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Title: MAMA Software Features: Visual Examples of Quantification

Author(s): Ruggiero, Christy E.
Porter, Reid B.

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MAMA Software Features:
Visual Examples of Quantification

Abstract:

This document shows examples of the results from quantifying objects of certain sizes and types in the software. It is intended to give users a better feel for some of the quantification calculations, and, more importantly, to help users understand the challenges with using a small set of 'shape' quantification calculations for objects that can vary widely in shapes and features. We will add more examples to this in the coming year.

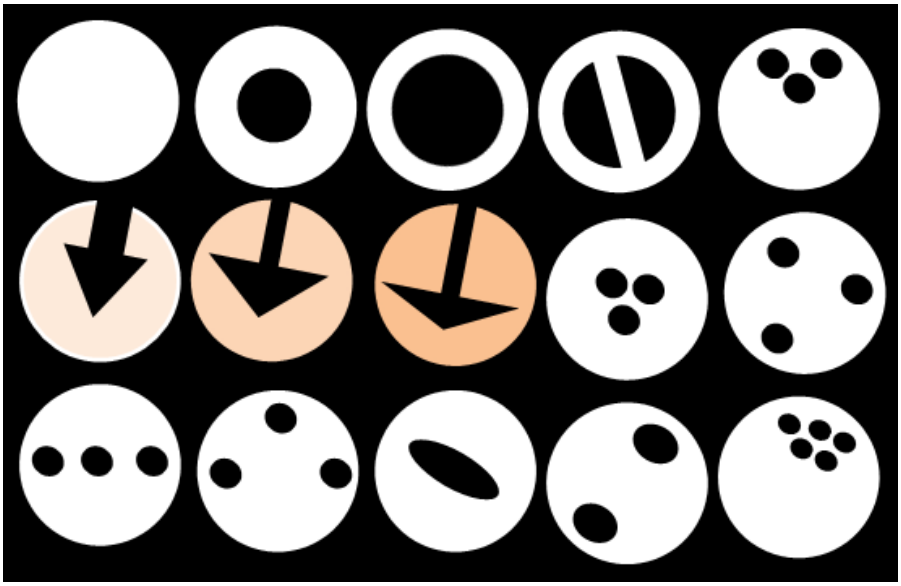
Contents

DHS Funding Statement: The Department of Homeland Security sponsored the production of this material under the Department of Energy contract for the management and operation of Los Alamos National Laboratory

Visual Examples & Quantification Cautions

The following pages show some examples of shapes that may not quantify exactly as you would intuitively expect due to the way the calculation math is implemented. These are presented as simple examples to better help you understand the attributes

Holes:



Area & Perimeter do not take any holes into account: All but the 'arrow' circles (light orange shades) are identical in area, convex hull area, circularity/roundness, area convexity and perimeter convexity (Because the derived attributes--circularity/roundness, convexities-- are based on area and perimeter, they are identical as well.) The 'arrow' circles have the same convex hull area, but are smaller in area since the missing part of the circle is not an enclosed hole. All differ in pixel count.

Aspect Ratio-ellipse and Aspect Ratio Chordal are slightly different calculations: These shapes all have nearly identical chordal aspect ratios, but differ slightly in ellipse aspect ratio (1.0 for chordal, 1.0 to 1.1 for ellipse.)

Perimeter and Area Convexity are different but both useful for shape: The 'arrow' circles in the section above vary more in perimeter convexity (0.63-0.52, Left to right) than they do in area convexity (0.76 - 0.79, L to R) because the missing 'arrow' part of the circle is nearly the same area in all, but the arrows are different in perimeter.

