1. GUI adjustments
   1. remove selection buttons (✓)
   2. move rectangle transform next to point move (✓)
   3. combine “update” and check mark
      1. or else auto-update (✓)
   4. use check marks to determine zoom target(s)
   5. report when unable to perform transformation
   6. show tool guidance
   7. Clean up toolbar for presentation (✓)
2. Generalizability
   1. Allow transformation on both source and target maps equally
      1. Eliminate secondary transformation
      2. create buttons to transfer from one map to the other
      3. create options to auto-transform
3. Performance Enhancements
   1. Use faster versions of:
      1. polygon area (✓)
      2. triangle area (✓)
      3. traverse edge
      4. …
4. Functional enhancements
   1. Use halo when ironing
   2. When transformation fails, auto-halo and retry
5. Create first transform pattern
   1. Design interface (✓)
   2. Design transform TINs (✓)
   3. Design mouse procedure (✓)
   4. implement (✓)
   5. test (✓)
6. Add legend for transform map
   1. remove redundant symbology from legend (✓)
   2. make sure symbology stays when updating transformation (✓)
   3. give name to popPolys on transform map (✓)
   4. maximize visibility and allow collapse (✓)
7. Solve problem with disappearing lines (!!!) (even if it’s an ad hoc solution) (✓)
8. Speed up everything by using suspend and resume layout, events… (✓)
9. Speed up Subdivide
   1. Remove “CountSurplus” from Subdivide (✓)
   2. build using edges instead of polygons (✓)
10. Speed up transformation
    1. maintain marker of last updated action in action stack (✓)
    2. create function to identify nodes updated since last action (✓)
    3. create transform function that allows following parameters:
       1. previousTransformedFS (✓)
       2. transformationExtent (✓)
    4. Try alternatives for pointInTriangle
11. Create button to identify polygons with largest size error
    1. create functionality (✓)
    2. create icons
    3. create identify tool and area for “watch” regions
12. Allow add other data (✓)
13. Base legend on max multiple too small (ignore too large) (✓)
14. Allow selection with mousemove
15. After updating:
    1. Don’t turn on node layer
    2. don’t change symbology (✓)
    3. give names to edge and node layers (✓)
16. Make able to handle multi-polygons
    1. transform multi-polygons (✓)
    2. make sure area calculations are correct for multi-polygons
17. Auto-smooth grid
    1. function to extract polygon kernel (✓)
    2. implement for single point (✓)
    3. implement for mouse move (✓)
18. Clean up selection
    1. standardize functions for selection weight, color (✓)
    2. function to count all drawObjs with weight=1 (✓)
    3. function to extract IDs from drawObj list (✓)
    4. fix SelectByRectangle so it runs efficiently(✓)
    5. create options to create new selection, add to selection, etc. (✓)
19. Set up tool to create transformation
    1. need to fix: (✓)
       1. why isn’t it omitting unnecessary triangles?
       2. why is it asking for a projection?
    2. change input process (✓)
       1. load population first, then load/create mesh
20. Change size metric
    1. use Sorenson metric(✓)
21. Fix zoom out button (✓?)
22. Fix rectangular selection (✓?)
23. Fix slow selection (✓)
24. Fix constraints on node movement (✓)
25. Fix undo to allow multiple node movement undo (✓)
26. Add feedback to UNDO button (✓)
27. Show polygon information on mouseover (✓)
28. Update legend/poppoly symbology so that boundary lines are visible (make them white?) (✓)
29. Revamp Drawing objects
    1. expand drawObj structure to allow simultaneous drawing on both maps (✓)
    2. Fix problems with nodes disappearing (after subdivide???) (✓)
    3. Revamp drawing objects to show on both maps (✓)
30. Make fuzzy selection visible through grayscale(✓\*)
31. Update defaults in CreateGrid so that total # nodes = ~2000 (✓)
32. Copy source TIN on update(✓)
33. Automatically clear selection after move(✓)
34. Disable zoom to all on transformmap on update(✓)
35. Allow zooming out on transform map(✓)
36. Fix bug where buffer around mouse appears selected when selecting by rectangle (✓)
37. Streamline process of adding data (✓)
38. Add tooltip text to buttons (✓)
39. Clean up mouse actions to generalize to two maps (✓)
40. Create functions for reverse movement (in cTriangularCartogram)
    1. class or structure for movement swarm (✓)
       1. NodeIDs
       2. DestCoord
       3. Notes:
          1. Must comprise Nodes that form convext Set
    2. Function to create reverse swarm (✓)
       1. Reverse movement vectors (Orig ⬄ Dest)
       2. Triangulate
       3. Interpolate movement vectors from Origins to Nodes
    3. Function to transfer Target Reverse Swarm to source TIN (✓)
       1. Simply translate node destinations into SourceTIN coordinate space
    4. Test Functions for ReverseSwarm and TransferSwarm
41. Change triangle shape metric from p^2/a to max angle
42. Add way to “free-form select”
    1. first mouse movement selects
    2. mousemode (and selected radio button) automatically switched to “move nodes” after mouseup
43. Create Options:
    1. Graphical slider option for Selection Halo
    2. legend color scheme
    3. polygon outlines (black or white)
    4. tension (controls exponent on neighbor weights when moving nodes)
    5. minimum triangle metric (controls how much local distortion is allowed. Allowing more local distortion allows more flexibility, but can cause certain attempts and space adjustment to fail
44. Add selection options
    1. createNew, addTo, removeFrom, selectWithin
    2. create icons
    3. option to auto-clear selection after move
45. Alter point categories
    1. selected (with value)
    2. highlighted
    3. focused (temporary highlight)
46. Add feedback when densifying grid
    1. how many grid points?
47. Add feedback with mouseUp when moving nodes (??)
48. Add size metric to display when mousing around (X determined to be too slow)
49. Create methods to draw quickly on transform map
50. Set up functions to save adjustment history
    1. manually save to file first
    2. test
    3. save to transformation
51. Disallow movement of exterior nodes (✓)
52. Create tool to expand mesh
53. Fix disappearing polygons (✓)
    1. Find out when they disappear & why (✓)

