Visualizing the distributions of the escape paths of quaternion fractals

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Abstract

The length and displacement distributions of the escape paths of the points in some quaternion fractal sets are visualized.

1 Escape path length and displacement histograms

As discussed in [1, 2], a 3D scalar field of quaternion magnitudes (e.g. $|Z|$) results from calculating a quaternion fractal set when using a finite 3D lattice of regularly spaced points as input.

Here we visualize the distributions of the escape paths' lengths, as well as the escape paths' displacements, for those points within the set.

As in [1, 2], the threshold for infinite distance is 4.0, and the maximum number of iterations is 8.

The histograms themselves are fractal in nature – there is extra detail when one increases the resolution.

Fig. 2 and Fig. 3 together show how the maximum length is generally greater than the maximum displacement, which is indicative of curved escape paths. In some cases a curved escape path forms a loop, which gives rises to the commonly-used name 'orbit'.

References

[1] Halayka S. *Some visually interesting non-standard quaternion fractal sets* Chaos, Solitons & Fractals Vol. 41, Issue 5

[2] Halayka S. *Visualizing the escape paths of quaternion fractals* Unpublished

[3] `http://paulbourke.net/fractals/trajectories/`

[4] `https://iquilezles.org/www/articles/arquimedes/arquimedes.pdf`

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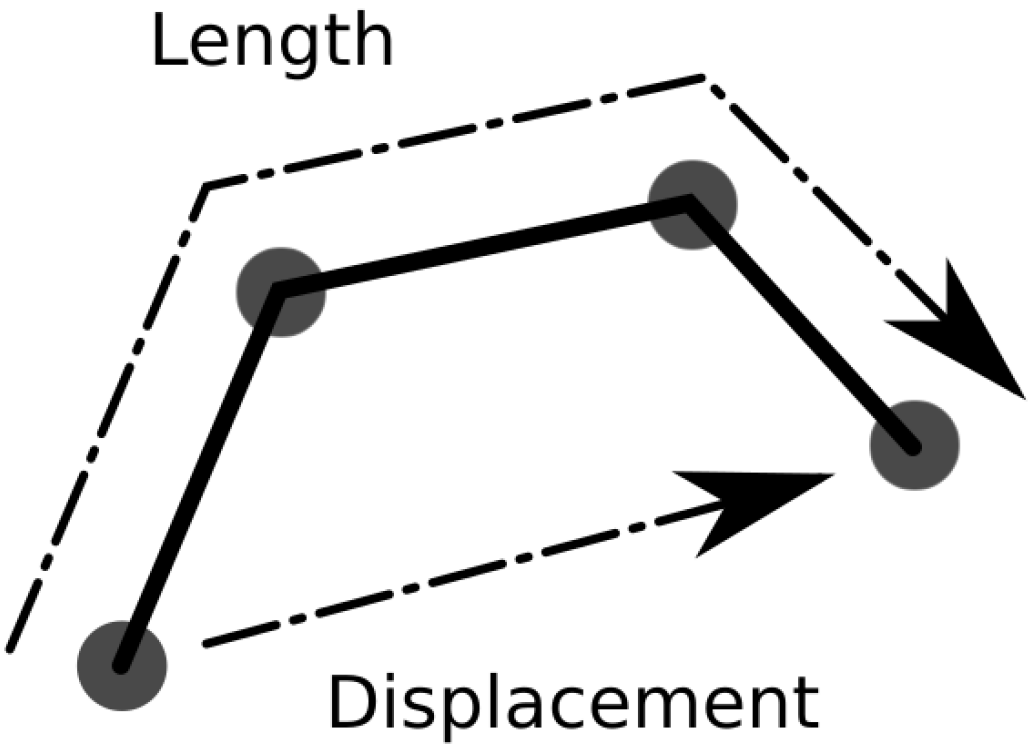

