Computational Fabrication

CS 491 and 591
Professor: Leah Buechley
https://handandmachine.cs.unm.edu/classes/Computational_Fabrication_Spring2021/

Large Assignment 1:
Turtle Geometry & L-Systems

now due Thursday

2D Fabrication Options

Laser Cutter, Craft Cutter

OR

Any Regular Inkjet Printer +
Interesting Material

Materials: Printable Fabric

Basics

- Fabric with stiffener attached so it can go through a printer
- Peel off stiffener to use as a custom printed fabric
- Make your own by ironing a stabilizer to most thin natural-fiber fabrics

Limitations

- Small size (size of printer paper)
- Colors don't work well on dark colored fabrics

Misc.

- Fabric printing services: spoonflower, contrado, etc.

Materials: Fabric Transfers

Basics

- Print design on a sheet of film
- Iron or heat press film onto fabric
- Common fabric printing process
- Clear for light fabrics, opaque white for dark fabrics
- Overcomes some of the limitations of printable fabrics

Limitations

- Have to cut out precisely.
- A craft cutter or laser cutter makes life easier
- Slightly challenging process

Materials: Decals and Hydrographic Film

Basics

- Apply design to almost anything!
- Print design on a sheet of film
- Spray with clear acrylic to fix design
- Wet film and apply to object
- Bake to set design

Limitations

- Somewhat challenging process
- Requires acrylic spray

Misc.

- Dipping process. A cool computational exploration

Materials: Temporary Tattoos

Basics

- Print design onto paper
- Wet paper and apply design to skin
- Realistic-looking tattoo lasts a few days
- Unique and compelling location for design

Limitations

- Have to cut out precisely.
- A craft cutter or laser cutter makes life easier

Materials: Shrinky Dink Plastic

Basics

- Sheet of plastic shrinks dramatically (to 1/3 of original size) when heated
- Print line drawing on plastic. Hand-color.
- Heat in 350 degree oven for a few minutes. Watch shrinking.
- Result = approx. 1/16" thick hard plastic

Limitations

- Blocks of color don't work well. Line drawings work best.
- Have to cut out precisely.
- A craft cutter makes life easier

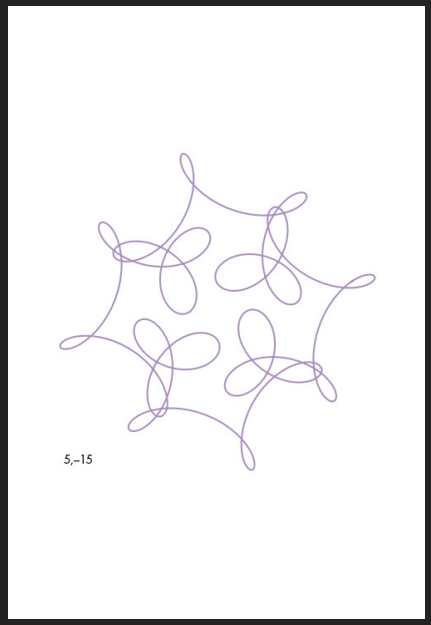
Misc.

