# Synthesizing Structured Doodle Hybrids

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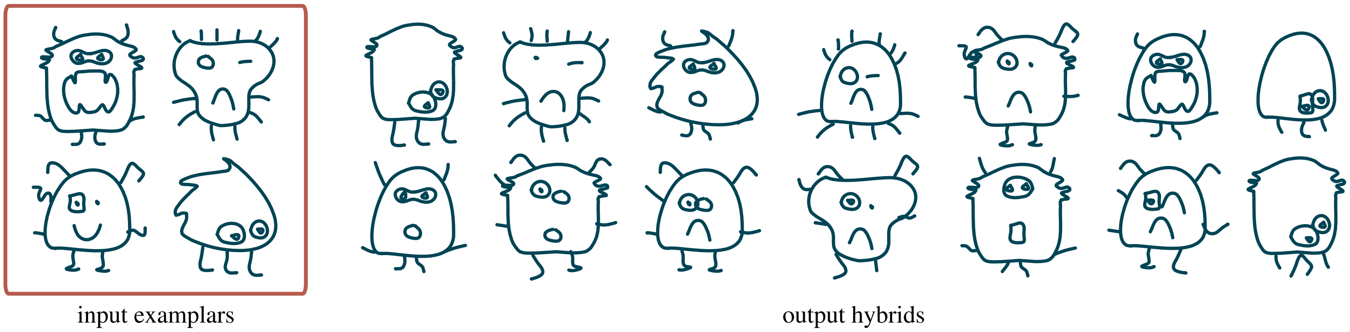


**Figure 1:** *Given a set of input doodles (left), our approach synthesizes similar yet unique hybrids (right).*

## 1 Introduction

Creating large sets of similar objects is a common problem in many Computer Graphics applications such as games, animation and illustration. Generally, cloning the objects is not a decent solution. The issue then boils down to creating objects that are similar, yet not identical to, existing ones. This issue has been recently tackled in Computer Graphics for 2D images [Risser et al. 2010] and 3D objects [Kalogerakis et al. 2012]. Based on a few given examples, an automatic algorithm outputs new objects that respect the above issue. In this paper, we propose an approach that deals with simple line-drawings, or *doodles*.

Previously, *Latent Doodle Space* proposes to project given examplars in a feature space where interpolation can take place [Baxter and Anjyo 2006]. Although capable of impressive results and due to its interpolation scheme, this approach cannot create new objects as combinations of some input doodles' subparts. Besides, in order for the interpolation to give continuously consistent results, this method requires the user to correct some of the stroke correspondences.

In this work we propose a jitter/correction approach producing a discrete combination of the inputs strokes, as inspired by [Risser et al. 2010; Kalogerakis et al. 2012]. Starting from one of the input doodles, we exchange each stroke by *jittering* it in a convenient feature space that gathers all the strokes from all input doodles. A geometric relaxation step ensures that the local spatial organization of the strokes is still plausible with regard to the given examplars.

## 2 Our Approach

A doodle is a collection of 1D strokes. A natural and practical data representation for strokes are cubic Bezier curves holding some style information such as color etc. The counterpart of using a vector representation is the loss of the pixel grid that naturally structures the information of raster images. In order to infer a plausible doodle structure, we build an inclusion tree based on the pairwise relative overlap between strokes' convex hulls. If the convex hull of one stroke has more than $50\%$ of its area over another one, we consider it as included in the latter.

Starting from one of the input doodles, thereafter named the *shell doodle*, the overall idea consists in exchanging each stroke from the shell with another doodle stroke similar in terms of two features: inclusion genealogy and overall rough shape. A stroke *inclusion genealogy* is measured by its number of parents and children in its associated doodle's tree. Shape similarity is estimated by the matching error given by a thin plate spline warping. The new stroke is randomly picked out in a nearby volume regarding these two features, around the shell stroke values. Finally, the new stroke is axis-aligned along the direction of the considered shell stroke.

Once all the shell strokes have been exchanged, our new doodle has inherited a plausible overall structure. Yet, the relative position of each stroke needs to be fine tuned, as the spatial extents of our hybrid doodle's strokes are likely to differ from the shell doodle's. We use a bottom-up relaxation method that goes from each leaf of the inclusion tree to its last parent. Each node, along with its children, is translated respectively to its parent if any, or its nearest neighbor among its siblings otherwise. The translation is computed by matching the current distance value to the distance value observed in the shell. We use the simple minimal distance between the two strokes if they do not cross, or a symmetrized Hausdorff distance estimating the mutual penetration otherwise. By optimizing only one distance for each stroke, this relaxation do not well handles complex drawings, where a stroke cross another at multiple locations. We plan to tackle this limitation by using a multiple *anchor points* optimization scheme, as in [Kalogerakis et al. 2012].

## References

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RISSER, E., HAN, C., DAHYOT, R., AND GRINSPUN, E. 2010. Synthesizing structured image hybrids. *ACM Trans. Graph. 29*, 4, 85.

