# Shape Deformation (I)

Volume-based deformation

*Parametric deformation*

# Parametric deformation

Use succession of parameterized space varying deformation

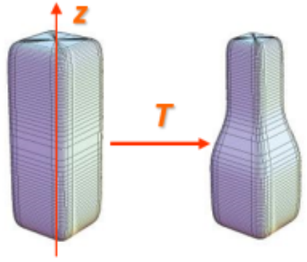
- Rotation: Bending, Twisting
- Scaling: Squeezing/tapering, Stretch

Old idea: First proposed in

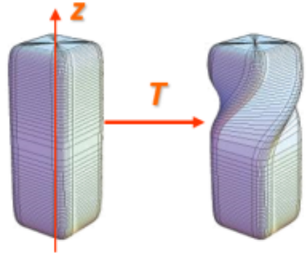
*[ Alan H. Barr. Global and Local Deformations of Solid Primitives. SIGGRAPH 1984 ]*

(+) Explicit formulation $q = f(p)$

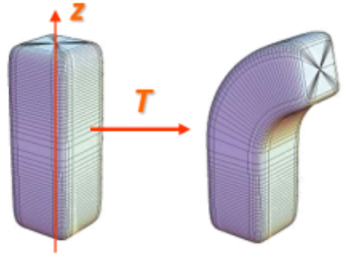
(-) Limited degrees of freedom




$$\begin{pmatrix} s(z) & 0 & 0 & 0 \\ 0 & s(z) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} p_x \\ p_y \\ p_z \\ 1 \end{pmatrix}$$




$$\begin{pmatrix} \cos\theta(z) & \sin\theta(z) & 0 & 0 \\ -\sin\theta(z) & \cos\theta(z) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} p_x \\ p_y \\ p_z \\ 1 \end{pmatrix}$$




$$\begin{pmatrix} \cos\theta(z) & 0 & -\sin\theta(z) & 0 \\ 0 & 1 & 0 & 0 \\ \sin\theta(z) & 0 & \cos\theta(z) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} p_x \\ p_y \\ p_z \\ 1 \end{pmatrix}$$

# Local deformers

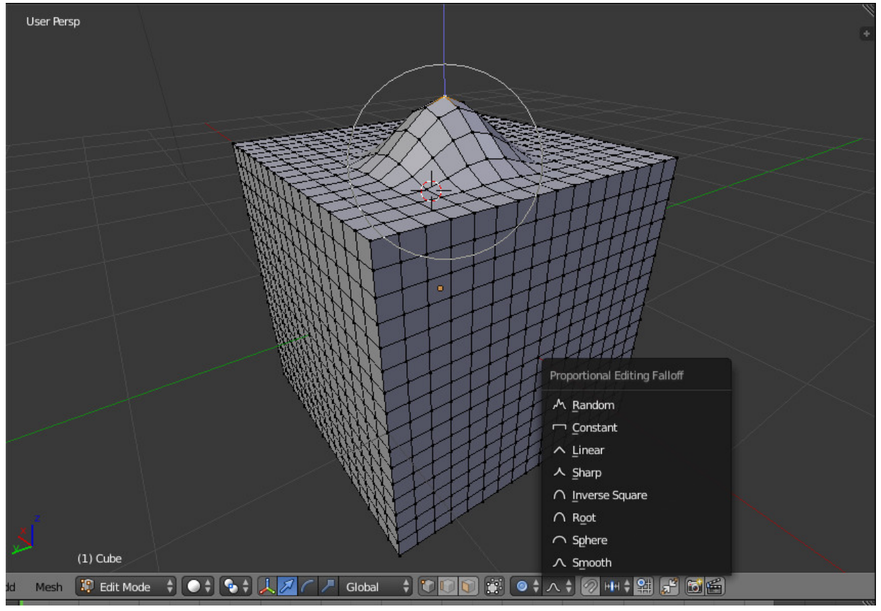
Variety of interactive local and parametric **deformers** in 3D modeling softwares