- High tech uses. ie: microfluidics

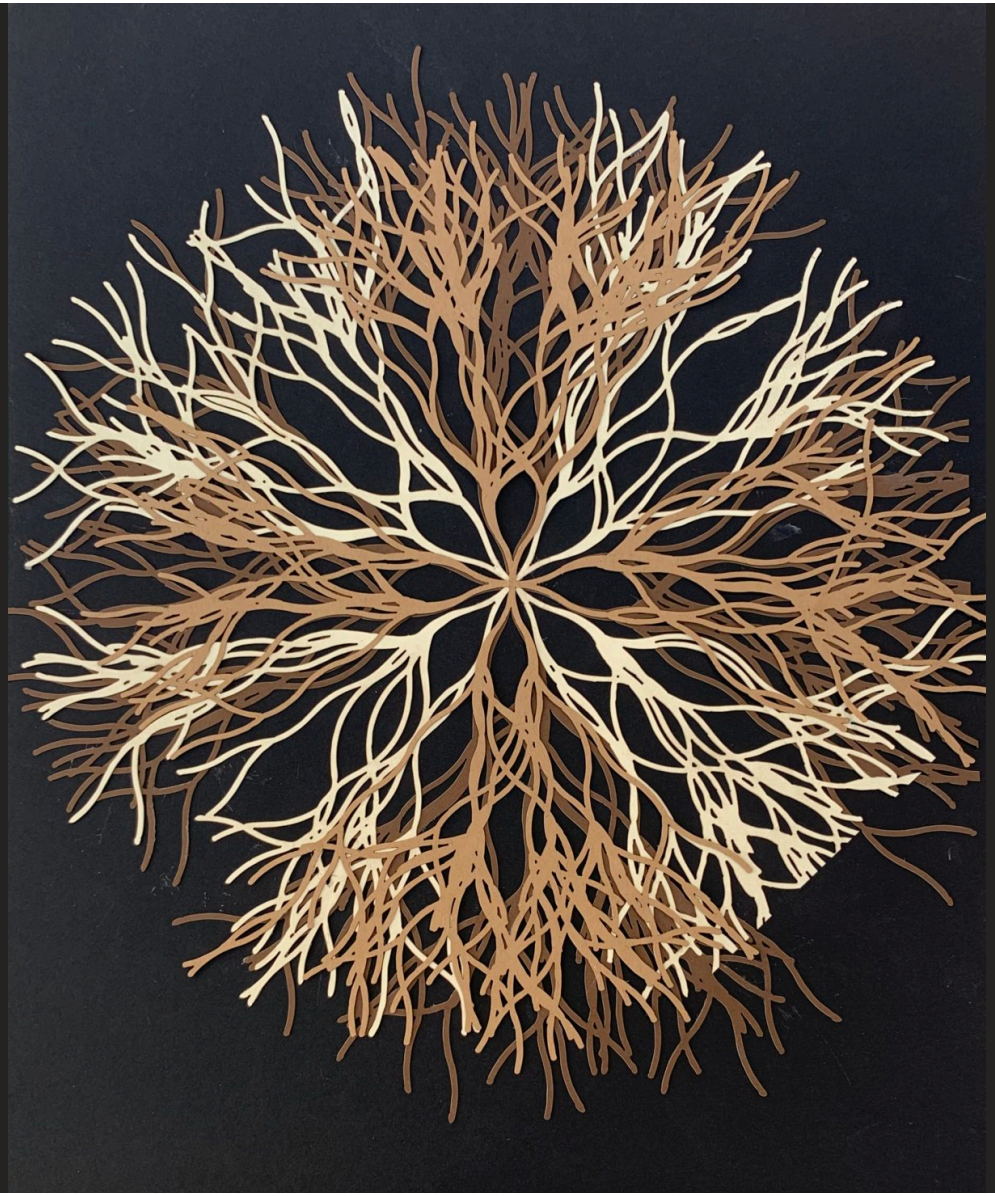
Other Interesting Materials

- Tyvek
- Magnet paper
- Ultra thin wood veneer
- Vinyl stickers and regular stickers
- ??

