Kojo/Scala

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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 programming language

Scala functional programming language:

- compiles to the Java VM (and can import Java libs)
- simpler readable syntax (e.g. object method parameter)
- functions + OOP
  - anonymous functions, map/filter/…
  - simplified definition of classes (no need for getters/setters)
- preferred immutable structures vs. mutable:
  - immutable (val) vs. mutable (var) variables
  - imm. collections are copied while mutable can be changed
  - method arguments are always immutable
- 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

Programming style

Single-threaded? YES (Concurrency? YES)

Procedural? YES (Lazy evaluation? YES)

Functional? YES!

Statically typed:

- complex abstract types
- metaprogramming

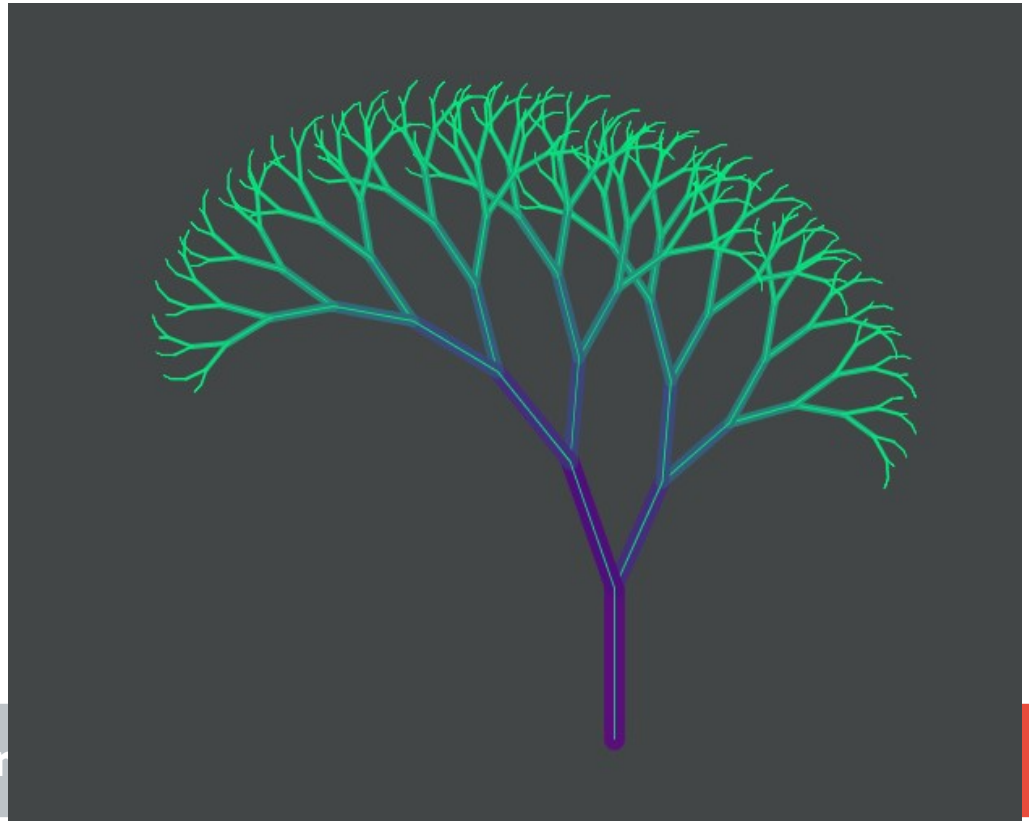
Data types:

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

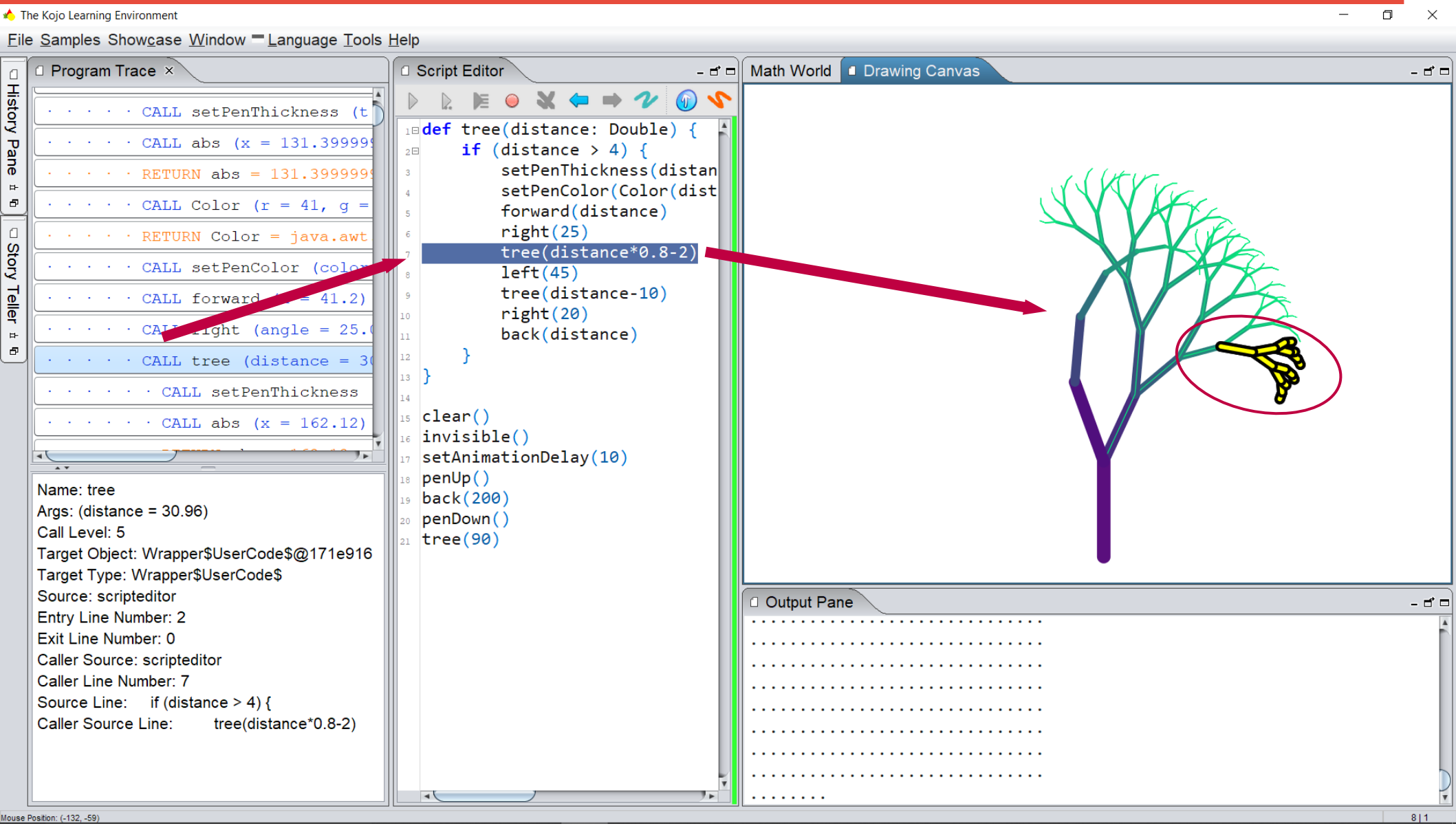
Demo 1: recursive tree by turtle graphics (as usual)

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

```
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)
  }
}
```



