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Analysis

# Description

[TODO]

# Target Audience/Stakeholders

There is no target audience due to the simple/casual nature of the game, and the fact that most people seem to know what tic-tac-toe is. This means that the stakeholders will most likely be anyone who is 6 years or older.

The game should provide instructions however, in the case someone does not know how to play tic-tac-toe.

# Why a computer is suitable for the task

Computers are very fast at performing calculations, and the only errors they make are generally due to human errors (coding mistakes, for example). For a game as simple as tic-tac-toe, a computer is more than capable of calculating what it should do in a reasonable amount of time, and can possibly be almost impossible to beat.

As an example, when two human players are playing against each other, Player 1 may be one move away from winning the match with Player 2 not noticing they can stop them; however, when a human is against a computer, the computer can be made so it will always block the human from winning, if there’s a chance to. This is due to the point made earlier, the only errors a computer can make are usually due to human errors, so if a human tells the computer to always block the other player, then it will do so without fail (assuming there’s no errors in the code).

As another example, for a simple game like tic-tac-toe, the computer may be able to plan ahead of time and think of the most optimal route to take, similar to a human. The difference is that a computer can analyse the paths it can take significantly faster than a human, and a computer will be able to ‘remember’ them all perfectly, whereas a human might forget something or make mistakes in their logic.

# Research

While researching on what algorithms I might use when writing the AI for the game, I came upon the Minimax [1] algorithm.

After further research, I came upon a website [2] where a programmer describes how they used the Minimax algorithm with tic-tac-toe. The general idea is, they calculated every possible route the AI could take, and used points to weigh between which route will have the least chance for the AI to lose, and which ones would make the AI win/tie (with some other tweaks to make the algorithm work well).

The issue with this algorithm is, it creates an unbeatable AI, which is not fun for the human to fight against (nor does it seem terribly interesting to code). The upside is, this algorithm is a perfect example of how a computer is suitable for playing tic-tac-toe, and can be better at it than humans.

The idea of weighing which path is most likely to win/lose was interesting to me, and my tutor during an earlier session was discussing about possibly using machine learning, where the computer stores data of past games and then uses that data to determine which moves have led to a win in the past.

The advantage of the AI using past data, instead of calculating the best moves to make on the spot, is that it can attempt to ‘learn’ the best way to win which I see as an acceptable compromise between ‘impossible to beat’ and ‘impossible to lose against’. At the start, when the AI lacks data, it should be pretty easy to beat; but as time goes on the AI will gradually get more data and will be able to perform better than when it started.

Similar to how the minimax algorithm would create a tree of moves to analyse, my AI can store the data of its past games in a tree. For example, it may be formatted like:

“empty grid” -> “X is placed in the top-middle slot” -> “O is placed in the bottom-right slot”  
 -> “X is placed in the top-left slot” -> “O is placed in the bottom-middle slot” etc.

[1] <https://en.wikipedia.org/wiki/Minimax>

[2] <http://neverstopbuilding.com/minimax>

# Features and limitations

The game must provide a GUI. This GUI must display the 3x3 grid which shows the current up-to-date state of the match. The GUI must at the very least allow the player to play multiple matches without having to restart the game. Finally, The GUI must allow the player to interact with the 3x3 grid, following the rules of how you’re allowed to play pieces in tic-tac-toe.

The game should provide a message box that details how to play tic-tac-toe. Ideally this should be shown when the game is opened for the first time, and whenever the user presses some sort of “help” button.

The game will require having to store data on previous games, and being able to load this data when it is opened. The game should use a binary format, as it allows for more compact file sizes, but there is a trade-off of easily being able to read and debug the data as would be possible using a text format.

Multiplayer, while a desirable feature, is not the focus point of the project; that would be the AI. Therefore, multiplayer capabilities won’t be added to the game until sometime in the far future, if at all.

The game will require an AI for a human to fight against. This AI should make use of its past matches with humans to aid it with choosing what moves to make during a match. The AI should not be unbeatable, as it would be unfun to fight against.

An animated GUI that comes with sound effects is quite a bit of effort with very little worth considering how simple a game tic-tac-toe is, so I have decided to go with a very simple, soundless GUI.

# Requirements

OS: Windows Vista SP2 (with .Net 4.5 installed) or later (Any Windows OS that can run WPF [1])

CPU: [TODO] (Any CPU that can comfortably run windows, really)

GPU: [TODO] (Research into whether WPF can be run without a GPU. I know it uses DirectX 9)

The project will be built and tested against .Net 4.5, so .Net 4.5 must be installed on the computer. The project *might* work with older versions of .Net, but it is not guaranteed. .Net 4.5 comes preinstalled with Windows 8 and later versions of the Windows operating system.

A Windows operating system must be used, and it must include support for WPF [1].

[1] <https://en.wikipedia.org/wiki/Windows_Presentation_Foundation>

# Success Criteria

To be deemed a success, the game must provide:

* A GUI that provides, the 3x3 grid with an up-to-date view of the game board’s state, text informing the player which piece they’re playing as, text that displays whether it is the player’s or AI’s turn, and allows the player to place their piece via the 3x3 grid.
* An AI that is not impossible to win against, and is capable of analysing the data from its past matches to determine which move it should take.
* The game must not crash unexpectedly, and in the event somethings goes wrong, it must simply show the user an error box saying something’s gone wrong.
* The game must be stable and free of any major bugs (for example, if the GUI suddenly stopped functioning, this is a major bug and should not happen). Certain features of the game (explained below), and small parts of the code can and should be tested. The preferred method of testing is unit testing, where a small piece of code is written to test a very specific part of the code. Features of the game that are tricky to test via code (such as how the GUI functions) should be manually tested and documented.

Design

# Decomposition of the problem

[TODO]

# Proposed structure of the program

[TODO]

# Algorithms

[TODO]

# Usability

[TODO]

# Key variables and data structures

[TODO]

# Test Data for development

[TODO]

# Test Data for beta testing

[TODO]

Development

# Iterations of development

[TODO] (Self note, remember to use Git to ‘go back in time’)

# Prototypes

[TODO]

# Evidence of modular code

[TODO]

# Evidence of validation

[TODO]

# Review

[TODO]

Evaluation

# Testing

[TODO]

# Testing of usability features

[TODO]

# Overall evaluation

[TODO]

# Future Maintenance

[TODO]