# Introduction

## Goals of project

Learn programming

Deliver a real application

## Story-based development

Based on agile development

Each story adds some new value to user

Each story kept to the minimum complexity that adds some value

## Learning approach

Programming patterns, tools & techniques introduced only as they are used

Where possible, each is introduced in a context outside the app

The student is then invited to apply this learning, with some hints and guidelines

Model code available at the end of each module

## Technical approach

Web-based

Microsoft tooling platform

TypeScript rather than JavaScript

## Professional perspective

What’s realistic and what’s not

Stories have been nicely ordered

While there is some change to code, this is reduced because we know where we are going.

Watch out for ‘Professional Perspective’

TODO: Use ‘function’ and ‘method’ consistently - former when they are called function, latter on objects.

# Create a web page with a welcome screen

## Learnings: patterns & techniques

Use Visual Studio

Create a web-based project

The index page

The run-edit cycle

Some simple Html

## Exercises

Create new typescript project

Run it unmodified.

Explain parts, including: TypeScript vs. JavaScript

Empty App.ts for now

Modify Index

Modify CSS

Show that if app is still running, changes can be picked up by refreshing the browser

## Code written

Index.html

<!DOCTYPE html>

<html lang="en">

<head>

<meta charset="utf-8" />

<title>My board game</title>

<link rel="stylesheet" href="app.css" type="text/css" />

<script src="app.js"></script>

</head>

<body>

<h1>Reversi Game</h1>

<p>Look up the <a href="http://www.yourturnmyturn.com/rules/reversi.php" target="\_blank">rules</a></p>

~~<div id="content"></div>~~

</body>

</html>

app.ts - empty

app.css – as is

# Draw the outline of a board

Large green square with an outline. Text to the side

## Learnings: patterns & techniques

Canvas

Script files

TypeScript (& JavaScript)

Renderer

Rectangle

Fill & stroke

Arc

Procedural programming - executed in order

Global variables (which we want to avoid)

## Exercises

Add code

Explain code

What happens if:

* You change numbers in the rectangle method
* You change the order of the statements
* Draw another rectangle of different size, colour & location
* You spell canvas wrong in various places.
* Step through code

## Code written

TODO: Talk about running, stopping or just refreshing

index.html

<body>

<canvas width="500" height="500"></canvas>

<h1>Reversi Game</h1>

app.ts

//Global variables

var canvas: HTMLCanvasElement;

var renderer: CanvasRenderingContext2D;

window.onload = function () {

canvas = document.getElementsByTagName("canvas")[0];

renderer = canvas.getContext("2d");

//Draw background

renderer.fillStyle = 'green';

renderer.fillRect(0, 0, 480, 480);

//Draw outline

renderer.strokeStyle = 'black';

renderer.strokeRect(0, 0, 480, 480);

}

app.css – append to end of file

canvas {

float: left;

}

# Create squares in specific positions

## Learnings: patterns & techniques

Separation of concerns - domain logic from presentation

Beginnings of object modelling

Classes and instances

Constructor

Writing a generalised function

Passing params

## Code written

TODO: Should we really introduce a namespace to App, just for consistency. It would make sense. Then talk generally about namespaces and importing. Do we really want to do importing, or just qualify the names (as we do with drawing).

model.ts

namespace model {

export class Square {

constructor(public col: number, public row: number) {

}

}

}

drawing.ts

namespace drawing {

export function drawSquare(sq: model.Square, renderer: CanvasRenderingContext2D) {

//Draw background

renderer.fillStyle = 'green';

renderer.fillRect(sq.col \* squareSide, sq.row \* squareSide, squareSide, squareSide);

//Draw outline

renderer.strokeStyle = 'black';

renderer.strokeRect(sq.col \* squareSide, sq.row \* squareSide, squareSide, squareSide);

}

}

app.ts

const squareSide: number = 60;

//Global variables

var canvas: HTMLCanvasElement;

var renderer: CanvasRenderingContext2D;

window.onload = function () {

canvas = document.getElementsByTagName("canvas")[0];

renderer = canvas.getContext("2d");

var sq = new model.Square(0, 0);

drawing.drawSquare(sq, renderer);

sq = new model.Square(0, 1);

drawing.drawSquare(sq, renderer);

var sq = new model.Square(1, 0);

drawing.drawSquare(sq, renderer);

}

Run, get error, containing this phrase:

JavaScript runtime error: 'model' is undefined

Need to add the **.js** version of these two new files into the Index.html

Note that the order is important (try changing the order and running. Can you figure out why the error is occuring if the order is wrong?

<head>

<meta charset="utf-8" />

<title>My board game</title>

<link rel="stylesheet" href="app.css" type="text/css" />

<script src="model.js"></script>

<script src="drawing.js"></script>

<script src="app.js"></script>

</head>

# Create a whole board

You will need to stop the application running for this next change.

