

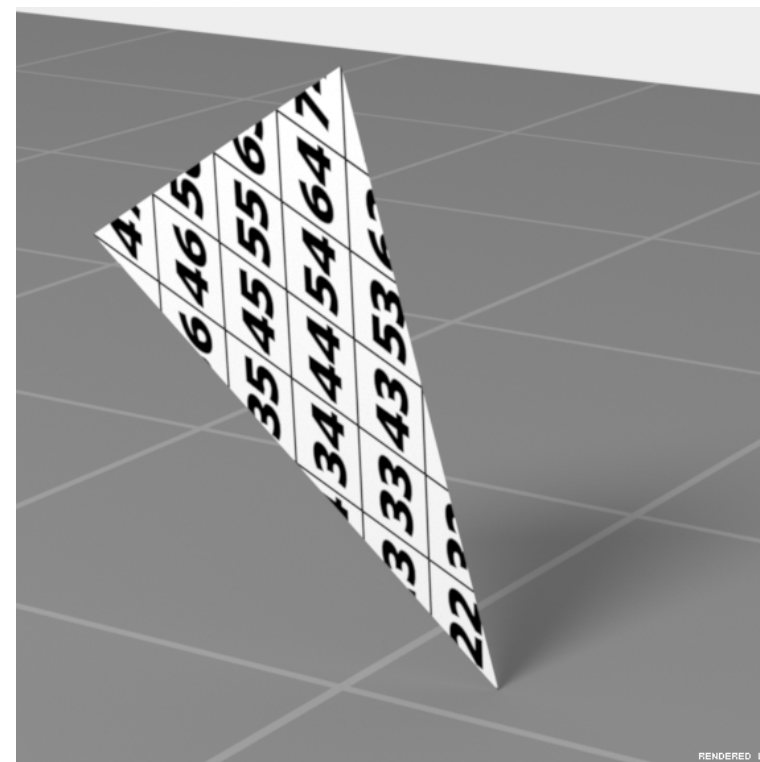
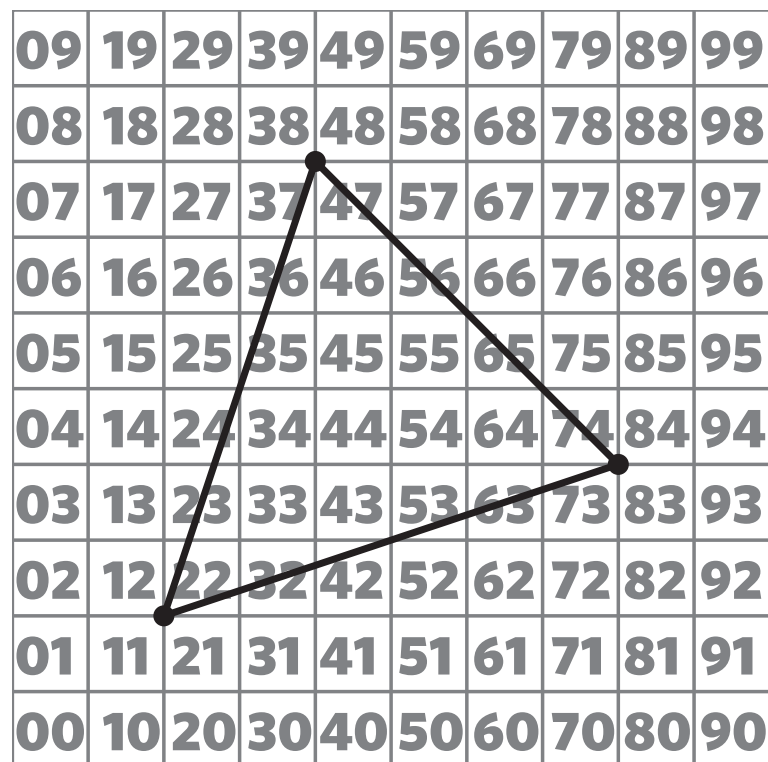
Interpolated values in ray tracing

