

Kids Programming with Smalltalk

Hilaire Fernandes

Department of Public Instruction
Geneva

November 2023



About me

- Educator in public school, Geneva, B.Math, Ma.Ed
- Computer scientist, Ma.CS, PhD.CS
- Free software enthusiast and user since 1998
- And of course, Smalltalk user since 2002

Contents

- 1 Why this presentation ?
- 2 Constrained systems
- 3 Geometric system, Smalltalk approach
- 4 DSL – Kids programming
- 5 References

Morphic mark III

Mature – Simplified – Understandable – Vector quality!

```

DyViewerVisitor>>visitCourse: course
| column |
visitedModel := course.
column := LayoutMorph newColumn.
column
  addMorph: (self
    paneFor: course courseHour.
    label: 'Periods' translated
    browse: false);
  addMorph: (self
    paneFor: course teacher
    label: 'Teacher' translated
    browse: false);
  addMorph: (self
    paneFor: course topics
    label: 'Topics' translated
    browse: false).
↑ self plugView: column

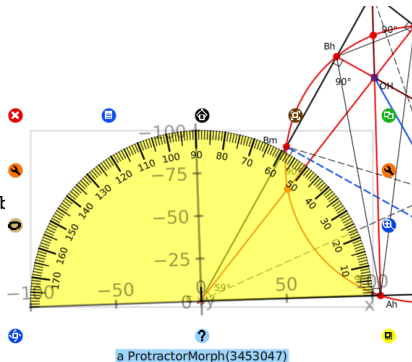
```



Vector Graphics

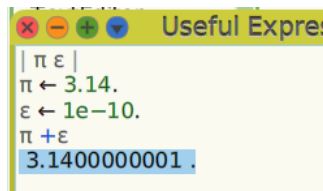
Mature too, API SVG compatible. Fast !

```
ProtractorMorph>>drawOn: canvas
| p1 p2 |
canvas
  strokeWidth: 1
  color: Color black
  do: [
    canvas moveTo: 0 @ -0.5;
    lineTo: 0 @ -8].
-180 to: 0 do: [:degree |
  canvas strokeWidth: 0.5 color: Color t
  p1 := Point
    r: 100
    degrees: degree.
  p2 := Point
    r: 95
    degrees: degree.
  engine moveTo: p1 ; lineTo: p2]]
```



Unicode

- The default encoding for source code, text and text files
- Methods can be named with Unicode symbols
- Variables too!



```
| π ε |  
π ← 3.14.  
ε ← 1e-10.  
π + ε  
3.1400000001.
```

Packaging System

```
"Install DrGeo code"
Feature require: #'DrGeo'.
Feature require: #'DrGeoFrench'.
```

Installed Packages

Package Name	File Name
Commander 1.4	/home/hilaire/Travaux/Developpement/Cuis/Cuis--
Compression 1.33	/home/hilaire/Travaux/Developpement/Cuis/Cuis--
DrGeo 1.639	/home/hilaire/Travaux/Developpement/Cuis/Cuis--
DrGeoFrench 1.8	/home/hilaire/Travaux/Developpement/Cuis/Cuis--
Erudite 1.239	/home/hilaire/Travaux/Developpement/Cuis/Erudit
Gettext 1.26	/home/hilaire/Travaux/Developpement/Cuis/Cuis--
Graphics-Files-Additional 1.27	/home/hilaire/Travaux/Developpement/Cuis/Cuis--
LinearAlgebra 1.60	/home/hilaire/Travaux/Developpement/Cuis/Nume
PetitParser 1.4	/home/hilaire/Travaux/Developpement/Cuis/Parser
PetitParserBinding 1.3	/home/hilaire/Travaux/Developpement/Cuis/Erudit
?	?

save new delete/merge changes browse addRequirement

Package: DrGeo -- From Cuis 6.0 [latest update: #5980] on 15 August 2023 at 9:55:49 pm -- Number of system categories 18. -- Number of classes: 289. Number of extension methods: 71. Total number of methods: 3227. Total lines of

Please enter a description for this package

FeatureRequirement(Gettext 1.17 to *.*)
 FeatureRequirement(SVG 1.16 to *.*)
 FeatureRequirement(YAXO 1.19 to *.*)
 FeatureRequirement(UI-Widgets 1.0 to *.*)
 FeatureRequirement(UI-Preference 1.15 to *.*)
 FeatureRequirement(UI-Panel 1.17 to *.*)

delete update

Example of fine tuned end-user application with **Smalltalk** !