First, install LoDash & . Explain NuGet packages. See the script added.

Explain loDash

As with your own files you will need to add a reference

### Board object – in model.ts

/// <reference path="../Scripts/typings/lodash/lodash.d.ts" />

namespace model {

export class Square {

constructor(public col: number, public row: number) {

}

}

export class Board {

constructor() {

this.squares = [];

for (var col = 0; col < 8; col++) {

for (var row = 0; row < 8; row++) {

this.squares.push(new Square(col, row));

}

}

}

private squares: Square[];

//If the coordinates lie outside of the board boundaries, returns 'undefined'

public getSquare(col: number, row: number): Square {

return \_.find(this.squares, sq => sq.col === col && sq.row == row);

}

}

}

Note: added new class *inside the namespace*

### initialise board within onload (app.ts)

const squareSide: number = 60;

//Global variables

var canvas: HTMLCanvasElement;

var renderer: CanvasRenderingContext2D;

var board: model.Board;

window.onload = function () {

canvas = document.getElementsByTagName("canvas")[0];

renderer = canvas.getContext("2d");

~~//Draw background~~

~~renderer.fillStyle = 'green';~~

~~renderer.fillRect(0, 0, 480, 480);~~

~~//Draw outline~~

~~renderer.strokeStyle = 'black';~~

~~renderer.strokeRect(0, 0, 480, 480);~~

~~var sq = new Square(0, 0);~~

~~drawing.drawSquare(sq, renderer);~~

~~sq = new Square(0, 1);~~

~~drawing.drawSquare(sq, renderer);~~

~~var sq = new Square(1, 0);~~

~~drawing.drawSquare(sq, renderer);~~

board = new model.Board();

drawing.drawBoard(board, renderer);

}

### drawBoard function (in drawing.ts)

Note: added new function *inside the namespace*

namespace drawing {

export function drawSquare(sq: Square, renderer: CanvasRenderingContext2D) {

//Draw background

renderer.fillStyle = 'green';

renderer.fillRect(sq.col \* squareSide, sq.row \* squareSide, squareSide, squareSide);

//Draw outline

renderer.strokeStyle = 'black';

renderer.strokeRect(sq.col \* squareSide, sq.row \* squareSide, squareSide, squareSide);

}

export function drawBoard(board: model.Board, renderer: CanvasRenderingContext2D) {

for (var col: number = 0; col <= 7; col++) {

for (var row: number = 0; row <= 7; row++) {

const sq = board.getSquare(col, row);

drawSquare(sq, renderer);

}

}

}

}

# Set up the starting position

## Learnings: patterns & techniques

Enum

Importance of naming & renaming

### new constant PieceRadius (in App, underneath the )

const squareSide: number = 60;

const pieceRadius = 25;

### New enum (in models, within namespace (link))

export enum Side { black, white }

### Function to get drawing colour from Side value

In drawing, within namespace,

export function getColourForSide(side: model.Side): string {

return side === Side.black? 'black' : 'white';

}

### Modify Square class to know if occupied

export class Square {

constructor(public col: number, public row: number) {

this.occupiedBy = null;

}

public occupiedBy: Side;

}

### new drawPiece function in drawing.ts, within namespace

export function drawPiece(

sq: model.Square,

colour: string,

renderer: CanvasRenderingContext2D) {

var centreX: number = sq.col \* squareSide + squareSide / 2;

var centerY: number = sq.row \* squareSide + squareSide / 2;

renderer.fillStyle = colour;

renderer.beginPath();

renderer.arc(centreX, centerY, pieceRadius, 0, 2 \* Math.PI);

renderer.fill();

}

### Modify drawSquare to draw piece if occupied

export function drawSquare(sq: Square, renderer: CanvasRenderingContext2D) {

//Draw background

renderer.fillStyle = 'green';

renderer.fillRect(sq.col \* squareSide, sq.row \* squareSide, squareSide, squareSide);

//Draw outline

renderer.strokeStyle = 'black';

renderer.strokeRect(sq.col \* squareSide, sq.row \* squareSide, squareSide, squareSide);

if (sq.occupiedBy != null) {

var colour: string = getColourForSide(sq.occupiedBy);

drawPiece(sq, colour, renderer);

}

}

### Set up starting pieces in the Board’s constructor

export class Board {

constructor() {

this.squares = [];

for (var col = 0; col < 8; col++) {

for (var row = 0; row < 8; row++) {

this.squares.push(new Square(col, row));

}

}

this.getSquare(3, 3).occupiedBy = Side.white;

this.getSquare(4, 4).occupiedBy = Side.white;

this.getSquare(4, 3).occupiedBy = Side.black;

this.getSquare(3, 4).occupiedBy = Side.black;

