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**Exploring Real-World Applications of Genetic Algorithms**

**I. Introduction**

Genetic Algorithms are computational optimization methods based on genetics and natural selection. These algorithms solve real world problems by simulation of the evolution process to improve population of solution sets. These solution sets are either binary encoded or another structure.[1]

B. Brief overview of the essay's focus on real-world applications

C. Importance of genetic algorithms in problem-solving and optimization

**II. Genetic Algorithms: A Brief Overview**

A. Basic principles and mechanics

B. Evolutionary processes and selection mechanisms

C. Representation of solutions and genetic operators

**III. Real-World Application 1: Android Malware Detection**

**Introduction**

2 sets of APKs (Android Application Package) Malware and Goodware are reverse engineered from which features are extracted such as App permissions and statistics of app activity, content provider, etc. The obtained features are represented as vectors with binary values in CSV (Comma Separated Values) format. This CSV is provided as an input to a genetic algorithm for optimised feature selection, which is then used to train the SVM (Support Vector Machine) and neural network.[2]

**Individual Representation**

Features extracted are mapped into the feature vector into 2 categories: - 1) App Components; that count components such as Acitvity, Content Provider, Services, etc and 2) Permissions; that are mapped to a vector space such that if the app has the feature the dimension is 1, otherwise it is 0. These features represented in a binary form and are called chromosomes. The algorithm is initialised using these feature subsets and an initial population set of these chromosomes is generated randomly.[2]

**Fitness Function**

The algorithm keeps a set of chromosomes called population along with their fitness scores. Chromosomes with better fitness scores have a better chance to reproduce. The fitness function used here assigns a higher score to the chromosome with best accuracy after training in the ML (Machine Learning) classifier and features with lower accuracy are assigned lower scores. Chromosomes with the highest fitness scores are chosen to be the next generation parents. [2,3]

This is done through crossover and mutation. It is a technique that automatically improves characteristics to create the best offspring. Based on fitness requirements, even the worst generation can become the best. Based on features, if a generation is unmatched, it is excluded by the GA (Genetic Algorithm). This step is repeated until the best generation is found. Even if it cannot find a final solution to the problem, the GA can at least select the optimal features.[3]

**IV. Real-World Application 2: Infinite Mario Bross AI**

**Introduction**

**Individual Representation**

**Fitness Function**

**V. Comparative Analysis of Applications**

A. Identifying commonalities and differences between the examples

B. Analysing the adaptability of genetic algorithms across diverse domains

C. Consideration of challenges and limitations faced in each application

**VI. Future Prospects and Challenges**

A. Exploration of potential future applications of genetic algorithms

B. Discussion on ongoing research and advancements in genetic algorithm technology

C. Addressing challenges and ethical considerations in the expanding use of genetic algorithms

**VII. Conclusion**

A. Recapitulation of key points discussed in the essay

B. Emphasis on the significance of genetic algorithms in solving complex real-world problems

C. Encouragement for further exploration and application of genetic algorithms in diverse fields

**VIII. References**

[1] Vijay Kanade, Spiceworks. (2023, September 6th). What are Genetic Algorithms? Spiceworks. <https://www.spiceworks.com/tech/artificial-intelligence/articles/what-are-genetic-algorithms/>

[2] A. Fatima, R. Maurya, M. K. Dutta, R. Burget and J. Masek, "Android Malware Detection Using Genetic Algorithm based Optimized Feature Selection and Machine Learning," 2019 42nd International Conference on Telecommunications and Signal Processing (TSP), Budapest, Hungary, 2019, pp. 220-223, doi: 10.1109/TSP.2019.8769039.

[3] Firdaus, A., Anuar, N.B., Karim, A. *et al.* Discovering optimal features using static analysis and a genetic search based method for Android malware detection. *Frontiers Inf Technol Electronic Eng* **19**, 712–736 (2018). <https://doi.org/10.1631/FITEE.1601491>

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