Modélisation de la croissance d'une plante avec L-Py

OpenAlea

Modèles & softwares :

Core,

VisuAlea,

Standard Library,

SconsX,

Virtual Plants,

Alinea,

Mars-alt

…

Packages :

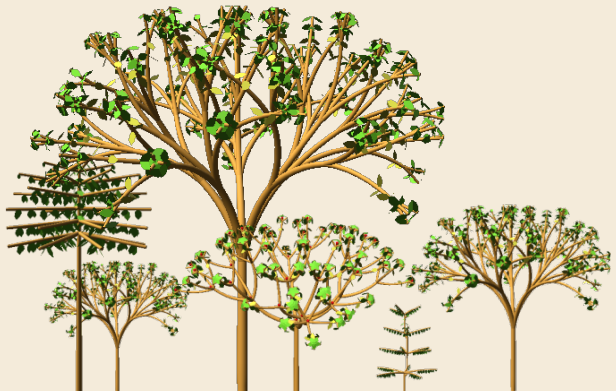
AML,

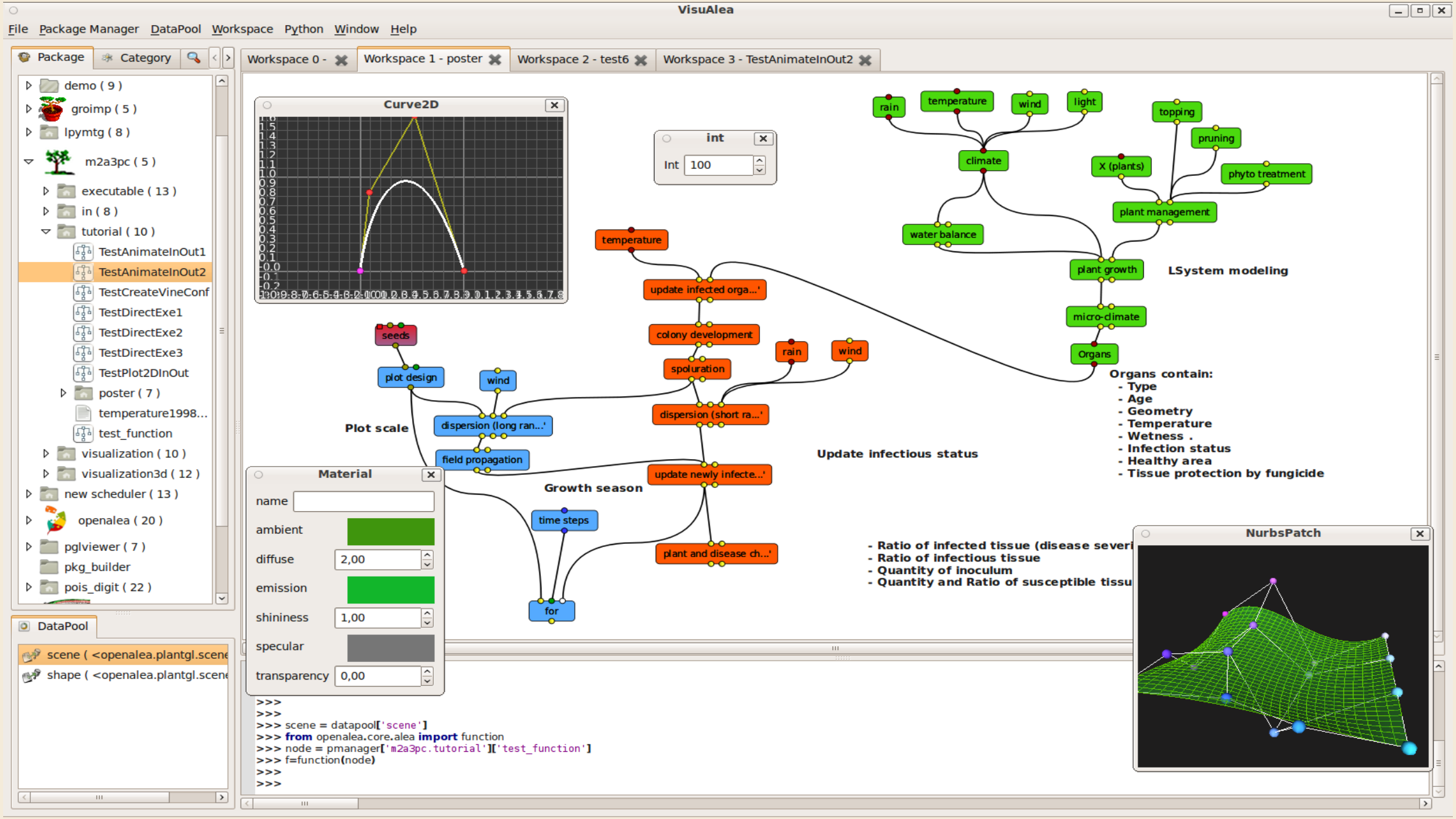
PlantGL,

L-py

…

…




VisuAlea
File Package Manager DataPool Workspace Python Window Help
Package
Category
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groimp (5)
lpymtg (8)
m2a3pc (5)
executable (13)
in (8)
tutorial (10)
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TestAnimateInOut2
TestCreateVineConf
TestDirectExe1
TestDirectExe2
TestDirectExe3
TestPlot2DInOut
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temperature1998...
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Workspace 3 - TestAnimateInOut2
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int
Int 100
Material
name
ambient
diffuse 2,00
emission
shininess 1,00
specular
transparency 0,00
rain
temperature
wind
light
climate
topping
pruning
X (plants)
phyto treatment
plant management
water balance
plant growth
LSystem modeling
micro-climate
Organs
Organs contain:
- Type
- Age
- Geometry
- Temperature
- Wetness .
- Infection status
- Healthy area
- Tissue protection by fungicide
temperature
update infected orga...'
colony development
spoluration
rain
wind
dispersion (short ra...'
Update infectious status
update newly infecte...'
plant and disease ch...'
- Ratio of infected tissue (disease severi
- Ratio of infectious tissue
- Quantity of inoculum
- Quantity and Ratio of susceptible tissu
seeds
plot design
wind
Plot scale
dispersion (long ran...'
field propagation
Growth season
time steps
for
NurbsPatch
>>>
>>>
>>> scene = datapool['scene']
>>> from openalea.core.alea import function
>>> node = pmanager['m2a3pc.tutorial']['test_function']
>>> f=function(node)
>>>
>>>