}

# Add a cursor, initially in the top-left corner

### Create a cursor location global variable on app & initialise in the OnLoad & draw it

In app.ts, a new global variable

//Global variables

var canvas: HTMLCanvasElement;

var renderer: CanvasRenderingContext2D;

var board: Board;

var cursorLocation: Square;

Initilise this in onload

window.onload = function () {

canvas = document.getElementsByTagName("canvas")[0];

renderer = canvas.getContext("2d");

var board = new Board();

drawing.drawBoard(board, renderer);

cursorLocation = board.getSquare(0, 0);

renderer.strokeStyle = 'yellow';

renderer.strokeRect(cursorLocation.col \* squareSide, cursorLocation.row \* squareSide, squareSide, squareSide);

}

### Test at this stage

### Now refactor by extracting a general function to draw square outline in any colour

Put in drawing. Recall: where do we insert new functions?

export function drawSquareOutline(square: Square, colour: string, renderer: CanvasRenderingContext2D) {

renderer.strokeStyle = colour;

renderer.strokeRect(square.col \* squareSide, square.row \* squareSide, squareSide, squareSide);

}

Simplify the onLoad function to:

window.onload = function () {

canvas = document.getElementsByTagName("canvas")[0];

renderer = canvas.getContext("2d");

var board = new Board();

drawing.drawBoard(board, renderer);

cursorLocation = board.getSquare(0, 0);

~~renderer.strokeStyle = 'yellow';~~

~~renderer.strokeRect(cursorLocation.col \* squareSide, cursorLocation.row \* squareSide, squareSide, squareSide);~~

drawing.drawSquareOutline(cursorLocation, 'yellow', renderer);

}

And also re-use it to simplify the drawSquare function

export function drawSquare(sq: Square, renderer: CanvasRenderingContext2D) {

//Draw background

renderer.fillStyle = 'green';

renderer.fillRect(sq.col \* squareSide, sq.row \* squareSide, squareSide, squareSide);

//Draw outline

~~renderer.strokeStyle = 'black';~~

~~renderer.strokeRect(sq.col \* squareSide, sq.row \* squareSide, squareSide, squareSide);~~

drawSquareOutline(sq, 'black', renderer);

if (sq.occupiedBy != null) {

var colour: string = getColourForSide(sq.occupiedBy);

drawPiece(sq, colour, renderer);

}

}

Test again

# Move the cursor around using the arrow keys

## MoveCursorBy in App

function moveCursorBy(cols: number, rows: number) {

var col = cursorLocation.col + cols;

var row = cursorLocation.row + rows;

cursorLocation = board.getSquare(col, row);

drawing.drawBoard(board, renderer); //Re-drawing board clears the current cursor

drawing.drawSquareOutline(cursorLocation, 'yellow', renderer);

}

Test this by moving to a possible start location on loading

(don’t need the drawBoard now, because it is included within the moveCursorBy

window.onload = function () {

canvas = document.getElementsByTagName("canvas")[0];

renderer = canvas.getContext("2d");

board = new Board();

~~drawing.drawBoard(board, renderer);~~

cursorLocation = board.getSquare(0, 0);

moveCursorBy(3, 2);

~~drawing.drawSquareOutline(cursorLocation, 'yellow', renderer);~~

}

## OnKeyDown (in App)

window.onkeydown = function (ke: KeyboardEvent) {

ke.preventDefault();

switch (ke.keyCode) {

case 37: // left arrow

moveCursorBy(-1, 0);

break;

case 38: // up arrow

moveCursorBy(0, -1);

break;

case 39: // right arrow

moveCursorBy(1, 0);

break;

case 40: // down arrow

moveCursorBy(0, 1);

break;

}

}

Test this. But see what happens when you move to the edge of the board.

JavaScript runtime error: Unable to get property 'col' of undefined or null reference

Explain: debug (we flagged this in an earlier comment on getSquare)

So …

## Key the cursor within bounds

On Board object

public keepWithinBounds(value: number): number {

if (value < 0) return 0;

if (value > 7) return 7;

return value;

}

and use this within the moveCursorBy function:

function moveCursorBy(cols: number, rows: number) {

var col = board.keepWithinBounds(cursorLocation.col + cols);

var row = board.keepWithinBounds(cursorLocation.row + rows);

cursorLocation = board.getSquare(col, row);

drawing.drawBoard(board, renderer); //Re-drawing board clears the current cursor

drawing.drawSquareOutline(cursorLocation, 'yellow', renderer);

}

Test

## Add user instructions

In Index.html:

<body>

<canvas width="500" height="500"></canvas>

<h1>Reversi Game</h1>

<h3>Instructions</h3>

<p>Use the four arrow keys to position the cursor.</p>

# Place a piece on the board

## placePiece function in App

function placePiece(side: model.Side): void {

cursorLocation.occupiedBy = side;

}

test this by *temporarily* calling it within onload:

window.onload = function () {

canvas = document.getElementsByTagName("canvas")[0];

renderer = canvas.getContext("2d");

board = new Board();

cursorLocation = board.getSquare(0, 0);

moveCursorBy(3, 2);

placePiece(model.Side.black);

}

It doesn’t work!

