OXO Debrief

COMSM0086

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Aim of this session

Our aim is to give you insight into OXO exercise
By working through JUST ONE possible solution
(other approaches might be equality valid)

It is problematic to produce an "ideal" solution
(Probably couldn't agree on the best approach ;o)

Aim to provide something simple & understandable
A sensible and achievable implementation of OXO
(rather than trying to show off how "clever" we are)

Driving Principles

Divide and Conquer: delegate clearly defined tasks

Granularity: short methods to aid understandability

Simplicity: avoid unnecessarily complex control flow

Modesty: avoid sophisticated language constructs

Understandability: give things clear sensible names

Overall aim:

Produces a solution everyone can understand !

Short and simple: My OXOController is 190 lines

Recap of Features

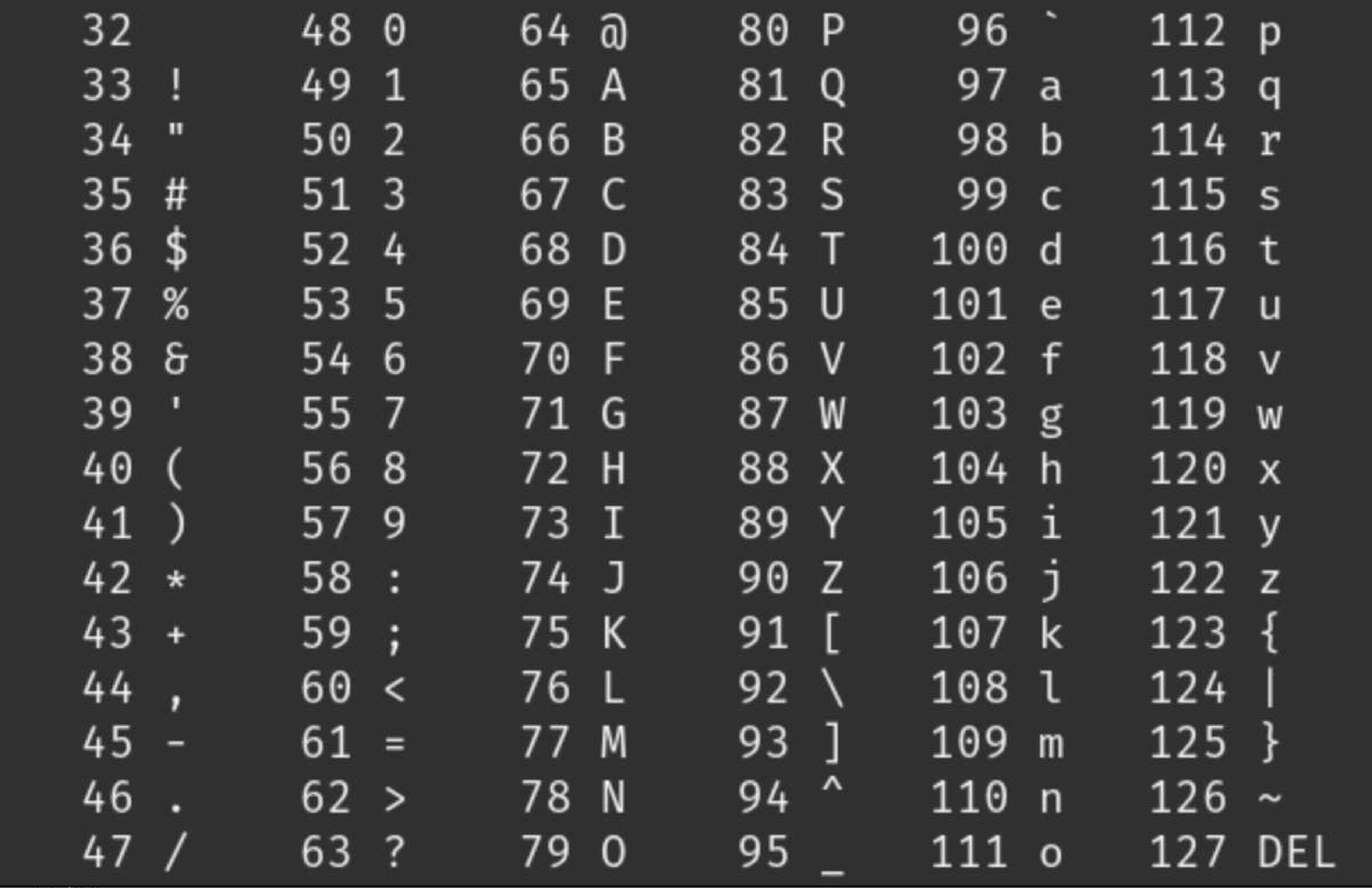
Build OXO / Tic-Tac-Toe / noughts & crosses with:

