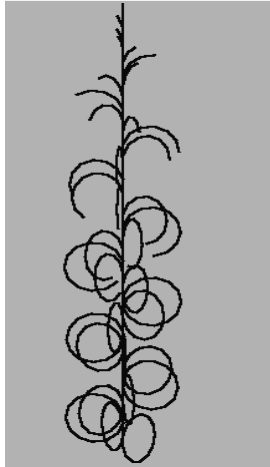
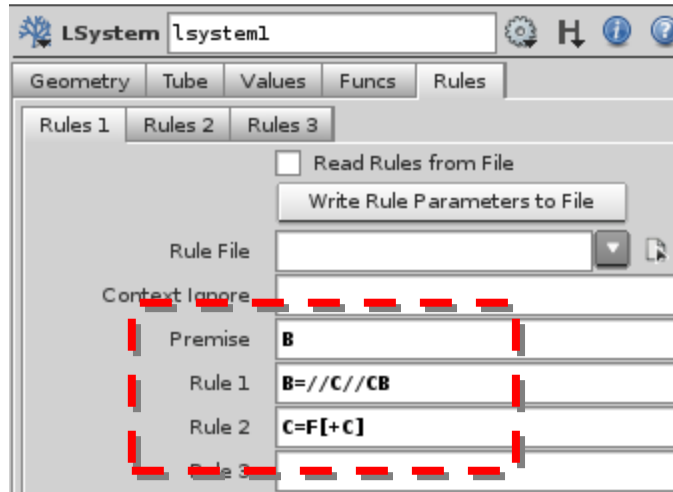
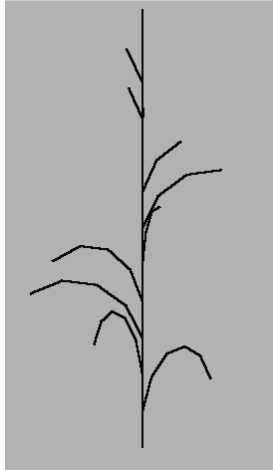


Workshop 10: L-system

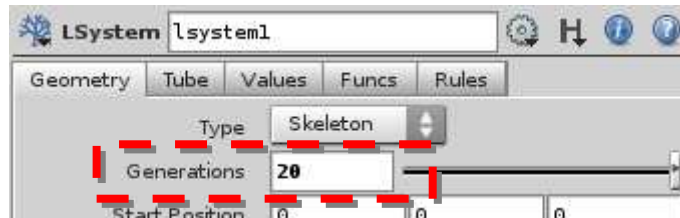
L-system plant

Houdini has a powerful OP called LSYSTEM. You can create funny geometry by providing L-system rules to this OP.

Under /obj, create a **GEOMETRY**. Go inside it, and create a **LSYSTEM**. Type the following rules:

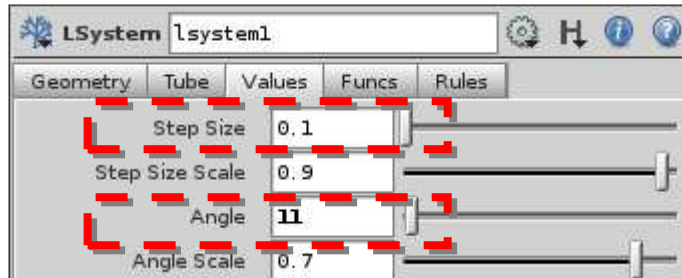


You should learn the L-system concept in the lecture, so I am not going to explain the rules. Now, under "**Geometry**", change the **Generations** to 20:

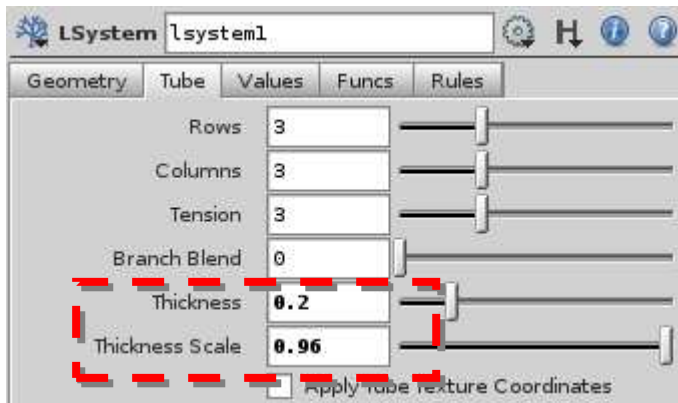
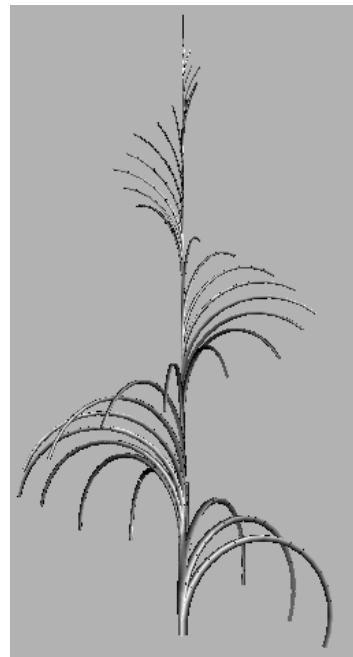
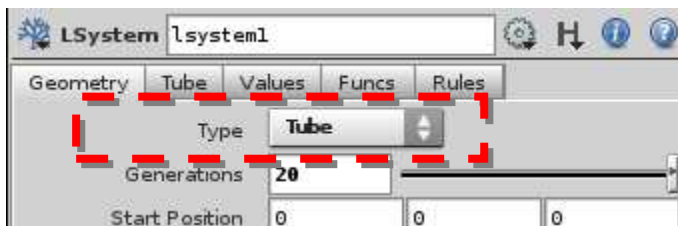




You may think that the tree “blends” too much. You can change the value of “blending” under **Values > Angle**. Actually it is the amount of rotation used for the “/” and “+” symbol. Similarly, the **Values>Step Size** is the length to be used for the “F” symbol:



The default L-system has a type “skeleton”, which contains points and lines only. To render it as tube, we can set **Geometry>Type** to be **Tube**, and try to fine-tune the values **Tube>Thickness** and **Tube>Thickness Scale**:



The “**Thickness scale**” supposed to make the tree thick at the root, but thin at the tips. However, you may find that it doesn’t work. To make it work, you have to add the symbol “!” to the rules. The “!” symbol in the rules means “**multiply the current thickness by the thickness scale**”.

Premise	B
Rule 1	B=//!C//CB
Rule 2	C=!F[+C]

Similarly, to make the value **Values>Step Size Scale** (.ie. makes "F" shorter and shorter) and **Values>Angle Scale** (i.e. makes the blend angles smaller and smaller) works, you have to add the symbol " and ; respectively.

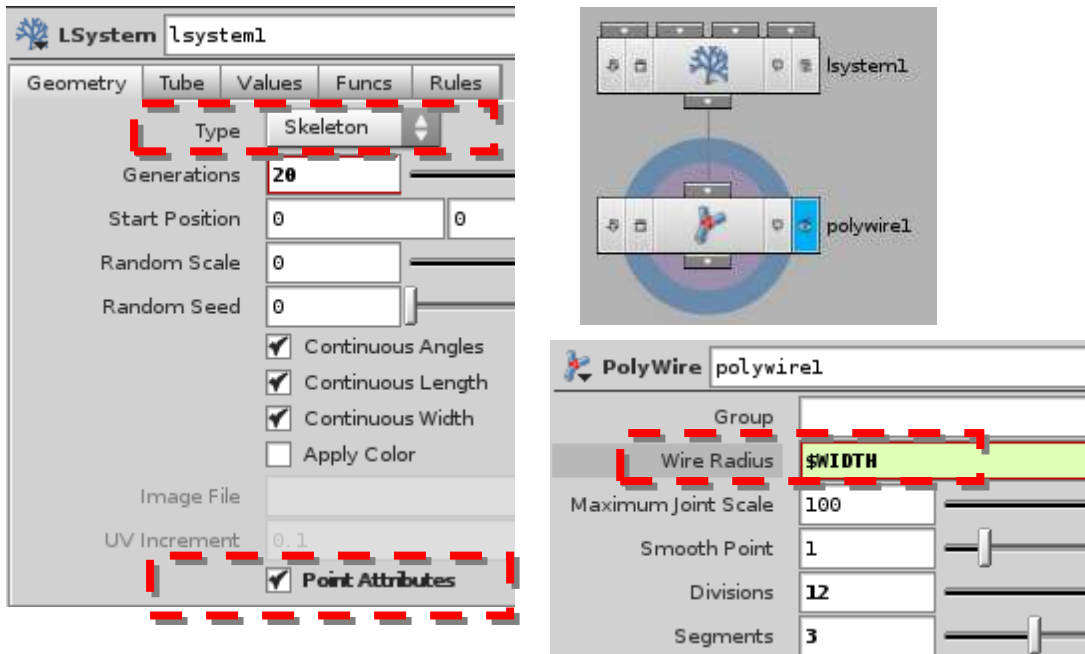
Quick summary of some useful L-system symbol used in Houdini:

! – makes the *thickness scale* works
 “ – makes the *step size scale* works
 ; – makes the *angle scale* works

Using POLYWIRE instead of Tube

However, if you zoom closer to the tree, you will find gaps between the "tubes". It is because the rules are not well-written, and they create too many "branching" on the "curve shape" (can you find out which part of the rule makes this problem?).

If you don't want to change the rule, a simpler method to fix this is to use POLYWIRE rather than the "Tube" option of the L-system. Let's keep the LSYSTEM to be "skeleton" type, but turn on the "**Point Attributes**" option, so that some point attributes, in particular the **\$WIDTH** in our case, can be passed to the next OP, the **POLYWIRE**:



Randomness in LSYSTEM

Let's add some randomness, by using "rules with probability". Modify the rules as shown in the left figure.

Also try setting the **Geometry>Random Seed** to other values. Different values will give you different shapes.

This is a good place for a **stamp()** variable, if you want to make a forest of trees.

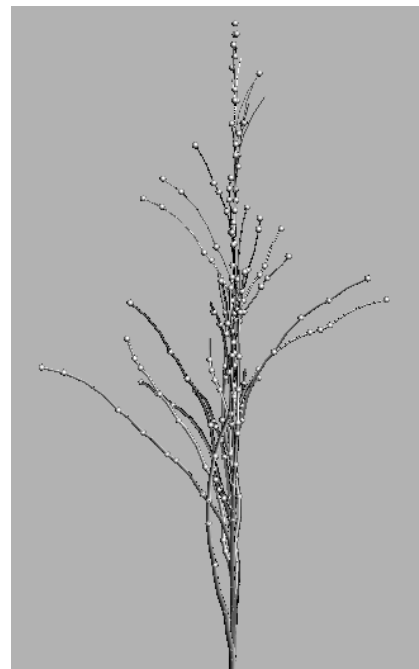
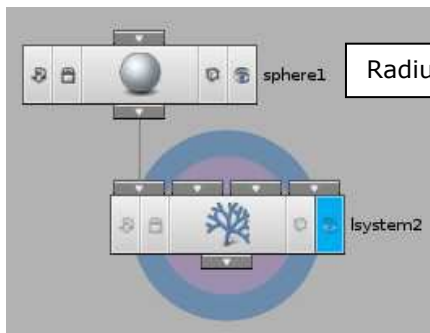
Premise	B
Rule 1	B = //!C//CB
Rule 2	C = !FF[+C] : 0.33
Rule 3	C = !F[+C] : 0.33
Rule 4	C = !FF[-C] : 0.33

Class exercise 1: a forest of plants

- 1) Use GRID and MOUNTAIN to create a landscape.
- 2) Use SCATTER to distribute 50 random points on the landscape.
- 3) Use COPY to copy the L-system plant that we have just created to those points.
- 4) Use stamp() to make each plant different from the others.

