

# Application of Graph Theory in Pacman

<sup>1</sup>Ms.Preethi.V, <sup>2</sup>Tanmay Modh, <sup>3</sup>Kevin Rohan Vaz

<sup>1</sup>Assistant Professor, <sup>2</sup>Student, <sup>3</sup>Student

<sup>1,2,3</sup> Department of Computer Science and Engineering, SRM Institute of science and technology, Chennai, India

**Abstract :** Pac-man has been a very popular arcade game since it's release in 1980. The goal of the game was to navigate pac-man through a maze and collect pac-dots while avoiding the four ghosts in the game. The original game used a static maze that players get used to over time, we propose to generate random mazes through the use of heuristic search techniques and apply best first search to the ghosts in order to find pac-man in the maze quickly and efficiently. Heuristic search techniques such as genetic algorithms will allow us to find optimal maze structures through a number of iterations in which the best candidates are chosen in an approach similar to that of evolution. The ghosts in this project will be using best first search, or specifically a\* algorithm which uses a heuristic search function to guide the search, what makes a\* better than other shortest path algorithms is its ability to cut down the size of the subgraph that must be explored, if additional information is available that provides a lower bound on the "distance" to the "target", the target being pac-man. The game will also be designed in such a way that it'll be cross-platform in nature i.e. it can run as a desktop,web or mobile app.