- Command Parsing & Validation
- Cell Claiming
- Dynamic Board Size
- Dynamic Win Threshold
- Automated Win and Draw Detection
- Extendable Number of Players
- Game Reset

Identified Classes

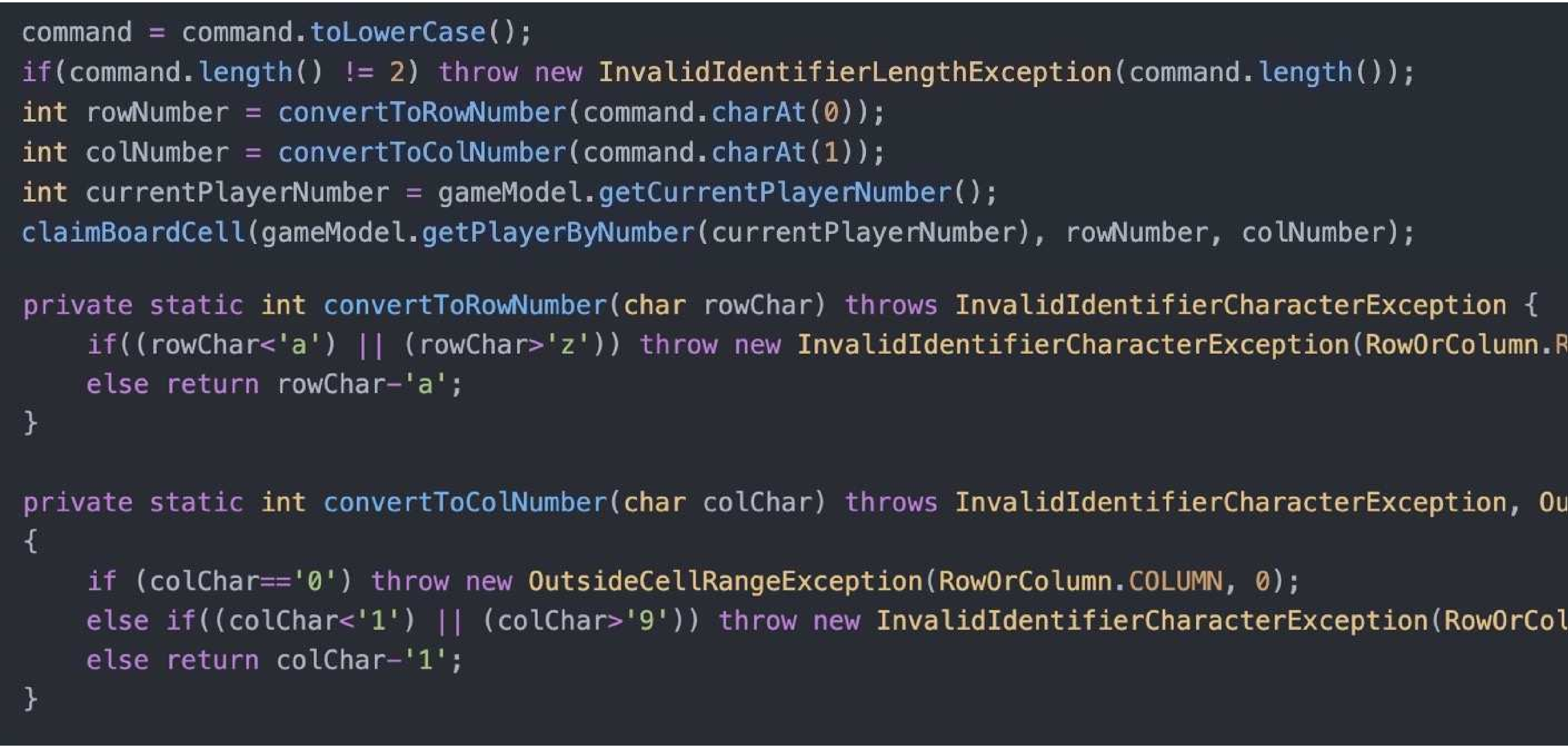
Main Class:	OXOGame
MVC:	OXOModel, OXOView, OXOController
Exceptions:	OXOMoveException
Player class:	OXOPlayer
Test class:	OXOTests

