which leads to empty pointer calls that cause crashes.

After several attempts to solve this problem, the solution was to remove one of the references to the other animals when deleting the point of interest. This on a large scale could cause serious optimization problems that in the case of expanding the project should be solved. But it showed a good problem-solving ability.

Application of genetics algorithm

The main pillar of this work, the genetics algorithm, has not been without problems either. Mainly, the difficulty of setting up a system to test the effectiveness of the algorithm in a non-perfect simulation, which entails many difficulties in making a clean test without external interferences to the experiment.

The main difficulty has been simulating a fast passage of time in Unreal, and even having ways to accelerate the speed of the game, this brings with it several other problems. All these difficulties have forced me to touch several variables of speeds, that although they subtract fidelity to the part that should

be more similar to the reality of the simulation, allow me to analyze in an effective way and without having to spend hours running the simulation the different generations that are created while the time is passing.

Alternative Options

There are other methodologies for simulating animal evolution, such as evolutionary programming or reinforcement learning. However, the genetic algorithm offers an intuitive and effective way to model natural selection and inheritance.

Other applications

The evolutionary simulation technique could be integrated into games or products in a variety of ways:

- Creation of non-playable characters (NPCs): Animals could be used as NPCs with adaptive and emergent behaviours.
- Evolutionary game modes: Players could experience the evolution of their creatures or ecosystems.
- World design tools: Simulation could be used to generate virtual environments populated by realistic creatures.

Overall, evolutionary simulation offers a powerful tool for creating dynamic and engaging experiences in virtual games and products.

Improvements and Challenges

The AI technique can be improved by incorporating additional factors such as:

- Environmental variability: changes in climate, resource availability, and presence of predators.
- Social interactions: Competition, cooperation and hierarchies within populations.
- Variety of genomes: Increasing the number of variables to be applied to the genetic algorithm.

A major challenge is the optimization of the algorithm to ensure computationally efficient performance as the complexity of the simulation increases.

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