**IndexTerms** – Graph theory, AI, pacman.

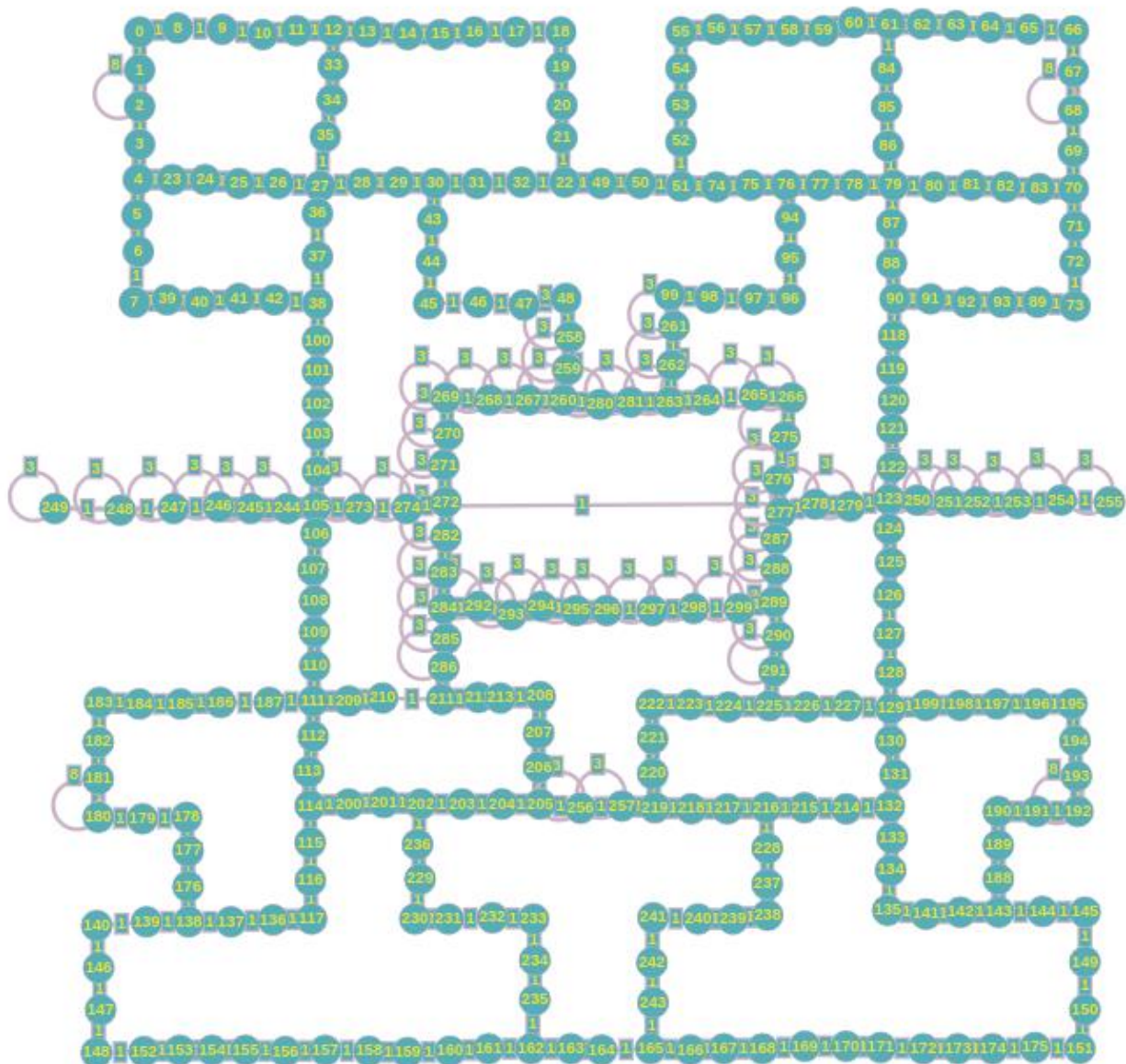
## I. INTRODUCTION

The premise of Pac-Man is delightfully simple: using a four-way joystick, the player guides Pac-Man-up, down, left, and right-through a maze filled with dots for him to gobble up. Four ghost monsters are also in the maze and chase after our hero, trying to capture and kill him. The goal is to clear the maze of dots while avoiding the deadly ghosts. Each round starts with the ghosts in the "monster pen" at the center of the maze, emerging from it to join in the chase. If Pac-Man is captured by a ghost, a life is lost, the ghosts are returned to their pen, and a new Pac-Man is placed at the starting position before play continues. When the maze is cleared of all dots, the board is reset, and a new round begins. If Pac-Man gets caught by a ghost when he has no extra lives, the game is over.