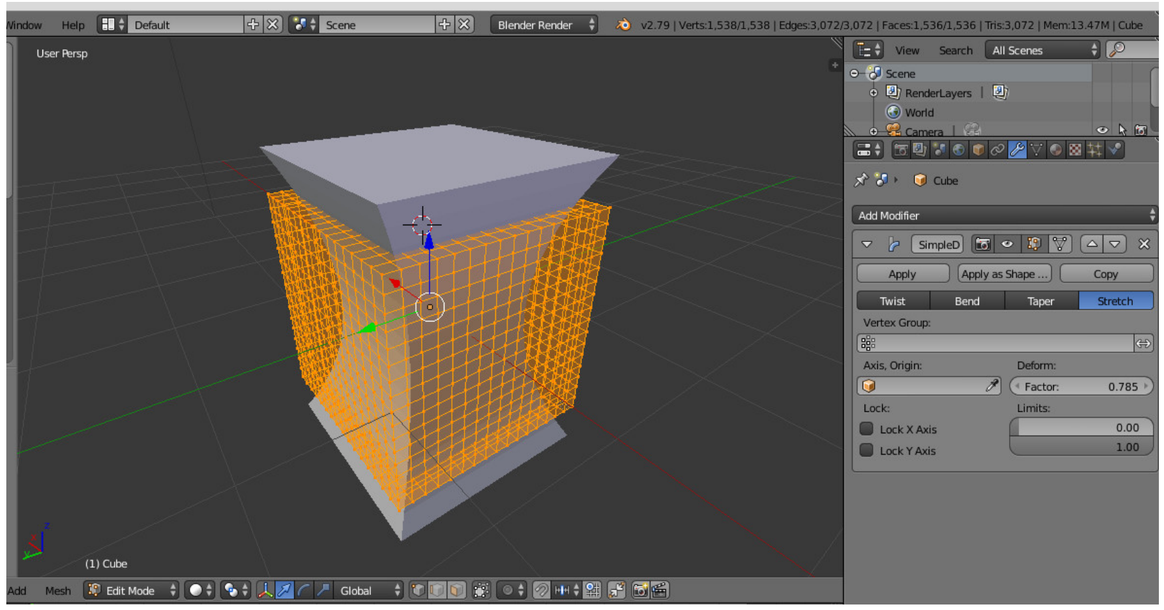
Example: Applying a translation $t$ only locally around $c$

$$q = p + w(p)\,t \quad , \quad w(p) = \exp(-\|p - c\|^2/\sigma^2)$$

$t$ can be controled interactively

*and other parameters (rotation axis, angle, etc) as well.*



# Deformers example cases

Q. How to model this interactive deformer ?

Input:

- $c$: Selected position on the surface
- $t_{2D}$: 2D displacement coordinates of the mouse on screen while dragging
- $r$: Circle radius

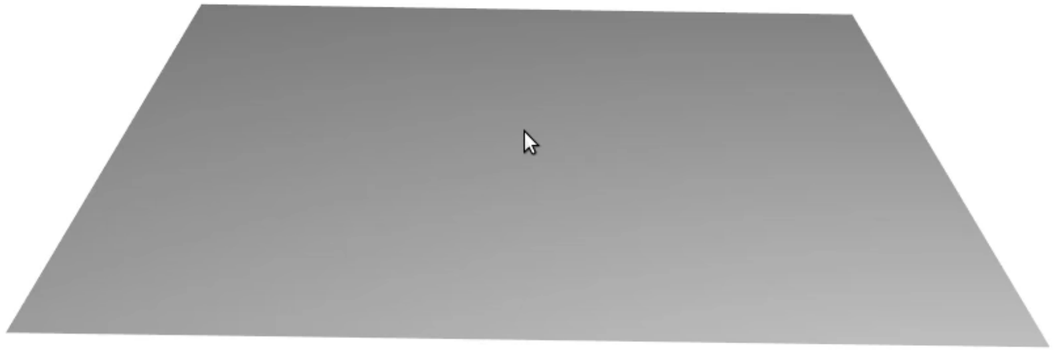
Computation:

For all positions of the surface $p$

...

