

Kojo/Scala



Andrea Sterbini – sterbini@di.uniroma1.it

Kojo learning environment: Scala language + turtles + math/geometry

Kojo IDE:

- HTML “stories” to guide you in simple programming tasks
- Code editor
- 2D canvas (turtle-based)
- ~~- 2D math and geometry cartesian canvas (Geogebra): - [OLD]~~
 - ~~- lines, points, segments, angles, areas, formulas, plots, ...~~
- Arithmetic exercises
- Music player (with Midi instruments)
- Game programming (Processing-like Stage) [NEW]

Other: Arduino programming (with an arduino driver/interface)

AI with Tensorflow: (<https://github.com/litan/kojo-ai-2>) [NEW]

Scala is a functional programming language

- compiles to Java VM (can use Java libs)
- has a simpler readable syntax
- functions + OOP
 - anonymous functions, map/filter/...
 - simpler classes (no getters/setters)
- prefer immutable structures vs. mutable:
 - immutable (**val**) vs. mutable (**var**) vars
 - arguments are always immutable
- implicit return (last instruction)
- operator overloading
- recursive structure matching (“similar” to unification in Prolog)
- multiple assignment (like Python)

Scala resources

Programming in Scala

[by Martin Odersky, Lex Spoon, and Bill Venners]

<https://www.scala-lang.org>

the Scala language community

Good IDE for Scala:

- Eclipse
- Netbeans
- Idea

Programming style

Single-threaded? YES (Concurrency? YES)

Procedural? YES (Lazy evaluation? YES)

Functional? YES!

Statically typed:

- complex abstract types
- metaprogramming

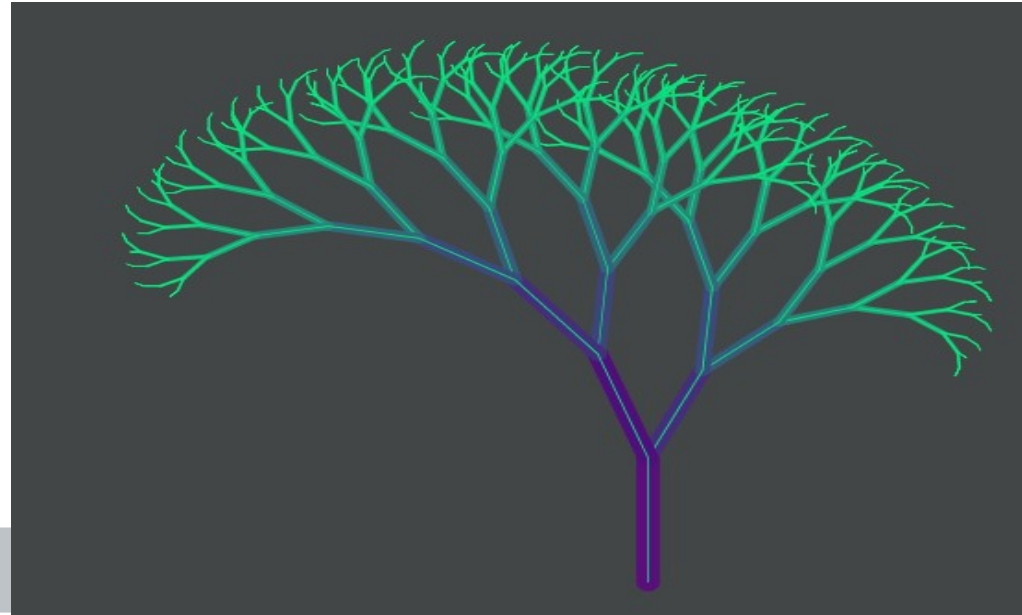
Data types:

- Objects + Classes (+ Singletons + Structs)
- sequential/parallel collections
- list-based operations (map/filter/...)
- anonymous functions (code blocks)

Demo 1: recursive tree by turtle graphics (as usual)

```
def tree(distance: Double) {  
  if (distance > 4) {  
    setPenThickness(distance/7)  
    setPenColor(  
      Color(distance.toInt, math.abs(255-distance*3).toInt, 125))  
    forward(distance)  
    right(25)  
    tree(distance*0.8-2)  
    left(45)  
    tree(distance-10)  
    right(20)  
    hop(-distance)  
  }  
}
```

```
clear()  
invisible()  
setAnimationDelay(10)  
hop(-200)  
tree(90)
```



