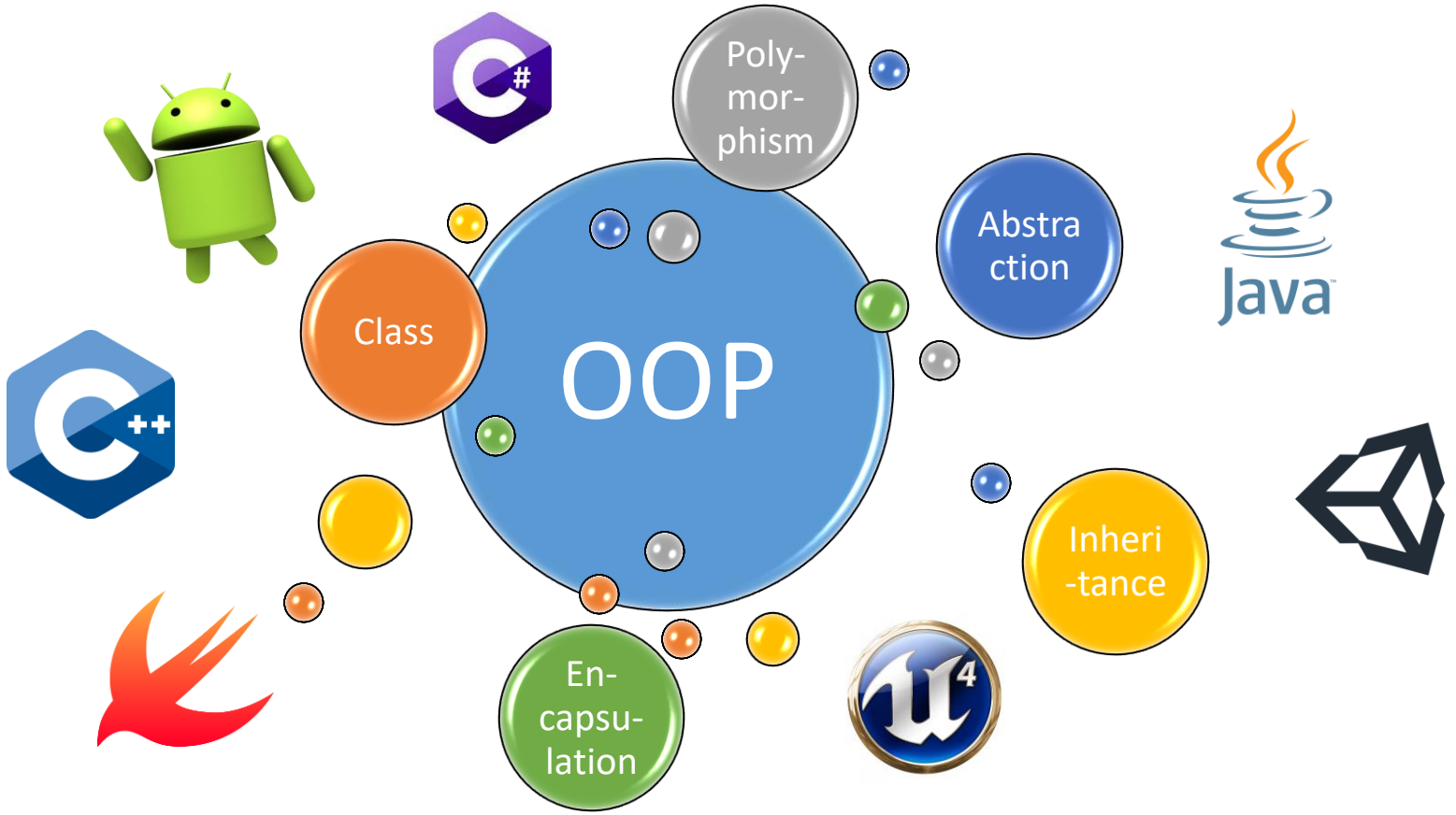

OOP Homework 3 - Tetris

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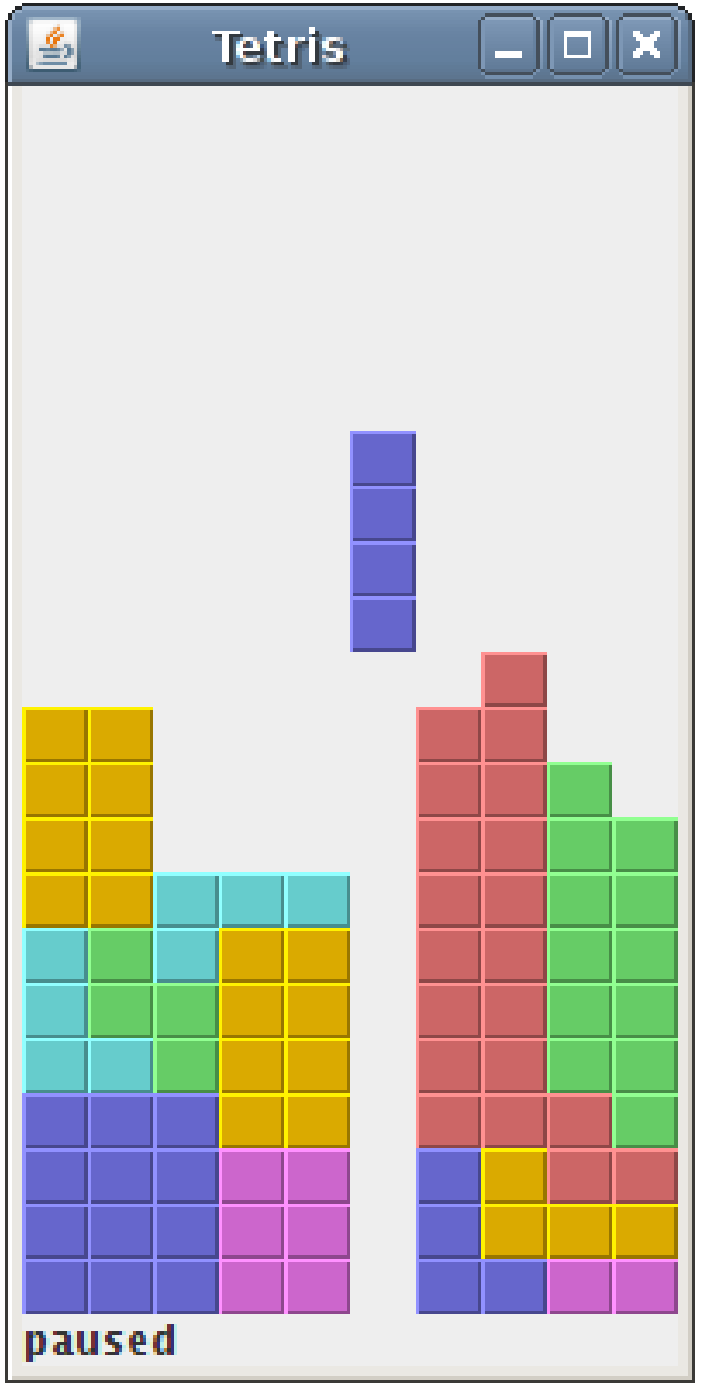
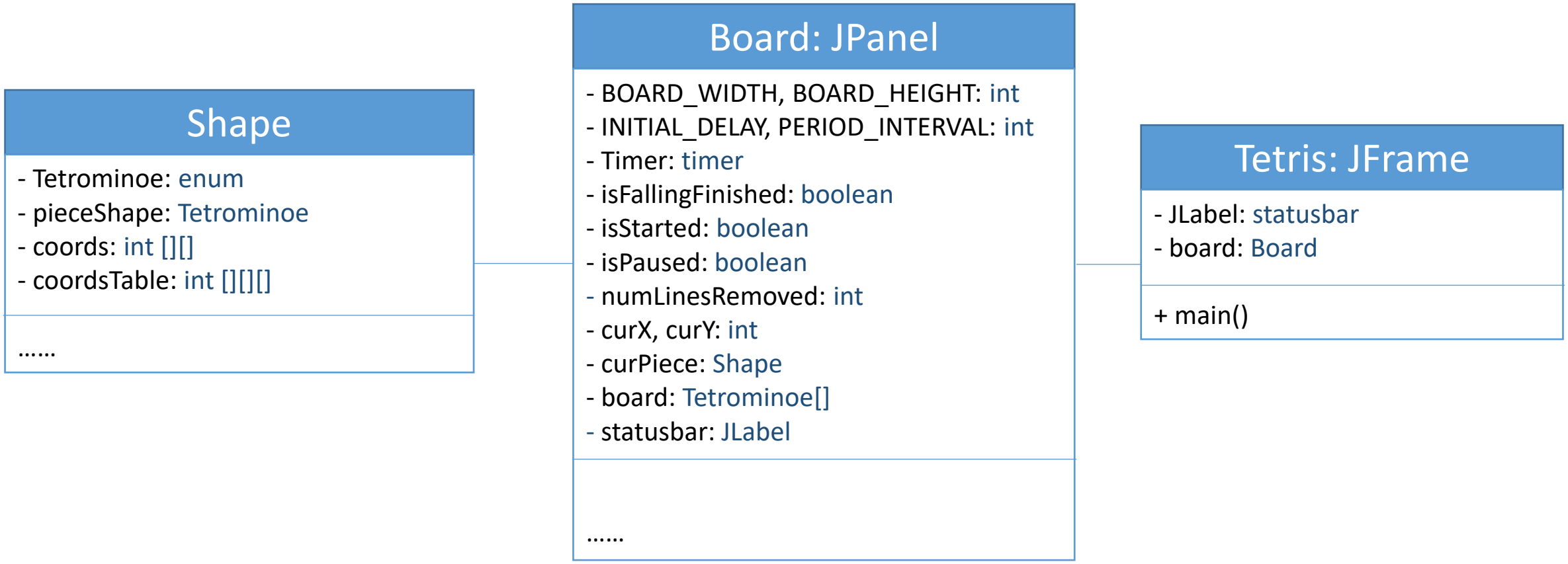
2021/6/16

