KAUNO TECHNOLOGIJOS UNIVERSITETAS

INFORMATIKOS FAKULTETAS

Programavimo kalbų teorija (P175B124)

Antro laboratorinio darbo ataskaita

Atliko:

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Priėmė:

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TURINYS

1. Scala (L2)

1.1. Darbo užduotis

Aprašymas

Antroje užduotyje pradedame mokytis funkcinę/objektinę kalbą "Scala". http://www.scala-lang.org/
Jos kompiliatorių rasite virtualioje mašinoje.

Naudosime programavimo įrankį / žaidimo kūrimo imitatorių "Scalatron", parsisiųsti galite iš: http://scalatron.github.io
Užduotis: atsiųsti, įsidiegti ir naudojantis Scalatron API Scala kalba parašyti savo "bot'ą".

Scalatron`ą galima pasileisti su komanda:
java -server -jar Scalatron.jar -x 100 -y 100 -steps 1000 -maxfps 1000

Galima naudotis visa medžiaga ir pateikiamais kodo pavyzdžiais.
Žaidime pateikiamas "reference" (pavyzdinis/etaloninis) botas, nuo kurio galima pradėti programuoti.
Rekomenduojama pereiti visas naršyklėje pateikiamas Scalatron pamokas (tutorials).

Reikalavimai programai/botui

1. Panaudoti bent kelis master boto išleidžiamus botų padėjėjų tipus
(pvz.: minos, raketos į priešus, "kamikadzės", rinkikai, masalas ir pan.)
2. Panaudoti bet kurį vieną iš kelio radimo algoritmų (DFS, BFS, A*, Greedy, Dijkstra).

Geras įrankis kelio radimo testavimui.

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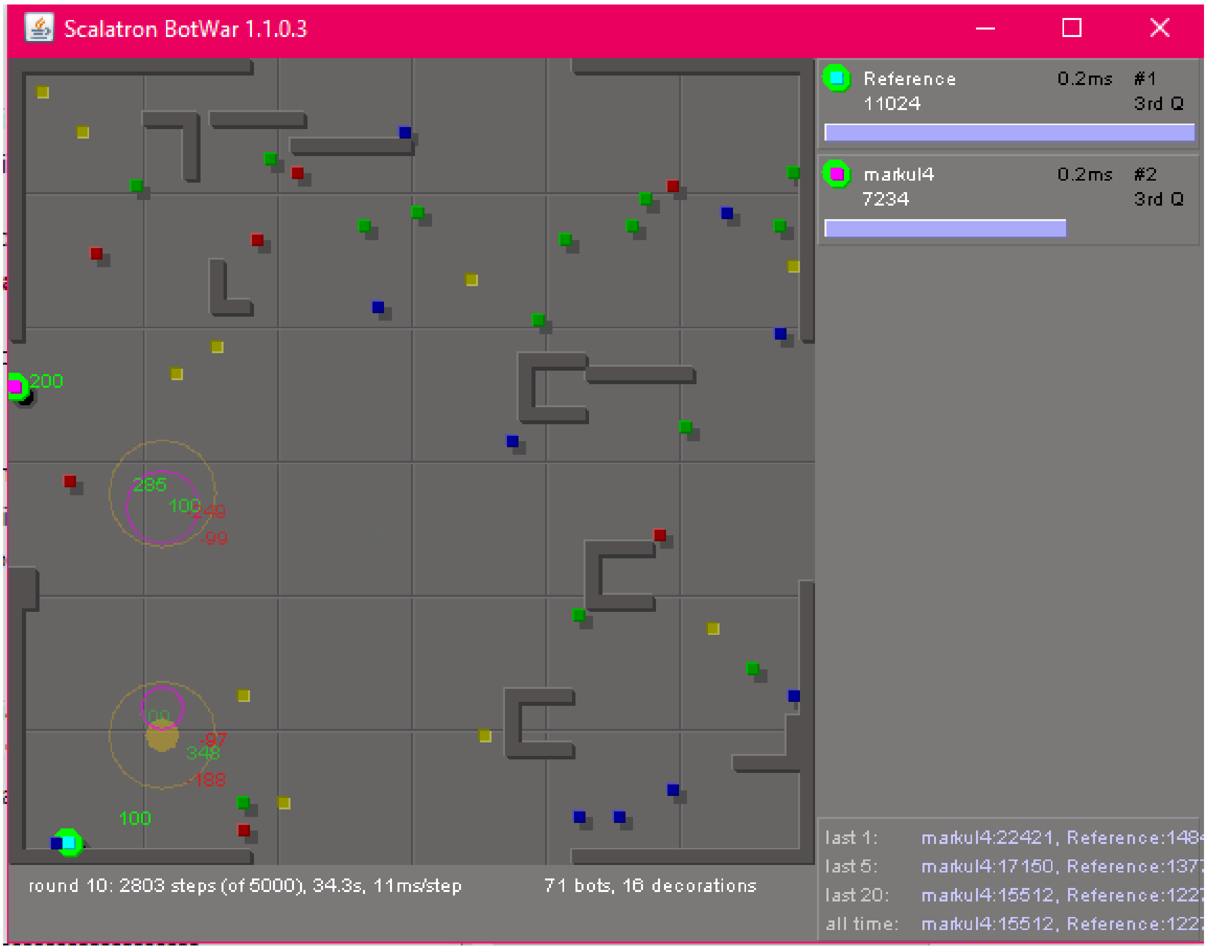
Pastaba: Scalatron geriausiai suderinamas su **Java 1.7** versija ir senesnėmis interneto naršyklėmis.
Esant problemoms pirmiausia įsitikinkite, jog leidžiate su teisinga Java.