- Set up your development environment
- Spread your code in packages
- Use different code repositories
- Localise your application
- Elaborate vector graphic user interface
- Develop your own widget
- Deliver end-user bundle

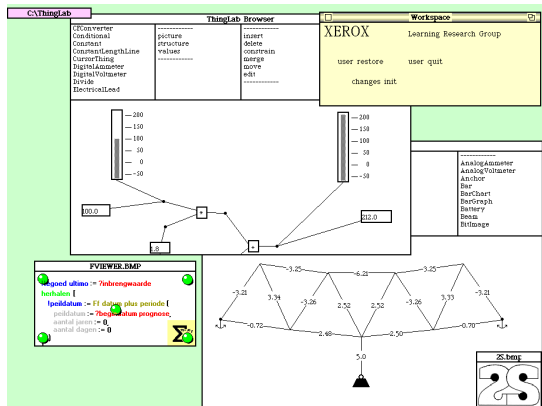
Interested to know more ?

⇒ Workshop Friday 16 :00 *Develop end-user GUI application with Cuis*

- Kids write code the old way
- Learning by the example
- Step-by-step introduction to programming concepts
- Do math as well !
- Write **Smalltalk** code in native language

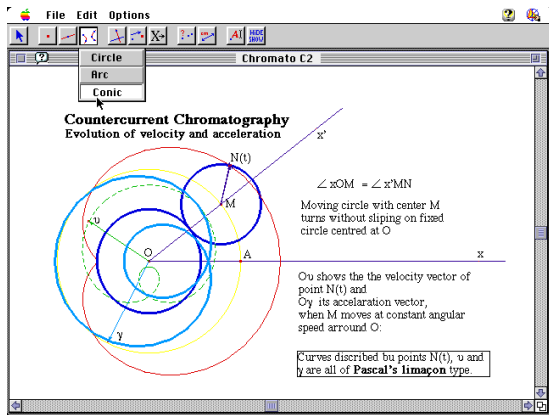
Thinglab, 1979[1]

A Smalltalk system that provides an object-oriented environment for building simulations [...] constraints are employed as a way of describing the relations among its parts.



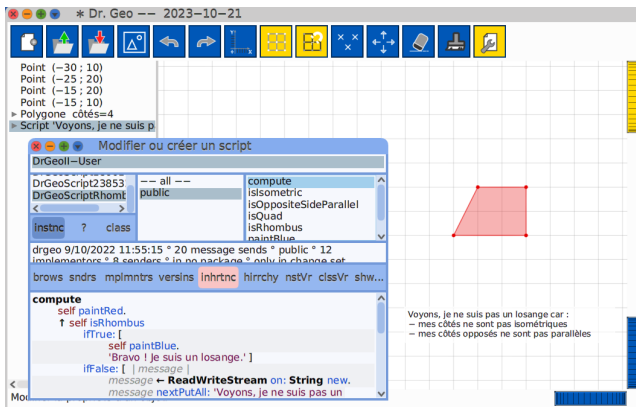
Cabri Geometer, 1986[4]

First interactive geometry system dedicated to education in mathematics.
A top-down approach to describe the relations among the parts.



Dr. Geo, 1998[2, 3]

First interactive geometry system for GNU/Linux, enhanced with a touch of end-user programming.



- A collection of math objects – items – in a child-parents relation
- A child depends on its parents.