Developing a Tetris Game

- zetcode.com/tutorials/javagamestutorial/tetris/
- Using Java Swing
- ↑ ↓: Rotate
- ← →: Move left/right
- Space: drop immediately
- d: drop faster



Class Diagram

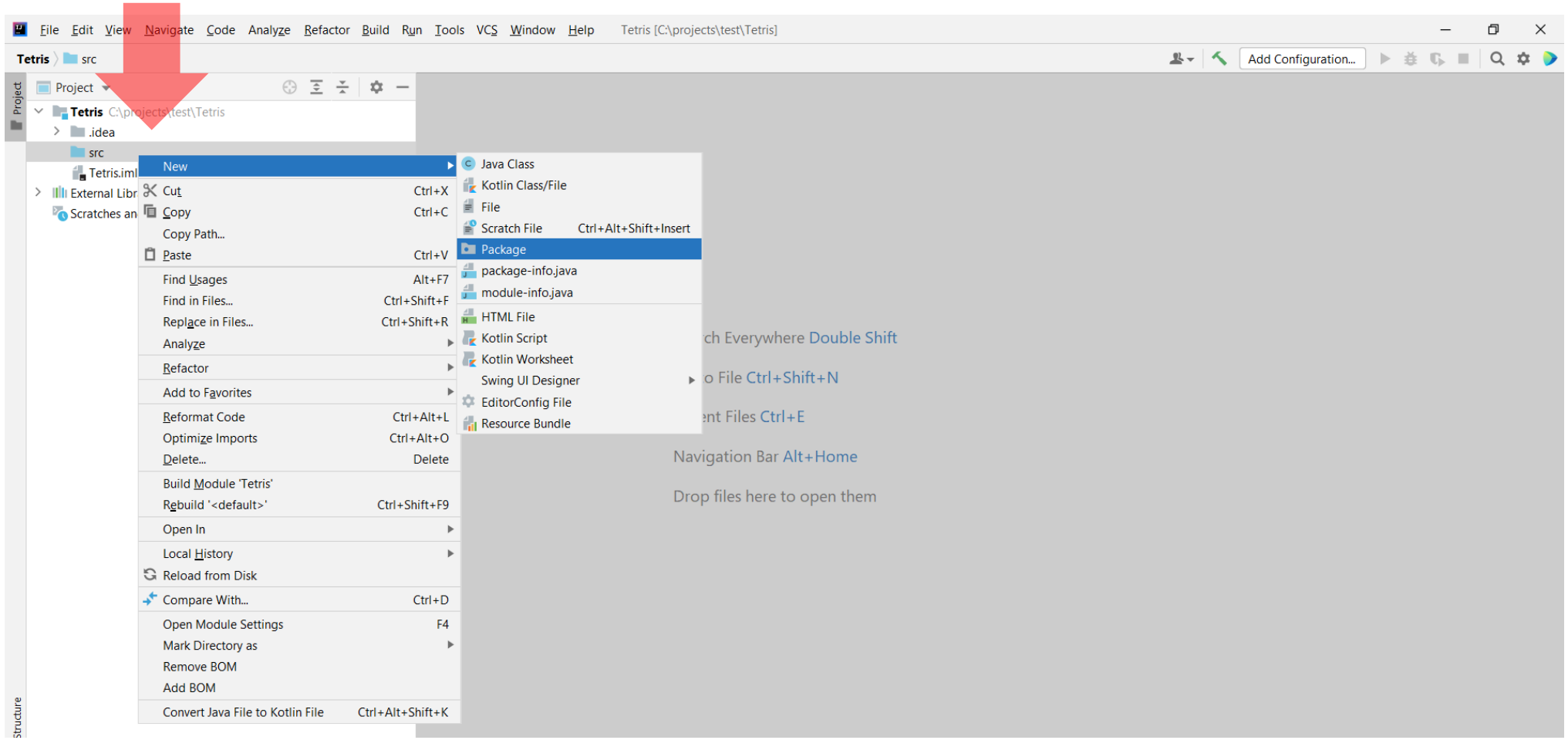


Building Tetris using IntelliJ

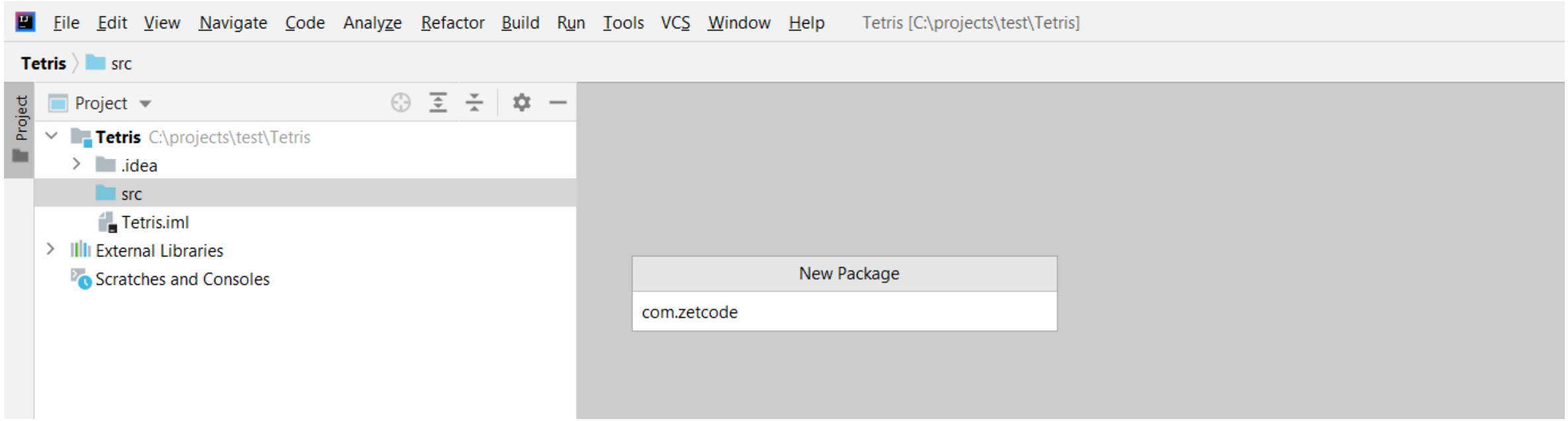
- Create a project “Tetris”
- Add a package “com.zetcode”
- Add three files in the package:
  - “Shape.java”, “Board.java”, “Tetris.java”