# Deformers example cases

Q. How to model this interactive deformer ?



# Deformers example cases

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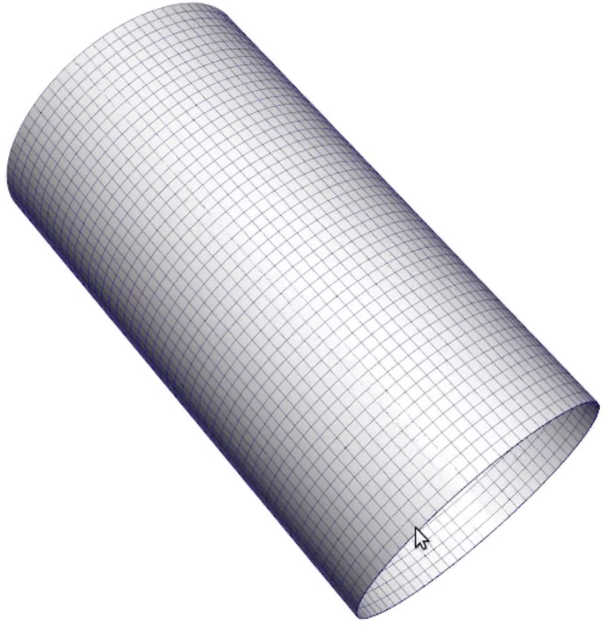
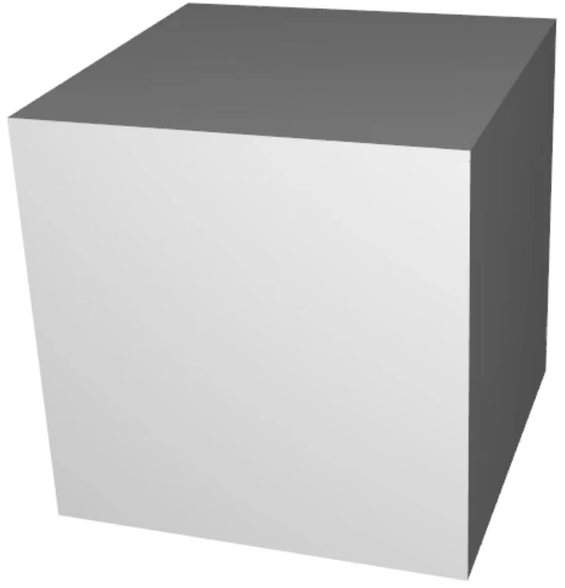


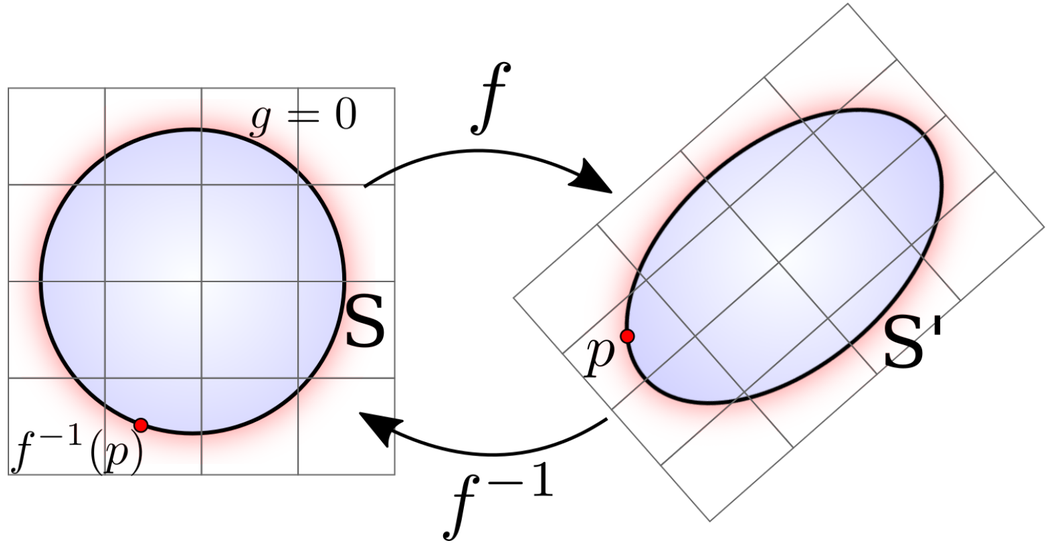


# Case of implicit surfaces

Undeformed implicit surface $S = \{p \in \mathbb{R}^3 \mid \ g(p) = 0\}$

Given a volume deformation $f : p \to f(p)$

The implicit surface $S'$ deformed by $f$ is defined by

$$S' = \{p \in \mathbb{R}^3 \mid \ (g \circ f^{-1})(p) = 0\}$$

$p \in S' \Rightarrow f^{-1}(p) \in S \Rightarrow g(f^{-1}(p)) = 0$