Rezultatų pavyzdys



1.2. Programos tekstas

```
// Martynas Kuliešius IFF-1/9

object ControlFunction
{
    def forMaster(bot: Bot) {
        val (directionValue, nearestEnemyMaster, nearestEnemySlave) =
analyzeViewAsMaster(bot.view)
        val dontFireAggressiveMissileUntil =
bot.inputAsIntOrElse("dontFireAggressiveMissileUntil", -1)
        val dontFireDefensiveMissileUntil =
bot.inputAsIntOrElse("dontFireDefensiveMissileUntil", -1)
        val lastDirection = bot.inputAsIntOrElse("lastDirection", 0)
        // determine movement direction
        directionValue(lastDirection) += 10 // try to break ties by favoring the
last direction
        val bestDirection45 = directionValue.zipWithIndex.maxBy(_._1)._2
        val direction = XY.fromDirection45(bestDirection45)
        val nextDirection = PathForMaster(bot.view, direction)
        bot.move(nextDirection)
        bot.set("lastDirection" -> bestDirection45)


        val int = bot.view.offsetToNearest('m').getOrElse(XY(1000,1000))
        val bint = bot.view.offsetToNearest('s').getOrElse(XY(1000,1000))




        if( bot.energy > 0 && (bot.time % 30) == 0)
        {

            nearestEnemyMaster match {
                case None =>
                case Some(relPos) =>
                    val unitDelta = relPos.signum
                    val remainder = relPos - unitDelta
                    bot.spawn(unitDelta, "mood" -> "SnorgTempter", "target" ->
remainder)
                    bot.say("I did it :D")
            }
        }

        if ((closestEmaster.stepCount < 4 || closestEnemy.stepCount < 1) &&
bot.energy > 100 )
        {
            bot.spawn(XY(1,1), "mood" -> "Mine")
            bot.say("Bomb!")
        }

            if (closestEnemy.stepCount < 6 && bot.energy > 75 )
        {
            bot.spawn(XY(1,1), "mood" -> "Bomb")
                  bot.say("Mine!")
        }


        if(dontFireAggressiveMissileUntil < bot.time && bot.energy > 100) { //
fire attack missile?
            nearestEnemyMaster match {
                case None =>            // no-on nearby
                case Some(relPos) =>    // a master is nearby
                    val unitDelta = relPos.signum
                    val remainder = relPos - unitDelta // we place slave nearer
target, so subtract that from overall delta
```

```
                    bot.spawn(unitDelta, "mood" -> "Aggressive", "target" ->
remainder)
                    bot.set("dontFireAggressiveMissileUntil" -> (bot.time +
relPos.stepCount + 1))
            }
        }
        else
        if(dontFireDefensiveMissileUntil < bot.time && bot.energy > 100) { // fire
defensive missile?
            nearestEnemySlave match {
                case None =>            // no-on nearby
                case Some(relPos) =>    // an enemy slave is nearby
                    if(relPos.stepCount < 8) {
                        // this one's getting too close!
                        val unitDelta = relPos.signum
                        val remainder = relPos - unitDelta // we place slave
nearer target, so subtract that from overall delta
                        bot.spawn(unitDelta, "mood" -> "Defensive", "target" ->
remainder)
                        bot.set("dontFireDefensiveMissileUntil" -> (bot.time +
relPos.stepCount + 1))
                    }
            }
        }
    }

    def forSlave(bot: MiniBot) {
        bot.inputOrElse("mood", "Lurking") match {
            case "Aggressive" => reactAsAggressiveMissile(bot)
            case "Defensive" => reactAsDefensiveMissile(bot)
            case "Mine" => reactAsMine (bot)
            case "SnorgTempter" => reactAsSnorgTempter (bot)
            case s: String => bot.log("unknown mood: " + s)
        }
    }
    def reactAsMine (bot: MiniBot){
        bot.view.offsetToNearest('m') match{
            case Some(delta: XY) => if(delta.length <= 4){
            bot.explode(6)   }

            case None =>
            bot.set("mood" -> "Lurking", "target" -> "")