Create New Project & New Package

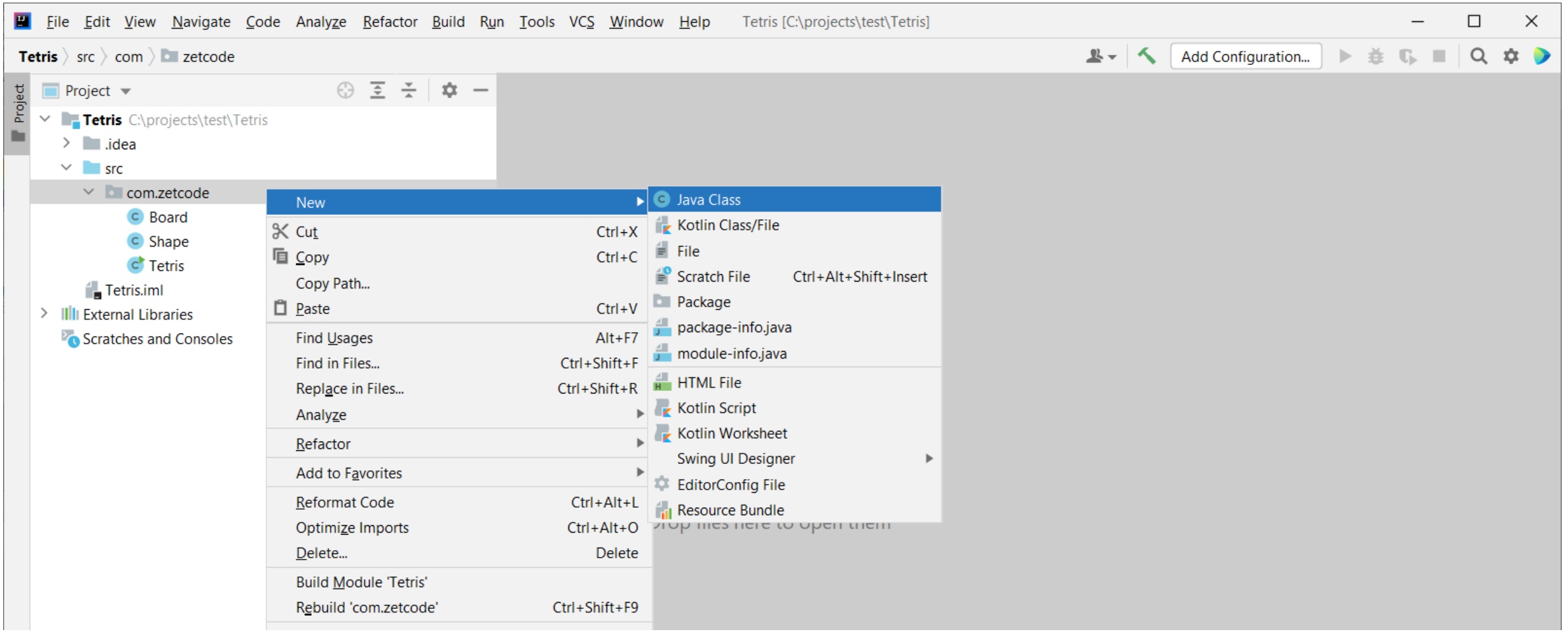
1. File -> New Project -> Next -> Next -> Project name: Tetris
2. Right click on src -> New -> Package



New Package name: com.zetcode



Add 3 files: Board.java, Shape.java & Tetris.java



Shape.java

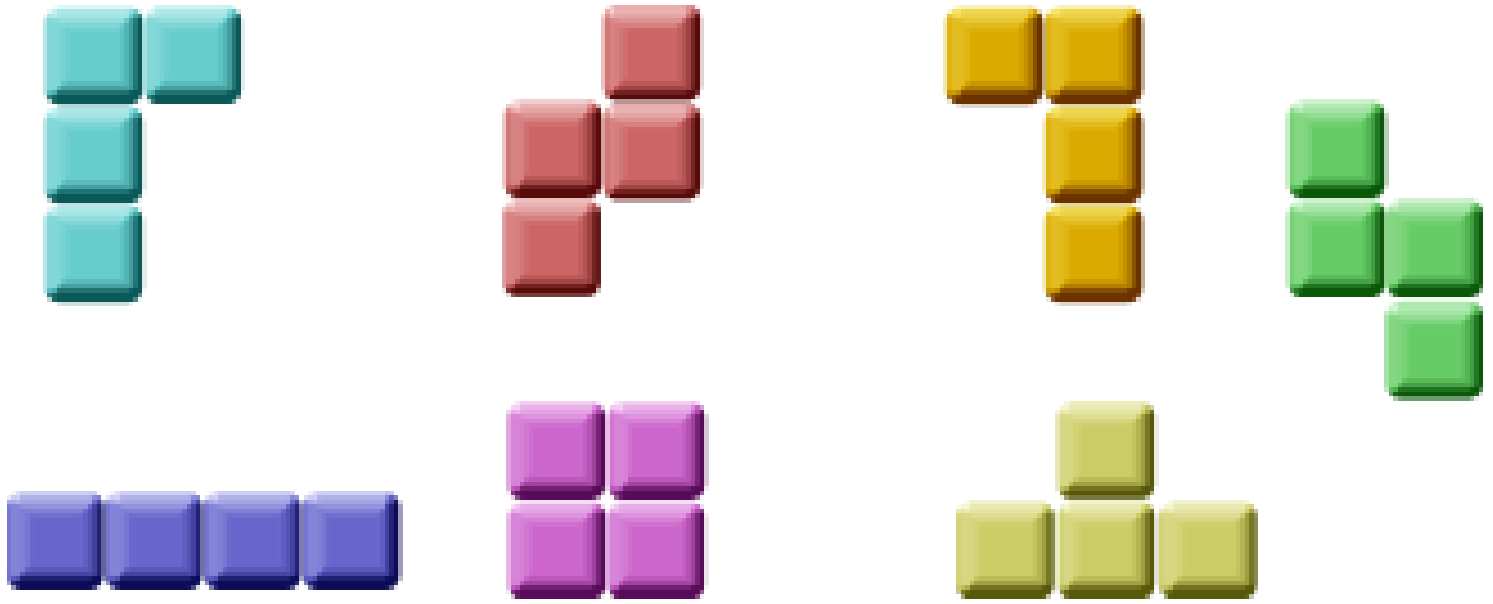
Shape

- Tetrominoe: enum
- pieceShape: Tetrominoe
- coords: int [][]
- coordsTable: int [][][]

+ Shape()
# setShape(shape: Tetrominoe)
+ getShape() : Tetrominoe
+ setRandomShape()
+ x(index: int) : int
+ y(index: int) : int
+ minX() : int
+ minY() : int
+ rotateLeft() : Shape
+ rotateRight() : Shape
- initShape()
- setX(index: int, x: int)
- setY(index: int, y: int)

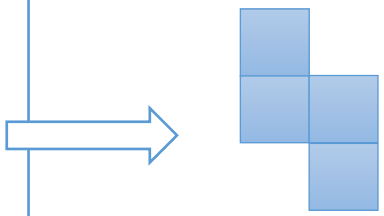
Tetrominoe

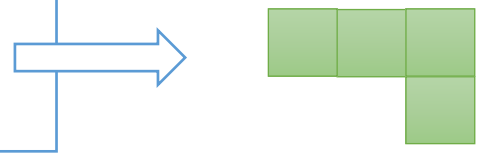
```
protected enum Tetrominoe { NoShape, ZShape, SShape, LineShape,
    TShape, SquareShape, LShape, MirroredLShape };
```

