Visualizing Strategy in a Turn-Based Strategy Game

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ABSTRACT

In this paper we describe several visualization techniques for depicting strategy in a turn-based video game called Advance Wars. We propose one main method, influence mapping, and describe its implementation. Influence mapping allows a player to view the battlefield from a bird’s eye view and to instantly extrapolate key strategic conclusions from this visualization. This technique enables novices players to learn the abstract nature of strategy and learn how to effectively play the game against more advanced players.

Author Keywords
Visualization, Turn-Based Strategy Game, AI, Influence Maps

INTRODUCTION

Turn-based video games represent an increasingly popular segment of the video game market, and some of the best titles deeply emphasize the ability to develop both low level and high level strategies in order to obtain victory. With an increase in sophistication of these kinds of games has come a higher barrier to entry for new players. Games like these are dominated primarily by seasoned experts while novices to these games are confounded and find it difficult to grasp the higher level strategies required to succeed.

This project aims to take Advance Wars, a popular turn-based game and offer various visualizations that educate the player about what moves to make and visualize the abstract nature of “strategy” in a form that can be easily grasped by anybody. In this way, these visualizations can educate the player and serve as a compelling alternative or supplement to tutorials or traditional step-by-step guides.

Advance Wars is a two-dimensional turn-based strategy game developed by Intelligent Systems and published by Nintendo. In a gist, action takes place on a game board that is split into equally sized tiles. Multiple armies occupy these maps, and each army takes a turn to move all of its units. This approach contrasts with chess, in which each player takes a turn moving one piece at a time.

Units in Advance Wars contain various properties that define their behavior. Each unit has a movement range, a finite number of hit points and a complicated matrix of attack/defense values that vary depending on what kind of unit the attacker/defender is.

In addition to units, each tile on the board is of a specific terrain type. Some terrain types offer more cover than others while some types such as cities and bases offer cover, ownership by an army and auto-healing abilities.

It is abundantly clear that Advance Wars is quite a complex game and that offering compelling visualizations will allow novices to learn the ropes quickly and be able to visualize strategy.

RELATED WORK

Hoobler et al. [2] maintain that techniques for visualizing data in video games fall into one of two broad categories: spectacle visualization and analytical visualization. Spectacle visualization is a technique in which the viewpoint is locked to an active in-game entity, keeping the view dynamic and engaging. On the other hand, analytical visualization provides more of a bird’s eye view of the field, allowing observers to capture the big picture and analyze trends. While both techniques are presented in the context of first person shooter games, they carry over seamlessly to two-dimensional tile-based strategy games.

Spectacle Visualization

As its name suggests, spectacle visualization is a technique in which the viewpoint constantly follows an active in-game entity. In the context of a first person shooter, this approach contrasts with chess, in which each player takes a turn moving one piece at a time.
would involve viewing the world from the perspective of that entity [2, 4]. In a two-dimensional game, this means centering the view on the given entity.

While spectacle visualization has some compelling use cases for first person shooters in the form of future playback [2], it is a far less compelling form of visualization in the two dimensional space. Particularly, in the case of a turn-based strategy game, the technique is not compelling due to the fact that the game is turn-based rather than real time.

**Analytical Visualization**

Analytical visualization is a technique for presenting a bird’s eye view of the playing field and its underlying data in order to allow an observer to discover trends and form higher level conclusions. In addition, showing most or all of the action allows the observer to notice virtually everything that is happening [2]. While this may provide an overwhelming amount of information to sort through, the purpose of the visualization is to aggregate and simplify this data into something useful.

Some games use a radar overlay that shows an overview of the immediate area, but this method degrades rapidly as maps get more crowded [2]. Moreover, this kind of display has little pertinence for turn-based strategy games and is best suited for real-time games.

Some games overlay the visualization straight over the map. In Sim City 4 [1], a player could view various graphs depicting the state of the city in areas such as pollution, water, power consumption and land value. These graphs were highly effective for a player because they provided both a bird’s eye view while still having enough granularity to depict individual areas that needed to be addressed.

![Figure 2. Flammability depicted using an overlay graph in Sim City 4. Red indicates that a building is more flammable while yellow indicates lower flammability. [2]](image)

Our method falls under analytical visualization by borrowing the occupancy coverage map [2] concept from Hoobler et al. and expanding upon this idea in order to best adapt it for turn-based strategy games.

**METHODS**

This section describes the techniques and algorithms that we used in order to implement this visualization. I will also cover various techniques that I implemented but did not use for various reasons.

**Infrastructure**

In order to allow this project to be completed in a reasonable amount of time, we sought out an existing implementation of Advance Wars to build up upon. We decided to use a Java-based fan project called Custom Wars. Custom Wars is effectively a fan-developed Java-based clone of Advance Wars DS. It contains most of the functionality of the original game and allowed us to focus mainly on the visualization aspects of the project. However, it is worth noting that the API took a fairly long time to pick up due to the sloppy design and lack of documentation for the project.

**Influence Maps**

The primary technique used is the influence map, a concept mentioned in Millington [3] that originates from the field of artificial intelligence. Coincidentally, the technique presented there is applied to real-time strategy games but has been applied to turn-based strategy games in our case. Influence maps are somewhat similar to occupancy coverage maps [2] but are far more reaching in scope.

![Figure 3. Influence Maps can clearly show what parts of the map are “owned” by a particular side. Green pertains to team 1. Red pertains to team 2. Higher influence is indicated with a more saturated and opaque color.](image)

Like occupancy coverage maps, influence maps are maps that describe the relative influence of each tile on a map for a given army. A positive influence indicates that that tile is “owned” by team 1 while a negative influence indicates that
that tile is “owned” by team 2. In addition, tiles owned by team 1 are shaded in green while those for team 2 are shaded in red. We use opacity in order to delineate different levels of influence. A low influence may hardly be visible on the map while a high influence will be more opaque and saturated in appearance. Lastly, influences are normalized to the tile with the highest influence, so that the advent of powerful units is properly reflected.

