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# Arboreal Aging

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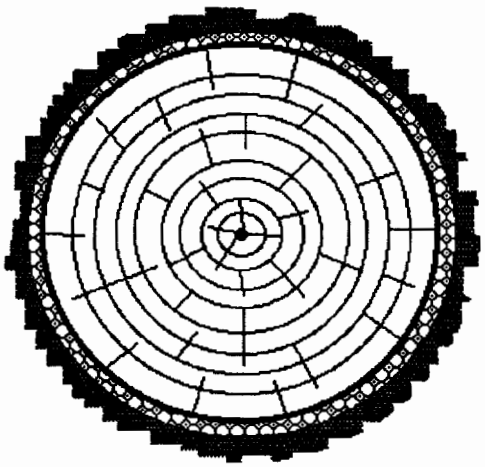
by Judi Harris

Age can be represented in many ways. Years accumulate to a running total, resale values depreciate, grey hairs multiply, wrinkles trace tributaries of skin folds, and, in the plant kingdom, arboreal perennials get taller and thicker. One way to represent *Logo Exchange*'s age looks like this:

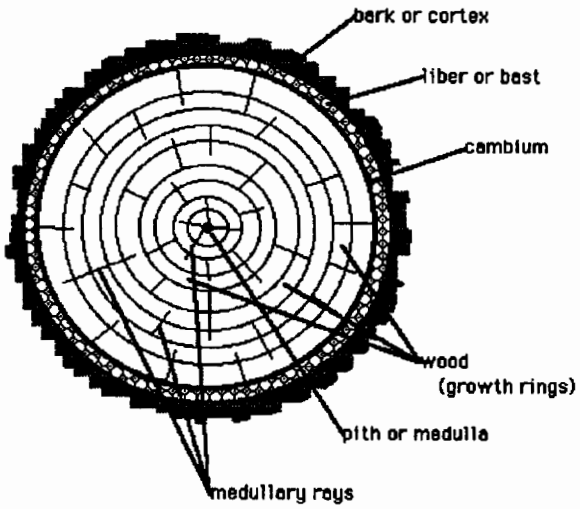


Since the 2000+ copies of *LX* that are mailed for each issue are primarily made from trees, it is fitting that this 10th anniversary edition of *Logo LinX* link Logo exploration to arboreous study. Certainly the *LX* exists because of the creativity, dedication, labor, and interest of its authors and readers, but without the paper on which it is printed, the exchange of ideas, experience, and support that has characterized *LX*'s 10-year history would have been impossible.

**A Timely Topic**

Autumnal curricula often include the study of trees. Students make leaf collections, take hikes with their field guides to identify tree types, explore the chemical processes that cause leaves to change color, diagram and analyze venation and branching structures, and make rubbings of bark and leaf textures. This fall, why not help your students to encode and decode arboreal age? (Lanzara & Lanzara, 1978)

The trunk of a tree grows larger each year as it performs its job of sustaining leaves, flowers and fruit. A cross-section of a tree trunk reveals several distinct types of cells, each with its own purpose.




- The *bark* or *cortex* protects the tree from atmospheric changes and, to a certain extent, from damage caused by animals and people.

- The *liber* or *bast* allows the sap to descend and redistribute after it has been photosynthetically processed in the leaves. It also fuels the growth of the *cambium*, the next cell layer toward the center of the tree.

- The *cambium* is primarily responsible for the diametric growth of the tree. It produces woody cells toward the inside of the trunk, and liber cells toward the outside of the trunk.

- The *wood* is comprised of a series of concentric rings, one for each year that the tree has been alive. Woody fibers and vessels in the outer rings (*sapwood*) transport raw sap (a watery solution of mineral salts taken from the soil) to the tree's leaves, where photosynthesis transforms these inorganic elements to a solution of organic compounds. Older growth rings (*heartwood*) are dead, performing the functions of support and storage. This is the wood that is cut and used for building.

- The *pith* or *medulla* is the central part of a trunk in its first year, but as the tree ages, its size reduces, and it can even disappear, leaving an empty medullary cylinder.