Good debugger with recursion trace/visualization

The Kojo Learning Environment

File Samples Showcase Window Language Tools Help

Program Trace

- CALL setPenThickness (t
- CALL abs (x = 131.399999
- RETURN abs = 131.3999999
- CALL Color (r = 41, g =
- RETURN Color = java.awt
- CALL setPenColor (color
- CALL forward (n = 41.2)
- CALL right (angle = 25.0
- CALL tree (distance = 30
- CALL setPenThickness
- CALL abs (x = 162.12)

Name: tree
Args: (distance = 30.96)
Call Level: 5
Target Object: Wrapper\$UserCode\$@171e916
Target Type: Wrapper\$UserCode\$
Source: scripteditor
Entry Line Number: 2
Exit Line Number: 0
Caller Source: scripteditor
Caller Line Number: 7
Source Line: if (distance > 4) {
Caller Source Line: tree(distance*0.8-2)

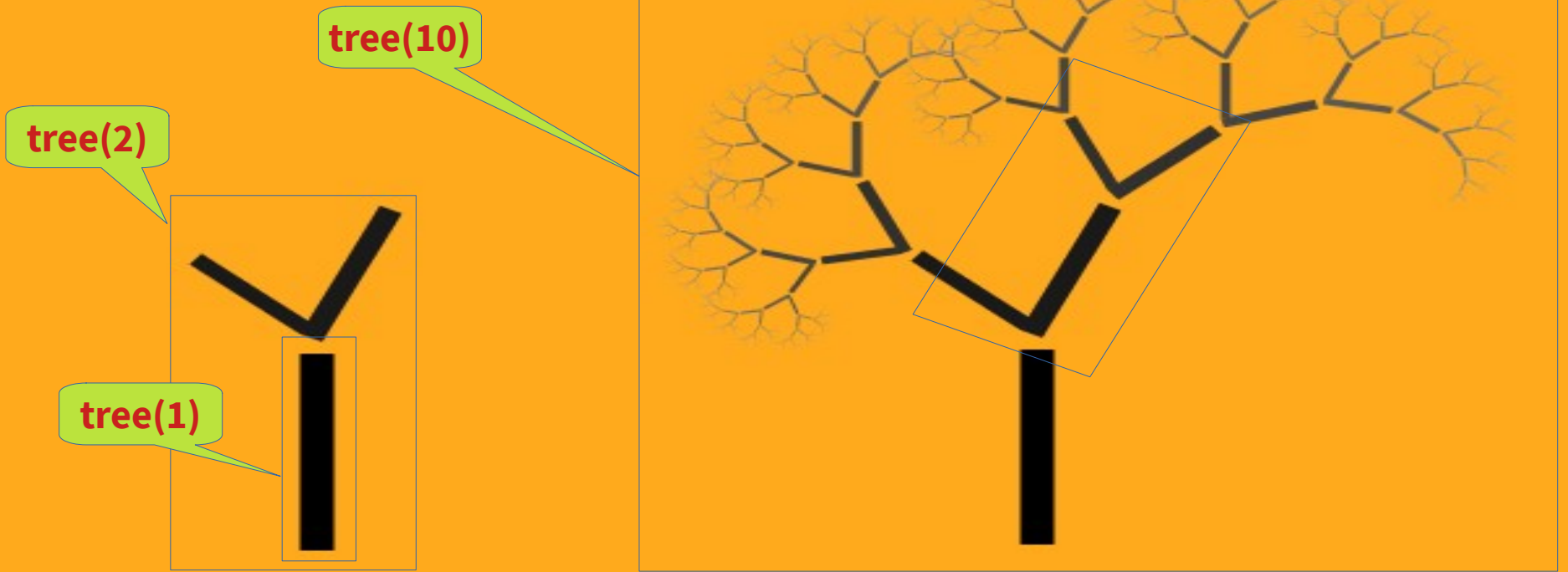
Script Editor

```
1 def tree(distance: Double) {  
2   if (distance > 4) {  
3     setPenThickness(distan  
4     setPenColor(Color(dist  
5     forward(distance)  
6     right(25)  
7     tree(distance*0.8-2)  
8     left(45)  
9     tree(distance-10)  
10    right(20)  
11    back(distance)  
12  }  
13 }  
14  
15 clear()  
16 invisible()  
17 setAnimationDelay(10)  
18 penUp()  
19 back(200)  
20 penDown()  
21 tree(90)
```

Math World Drawing Canvas

Output Pane

Tree2 = recursive transformations of a rectangle figure
rotate(-25°) + scale(72%) + brightness(+10%)