            bot.say("Landmine")
        }

    }
    def reactAsBomb(bot: MiniBot){
        bot.explode(4)
    }

    def reactAsSnorgTempter(bot: MiniBot) {
    bot.view.offsetToNearest('m') match {
        case Some(delta: XY) =>
           // another master is visible at the given relative position (i.e.
position delta)
                // if not too close, move closer
            if(delta.length > 2) {
                bot.move(delta.signum)
                bot.set("rx" -> delta.x, "ry" -> delta.y)
            }
        case None =>
                // no target visible -- follow our targeting strategy
            val target = bot.inputAsXYOrElse("target", XY.Zero)
                // did we arrive at the target?
            if(target.isNonZero) {
                    // no -- keep going
```

```
                val unitDelta = target.signum // e.g. CellPos(-8,6) => CellPos(-
1,1)
                bot.move(unitDelta)
                    // compute the remaining delta and encode it into a new
'target' property
                val remainder = target - unitDelta // e.g. = CellPos(-7,5)
                bot.set("target" -> remainder)
            }
                // else tempter is idle
        }
    }

    def reactAsAggressiveMissile(bot: MiniBot) {
        bot.view.offsetToNearest('m') match {
            case Some(delta: XY) =>
                // another master is visible at the given relative position (i.e.
position delta)
                // close enough to blow it up?
                if(delta.length <= 2) {
                    // yes -- blow it up!
                    bot.explode(4)
                } else {
                    // no -- move closer!
                    bot.move(delta.signum)
                    bot.set("rx" -> delta.x, "ry" -> delta.y)
                }
            case None =>
                // no target visible -- follow our targeting strategy
                val target = bot.inputAsXYOrElse("target", XY.Zero)
                // did we arrive at the target?
                if(target.isNonZero) {
                    // no -- keep going
                    val unitDelta = target.signum // e.g. CellPos(-8,6) =>
CellPos(-1,1)
                    bot.move(unitDelta)
                    // compute the remaining delta and encode it into a new
'target' property
                    val remainder = target - unitDelta // e.g. = CellPos(-7,5)
                    bot.set("target" -> remainder)
                } else {
                    // yes -- but we did not detonate yet, and are not pursuing
anything?!? => switch purpose
                    bot.set("mood" -> "Lurking", "target" -> "")
                    bot.say("Lurking")
                }
        }
    }
    def reactAsDefensiveMissile(bot: MiniBot) {
        bot.view.offsetToNearest('s') match {
            case Some(delta: XY) =>
                // another slave is visible at the given relative position (i.e.
position delta)
                // move closer!
                bot.move(delta.signum)
                bot.set("rx" -> delta.x, "ry" -> delta.y)
            case None =>
                // no target visible -- follow our targeting strategy
                val target = bot.inputAsXYOrElse("target", XY.Zero)
                // did we arrive at the target?
                if(target.isNonZero) {
                    // no -- keep going
                    val unitDelta = target.signum // e.g. CellPos(-8,6) =>
CellPos(-1,1)
                    bot.move(unitDelta)
                    // compute the remaining delta and encode it into a new
'target' property
```

```
                    val remainder = target - unitDelta // e.g. = CellPos(-7,5)
                    bot.set("target" -> remainder)
                } else {
                    // yes -- but we did not annihilate yet, and are not pursuing
anything?!? => switch purpose
                    bot.set("mood" -> "Lurking", "target" -> "")
