**KAUNO TECHNOLOGIJOS UNIVERSITETAS**
**INFORMATIKOS FAKULTETAS**

# Programavimo kalbų teorija (P175B124)

***Laboratorinių darbų ataskaita***

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# TURINYS

# 1. C++(L1)

## 1.1. Darbo užduotis

p575

When a number is expressed in decimal, the $k$-th digit represents a multiple of $10^k$. (Digits are numbered from right to left, where the least significant digit is number 0.) For example,

$$81307_{10} = 8 \times 10^4 + 1 \times 10^3 + 3 \times 10^2 + 0 \times 10^1 + 7 \times 100 = 80000 + 1000 + 300 + 0 + 7 = 81307.$$

When a number is expressed in binary, the $k$-th digit represents a multiple of $2^k$. For example,

$$10011_2 = 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 16 + 0 + 0 + 2 + 1 = 19.$$

In **skew binary**, the $k$-th digit represents a multiple of $2^{k+1} - 1$. The only possible digits are 0 and 1, except that the least-significant nonzero digit can be a 2. For example,

$$10120_{skew} = 1 \times (2^5 - 1) + 0 \times (2^4 - 1) + 1 \times (2^3 - 1) + 2 \times (2^2 - 1) + 0 \times (2^1 - 1) = 31 + 0 + 7 + 6 + 0 = 44.$$

The first 10 numbers in skew binary are 0, 1, 2, 10, 11, 12, 20, 100, 101, and 102. (Skew binary is useful in some applications because it is possible to add 1 with at most one carry. However, this has nothing to do with the current problem.)

### Input

The input file contains one or more lines, each of which contains an integer $n$. If $n = 0$ it signals the end of the input, and otherwise $n$ is a nonnegative integer in skew binary.

### Output

For each number, output the decimal equivalent. The decimal value of $n$ will be at most $2^{31} - 1 = 2147483647$.

### Sample Input

```
10120
200000000000000000000000000000
10
1000000000000000000000000000000
11
100
11111000001110000101101102000
0
```