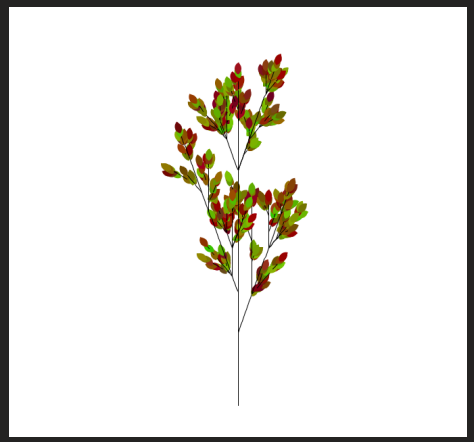
Example projects from previous years



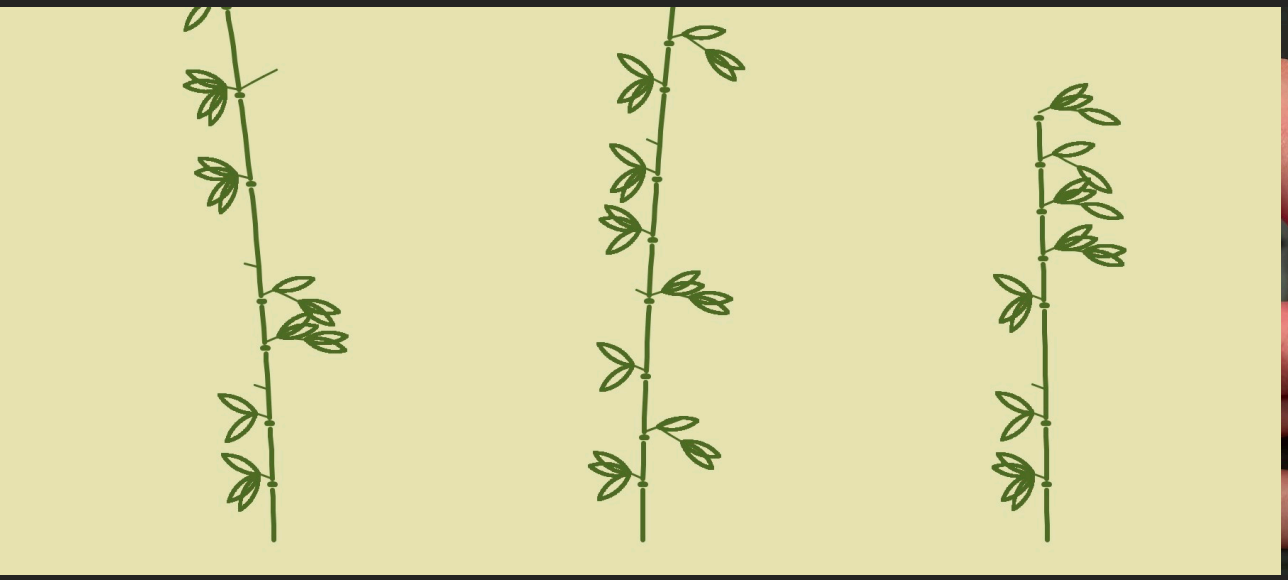
Michelle Louie



Ben Liu



Alyshia Bustos



Amber Sausaita

questions

For next class

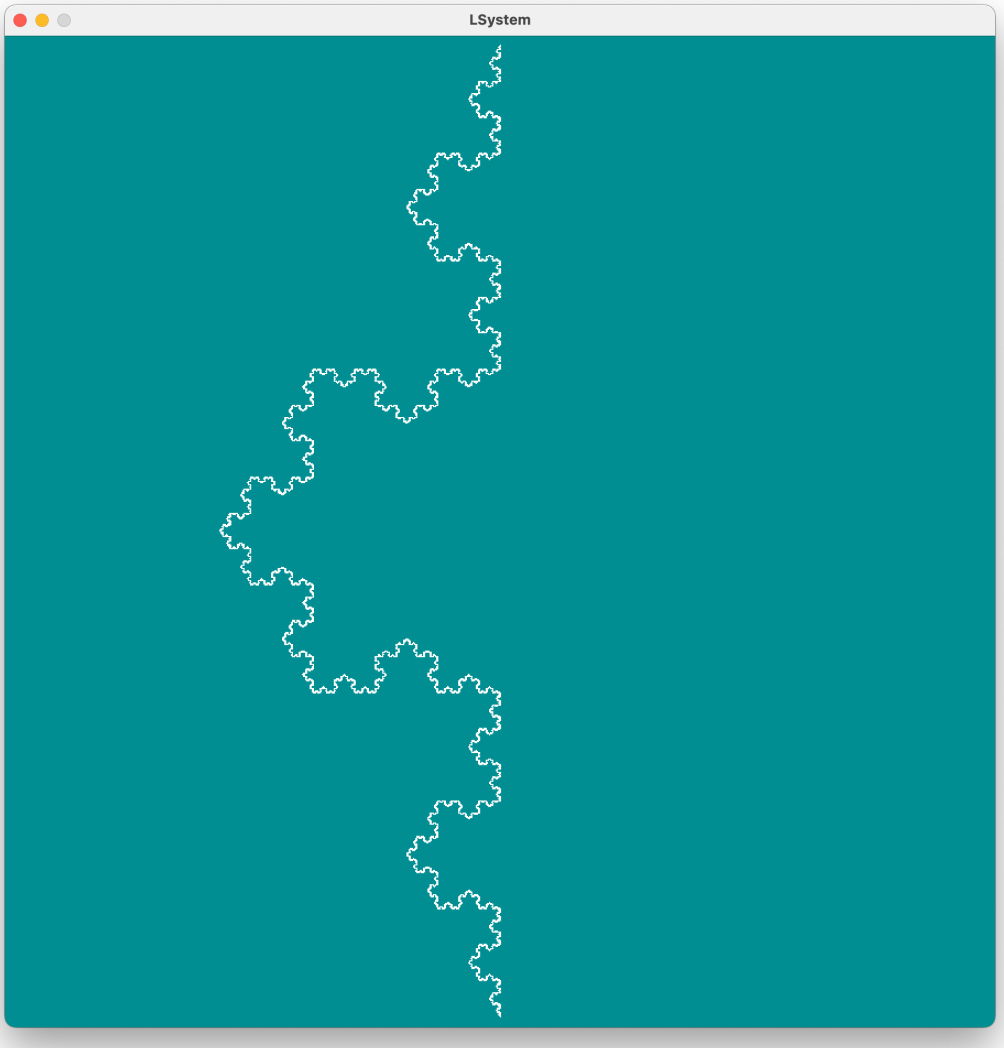
Install Rhino (look for invitation)
Bring 3D printer if you can

questions?

L-Systems cont.

Open program from last class

Last class



Saving images

```
void keyPressed() {
  //save an image each time you press the spacebar
  if (key==' ') {
    String filename = "lsystem" + (int)random(0,100)+".png");
    save(filename);
    println("saved image");
  }
}
```

will save an image each time you press space
saved in the same directory as your program

questions?

Modeling Plants

Adding Some Symbols & Turtle Behavior

New Symbols

[ ]

will represent a memory

New Turtle Behavior for Symbols

push [= remember where you are right now
pop] = jump back to the last place you remembered

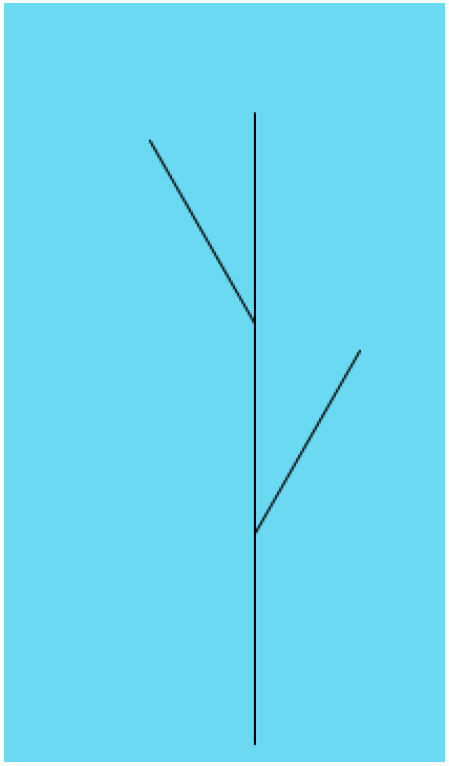
remember both your location and heading

push = [
pop =]

questions?

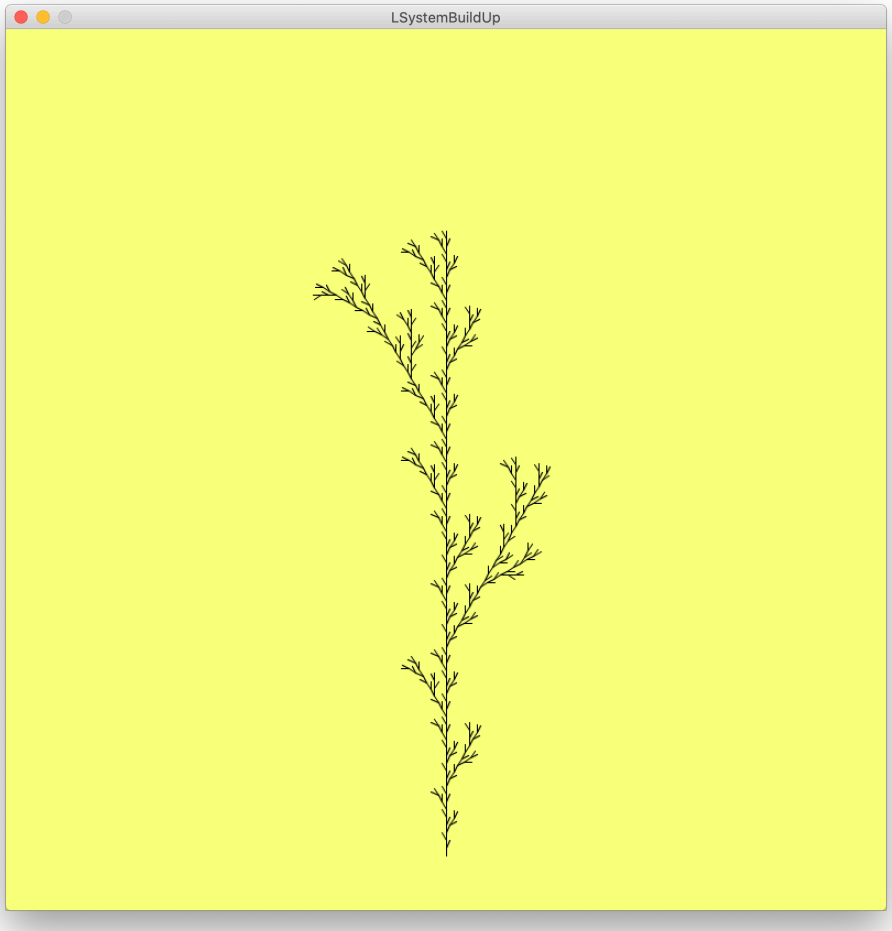
Thinking about a branching structure

what is a good expression for this structure using [and]?