Trace through to see what is happening. All is working but the board isn’t being re-drawn. So add:

function placePiece(side: model.Side): void {

cursorLocation.occupiedBy = side;

drawing.drawBoard(board, renderer);

}

this should now draw, but note that we have lost the cursor. We could add functionality to draw the cursor again, but a simpler option would be to replace that line with a call to move the cursor, but by zero, which causes both the board and cursor to be re-drawn.

function placePiece(side: Side): void {

cursorLocation.occupiedBy = side;

~~drawing.drawBoard(board, renderer);~~

moveCursorBy(0,0);

}

Now *delete the* placePiece(Side.black); linefrom onload as soon as you can see it is working

window.onkeydown = function (ke: KeyboardEvent) {

ke.preventDefault();

switch (ke.keyCode) {

case 37: // left arrow

moveCursorBy(-1, 0);

break;

case 38: // up arrow

moveCursorBy(0, -1);

break;

case 39: // right arrow

moveCursorBy(1, 0);

break;

case 40: // down arrow

moveCursorBy(0, 1);

break;

case 66: // 'b'

placePiece(model.Side.black);

break;

case 87: // 'w'

placePiece(model.Side.white);

break;

}

}

## Add user instructions

In Index.html:

<body>

<canvas width="500" height="500"></canvas>

<h1>Reversi Game</h1>

<h3>Instructions</h3>

<p>Use the four arrow keys to position the cursor.</p>

<p>Use the ‘b’ and ‘w’ keys to place pieces.</p>

TODO: Need to capture the turquoise colouring of namespaces/classes

Test it out.

# Alternate turns

## Add a GameManager class

**Tip: to reformat your code (and get the indents right) use ctrl-k ctrl-d (only works properly if your code is compiling)**

Think of this as the referee that has responsibility to manage the turns, enforce the rules, and decide the outcome of the game. In Model

export class GameManager {

public constructor(public board: Board) {

this.turn = Side.black; //The rules state that Black always moves first

}

public turn: Side;

public placePiece(sq: Square): void {

sq.occupiedBy = this.turn;

//Now set the next turn

if (this.turn == Side.black) {

this.turn = Side.white

} else {

this.turn = Side.black;

}

}

}

Initialise the GameManager in the onload function:

//Global variables

var canvas: HTMLCanvasElement;

var renderer: CanvasRenderingContext2D;

var cursorLocation: model.Square;

var board: model.Board;

var game: model.GameManager;

window.onload = function () {

canvas = document.getElementsByTagName("canvas")[0];

renderer = canvas.getContext("2d");

board = new Board();

game = new model.GameManager(board);

cursorLocation = board.getSquare(0, 0);

moveCursorBy(3, 2);

}

Change the onKeyDown function using ‘Enter’ to place next piece instead of

window.onkeydown = function (ke: KeyboardEvent) {

ke.preventDefault();

switch (ke.keyCode) {

case 37: // left arrow

moveCursorBy(-1, 0);

break;

case 38: // up arrow

moveCursorBy(0, -1);

break;

case 39: // right arrow

moveCursorBy(1, 0);

break;

case 40: // down arrow

moveCursorBy(0, 1);

break;

~~case 66: // 'b'~~

~~placePiece(Side.black);~~

~~break;~~

~~case 87: // 'w'~~

~~placePiece(Side.white);~~

~~break;~~

case 13: // Enter

game.placePiece(cursorLocation);

moveCursorBy(0,0);

break;

}

}

Delete the now redundant placePiece function in app

~~function placePiece(side: Side) : void {~~

~~cursorLocation.occupiedBy = side;~~

~~moveCursorBy(0, 0);~~

~~}~~

## Modify user instructions

In Index.html:

<body>

<canvas width="500" height="500"></canvas>

<h1>Reversi Game</h1>

<h3>Instructions</h3>

<p>Use the four arrow keys to position the cursor.</p>

~~<p>Use the ‘b’ and ‘w’ keys to place pieces.</p>~~

<p>Use the ‘Enter’ key to place a piece.<p>

# Update status

## Add method and property within the GameManager class

public status: string;

public updateStatus(): void {

switch (this.turn) {

case Side.black:

this.status = 'Black to play';

break;

case Side.white:

this.status = 'White to play';

break;

}

}

and call it in the GameManager’s constructor,

public constructor(board: Board) {

this.turn = Side.black; //The rules state that Black always moves first

this.updateStatus();

}

and again after a piece has been placed:

public placePiece(sq: Square): void {

sq.occupiedBy = this.turn;

//Now set the next turn

if (this.turn == Side.black) {

this.turn = Side.white

} else {

this.turn = Side.black;

