



Procedural Texturing and Shading



Procedural Texturing/Shading

Paradigm for programmability in the graphics pipeline

Allows for a wide variety of surface materials and embellishments

May be facilitated by a custom shading language

- **e.g. Pixar's RenderMan, NVIDIA's CG**



Potential Advantages of Procedural Textures

Compact representation

No fixed resolution

No fixed area

Parameterized - generates class of related textures



Disadvantages of Procedural Textures

Difficult to build and debug

Surprising results

Slow evaluation

Antialiasing handled manually



Procedural Texture Conventions

Avoid conditionals

- Convert to mathematical functions when possible
- Makes anti-aliasing easier

Parameterize rather than building in constants

- Assign reasonable defaults which may be overridden



Simple Building Blocks

Mix (lerp)

Step, smoothstep, pulse

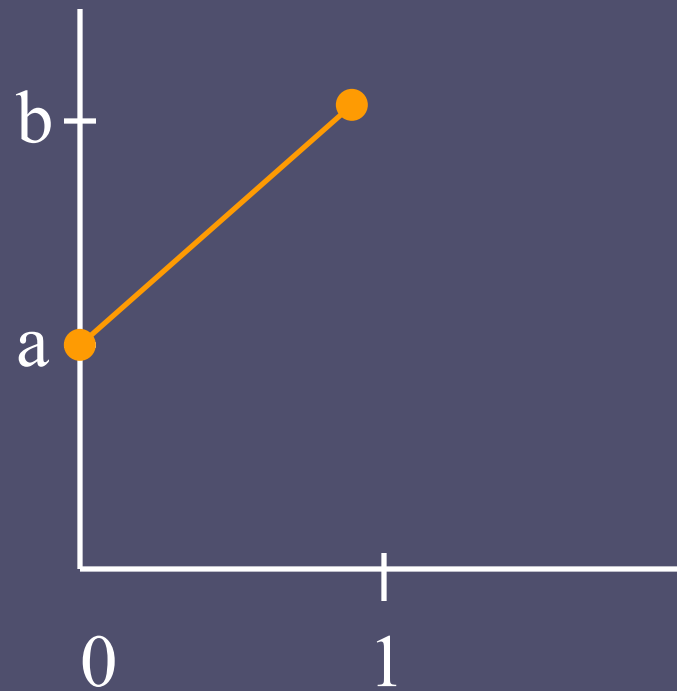
Min, max, clamp, abs

Sin, cos

Mod, floor, ceil



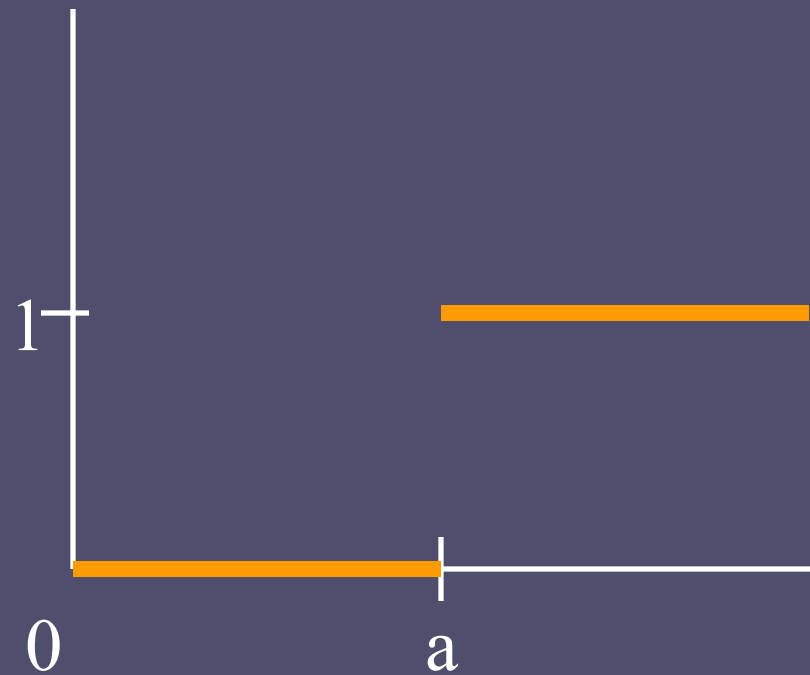
Mix



$\text{mix}(a,b,x)$



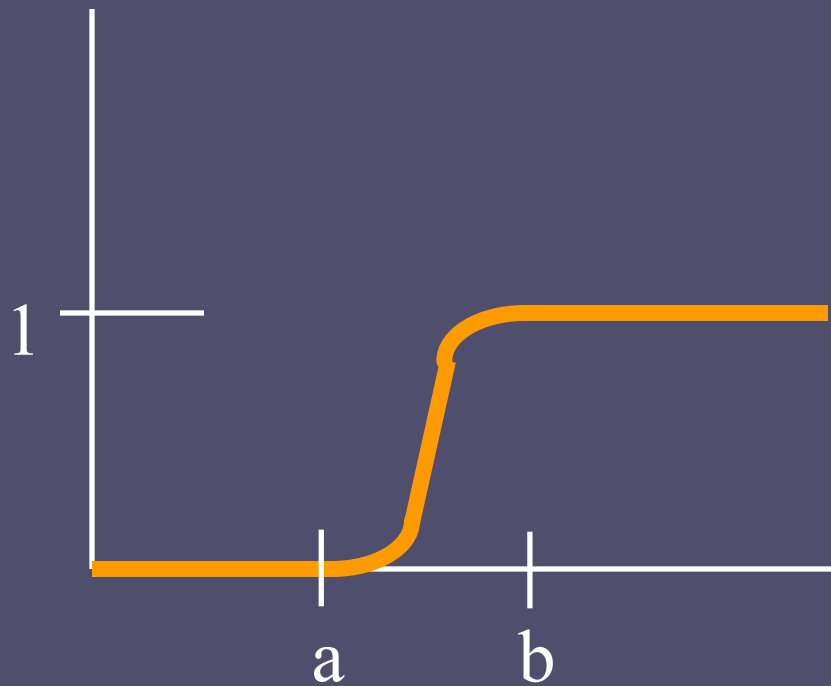
Step



$\text{step}(a, x)$



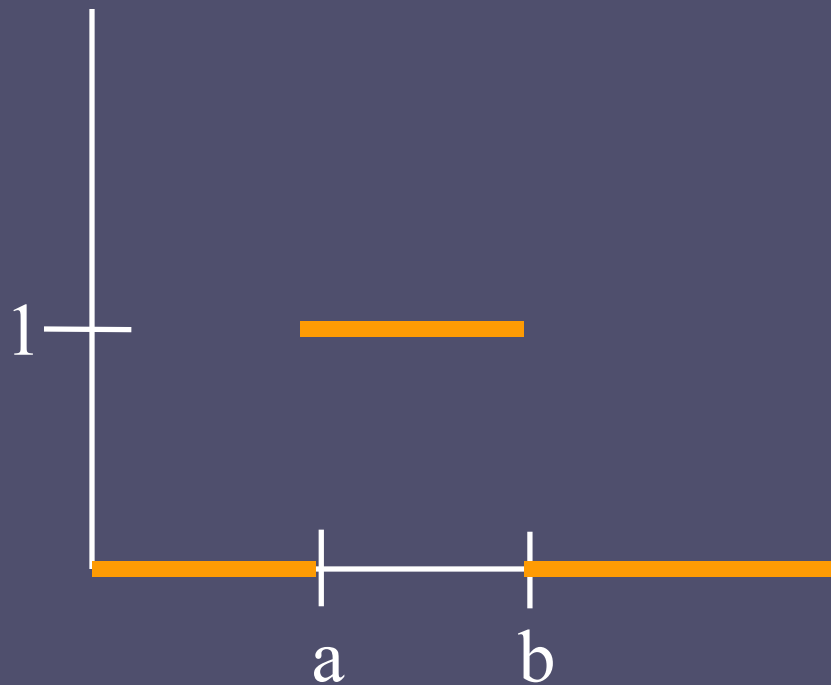
Smoothstep



$\text{smoothstep}(a,b,x)$



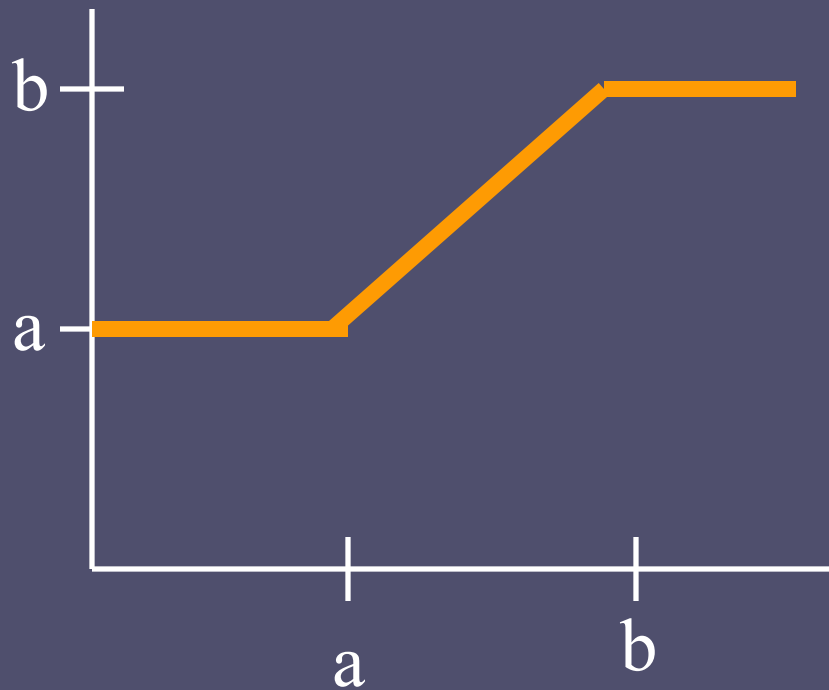
Pulse



$$\text{pulse}(a,b,x) = \text{step}(a,x) - \text{step}(b,x)$$



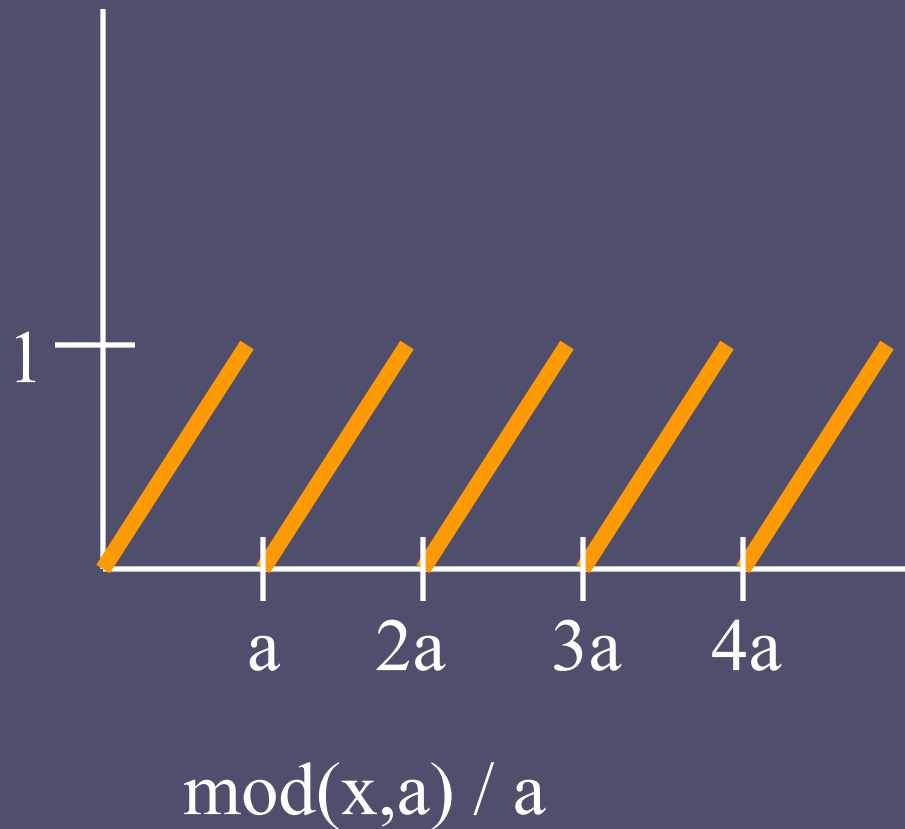