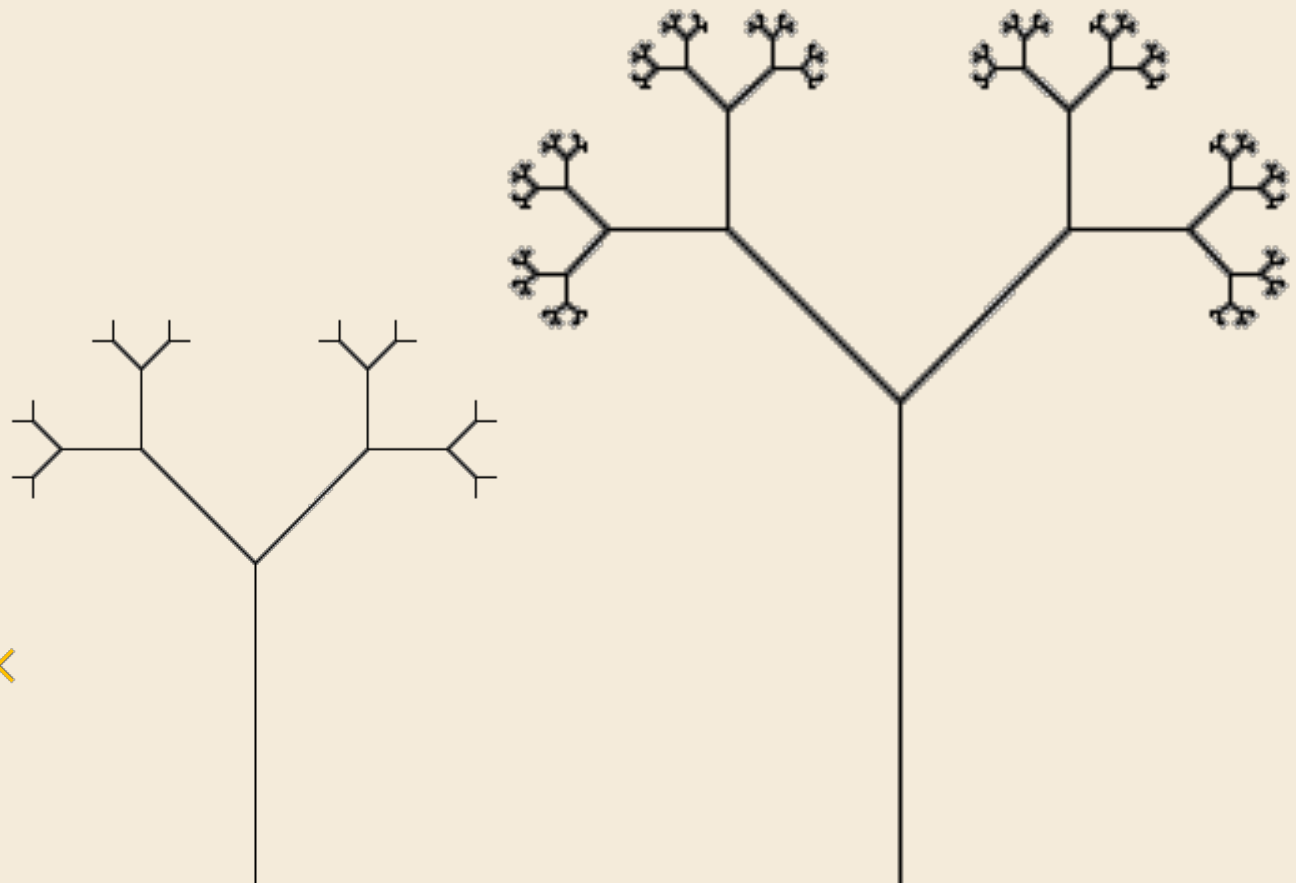
Système de Lindenmayer (L-system)

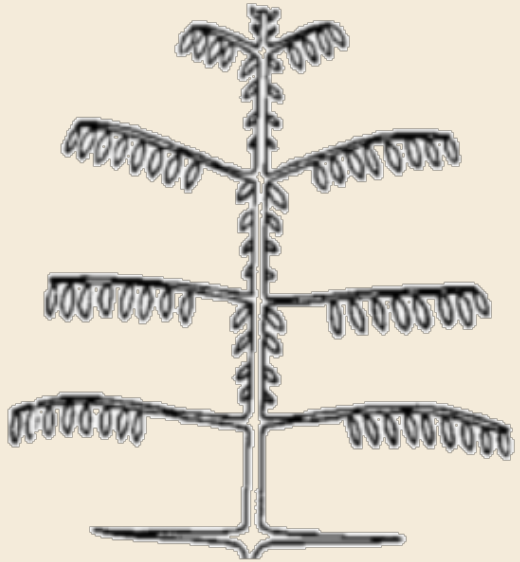
Règles: (A → AB), (B → A)

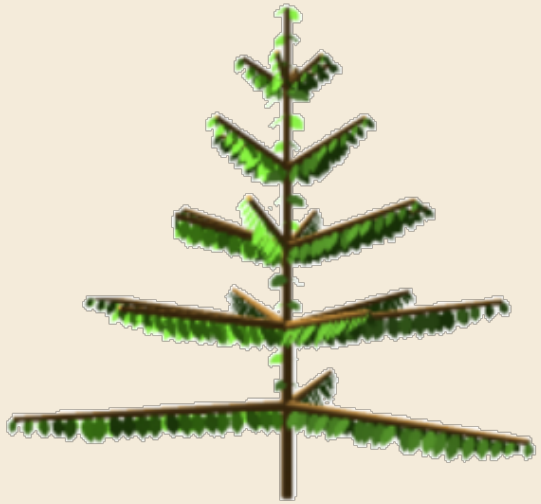
```
n=0:          A
             / \
n=1:        A   B
           /|    \
n=2:      A B     A
         /| |     |\
n=3:    A B A     A B
       /| | |\    |\ \
n=4: A B A A B    A B A
```

