

cs229 Final project
Animation of plant development

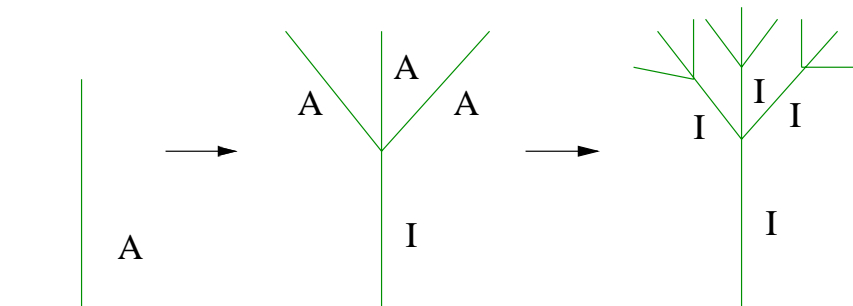
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L-Systems: Introduction

- View plant as a branching structure composed of repeated modules



- L-system: describe this structure with a set of productions

$$A \rightarrow I[-A][+A]A$$

L-strings

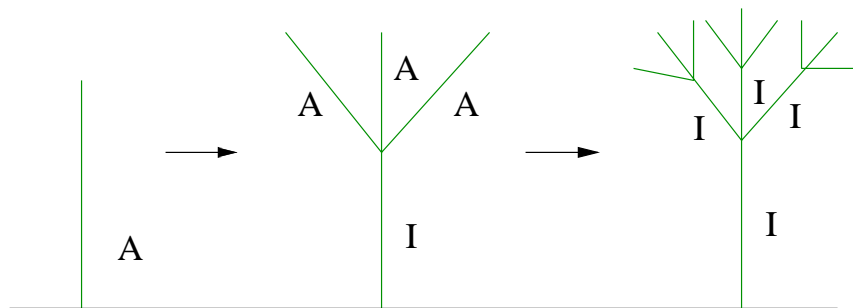
- Axiom: A
- Rule: $A \rightarrow I[-A][+A]A$

Sequence of generated strings:

Iteration 0: A

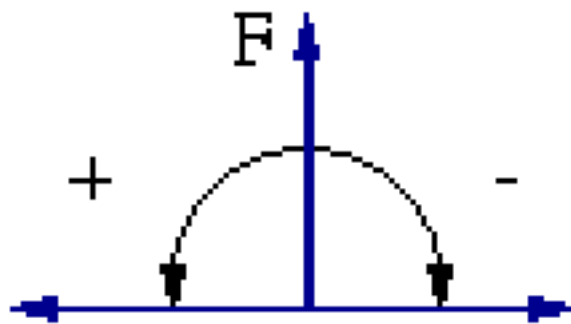
Iteration 1: $I[-A][+A]A$

Iteration 2: $I[-I[-A][+A]A][+I[-A][+A]A]I[-A][+A]A$



Graphical Interpretation of L-systems

A state of the turtle is the triple (x, y, α)



- F Move one step forward $(x + d \cdot \cos\alpha, y + d \cdot \sin\alpha, \alpha)$.
- + Turn left by angle δ : $(x, y, \alpha + \delta)$.
- - Turn left by angle δ : $(x, y, \alpha - \delta)$.