Figure 1: Length and displacement per escape path

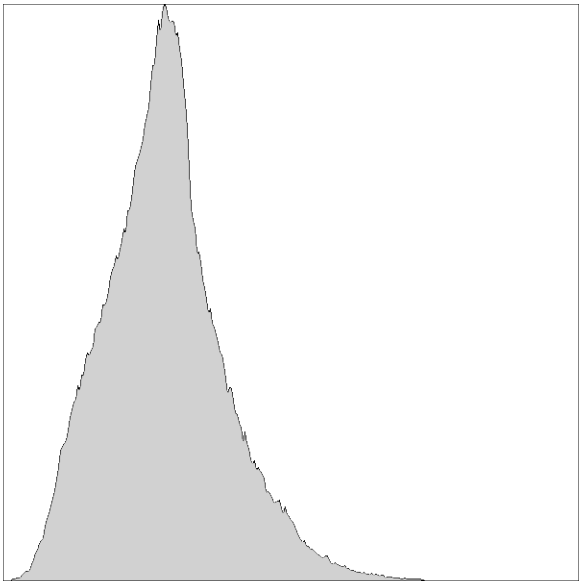

Figure 2: Lengths of $Z' = Z^2 + C$, where $C_{xyzw} = 0.3, 0.5, 0.4, 0.2$. For instance, for this histogram, the maximum length is 21.2391.

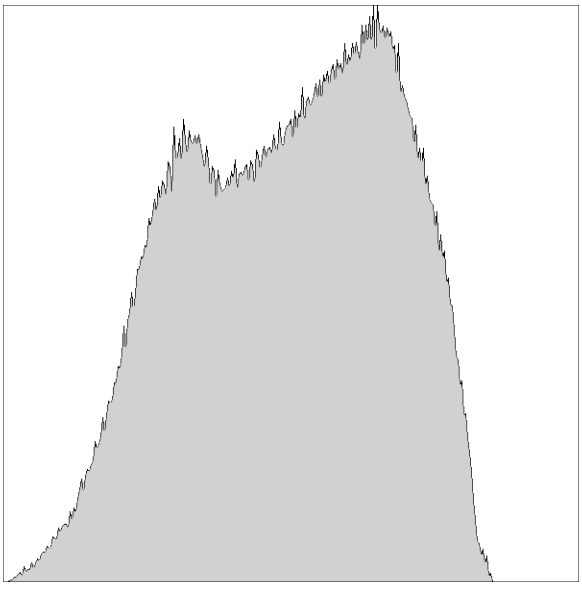

Figure 3: Displacements of $Z' = Z^2 + C$, where $C_{xyzw} = 0.3, 0.5, 0.4, 0.2$. For instance, for this histogram, the maximum displacement is 2.36506.

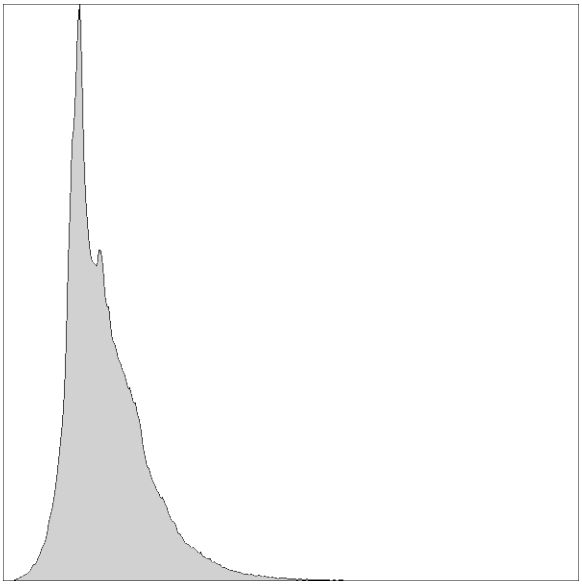

Figure 4: Lengths of $Z' = Z^5 + C$, where $C_{xyzw} = 0.3, 0.5, 0.4, 0.2$.