                    bot.say("Lurking")
                }
        }
    }
    /** Analyze the view, building a map of attractiveness for the 45-degree
directions and
      * recording other relevant data, such as the nearest elements of various
kinds.
      */
    def analyzeViewAsMaster(view: View) = {
        val directionValue = Array.ofDim[Double](8)
        var nearestEnemyMaster: Option[XY] = None
        var nearestEnemySlave: Option[XY] = None

        val cells = view.cells
        val cellCount = cells.length
        for(i <- 0 until cellCount) {
            val cellRelPos = view.relPosFromIndex(i)
            if(cellRelPos.isNonZero) {
                val stepDistance = cellRelPos.stepCount
                val value: Double = cells(i) match {
                    case 'm' => // another master: not dangerous, but an obstacle
                        nearestEnemyMaster = Some(cellRelPos)
                        if(stepDistance < 2) -1000 else 0
                    case 's' => // another slave: potentially dangerous?
                        nearestEnemySlave = Some(cellRelPos)
                        -100 / stepDistance
                    case 'S' => // out own slave
                        0.0
                    case 'B' => // good beast: valuable, but runs away
                        if(stepDistance == 1) 600
                        else if(stepDistance == 2) 300
                        else (150 - stepDistance * 15).max(10)
                    case 'P' => // good plant: less valuable, but does not run
                        if(stepDistance == 1) 500
                        else if(stepDistance == 2) 300
                        else (150 - stepDistance * 10).max(10)
                    case 'b' => // bad beast: dangerous, but only if very close
                        if(stepDistance < 4) -400 / stepDistance else -50 /
stepDistance
                    case 'p' => // bad plant: bad, but only if I step on it
                        if(stepDistance < 2) -1000 else 0
                    case 'W' => // wall: harmless, just don't walk into it
                        if(stepDistance < 2) -1000 else 0
                    case _ => 0.0
                }
                val direction45 = cellRelPos.toDirection45
                directionValue(direction45) += value
            }
        }
        (directionValue, nearestEnemyMaster, nearestEnemySlave)

    }
    def Obsticless(where: XY, view:View) = {
        view.cellAtRelPos(where) match{
            case 'M' => true
            case 'm' => false
            case 's'  => false
            case 'S'  => false
            case 'B'  => true
```

```
            case 'P'  => true
            case 'b'  => false
            case 'p'  => false
            case 'W'  => false
            case '_'  => true
            case '?'  => true
            case _  => false
        }
    }

    def PathForMaster(view: View, random: XY) =
    {
        val blue = GetPath(view, 'B', 125)
        if (blue == XY(0,0))
        {
            val plant = GetPath(view, 'P', 125)
            if (plant == XY(0,0))
            {
                if (plant == XY(0,0))
                {
                    random
                }
                else
                {
                    plant
                }
            }
            else
            {
                plant
            }
        }
        else
        {
            blue
        }
    }

    case class Location(xy: XY, distance:Int, direction:Int){
    }

    def GetPath(view: View, find: Char, maxSearch: Int): XY = {
        var counter = 0;
        var locationQueue = new scala.collection.mutable.Queue[Location]()
        val size = view.cells.size;
        val length = view.cells.length;
        def visited = new Array[Boolean](length)
        def starting = XY(0,0)
        var bestFind = new Location(new XY(0,0), 999, -1)
        locationQueue.enqueue(new Location(starting, 0, -1))