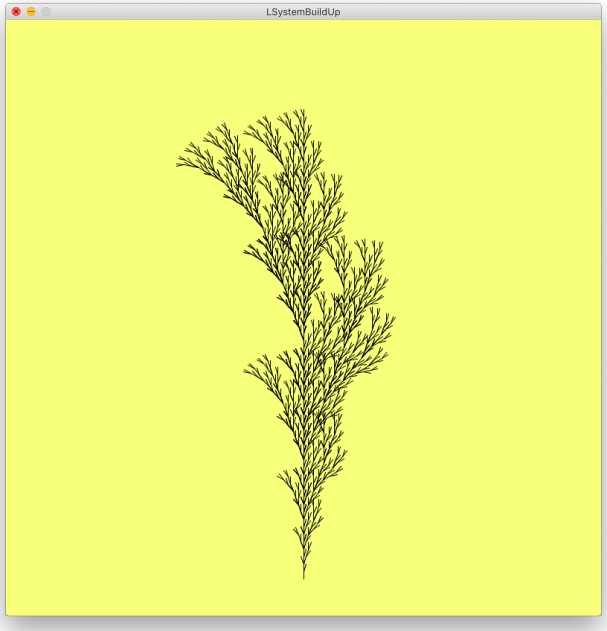
F[+F]F[-F]F

Implementation in Code

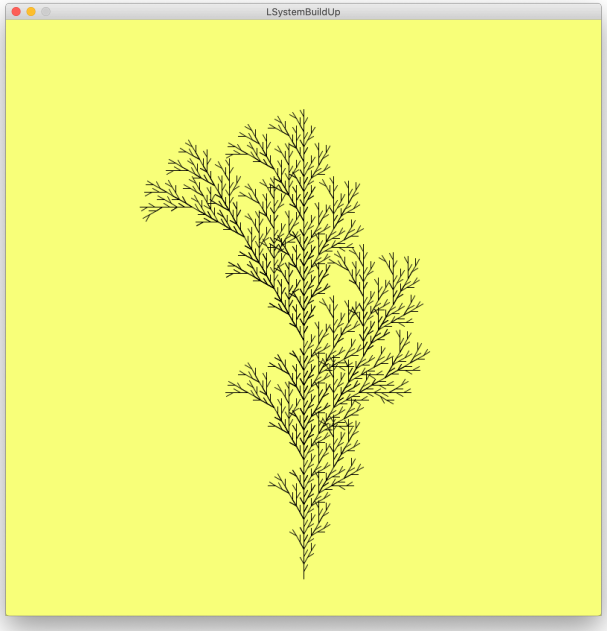


Slightly different rule

```
String[][] rules = {{"F", “F[+F]F[-F][F]"},
                    {"+", "+"},
                    {"-", "-"},
                    {"[", "["},
                    {"]", "]"}};
```



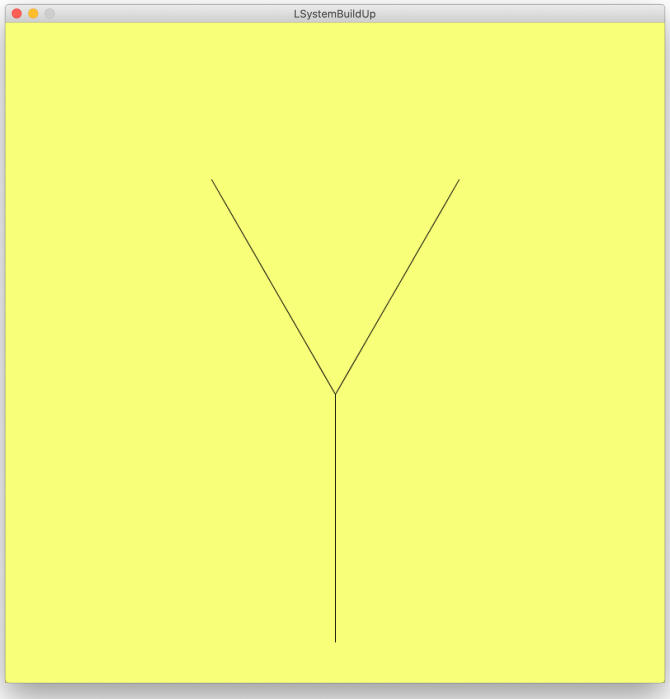
angle = 20;



angle = 30;