Didn't really feel the need for additional classes



```
32        48 0      64 @      80 P       96 `     112 p
33 !      49 1      65 A      81 Q       97 a     113 q
34 "      50 2      66 B      82 R       98 b     114 r
35 #      51 3      67 C      83 S       99 c     115 s
36 $      52 4      68 D      84 T      100 d     116 t
37 %      53 5      69 E      85 U      101 e     117 u
38 &      54 6      70 F      86 V      102 f     118 v
39 '      55 7      71 G      87 W      103 g     119 w
40 (      56 8      72 H      88 X      104 h     120 x
41 )      57 9      73 I      89 Y      105 i     121 y
42 *      58 :      74 J      90 Z      106 j     122 z
43 +      59 ;      75 K      91 [      107 k     123 {
44 ,      60 <      76 L      92 \      108 l     124 |
45 -      61 =      77 M      93 ]      109 m     125 }
46 .      62 >      78 N      94 ^      110 n     126 ~
47 /      63 ?      79 O      95 _      111 o     127 DEL
```

Command Parsing



```java
command = command.toLowerCase();
if(command.length() != 2) throw new InvalidIdentifierLengthException(command.length());
int rowNumber = convertToRowNumber(command.charAt(0));
int colNumber = convertToColNumber(command.charAt(1));
int currentPlayerNumber = gameModel.getCurrentPlayerNumber();
claimBoardCell(gameModel.getPlayerByNumber(currentPlayerNumber), rowNumber, colNumber);

private static int convertToRowNumber(char rowChar) throws InvalidIdentifierCharacterException {
    if((rowChar<'a') || (rowChar>'z')) throw new InvalidIdentifierCharacterException(RowOrColumn.R
    else return rowChar-'a';
}

private static int convertToColNumber(char colChar) throws InvalidIdentifierCharacterException, Ou
{
    if (colChar=='0') throw new OutsideCellRangeException(RowOrColumn.COLUMN, 0);
    else if((colChar<'1') || (colChar>'9')) throw new InvalidIdentifierCharacterException(RowOrCol
    else return colChar-'1';
}
```

Claiming Cells

Again, let's try to keep everything clean and simple

A simple multi-part IF statement to check validity

Appropriate exception thrown if command is invalid

The final branch claims the cell for the player

```
public void claimBoardCell(OXOPlayer player, int rowNum, int colNum) throws OXOMoveException
{
    if(rowNum>=gameModel.getNumberOfRows()) throw new OutsideCellRangeException(RowOrColumn.ROW
    else if(colNum>=gameModel.getNumberOfColumns()) throw new OutsideCellRangeException(RowOrCo
    else if(gameModel.getCellOwner(rowNum, colNum) != null) throw new CellAlreadyTakenException
    else gameModel.setCellOwner(rowNum, colNum, player);
}
```

