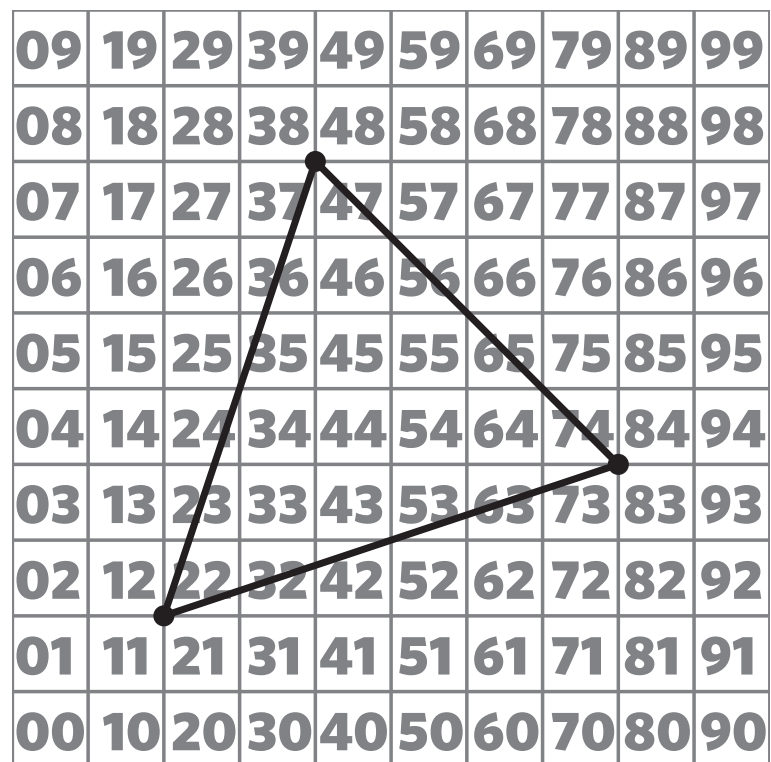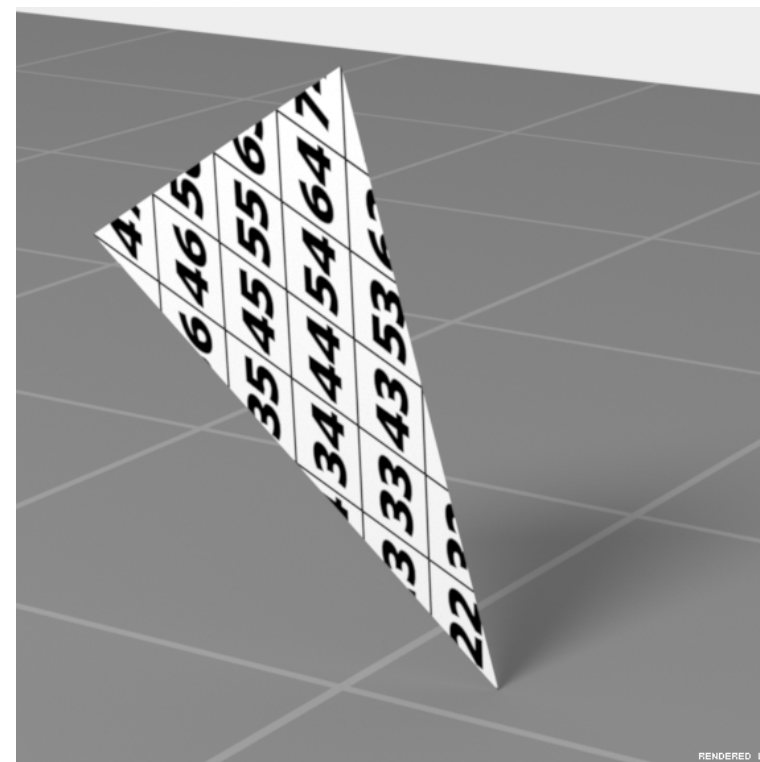# Interpolated values in ray tracing

CS 4620 Lecture 6.5

Texture coordinates on meshes

- **Texture coordinates are per-vertex data like vertex positions**
  - can think of them as a second position: each vertex has a position in 3D space and in 2D texture space
- **How to come up with (u,v)s for points inside triangles?**