}

this.updateStatus();

}

## Add a placeholder into the Index page for the status

<body>

<canvas width="500" height="500"></canvas>

<h1>Reversi Game</h1>

<p>Status: <span id="status"></span></p>

<p>Look up the <a href="http://www.yourturnmyturn.com/rules/reversi.php" target="\_blank">rules</a></p>

</body>

## Add a function to copy the status from the GameManager to the page

In drawing.ts:

export function updateText(game: model.GameManager) {

document.getElementById("status").innerHTML = game.status;

}

Call this from within onload…

window.onload = function () {

canvas = document.getElementsByTagName("canvas")[0];

renderer = canvas.getContext("2d");

board = new Board();

game = new GameManager(board);

cursorLocation = board.getSquare(0, 0);

drawing.updateText(game);

moveCursorBy(3, 2);

}

and when after the user places a piece …

case 13: // Enter

game.placePiece(cursorLocation);

drawing.updateText(game);

moveCursorBy(0, 0);

# Can only place piece onto an empty square

## Add function to test if a placement would be valid

Add to Board class:

public wouldBeValidMove(sq: Square): boolean {

return sq.occupiedBy == null;

}

Only place a piece if this function passes (notice the brace at the end) - in GameManager class:

public placePiece(sq: Square): void {

if (this.board.wouldBeValidMove(sq)) {

sq.occupiedBy = this.turn;

//Now set the next turn

if (this.turn == Side.black) {

this.turn = Side.white

} else {

this.turn = Side.black;

}

this.updateStatus();

}

}

Test that you can’t place over another piece (or at least not of the opposite colour!)

## Change the cursor colour to show that a move

On App

function moveCursorBy(cols: number, rows: number) {

var col = board.keepWithinBounds(cursorLocation.col + cols);

var row = board.keepWithinBounds(cursorLocation.row + rows);

cursorLocation = board.getSquare(col, row);

drawing.drawBoard(board, renderer); //Re-drawing board clears the current cursor

var cursorColour = board.wouldBeValidMove(cursorLocation) ? 'yellow' : 'red';

drawing.drawSquareOutline(cursorLocation, cursorColour, renderer);

}

# New piece must be adjacent to a piece of opposite colour

## Write a function to find the adjacent squares (neighbours)

TODO: Draw a sketch. This *must* be built up gradually and tested at each stage, dealing progressively with:

* Exclude the square itself
* Exclude squares that would be off the edge of the board

Explain: why private

In the Board class

//Returns all squares (on the board) that are immediate neighbours

//of the given square - between 3 and 8 of them.

private getAdjacentSquares(sq: Square): Square[] {

var neighbours: Square[] = [];

for (var col: number = sq.col - 1; col <= sq.col + 1; col++) {

for (var row: number = sq.row - 1; row <= sq.row + 1; row++) {

var neighbour = this.getSquare(col, row);

if (neighbour != undefined && neighbour != sq) {

neighbours.push(neighbour);

}

}

}

return neighbours;

}

## Write a function to test if a square has at least one neighbour occupied by specified side

private isAdjacentToPiece(sq: Square, piece: Side): boolean {

var neighbours = this.getAdjacentSquares(sq);

return \_.some(neighbours, sq => sq.occupiedBy == piece);

}

Explain: second line

## Call new function from within the test for a valid move

public wouldBeValidMove(sq: Square, side: Side): boolean {

return sq.occupiedBy == null && this.isAdjacentToPiece(sq, side);

}

Compile – **Ctlr-Shift-b** (if you are still running, hit Ok in response to Q Do you want to stop debugging)

Note the compile errors in the window and click on each one to see where it is.

Adding new parameter will break other code, so we need to add it within the calls

function moveCursorBy(cols: number, rows: number) {

var col = board.keepWithinBounds(cursorLocation.col + cols);

var row = board.keepWithinBounds(cursorLocation.row + rows);

cursorLocation = board.getSquare(col, row);

drawing.drawBoard(board, renderer); //Re-drawing board clears the current cursor

var cursorColour = board.wouldBeValidMove(cursorLocation, game.turn) ? 'yellow' : 'red';

drawing.drawSquareOutline(cursorLocation, cursorColour, renderer);

}

and

public placePiece(sq: Square): void {

if (this.board.wouldBeValidMove(sq, this.turn)) {

sq.occupiedBy = this.turn;

//Now set the next turn

if (this.turn == Side.black) {

this.turn = Side.white

} else {

this.turn = Side.black;

}

this.updateStatus();

}

}

Test. IT DOESN’T WORK as planned! Error in logic.

We need to be testing for adjacency to piece of the *opposite*  side.