Demo 2: recursive tree = recursive pictures + graphic transformations

// we start with a square

```
def square = Picture {  
  repeat (4) {  
    forward(100)  
    right()      // default 90°  
  }  
}
```

// a stem is a distorted black square

```
def stem = scale(0.13, 1) *  
  penColor(noColor) *  
  fillColor(black) -> square
```

```
def drawing(n: Int): Picture = {  
  if (n < 2)  
    stem  
  else  
    GPics(stem,  
      trans(0, size + 10) * brit(0.1) -> Gpics(  
        rot(-25) * scale(0.72) -> drawing(n-1),  
        rot( 50) * scale(0.55) -> drawing(n-1)  
      )  
    )  
}  
  
clear()  
setBackground(Color(255, 170, 29))  
invisible()  
val pic = trans(0, -300) -> drawing(10)  
draw(pic)
```

Demo 3

[S. Penge]

choose the correct article for an italian word

Type: definite/indefinite (determinativo/indeterminativo)

Gender: male/female

Number: singular/plural

1) deduce the word gender from final char

2) select proper gender/number from final char

3) handle normality and exceptions (here for indefinite male singular only)

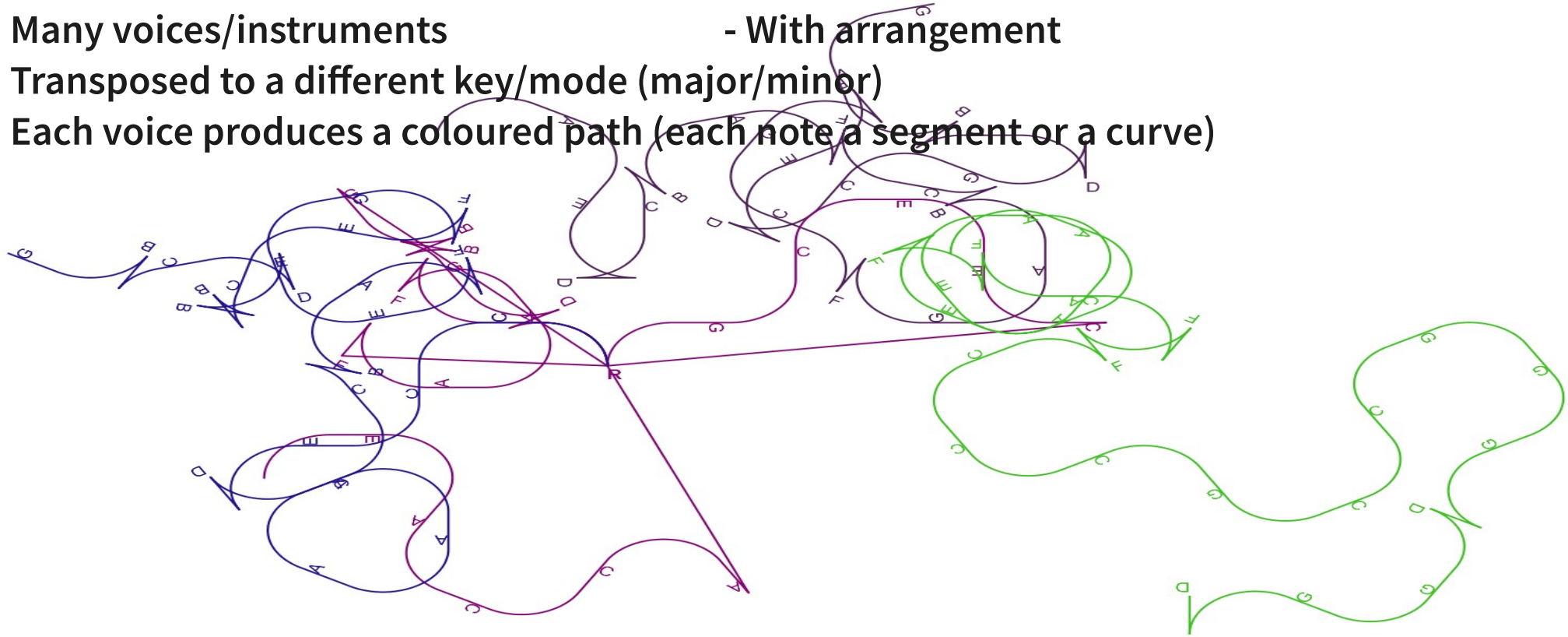
- starts with vowel → "un" (normal case)
- starts with consonant → "un" (normal case)
- starts with 2 special vowels ('ia', 'ie', 'io', 'iu') → "uno" (special case)
- starts with 1 or 2 special consonants → "uno" (special case)
("x", "y", "z", "gn", "pt", "ps", "pn", "sc", "sf", "sq", "st")