The bulk of the problem is figuring out how to calculate the influence of any given tile, and much like writing a static evaluator for a game tree, this problem morphs into an exercise in knowing enough about the game to understand what factors are sensible and what factors are not.

**Evaluating Influence**

As mentioned earlier, evaluating influence is similar to evaluating a game state for a game tree in the respect that this is a zero sum game. Team 1’s victory is team 2’s demise. Due to this observation, it makes sense to attribute anything favorable to team 1 as a positive value and anything favorable to team 2 as a negative value. Therefore, the influence of any given tile is the sum of influences of all units and other forces on the map.

Calculating the influence of units is a tricky exercise since it is difficult to develop a true value that represents the worth of a unit since different players may value units differently. However, heuristics can be used to generate results that are sufficient for our needs and are quick to calculate. We settled on the following formula:

\[
\text{Monetary Value of Unit} \times (\text{Remaining Hit Point of Unit} / 10)
\]

Every unit in Advance Wars has a fixed cost associated with it, and each unit has a discrete number of remaining hit points, allowing this value to be calculated instantly. While this equation is not perfect, it is accurate enough to obtain satisfactory results.

**Temporal Component**

At one point, we were considering an implementation involving a temporal component. In effect unit influences would not only be based on current positions but also on previous positions using a linear fall off to reduce the amount of influence contribute by these previous steps. We implemented this and found that this information actually degraded the quality of the visualization by effectively smoothing out everything and reducing contrast.

This approach worked well in a real-time strategy game [2] but does not carry over to a turn-based strategy game. These results are consistent with the notion that an experienced player should only consider the present and the future, not the past, in games like these.

**Game Trees**

Earlier in the project, we were also considering the idea of visualizing game trees and artificial intelligence. The idea involved rating every possible move for a given unit, assigning a color (green for good, red for bad) and opacity based on the rating and placing a star next to the “best moves.”

While we think that this would be a fairly useful feature for early novices, we also believe that given the limited number
of possible moves, it doesn’t entirely qualify as a serious visualization technique due to its limited scope.

RESULTS AND DISCUSSION

This section will evaluate the efficacy of our approach and include some observations about certain weaknesses in this approach.

Conveying Strategy
Overall, our approach is successful in conveying various elements of strategy to players. Upon first glance, one can rapidly determine what areas of the map are occupied by what team and to what degree these maps are held, whether they are strongly held using powerful units such as Tanks or weakly held by Infantry.

Moreover, players can rapidly determine weak spots in an enemy’s defense and use that intelligence to their advantage. For example, the enemy is guarding the top and bottom with powerful units, but the middle is relatively unguarded.

On a more holistic level, one can determine how well each side is performing. More green overall probably means that team 1 is performing better while more red means that team 2 is winning.

One of the more interesting effects is that of clustering units together. Since influences are calculated by summing up all relevant forces, clustering leads to tiles with higher influences. This is consistent with the notion that keeping one’s troops close together is tactically sound while spreading them out is a poor idea. An observer can therefore determine quickly how spread out of concentrated one’s forces are in a glance.

Figure 5. In this situation, green is very strong on the top and bottom, but its middle is comparatively weak and could be seen as an Achilles Heel that red can capitalize upon.

Overall, all of these benefits are quick to analyze and convey useful information in a simple and elegant manner, making this a compelling visualization overall.

Limitations
While our method is successful in conveying lots of high level information at a quick glance, it currently stumbles in a few areas.

One problem occurs when two forces are close to engaging in combat. What sometimes happens, particularly if the forces are equal is that the influences will cancel themselves out, leaving those areas lightly colored or not colored at all. One possible solution is to shade these zones as orange as was done in Hoobler et al’s occupancy map. However, the drawback to this approach is that it could complicate the visualization and lead to many little patches of orange where there’s any overlap.

Figure 6. Compare red’s situation with that in Figure 6. Red’s units are spread out and lose the clustering effect that makes its influence appear much stronger.

Another limitation comes about from the process of...
normalizing all of the opacities, so that the tile(s) with the highest magnitude of influence are close to opaque. The problem with normalization occurs when the battlefield is heavily divided so that there could be cases in which there is a threat, but since that threat is so weak compared to the strongest unit, it doesn’t appear as such.

For example, in the following situation, there is a powerful MegaTank ($30,000) sitting in the lower right hand corner, causing the normal tank ($7,000) in the upper left hand corner to be not seen as a threat to team 1’s Infantry. A solution to this problem would be to normalize in a more localized fashion such as dividing up the map. However, this would negate the major advantage of this visualization, which is to offer a holistic view of things.

FUTURE WORK

One of the major features that we would like to add in the future is Fog of War, a device used in strategy games to obscure part of a map from a player’s view. This would introduce the concept of uncertainty into the mix of things. Uncertainty brings a lot of extra complexity to the table since the player now can only base knowledge on what he or she has seen in the past, and perhaps, this is where a temporal element would make a lot more sense. For example, recording where certain units were in the past and fading that out over time if they are covered by Fog of War would be a plausible solution to this problem.

Another future idea to evaluate is the introduction of other kinds of maps besides an influence map. Like the Sim City mentioned earlier, it may be useful to provide many different kinds of views of the battlefield. For example, a medpac map [2] could be useful for evaluating one’s usage of healing units. Another type of map could be a support fire map [2], which would display how effective a player was positioning his melee and ranged units. While these maps would be more specialized than a general influence map, they would nonetheless be useful for some players to grasp some of the finer points of strategy.

REFERENCES