Example :

- 1 **Child.** A point, *middle* of a segment
- 2 **Parent.** A segment with liberty of movement.
- 3 **Dragging child.** ✗ child stuck as a middle
- 4 **Dragging parent.** ✓ child updated accordingly to keep its property of middle of the segment

DEMO

Demo contents

- ① Preferences at: `#defaultFontSize` put: 12.
- ② segment, middle → drag segment
- ③ segment (one extremity constrained), middle → drag segment, observe
- ④ segment, perpendicular bisector → reverse drag the line, observe
- ⑤ triangle with one vertex “A” on a circle → drag circle
- ⑥ elaborate previous with constructed altitude (3), construct H → what are the positions of “H”
- ⑦ elaborate previous with locus of “H” when “A”
- ⑧ Locus and script

Why describing a geometric sketch with code?

Point & Click is cool, it hides complexity.

Nevertheless :

- We may want it (complexity) back, to elaborate on the math underneath i.e. coordinates system.
- Describe a sketch as a text. How can be described a segment? Think of its mathematical nature.
- Capitalize on the programming features
- Growing in complexity, difficult to achieve with *Point & Click*.
 - Constructing hundred of items
 - Grouping items in collection to apply an arbitrary transformation
 - ...

Stance on lesson organisation

Each teaching lesson¹ is organised in three parts, in one A4 document :

- **An example.** A code example to type-in and its expected visual result.
- **Challenges.** There are visuals the learner must code by adapting the code example.
- **Glossary.** There are explanations on key concepts of Smalltalk programming. The glossaries are incremental from one lesson to the next one.

Lesson – 1. Example

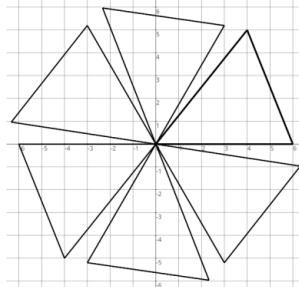
An example. A code example to type-in and its expected visual result.

1. Exemple Triangle Rosace

```
| figure triangle angle|
figure ← DrGeoFigure nouveau.
angle ← 60 radians.
figure afficherAxes; afficherGrille.
triangle ← {figure segmentDe: 0 @ 0 à: 6 @ 0.
  ____ figure segmentDe: 6 @ 0 à: 4 @ 5.
  ____ figure segmentDe: 4 @ 5 à: 0 @ 0}.
5 foisRépéter: [
  ____ triangle ← triangle collecter: [ :segment |
    ____ figure rotationDe: segment centre: 0 @ 0 angle: angle]].
(figure point: 0 @ 0) montrer
```

Dans la figure, le triangle motif de base est en gras, il est à droite.

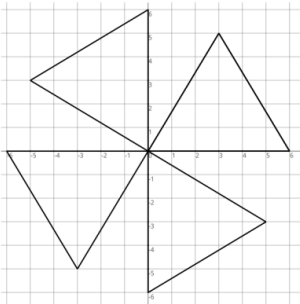
Attrape à la souris ses côtés pour modifier interactivement la rosace !



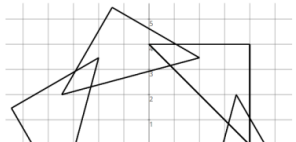
Lesson – 2. Challenges

Challenges. There are visuals the learner must code by adapting the code example.

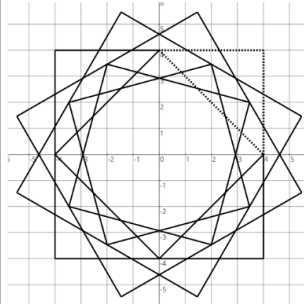
☐ Triangle isocèle rosace



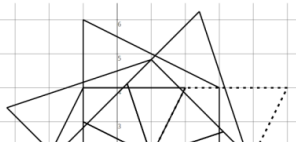
☐ Triangle rectangle isocèle rosace



☐ Triangle rectangle isocèle rosace 2



☐ Parallélogramme rosace



Lesson – 3. Glossary

Glossary. There are explanations on key concepts of Smalltalk programming. The glossaries are incremental from one lesson to the next one.