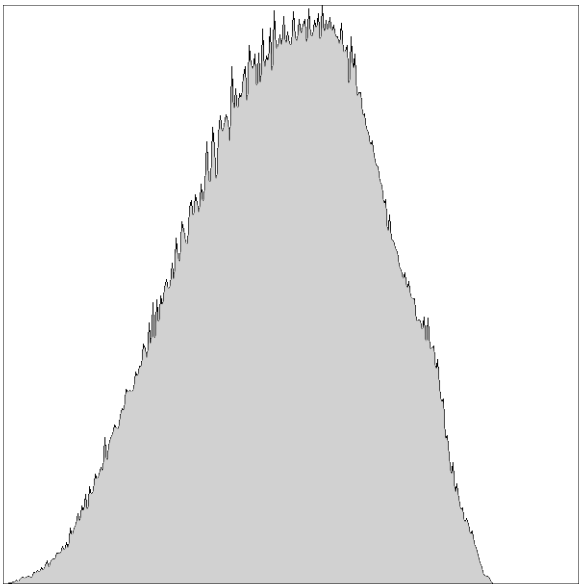

Figure 5: Displacements of $Z' = Z^5 + C$, where $C_{xyzw} = 0.3, 0.5, 0.4, 0.2$.

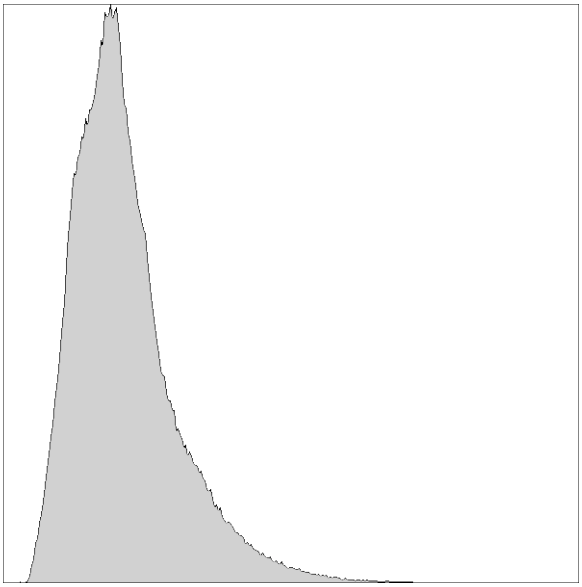

Figure 6: Lengths of $Z' = \sin(Z) + C \cdot \sin(Z)$, where $C_{xyzw} = 0.3, 0.5, 0.4, 0.2$.

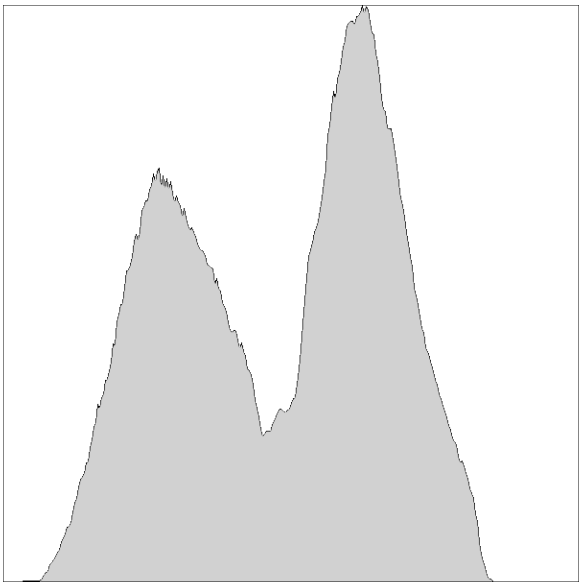

Figure 7: Displacements of $Z' = \sin(Z) + C \cdot \sin(Z)$, where $C_{xyzw} = 0.3, 0.5, 0.4, 0.2$.