        while(!locationQueue.isEmpty && counter < maxSearch)
        {
            counter = counter + 1;
            var current = locationQueue.dequeue()
            visited(view.indexFromRelPos(current.xy)) = true

            for (direction <- Seq(1,3,5,7,0,2,4,6))
            {
                val goingTo = current.xy + XY.fromDirection45(direction);
                if(Obsticless(goingTo, view))
                {
                    val newLocationDirection = if(current.direction != -1)
current.direction else direction
                    val newLocation = new Location(goingTo, current.distance + 1,
newLocationDirection)
```

```
                    if(newLocation.distance < bestFind.distance &&
view.cellAtRelPos(goingTo) == find)
                    {
                        bestFind = newLocation
                    }
                    locationQueue.enqueue(new Location(goingTo, current.distance +
1, newLocationDirection))
                }
            }
        }

        if (bestFind.direction != -1) XY.fromDirection45(bestFind.direction) else
new XY(0,0)
    }
}
// ---------------------------------------------------------------------------------
------------------
// Framework
// ---------------------------------------------------------------------------------
------------------
class ControlFunctionFactory {
    def create = (input: String) => {
        val (opcode, params) = CommandParser(input)
        opcode match {
            case "React" =>
                val bot = new BotImpl(params)
                if( bot.generation == 0 ) {
                    ControlFunction.forMaster(bot)
                } else {
                    ControlFunction.forSlave(bot)
                }
                bot.toString
            case _ => "" // OK
        }
    }
}
// ---------------------------------------------------------------------------------
------------------
trait Bot {
    // inputs
    def inputOrElse(key: String, fallback: String): String
    def inputAsIntOrElse(key: String, fallback: Int): Int
    def inputAsXYOrElse(keyPrefix: String, fallback: XY): XY
    def view: View
    def energy: Int
    def time: Int
    def generation: Int
    // outputs
    def move(delta: XY) : Bot
    def say(text: String) : Bot
    def status(text: String) : Bot
    def spawn(offset: XY, params: (String,Any)*) : Bot
    def set(params: (String,Any)*) : Bot
    def log(text: String) : Bot
}
trait MiniBot extends Bot {
    // inputs
    def offsetToMaster: XY
    // outputs
    def explode(blastRadius: Int) : Bot
}
case class BotImpl(inputParams: Map[String, String]) extends MiniBot {
    // input
    def inputOrElse(key: String, fallback: String) = inputParams.getOrElse(key,
fallback)
```

```
    def inputAsIntOrElse(key: String, fallback: Int) =
inputParams.get(key).map(_.toInt).getOrElse(fallback)
    def inputAsXYOrElse(key: String, fallback: XY) = inputParams.get(key).map(s =>
XY(s)).getOrElse(fallback)
    val view = View(inputParams("view"))
    val energy = inputParams("energy").toInt
    val time = inputParams("time").toInt
    val generation = inputParams("generation").toInt
    def offsetToMaster = inputAsXYOrElse("master", XY.Zero)
    // output
    private var stateParams = Map.empty[String,Any]     // holds "Set()" commands
    private var commands = ""                           // holds all other
commands
    private var debugOutput = ""                        // holds all "Log()"
output
    /** Appends a new command to the command string; returns 'this' for fluent
API. */
    private def append(s: String) : Bot = { commands += (if(commands.isEmpty) s
else "|" + s); this }
    /** Renders commands and stateParams into a control function return string. */
    override def toString = {
        var result = commands
        if(!stateParams.isEmpty) {
            if(!result.isEmpty) result += "|"
            result += stateParams.map(e => e._1 + "=" +
e._2).mkString("Set(",",",")")