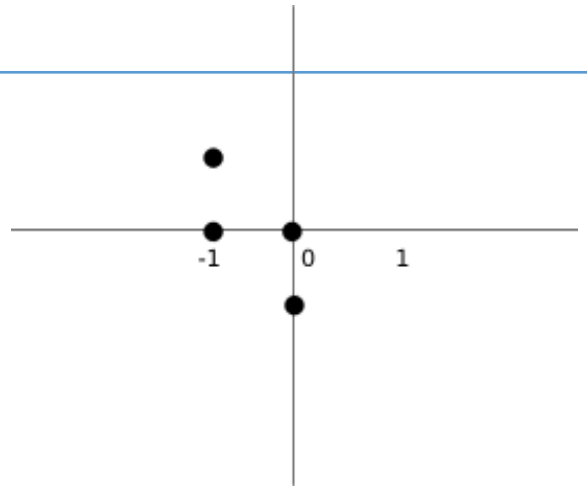


coordsTable for Tetrominoe

```
coordsTable = new int[][][] {
        { { 0, 0 },   { 0, 0 },   { 0, 0 },   { 0, 0 } },
        { { 0, -1 },  { 0, 0 },   { -1, 0 },  { -1, 1 } },
        { { 0, -1 },  { 0, 0 },   { 1, 0 },   { 1, 1 } },
        { { 0, -1 },  { 0, 0 },   { 0, 1 },   { 0, 2 } },
        { { -1, 0 },  { 0, 0 },   { 1, 0 },   { 0, 1 } },
        { { 0, 0 },   { 1, 0 },   { 0, 1 },   { 1, 1 } },
        { { -1, -1 }, { 0, -1 },  { 0, 0 },   { 0, 1 } },
        { { 1, -1 },  { 0, -1 },  { 0, 0 },   { 0, 1 } }
};
```

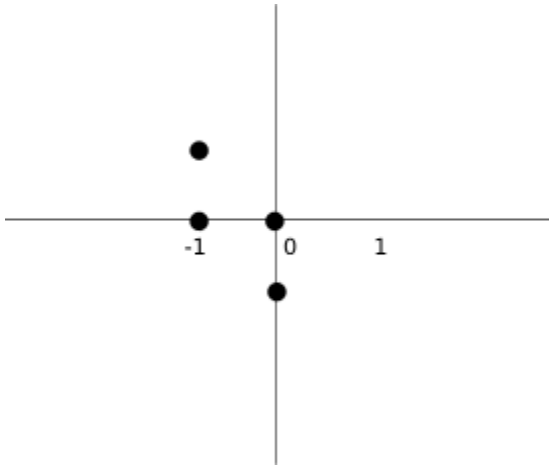






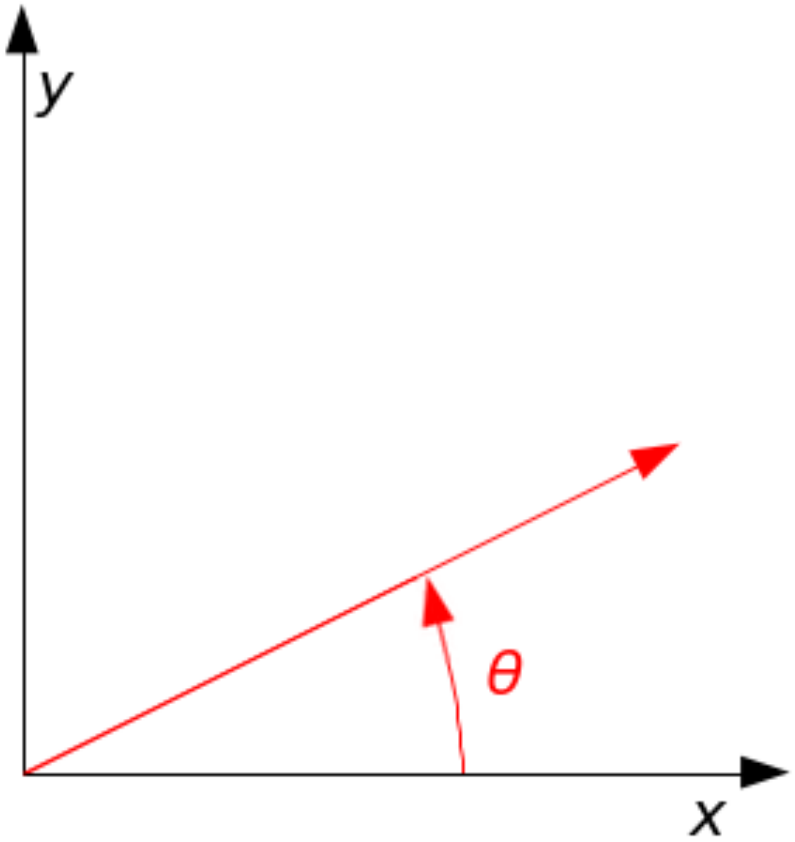
Get Shapes' Coordinates

```
for (int i = 0; i < 4 ; i++) {
    for (int j = 0; j < 2; ++j) {
        coords[i][j] = coordsTable[shape.ordinal()][i][j];
    }
}
```

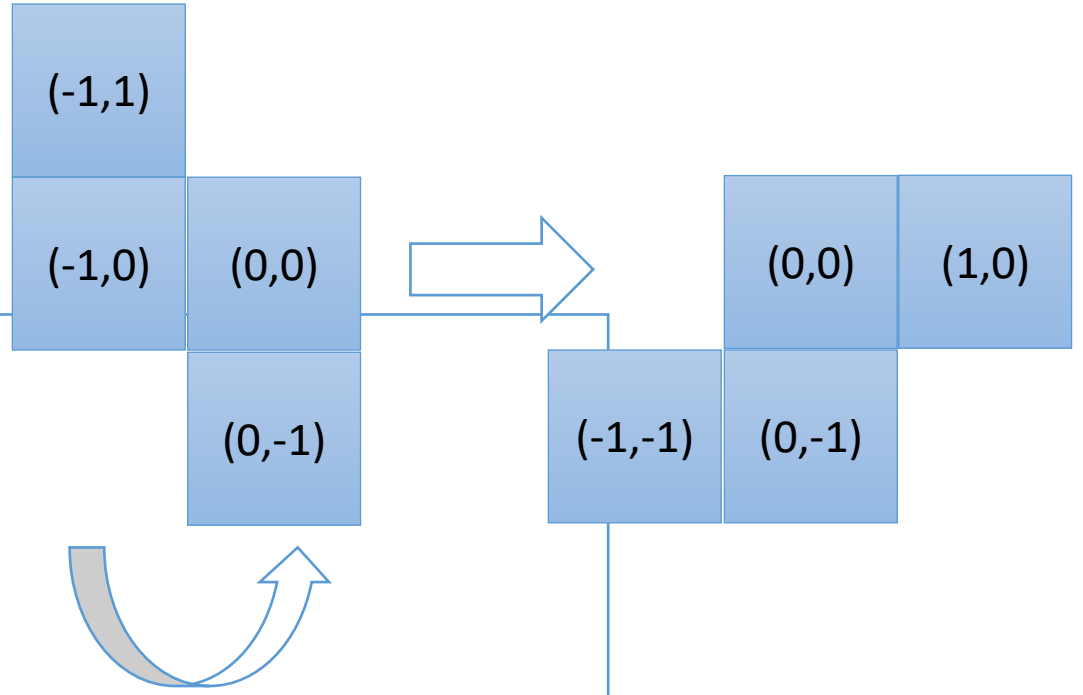


Rotation Matrix

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$



Rotate Right (x'=-y, y'=x)




```
public Shape rotateRight()
{
    if (pieceShape == Tetrominoe.SquareShape)
        return this;
    Shape result = new Shape();
    result.pieceShape = pieceShape;
    for (int i = 0; i < 4; ++i) {
        result.setX(i, -y(i));
        result.setY(i, x(i));
    }
    return result;
}
private void setX(int index, int x) { coords[index][0] = x; }
private void setY(int index, int y) { coords[index][1] = y; }
public int x(int index) { return coords[index][0]; }
public int y(int index) { return coords[index][1]; }
```