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## Synthesizing Structured Doodle Hybrids - Supplementary Results

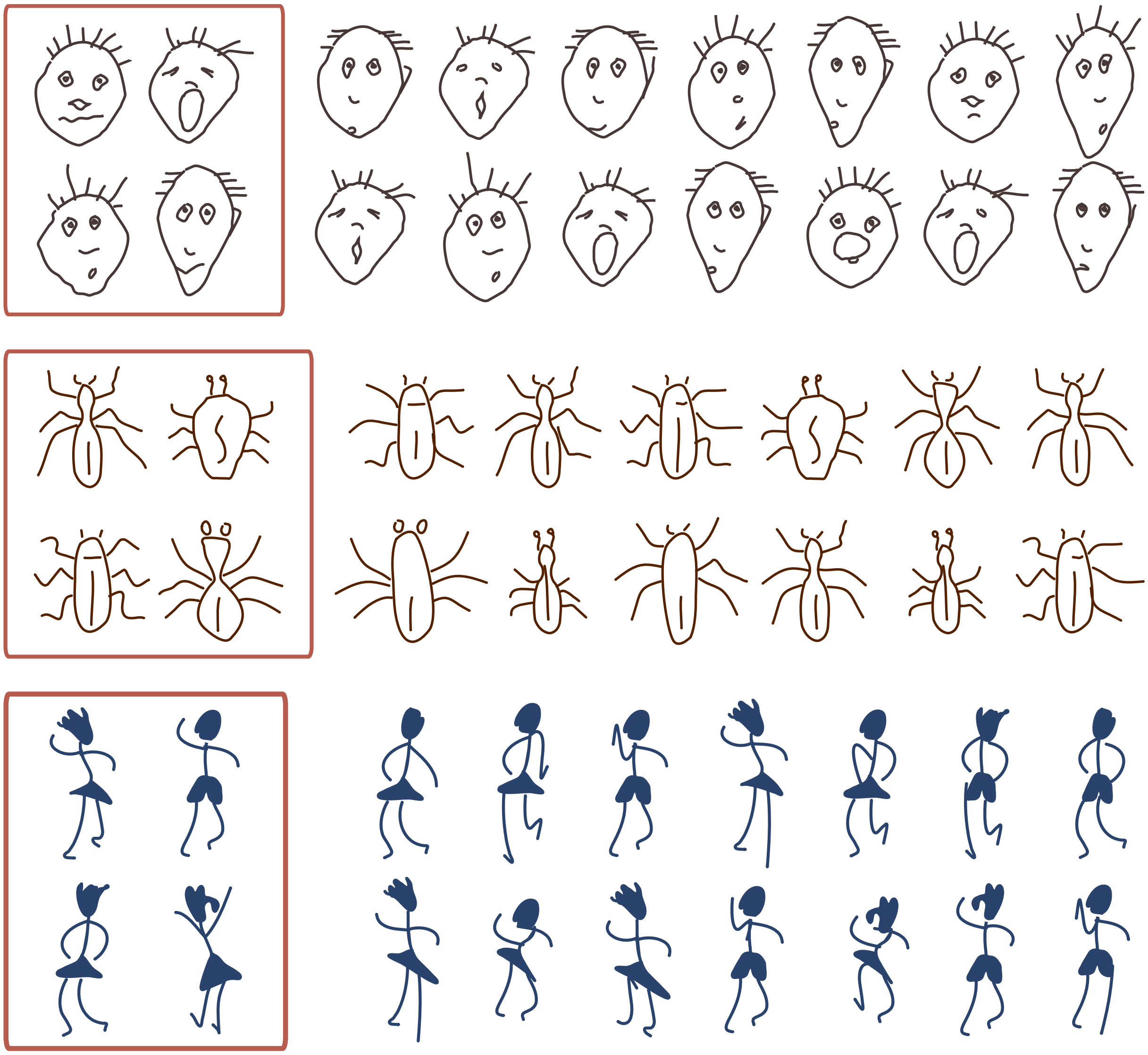

**Figure 1:** *More examples. The inputs are framed on the left.*

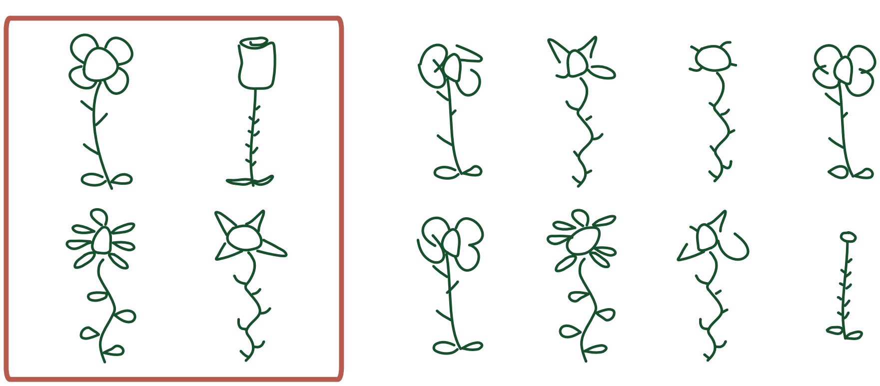

**Figure 2:** *An illustration of the "unique anchor point" limitation. The petals in the first and fourth inputs would be better handled with a* $N > 1$ *anchor points approach. We plan to tackle this issue with a more sophisticated relaxation procedure.*