Current status of triangulation cartograms:

* Point Index is working!!!
* DCEL is working!!!
* TIN is working!!!
* Function to determine node surplus is working
* Ability to mark edges as excluded is working
* Interface colors nodes and edges accordingly

Data Preparation:

1. Create external points
   1. define smaller area (AOI)
   2. calculate density of points
   3. create larger area (Buffer)
   4. fill in points with same density (preferrably in a hexagonal grid)
      1. hexagon width:
      2. w=sqrt(8a/3sqrt(3))
      3. where a is the area of a hexagon
   5. clip out AOI
   6. merge with original points
2. Massage points
   1. do:
      1. create Thiessen polygons
      2. clip by AOI
      3. calculate centroids
   2. repeat as necessary

Steps to Create Transformation

* put above functionality into a cTriangularCartogram class that inherits from cTIN
* function to determine total area (or area of average triangle)
* function to create TRN
  + calculate edge length
  + designate codes for 6 edge directions (0-5)
  + calculate edge x & y displacement for each coded direction (place in array)
  + create list of polygons already handled
  + create work list [triangle, orientation, horizontal edge]
  + create output edge FC
  + p1 = any polygon (not excluded)
  + with p1:
    - designate orientation (N or S), horizontal edge
    - translate edges, add to output FC and mark triangle as handled
  + add p1 to work list
  + do while work list is not empty
    - pop polygon from worklist
    - for adjTriNum=0 to 2
      * curP= adjacent triangle #
      * if triangle is not marked as handled:
        + orientation is reverse of input
        + determine horizontal edge
        + translate edges and add to output
        + mark as handled
        + add curP to worklist
* function to recenter and rotate