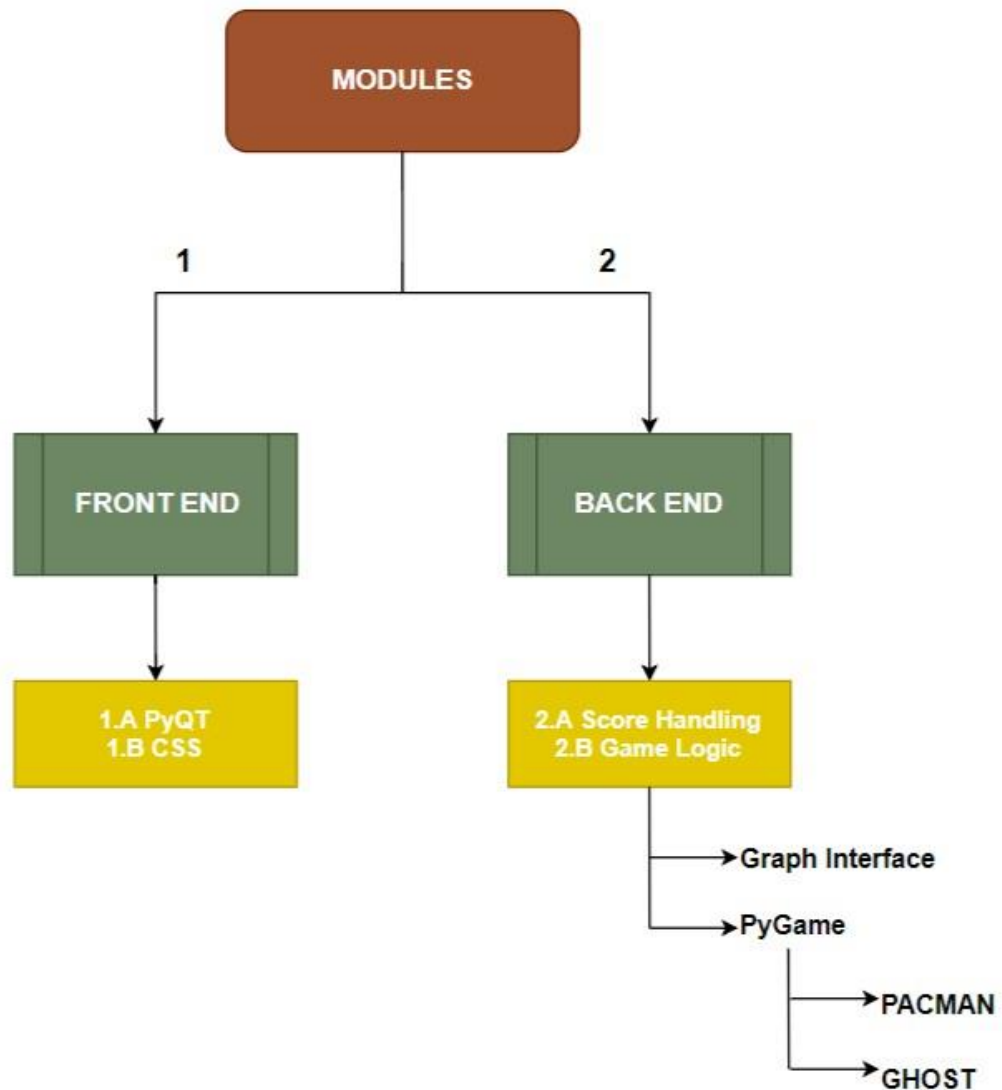
## II. PROPOSED SYSTEM

The current system implements pac-man using a matrix like data-structure as described in the introduction chapter, we plan to implement the game using graphs which will allow better use of path finding algorithms in graphs and reduce the time complexity of traversal. The existing system of the game also uses the concept of legal spaces and dead spaces to determine where pacman or the ghosts can traverse, this includes the unnecessary checking of legal spaces, but by using a graph we can restrict the area of traversal only to the nodes in the graph thereby decreasing the cost of checking for legal spaces since now traversal can only be done in legal spaces. Also using memoization concept from dynamic programming we will be able to determine paths quickly by storing the computed paths in a hash table and whenever we try to compute the same path again, we can simply look up the path in the hash table and return it thereby reducing cost of recomputations significantly.



This above graph consists of 300 vertices and is used to represent the maze. The representation we choose to model the graph was an adjacency set. An Adjacency Set representation would allow reduced storage of  $O(E+V)$  but at the same time allow quick look up of edge weights using hash tables to attain  $O(1)$ .

### III. MODULES



#### FRONTEND

##### 1. PYQT

PyQt is a Python binding of the cross-platform GUI toolkit Qt, implemented as a Python plug-in. PyQt is free software developed by the British firm Riverbank Computing. It is available under similar terms to Qt versions older than 4.5; this means a variety of licenses including GNU General Public License (GPL) and commercial license, but not the GNU Lesser General Public License (LGPL). PyQt supports Microsoft Windows as well as various flavours of UNIX, including Linux and MacOS (or Darwin).

##### 2. CSS

Cascading Style Sheets (CSS) is a style sheet language used for describing the presentation of a document written in a markup language like HTML. CSS is a cornerstone technology of the World Wide Web, alongside HTML and JavaScript.

#### BACKEND

##### 1. GRAPH INTERFACE

We use graph interface to model the graph

##### 2. PYGAME

Pygame is a cross-platform set of Python modules designed for writing video games. It includes computer graphics and sound libraries designed to be used with the Python programming language. Pygame was originally written by

Pete Shidders to replace PySDL after its development stalled. It has been a community project since 2000 and is released under the open source free software GNU Lesser General Public License.

#### IV. CONCLUSION

Using the literature survey we can choose a good algorithm to implement the pathfinding logic for our graph implementation. The A\* algorithms stands out for its ability to return globally optimum minimum cost paths as compared to traditional pathfinding algorithms like bellman-ford which returns a locally optimal minimum cost path.

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