CS 4620 Lecture 7

Texture coordinates on meshes

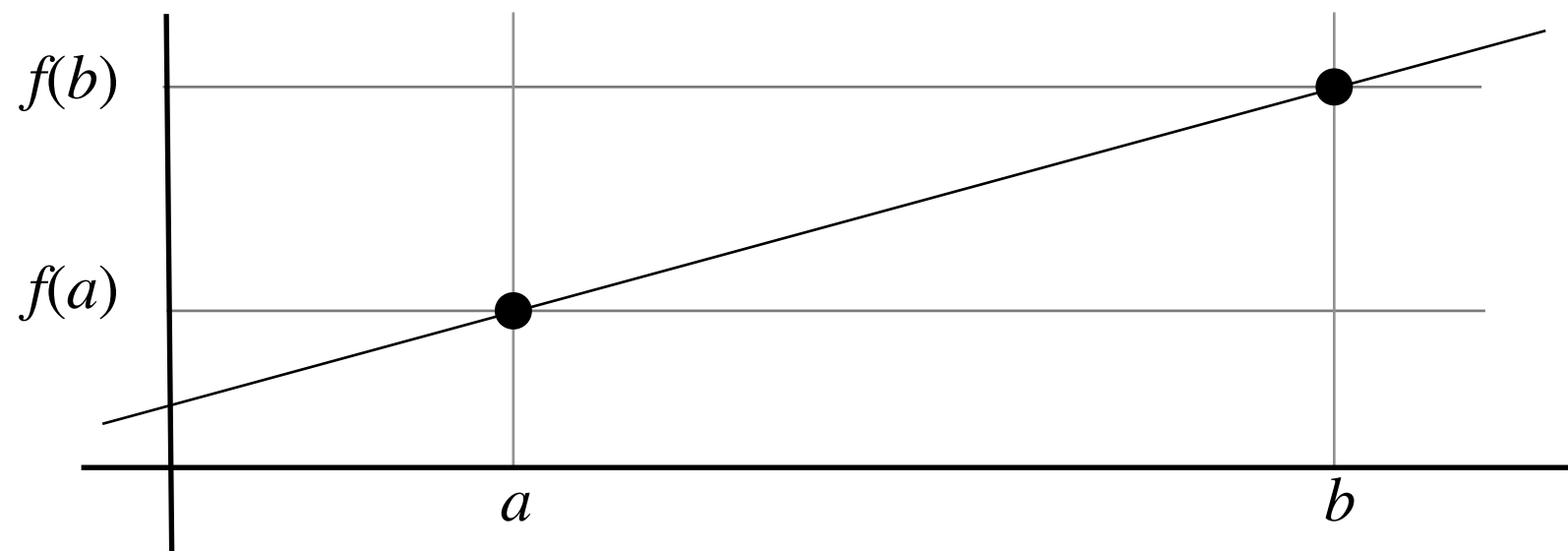
- **Texture coordinates are per-vertex data like vertex positions**
 - can think of them as a second position: each vertex has a position in 3D space and in 2D texture space
- **How to come up with (u,v) s for points inside triangles?**

09	19	29	39	49	59	69	79	89	99
08	18	28	38	48	58	68	78	88	98
07	17	27	37	47	57	67	77	87	97
06	16	26	36	46	56	66	76	86	96
05	15	25	35	45	55	65	75	85	95
04	14	24	34	44	54	64	74	84	94
03	13	23	33	43	53	63	73	83	93
02	12	22	32	42	52	62	72	82	92
01	11	21	31	41	51	61	71	81	91
00	10	20	30	40	50	60	70	80	90



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 $f(b)$

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

Linear interpolation in 1D

- **Alternate story**

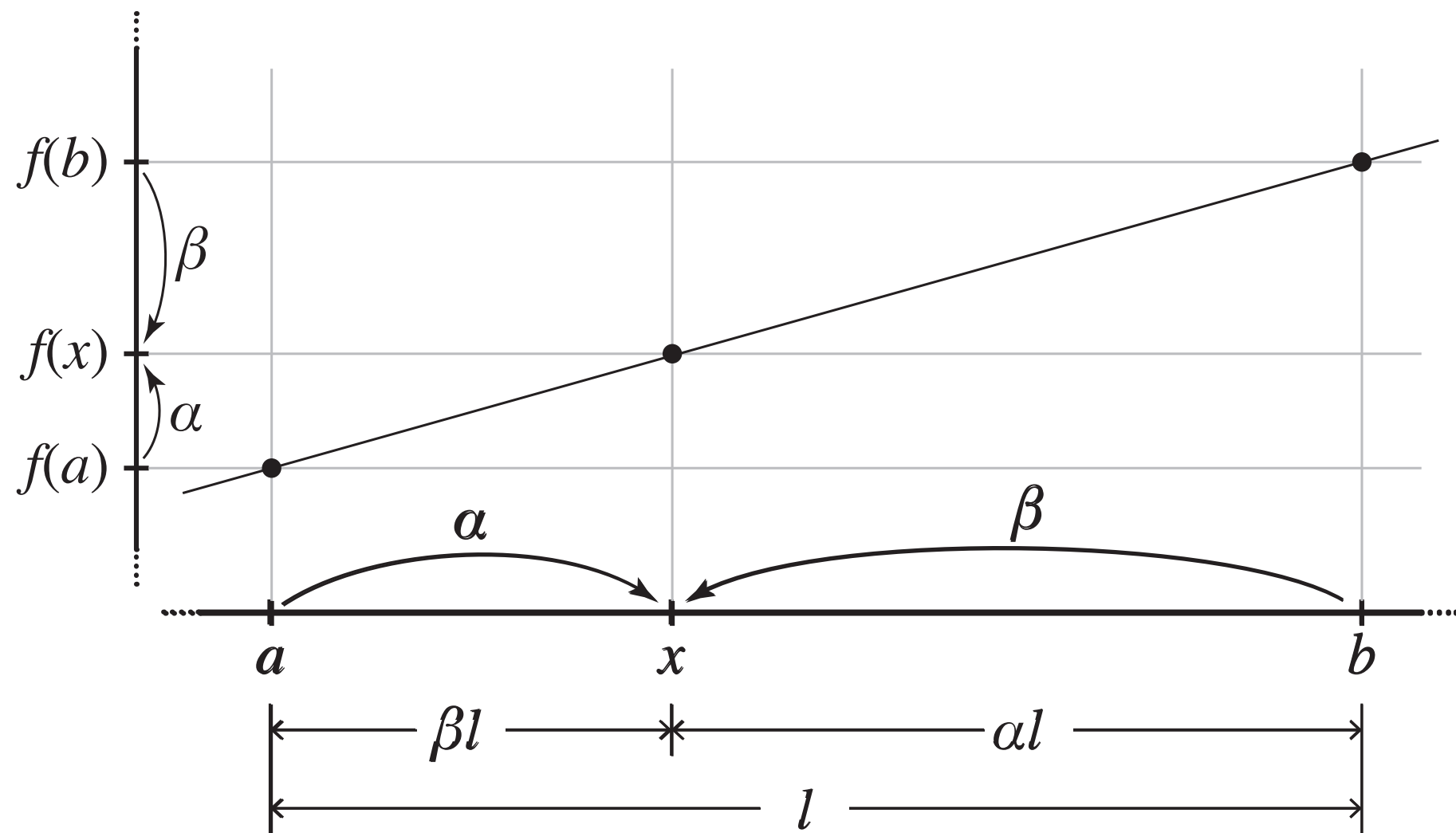
1. write x as convex combination of a and b