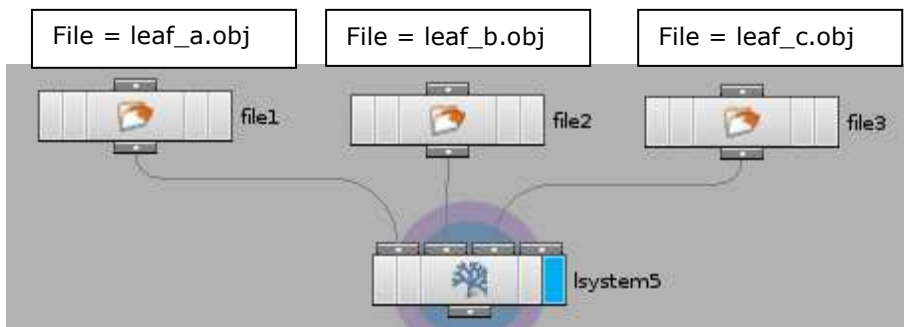
J, K, and M input of LSYSTEM

Let's add some "leaf and flowers" to the tree. Houdini uses **J**, **K**, and **M** symbol to represent "leaf". You need to give the "leaf" geometry to the first (J-input), the second (K-input), and the third input (M-input) of a LSYSTEM. You can use whatever geometry (say, a sphere). Then, you can insert some "J", "K" and/or "M" into the rules:



Premise	B
Rule 1	B = //!C//CB
Rule 2	C = !FF[+CJ] : 0.33
Rule 3	C = !FJ[+C] : 0.33
Rule 4	C = !FF[-C] : 0.33

If you don't like sphere, I have prepared several "leaf" geometries, and stored them in example folder. You can use **FILE** to read them into Houdini, and pass them to the LSYSTEM:



Insert some J, K and M into the rules:

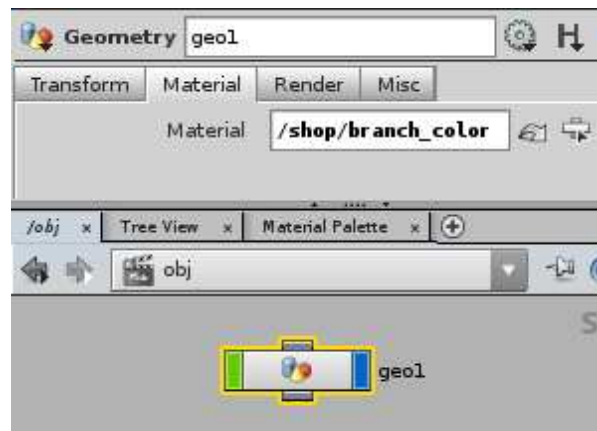
Premise	B
Rule 1	B = <code>///C//CB</code>
Rule 2	C = <code>!FF[+CJ] : 0.33</code>
Rule 3	C = <code>!FK[+C] : 0.33</code>
Rule 4	C = <code>!FF[-CM] : 0.33</code>



The FILE operator can read other 3D model format, such as DXF, OBJ, LWO, etc. You can build your model using your favorite 3D software such as Maya or 3DSMAX, and then export as OBJ format and read it back into Houdini.

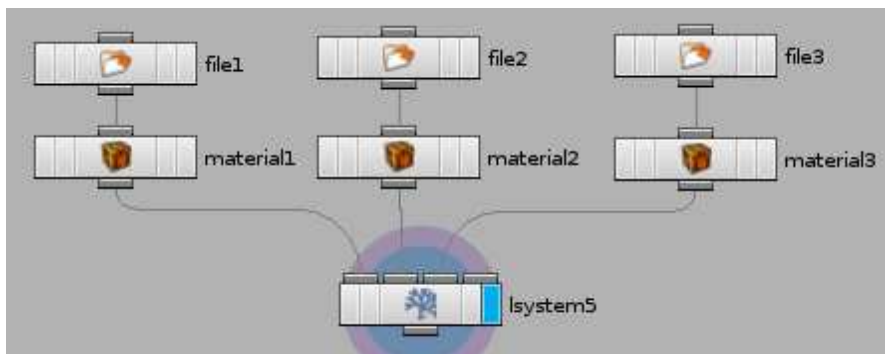
Finally, let's assign some materials and render our final image.

Open the **Material Palette**, and drag a "basic surface" to the L-system object. Go to SHOP, rename the material to "branch_color", and assign a brown color to it. The "branch_color" has been assigned to the whole geometry object automatically.