Linear interpolation, 1D domain

- **Given values of a function f(x) for two values of x, you can define in-between values by drawing a line**
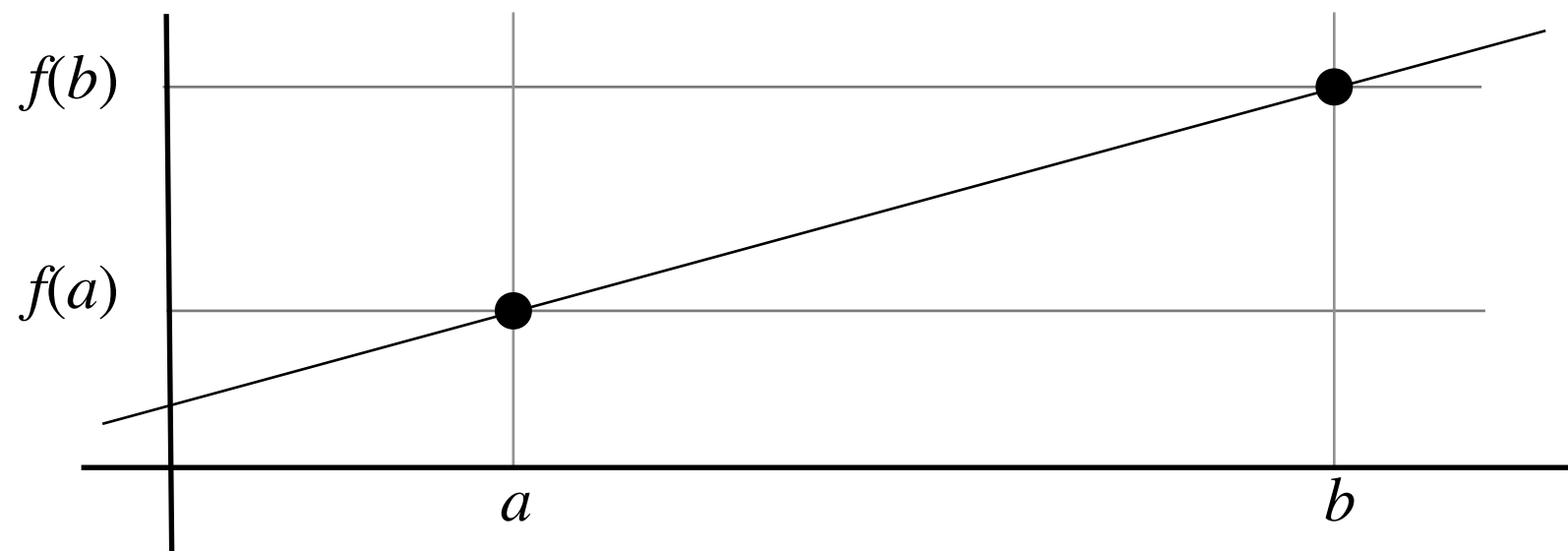
See textbook Sec. 2.6

- there is a unique line through the two points
- can write down using slopes, intercepts
- …or as a value added to f(a)
- …or as a convex combination of f(a) and f(b)

$$f(x) = f(a) + \frac{x - a}{b - a}(f(b) - f(a))$$
$$= (1 - \beta)f(a) + \beta f(b)$$
$$= \alpha f(a) + \beta f(b)$$

Linear interpolation in 1D
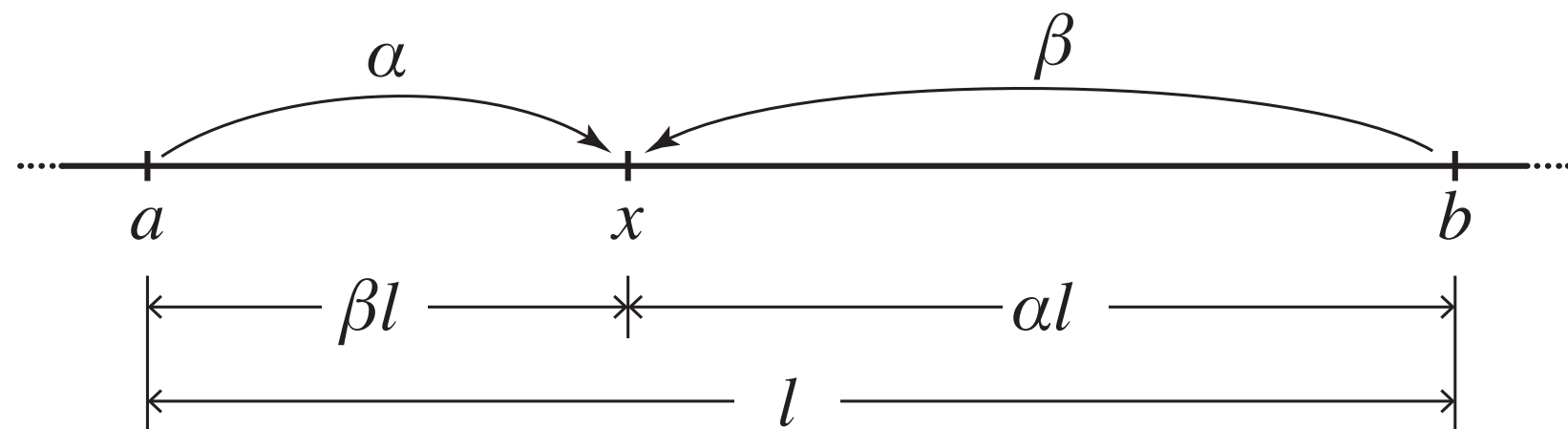
- **Alternate story**