### Sample Output

```
44
2147483646
3
2147483647
4
7
1041110737
```

### 1.2. Programos tekstas

```
#include <iostream>
#include <fstream>
#include <string>
#include <cmath>
#include <chrono>
using namespace std;
using namespace std::chrono;

/// <summary>
/// Skew binary to decimal number class
/// </summary>
struct SkewBinaryToDecimal
{
    string line; //binary number

    /// <summary>
    /// Converting from skew binary to decimal number
    /// </summary>
    /// <param name="line"> Skew binary number </param>
    /// <param name="n"> Amount of numbers </param>
    /// <returns> Converted decimal number </returns>
    int to_decimal(string line, int& n)
    {
        int res = 0;
        for (int j = 0; j < n; j++)
        {
            int l = line.size();
            for (int i = 0; i < l; i++) {
                res += (((int)line[i] - 48) * (pow(2, l - i) - 1));
            }
            return res;
        }
    }
};

/// <summary>
/// Decimal to skew binary number class
/// </summary>
struct DecimalToSkewBinary {

    int decimal; //decimal number

    string decimalToSkewBinary(int number) {

        if (number == 0) {
            return "0";
        }
        string result = "";
        while (number > 0) {
            int remainder = number % 3;
            result = to_string(remainder) + result;
            number /= 3;
            if (remainder == 2 && number > 0) {
                number++;
            }
        }
        return result;
    }
};


/// <summary>
/// Printing converted numbers to file
/// </summary>
/// <param name="outputFile"> Output file </param>
/// <param name="line"> Binary numbers </param>
```

```
/// <param name="convertedNumber"> Decimal numbers </param>
/// <param name="append"></param>
void PrintResult1(string outputFile, string line,
    int convertedNumber, bool append)
{
    ofstream result;

    if (append)
        result.open(outputFile, ios_base::app);
    else
        result.open(outputFile);
    result << "Skew binary: " << line << "  " << "decimal: " << convertedNumber <<
endl;
    return;
}

/// <summary>
/// Reading data and performing all tasks
/// </summary>
/// <param name="inputFile"> Data file </param>
/// <param name="outputFile"> Result file </param>
void ReadAndPerformToDecimal(string inputFile, string outputFile)
{
    int n;// Amount of numbers
    SkewBinaryToDecimal toDecimal[20];

    ifstream data(inputFile);
    data >> n;
    for (int i = 0; i < n; i++)
    {
        string line;
        data.ignore();
        data >> toDecimal[i].line;
        line = toDecimal[i].line;

        int calculated = toDecimal->to_decimal(line, n);

        //string skew_Binary = toBinary->to_skew_binary(calculated, n)

        bool append = false;
        if (i > 0)
            append = true;
        PrintResult1(outputFile, line, calculated, append);
    }

    data.close();
    return;
}
// <summary>
/// Printing converted numbers to file
/// </summary>
/// <param name="outputFile"> Output file </param>
/// <param name="line"> Binary numbers </param>
/// <param name="convertedNumber"> Decimal numbers </param>
/// <param name="append"></param>
void PrintResult2(string outputFile, int line,
    string convertedNumber, bool append)
{
    ofstream result;

    if (append)
        result.open(outputFile, ios_base::app);
    else
        result.open(outputFile);
    result << "Decimal: " << line << "  " << "skew binary: " << convertedNumber <<
endl;
    return;
}

/// <summary>
```

```cpp
/// Reading data and performing all tasks
/// </summary>
/// <param name="inputFile"> Data file </param>
/// <param name="outputFile"> Result file </param>
void ReadAndPerformToBinary(string inputFile, string outputFile)
{
    int n;// Amount of numbers
    DecimalToSkewBinary toBinary[100];

    ifstream data(inputFile);
    data >> n;
    for (int i = 0; i < n; i++)
    {
        int line;
        data.ignore();
        data >> line;
        //line = toBinary[i].decimal;

        string calculated = toBinary->decimalToSkewBinary(line);

        bool append = false;
        if (i > 0)
            append = true;
        PrintResult2(outputFile, line, calculated, append);
    }

    data.close();
    return;
}

int main()
{
    string inputFile1 = "Data1.txt";
    string outputFile1 = "Results1.txt";
    string inputFile2 = "Data2.txt";
    string outputFile2 = "Results2.txt";

    // Duration of operations start point
    auto start = high_resolution_clock::now();

    // Main calculations method
    ReadAndPerformToDecimal(inputFile1, outputFile1);
    ReadAndPerformToBinary(inputFile2, outputFile2);

    // Duration of operations end point
    auto stop = high_resolution_clock::now();

    // Duration
    auto duration = duration_cast<microseconds>(stop - start);
    cout << "Time taken by function: "
        << duration.count() << " microseconds" << endl;

    return 0;
}
```

## 1.3. Pradiniai duomenys ir rezultatai

Data1( skew binary numbers)

Data1.txt:

```
8
10120
200000000000000000000000000000
10
1000000000000000000000000000000
11
100
11111000001110000101101102000
0
```

Result1.txt:

```
Skew binary: 10120  decimal: 44
Skew binary: 200000000000000000000000000000  decimal: 2147483646
Skew binary: 10  decimal: 3
Skew binary: 1000000000000000000000000000000  decimal: 2147483647
Skew binary: 11  decimal: 4
Skew binary: 100  decimal: 7
Skew binary: 11111000001110000101101102000  decimal: 1041110737
Skew binary: 0  decimal: 0
```

Data2 ( binary numbers)

Data2.txt:

```
8
44
2147483646
3
2147483647
4
7
1041110737
0
```

Result2.txt:

```
Decimal: 44  skew binary: 2202
Decimal: 2147483646  skew binary: 20220200022111212100
Decimal: 3  skew binary: 10
Decimal: 2147483647  skew binary: 20220200022111212101
Decimal: 4  skew binary: 11
Decimal: 7  skew binary: 21
Decimal: 1041110737  skew binary: 10201220001020110021
Decimal: 0  skew binary: 0
```

## 2. Scala(L2)

### 2.1. Darbo užduotis

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).

Šiame Scalatron bot‘e buvo panaudotas BFS kelio radimo algoritmas. Taip pat pritaikyti buvo reference boto išleidžiami padėjėjai: raketos. Implementuoti papildomi pagalbiniai botai: minos, bei rinkikai kurie gali keisti savo tipą, o surinkę tam tikrą kiekį taškų grižta pas main botą. Minos nėra dedamos kol pagrindinio boto energija yra didesnė už 50. Raketos nėra šaudomos kol energija didesnė už 10. Gynybinė raketa nėra šaunama kol energija didesnė už 65. Pagalbininkai nėra kviečiami, kol boto energija didesnė už 20.