        }
        if(!debugOutput.isEmpty) {
            if(!result.isEmpty) result += "|"
            result += "Log(text=" + debugOutput + ")"
        }
        result
    }
    def log(text: String) = { debugOutput += text + "\n"; this }
    def move(direction: XY) = append("Move(direction=" + direction + ")")
    def say(text: String) = append("Say(text=" + text + ")")
    def status(text: String) = append("Status(text=" + text + ")")
    def explode(blastRadius: Int) = append("Explode(size=" + blastRadius + ")")
    def spawn(offset: XY, params: (String,Any)*) =
        append("Spawn(direction=" + offset +
            (if(params.isEmpty) "" else "," + params.map(e => e._1 + "=" +
e._2).mkString(",")) +
            ")")
    def set(params: (String,Any)*) = { stateParams ++= params; this }
    def set(keyPrefix: String, xy: XY) = { stateParams ++= List(keyPrefix+"x" ->
xy.x, keyPrefix+"y" -> xy.y); this }
}
// -------------------------------------------------------------------------------
------------------
/** Utility methods for parsing strings containing a single command of the format
  * "Command(key=value,key=value,...)"
  */
object CommandParser {
    /** "Command(..)" => ("Command", Map( ("key" -> "value"), ("key" -> "value"),
..}) */
    def apply(command: String): (String, Map[String, String]) = {
        /** "key=value" => ("key","value") */
        def splitParameterIntoKeyValue(param: String): (String, String) = {
            val segments = param.split('=')
            (segments(0), if(segments.length>=2) segments(1) else "")
        }
        val segments = command.split('(')
        if( segments.length != 2 )
            throw new IllegalStateException("invalid command: " + command)
        val opcode = segments(0)
        val params = segments(1).dropRight(1).split(',')
```

```
        val keyValuePairs = params.map(splitParameterIntoKeyValue).toMap
        (opcode, keyValuePairs)
    }
}
// -----------------------------------------------------------------------------------
------------------
/** Utility class for managing 2D cell coordinates.
  * The coordinate (0,0) corresponds to the top-left corner of the arena on
screen.
  * The direction (1,-1) points right and up.
  */
case class XY(x: Int, y: Int) {
    override def toString = x + ":" + y
    def isNonZero = x != 0 || y != 0
    def isZero = x == 0 && y == 0
    def isNonNegative = x >= 0 && y >= 0
    def updateX(newX: Int) = XY(newX, y)
    def updateY(newY: Int) = XY(x, newY)
    def addToX(dx: Int) = XY(x + dx, y)
    def addToY(dy: Int) = XY(x, y + dy)
    def +(pos: XY) = XY(x + pos.x, y + pos.y)
    def -(pos: XY) = XY(x - pos.x, y - pos.y)
    def *(factor: Double) = XY((x * factor).intValue, (y * factor).intValue)
    def distanceTo(pos: XY): Double = (this - pos).length // Phythagorean
    def length: Double = math.sqrt(x * x + y * y) // Phythagorean
    def stepsTo(pos: XY): Int = (this - pos).stepCount // steps to reach pos: max
delta X or Y
    def stepCount: Int = x.abs.max(y.abs) // steps from (0,0) to get here: max X
or Y
    def signum = XY(x.signum, y.signum)
    def negate = XY(-x, -y)
    def negateX = XY(-x, y)
    def negateY = XY(x, -y)
    /** Returns the direction index with 'Right' being index 0, then clockwise in
45 degree steps. */
    def toDirection45: Int = {
        val unit = signum
        unit.x match {
            case -1 =>
                unit.y match {
                    case -1 =>
                        if(x < y * 3) Direction45.Left
                        else if(y < x * 3) Direction45.Up
                        else Direction45.UpLeft
                    case 0 =>
                        Direction45.Left
                    case 1 =>
                        if(-x > y * 3) Direction45.Left
                        else if(y > -x * 3) Direction45.Down
                        else Direction45.LeftDown
                }
            case 0 =>