Board.java

Board: JPanel

- Timer: timer
- isFallingFinished, isStarted, isPaused : boolean
- numLinesRemoved: int
- curX, curY: int
- curPiece: Shape
- board: Tetrominoe[]

+ Board()
+ paintComponent(g: Graphics)
- squareWidth()
- squareHeight()
- shapeAt(x: int, y: int)
- start()
- pause()
- doDrawing(g: Graphics)
- dropDown()
- oneLineDown()
- clearBoard()
- pieceDropped()
- newPiece()
- removeFullLines()
- doGameCycle()
- update()
- tryMove(newPiece: Shape, newX: int, newY: int): boolean
- drawSquare(g: Graphics, x: int, y: int, shape: Tetrominoe)

Initializing Board

```
private void initBoard(Tetris parent) {

    setFocusable(true);
    timer = new Timer();
    timer.scheduleAtFixedRate(new ScheduleTask(),
            INITIAL_DELAY, PERIOD_INTERVAL);

    curPiece = new Shape();

    statusbar = parent.getStatusBar();
    board = new Tetrominoe[BOARD_WIDTH * BOARD_HEIGHT];
    addKeyListener(new TAdapter());
    clearBoard();
}
```

Updating Game

- Inheriting TimerTask

```
private void doGameCycle() {
    update();
    repaint();
}
private void update() {
    if (isPaused) {
        return;
    }
    if (isFallingFinished) {
        isFallingFinished = false;
        newPiece();
    } else {
        oneLineDown();
    }
}
private class ScheduleTask extends TimerTask {
    @Override
    public void run() {
        doGameCycle();
    }
}
```

Start & Pause

```
public void start() {
    isStarted = true;
    clearBoard();
    newPiece();
}

private void pause() {
    if (!isStarted) {
        return;
    }
    isPaused = !isPaused;
    if (isPaused) {
        statusbar.setText("paused");
    } else {
        statusbar.setText(String.valueOf(numLinesRemoved));
    }
}
```

Two-stage Drawing

```
private void doDrawing(Graphics g) {
    Dimension size = getSize();
    int boardTop = (int) size.getHeight() - BOARD_HEIGHT * squareHeight();
    for (int i = 0; i < BOARD_HEIGHT; ++i) {
        for (int j = 0; j < BOARD_WIDTH; ++j) {
            Tetrominoe shape = shapeAt(j, BOARD_HEIGHT - i - 1);
            if (shape != Tetrominoe.NoShape) {
                drawSquare(g, 0 + j * squareWidth(),
                           boardTop + i * squareHeight(), shape);
            }
        }
    }
    if (curPiece.getShape() != Tetrominoe.NoShape) {
        for (int i = 0; i < 4; ++i) {
            int x = curX + curPiece.x(i);
            int y = curY - curPiece.y(i);
            drawSquare(g, 0 + x * squareWidth(),
                       boardTop + (BOARD_HEIGHT - y - 1) * squareHeight(),
                       curPiece.getShape());
        }
    }
}
```

drawSquare()

```
private void drawSquare(Graphics g, int x, int y, Tetrominoe shape) {
    Color colors[] = {
            new Color(0, 0, 0), new Color(204, 102, 102),
            new Color(102, 204, 102), new Color(102, 102, 204),
            new Color(204, 204, 102), new Color(204, 102, 204),
            new Color(102, 204, 204), new Color(218, 170, 0)
    };

    Color color = colors[shape.ordinal()];
    g.setColor(color);
    g.fillRect(x + 1, y + 1, squareWidth() - 2, squareHeight() - 2);

    g.setColor(color.brighter());
    g.drawLine(x, y + squareHeight() - 1, x, y);
    g.drawLine(x, y, x + squareWidth() - 1, y);

    g.setColor(color.darker());
    g.drawLine(x + 1, y + squareHeight() - 1, x + squareWidth() - 1, y + squareHeight() - 1);
    g.drawLine(x + squareWidth() - 1, y + squareHeight() - 1, x + squareWidth() - 1, y + 1);
}
```

tryMove()

```
private boolean tryMove(Shape newPiece, int newX, int newY) {

    for (int i = 0; i < 4; ++i) {
        int x = newX + newPiece.x(i);
        int y = newY - newPiece.y(i);

        if (x < 0 || x >= BOARD_WIDTH || y < 0 || y >= BOARD_HEIGHT) {
            return false;
        }
        if (shapeAt(x, y) != Tetrominoe.NoShape) {
            return false;
        }
    }

    curPiece = newPiece;
    curX = newX;
    curY = newY;

    repaint();
    return true;
}
```

```
private class TAdapter extends KeyAdapter {
    @Override
    public void keyPressed(KeyEvent e) {
        System.out.println("key pressed");
        if (!isStarted || curPiece.getShape() == Tetrominoe.NoShape) {
            return;
        }
        int keycode = e.getKeyCode();
        if (keycode == KeyEvent.VK_P) {
            pause();
            return;
        }
        if (isPaused) {
            return;
        }
        switch (keycode) {
            case KeyEvent.VK_LEFT: tryMove(curPiece, curX - 1, curY); break;
            case KeyEvent.VK_RIGHT: tryMove(curPiece, curX + 1, curY); break;
            case KeyEvent.VK_DOWN: tryMove(curPiece.rotateRight(), curX, curY); break;
            case KeyEvent.VK_UP: tryMove(curPiece.rotateLeft(), curX, curY); break;
            case KeyEvent.VK_SPACE: dropDown(); break;
            case KeyEvent.VK_D: oneLineDown(); break;
        }
    }
}
```

Dropping Tetrominoe

```
private void dropDown() {
    int newY = curY;
    while (newY > 0) {
        if (!tryMove(curPiece, curX, newY - 1)) {
            break;
        }
        --newY;
    }
    pieceDropped();
}

private void oneLineDown() {
    if (!tryMove(curPiece, curX, curY - 1)) {
        pieceDropped();
    }
}
```

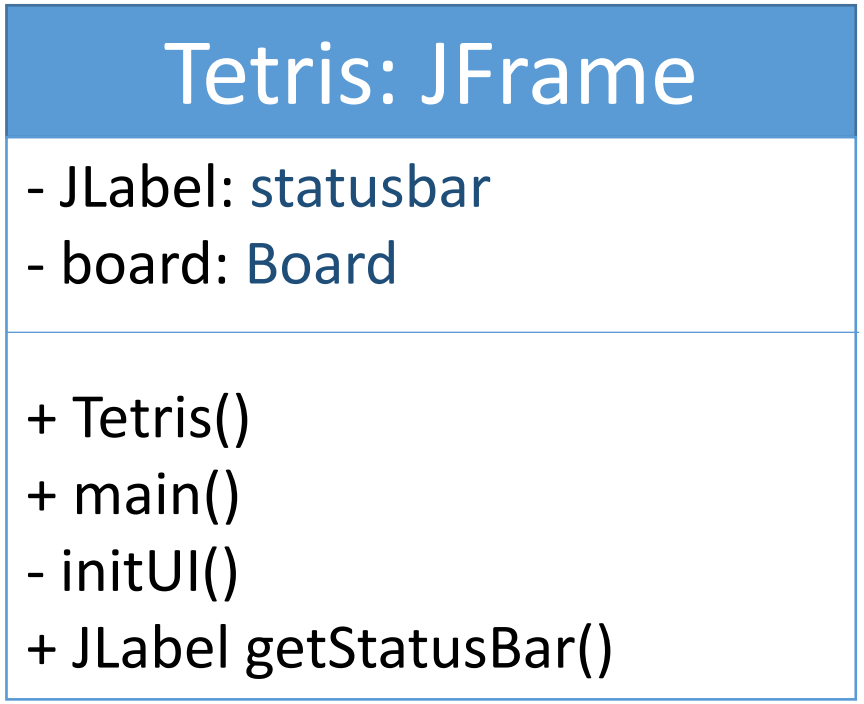
pieceDropped()

```
private void pieceDropped() {

    for (int i = 0; i < 4; ++i) {

        int x = curX + curPiece.x(i);
        int y = curY - curPiece.y(i);
        board[(y * BOARD_WIDTH) + x] = curPiece.getShape();
    }

    removeFullLines();

    if (!isFallingFinished) {
        newPiece();
    }
}
```

newPiece()

```
private void newPiece() {

    curPiece.setRandomShape();
    curX = BOARD_WIDTH / 2 + 1;
    curY = BOARD_HEIGHT - 1 + curPiece.minY();

    if (!tryMove(curPiece, curX, curY)) {

        curPiece.setShape(Tetrominoe.NoShape);
        timer.cancel();
        isStarted = false;
        statusbar.setText("Game over");
    }
}
```