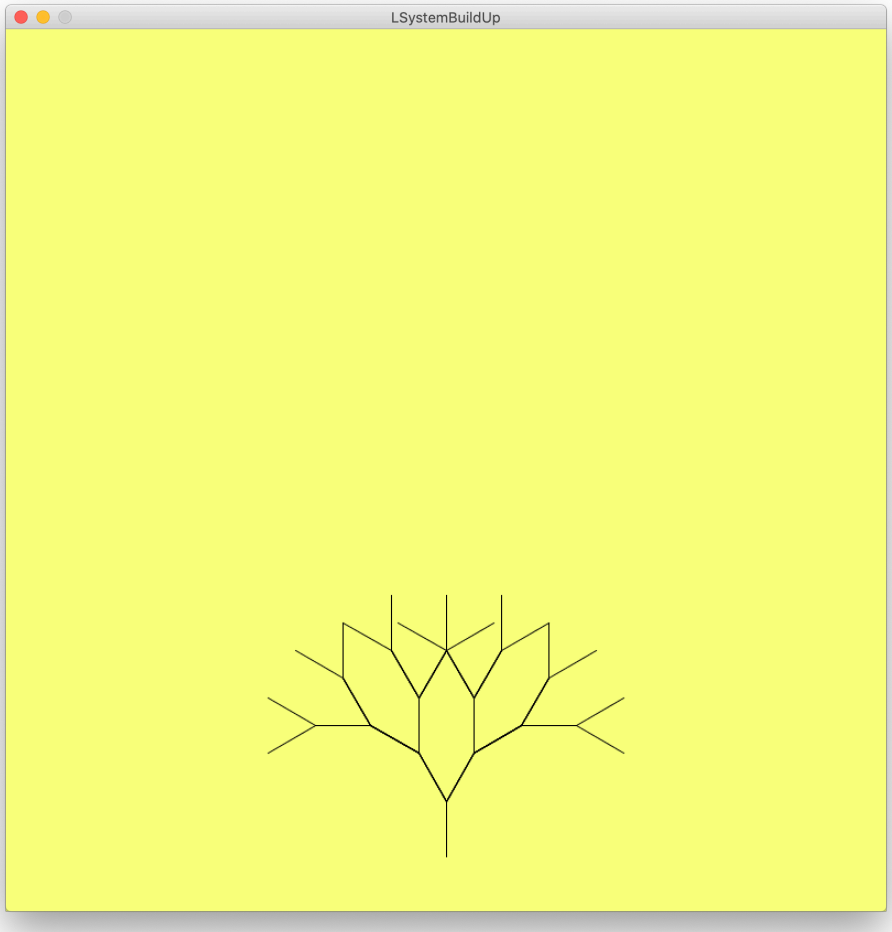
Thinking about a more traditional tree

what is a good expression for this beginning of a tree using [&]?



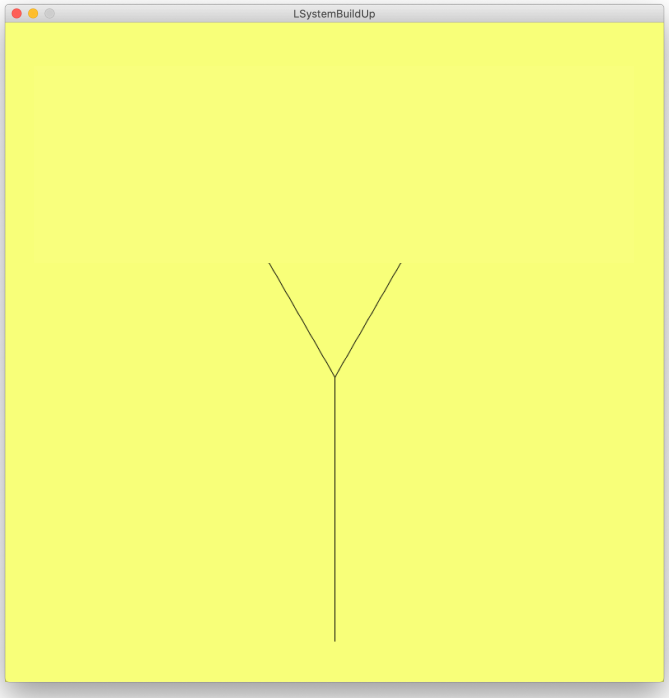
F[-F][+F]

Implementation in Code



Adjustments

what is a good expression for this better beginning of a tree?

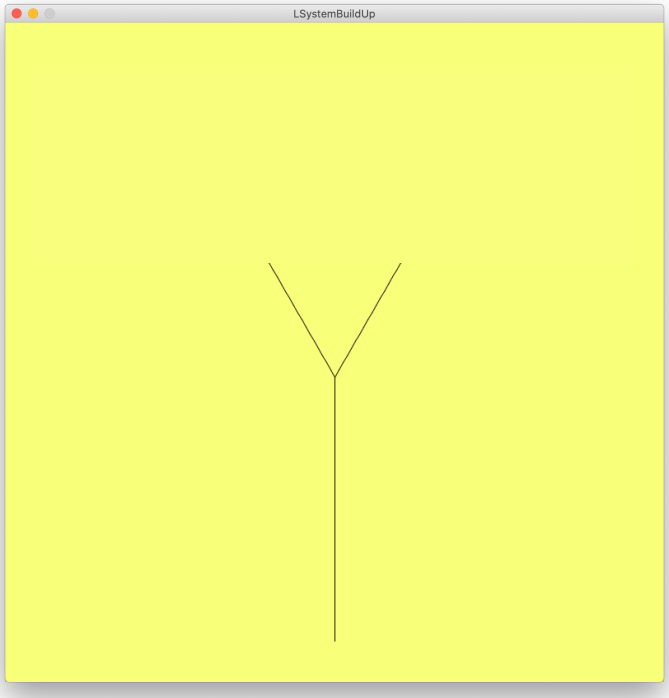


old expression: F[-F][+F]

new expression: FF[-F][+F]

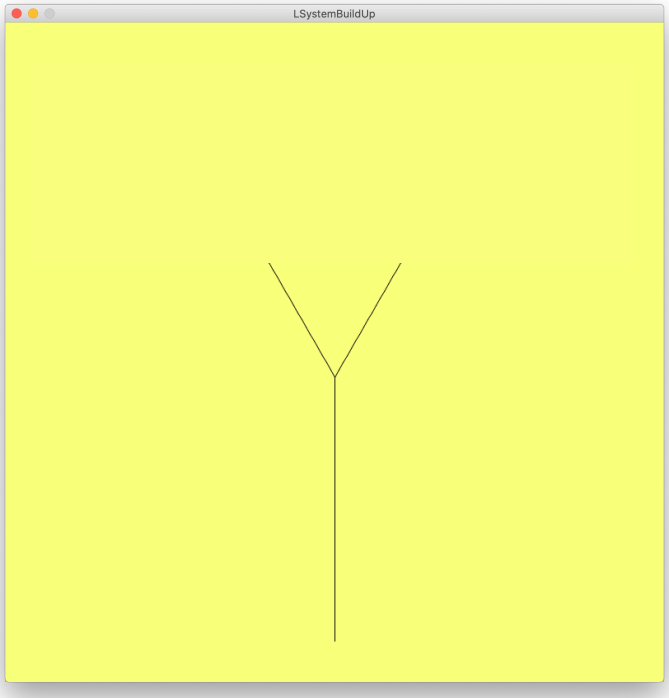
Adjustments

how can we write a rule that results in the behavior we want?



