

COMP 4106 - ARTIFICIAL INTELLIGENCE  
WINTER 2018

ASSIGNMENT #1

DUE DATE: FEBRUARY 14, 2018

# Peg Solitaire

## Introduction

In this assignment you will be implementing the European (French) version of the game *Peg Solitaire*. Different from the popular card game *solitaire*, this board game is said to date back to the court of Louis XIV.

The game is played by one player moving pegs (or marbles) on a cross-shaped board. The English game starts with the entire board filled with pegs except for one open square. The player chooses a peg that will jump over an adjacent peg into any open position. The jumped peg is then removed from the board. The objective for the player is to move the pegs in such a way that at the end of the game all that remains is [a single peg anywhere on the board](#). [In the English version, there is a solution for the last peg to be in the center position.](#)

## Game Definition

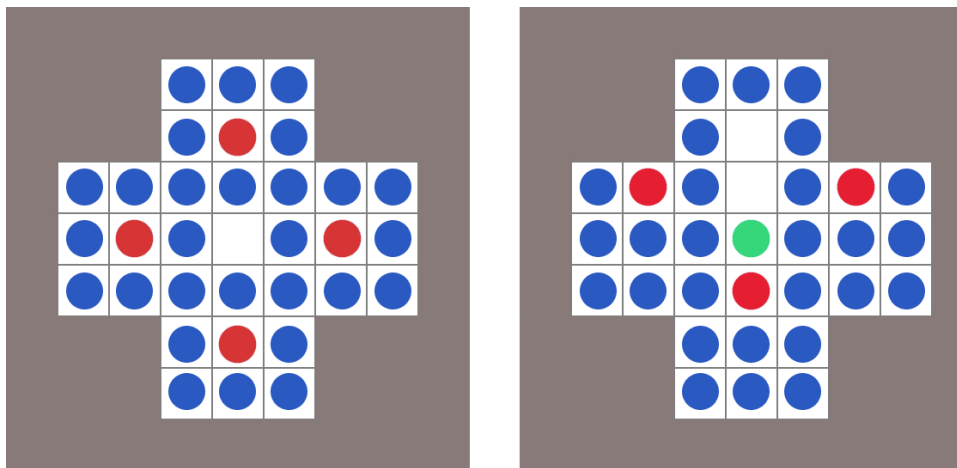


Figure 1: An illustration of the English version of the game Peg Solitaire.

The above figure illustrates both the starting position (the left board) and a possible board state after the first move of the game (the right board). At the start of the game, there are four valid moves. The **red pegs** represent the four pegs that the player may legally move to start the game. In the second picture, the **green peg** was moved from the top position into the open spot. Here a second spot becomes open and new set of possible moves is again highlighted by the **red pegs**. The game continues on until such time as either no more moves are possible (failure), or the last peg is found in the middle (success).

The video at <http://www.youtube.com/watch?v=I6uW03APKvw> will give you an idea of one way in which the game is solved. If you watch the video, keep in mind the restrictions placed on the game in this assignment. The video was not made for this assignment and should only be used to get an idea of what the game is like.

## Assignment Objectives

Implement the European (French) game of *Peg Solitaire* where the picture of the board is given in Figure 2. Please note that there is no solution if the empty peg is in the middle. However,

there is a solution if the empty hole is one step above the middle position as in Figure 3. A solution to this is at [https://m.youtube.com/watch?v=qGGBUnYYI\\_U](https://m.youtube.com/watch?v=qGGBUnYYI_U). Notice that in this case the final peg is not in the center position, but one slot above it.

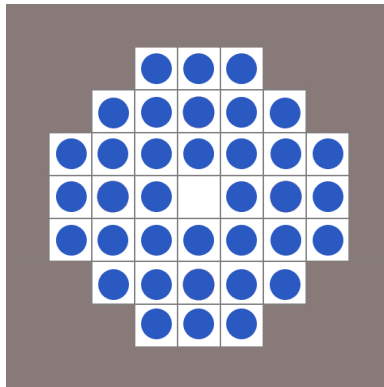


Figure 2: An illustration of the European (French) version of the game Peg Solitaire.