Règles : (1 → 11), (0 → 1[0]0)

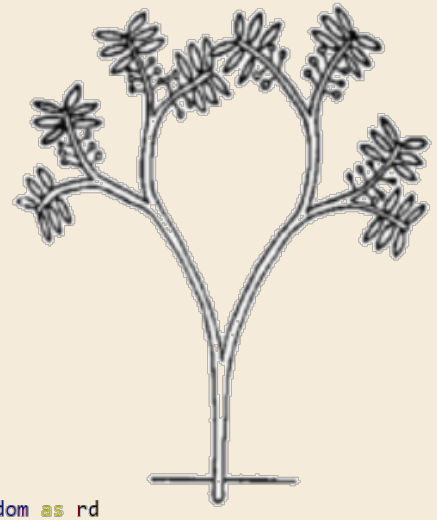
n=0: 0
n=1: 1[0]0
n=2: 11[1[0]0]1[0]0
n=3: 1111[11[1[0]0]1[0]0]11[1[0]0]1[0]0

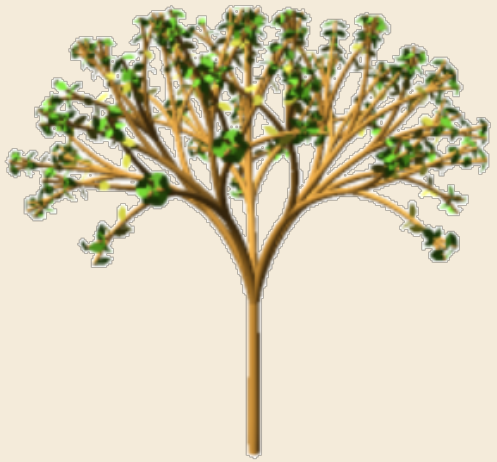






```
import random as rd

stagelength = 3
nbcycle = 8
leafduration = 20
leafmaturation = 5
angdev = 10
leafel = -60
radinc = 0.005

def maxleafsize(s,maxs):
  return ((maxs-s)*0.5/float(maxs))+0.5

def leafsize(maxsize, t):
  at = leafduration - t
  if at < leafmaturation:
    return maxsize * ((at*0.5/float(leafmaturation))+0.5)
  else:
      return maxsize

def branch_angle(nc):
    return 30+ 60*(nc/float(nbcycle))

Axiom: !(0.1)I(0.5,0.1)A(stagelength,nbcycle)

derivation length: nbcycle*stagelength
production:

A(t,nc) :
  if t == 0:
    if nc > 0:
     produce V(nc,rd.randint(3,6),0)A(stagelength,nc-1)
  else:
```