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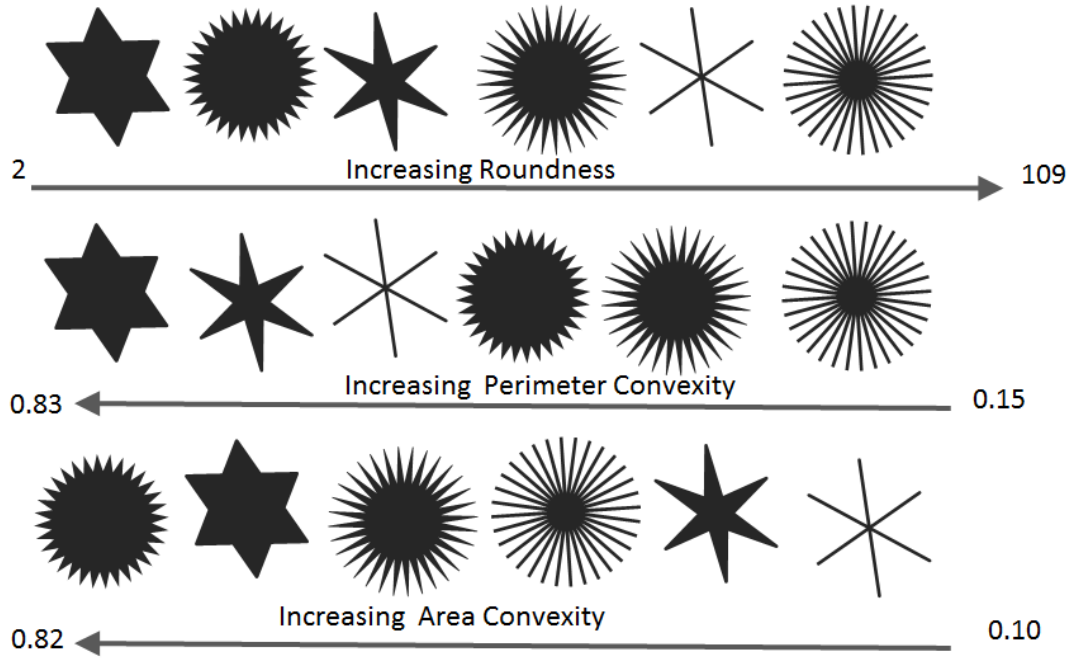
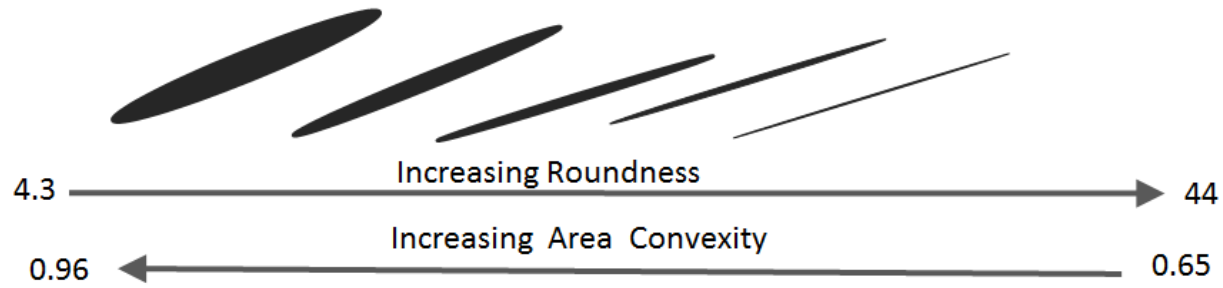
Convex Shapes-Stars:

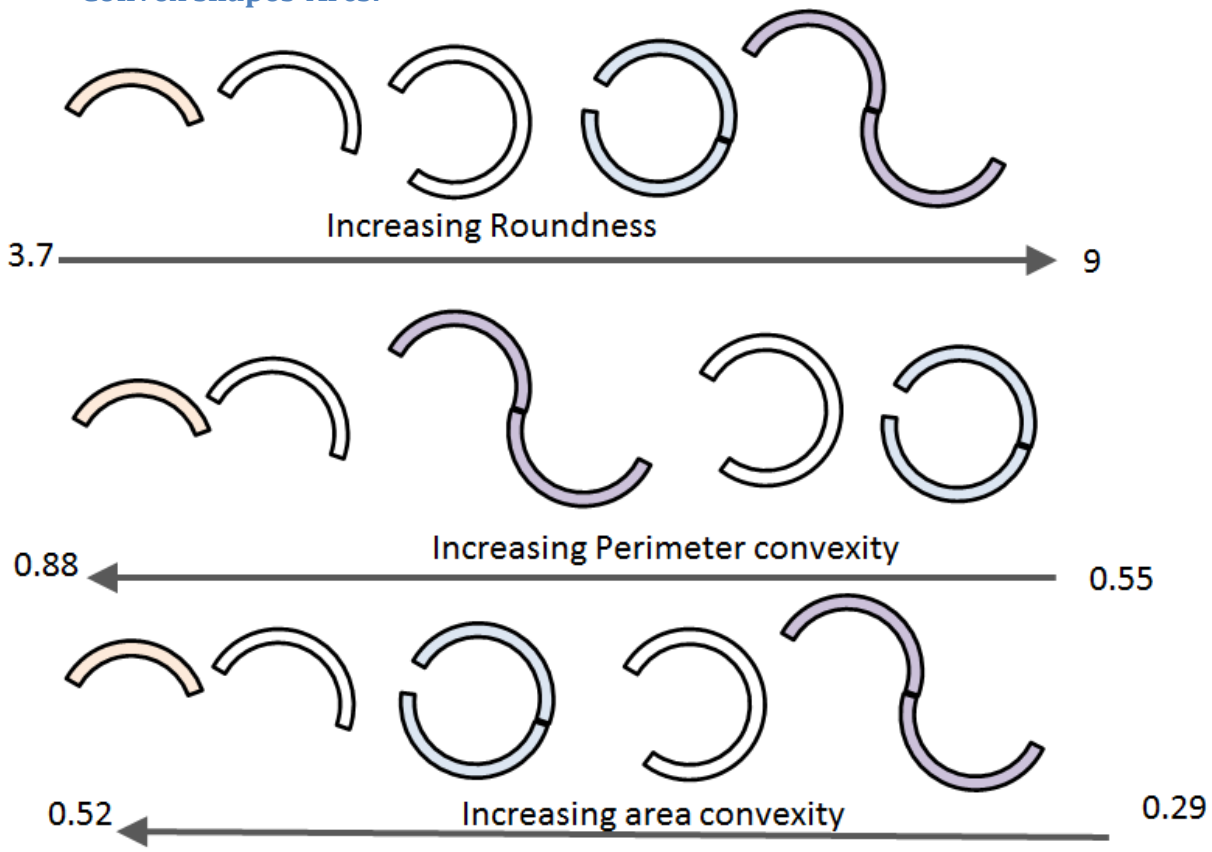


These Sun and Star shapes vary most in Circularity/ Roundness. They are all nearly identical in aspect ratio. The suns vary more in perimeter convexity than do the stars (0.44 to 0.15 for suns, 0.83 to 0.49 for star), while the stars vary more in area convexity than do the suns (0.82 to 0.42 for suns, 0.70 to 0.10 for stars).



In contrast to the stars and suns, non-convex ellipses do not vary in perimeter convexity, but do vary in roundness and area convexity. The area convexity is a result of the pixel representation—the off-angle (not on pixel axes, not on 45-degree axes) requires that pixels on the perimeter are in non-uniform steps.