If we want to have different colors for the leaf, we can assign a different material in the SOP level to override the "branch_color". Now, in SHOP, copy and paste from the "branch_color" to create 3 more materials, one for each leaf type. Choose some green color for each newly created leaf material.

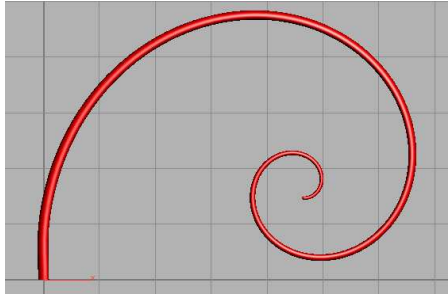
After that, connect a **MATERIAL OP** to each leaf, and choose the corresponding material. Each leaf will use its own material then:



Class exercise 2: L-system shape

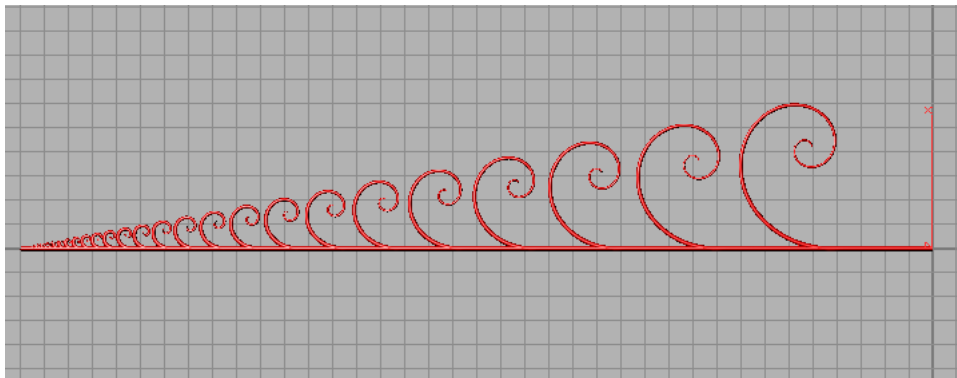
The best way to explore L-system is to start from a simple rule, and then add more components step-by-step.

- 1) Try to create the following "curve shape", starting from a single symbol, say, a "C".

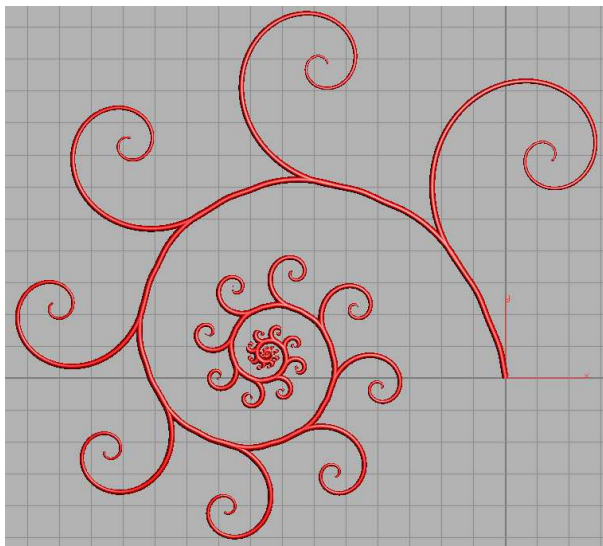


Premise: C
Rule 1 : C = ???

- 2) Try to add other symbols, say, a "A" for a long "forward", and a "B" for a forward and also a branch of "curve shape".



- 3) Try to add some bending to "A" or "B" (or both) to make the following shape.