Tetris.java

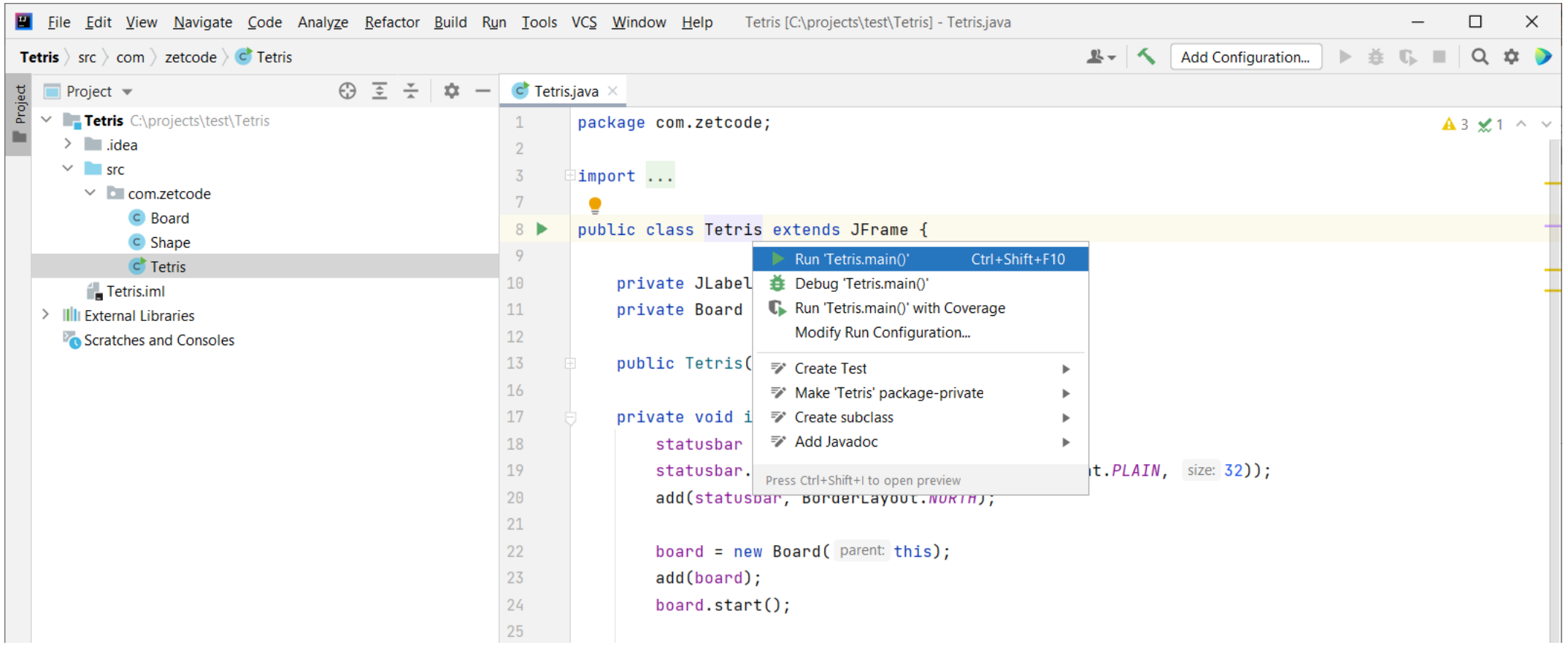

Tetris: JFrame
- JLabel: statusbar
- board: Board
+ Tetris()
+ main()
- initUI()
+ JLabel getStatusBar()

Tetris.java

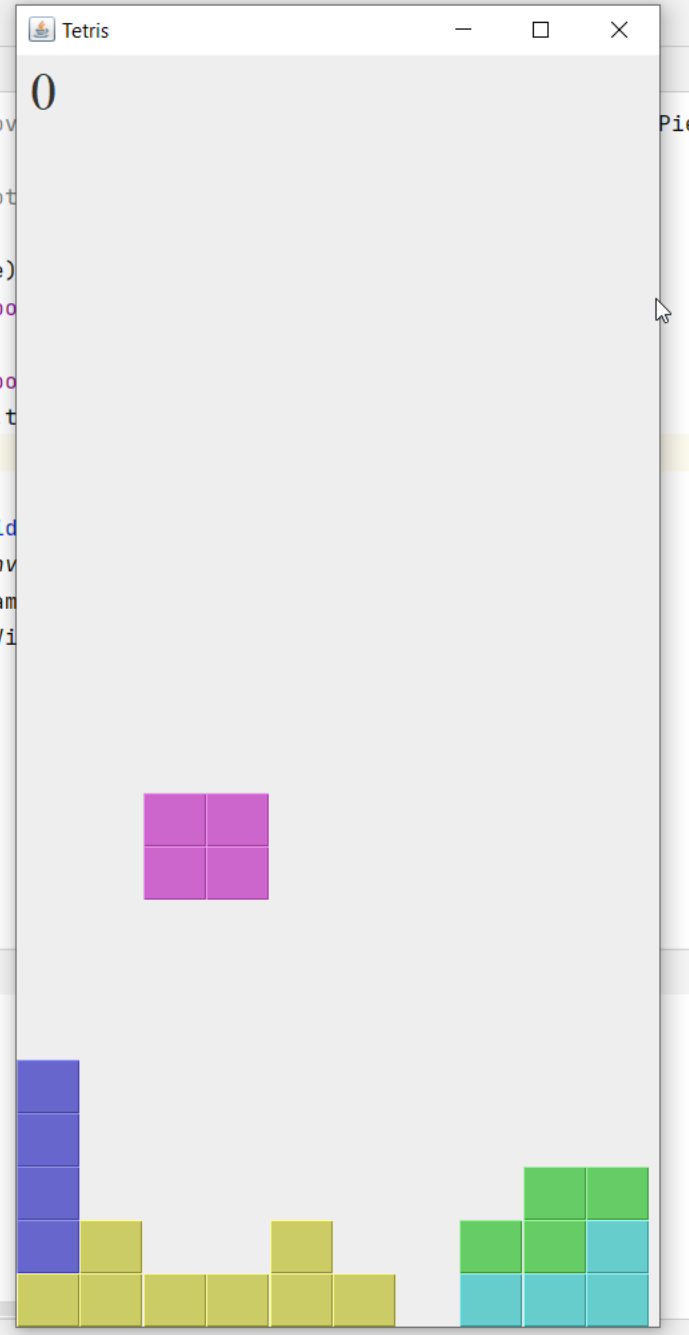
```
public class Tetris extends JFrame {
    private JLabel statusbar;
    private Board board;
    public Tetris() { initUI(); }
    private void initUI() {
        statusbar = new JLabel(" 0");
        statusbar.setFont(new Font("Serif", Font.PLAIN, 32));
        add(statusbar, BorderLayout.NORTH);

        board = new Board(this);
        add(board);
        board.start();

        setTitle("Tetris");
        setSize(400, 800);
        setDefaultCloseOperation(EXIT_ON_CLOSE);
        setLocationRelativeTo(null);
    }
    public JLabel getStatusBar() { return statusbar; }
    public static void main(String[] args) {
        EventQueue.invokeLater(() -> {
            Tetris game = new Tetris();
            game.setVisible(true);
        });
    }
}
```

Run Tetris (ALT + enter)

- ALT + enter -> Run Tetris.main()



