

CSCE 580: Artificial Intelligence  
Coding Homework 3: Prolog  
Due: 2/26/2023 at 11:59pm

In this homework, you will implement Prolog predicates that describe different scenarios in tic-tac-toe. You can invent as many predicates as you need to solve the problem.

**Your code must run in order to receive credit.**

## Installation

Download swi-Prolog from <https://www.swi-prolog.org/download/stable>.

The entire GitHub repository should be downloaded again as changes were made to other files. You can download it with the green “Code” button and click “Download ZIP”.

## Helper Predicates

`seq(State, [Elem1, Elem2, Elem3], [Pos1, Pos2, Pos3])` is true if, for a state, the three elements (which will be consecutive elements in a row, column, or diagonal) are in the corresponding positions. The elements can be “x”, “o”, or “b” (blank spaces are denoted with a “b”). The positions can be integers 0 through 8 and correspond to the 9 positions on a tic-tac-toe board.

Make sure to put the `valid_state(S)` as the first predicate in your definition of the predicates for your homework. This will ensure that the solutions found are valid states.

You can use the `print_state(S)` predicate to print a 3x3 grid to the terminal every time you find a solution. You can do this by adding it on to the end of the predicate you are defining to. For example `two_ways_x(S) :- valid_state(S), pred1, pred2, ..., print_state(S)`.

## Two Ways for X to Win (100 pts)

Define a predicate `two_ways_x(S)` that is true for state `S` when there are at least two different ways that X can immediately win (get three in a row). In English, the predicate should be true if there are two rows, columns or diagonals that both have two X’s and one blank and the positions of the blanks in the two sequences are different. Note that, though the blanks must be in different positions, the X’s can overlap.

**While you can invent as many predicates as you need, the final predicate that depends on them to solve the problem must be named `two_ways_x(S)`.**

A subset of the solutions is shown below. Depending on your implementation, your solutions may be returned in a different order and there may be duplicates.

First, load your Prolog file with `swipl coding_hw/coding_hw3.pl`

```
?- two_ways_x(S).  
oob  
obx  
bxx  
S = [o, o, b, o, b, x, b, x, x] ;  
oob  
obx  
bxx  
S = [o, o, b, o, b, x, b, x, x] ;  
oob  
obx  
xbx  
S = [o, o, b, o, b, x, x, b, x] ;  
oob  
obx  
xbx  
S = [o, o, b, o, b, x, x, b, x] ;  
oob  
oxb  
xbx  
S = [o, o, b, o, x, b, x, b, x] ;  
oob  
oxb  
xbx  
S = [o, o, b, o, x, b, x, b, x] ;  
oob  
oxb  
xxb  
S = [o, o, b, o, x, b, x, x, b] ;  
oob  
oxb  
xxb  
S = [o, o, b, o, x, b, x, x, b] ;  
oob  
box  
bxx  
S = [o, o, b, b, o, x, b, x, x] ;  
oob  
box  
bxx  
S = [o, o, b, b, o, x, b, x, x] ;  
oob  
box  
xbx  
S = [o, o, b, b, o, x, x, b, x] ;
```

## Extra Credit (20 pts)

Define a predicate `no_ways_x(S)` that is true for state `S` when there is no way that `X` can win (get three in a row).

While you can invent as many predicates as you need, the final predicate that depends on them to solve the problem must be named `no_ways_x(S)`.

## What to Turn In

Turn in your implementation of `coding_hw/coding_hw3.pl` to Blackboard.