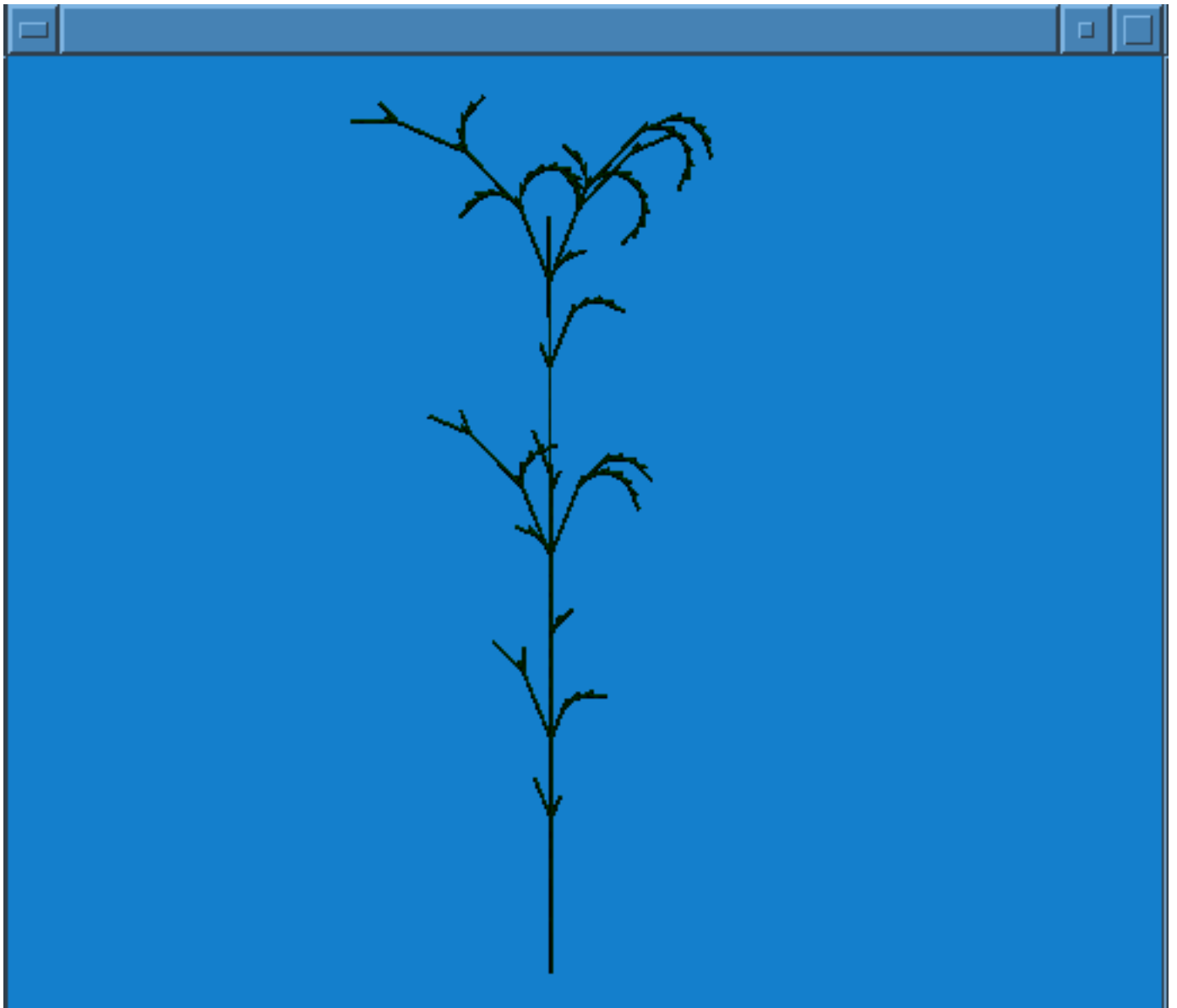
Static plants

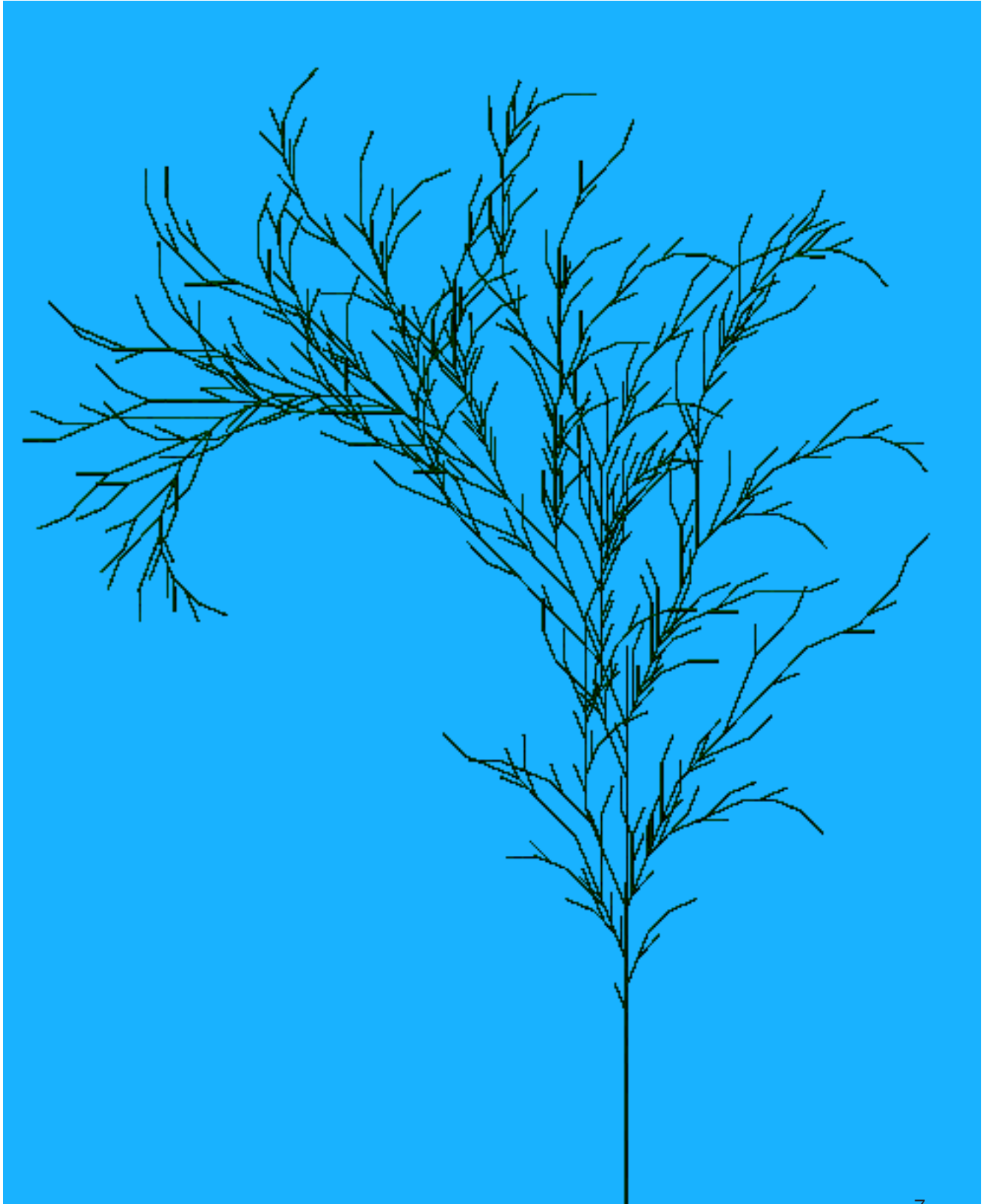
- Parse a file containing an L-grammar description
- Generate L-string by applying appropriate rules to the modules of the initial string (axiom)
- Parse final string using turtle interpretation, create a scenegraph for this model
- Display final geometry