Demo 4

[S. Penge]

Music transposition and art

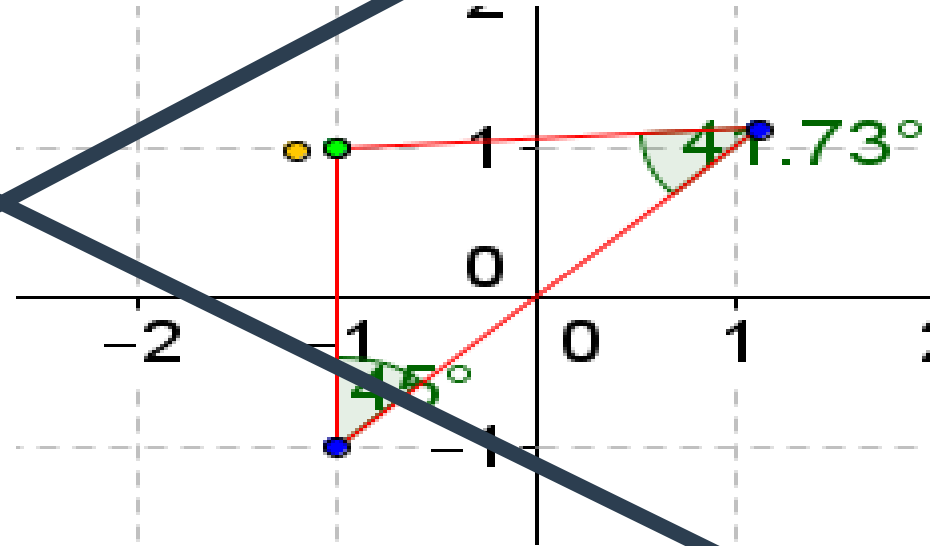
- Many voices/instruments
- Transposed to a different key/mode (major/minor)
- Each voice produces a coloured path (each note a segment or a curve)



~~Demo 5: MathWorld pane = Geogebra [v 2.7]~~

Just use turtle graphics with the Mw class to create lines and angles

```
val t = Mw.turtle(-1, 0)
t.showExternalAngles()
t.forward(-2)
t.right(45)
t.forward(3)
t.moveTo(-1,0)
```



Full GeoGebra with spreadsheet

Not (yet?) possible to get all properties FROM Geogebra elements

NEW

Game programming with “Staging”

[V 2.9]

```
import Staging._                // import the Staging library
import Staging.{circle, clear, animate} // explicitly import names that clash

clear()
gridOn()
val width = 300
val height = 200
rectangle(0,0,width,height)
val ball = circle(100, 100, 5)
var y = height/2 ; var x = width/2 // ball position
var dy = 10; var dx = 5           // ball speed

animate {                        // animation is around 30 - 50 frames per second
    ball.setPosition(x,y)
    // update ball speed, detecting out of bounce area
    dx = if(x < 0 || x > width) -dx else dx
    x += dx
    dy = if(y < 0 || y > height) -dy else dy
    y += dy
}
```

Arithmetic exercises

Sum, Multiplication, Division, Subtraction

Numbers to be Added:

Digits per Number:

Difficulty Level:

Time Limit:

[New Question](#)

[Reset Parameters](#)

00 : 00

7	7	8	9
4	5	8	6
+	6	4	4

Digits per Number:

Difficulty Level:

Time Limit:

[New Question](#)

[Reset Parameters](#)

00 : 00

		6		
Click ² Borrow	3	7	12	5
-	2	4	4	5

1 2 8 0

Congratulations! You've got it right. Your grade (based on time taken and mistakes made) is:

A

Digits in Dividend:

Difficulty Level:

Time Limit:

[New Question](#)

[Reset Parameters](#)

00 : 00

3	4	4	7	0

Digits per Number:

Difficulty Level:

Time Limit:

[New Question](#)

[Reset Parameters](#)

00 : 00

		6		
Click ² Borrow	3	7	12	5
-	2	4	4	5

1 2 8 0

Congratulations! You've got it right. Your grade (based on time taken and mistakes made) is:

A

Demo

DEMO