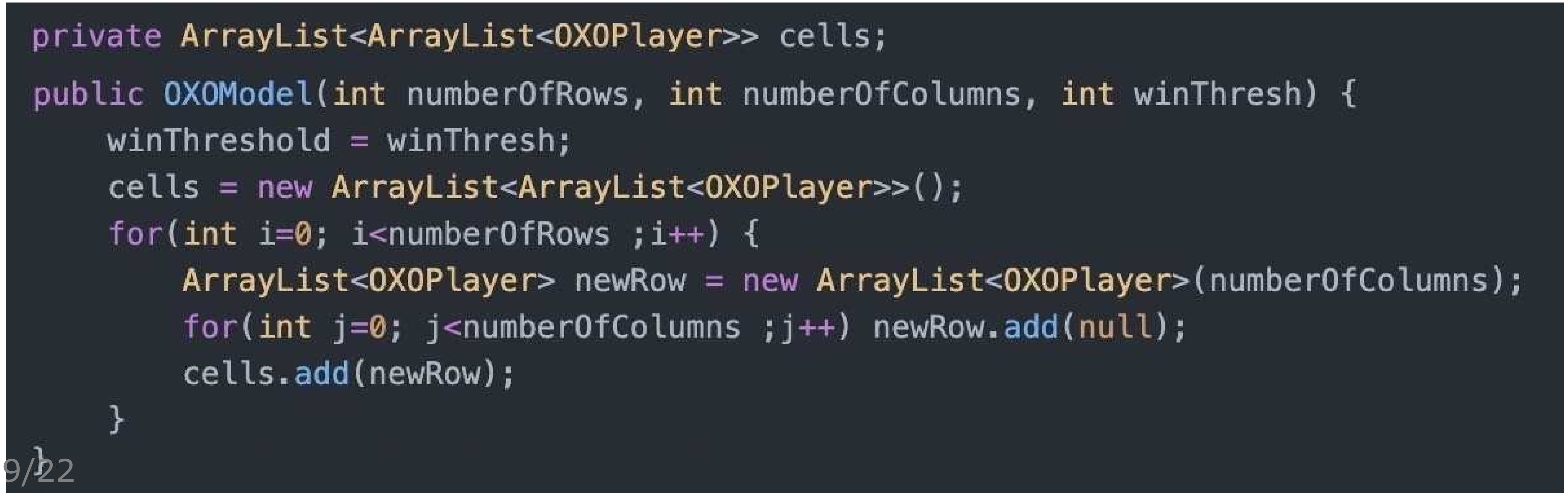
Dynamic Board Size

Replace 2D array: ArrayList of ArrayLists of Players

Create top level list ("cells") to hold all the rows

For each row in board, create a new list of players

Initialise all elements in each row to null (empty)



```java
private ArrayList<ArrayList<OXOPlayer>> cells;

public OXOModel(int numberOfRows, int numberOfColumns, int winThresh) {
    winThreshold = winThresh;
    cells = new ArrayList<ArrayList<OXOPlayer>>();
    for(int i=0; i<numberOfRows ;i++) {
        ArrayList<OXOPlayer> newRow = new ArrayList<OXOPlayer>(numberOfColumns);
        for(int j=0; j<numberOfColumns ;j++) newRow.add(null);
        cells.add(newRow);
    }
}
```