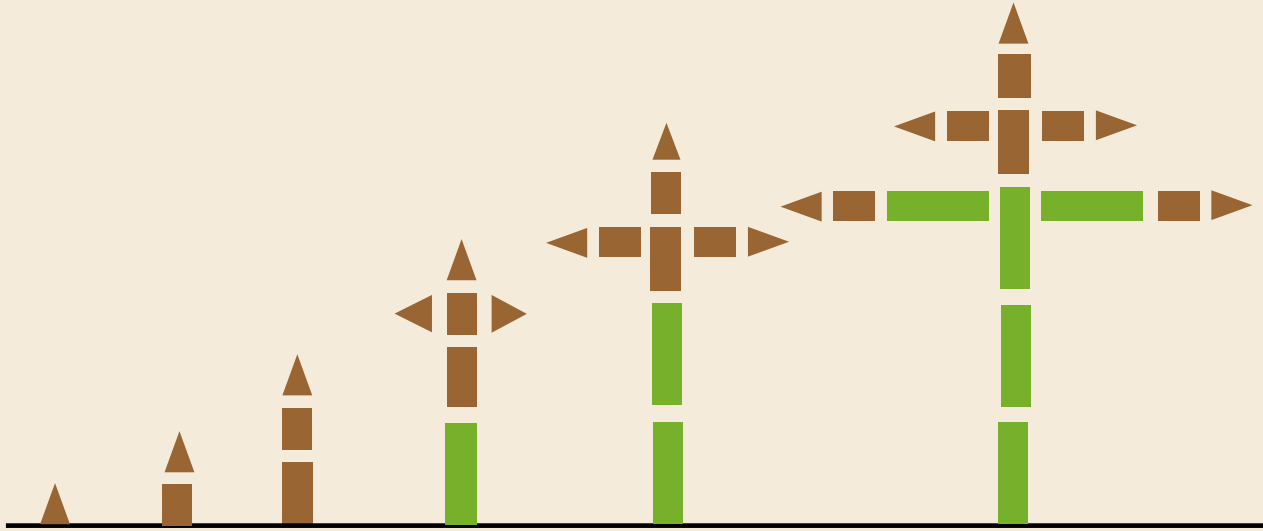


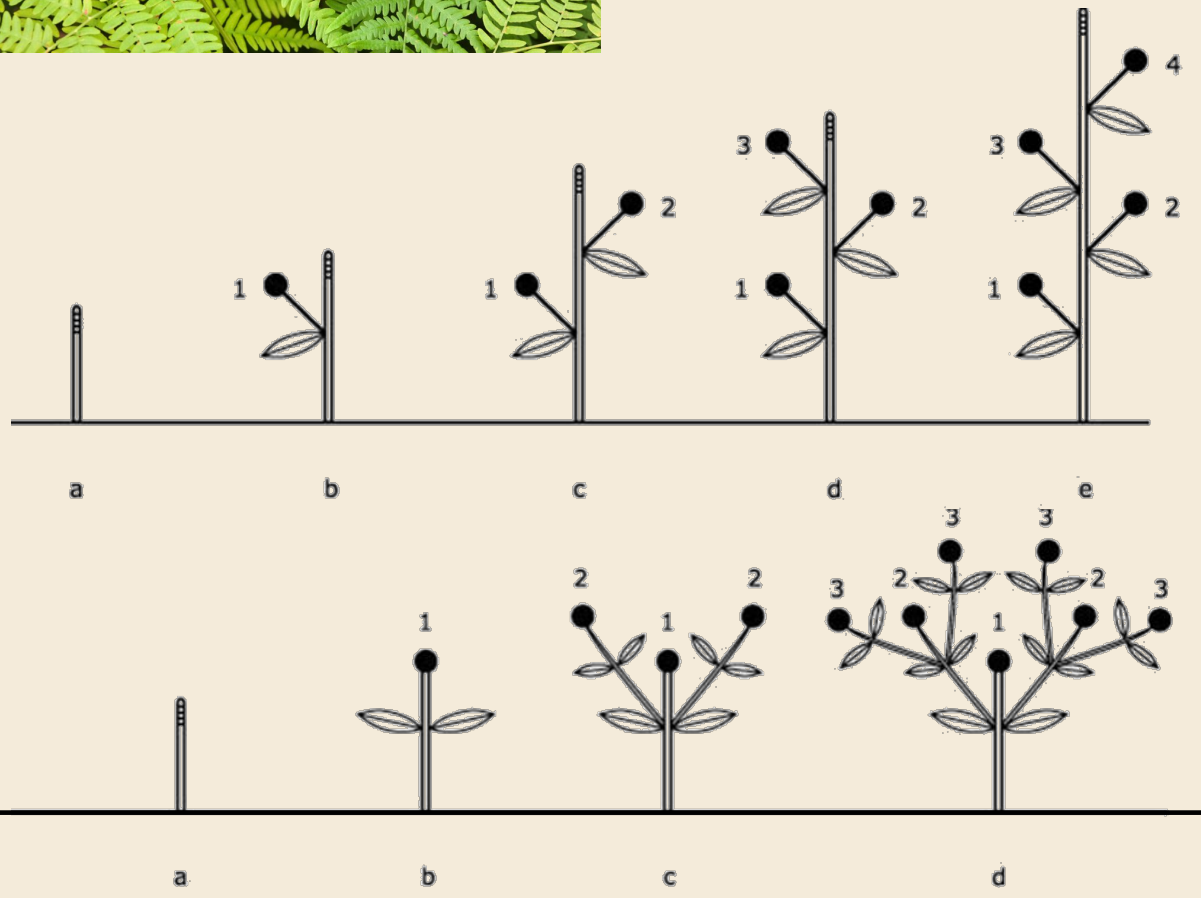


```
import random as rd

leafduration = 4 # life time of a leaf
leafold =      2 # age at which a leaf is considered as old
maxorder =     4 # maximum number of branching order
radinc =    0.01 # increment of radius through time

maxduration = lambda order : int(5./(order+1))+5  # life time of an apex
branch_angle = lambda order : 8 # branching angle
# number of axe at a ramification
nb_axes = lambda order : rd.randint(2,4) if order > 2 else rd.randint(4-int((order+1)/2),5-int((orde
up_angle = lambda t,order : -5        # up angle for lateral branches

# number total of iterations of the system
nbiter = sum([maxduration(o) for o in xrange(maxorder+1)])

module A # represent trunk apical meristem
module B # represent apical meristem of lateral branches
module L # whorl of leaf
module I # Internode


Axiom: _(0.05)@GcI(0.5,0.05)A(0,0)

derivation length: nbiter
production:

A(t,o) :
  if t < maxduration(o):
     # simply produces a metamer and ages the apex
```