We *could* write:

public wouldBeValidMove(sq: Square, side: Side): boolean {

var oppositeSide: Side;

if (side == Side.black) {

oppositeSide = Side.white

} else {

oppositeSide = Side.black;

}

return sq.occupiedBy == null && this.isAdjacentToPiece(sq, oppositeSide);

}

But notice that this is very similar to some code above. So much better to ‘factor out’ a function for getting the opposite side (in model.ts) *using new ‘ternary operatory’*. This best goes in the model namespace but not inside any of the classes.

function oppositeSideTo(side: Side): Side {

return side === Side.black ? Side.white : Side.black;

}

then call this from both here (in Game class):

public placePiece(sq: Square): void {

if (this.board.wouldBeValidMove(sq, this.turn)) {

sq.occupiedBy = this.turn;

//Now set the next turn

~~if (this.turn == Side.black) {~~

~~this.turn = Side.white~~

~~} else {~~

~~this.turn = Side.black;~~

~~}~~

this.turn = oppositeSideTo(this.turn);

this.updateStatus();

}

}

and (in Board):

public wouldBeValidMove(sq: Square, side: Side): boolean {

~~var oppositeSide: Side;~~

~~if (side == Side.black) {~~

~~oppositeSide = Side.white~~

~~} else {~~

~~oppositeSide = Side.black;~~

~~}~~

return sq.occupiedBy == null && this.isAdjacentToPiece(sq, oppositeSideTo(side));

}

Test this

# Identify captured pieces

This is a big story, which we will attempt to break up into as small chunks as we can

First, let’s identify all the squares from the cursor to the edge of the board in all eight directions. Start by trying one direction, North. (new method on Board class):

public squaresFrom(location: Square): Square[] {

var squares: Square[] = [];

for (var i = 1; i <= 7; i++) { //Can only be maximum of 7 steps to edge

var sq: Square = this.getSquare(location.col, location.row - i);

if (sq != undefined) {

squares.push(sq);

}

}

return squares;

}

We can test this by drawing the outline of those squares in blue, by adding (in App.ts):

function moveCursorBy(cols: number, rows: number) {

var col = board.keepWithinBounds(cursorLocation.col + cols);

var row = board.keepWithinBounds(cursorLocation.row + rows);

cursorLocation = board.getSquare(col, row);

drawing.drawBoard(board, renderer); //Re-drawing board clears the current cursor

var cursorColour = board.wouldBeValidMove(cursorLocation, game.turn) ? 'yellow' : 'red';

drawing.drawSquareOutline(cursorLocation, cursorColour, renderer);

var captured = board.squaresFrom(cursorLocation);

\_.forEach(captured, n => drawing.drawSquareOutline(n, 'blue', renderer));

}

Test this, and when you are happy it works, delete those last two lines again.

Now we’ll do East, but instead of writing a new function, we’ll rename and generalise this one, first adding an Enum for the different directions (in model.ts):

export enum Direction { north, east }

then change squaresFrom function to:

public squaresFrom(location: Square, dir: Direction): Square[] {

var squares: Square[] = [];

for (var i = 1; i <= 7; i++) { //Can only be maximum of 7 steps to edge

~~var sq: Square = this.getSquare(location.col, location.row - i);~~

var sq: Square;

switch (dir) {

case Direction.north:

sq = this.getSquare(location.col, location.row - i);

break;

case Direction.east:

sq = this.getSquare(location.col + i, location.row);

break;

}

if (sq != undefined) {

squares.push(sq);

}

}

return squares;

}

This will give you a compile error that will need fixing

function moveCursorBy(cols: number, rows: number) {

var col = board.keepWithinBounds(cursorLocation.col + cols);

var row = board.keepWithinBounds(cursorLocation.row + rows);

cursorLocation = board.getSquare(col, row);

drawing.drawBoard(board, renderer); //Re-drawing board clears the current cursor

var cursorColour = board.wouldBeValidMove(cursorLocation, game.turn) ? 'yellow' : 'red';

drawing.drawSquareOutline(cursorLocation, cursorColour, renderer);

var captured = board.squaresFrom(cursorLocation, model.Direction.north);

\_.forEach(captured, n => drawing.drawSquareOutline(n, 'blue', renderer));

}

Test again that it still works the same way.

Now a new function to identify captured squares in that direction:

public capturedSquares(placement: Square, side: Side, dir: Direction): Square[] {

var coveredSquares = [];

var squares = this.squaresFrom(placement, dir);

for (var i: number = 0; i < squares.length; i++) {

var sq: Square = squares[i];

if (sq.occupiedBy == side) {

return coveredSquares;; //Terminate loop

}

if (sq.occupiedBy == undefined) {

return []; //no squares are bookended

}

coveredSquares.push(sq);

}

return []; //Didn't find a bookend so return no squares;