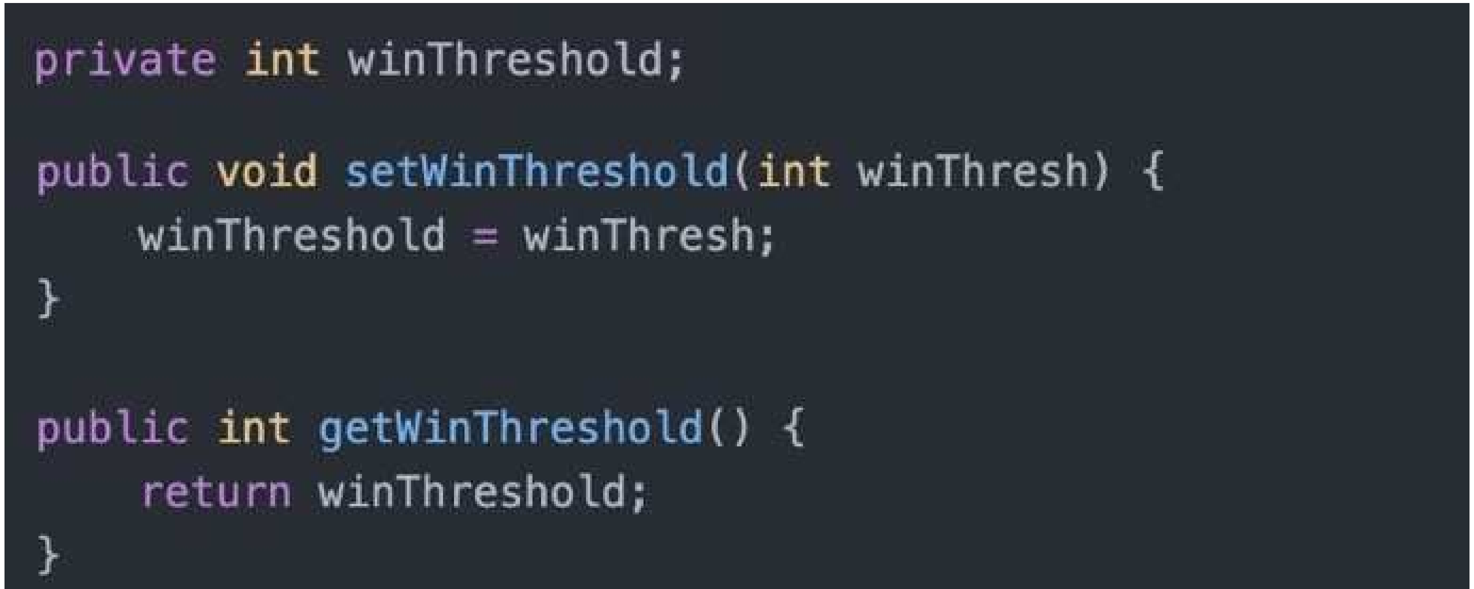
Dynamic Win Threshold

Win threshold maintained inside OXOModel object

No copies of this value kept anywhere in the code

All references to threshold call the accessor method

When central value changes, all references updated



```
private int winThreshold;

public void setWinThreshold(int winThresh) {
    winThreshold = winThresh;
}

public int getWinThreshold() {
    return winThreshold;
}
```

Win Detection

Basic principle: Scan through the board, cell by cell
Keep a count of consecutively claimed cells

Don't try to be clever (1 method for all directions !)
Use separate (simpler) methods for each direction

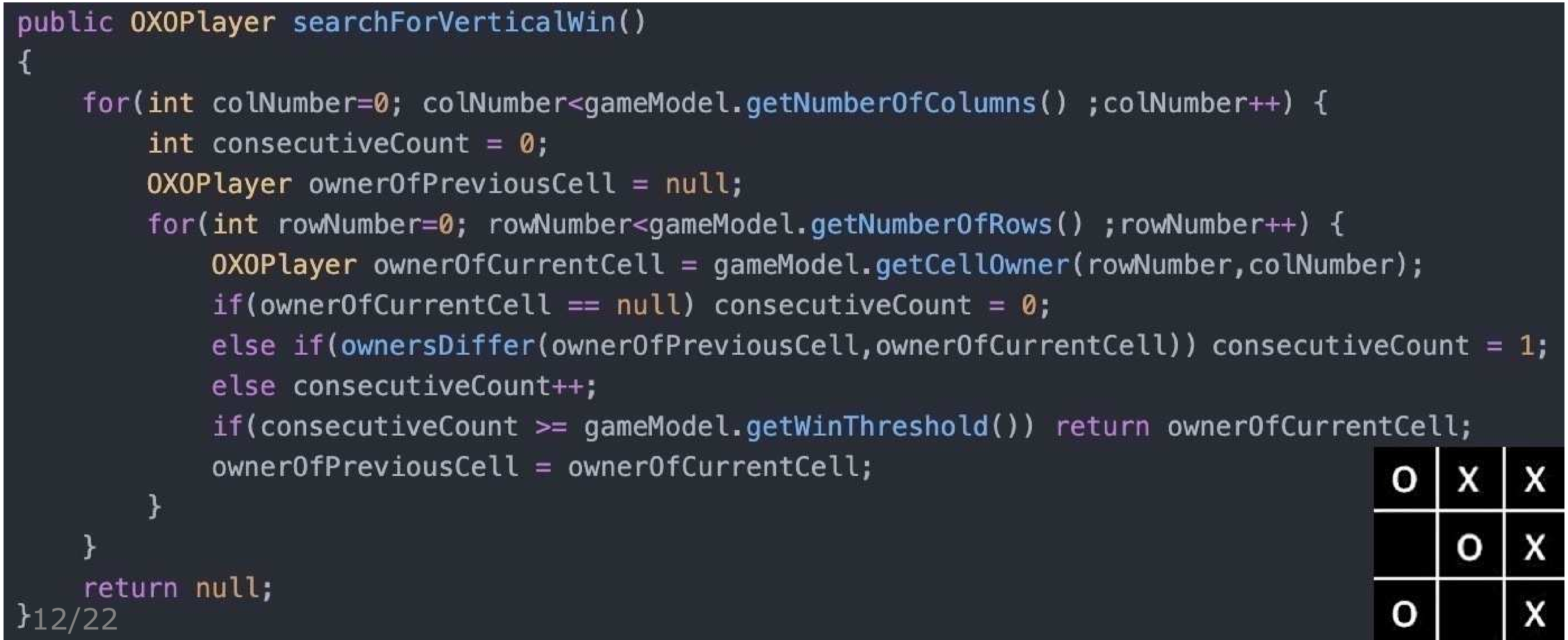
Horizontal and Vertical lines are relatively easy
Diagonal is a bit tricker

Let's take a look at Vertical first...