    1. write *x* as convex combination of a and b

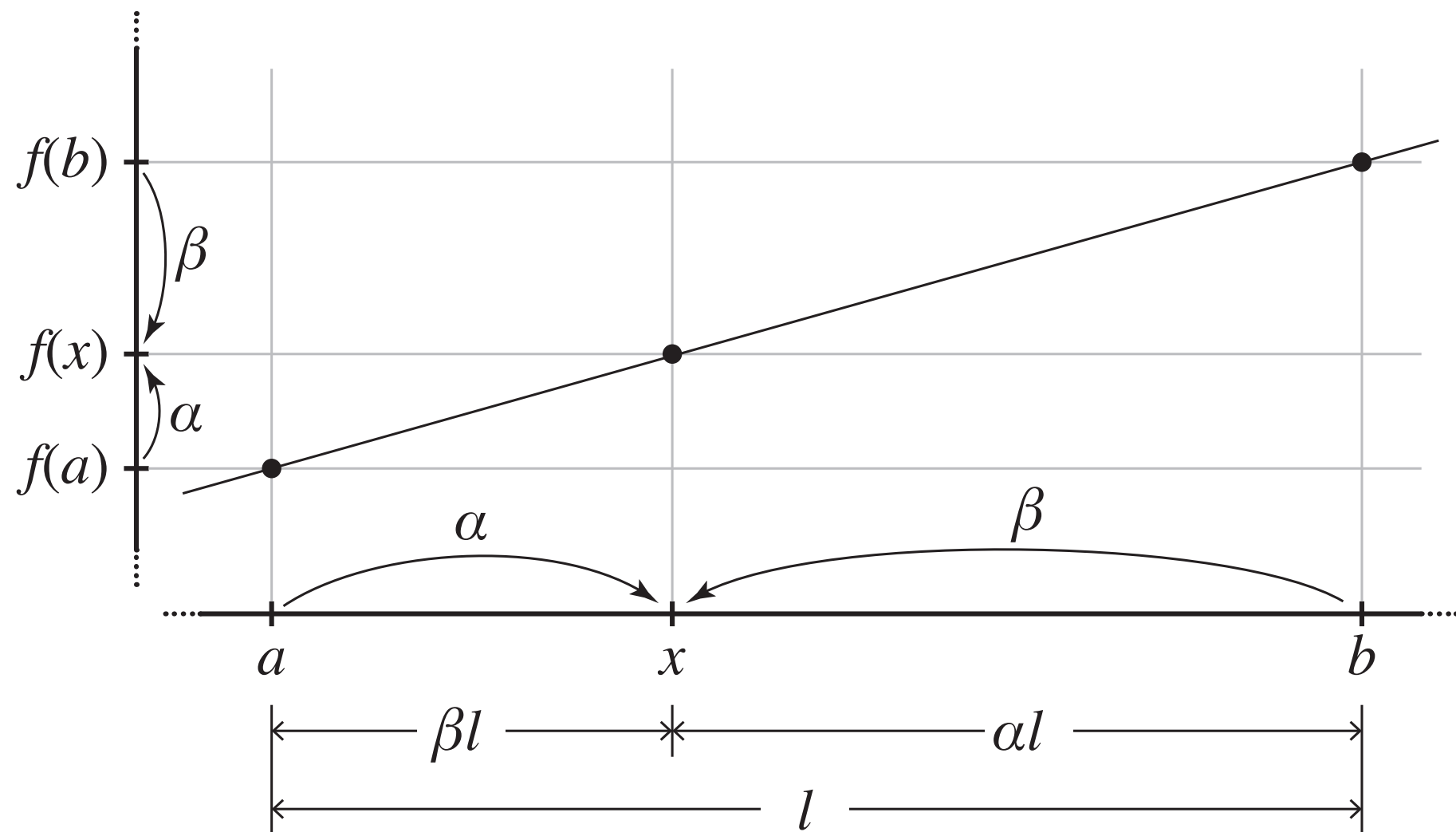 $$x = \alpha a + \beta b \quad \text{where } \alpha + \beta = 1$$