}

modify the moveCursorBy function so that it now calls capturedSquares:

function moveCursorBy(cols: number, rows: number) {

var col = board.keepWithinBounds(cursorLocation.col + cols);

var row = board.keepWithinBounds(cursorLocation.row + rows);

cursorLocation = board.getSquare(col, row);

drawing.drawBoard(board, renderer); //Re-drawing board clears the current cursor

var cursorColour = board.wouldBeValidMove(cursorLocation, game.turn) ? 'yellow' : 'red';

drawing.drawSquareOutline(cursorLocation, cursorColour, renderer);

var captured = board.capturedSquares(cursorLocation, game.turn, model.Direction.north);

\_.forEach(captured, n => drawing.drawSquareOutline(n, 'blue', renderer);

}

Test this sout (you’ll have to move the cursor around until you find a piece to the north)

Then change the penultimate line in the moveCursorBy to specify east instead of north and test that this works:

var captured = board.capturedSquares(cursorLocation, game.turn, model.Direction.east);

Now a new method (in Board) to cover all of the directions (currently north and east only - we’ll add the others shortly)

public allCapturedSquares(placement: Square, side: Side): Square[] {

var results = [];

\_.forEach(Direction, d => {

var toAdd = this.capturedSquares(placement, side, d);

\_.forEach(toAdd, sq => results.push(sq));

});

return results;

}

function moveCursorBy(cols: number, rows: number) {

var col = board.keepWithinBounds(cursorLocation.col + cols);

var row = board.keepWithinBounds(cursorLocation.row + rows);

cursorLocation = board.getSquare(col, row);

drawing.drawBoard(board, renderer); //Re-drawing board clears the current cursor

var cursorColour = board.wouldBeValidMove(cursorLocation, game.turn) ? 'yellow' : 'red';

drawing.drawSquareOutline(cursorLocation, cursorColour, renderer);

var captured = board.allCapturedSquares(cursorLocation, game.turn);

\_.forEach(captured, n => drawing.drawSquareOutline(n, 'blue', renderer));

}

*Remember that it is currently only looking for squares captured to the north and east - you’ll need to position the cursor to find them.*

Now sdd the remaining six directions to Direction:

export enum Direction { north, northEast, east, southEast, south, southWest, west, northWest }

the order doesn’t matter, but it is best to be neat and logical.

Modify logic in squaresFrom to work with all 8 directions:

public squaresFrom(location: Square, dir: Direction): Square[] {

var squares: Square[] = [];

for (var i = 1; i <= 7; i++) { //Can only be maximum of 7 steps to edge

var sq: Square;

switch (dir) {

case Direction.north:

sq = this.getSquare(location.col, location.row - i);

break;

case Direction.northEast:

sq = this.getSquare(location.col + i, location.row - i);

break;

case Direction.east:

sq = this.getSquare(location.col + i, location.row);

break;

case Direction.southEast:

sq = this.getSquare(location.col + i, location.row + i);

break;

case Direction.south:

sq = this.getSquare(location.col, location.row + i);

break;

case Direction.southWest:

sq = this.getSquare(location.col - i, location.row + i);

break;

case Direction.west:

sq = this.getSquare(location.col - i, location.row);

break;

case Direction.northWest:

sq = this.getSquare(location.col - i, location.row - i);

break;

}

if (sq != undefined) {

squares.push(sq);

}

}

return squares;

}

test this. Should now see all potentially captured squares highlighted in blue.

# 14: Captured pieces flipped automatically

## Add the rule that a move is only valid if at least one piece is going to be captured

In Board, change:

public wouldBeValidMove(sq: Square, side: Side): boolean {

return sq.occupiedBy == null &&

this.isAdjacentToPiece(sq, oppositeSideTo(side)) &&

this.allCapturedSquares(sq, side).length > 0;

}

Test this (checking that cursor shows red otherwise.

## Flip the captured pieces as part of the place piece function

public placePiece(sq: Square): void {

if (this.board.wouldBeValidMove(sq, this.turn)) {

//Place new piece

sq.occupiedBy = this.turn;

//Flip captured pieces

var flips: Square[] = this.board.allCapturedSquares(sq, this.turn);

\_.forEach(flips, sq => sq.occupiedBy = this.turn);

//Now set the next turn

this.turn = oppositeSideTo(this.turn);

this.updateStatus();

}

}

Test

## Fix bug

note that squares may be highlighted blue even if move is invalid.

function moveCursorBy(cols: number, rows: number) {

var col = board.keepWithinBounds(cursorLocation.col + cols);

var row = board.keepWithinBounds(cursorLocation.row + rows);

cursorLocation = board.getSquare(col, row);

drawing.drawBoard(board, renderer); //Re-drawing board clears the current cursor

if (board.wouldBeValidMove(cursorLocation, game.turn)) {

drawing.drawSquareOutline(cursorLocation, 'yellow', renderer);

var captured = board.allCapturedSquares(cursorLocation, game.turn);

\_.forEach(captured, n => drawing.drawSquareOutline(n, 'blue', renderer));

} else {

drawing.drawSquareOutline(cursorLocation, 'red', renderer);