Comme la Nature, basé sur l'itération



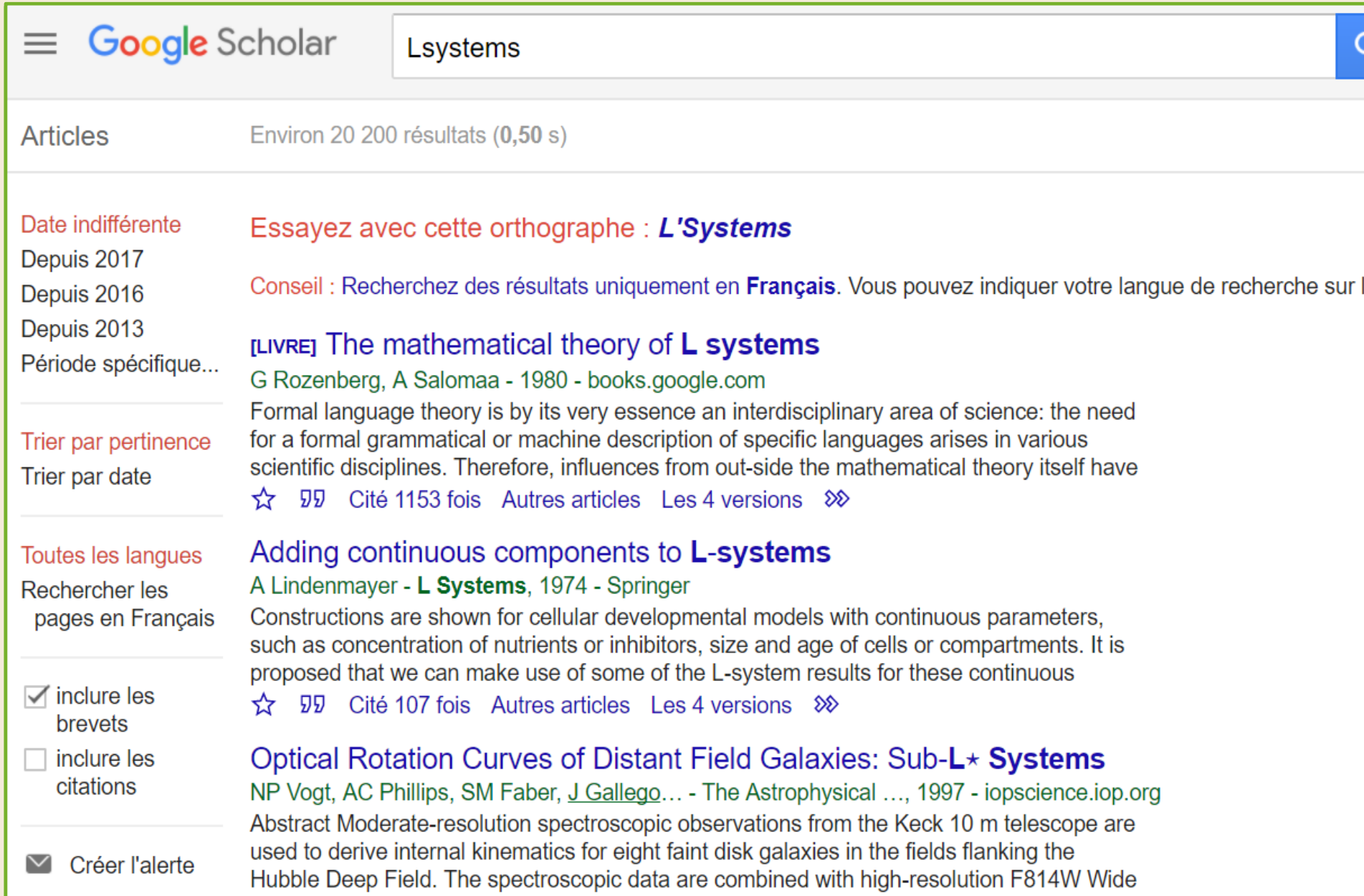





Comment ça marche ?

Dans la littérature

- Christophe Godin
- Christophe Pradal
- …



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Developmental model of an