    2. use the same weights to compute *f(x)* as a convex combination of *f(a)* and *f(b)*

    $$f(x) = \alpha f(a) + \beta f(b)$$

Linear interpolation in 1D

Linear interpolation in 1D

Linear interpolation in 2D

- **Use the alternate story:**

    1. Write **x**, the point where you want a value, as a convex linear combination of the vertices

    $$\mathbf{x} = \alpha \mathbf{a} + \beta \mathbf{b} + \gamma \mathbf{c} \quad \text{where } \alpha + \beta + \gamma = 1$$

    2. Use the same weights to compute the interpolated value $f(\mathbf{x})$ from the values at the vertices, $f(\mathbf{a})$, $f(\mathbf{b})$, and $f(\mathbf{c})$

    $$f(\mathbf{x}) = \alpha f(\mathbf{a}) + \beta f(\mathbf{b}) + \gamma f(\mathbf{c})$$

See textbook
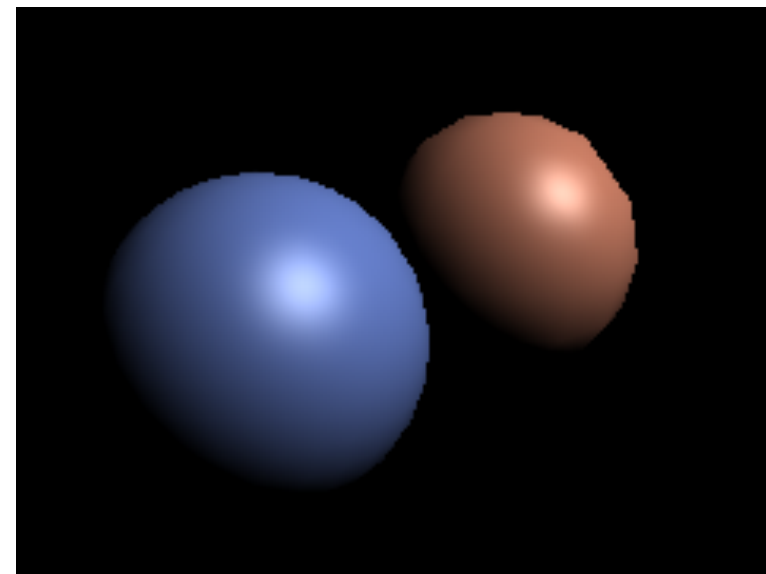Sec. 2.7

Interpolation in ray tracing

- **When values are stored at vertices, use linear (barycentric) interpolation to define values across the whole surface that:**

  1. …match the values at the vertices

  2. …are continuous across edges

  3. …are piecewise linear (linear over each triangle)

     as a function of 3D position, not screen position—more later

- **How to compute interpolated values**

  4. during triangle intersection compute barycentric coords

  5. use barycentric coords to average attributes given at vertices

What to interpolate?

- **Texture coordinates**
  - without interpolating there can't really be textures
- **Surface normals**
  - for smooth surfaces approximated with meshes
  - use interpolated normal for shading in place of actual normal
  - "shading normal" vs. "geometric normal"
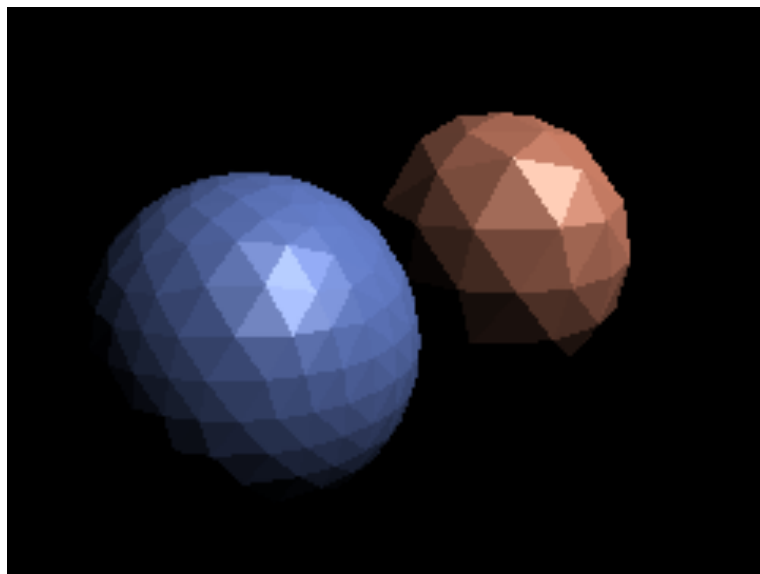
geometric normals   interpolated normals