Running the Code



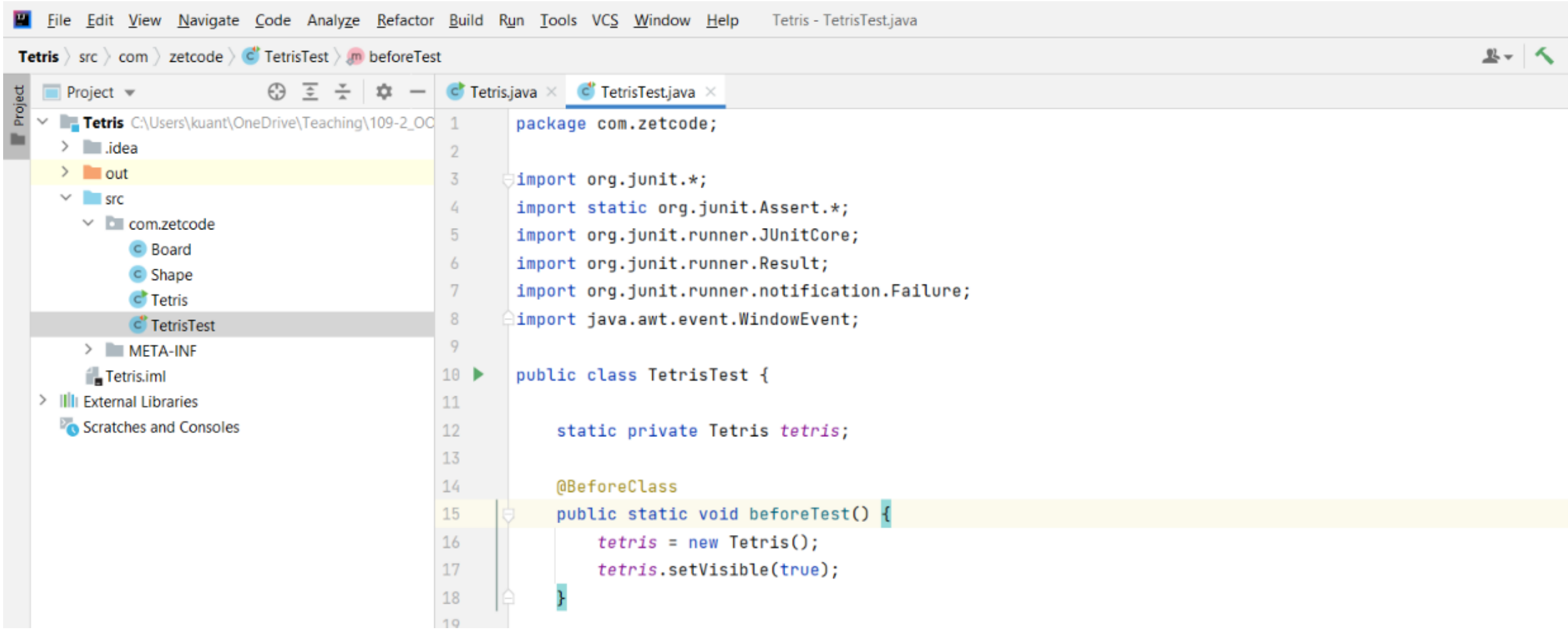

```
key pressed
key pressed
key pressed
key pressed
key pressed
key pressed
key pressed
```

Adding Test APIs

Add Test APIs in Tetris.java

```
public class Tetris extends JFrame {
    private JLabel statusbar;
    private Board board;
    public Tetris() { initUI(); }
    private void initUI() {…}
    public JLabel getStatusBar() {  return statusbar; }
    public void dropDown() { board.dropDown(); }
    public boolean isGameOver() { return (statusbar.getText() == "Game over"); }
    public int getLinesRemoved() { return board.getLinesRemoved(); }
    public void restart() {
        board.start();
        statusbar.setText("");
    }
    public boolean move(int x_val) {
        return board.tryMove(board.getCurPiece(), board.curX  + x_val, board.curY);
    }
    public boolean rotate(boolean clockwise) {
        Shape piece;
        if (clockwise)
            piece = board.getCurPiece().rotateLeft();
        else
            piece = board.getCurPiece().rotateRight();
        return board.tryMove(piece, board.curX, board.curY);
    }
    public static void main(String[] args) {…}
}
```

Add class TetrisTest



Adding Test Cases

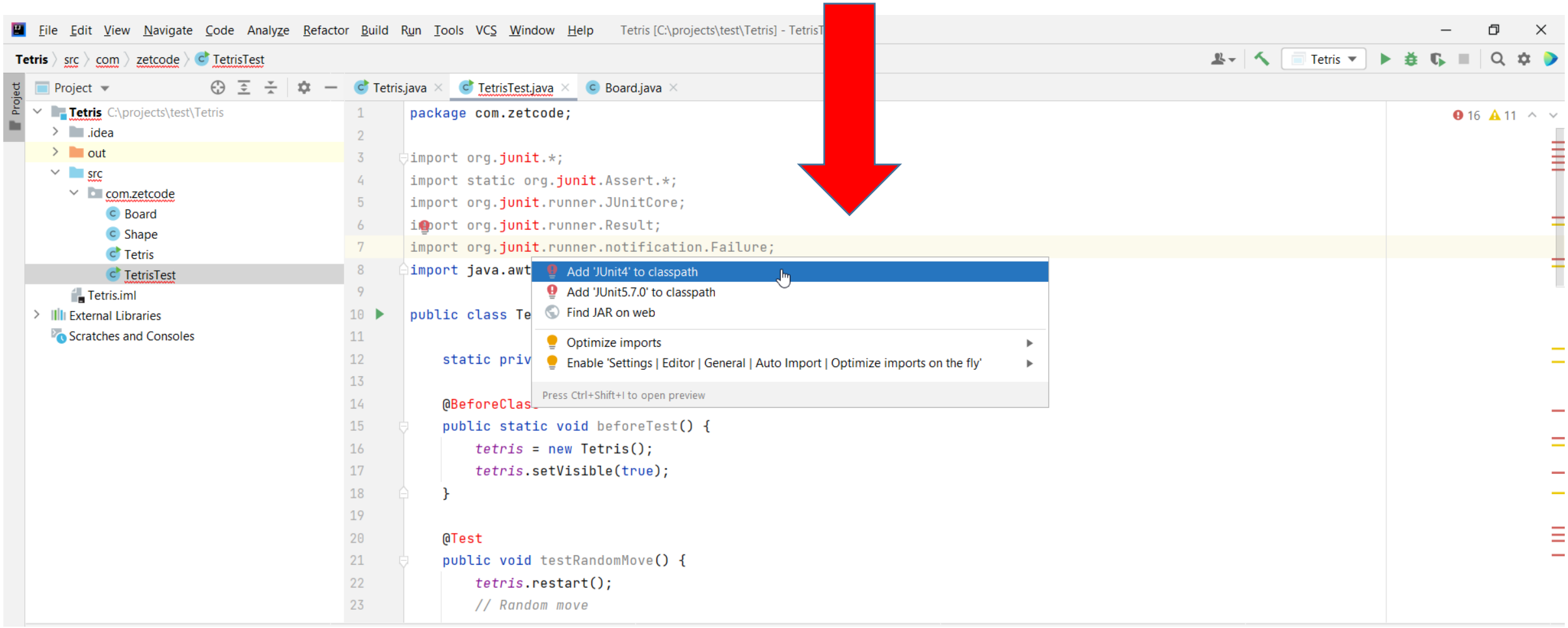
1. testGameOver()

2. testRandomMove()

