6.849	Class 4	Sept. 18. 2012

- Is the complex origami design we see really "uniaxial"? YES
  - axis refers to "elevation"
  - tree is all at same vertical level
  - Montroll's dog base is biaxial

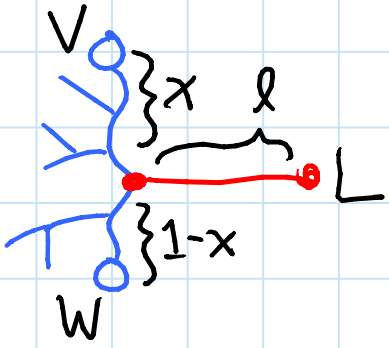
- Tree Maker & Origamizer in practice
  - ↳ common in complex origami design (tree method, maybe not software)
  - ↳ not yet common, but exciting power

- Boxpleating + Tree Maker? YES [Lang, Demaine, Demaine]
  - main ref. is Origami Design Secrets, 2e
  - circles → squares
  - rivers → orthogonal
  - universal molecule + straight skeleton

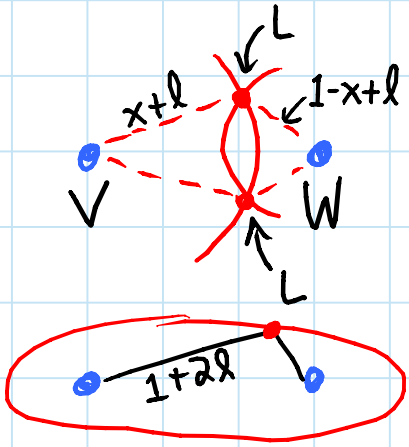
○ TreeMaker triangulation algorithm:

[GFALOP Lemma 16.6.2]

- regions bounded by active paths & paper boundary
- suppose >3 sides
- take any active path VW (side of region)
  - rescale to make length 1
- in tree:
  - subdivide path V→W at x fraction
  - add leaf edge of length ℓ (leaf L)

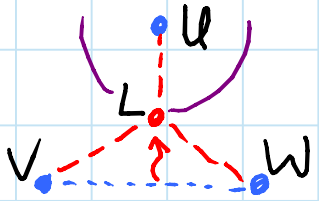


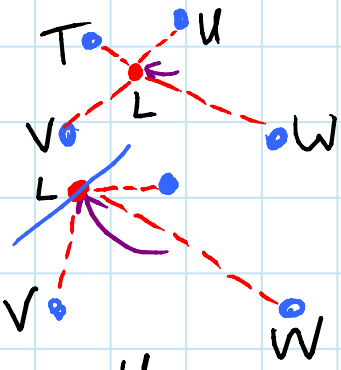
- in paper:
  - VL & WL active for 2 L placements
  - x varies ⇒ L on ellipse of foci V & W & major axis 1+2ℓ
  - ℓ varies ⇒ L visits whole plane



⇒ view L in plane as input & set x & ℓ accordingly

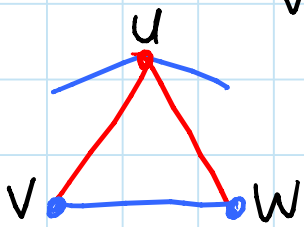
- start L on VW & move into region
  ⇒ initially, no LU active
- before hitting an active path, some LU must become active
  ⇒ move L on U circle until some LT becomes active





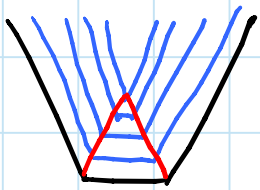
OR hit paper boundary

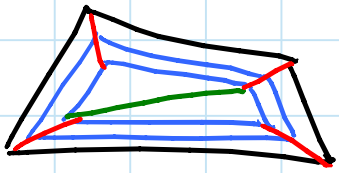
OR hit paper boundary
⇒ put L at vertex ≠ V, W



- in all cases, subdivide region into smaller polygons (4 pieces or diagonals)
- induction ⇒ triangulate □

- **TreeMaker universal molecule:**
  - 2 events:





(example)

gusset (newly active)

- **Gift wrapping problems:**

OPEN: optimal square → regular tetrahedron
↳ equilateral △ trivial

OPEN: x × y rectangle → largest cube

- Checkerboards:

  - slots & tabs made with custom gadgets (similar to Lecture 6)

  PROJECT: implement algorithm to generate crease pattern for arbitrary pixel pattern (black & white)

  OPEN: optimal 2×2 checkerboard?

- Origamizer:

  - software version: [Tachi 2010]
    - practical but doesn't always work
    - polyhedron faces layed out such that:
    - edge tucking molecule just one crease
      (actually more if tuck proxy self-intersects)
    - vertex tucking = "Voronoi diagram"

  - mathematical version: [Demaine & Tachi]
    - always works
    - any face layout, scaled appropriately
    - molecules only in spirit
    - final step is one big Voronoi diagram
    - choose to align edges

6.849 Geometric Folding Algorithms: Linkages, Origami, Polyhedra
Fall 2012