07 Lab
Advanced mechanisms of the Scala language

Mirko Viroli, Roberto Casadei, Gianluca Aguzzi
{mirko.viroli,roby.casadei,gianluca.aguzzi}@unibo.it

C.D.L. Magistrale in Ingegneria e Scienze Informatiche
Alma Mater Studiorum—Università di Bologna, Cesena

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Lab 07: Outline

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- Consolidate your knowledge of Scala
- Practice with advanced Scala features

Repo with exercises

- Fork/clone `https://github.com/unibo-pps/pps-lab07`
- For each exercise, you are given a (statically correct) code template that you have to complete as well as a main program to be executed for checking your solution and making experiments
- As usual, you may commit your changes and push them to your own (forked) repository

Exercise 1: `Parser`

1) Provide missing implementations such that the code in `TryParsers` works correctly.
   - Consider the `Parser` example shown in previous lesson.
   - Analogously to `NonEmpty`, create a mixin `NotTwoConsecutive`, which adds the idea that one cannot parse two consecutive elements which are equal.
   - Use it (as a mixin) to build class `NotTwoConsecutiveParser`, used in the testing code at the end.
   - Note we also test that the two mixins can work together!!
   - Write as a comment the full linearisation of `parserNTCNE`
   - **N.B.:** tests are written in such a way that each call to `parseAll` runs on a brand-new parser (got via a 0-arg `def`). If you want to avoid this (i.e., running `parseAll` multiple times on the same parser object), you need to reset the parser after use (e.g., in `parseAll`)
2) Extend Scala type `String` with a factory method that creates a parser which recognises the set of chars of a string.
3) Rewrite the given tests in Scala tests
4) **Optional** Implement mixin `ShortenThenN` which accepts a sequence of chars of length at most `n` (part of the trait constructor).

Exercise 2: `Robot` composition

- Examine the provided `Robot` trait and its implementations (refer to the corresponding text)
- Study the examples `DumbRobot` and `LoggingRobot` which demonstrate composition between robots
- Implement the following robot variations using Scala's `export` feature:
  - `RobotWithBattery`: A robot that tracks battery level
    - Battery decrements by a specified amount for each action
    - Actions cannot be performed when battery level reaches 0
  - `RobotCanFail`: A robot that may fail to perform actions
    - Takes a probability parameter to determine failure chance
    - When it fails, the requested action is not performed
  - `RobotRepeated`: A robot that performs actions multiple times
    - Takes a parameter for the number of repetitions
    - Each action is executed the specified number of times

Exercise 3: Solitaire game

Consider the solitaire game described here:
`http://www.luigilamberti.it/Software/Sol35/Sol35.htm`

- **Description**: A board with dimensions `width`(w) x `height`(h) is given (start with 5x5), and the objective is to place a total of $w * h$ numbers (25 in this case) on the board according to specific rules:
  1. The game starts with the player placing a number in the center of the board, at position `(width/2, height/2)`.
  2. From there, the player can move the number to any adjacent position, either vertically or horizontally by two positions, or diagonally by one position
     - e.g., giving a board 6 x 6 and starting from (3, 3), you can move to (0, 3), (6, 3), (3, 0), (3, 6), (1, 1), (5, 5), (1, 5), (5, 1)
  3. The player must continue placing numbers on the board until all positions are filled, making sure that the number being placed is not already occupied
- **Goal**: implement a function `placeMarks` that, given a board (w x h), computes all the possible solutions
- **Hints**:
  - A solution can be represented as a list of positions
  - Follow the structure of the eight queens problem demonstrated in class

Exercise 4 (Optional): `ConnectThree`

Follow the exercises sketched in object `ConnectThree` – a simplified version of `ConnectFour` in which the board is 4x4 and a player wins with three aligned disks

1. Implement `find` such that the code provided behaves as suggested by the comments
2. Implement `placeAnyDisk` such that the code provided behaves as suggested by the comments
3. Implement `firstAvailableRow` following the output provided in the comments
4. (Advanced) Implement `computeAnyGame` such that the code provided behaves as suggested by the comments
5. (Very advanced) Modify the above one so as to stop each game when someone won
6. (Advanced) Create an AI that plays:
   - `randomAI` that places a disk in a random column
   - `smartAI` that places a disk in the column that maximises the number of disks in a row (or implement a good strategy, like minmax)
7. (Optional) Create a whole application that allows two players to play against each other (or against the AI)
   - Follow a MVC pattern, the View can be textual or graphical
8. (Optional) Try to implement TicTacToe logic following this structure