CS 101 :: Project Report

TEAM TIC TAC TOE

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The Motivation

“ Quantum tic tac toe offers a way of introducing quantum physics without mathematics, provides a conceptual foundation for understanding the meaning of quantum mechanics, and is fun to play — Allan Goff “

The motivation to invent quantum tic-tac-toe was to explore what it means to be in two places at once. In classical physics, a single object cannot be in two places at once. In quantum physics, however, the mathematics used to describe quantum systems seems to imply that before being subjected to quantum measurement (or "observed") certain quantum particles can be in multiple places at once. (The textbook example of this is the double-slit experiment.) How the universe can be like this is rather counterintuitive. There is a disconnect between the mathematics and our mental images of reality, a disconnect that is absent in classical physics. This is why quantum mechanics supports multiple "interpretations."

The researchers who invented quantum tic-tac-toe were studying

abstract quantum systems, formal systems whose axiomatic foundation included only a few of the axioms of quantum mechanics. Quantum tic-tac-toe became the most thoroughly studied abstract quantum system and offered insights that spawned new research. It also turned out to be a fun and engaging game, a game which also provides good pedagogy in the classroom.

The rules of quantum tic-tac-toe attempt to capture several phenomena of quantum systems.
These phenomena are:

1. superposition,
2. entanglement and
3. Collapse.

- Superposition is the ability of quantum objects to be in two places at once.
- Entanglement is the phenomenon where distant parts of a quantum system display correlations that cannot be explained by either time like causality or common cause.
- Collapse is the phenomenon where the quantum states of a system are reduced to classical states. Collapses occur when a measurement happens, but the mathematics of the current formulation of quantum mechanics is silent on the measurement process. Many of the interpretations of quantum mechanics derive from different efforts to deal with the measurement problem.

Introduction

Quantum tic-tac-toe is a "quantum generalization" of tic-tac-toe in which the players' moves are "superpositions" of plays in the classical game. The game was invented by Allan Goff of Novatia Labs.

As in normal Tic-Tac-Toe, the game is played on a 3-by-3 board, and each of two players takes turns placing pieces, trying to get 3 in a row.

But in Quantum Tic-Tac-Toe, you place two "potential" moves at a time, in separate squares. Eventually, one of these will become a real (or classical) move, and the other will not. Potential moves are marked with the numbers of the turns they were played on. Each pair of potential moves is connected.

The game continues with each player placing their two potential moves per turn, until a special condition comes about and thus forming a classical move. Only classical moves count toward a win.

The game ends when there are one or more lines of three pieces in a row of the same colour, or when the board is full. Unlike in regular tic-tac-toe, it's possible for both players to get 3 in a row at once, or for one player to get two of them! There can also be a normal win (one player gets 3 in a row) or no win at all.

Functional Specifications

The basic functional specifications require that inputs shall be taken from the mouse, as and how the user responds to situations in the game which is being played. The user shall then see output (or the results of his actions) on screen and in a reasonably standard format.

The program objective, of course is to simulate the game of Quantum Tic Tac Toe on screen. It gives the users an interactive interface to play and enjoy the game.

The user shall provide information to the computer about his choices during gameplay using the mouse by clicking in suitable regions of the gaming screen after reading the instructions which shall continually be appearing on the screen.

The game ends when any of the players (may be human or computer) wins or if it is a draw.

Description of Data(Input/Output)

Input: The input is given by the user as per the guidelines on the interface using a mouse. The method to do this has been elaborated in the User Interface Requirements.

Output: The output of course is the state of the game at any point in time as well as specific messages conveyed by the system to the player(s). These also have been elaborated on in the section User Interface Requirements.

User Interface Requirements:

In general, the project has been designed to take inputs from on screen gestures using the mouse. The specific game requirements have been detailed as follows:

The initial interface asks the user to choose in between the two games quantum and classic.

Quantum Tic Tac Toe:

The basis of output is a modified tic tac toe grid on the screen. It is a 3x3 grid with 9 spaces in each square to receive entries. On this grid, as a standard configuration in the beginning of the game, we shall have all the grids and all the spaces within them empty.

The game starts with the instructions appearing on the screen regarding the start of the game by a player. The players play alternately. Two different colours are assigned to the players. The spaces within the grids are highlighted in the colours of the players and also the particle name is

indicated in the highlighted space as per the input provide by the player by clicking on the grid.

In the case of loop formation (explained clearly in User Manual), the loop is indicated as a polygon on the screen with the vertices represented as nodes and input for collapse is requested on the screen from the player who formed the loop. The player clicks on one of the grids in which he placed his last particle which is a vertex of the loop so as to collapse his particle over there. All the particles in the loop are collapsed to their appropriate grids which are coloured depending on the colour of the player who owns the particle.

The program shall display appropriate messages and provide self-explanatory instructions to the user via a suitable chat box, so that the user can play accordingly.

The game ends when either side wins or it is a draw, at which point an appropriate message will be displayed. It may be noted that the graphics library SIMPLECPP has been used in order to implement the graphical user interface of the entire program.

Classic Tic Tac Toe:

The interface initially requires the user to select in between Single player game and two player game.

If single player is chosen, the interface requests the users to choose the difficulty between easy and hard.

It is a normal 3x3 grid. On this grid, as a standard configuration in the beginning of the game, we shall have all the grids and all the spaces within them empty.

The game starts with the instructions appearing on the screen regarding the start of the game by a player. The players play alternately. Two different colours are assigned to the players. The spaces within the grids are highlighted in the colours of the players.(Players may imply two humans or a human and the computer)

The game ends when either side wins or it is a draw, at which point an appropriate message will be displayed. It may be noted that the graphics library SIMPLECPP has been used in order to implement the graphical user interface of the entire program.

Ideas for Future Work

- Creating multiple levels of the game by increasing the number of positions the particle can be at a time.

- Adding artificial intelligence to the game so that on player can play.

- Designing a general program for an NxN Quantum Tic Tac Toe.

- The graphics can be made to look more elegant.

- Improvisation of graphics so as to demonstrate the sequential collapse of particles.

Division of work:

Uday Kusupati

Graphics and coding of all other functions.

Chanukya Vardhan Reddy Gujjula

Graphics and coding of all other functions.

Aditya Vardhan Varre

Algorithm of core functions and coding

Jagadeesh Boddeda

Algorithm of core functions and coding