



# 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

Workspace 0 - poster Workspace 1 - poster Workspace 2 - test6 Workspace 3 - TestAnimateInOut2

**LSystem modeling**

```

graph TD
    rain((rain)) --> climate[climate]
    temperature((temperature)) --> climate
    wind((wind)) --> climate
    light((light)) --> climate
    climate --> waterBalance[water balance]
    waterBalance --> plantGrowth[plant growth]
    plantManagement[plant management] --> plantGrowth
    plantGrowth --> microClimate[micro-climate]
    plantGrowth --> organs[Organs]
    
```

**Plot scale**

```

graph TD
    seeds((seeds)) --> plotDesign[plot design]
    plotDesign --> dispersionL[dispersion (long ran...)]
    dispersionL --> fieldPropagation[field propagation]
    fieldPropagation --> spoleration[spoleration]
    spoleration --> dispersionS[dispersion (short ra...)]
    dispersionS --> updateInfected[update infected orga...]
    updateInfected --> colonyDevelopment[colony development]
    rain((rain)) --> dispersionL
    wind((wind)) --> dispersionL
    
```

**Growth season**

```

graph TD
    timeSteps[time steps] --> forFor[for]
    forFor --> updateNewlyInfected[update newly infecte...]
    updateNewlyInfected --> plantDisease[plant and disease ch...]
    
```

**Update infectious status**

```

graph TD
    temperature((temperature)) --> updateInfected[update infected orga...]
    rain((rain)) --> updateInfected
    wind((wind)) --> updateInfected
    updateInfected --> colonyDevelopment
    
```

**DataPool**

scene (<openalea.plantgl.scene>) shape (<openalea.plantgl.scene>)

```

>>>
>>>
>>> scene = datapool['scene']
>>> from openalea.core.alea import function
>>> node = pmanager['m2a3pc.tutorial']['test_function']
>>> f=function(node)
>>>
>>>

```

**NurbsPatch**

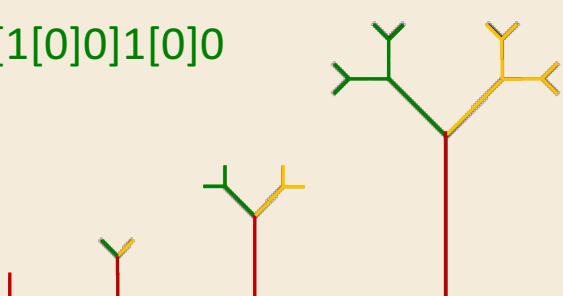
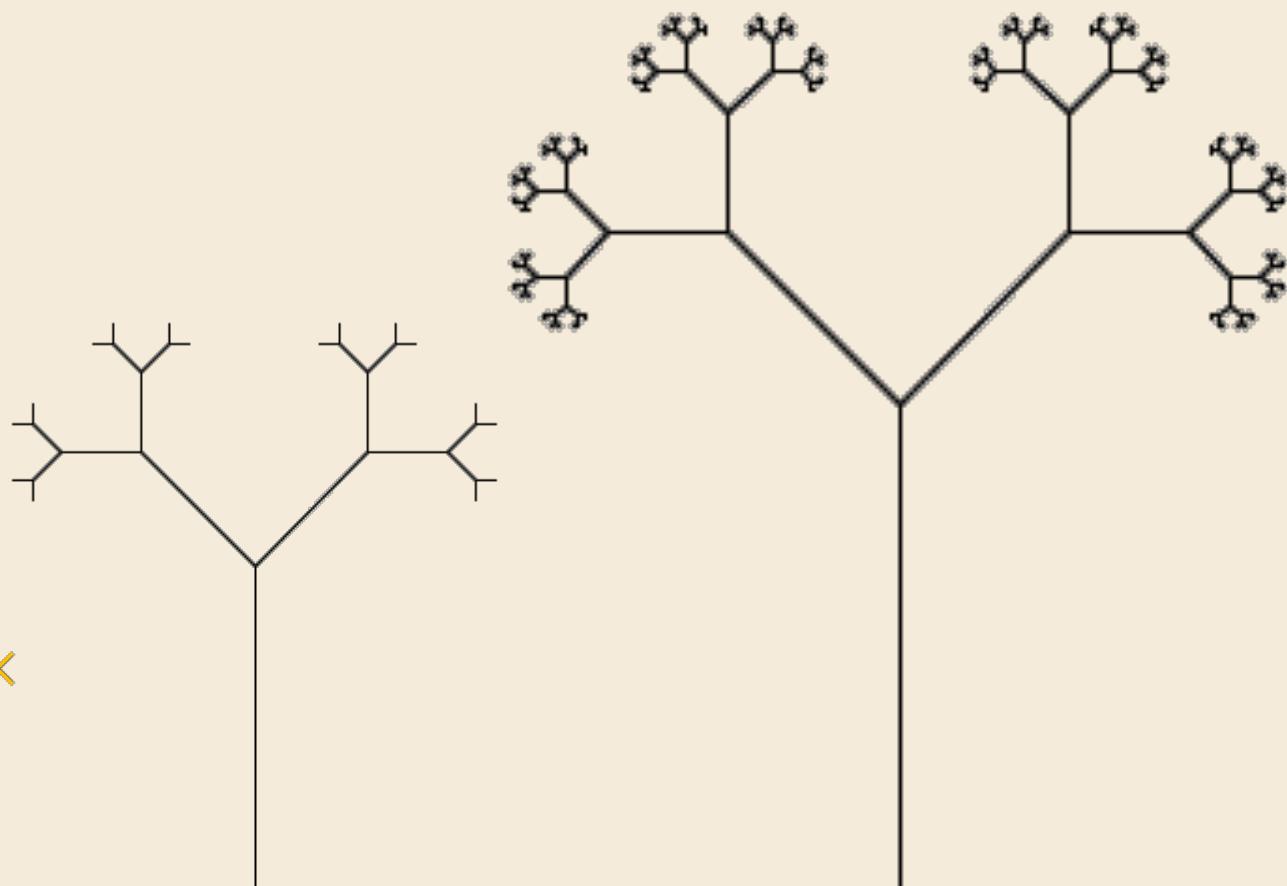
# Système de Lindenmayer (L-system)