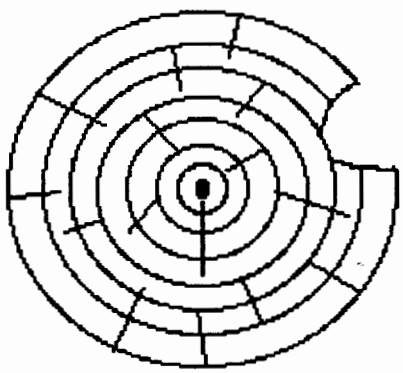
- The *medullary rays* are fine lines of cells that stretch along the trunk's radius from the pith to the bark and distribute nutrients to all parts of the tree.

**Ringed Maps of Time**

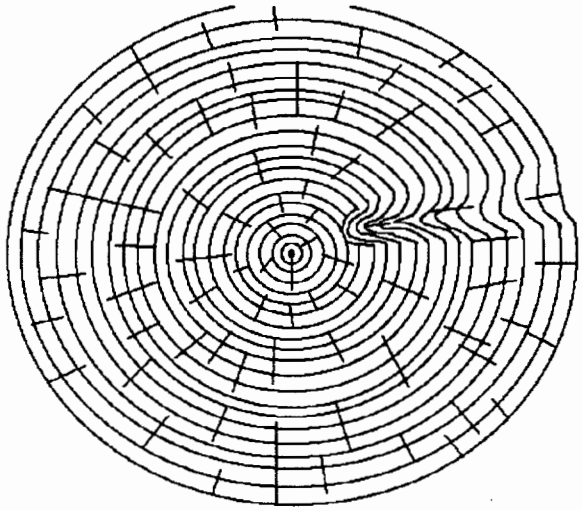
Scientists in ancient Greece and Rome recorded observations of tree trunk cross-sections, but it was Leonardo da Vinci who realized that a tree's age could be discovered by counting its rings, and that yearly climactic conditions could be deduced from differences in ring width. A.E. Douglass, an American astronomer living at the beginning of the 20th century, established the foundation of the science of dendro*chronology*, or the systematic study of the interrelationship of tree ring appearance, environmental variation and time. These scientists have shown us how to reconstruct a tree's life history from one cross-section of its trunk.

Each annual tree ring has two parts: a section light in color, comprised of large vessels, and formed during the spring, and a section darker in color, comprised of narrower, more numerous vessels, formed during the summer, when less moisture must be transported to the tree's already-formed foliage crown. Thus, counting a tree's annual rings reveals its age in years. But closer examination of the rings' width, form, and color can allow us to infer important events in the life of the tree.

The diameter of each tree ring depends directly upon the climactic conditions to which the tree was subjected during that year; wider rings indicate more favorable growing conditions than narrower rings. Ring color is determined, in part, by the chemical composition of the environment in which the tree exists. Marbling, or deviations from ring concentricity, is caused by a change in the growth pattern of the tree, such as the formation of a branch or the sustaining of an injury.



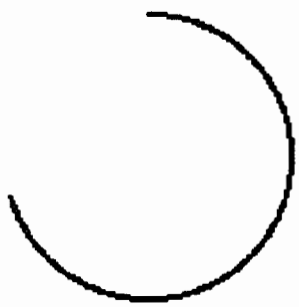
This injury, occurring in this tree's 7th year, is gradually accommodated until it is externally quite imperceptible in the tree's 20th year. Such intrusions upon ring patterns are what cause aesthetic elegance in the shape, color, and variety of cut wood grain.



The "Logo Link" should be obvious by now. Why not challenge your students to construct a tree trunk cross-section, ring by ring?

**Arboreal Arithmetic**

Successive tree rings differ primarily by diameter. Drawing these concentric circles can be quite a programming challenge in itself for novice Logo users. Discovering that a REPEAT 360 [FORWARD 1 RIGHT 1] circle, for example, can also be drawn with the turtle travelling along the circle's radius can represent an exciting change of cognitive context for a beginning Logo programmer.:



```
TO CIRCLE1
REPEAT 360 [PU FORWARD 57 MARK BACK
   57 RIGHT 1]
END
```

```
TO MARK
PD
FORWARD 1
BACK 1
PU
END
```