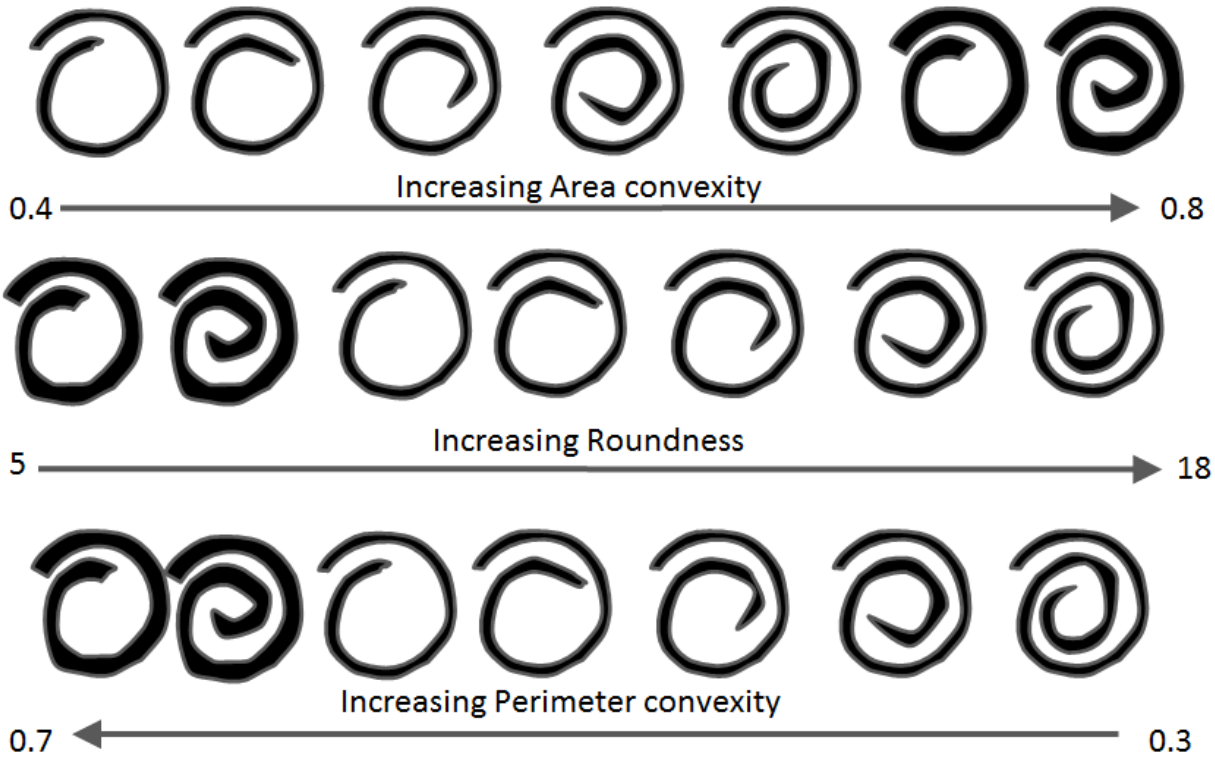
Convex shapes-Arcs:



These shapes vary more in chordal aspect ratio than ellipse aspect ratio. Chordal aspect ratio for these 'arc' shapes varies from 4 for the purple 's' shape to 1 for the blue shape, which is formed from the same two arc segments; The ellipse aspect range from 2.8 to 1. These aspect ratios are far lower than the ellipses, which have similar "length" and "width." (The widest ellipse has aspect ratios of 8 & 9 for ellipse and chordal calculations.) This seeming discrepancy is for the same reason as the spirals—the aspect ratios are not calculated along the path of the particle.