Add a symbol and rules

add a symbol X to represent branches.
use F to represent vertical growth.

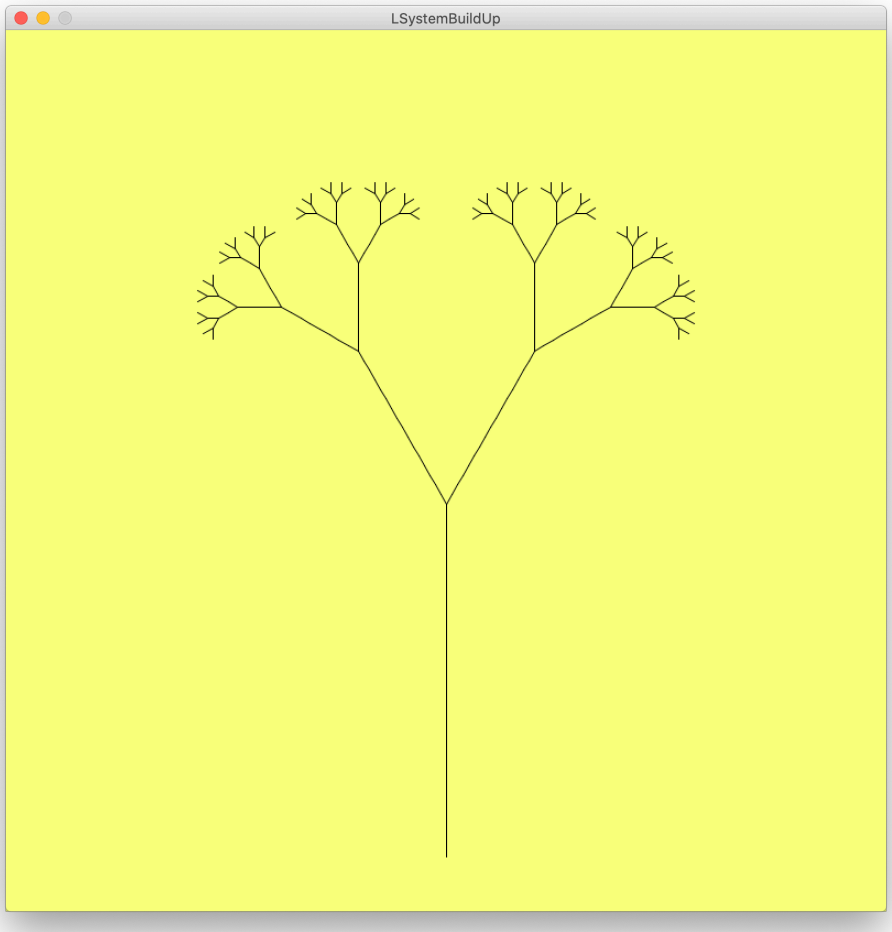


new symbol
X = branch

new rules
X —> F[-X][+X]
F —> FF

questions?

Implementation in Code

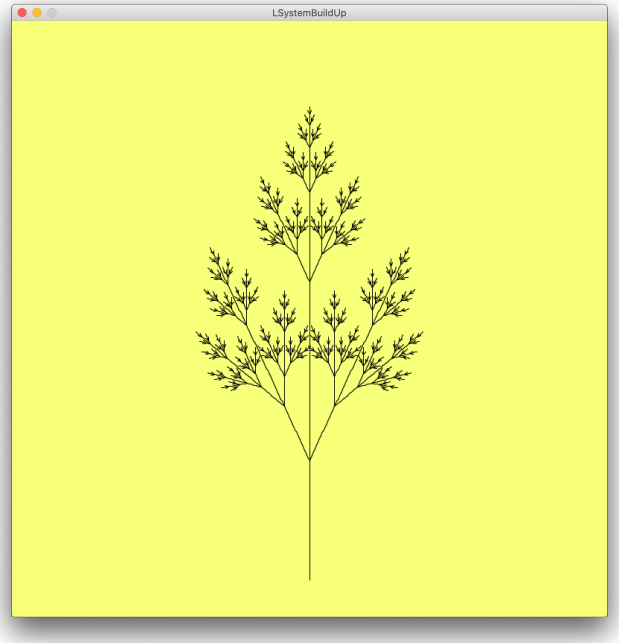


questions?

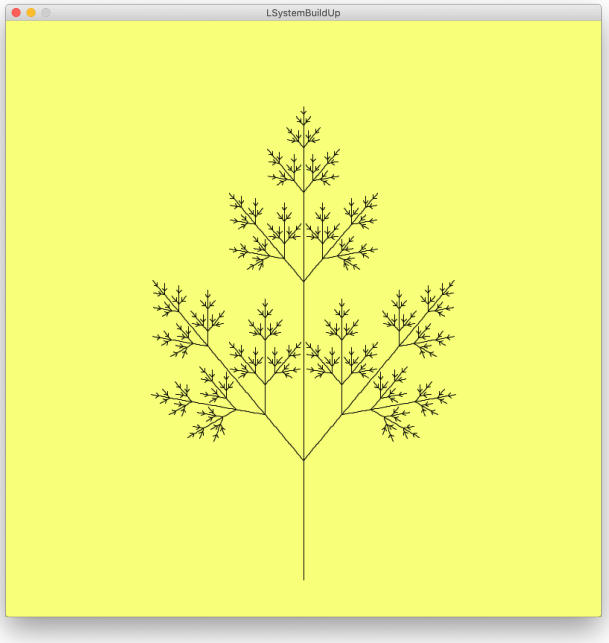
Slightly different rule

```
String [][] rules = {{"F", "FF"},
                     {"X", "F[-X][+X]FX"},
                     {"+", "+"},
                     {"-", "-"},
                     {"[", "["},
                     {"]", "]"}};

String axiom = “X";
```



angle = 25;



angle = 40;

Play with angle variable & rules.

questions?