3. Glossaire

```
triangle collect: [ :segment |  
    ...]
```



Cette boucle ressemble à la boucle `faire:` mais en plus elle collecte les objets créés dans une nouvelle collection.

```
figure rotationDe: segment centre:  
0 @ 0 angle: 60 radians
```



Pivote de 60° le segment selon le centre (0;0).

```
(figure point: 0 @ 0) montrer
```



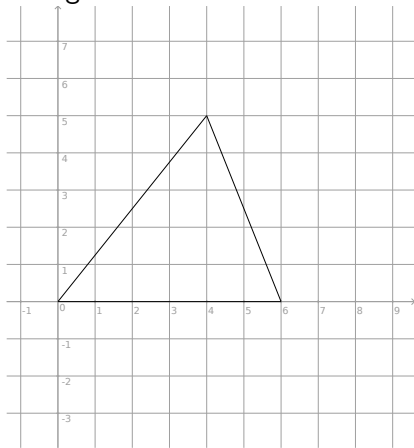
Crée ou appelle le point (0;0) et lui demande de se montrer

Declarative with messages[5]

Type-in program...

```
DrGeoSketch new  
  axesOn;  
  gridOn;  
  segment: 0 @ 0 to: 6 @ 0;  
  segment: 6 @ 0 to: 4 @ 5;  
  segment: 4 @ 5 to: 0 @ 0.
```

...to get this sketch



Challenges

Leçon 1

Lorsque tu es satisfait de ton résultat, sauvegarde le code source du programme, coche la case et passe à la figure.

☐ Triangle rectangle

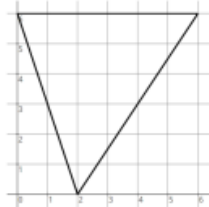


Lorsque tu es satisfait de ton résultat, coche la case et sauvegarde le code source sous le nom « Triangle rectangle ».

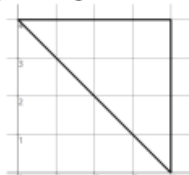
☐ Triangle isocèle



☐ Triangle sur la tête



☐ Triangle rectangle isocèle



Glossary

3. Glossaire

`DrGeoFigure` nouveau



Crée une nouvelle figure vide.

`afficherAxes` et `afficherGrille`



Messages envoyés à la figure pour afficher les axes et une grille.

`2 @ 3`



Point de coordonnées (2 ; 3), utilisé comme paramètre d'un message.

`segmentDe:à:`

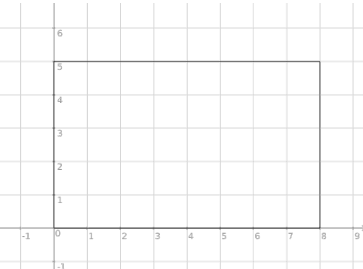


Message envoyé à une figure pour créer un segment dont les extrémités sont des points donnés en paramètres.

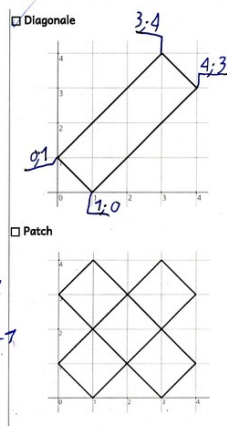
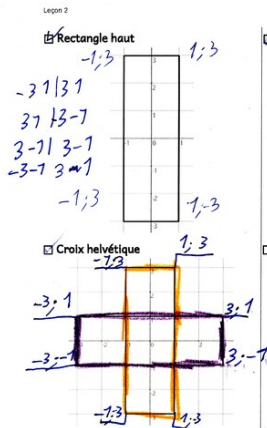
Introduce variable[6]

