Central tasks that all CBR methods have to deal with are [12]: "to identify the current problem situation, find a past case similar to the new one, use that case to suggest a solution to the current problem, evaluate the proposed solution, and update the system by learning from this experience. How this is done, what part of the process that is focused, what type of problems that drives the methods, etc. varies considerably, however".

While the underlying ideas of CBR can be applied consistently across application domains, the specific implementation of the CBR methods –in particular retrieval and similarity functions– is highly customized to the application at hand.

4.2 CBR and Games

Many different implementations of CBR exist in games. CBR technology is nicely suited for recognizing complex situations much easier and more elegant than traditional parameter comparison or function evaluation. There are especially evident cases in real time strategies where different attack and defense of global strategies are nicely defined by CBR datasets and later used in the running games. Also intelligent bots behavior is also another typical example. Depending on the number of enemy bots the layout of the terrain and position of human players the CBR system finds the closest CBR case and employs that strategy against the human players which in prior evaluation was proved to be highly efficient.

5. Game Trees with AI Planning – Tic-tac-toe

In order to show the expressive power of AI Planning in defining strategies for games, and the use of these plans to build Game Trees I implemented an algorithm that builds Game Trees for the Tic-Tac-Toe game.

The game tree of Tic-Tac-Toe shows 255,168 possible games of which 131,184 are won by X (the first player), 77904 are won by O and the rest 46,080 are draw [13]. All these games can be derived from building a complete Game Tree.

Even though it is possible to build a complete game tree of Tic-tac-toe it is definitely not an optimal solution. Many of the moves in this tree would be symmetrical and also there are a many moves that would be illogical or at least a bad strategy to even consider.

So what strategy should X (the first player) choose in order to win the game?

There are few positions that lead to certain victory. These positions involve simultaneous attack on two positions so the other player could not defend, basically the only trick in Tic-Tac-Toe.

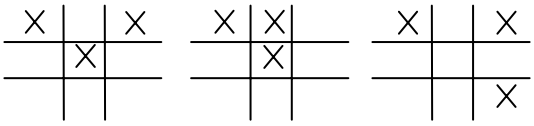

Figure 6: Tic-tac-toe winning strategy positions

Position 1 leads to victory if the two of the three fields: top middle, bottom left corner and bottom right corner are free [Figure 6].

Position 2 lead to victory if two of the three fields: top right corner, bottom right corner and bottom middle are free [Figure]. And in the third position if the two of center, middle top and middle left are available the position is a certain victory.

There are many different arrangements of the player's tokens that give equivalent positions as these three positions. By using planning we do not need to consider all possible layouts but just consider these three similar to what a human would consider.

The game starts from an empty table.

The two relevant strategies that would lead to these positions are to take one corner or to take the center [Figure 7].

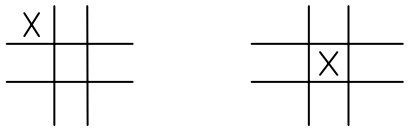

Figure 7: Tic-tac-toe Two starting moves

The center position as we can see in the simulation results lead to a bigger number of victorious endings but it is also a straight forward strategy with obvious defense strategy.

At this point we need to consider the moves of the opponent. If we take the left branch the opponent moves can be a center, a corner or a middle field. We also need to differentiate with a move to a corner adjacent with our like top left or bottom right or across the center to bottom right [Figure 8].

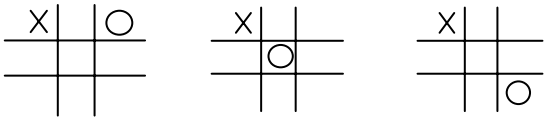

Figure 8: Tic-tac-toe opponent response to corner move

In cases one and two, we have a clear path to executing strategy 3 so we need to capture the diagonally opposite field. And as for the third case the best way to go is to capture the center and go for strategy 1 or 2 depending of the opponent's next move.

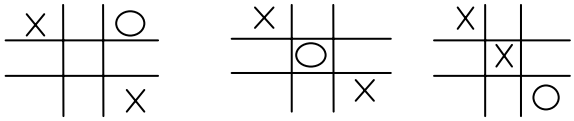

Figure 9: Tic-tac-toe move 2 after corner opening

The first move leads to certain victory, O will have to go to the center and X will achieve strategy 3 [Figure 9]. The second move is a possible way to strategy 3 if O makes a mistake in the next loop, so X goes to the opposite corner. For the third case since O is playing a valid strategy the only move that leaves a possible mistake from O would be to take the center and wait for O to go to the middle and then achieve strategy 1 or 3 which will be a symmetric situation to the one that we will find if we branched with the center.

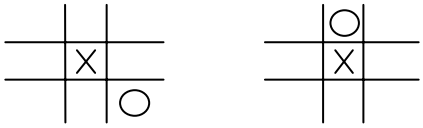

Figure 10: Tic-tac-toe opponent response to center move

If we go back to the second branch [Figure 10], a possible way for the second player to engage is corner or middle. The first