

CS 669 Class Activity: Core Rules

This activity is based on Jacobson, Baran, Popović and Sorkine-Hornung's paper "Bounded Biharmonic Weights for Real-Time Deformation", CACM **57**(4), April 2014, pp 99–106. We have deliberately added violations of the core rules to their text.

Your task is to

1. Identify places where the *Core Rules* are violated.
2. Re-write the text to follow the rules.

The single-spaced introductory paragraph is here to give you context; focus your re-writing on the double-spaced sections.

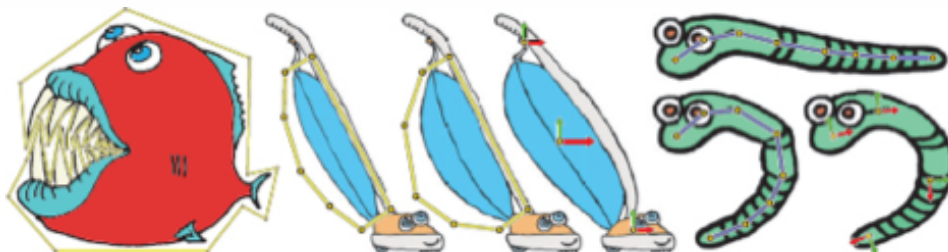
1. Introduction

Interactive deformation is the task of assisting the user to alter an object's shape. In the case of 2D cartoon deformation, we could ask the user to manually reposition each pixel of the image, but this is unnecessarily tedious. The space of coherent configurations of the 2D shape is much smaller than the space of all possible positions for every pixel of the image. Hence, we would rather the user provide only a few, high-level constraints like "open the mouth," "enlarge the belly," or "bend the tail." ... The rest of the shape should immediately deform in an intuitive manner. We may interface such high-level constraints to the user with handle structures, like skeletons composed of rigid bones, enclosing cages, and selected regions or points. ...

In a typical workflow, the user constructs handles and, in a step called *bind time*, the deformation system binds them to the object. Next, at *pose time*, the user manipulates the handles, and the system deforms the shape.

(It is unfortunate that existing linear blending schemes sometimes cause difficulty in use.) The choice of a particular handle type — cages, points or bones — must be made *a priori*, each type

Figure 2. Each of the handle types is appropriate for some situations and inappropriate for others. Cages can be both tedious and unintuitive to define, for example, weaving around the *Pirahna's* teeth. Control points can be too crude to make precise articulations, as with the *Vacuum cleaner*, where a cage is better. Bones are too rigid to deform the *Worm*, while points provide loose and smooth control.



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has its own advantages, as illustrated in Figure 2. Bones provide natural control for rigid limbs, but are less convenient for flexible regions. Cages control volume and area better than points, but must be closed (or nearly closed) to fully-encapsulate transformed objects, and can be tedious to manipulate. In contrast, variational techniques often support arbitrary handles at points or regions, but at a greater pose-time cost.

Real-time object deformations would be easier if the user could choose the most appropriate handle types—points, bones or cages—for the current object. Points are quick to place and easy to manipulate; they provide a way of specifying local deformation properties (position, rotation, and scaling) that that can be propagated smoothly to adjacent locations. Bones make some directions stiffer than others: if a region between two points appears too supple, bones can transform it into a rigid limb. Cages allow the user to influence a large portion of the object at once, making it easier to control bulging and thinning.