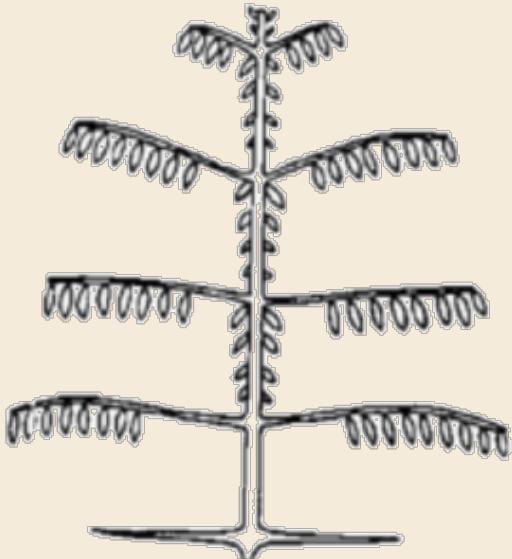
Règles: ( $A \rightarrow AB$ ), ( $B \rightarrow A$ )

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

Règles : ( $1 \rightarrow 11$ ), ( $0 \rightarrow 1[0]0$ )

$n=0:$	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((order+1)/2))
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)])

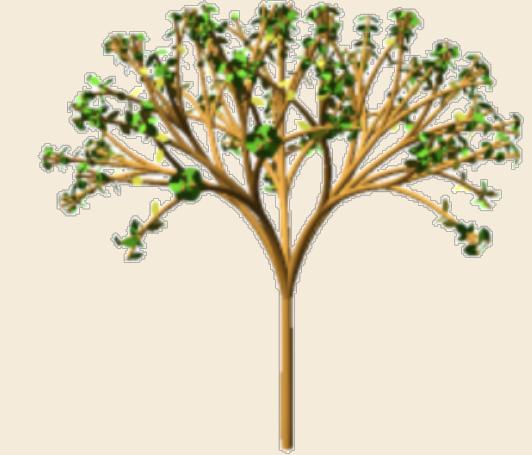
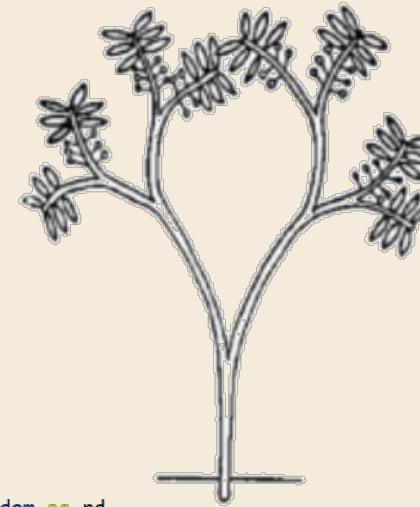
module A # represent trunk apical meristem
module B # represent apical meristem of lateral branches
module L # whorl of leaf
module I # Internode