Type-in program...

```
| sketch |
sketch := DrGeoSketch new.
sketch axesOn; gridOn.
sketch segment: 0 @ 0 to: 8 @ 0.
sketch segment: 8 @ 0 to: 8 @ 5.
sketch segment: 8 @ 5 to: 0 @ 5.
sketch segment: 0 @ 5 to: 0 @ 0
```



...then do the challenges



3. Glossaire

Une variable est déclarée en début de

Use variables

Type-in program...

```
| sketch w h |
h := 3.
w := 8.
sketch := DrGeosketch new.
sketch axesOn ; gridOn.
sketch segment: 0 @ 0 to: w @ 0.
sketch segment: w @ 0 to: w @ h.
sketch segment: w @ h to: 0 @ h.
sketch segment: 0 @ h to: 0 @ 0.
```

...and kid analysis

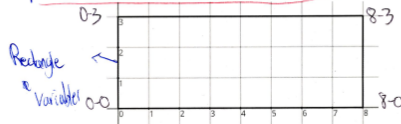
Leçon 3

RECTANGLES & CARRÉS

Au cours de cette activité tu vas construire des carrés et des rectangles en utilisant des variables pour représenter les longueurs de leurs côtés.

1. Exemple Rectangle Variable

```
| figure longueur largeur |
longueur := 3.
largeur := 8.
figure := DrGeoFigure nouveau.
figure afficherAxes; afficherGrille.
figure segmentDe: 0 @ 0 a: longueur @ 0.
figure segmentDe: longueur @ 0 a: longueur @ largeur.
figure segmentDe: longueur @ largeur a: 0 @ largeur.
figure segmentDe: 0 @ largeur a: 0 @ 0.
```



Pour lancer le programme, au clavier : **Ctrl - A** puis **Ctrl - D**.

2. Partie Pratique

Avant toute chose tu dois immédiatement renommer l'onglet avec

Compute with loop

The Dr. Geo kid IDE

The screenshot shows the Dr. Geo kid IDE window titled "Modifier un script Smalltalk". The interface includes a toolbar with icons for file operations, execution, and undo/redo. The script editor on the left contains the following Smalltalk code:

```

|| fig long larg pas|
larg ← 2.
long ← 5.
pas ← 2.
fig ← DrGeoFigure nouveau.
fig afficherAxes; afficherGrille.
6 foisRépéter: [
  fig segmentDe: 0 @ 0 à: long @ 0.
  fig segmentDe: long @ 0 à: long @ larg.
  fig segmentDe: long @ larg à: 0 @ larg.
  fig segmentDe: 0 @ larg à: 0 @ 0.
  long ← long + pas.
  larg ← larg + pas ]

```

The right side of the IDE displays a graph on a grid. The x-axis is labeled from 0 to 15, and the y-axis is labeled from 0 to 13. The graph shows a series of connected line segments forming a stepped pattern. The segments are defined by the coordinates (0,0) to (5,0), (5,0) to (5,2), (5,2) to (0,2), (0,2) to (0,4), (0,4) to (5,4), (5,4) to (5,6), (5,6) to (0,6), (0,6) to (0,8), (0,8) to (5,8), (5,8) to (5,10), (5,10) to (0,10), (0,10) to (0,12), (0,12) to (5,12), and (5,12) to (0,12). The graph is titled "Sélectionner et déplacer un objet." and has an "Abandon" button at the bottom right.

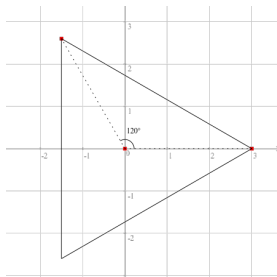
Explore mathematics

Regular polygon & transformation

```

| sketch pt1 pt2 seg angle |
sketch := DrGeoSketch new.
sketch axesOn; gridOn.
angle := 120.
pt1 := sketch point: 3 @ 0.
pt2 := sketch
  rotate: pt1
  center: 0 @ 0
  angleDegrees: angle.
seg := sketch segment: pt1 to: pt2.
2 timesRepeat: [
  seg := sketch
    rotate: seg
    center: 0 @ 0
    angleDegrees: angle].
(sketch segment: 0@0 to: pt1) small; dotted.
(sketch segment: 0@0 to: pt2) small; dotted

```



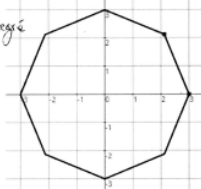
Challenges of regular polygons

Measures with a protractor...

