Optimizations in Strategy Games: Using GAs to Optimize City Development in Freeciv

Damir Azhar, Gary Chen, Wei Pan, and Yachu Yang

Introduction

- Videogame industry is massive and lucrative with 2004 annual US retail sales exceeding $9.9 billion [1].
- Hardware advances have meant that the consumer has access to a great deal more processing power.
- This has led to a change in the importance of AI in videogames.

Why has AI become more important in videogames?

- Vast improvements in graphics and sound have made it a lot easier for the user to detect nonsensical or questionable behavior on the part of NPCs [2].
- Increases in processing power have meant that more CPU resources are available for AI implementation [2].

Why has AI become more important in videogames?

- High quality graphics are common and hence expected. The use of AI techniques to improve NPC behavior is thus important to make a videogame stand out in what has become a highly competitive market [2].

Freeciv

- Turn-based multiplayer strategy game [4].
- Similar to Civilization, except that it's free and open source [4].
- Ultimate goal of the game is for the user to lead their civilization into becoming the "Greatest Civilization" [4].

The Greatest Civilization

- This occurs when the user has:
  - eradicated all other civilizations or,
  - achieved the goal of space colonization or,
  - has the most points at a certain preset deadline [3].

Main Interface [3]

Cities

- They are the building blocks of a civilization.
- To be successful, the player must spend significant amount of time managing the cities.
- Freeciv cities are characterized by a set of interrelated factors.

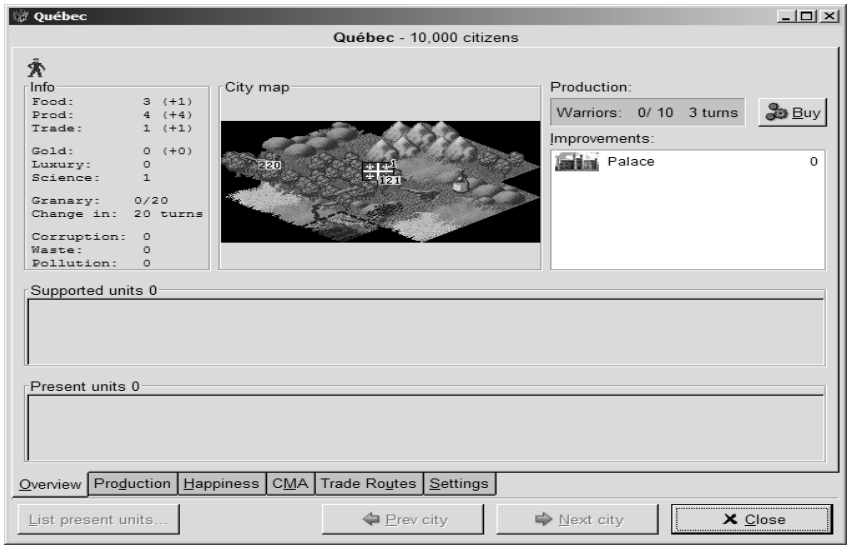
City Factors

- Factors affecting city growth:
  - Food
  - Production
  - Trade
  - Minor factors such as pollution and buildings can affect food, production and trade outputs
- Factors affecting citizen contentment:
  - Luxury
  - Minor factors such as number of entertainers, tax rate, buildings, government type and presence of military units can affect the luxury points

Resources

- Each city may work on resources surrounding the city, using citizens.
- The factors previously mentioned are dependent on how these resources are utilized:
  - This involves the assignment of citizens to particular resources.

City Interface



Genetic Algorithms (GAs)

- Provide a learning method motivated by an analogy to biological evolution [5].
- A GA can be viewed as a general optimization method that searches a large space of candidate solutions to seek one that performs best according to a predefined fitness function [5,6].

Fitness Function

- The fitness function defines the criterion for ranking candidate solutions and for probabilistically selecting them for inclusion in the next generation population [5].

Creating a New Generation

- Involves 3 steps [5].
- Selection: A proportion of the current generation is selected for the new generation. The probability of selecting a solution is based on its fitness value.

Creating a New Generation

- Crossover: The rest of the new generation is made up by probabilistically selecting pairs of solutions and producing 2 offspring by applying the Crossover operator.
- Mutation: A proportion of the new generation is changed (mutated).

The Problem

- Being a strategy game Freeciv requires attention to all aspects of the building an empire for example: acquisition of resources, exploration, expansion and diplomacy etc.
- A lot of micromanagement is required in all of the tasks, especially with regards to the management of cities.
- This can be difficult and tedious especially with large civilizations made up of numerous cities.

Our Objective

- To use Genetic Algorithms to optimize the growth of cities in Freeciv.
- Optimization will involve the various factors crucial to city development.
- As the game environment is dynamic the optimization is ongoing.

Plans

- Understanding the Freeciv source code.
- Creating a fitness function to evaluate city development.
- Identifying rule sets effecting the various city factors.
- Finding a suitable representation of these rule sets compatible for use with a genetic algorithm.
- Initial work will focus on the optimization of a single factor e.g. population.

Optimization

- As mentioned previously optimization will be ongoing.
- Optimization will occur every turn.
- The fitness value is calculated for each candidate solution in the solution space.
- Optimal solution will be used for the state transition.
- Generation of the new solution space using the steps described in slides 14 and 15.

References

1. http://retailindustry.about.com/od/seg_toys/a/bl_npd012703.htm
2. *Computer games with intelligence*, Johnson, D.; Wiles, J., Fuzzy Systems, 2001. The 10th IEEE International Conference on Volume 3, 2-5 Dec. 2001, Page(s):1355 - 1358
3. http://en.wikipedia.org/wiki/Freeciv
4. http://www.freeciv.org
5. *Machine learning*, Mitchell T. M., McGraw-Hill 1997, Page(s): 249 – 269.
6. *Genetically evolved strategies. Winning by selective processing of the chromosome pool,* Sgarbas, K.; Fakotakis, N.; Kokkinakis, G., Potentials, IEEE Volume 14, Issue 1, Feb-Mar 1995 Page(s):36 – 40 .