Data-Driven Guides: Supporting Expressive Design for Information Graphics

Supplemental Material

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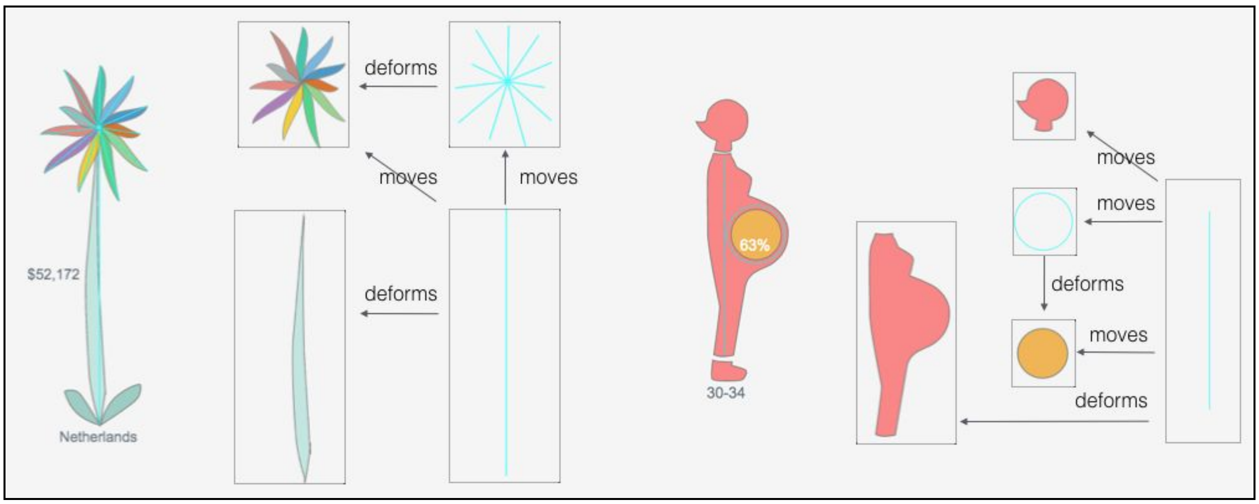
Link Structures for Selected Examples



We show the link structures for Fig. 12f and 12i from the main text in the above figure. The direction of an arrow represents the direction from the constraining element to the constrained element. When liking a shape to a guide, the default behavior is deformation, meaning that the user has to change the desired behavior for the flower from deformation to translation. Data guides can not be deformed and used to construct structures for infographics.

Data-Driven Deformation for Vector Graphics

Deforming graphics in an intuitive way is a well-studied topic in the area of computer graphics, where artists often create animations by defining a series of deformations for an object over time. The most common tool for this operation is known as Linear Blend Skinning (LBS). Given a number of points $p_0, \ldots p_i, \ldots p_n$ that define an object in its rest configuration, and number of affine transformation handles $T_0, \ldots T_j, \ldots T_m$, where typically $m << n$, a deformed configuration for each point on the object p_i' can be achieved by specifying transformations at each of the handles and evaluating a simple linear equation:

$$p_i' = \sum_{j=0}^{m} w_{ij} T_j p_i$$

where w_{ij} represents scalar weights specified by the user for each point-handle pair. The primary benefit of this technique is its speed; once weights and transformations are defined, deforming an object reduces to matrix-vector multiplication.

One caveat of this technique is that choosing weights w_{ij} poorly can lead to unintuitive or unwanted deformations. Additionally, choosing weights by hand is often tedious and difficult for novices. Fortunately, automatic LBS weight computation has been thoroughly studied. In our framework, we rely on Bounded Biharmonic Weights [Jacobson et. al. 2011] to compute these weights given only the domain of the points p_i and the initial locations of the handles T_j. Another caveat is that LBS gives strange results if applied naively to Bézier splines. Fortunately, [Liu et. al. 2014] describes a way to achieve the intended results by instead formulating the problem as a linear optimization, which is typically still fast enough to be solved interactively.

In our framework, we would like to allow a spline to act as a “backbone” for other splines; that is, by modifying the shape of a single parent curve, any child curves and shapes would deform automatically to follow the path of the parent. This concept is similar to Skeletal Strokes [Hsu et. al. 1993].

In our case, we simply discretize the backbone into a sequence of points, each of which we treat as a separate handle in the LBS framework described above. Because a single cubic Bézier segment only has so many ways it can deform (as its coordinates are defined by cubic functions), we found that dividing each backbone into a small fixed number of points per cubic Bézier segment provided sufficient flexibility. We use the direction and the magnitude of the backbone's tangent vector at each discretized point to determine the rotation and scaling components of the LBS handle; we found that non-uniform scaling in the direction of the tangent was more intuitive than uniform scaling in this scenario.

Occasionally, we would find that the deformation of a backbone would cause child shapes to extend beyond the end of the backbone. This is a particularly important scenario to avoid in our framework, as it can lead to misleading infographics. To solve this problem, we adjust the output of Bounded Biharmonic Weights slightly. If we can identify points on a child graphic that should exactly follow the end of its backbone, we place a transformation handle on the end of the backbone and set the LBS weights of the points on the child graphic to 1 for this handle and 0 for all others.

References

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