### 2.2. Programos tekstas

```
import scala.collection.mutable.Queue
import scala.collection.mutable.Stack
import scala.util.control._
import util.Random
object ControlFunction
{
 val random = new Random()
 def forMain(bot: Bot) {
    val (directionValue, nearestEnemyMain, nearestEnemySlave, _) = analyzeView(bot.view)
    val dontPutMine = bot.inputAsIntOrElse("dontPutMine", -1)
    val dontFireRocket = bot.inputAsIntOrElse("dontFireRocket", -1)
    val dontFireDefensiveRocket = bot.inputAsIntOrElse("dontFireDefensiveRocket", -1)
    val dontSpawnAssistant = bot.inputAsIntOrElse("dontSpawnAssistant", -1)
    var direction = BFS_SearchingAlgorythm(bot,bot.view)
    var temp = XY(0,0)
    if(temp == direction){
        direction = XY(random.nextInt(3)-1, random.nextInt(3)-1)
        var cell = bot.view(direction)
        while(cell == 'W' || cell == 'b' || cell == 'p'){
            direction = XY(random.nextInt(3)-1, random.nextInt(3)-1)
            cell = bot.view(direction)
            }
        bot.say("RANDOM:" + direction.toString())
        }
    bot.move(direction)

    if(dontPutMine < bot.time && bot.energy > 50){
       nearestEnemyMain match {
            case None => // no one nearby
```

```
                    case Some(relPos) => // a main bot is nearby
                    val unitFlat = relPos.signum
                    val remainder = relPos - unitFlat // we place slave
nearer target, so subtract that from overall flat surface
                    bot.spawn(unitFlat, "mood" -> "Mine", "target" ->
remainder)
                    bot.set("dontPutMine" -> (bot.time + relPos.stepCount +
1))
                    }
                }

            if(dontFireRocket < bot.time && bot.energy > 10) { // fire
rocket?
                nearestEnemyMain match {
                    case None => // no one nearby
                    case Some(relPos) => // a main bot is nearby
                    val unitFlat = relPos.signum
                    val remainder = relPos - unitFlat // we place slave
nearer target
                    bot.spawn(unitFlat, "mood" -> "Rocket", "target" ->
remainder)
                    bot.set("dontFireRocket" -> (bot.time + relPos.stepCount
+ 1))
                    }
                 }
            else
            if(dontFireDefensiveRocket < bot.time && bot.energy > 65) { //
fire defensive rocket?
                nearestEnemySlave match {
                case None => // no one nearby
                case Some(relPos) => // an enemy slave is nearby
                if(relPos.stepCount < 8) {
                    val unitFlat = relPos.signum
                    val remainder = relPos - unitFlat // we place slave
nearer target
                    bot.spawn(unitFlat, "mood" -> "DefensiveRocket", "target"
-> remainder)
                    bot.set("dontFireDefensiveRocket" -> (bot.time +
                    relPos.stepCount + 1))
                    }
                }
            }
            if(dontSpawnAssistant < bot.time && bot.energy > 20){
                bot.spawn(bot.view.center, "mood" -> "Assistant", "target" ->
"", "collector" -> 2000)
                bot.set("dontSpawnAssistant" -> (bot.time + 10))
            }
        }

        def slaveBots(bot: MiniBot) {
            bot.inputOrElse("mood", "Waiting") match {
                case "Mine" => reactAsMine(bot)
                case "Rocket" => reactAsRocket(bot)
                case "Defensive" => reactAsDefensiveRocket(bot)
                case "Assistant" => reactAsAssistant(bot)
                case "NonActive" => reactAsNonActive(bot)
                case s: String => bot.log("unknown mood: " + s)
                }
            }
        def BFS_SearchingAlgorythm(bot: Bot, view: View) : XY = {
```

```
    var queue = Queue[XY]()
    var visited = Set[XY]()
    var path = Map[XY,XY]()
    queue.enqueue(XY(0, 0))
    while (!queue.isEmpty) {
        val next = queue.dequeue()
        if (next.length > 15) {
            // if no available path found do not move
            return XY(0, 0)
            }
        for (i <- -1 to 1; j <- -1 to 1) {
            val xy = XY(i, j) + next
            val cell = view(xy)
            // if found food backtrack and return direction
            if (cell == 'P' || cell == 'B') {
                var currentSource = next
                if (xy.length < 1.5) {
                    return xy
                }
            while (currentSource.length > 1.5) {
                    val temp = view(currentSource)
                    if(temp != 'W')
                        currentSource = path(currentSource)
                    }
            return currentSource
            }
            if (cell == '_' && !visited.contains(xy)) {
                queue.enqueue(xy)
                visited += xy
                path += (xy -> next)
            }
        }
    }
    // default return - not move
    XY(0, 0)
}

def reactAsMine(bot: MiniBot){
    bot.view.offsetToNearest('m') match {
        case Some(delta: XY) =>
        // another master is visible at the given relative position
        if(delta.length <= 2) {
            // blowing it up
            bot.explode(4)
        } else
        {
          // no
        }
        case None =>
        bot.say("Mine")
    }
}

def reactAsRocket(bot: MiniBot) {
    bot.view.offsetToNearest('m') match {
        case Some(delta: XY) =>
        // another master is visible at the given relative position
        if(delta.length <= 2) {
            bot.explode(4)//exploding
```

```
            } else
            {
                // no
                bot.move(delta.signum)
                bot.set("rx" -> delta.x, "ry" -> delta.y)
            }
            case None =>
            // no target visible
            val target = bot.inputAsXYOrElse("target", XY.Zero)
            // did we arrive at the target?
            if(target.isNonZero) {