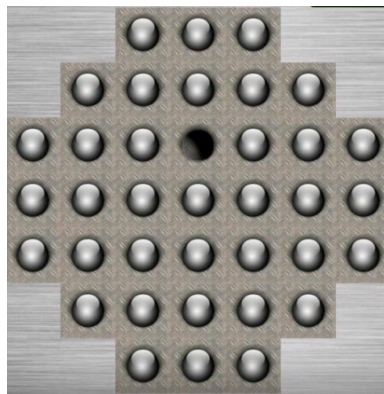


Figure 3: An illustration of the European (French) version of the game Peg Solitaire for which there is a solution.

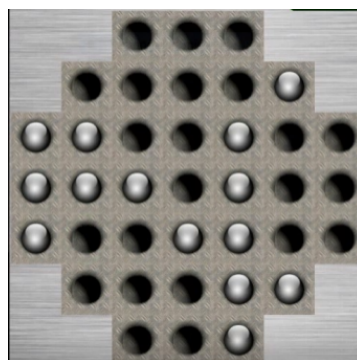


Figure 4: An illustration of the European (French) version of the game Peg Solitaire, with a lesser number of pieces. for which there is a simpler solution.

It turns out the original version of the Peg Solitaire given in Figure 3 takes a lot of time for a

BFS. So, for the BFS, submit a solution in which the puzzle is solved using the starting configuration shown in Figure 4. The link to the solution is at [https://youtu.be/qGGBUnYYI\\_U?t=53s](https://youtu.be/qGGBUnYYI_U?t=53s), and it starts from the 53rd second. [If you look at the video you will find the solution from this position. As mentioned, remember that the last peg need not be in the position of the empty slot in Figure 3. It will be in the slot above it.](#)

- Implement the European (French) game of *Peg Solitaire* where the picture of the board is given in Figure 3.
- Implement a *Breadth\_First Search* for the player to solve the game.
- Implement *Depth\_First search* for the player to solve the European game.
- Implement *A\* search*.
  - Implement two (2) different heuristics for the player to solve the European game.
  - Implement a third heuristic which takes the average of the first two heuristics.
- Write a short report (no more than one (1) page) about the state space of the game, and about the choice of your heuristics.

## Questions

During the demo you should be prepared to discuss the following questions:

- Which search worked best?
- Which heuristics did you use?
- Why did you choose these heuristics?
- Does the combination of the two heuristics work better or worse than they do individually?
- How well do the searches work if you increase the size of the board to 3x3 quadrants (45 holes) or 5x5 quadrants (125 holes).

## Bonus

The following items are considered as bonus. You should work on these if you have completed the required objectives.

- Implement the Asymmetric variation of the game-board where the picture of the board is given in Figure 5.
- Instead of the cross-variants, use a triangle-shaped board with five hole sides. In this case, if the base of the triangle is horizontal, the topmost layer has one hole, the next level has two holes and so on, and the bottom level has five holes.

## Tips

Don't spend too much time on the graphics. The search maybe slow. In this case, think about how you can optimize it. One of the first steps is to make sure that the search actually works.

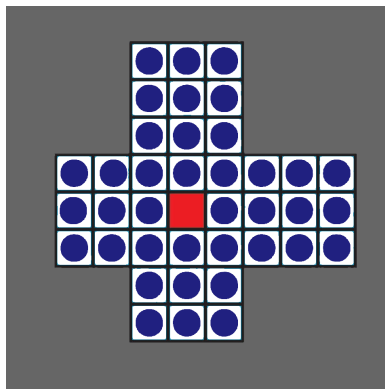


Figure 5: An illustration of the Asymmetric variation of the European version of the game Peg Solitaire.