Example: Vertical Win Detection

Scan down through each column, checking each cell

Compare owner of cell against owner of previous cell



```
public OXOPlayer searchForVerticalWin()
{
    for(int colNumber=0; colNumber<gameModel.getNumberOfColumns() ;colNumber++) {
        int consecutiveCount = 0;
        OXOPlayer ownerOfPreviousCell = null;
        for(int rowNumber=0; rowNumber<gameModel.getNumberOfRows() ;rowNumber++) {
            OXOPlayer ownerOfCurrentCell = gameModel.getCellOwner(rowNumber,colNumber);
            if(ownerOfCurrentCell == null) consecutiveCount = 0;
            else if(ownersDiffer(ownerOfPreviousCell,ownerOfCurrentCell)) consecutiveCount = 1;
            else consecutiveCount++;
            if(consecutiveCount >= gameModel.getWinThreshold()) return ownerOfCurrentCell;
            ownerOfPreviousCell = ownerOfCurrentCell;
        }
    }
    return null;
}
```

O	X	X
	O	X
O		X

Diagonal Win Detection

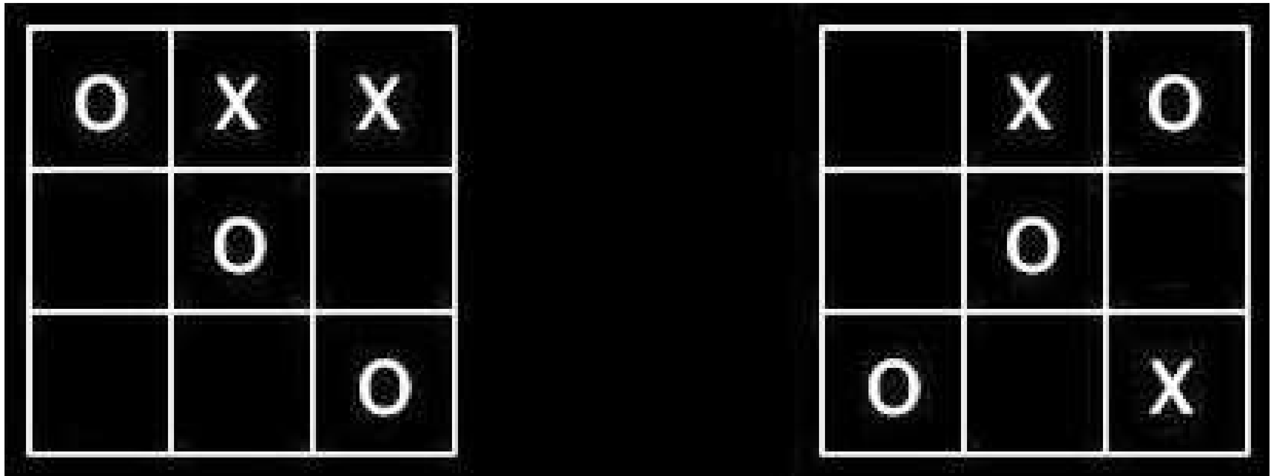
Diagonal Win Detection much harder to implement

Need to increment both x and y at the same time

Must also deal with two different directions of slope

Must work for ALL board sizes (not just 3x3)

