An Edgy Image Statistic: Semi-Automated Edge Extraction and Fractal Box-Counting Algorithm Allows for Quantification of Edge Dimension In Natural Scenes

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Edges are significant, ubiquitous features of natural scenes. Basic properties of visual stimuli such as edges should be controlled for in experiments and reported in the literature. Currently, no commonly reported image statistics describe natural scenes' edges.

An edge's fractal dimension (Df) could serve as a statistic that quantifies edge roughness in an image across scales. Researchers have often relied on hand tracing to isolate edges in natural scenes for box-counting, a Df measurement technique. For a typical experiment's stimulus set, this would be unfeasibly time consuming.

To expedite the process, we developed an algorithm to isolate selected edges of a natural scene for fractal analysis. Our algorithm consists of a three-step manual component (select specific color channels and average their intensity maps, apply an intensity-based threshold, and choose a set of binary objects to retain) followed by a two-step automated component (draw the edges and perform a box-count).

We implemented our algorithm in Matlab and applied it to 90 images of clouds. We found that clouds as viewed from the ground have mean Df=1.34 (SD=0.11). We also computed the slope (β) of the radially averaged power spectrum for each image to test for a relationship between Df and β. We found no significant correlation between Df and β ($r(90)=0.12$, $p=0.251$). This implies that an image's textures may be independent from the Df of the textures' borders. This distinction is important because β can be computed with full automation.

While computing Df for natural image's objects' edges has been time-intensive, our algorithm allows for quick determination of this critical scene statistic. Df could be used characterize the roughness of edges in visually presented natural scene stimuli. Studying how multi-scale contours affect visual processing would complement the literature on the visual processing of texture.