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

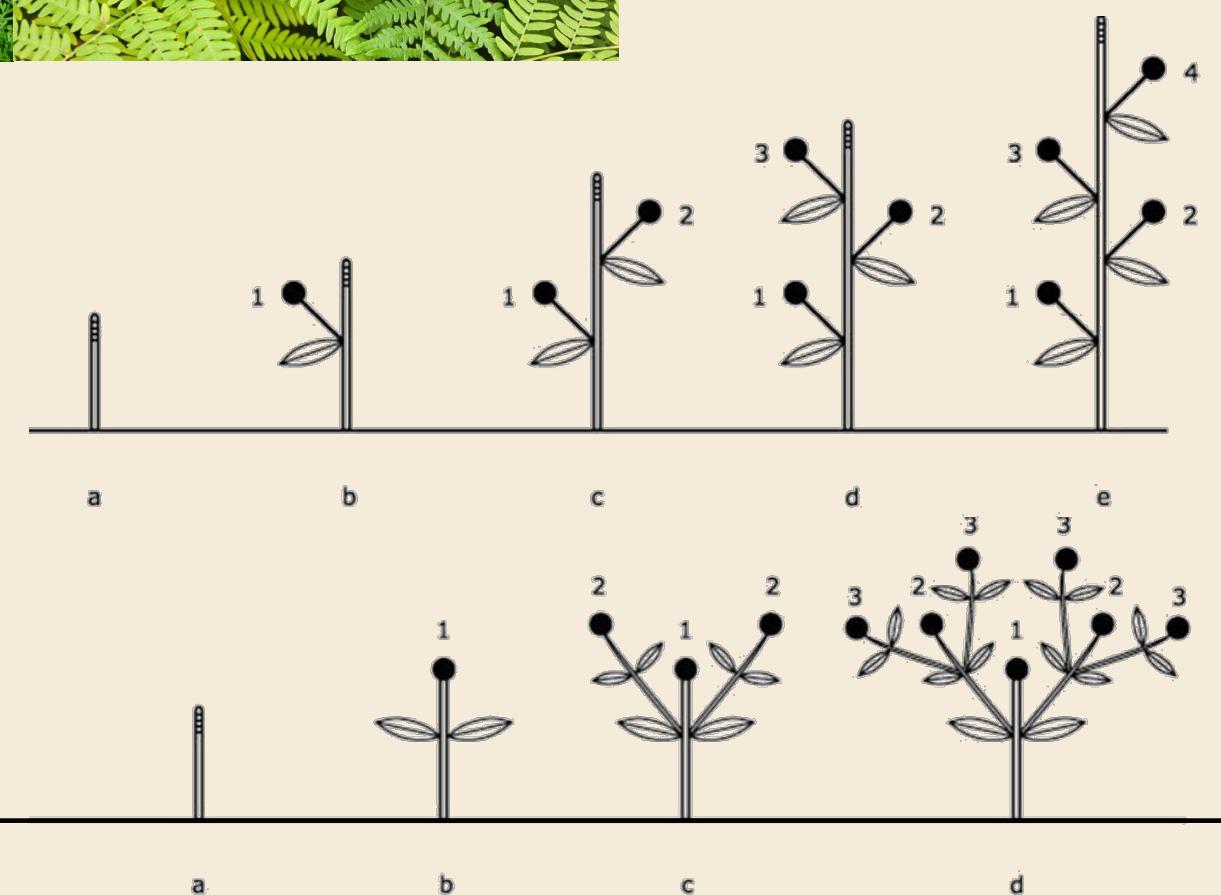
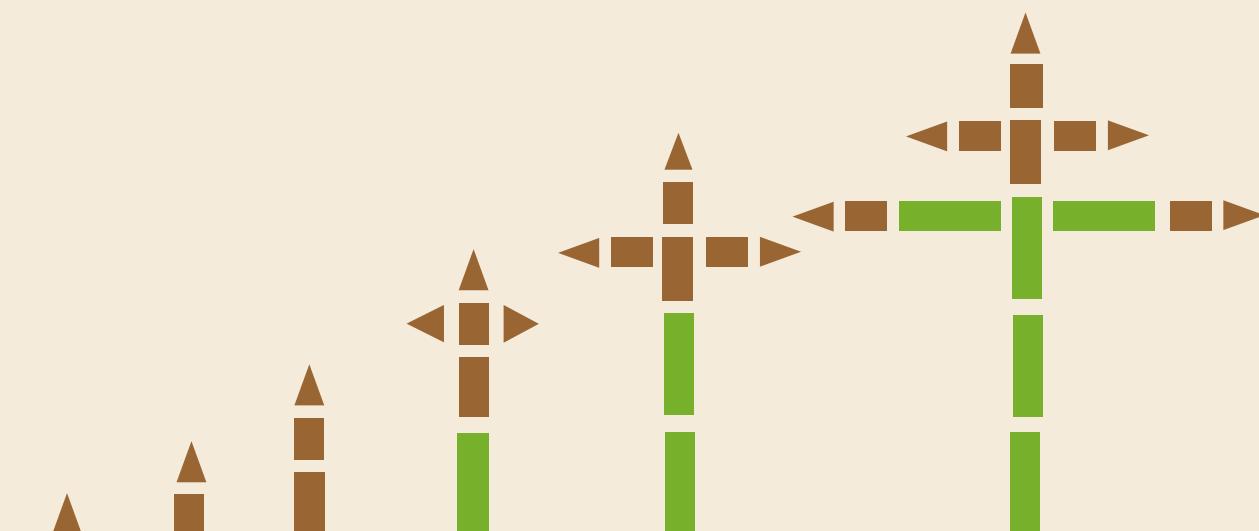
derivation length: nbiter
production:

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
- ...