}

}

# 15: Count pieces

## Add function to board for counting pieces of either side

public countPieces(side: Side): number {

return \_.filter(this.squares, sq => sq.occupiedBy == side).length;

}

## Add placeholders into index.html

<body>

<canvas width="500" height="500"></canvas>

<h1>Reversi Game</h1>

<p>Status: <span id="status"></span></p>

<p>Black count: <span id="black"></span></p>

<p>White count: <span id="white"></span></p>

<p>Look up the <a href="http://www.yourturnmyturn.com/rules/reversi.php" target="\_blank">rules</a></p>

</body>

## Update the updateText function

export function updateText(game: GameManager) {

document.getElementById("status").innerHTML = game.status;

document.getElementById("black").innerHTML = board.countPieces(Side.black).toString();

document.getElementById("white").innerHTML = board.countPieces(Side.white).toString();

}

# 16: End game and show result when the board is full

## Add a gameOver flag to the GameManager

public gameOver: boolean;

## Change the updateStatus method on GameManager

public updateStatus(): void {

if (this.gameOver) {

var black = board.countPieces(Side.black);

var white = board.countPieces(Side.white);

if (white > black) {

this.status = 'GAME OVER. White has won!';

} else if (black > white) {

this.status = 'GAME OVER. Black has won!';

} else {

this.status = 'GAME OVER. A draw!';

}

} else {

switch (this.turn) {

case Side.black:

this.status = 'Black to play';

break;

case Side.white:

this.status = 'White to play';

break;

}

}

}

## Test for board full

On Board

public isFull(): boolean {

return \_.filter(this.squares, sq => sq.occupiedBy).length == 64;

}

Test this after placing new piece

public placePiece(sq: Square): void {

if (this.board.wouldBeValidMove(sq, this.turn)) {

//Place new piece

sq.occupiedBy = this.turn;

//Flip captured pieces

var flips: Square[] = this.board.allCapturedSquares(sq, this.turn);

\_.forEach(flips, sq => sq.occupiedBy = this.turn);

//Now set the next turn

this.turn = oppositeSideTo(this.turn);

//test for game over

if (board.isFull()) {

this.gameOver;

}

this.updateStatus();

}

}

## Use the gameOver flag to prevent further play in App

window.onkeydown = function (ke: KeyboardEvent) {

ke.preventDefault();

if (game.gameOver) return; //Can't continue

switch (ke.keyCode) {

## Update user instructions

<h3>Instructions</h3>

<p>Use the four arrow keys to position the cursor.</p>

<p>Use the Enter key to place your piece.</p>

<p>To start a new game click the Refresh icon (or hit F5) on the browser</p>

# 17: Allow player to skip their turn if they can’t move

## Add SkipTurn function to GameManager

public skipTurn(): void {

this.turn = oppositeSideTo(this.turn);

this.updateStatus();

}

## Allow user to skip turn with the ‘Esc’ key

Add a new case into the onKeyDown function (in App)

case 27: //Esc - Skip turn

game.skipTurn();

drawing.updateText(game);

moveCursorBy(0, 0);

break;

Why do we need the moveCursorBy(0,0) - try without!

## Keep track of whether each side has skipped turn & end game if both skip

In GameManager

lastTurnWasSkipped: boolean;

public skipTurn(): void {

if (this.lastTurnWasSkipped) {

this.gameOver = true;

} else {

this.turn = oppositeSideTo(this.turn);

this.lastTurnWasSkipped = true;

}

this.updateStatus();

}

public placePiece(sq: Square): void {

if (this.board.wouldBeValidMove(sq, this.turn)) {

//Reset

this.lastTurnWasSkipped = false;

//Place new piece

sq.occupiedBy = this.turn;

//Flip captured pieces

var flips: Square[] = this.board.allCapturedSquares(sq, this.turn);

\_.forEach(flips, sq => sq.occupiedBy = this.turn);

//Now set the next turn

this.turn = oppositeSideTo(this.turn);

//test for game over

if (board.isFull()) {

this.gameOver;

}

this.updateStatus();

}

}

## Update user instructions in Index.html

<h3>Instructions</h3>

<p>Use the four arrow keys to position the cursor.</p>

<p>Use the Enter key to place your piece.</p>

<p>Use the Esc (Escape) key to skip turn, if you cannot move.</p>

# Automated player

## Learnings: patterns & techniques

Sub-classing: automated player and manual player

## Notes

Get list of valid moves.

First, pick one at random

Next option, go for move with highest number of pieces gained, otherwise random

# TO THINK ABOUT

When to introduce the idea of a Player object

Game master need to ask Players for next move

Introduce idea of an automated player

AutomatedPlayer1

# Match

Set up two players at the beginning

Specify number of games

Execute games, keeping cumulative score

Output results.

## Learnings: patterns & techniques

Executing model without a UI