Might not start in corners or go through centre cell



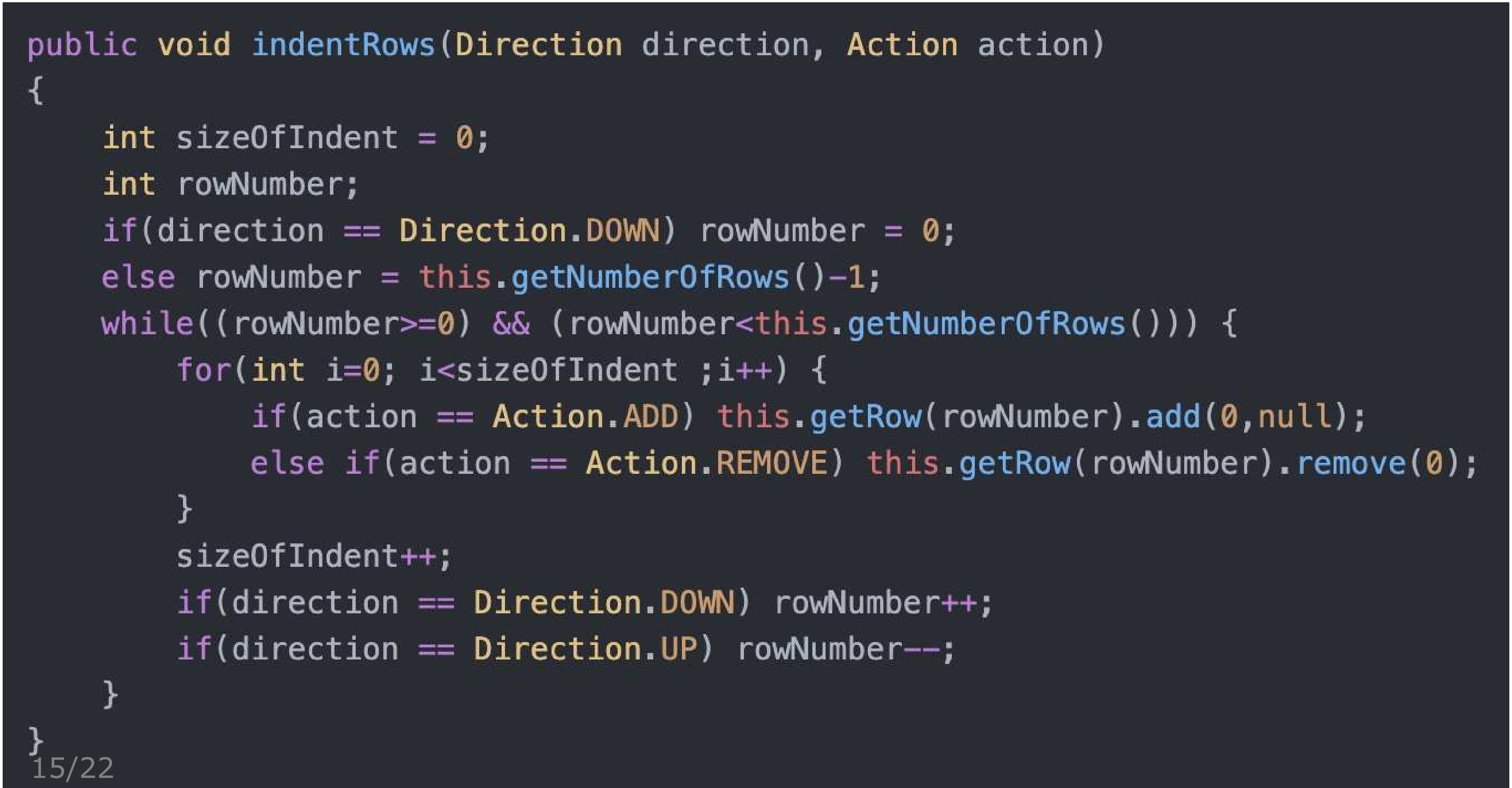
One Interesting Approach

Rather than trying to solve this difficult problem...
What if we could transform it into a simpler problem
(a problem that we *already* have a solution to ;o)

SmartWinDetection

This kind of intelligent preprocessing is powerful
Don't just try to brute-force the solution
Think laterally to make your life easier !

The Code: Versatile and Reusable



```java
public void indentRows(Direction direction, Action action)
{
    int sizeOfIndent = 0;
    int rowNumber;
    if(direction == Direction.DOWN) rowNumber = 0;
    else rowNumber = this.getNumberOfRows()-1;
    while((rowNumber>=0) && (rowNumber<this.getNumberOfRows())) {
        for(int i=0; i<sizeOfIndent ;i++) {
            if(action == Action.ADD) this.getRow(rowNumber).add(0,null);
            else if(action == Action.REMOVE) this.getRow(rowNumber).remove(0);
        }
        sizeOfIndent++;
        if(direction == Direction.DOWN) rowNumber++;
        if(direction == Direction.UP) rowNumber--;
    }
}
```

Automated Draw Detection

Draw detection is relatively simple:

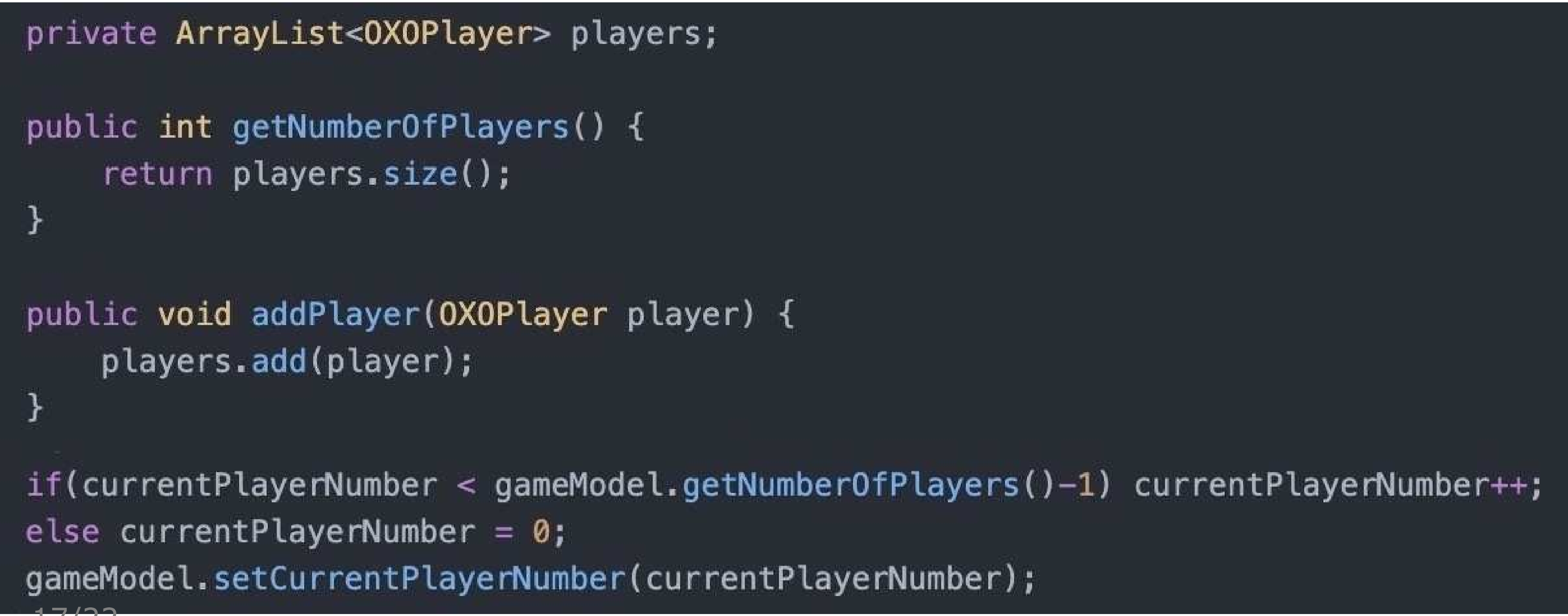
The game is a draw when all cells have been filled

(provided that no player has won the game !)

Extendable Number of Players

Make use of extendable ArrayList to store players

On advance to next player, check for wrap-around



```java
private ArrayList<OXOPlayer> players;

public int getNumberOfPlayers() {
    return players.size();
}

public void addPlayer(OXOPlayer player) {
    players.add(player);
}

if(currentPlayerNumber < gameModel.getNumberOfPlayers()-1) currentPlayerNumber++;
else currentPlayerNumber = 0;
gameModel.setCurrentPlayerNumber(currentPlayerNumber);
```

Game Reset

Reinitialise ArrayList of ArrayLists of OXOPlayers

Reset player number, winner, game drawn

Don't reset size of board or win threshold

```java
public void reset() {
    cells = new ArrayList<ArrayList<OXOPlayer>>();
    for(int i=0; i<numberOfRows ;i++) {
        ArrayList<OXOPlayer> newRow = new ArrayList<OXOPlayer>(numberOfColumns);
        for(int j=0; j<numberOfColumns ;j++) newRow.add(null);
        cells.add(newRow);
    }
    currentPlayerNumber = 0;
    winner = null;
    gameDrawn = false;
}
```

Common Problems and Issues...

Common Problems and Issues

- Broken encapsulation (direct access of internal state)
- State leakage (multiple inconsistent copies of data)
- Game can continue even after a win
- Unconstrained resize of board (add/remove row/col)
- Not all erroneous inputs detected and prevented
- Win not always detected (with expanded board size)
- Hardwired checking of playing letter (this isn't C !)
- Limited coverage of features by test cases
  (will provide guidance on testing in a later session)

Questions ?

Simon's Software Process Paradox

Those of you who are MOST concerned about the steady and sustainable accumulation of features, are likely to be the ones with LEAST to worry about

Those NOT concerned about their code evolution are probably those who should be worrying MOST !