L-file

```
num_iterations: 3
angle: 35
step: 3.0
radius: 0.03
axiom: XF
rules:
X:
produce F[-XF]X
endrule
F:
produce F[+F] [-F]F
endrule
end
```

Context-Sensitive L-grammars





<i>First plant</i>	<i>Second plant</i>
num_iterations: 24	num_iterations: 25
angle: 25.75	angle: 22.5
ignore: +-F	ignore: +-F
axiom: FKFBFB	axiom: FBFBFB
rules:	rules:
K<K>K=B	K<K>K=K
K<K>B=K[+FBFB]	K<K>B=B[+FBFB]
KK=K	KK=B
KB=BFB	KB=B
B<K>K=B	B<K>K=K
B<K>B=B[+FBFB]	B<K>B=BFB
BK=B	BK=K
BB=K	BB=K
+=-, -=+	+=-, -=+

3D Turtle Interpretation

(x,y,z) - turtle's position, (h,l,u) - turtle's orientation

Control symbols:

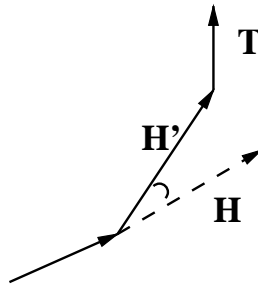
- $+(\delta)$ Turn left by angle δ
- $-(\delta)$ Turn right by angle δ
- $\&(\delta)$ Pitch down by angle δ
- $\wedge(\delta)$ Pitch up by angle δ
- $/(\delta)$ Roll left by angle δ
- $\backslash(\delta)$ Roll right by angle δ

Parametric L-systems

```
lssystem: 0
num_iterations: 2
angle: 22.5
step: 2
radius: 0.05
axiom: FA(4)B(3)C(5)
rules:
A(x)<B(y)>C(z):
  if (z+y+1<3)&(x=10)
    produce E((x+y)/2)F((y+z)/2,4,5*y)
  if x+y+z<=10
    produce F(2*x)
endrule
```

Tropism

At each step slightly rotate the turtle in the direction of a tropism vector T .



$$\alpha = e \cdot |H \times T|$$

Animation

We need to separate growth and discrete events:

```
axiom: A(1,4)
```

```
rules:
```

```
A(x,n):
```

```
if x<2.0
```

```
produce A(x+0.1,n)
```

```
if x=2.0&n=0
```

```
produce B(x)L(0.2)
```

```
if x=2.0&n>0
```

```
produce B(0.5*x) [(8.0)L(0.2)]
```

```
endrule
```

```
B(x):
```

```
produce B(1.01*x)
```

```
+(x) :  
produce +(1.05*x)  
endrule
```

```
~(x) :  
produce ~(1.05*x)  
endrule  
end
```

Conclusions

L-systems are so much fun :)