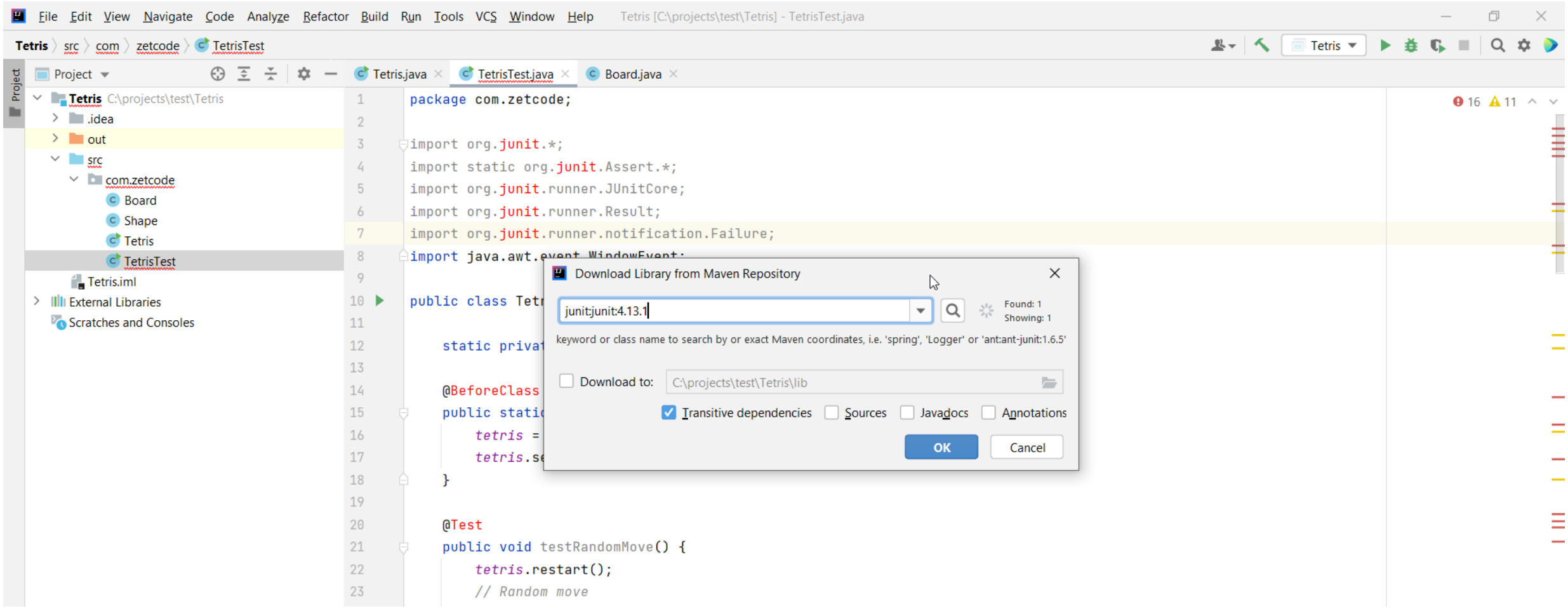
```java
package com.zetcode;
import org.junit.*;
import static org.junit.Assert.*;
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;
import java.awt.event.WindowEvent;

public class TetrisTest {
    static private Tetris tetris;

    @BeforeClass
    public static void beforeTest() {
        tetris = new Tetris();
        tetris.setVisible(true);
    }
    @Test
    public void testRandomMove() {…}
    @Test
    public void testGameOver() {…}

    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TetrisTest.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
        // Closing the window after the final result is printed
        tetris.dispatchEvent(new WindowEvent(tetris, WindowEvent.WINDOW_CLOSING));
    }
}
```

Add JUnit4 to classpath (ALT + enter)

- Press “ALT + enter”, select “Add JUnit4 to classpath “



Add default “junit:junit:4.13.1”



Testing Game-over

```
@Test
public void testGameOver() {
    for (int i=0; i<10; i++)
        tetris.dropDown();
    boolean ret = tetris.isGameOver();
    assertTrue(ret);
    try {
        Thread.sleep(1000);
    } catch (InterruptedException e) {
    }
}
```

Testing Random Move

```
public void testRandomMove() {
    tetris.restart();
    // Random move
    int t = 0;
    try {
        while (t < 100) {
            if (Math.random() > 0.5)
                tetris.move(1);
            else
                tetris.move(-1);
            try {
                Thread.sleep(100);
            } catch (InterruptedException e) {
            }
            if (Math.random() > 0.5)
                tetris.rotate(false);
            else
                tetris.rotate(true);
            t++;
        }
    } catch (Exception e) {
        fail();
    }
}
```

Adding API in Board.java

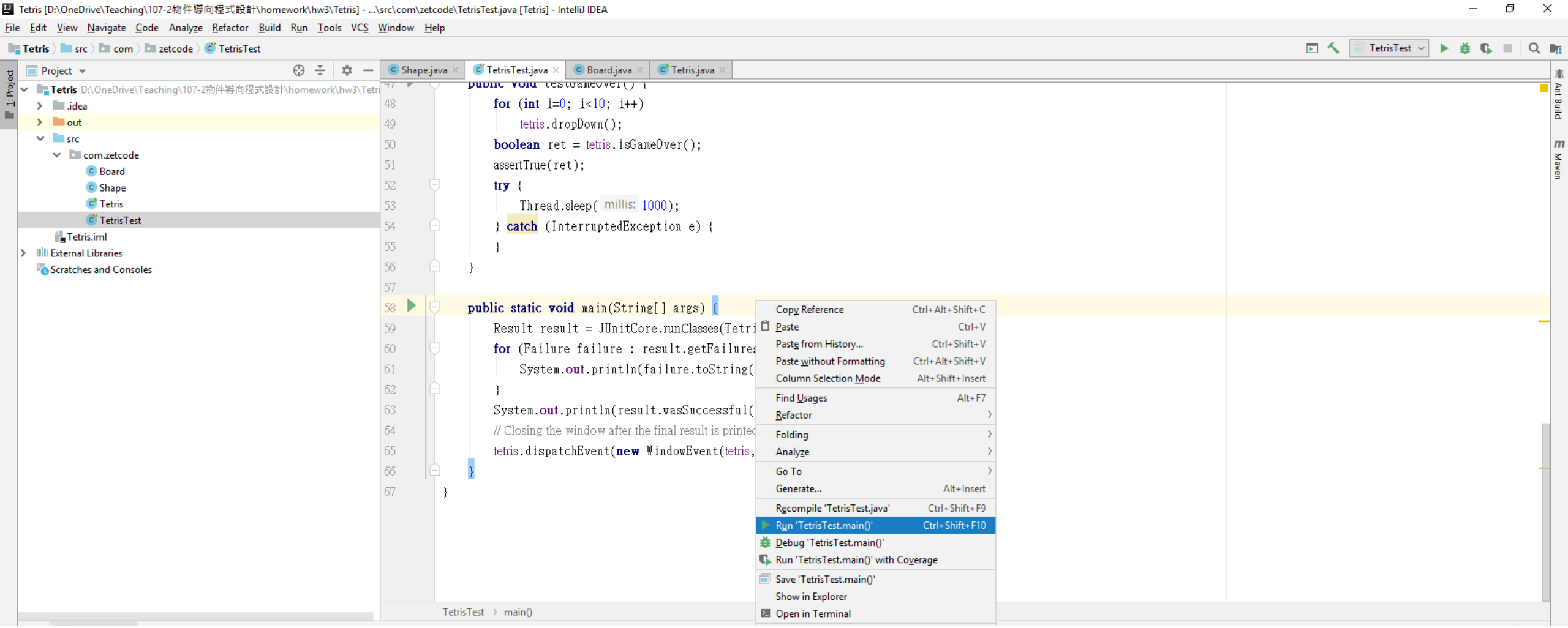
- Making the following variables and functions public
  - `public int curX = 0;`
  - `public int curY = 0;`
  - `public boolean tryMove(Shape newPiece, int newX, int newY) {…}`
  - `public Shape getCurPiece() { return curPiece;}`
  - `public void dropDown() {…}`

Initialing Timer in start()

```
public void start() {
    isStarted = true;
    clearBoard();
    newPiece();
    numLinesRemoved = 0;
    timer = new Timer();
    timer.scheduleAtFixedRate(
            new ScheduleTask(),
            INITIAL_DELAY, PERIOD_INTERVAL
    );
}
```

Running Test

- Right click on main() of TetrisTest.java



Test Result: Game over Test