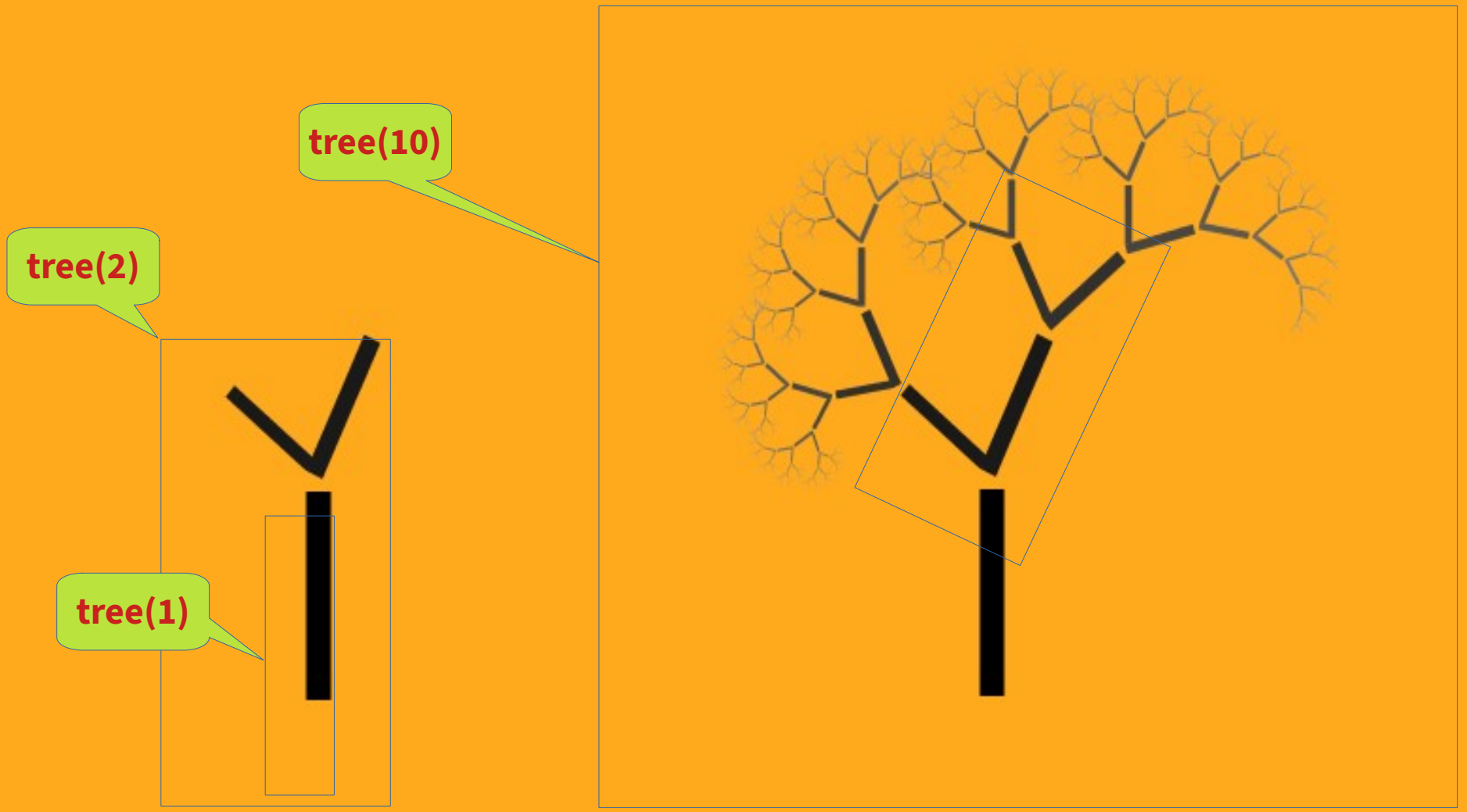
Good debugger with recursion trace/visualization



Methods in Computer Science education: Analysis

2021-22 Kojo/Scala

Tree2 = recursive transformations of a rectangle
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 ind. male sing. only)