Adding Randomness

Pick rule to execute with some probability

new rules
choose one randomly
X —> F[-X][+X]
X —> F[[X]+X]F[+[FX]-X]
X —> F - [[X]+X]+F[+FX]-X

Implementation in Code

Change rule structure

```
String[][] rules = {{"F", "FF", "FF", “FF”},
                    {"X", "F-[[X]+X]+F[+[FX]-X]", "F-[[X]+X]+F[+FX]-X", “F[-X][+X]"},
                    {"+", "+", "+", "+"},
                    {"-", "-", "-", "-"},
                    {"[", "[", "[", "["},
                    {"]", "]", "]", “]"}};

axiom = “X";
```

Change iteration method

```
computedWord = computedWord + rules[k][random(1,3)];
```

pick rule randomly

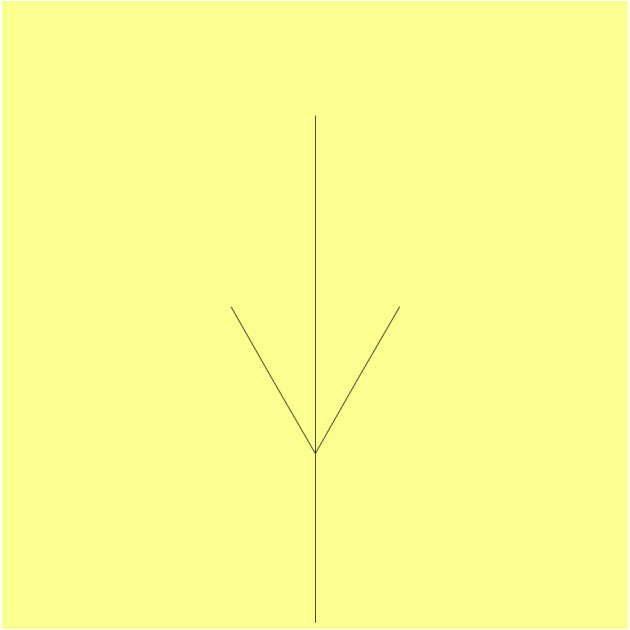
Slightly different rule

```
String[][] rules = {{"+", "+"},
                    {"-", "-"},
                    {"[", "["},
                    {"]", "]"},
                    {"X", "F[+X][-X]FX"},
                    {"F", "FF"}};
```

iterations (X replacements highlighted):
0: X

1: F[+X][-X]FX

2: FF[+F[+X][-X]FX][-F[+X][-X]FXF[+X][-X]FX

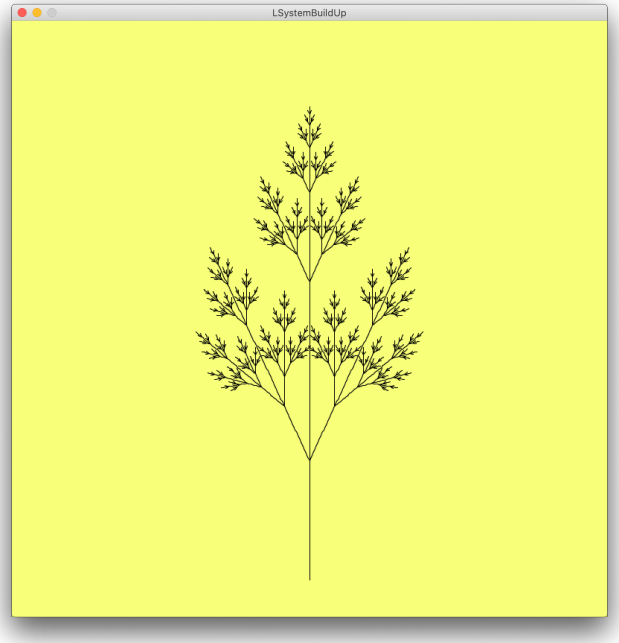


basic structure, iteration 2
draws: FF[+FF][-FF]FFFF

Slightly different rule

```
String [][] rules = {{"F", "FF"},
                     {"X", "F[-X][+X]FX"},
                     {"+", "+"},
                     {"-", "-"},
                     {"[", "["},
                     {"]", "]"}};

String axiom = “X";
```



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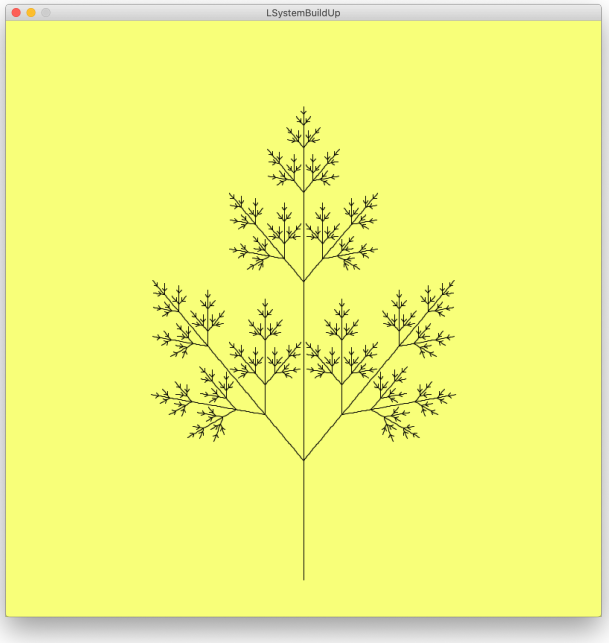

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Play with angle variable & rules.