≡ Google Scholar Lsystems

Articles Environ 20 200 résultats (0,50 s)

Date indifférente Essayer avec cette orthographe : **L'Systems**  
Depuis 2017 Conseil : Recherchez des résultats uniquement en **Français**. Vous pouvez indiquer votre langue de recherche sur la page d'accès.

Depuis 2016

Depuis 2013

Période spécifique...

Trier par pertinence [LIVRE] **The mathematical theory of L systems**  
G Rozenberg, A Salomaa - 1980 - books.google.com  
Formal language theory is by its very essence an interdisciplinary area of science: the need for a formal grammatical or machine description of specific languages arises in various scientific disciplines. Therefore, influences from outside the mathematical theory itself have  
☆ 99 Cité 1153 fois Autres articles Les 4 versions

Trier par date

Toutes les langues Adding continuous components to **L-systems**  
Rechercher les A Lindenmayer - **L Systems**, 1974 - Springer  
pages en Français Constructions are shown for cellular developmental models with continuous parameters, such as concentration of nutrients or inhibitors, size and age of cells or compartments. It is proposed that we can make use of some of the L-system results for these continuous  
☆ 99 Cité 107 fois Autres articles Les 4 versions

inclure les brevets

inclure les citations

Créer l'alerte Optical Rotation Curves of Distant Field Galaxies: Sub-L $\star$  **Systems**  
NP Vogt, AC Phillips, SM Faber, J Gallego... - *The Astrophysical Journal*, 1997 - iopscience.iop.org  
Abstract Moderate-resolution spectroscopic observations from the Keck 10 m telescope are used to derive internal kinematics for eight faint disk galaxies in the fields flanking the Hubble Deep Field. The spectroscopic data are combined with high-resolution F814W Wide



ELSEVIER

journal homepage: [www.intl.elsevierhealth.com/journals/cmpb](http://www.intl.elsevierhealth.com/journals/cmpb)

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



CrossMark

Amirabbas Davoodi, Ramin Bozorgmehry Boozarjomehry \*

Chemical and Petroleum Engineering Department, Sharif University of Technology, Azadi Av., Tehran, Iran

# Notre Projet



1<sup>ère</sup> étape : Comprendre L-Py et son langage ✓

2<sup>ème</sup> étape : Créer une plante modèle (croissance simulée) ✓

3<sup>ème</sup> étape : Implanter la plante dans le modèle de lumière ≈

4<sup>ème</sup> 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

```
278 t0lists = []
279 for k in xrange(len(lstring)):
280     if lstring[k].name == 'Leaf':
281         t0 = lstring[k].t0
282         lifetime = lstring[k].lifetime
283         x = []
284         y = []
285         lifetimeticks = int(lifetime / dt)
286         t0tics = int(t0 / dt)
287         for t in xrange(lifetimeticks):
288             #print "k, t0, lifetime", k, t0tics, lifetimeticks, t0, lifetime
289             x.append(t0tics+t)
290             #print lstring[k].carbon
291             #print k,t
292             y.append(lstring[k].carbon[t])
293             plt.plot(x,y)
294             plt.ylim([0,0.2])
295             plt.xlabel('Simulation steps')
296             plt.ylabel('Instantaneous carbon per leaf')
297             plt.title('Instantaneous photosynthesis per leaf')
```

Python Shell

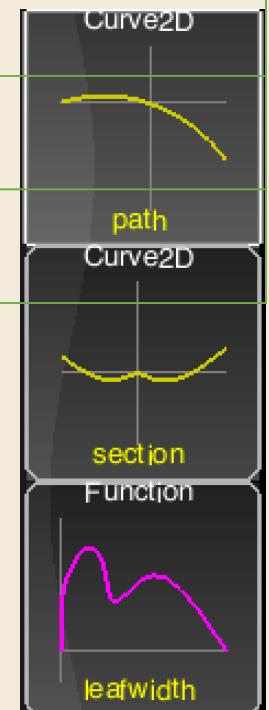
```
<string>:154: Warning: IndentationWarning: missing indent.
Total Photosynthesis during simulation by all leaves: 97.2946235639
```

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