Leçon 6

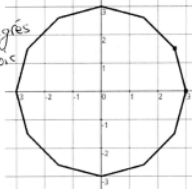
☐ Octogone régulier

angle 45 degrés
8 fois



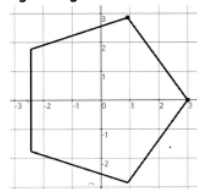
☐ Dodécagone régulier

30 degrés
12 fois

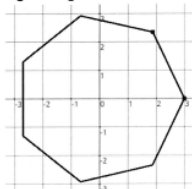


☐ Pentagone régulier

72 degrés
5 fois



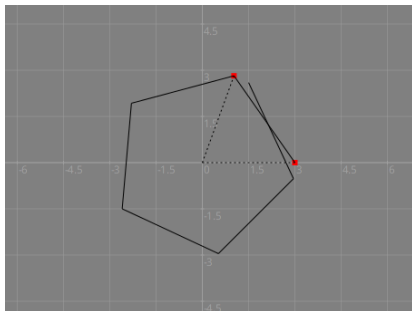
☐ Heptagone régulier



Houston, we've had a problem here !

...mathematics to the rescue

```
| sketch ptA ptB seg angle |  
sketch := DrGeoSketch new.  
sketch axesOn; gridOn.  
angle := 360 / 5.  
ptA := sketch point: 3 @ 0.
```

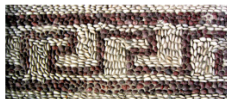


The benefit of collection

Leçon 9

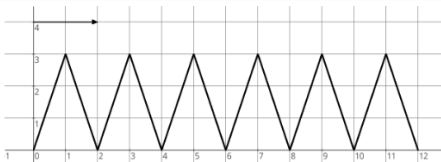
F R I S E 1

Connais-tu les frises ? Ce sont des motifs décoratifs qui se répètent, comme cette frise trouvée dans une rue de l'île grecque de Rhodes. A l'aide de translation, tu vas apprendre à les programmer.



1. Exemple Frise Triangle

```
| figure collection v |
figure ← DrGeoFigure nouveau.
figure afficherAxes; afficherGrille.
v ← figure vecteurOrigine: 0 @ 4 extrémité: 2 @ 4.
collection ← {figure segmentDe: 0 @ 0 à: 1 @ 3.
__figure segmentDe: 1 @ 3 à: 2 @ 0}.
5 foisRépéter: [
__collection ← collection collecter: [ :forme |
__figure translationDe: forme parVecteur: v ] ]
```



- Design a DSL related to a taught domain, *Dr. Geo* DSL
 - ⇒ vocabularies of the taught domain
- Makes DSL closes to the learner representations, *geometric idioms*
 - ⇒ DSL in **native language**. Easy with Smalltalk.
- Learn from examples, *Human copies by-design !*
 - ⇒ learner type-in code, do not elude this part
- Conceive challenges
 - ⇒ progressive, challenge the learner domain knowledge (i.e pentagon and heptagon)



Alan BORNING. *Thinglab – A constraint Oriented Simulation Laboratory*. Xerox PARC, 1979.



Hilaire FERNANDES *GNU Dr. Geo*. Free Software Foundation, 1998-2013



Hilaire FERNANDES *A Brief History of GNU Dr. Geo*. Free Software Foundation, 1998



Jean-Marie LABORDE. *Cabri history*. Cabrilog, 2007



Hilaire FERNANDES *Programmer Géométrie - Leçon 1*. 2020, 2023



Hilaire FERNANDES *Programmer Géométrie - Leçon 2*. 2020, 2023