                // keep going
                val  unitDelta  =  target.signum  //  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 // CellPos(-7,5)
                bot.set("target" -> remainder)
                }
            else{
                //  yes  --  but  we  did  not  detonate  yet,  and  are  not
pursuing anything
                bot.set("mood" -> "NonActive", "target" -> "")
                bot.say("NonActive")
            }
        }
    }

    def reactAsDefensiveRocket(bot: MiniBot) {
        bot.view.offsetToNearest('s') match {
            case Some(delta: XY) =>
            // another slave is visible at the given relative position
            // moving closer
            bot.move(delta.signum)
            bot.set("rx" -> delta.x, "ry" -> delta.y)
            case None =>
            // no target visible
            val target = bot.inputAsXYOrElse("target", XY.Zero)
            // did we arrive at the target?
            if(target.isNonZero) {
                // no
                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" -> "NonActive", "target" -> "")
                bot.say("NonActive")
                }
        }
    }
```

```
def reactAsAssistant(bot: MiniBot){
   val    (directionValue,    nearestEnemyMaster,    _,    master)    =
analyzeView(bot.view)

   val collector = bot.inputAsIntOrElse("collector", 0)
   if(bot.energy > collector){
      bot.set("mood" -> "NonActive", "target" -> "")
      reactAsNonActive(bot)
   }
   else if(bot.energy > collector/10 && !master.isEmpty){
      bot.set("mood" -> "NonActive", "target" -> "")
      reactAsNonActive(bot)
   }
   else     if(!nearestEnemyMaster.isEmpty     &&     bot.energy     <
collector/10){
      bot.set("mood" -> "Rocket", "target" -> "")
      reactAsRocket(bot)
   }
   else{
      val lastDirection = bot.inputAsIntOrElse("lastDirection", 0)
      directionValue(lastDirection) += 10
      val                        bestDirection45                        =
directionValue.zipWithIndex.maxBy(_._1)._2
      val direction = XY.fromDirection45(bestDirection45)
      bot.move(direction)
      bot.set("lastDirection" -> bestDirection45)
   }
}

def reactAsNonActive(bot: MiniBot){
   val     (directionValue,     nearestEnemyMaster,     master)     =
analyzeViewAsNonActive(bot, bot.view)
   val gather = bot.inputAsIntOrElse("gather", 0)
   if(bot.energy < gather && master.isEmpty){
      bot.set("mood" -> "Assistant", "target" -> "")
      reactAsAssistant(bot)
   }
   val masterDirectionXY = bot.inputAsXYOrElse("master",XY.Zero)
   val masterDirection = masterDirectionXY.toDirection45
   val masterDirectionLocal = XY.fromDirection45(masterDirection)
   directionValue(masterDirection) += 10
   if(bot.view(masterDirectionLocal)         ==         'W'         ||
bot.view(masterDirectionLocal) == 'p' || bot.view(masterDirectionLocal) ==
'b'){
      directionValue(masterDirection) -= 100
   }
   val bestDirection45 = directionValue.zipWithIndex.maxBy(_._1)._2
   val direction = XY.fromDirection45(bestDirection45)
   bot.move(direction)
   }
   def analyzeView(view: View) = {
      val directionValue = Array.ofDim[Double](8)
      var nearestEnemyMaster: Option[XY] = None
      var nearestEnemySlave: Option[XY] = None
      var master: Option[XY] = None

      view.cells.zipWithIndex foreach {case (c, i) =>
      val cellRelPos = view.relPosFromIndex(i)
      if (cellRelPos.isNonZero){
         val stepDistance = cellRelPos.stepCount
```

```
                val value: Double = c match{
                    case 'm' => // another master: not dangerous, but an
obstacle
                    nearestEnemyMaster = Some(cellRelPos)
                    - 100 / stepDistance

                     case 's' => // another slave: potentially dangerous?
                     nearestEnemySlave = Some(cellRelPos)
                     - 100 / stepDistance

                    case 'S' => // our own slave
                    -50 / stepDistance

                    case 'M' => // our own master
                    master = Some(cellRelPos)
                    0.0
                    case 'B' => // great beast: valuable, but runs away
                    if (stepDistance == 1) 600
                    else if (stepDistance == 2) 300
                    else (150 - stepDistance * 15).max(10)

                    case 'P' => // great 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, master)
    }

    def analyzeViewAsNonActive(bot: MiniBot, view: View) = {
       val directionValue = Array.ofDim[Double](8)
       var nearestEnemyMaster: Option[XY] = None
       var master: Option[XY] = None
       view.cells.zipWithIndex foreach {case (c, i) =>
       val cellRelPos = view.relPosFromIndex(i)
       if (cellRelPos.isNonZero){
           val stepDistance = cellRelPos.stepCount
           val value: Double = c match{
```

```
                    case 'm' => // another master: not dangerous, but an
obstacle
                    nearestEnemyMaster = Some(cellRelPos)
                    -100 / stepDistance

                    case 's' => // another slave: potentially dangerous?
                    -100 / stepDistance

                    case 'S' => // our own slave
                    -50 / stepDistance

                    case 'M' => // our own master
                    master = Some(cellRelPos)
                    1000
                    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, master)
       }
      }

      // ------------------------------------------------------------------
------------------------------
      // 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.forMain(bot)
```

```
                }
                else
                {
                    ControlFunction.slaveBots(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)
            }
        }
```