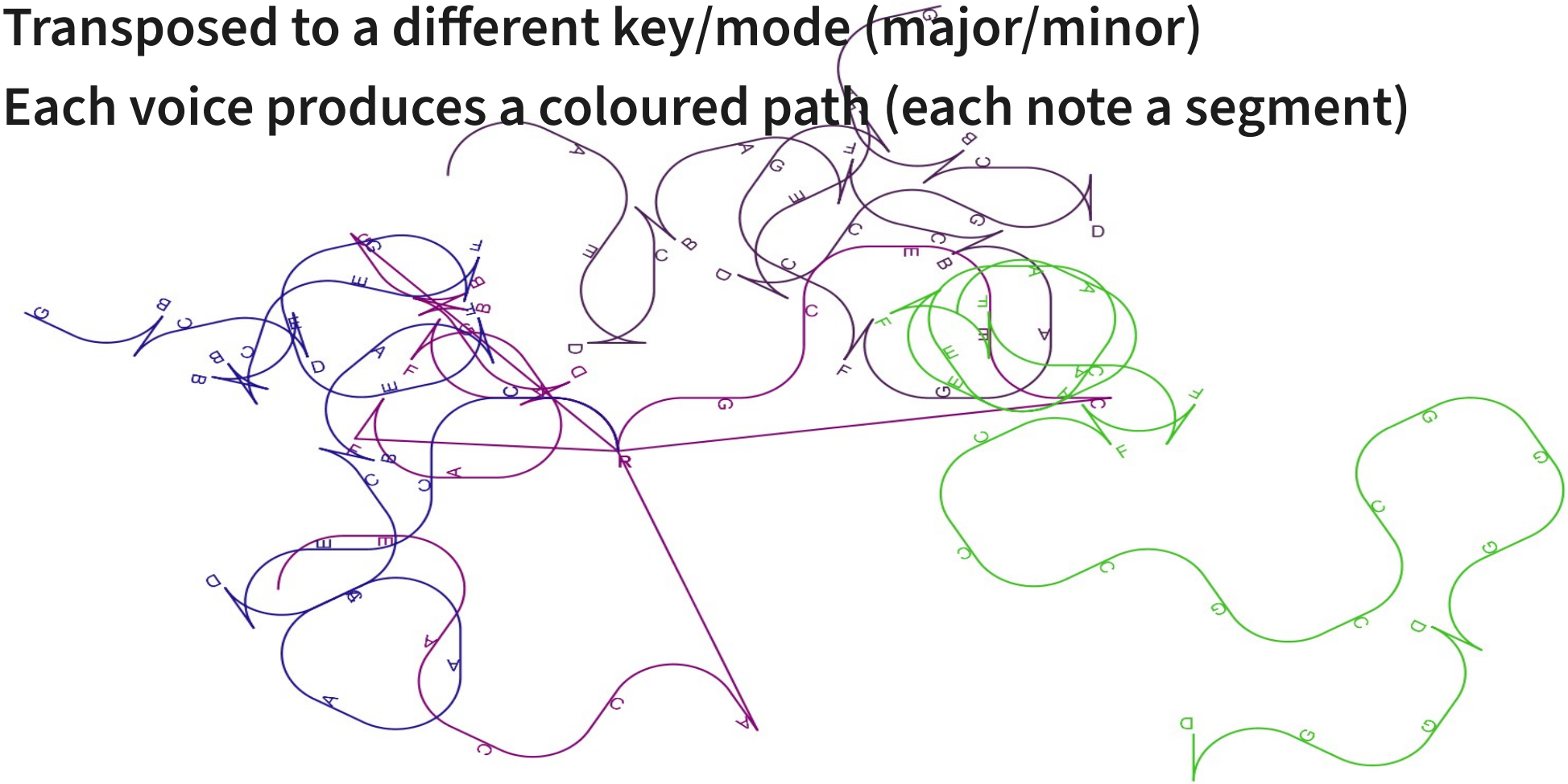
- starts with vowel → ”un”
- starts with consonant → “un”
- starts with 2 special vowels (‘ia’, ‘ie’, ‘io’, ‘iu’) → “uno”
- starts with 1 or 2 special consonants → “uno”

(“x”, “y”, “z”, “gn”, “pt”, “ps”, “pn”, “sc”, “sf”, “sq”, “st”)

Demo 4 [S. Penge]