Concentric circles can then be drawn by changing the inputs to FORWARD and BACK in CIRCLE1. This also can provide a perfect introduction to the use of local variables, since the length of the radius that the turtle travels is all that varies between tree rings:

```
TO CIRCLE1 :RADIUS
REPEAT 360 [PU FORWARD :RADIUS MARK
   BACK :RADIUS RIGHT 1]
END
```

More experienced Logo programmers may enjoy writing procedures that draw concentric circles with the turtle travelling around the circle's circumference rather than along its radius. In this interpretation of the challenge, radius size is used to make the computer calculate the size of each step the turtle takes. Since the circumference of a circle is equivalent to $2 \times \pi \times$ the radius, each step the turtle takes is equivalent to that product divided by 360:

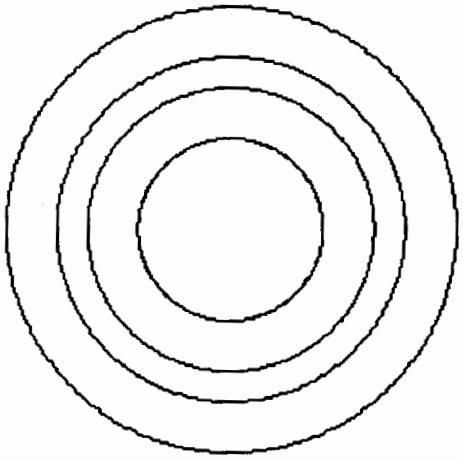
```
TO STEP :RADIUS
OUTPUT 2 * 3.1416 * :RADIUS / 360
END

TO CIRCLE2 :RADIUS
REPEAT 360 [FORWARD STEP :RADIUS
   RIGHT 1]
END
```

Concentric circles drawn with the above procedures can be positioned with MOVE.OUT and MOVE.BACK procedures, which are invoked before and after each call of CIRCLE2, respectively:

```
TO MOVE.OUT :RADIUS
SETH 0
PU
FORWARD :RADIUS
PD
SETH 90
END

TO MOVE.BACK :RADIUS
SETH 0
PU
BACK :RADIUS
PD
END
```



```
MOVE.OUT 45   CIRCLE2 45  MOVE.BACK 45
MOVE.OUT 70   CIRCLE2 70  MOVE.BACK 70
MOVE.OUT 85   CIRCLE2 85  MOVE.BACK 85
MOVE.OUT 110  CIRCLE2 110 MOVE.BACK110
```

**Arborescent Autobiographies**

If the appearance of tree trunk cross-sections symbolically tell the tree's life story, why not use these woody models to help your students construct their own arboreous autobiographies? The color, thickness, and ring pattern of each year in their lives could be drawn with LogoWriter, for example, with text on the screen explaining the events that caused ring modulation, color change, and diameter fluctuations. These diagrams could then be shared and compared with those of classmates to see if any "across-trunk" patterns during specific years in students' lives could be detected. Similar tree-ring histories for schools, historical figures, literary characters, or countries could also be created.

**Some Final Thoughts**

Marshall McLuhan once wrote:

> For tribal man space was the uncontrollable mystery. For technological man it is time that occupies the same role.
>
> *The Mechanical Bride*, 1951

Where will *LX* be 10 more years into the future? Will we still be reading it on printed pages or will it be distributed electronically to its subscribers? Will students still be using turtle graphics to explore *Logo LinX* like the mathematics of tree growth and personal histories expressed in arboreal symbols? Or will our classrooms be sufficiently "Logo-like" so that student-centered, interactive, interdisciplinary explorations, using a wide va-

riety of learner-based technological tools, will be the rule rather than the exception? Only time, and the collective vision and action of readers like you, will tell.

**Reference**

Lanzara, P. & Lanzara, M. (1978). *Simon & Schuster's guide to trees.* New York: Simon & Schuster Inc.

Judi Harris works in the Department of Teacher Education at the University of Nebraska at Omaha as an assistant professor of educational technology. Her teaching, research, and service interests include Logo (of course), developmental sequencing in interactive hypermedia materials design, computer-mediated educational telecommunications, the expressive qualities of children's computer-assisted artwork, and the restructuring of teacher education paradigms.

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