More L-system symbols: T and ~

Let's continue on our previous example:

Premise	B
Rule 1	B = // F [C] // F [C] B
Rule 2	C = F + C

Now, suppose that we want the main skeleton bend a little bit in a random manner. We can add $\sim(5)$ to the first rule. The symbol $\sim(5)$ means "bend randomly in any direction, with a maximum value of 5 degrees":

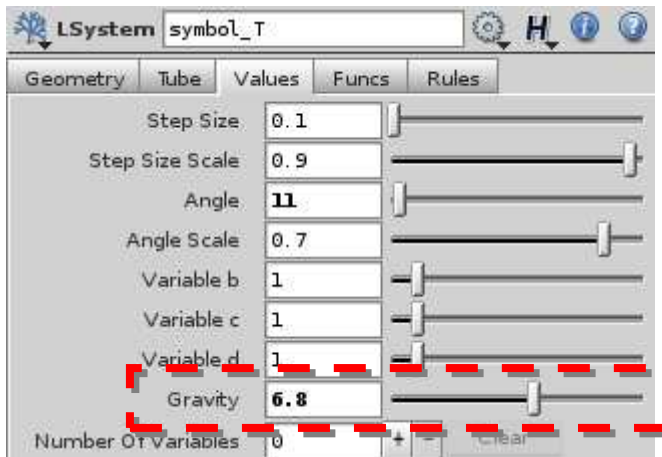
Premise	B
Rule 1	B = // F [C] // F [C] $\sim(5)$ B
Rule 2	C = F + C

Bend the main skeleton only

Premise	B
Rule 1	B = // F [C] // F [C] B
Rule 2	C = F + $\sim(10)$ C

Bend the branch only

Another interesting symbol is T. The T symbol will be affected by the value of **gravity** – to pull the point downward by gravity:



Premise	B
Rule 1	B = // F [C] // F [C] $\sim(5)$ T B
Rule 2	C = F + C

Has effect on the main skeleton only. Note that I have to bend the main skeleton a little bit.

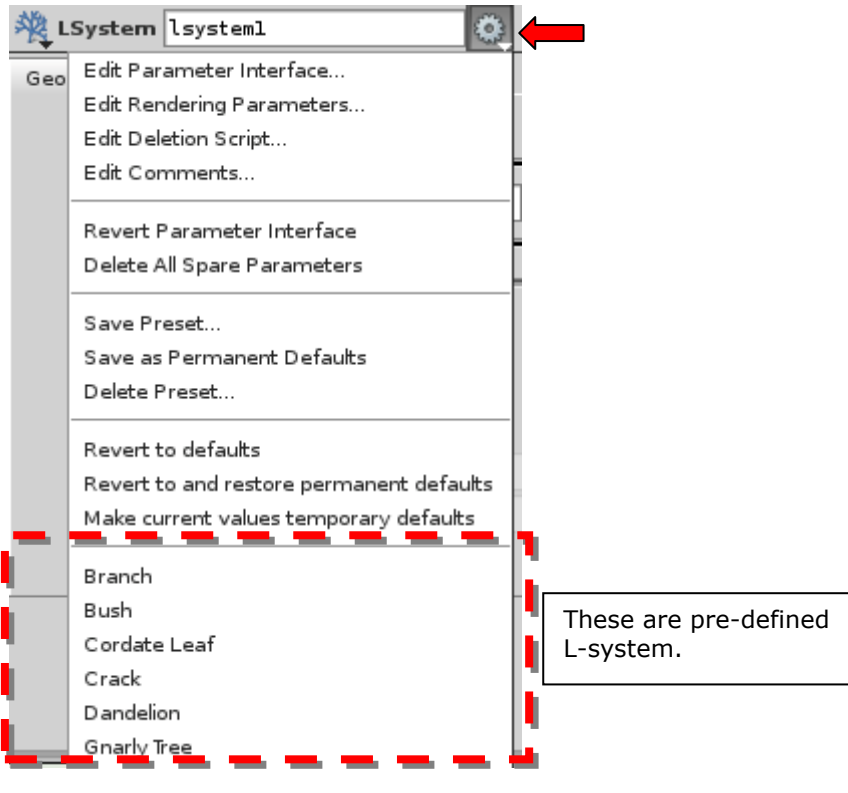
Premise	B
Rule 1	B = // F [C] // F [C] B
Rule 2	C = F + T C

Has effect on the branch only

You may consider animating the value of **Gravity** to create interesting animation.

Pre-defined L-system rules

In Houdini, there are several pre-defined L-system that you can use them as starting point to explore. (Some of them even have animation!) Click the "gear" icon besides the LSYSTEM name:



**** Week 10 END ****