Music transposition and art

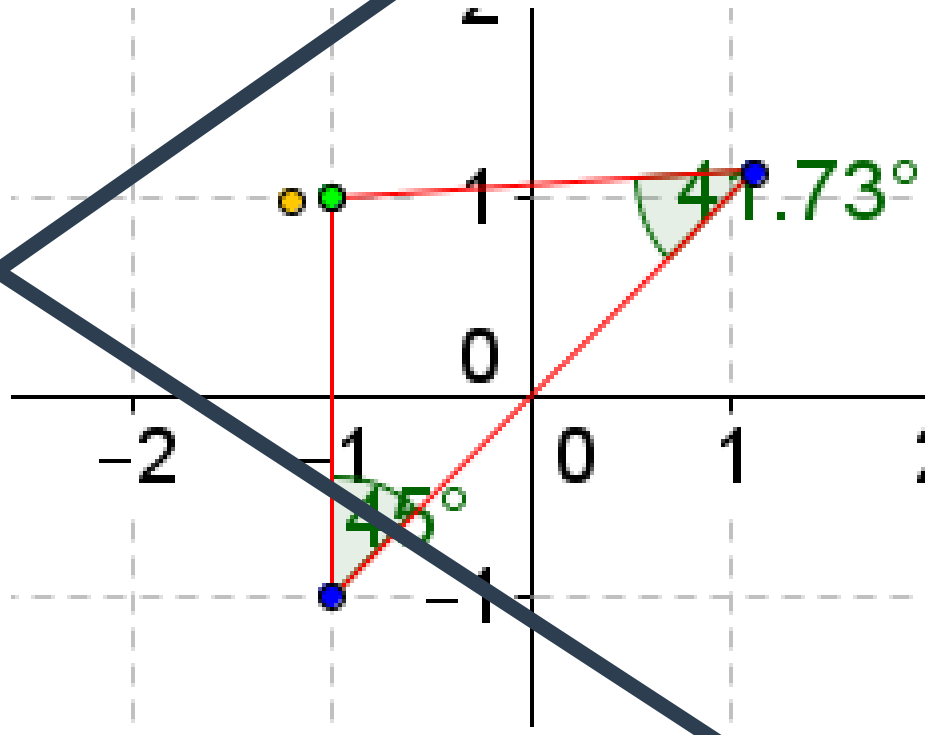
- Many voices/instruments
- With arrangement
- Transposed to a different key/mode (major/minor)
- Each voice produces a coloured path (each note a segment)



~~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

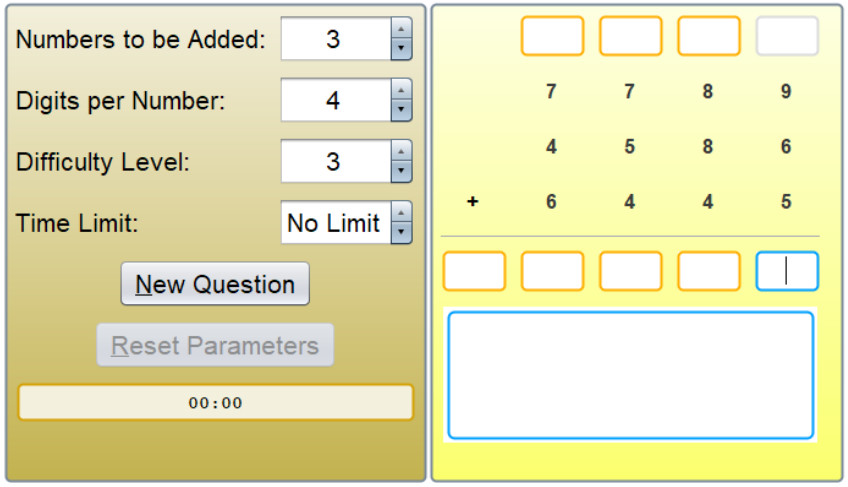
Not (yet?) possible to get all properties FROM Geogebra elements

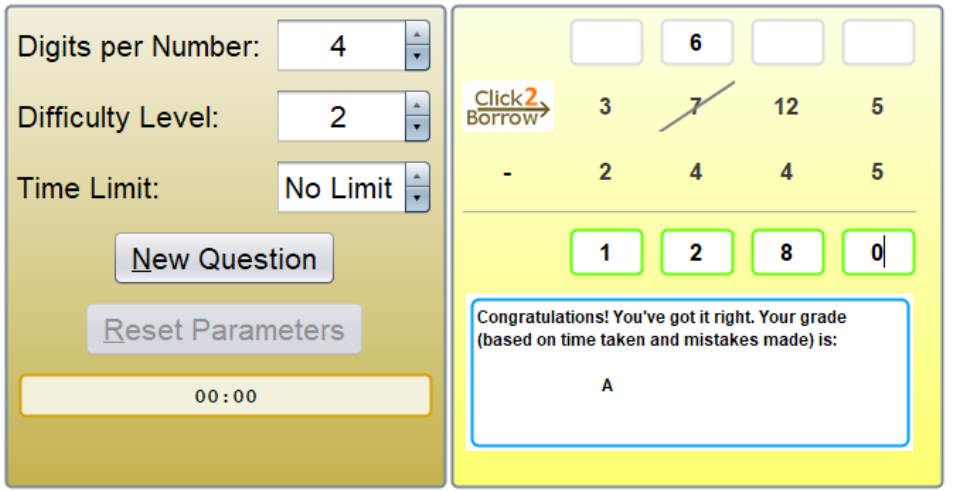
NEW
Game programming with “Staging” [V 2.9]