automatic production of the human bronchial tree based on L-system

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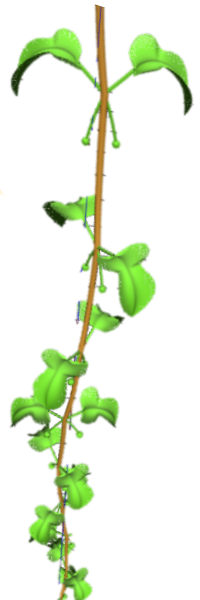
Notre Projet

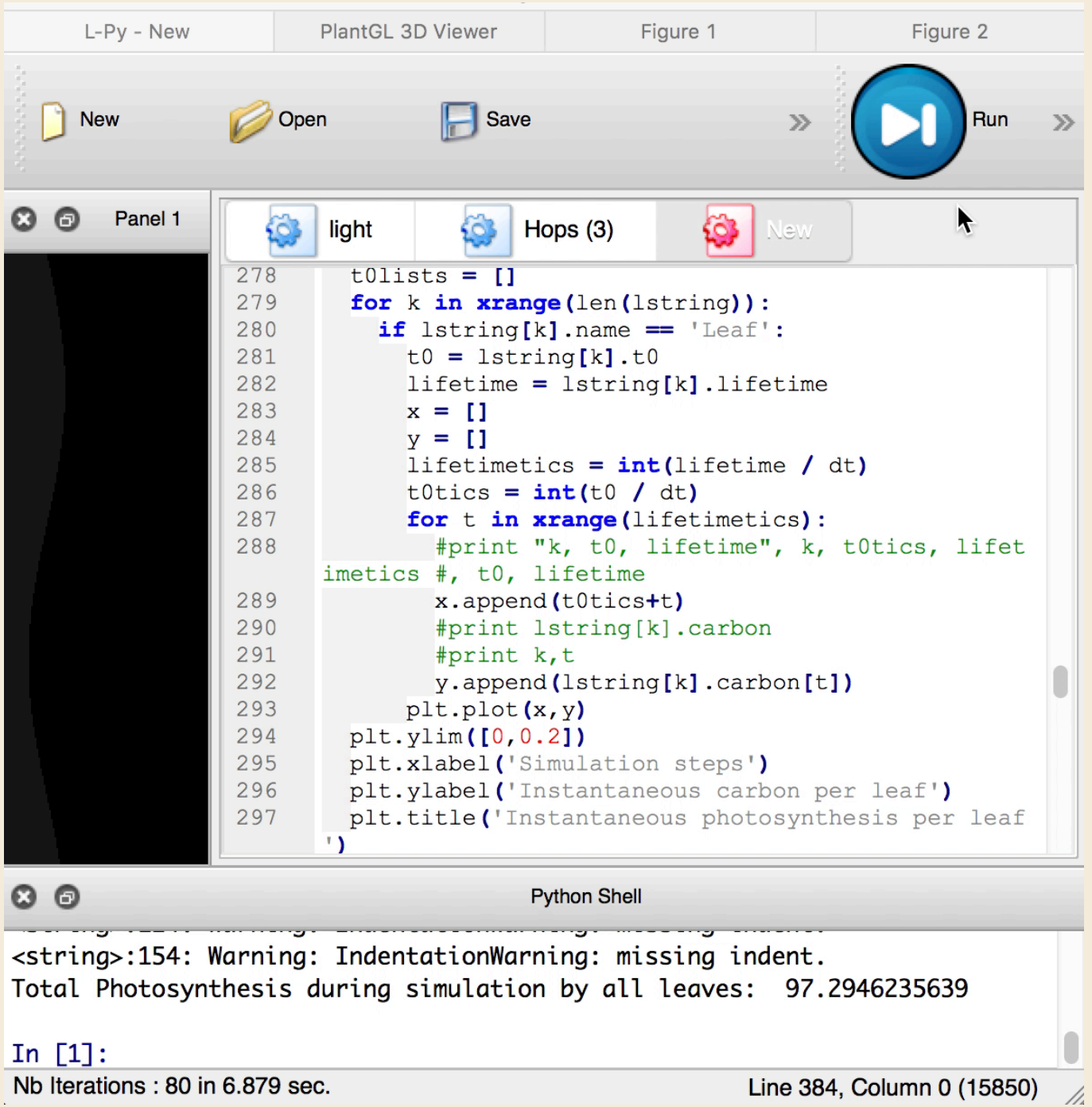
1ère étape : Comprendre L-Py et son langage ✓