Clamp



$$\text{clamp}(x, a, b) = \min(\max(x, a), b)$$

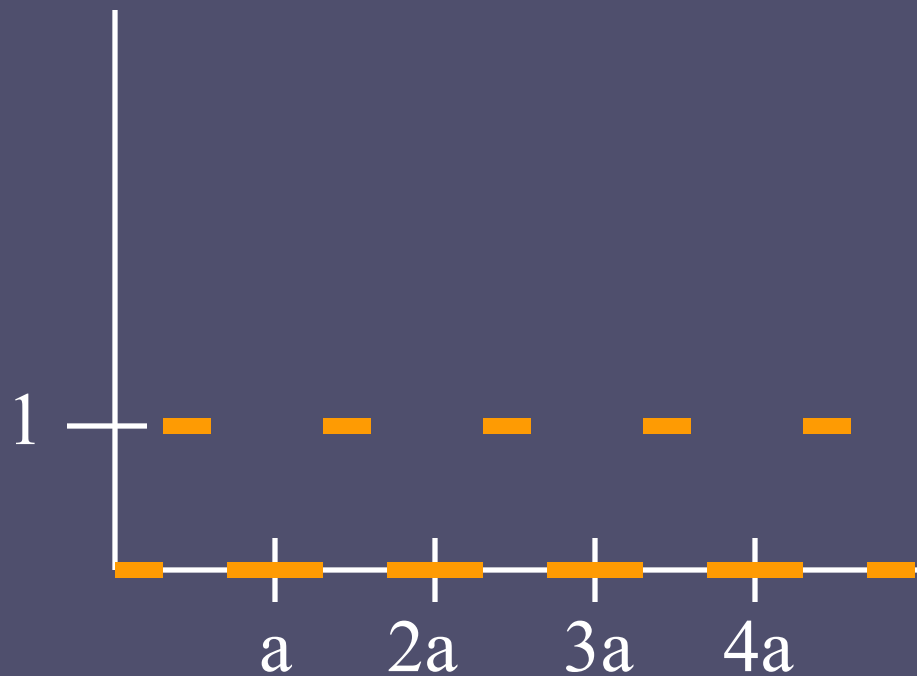


Mod





Periodic Pulse



$$\text{pulse}(0.4, 0.6, \text{mod}(x,a)/a)$$



Example 1 - brick (see handout)

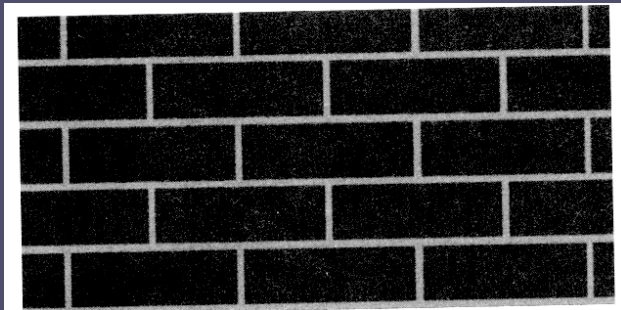
Brick is primarily a 2D pulse

Input parameters may include:

- color of brick and mortar
- size of brick
- thickness of mortar
- mortar bump size
- frequency of brick color variation
- etc.