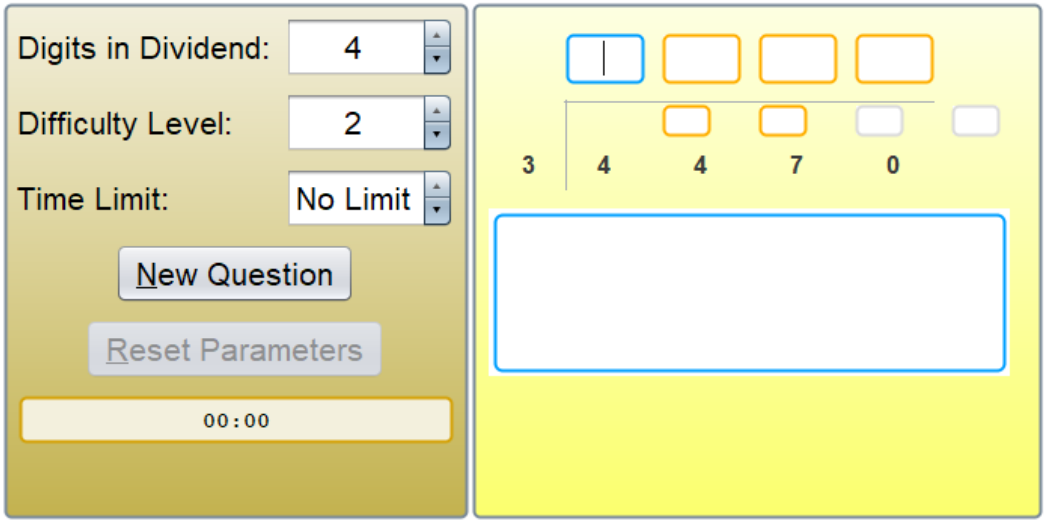
```
import Staging._                          // Import the Staging library
import Staging.{circle, clear, animate}   // explicitly import names that clash
clear()
gridOn()
rectangle(0,0,200,100)
val ball = circle(-200, -100, 5)
var y = 0 ; var x = 0                     // ball position
var dy = 10; var dx = 3                   // ball speed
Animate {                                 // animation is around 30 - 50 frames per second
  ball.setPosition(x,y)
  // update ball position, detect end of bounce area
  dx =  if(x < 0 || x > 200) -dx else dx
  x += dx
  dy =  if(y < 0 || y > 100) -dy else dy
  y += dy
}
```

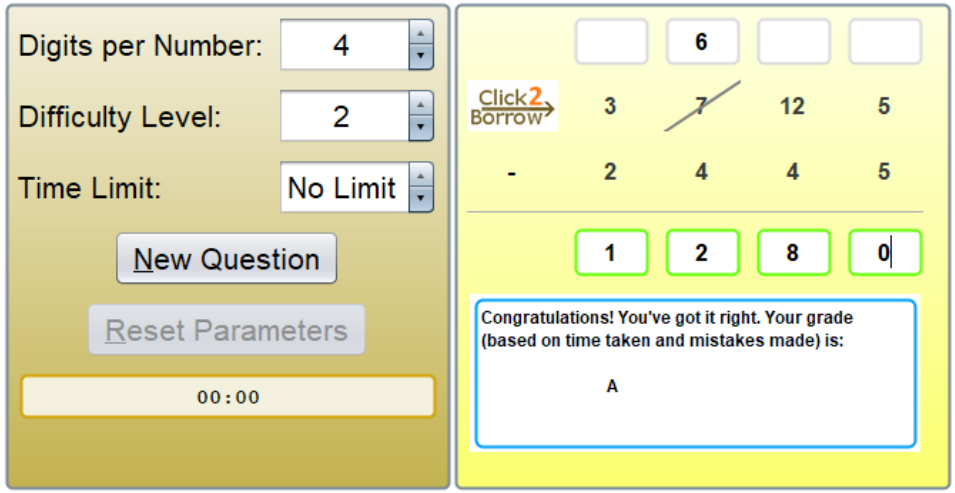
Arithmetic exercises

Sum, Multiplication, Division, Subtraction









Demo

DEMO