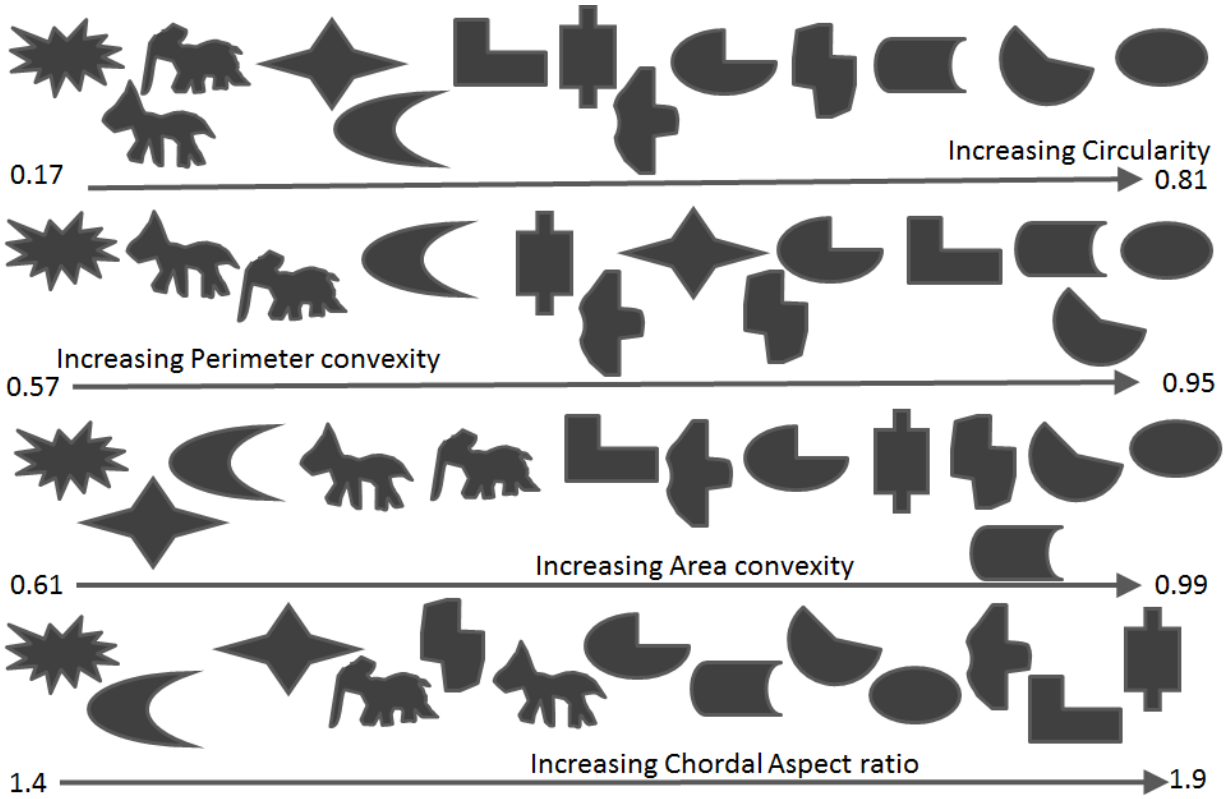
The area and perimeter convexity and roundness do not vary as much as with the sun/star shapes.

Spiral Shapes:



These spirals do not vary in ellipse or chordal aspect ratio, because neither aspect ratio is constrained to stay within particle boundaries (i.e. the longest diameter is the longest straight line between two points on the perimeter, not the longest path through the particle.) They do vary in area convexity, perimeter convexity, and roundness. (For a series of Ellipses, as the aspect ratio increases, roundness increases but area convexity decreases but only as the aspect ratio gets very large, and perimeter convexity does not vary). Note that for spirals, unlike other shapes shown, the area and ellipse convexity are inversely related.

A Special Note on Ellipse Aspect Ratio:



Ellipse aspect ratio is intuitively nice, but it is a fitted ellipse, so it is a smoothed, data-reduced result. All these shapes (shown smaller here than in testing) vary by less than 1% in Area and Ellipse Aspect ratio (i.e. none could be distinguished by ellipse aspect ratio and area alone.) They vary by less than 6% in their major/minor ellipse lengths. Without a convexity measurement, you can't tell them apart by their numerical attributes. They vary by 7% in chordal aspect ratio, 15% in area convexity and perimeter convexity, and 40% in circularity.