2ème étape : Créer une plante modèle (croissance simulée) ✓

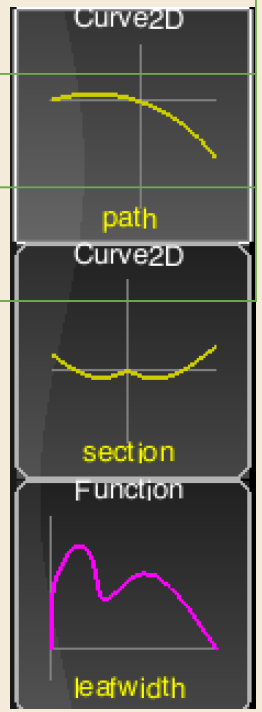
3ème étape : Implanter la plante dans le modèle de lumière ≈

4ème étape : Vérification avec données réelles ✗




L-Py - New
PlantGL 3D Viewer
Figure 1
Figure 2
New
Open
Save
Run
Panel 1
light
Hops (3)
New
t0lists = []
for k in xrange(len(lstring)):
if lstring[k].name == 'Leaf':
t0 = lstring[k].t0
lifetime = lstring[k].lifetime
x = []
y = []
lifetimetics = int(lifetime / dt)
t0tics = int(t0 / dt)
for t in xrange(lifetimetics):
#print "k, t0, lifetime", k, t0tics, lifetimetics #, t0, lifetime
x.append(t0tics+t)
#print lstring[k].carbon
#print k,t
y.append(lstring[k].carbon[t])
plt.plot(x,y)
plt.ylim([0,0.2])
plt.xlabel('Simulation steps')
plt.ylabel('Instantaneous carbon per leaf')
plt.title('Instantaneous photosynthesis per leaf')
Python Shell
<string>:154: Warning: IndentationWarning: missing indent.
Total Photosynthesis during simulation by all leaves: 97.2946235639
In [1]:
Nb Iterations : 80 in 6.879 sec.
Line 384, Column 0 (15850)

Problèmes rencontrés	Solutions trouvées
Représentation réaliste des feuilles	Utilisation de graphiques Polyline
Téléchargement de Open Alea	Utilisation d'un modèle fonctionnant sous L-Py
Fonctionnement du modèle de lumière sur PC	Utilisation uniquement sur Mac
Intégration de notre plante dans le modèle de lumière	Pas de solutions trouvées…



Conclusion

- Bugs d’installation, de codages,…
- Modèle ≠ réalité
- Importance de la communication
- Interaction de différents modèles