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Adding Randomness

Pick rule to execute with some probability

new rules
choose one randomly
X —> F[-X][+X]
X —> F[[X]+X]F[+[FX]-X]
X —> F - [[X]+X]+F[+FX]-X

Implementation in Code

Change rule structure

```
String[][] rules = {{"F", "FF", "FF", “FF”},
                    {"X", "F-[[X]+X]+F[+[FX]-X]", "F-[[X]+X]+F[+FX]-X", “F[-X][+X]"},
                    {"+", "+", "+", "+"},
                    {"-", "-", "-", "-"},
                    {"[", "[", "[", "["},
                    {"]", "]", "]", “]"}};

axiom = “X";
```

Change iteration method

```
computedWord = computedWord + rules[k][random(1,3)];
```

pick rule randomly

Generating variations quickly

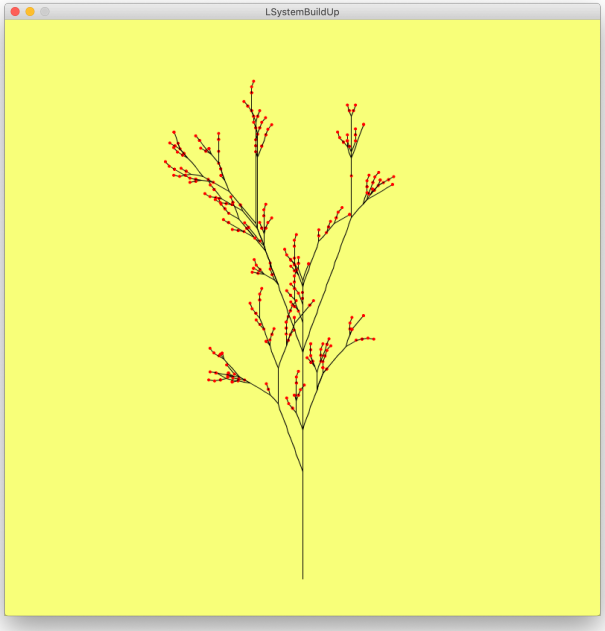
move LSystem generation and iteration into a **mouseClicked** method

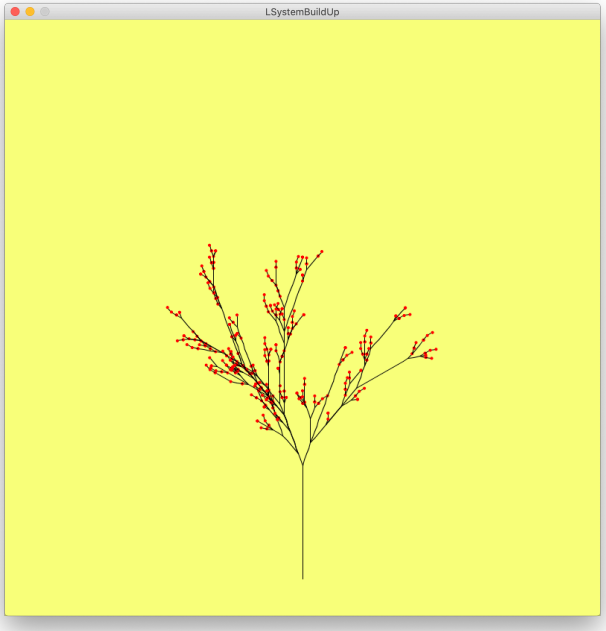
questions?

where on the tree are Xs?

Adding Berries

```
void drawLSystem(Turtle t) {
  for (int i=0; i<computedString.length(); i++) {
    switch(computedString.charAt(i)) {
    case 'F':
      t.forward(size);
      break;
    case 'X':
      fill(255,0,0);
      noStroke();
      ellipse(t.getX(), t.getY(), 2,2);
      stroke(0);
      noFill();
      break;
    case 'T':
      t.forward(size);
      break;
    case '+':
      t.right(angle);
      break;
    case '-':
      t.left(angle);
      break;
    case '[':
      t.push();
      break;
    case ']':
      t.pop();
      break;
    }
  }
}
```

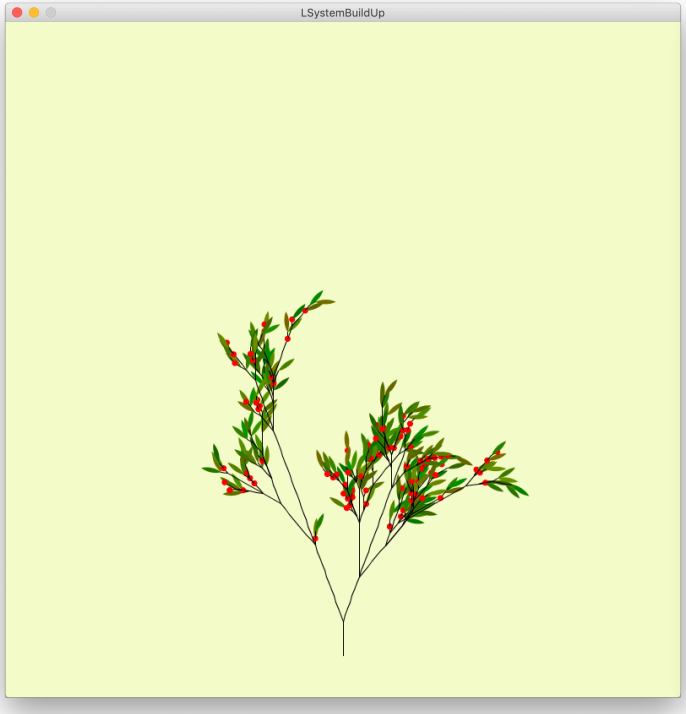




Adding Leaves

```
void drawLSystem(Turtle t) {
  for (int i=0; i<computedString.length(); i++) {
    switch(computedString.charAt(i)) {
    case 'F':
      t.forward(size);
      break;
    case 'X':
      leaf(t);
      break;
    case 'T':
      t.forward(size);
      break;
    case '+':
      t.right(angle);
      break;
    case '-':
      t.left(angle);
      break;
    case '[':
      t.push();
      break;
    case ']':
      t.pop();
      break;
    }
  }
}
```

Adding Leaves & Berries



questions?

Large Assignment 1:
Turtle Geometry & L-Systems

For next class: Install Rhino

Thank you!

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