                unit.y match {
                    case 1 => Direction45.Down
                    case 0 => throw new IllegalArgumentException("cannot compute
direction index for (0,0)")
                    case -1 => Direction45.Up
                }
            case 1 =>
                unit.y match {
                    case -1 =>
                        if(x > -y * 3) Direction45.Right
                        else if(-y > x * 3) Direction45.Up
                        else Direction45.RightUp
                    case 0 =>
                        Direction45.Right
```

```
                    case 1 =>
                        if(x > y * 3) Direction45.Right
                        else if(y > x * 3) Direction45.Down
                        else Direction45.DownRight
                }
            }
        }
    def rotateCounterClockwise45 = XY.fromDirection45((signum.toDirection45 + 1) %
8)
    def rotateCounterClockwise90 = XY.fromDirection45((signum.toDirection45 + 2) %
8)
    def rotateClockwise45 = XY.fromDirection45((signum.toDirection45 + 7) % 8)
    def rotateClockwise90 = XY.fromDirection45((signum.toDirection45 + 6) % 8)
    def wrap(boardSize: XY) = {
        val fixedX = if(x < 0) boardSize.x + x else if(x >= boardSize.x) x -
boardSize.x else x
        val fixedY = if(y < 0) boardSize.y + y else if(y >= boardSize.y) y -
boardSize.y else y
        if(fixedX != x || fixedY != y) XY(fixedX, fixedY) else this
    }
}
object XY {
    /** Parse an XY value from XY.toString format, e.g. "2:3". */
    def apply(s: String) : XY = { val a = s.split(':'); XY(a(0).toInt,a(1).toInt)
}
    val Zero = XY(0, 0)
    val One = XY(1, 1)
    val Right     = XY( 1,  0)
    val RightUp   = XY( 1, -1)
    val Up        = XY( 0, -1)
    val UpLeft    = XY(-1, -1)
    val Left      = XY(-1,  0)
    val LeftDown  = XY(-1,  1)
    val Down      = XY( 0,  1)
    val DownRight = XY( 1,  1)
    def fromDirection45(index: Int): XY = index match {
        case Direction45.Right => Right
        case Direction45.RightUp => RightUp
        case Direction45.Up => Up
        case Direction45.UpLeft => UpLeft
        case Direction45.Left => Left
        case Direction45.LeftDown => LeftDown
        case Direction45.Down => Down
        case Direction45.DownRight => DownRight
    }
    def fromDirection90(index: Int): XY = index match {
        case Direction90.Right => Right
        case Direction90.Up => Up
        case Direction90.Left => Left
        case Direction90.Down => Down
    }
    def apply(array: Array[Int]): XY = XY(array(0), array(1))
}
object Direction45 {
    val Right = 0
    val RightUp = 1
    val Up = 2
    val UpLeft = 3
    val Left = 4
    val LeftDown = 5
    val Down = 6
    val DownRight = 7
}
object Direction90 {
    val Right = 0
    val Up = 1
```

```
    val Left = 2
    val Down = 3
}
// -------------------------------------------------------------------------------
------------------
case class View(cells: String) {
    val size = math.sqrt(cells.length).toInt
    val center = XY(size / 2, size / 2)
    def apply(relPos: XY) = cellAtRelPos(relPos)
    def indexFromAbsPos(absPos: XY) = absPos.x + absPos.y * size
    def absPosFromIndex(index: Int) = XY(index % size, index / size)
    def absPosFromRelPos(relPos: XY) = relPos + center
    def cellAtAbsPos(absPos: XY) = cells.charAt(indexFromAbsPos(absPos))
    def indexFromRelPos(relPos: XY) = indexFromAbsPos(absPosFromRelPos(relPos))
    def relPosFromAbsPos(absPos: XY) = absPos - center
    def relPosFromIndex(index: Int) = relPosFromAbsPos(absPosFromIndex(index))
    def cellAtRelPos(relPos: XY) = cells.charAt(indexFromRelPos(relPos))
    def offsetToNearest(c: Char) = {
        val matchingXY = cells.view.zipWithIndex.filter(_._1 == c)
        if( matchingXY.isEmpty )
            None
        else {
            val nearest = matchingXY.map(p =>
relPosFromIndex(p._2)).minBy(_.length)
            Some(nearest)
        }
    }
}
```