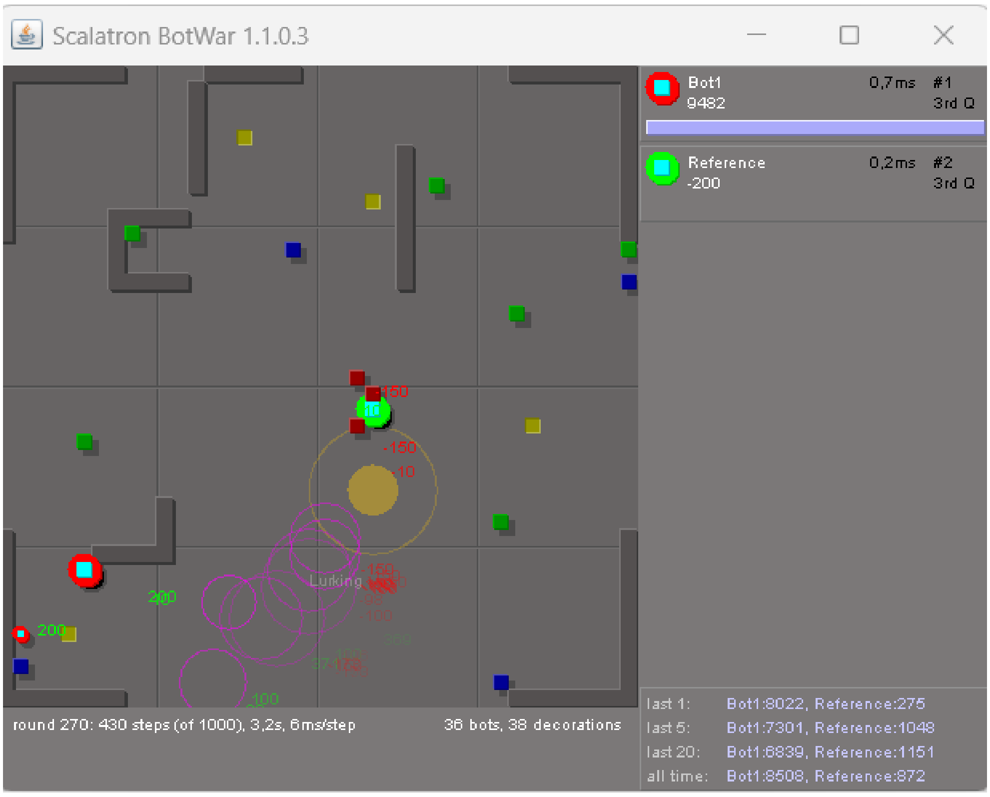
```
    // -----------------------------------------------------------------
-----------------------------
    /** Utility class for managing 2D cell coordinates.
     * The coordinate (0,0) corresponds to the top-left corner of the
arena on screen.
     * The direction (1,-1) points right and up.
     */
    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)
            }
        }
    }
```