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

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 2D

- **Use the alternate story:**

1. Write \mathbf{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 $f(\mathbf{c})$

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

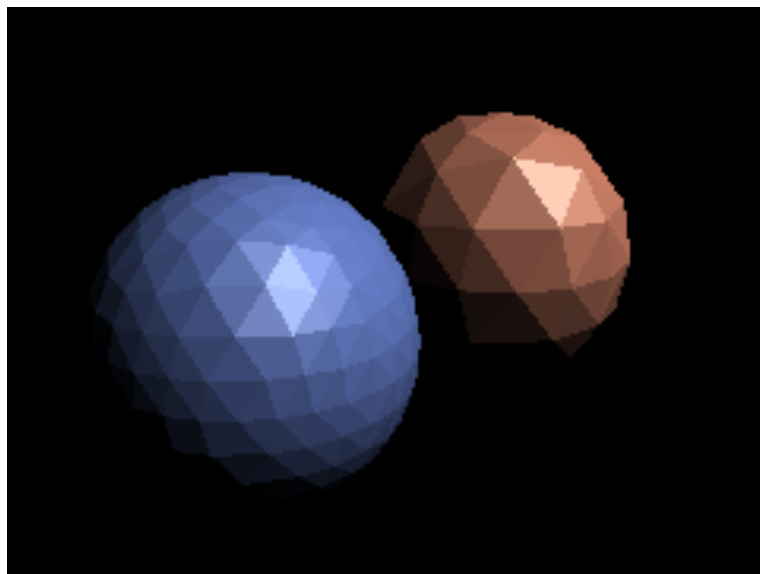
See textbook
Sec. 2.7

Interpolation in ray tracing

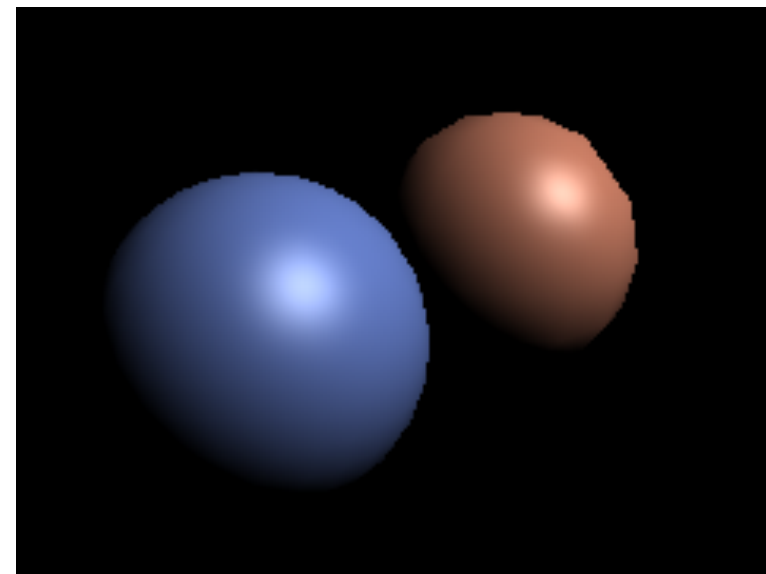
- **When values are stored at vertices, use linear (barycentric) interpolation to define values across the whole surface that:**
 1. ...match the values at the vertices
 2. ...are continuous across edges
 3. ...are piecewise linear (linear over each triangle)
as a function of 3D position, not screen 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