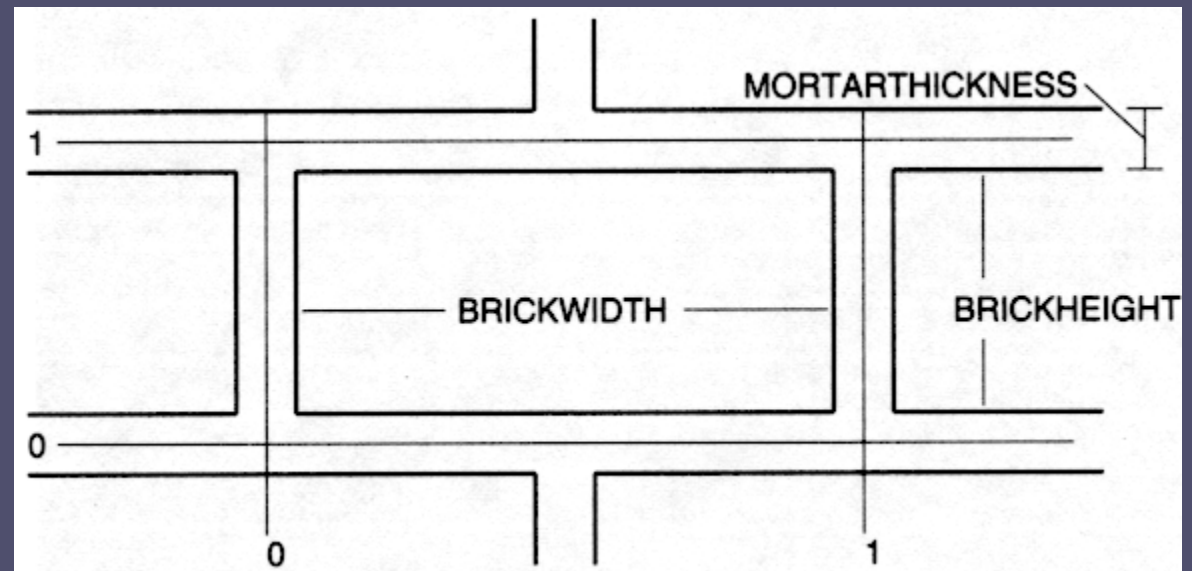
Brick



(pulse)



(pulse)



from Ebert, ed., *Texturing and Modeling: a Procedural Approach*, 1994, pages 37-38.



Example 2 - star (see handout)

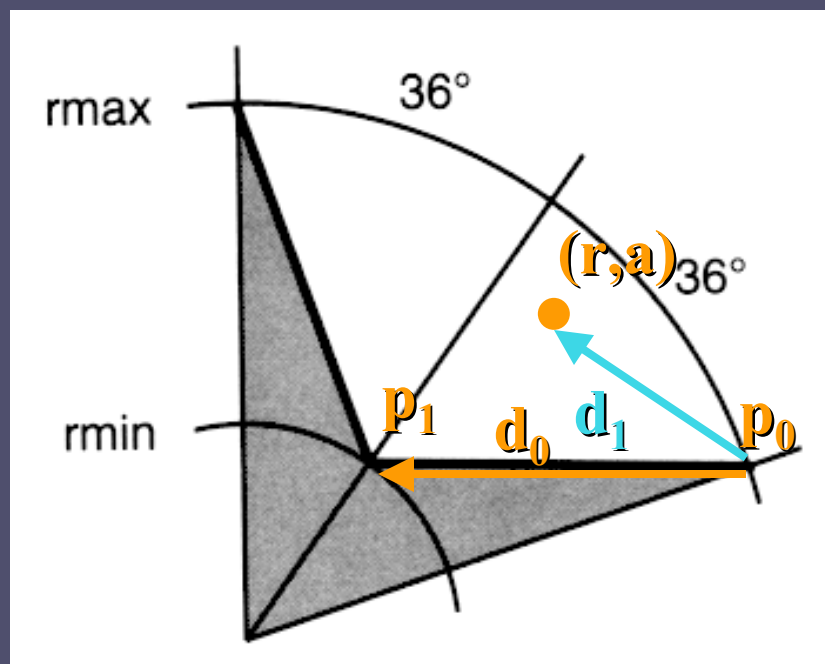
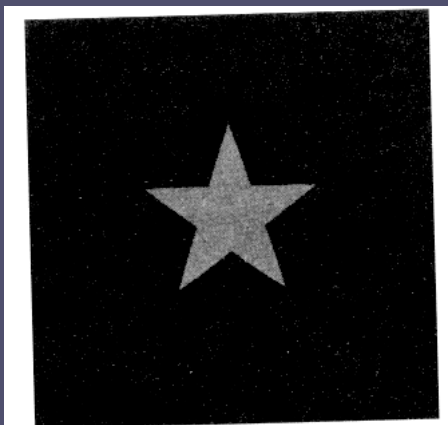
Exploit symmetry of star geometry

Input parameters may include:

- **Inner and outer star radii**
- **Number of points**
- **Star and background colors**
- **Star bump parameters**
- **Parameters for star distribution**



Star



from Ebert, ed., *Texturing and Modeling: a Procedural Approach*, 1994, pages 44-46.