### *2.3. Rezultatai*

Suprojektuotas botas (Bot1) buvo paliktas kovoti su reference botu. Naujasis botas surenka daugiau taškų. Taip yra todėl, kad naujasis botas turi pagalbininkus renkančius maistą, taip taškai pradeda kilti eksponentiškai – tai ir yra didžiausias pranašumas prieš reference botą, kadangi jis tik vienas ir vieninteliai pagalbininkai kuriuos jis naudoja yra tik raketos, kurių naujasis botas nebijo, turi savas tiek atakuojančias tiek gynybines.



# 3. Haskell(L3)

## 3.1. Darbo užduotis

# 568 Just the Facts

The expression $N!$, read as "$N$ factorial," denotes the product of the first $N$ positive integers, where $N$ is nonnegative. So, for example,

| $N$ | $N!$ |
|---|---|
| 0 | 1 |
| 1 | 1 |
| 2 | 2 |
| 3 | 6 |
| 4 | 24 |
| 5 | 120 |
| 10 | 3628800 |

For this problem, you are to write a program that can compute the last non-zero digit of any factorial for ($0 \leq N \leq 10000$). For example, if your program is asked to compute the last nonzero digit of 5!, your program should produce "2" because $5! = 120$, and 2 is the last nonzero digit of 120.

## Input

Input to the program is a series of nonnegative integers not exceeding 10000, each on its own line with no other letters, digits or spaces. For each integer $N$, you should read the value and compute the last nonzero digit of $N!$.

## Output

For each integer input, the program should print exactly one line of output. Each line of output should contain the value $N$, right-justified in columns 1 through 5 with leading blanks, not leading zeroes. Columns 6 - 9 must contain ' -> ' (space hyphen greater space). Column 10 must contain the single last non-zero digit of $N!$.

## Sample Input

```
1
2
26
125
3125
9999
```

## Sample Output

```
    1 -> 1
    2 -> 2
   26 -> 4
  125 -> 8
 3125 -> 2
 9999 -> 8
```

### 3.2. Programos tekstas

```haskell
-- Importing necessary functions from standard libraries
import Data.Char (digitToInt)
import Data.List (find)
import Text.Printf (printf)

-- Function to calculate factorial of a given integer
factorial :: Integer -> Integer
factorial n = product [1..n]

-- Function to find the last non-zero digit of the factorial of a given integer
lastNonZeroDigit :: Integer -> Maybe Int
lastNonZeroDigit n = find (/= 0) $ reverse $ map digitToInt $ show $ factorial n

-- Function to format the output in the desired way
formatOutput :: Integer -> Maybe Int -> String
formatOutput n Nothing = printf "%5d -> %s" n "none"
formatOutput n (Just d) = printf "%5d -> %d" n d

-- The main function
main :: IO ()
main = do
  -- Read input from file and convert to list of integers
  input <- readFile "input.txt"
  let ns = map read $ lines input :: [Integer]
  -- Calculate the last non-zero digit of factorial for each integer in the input list
  let results = map (\n -> (n, lastNonZeroDigit n)) ns
  -- Format the output for each integer in the results list and join them into a single string
  let output = unlines $ map (\(n, d) -> formatOutput n d) results
  -- Write the output to a file and print a message indicating completion
  writeFile "output.txt" output
  putStrLn "Done!"
```

### 3.3. Pradiniai duomenys ir rezultatai

Input.txt:

```
1
2
26
125
3125
9999
```

Output.txt:

```
    1 -> 1
    2 -> 2
   26 -> 4
  125 -> 8
 3125 -> 2
 9999 -> 8
```