# Using Vertex Shaders for Hyperbolic Geometry



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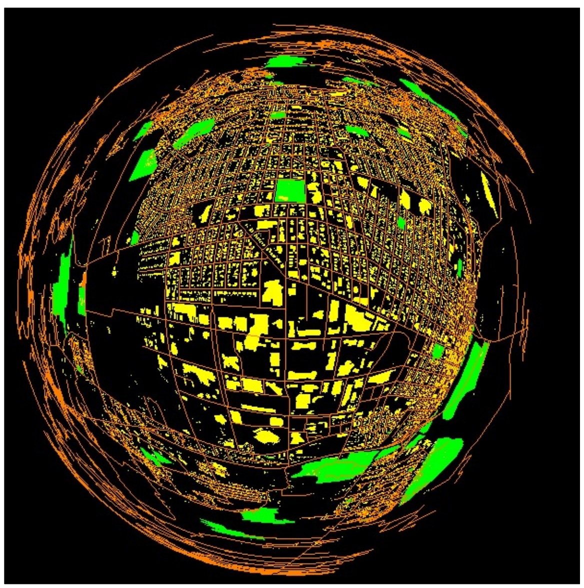
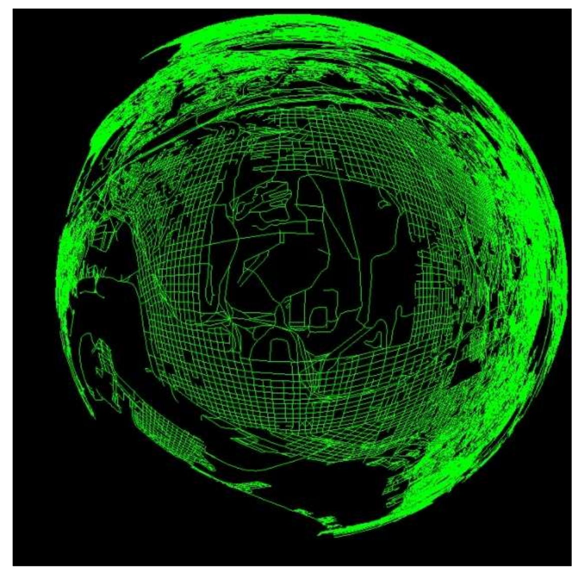




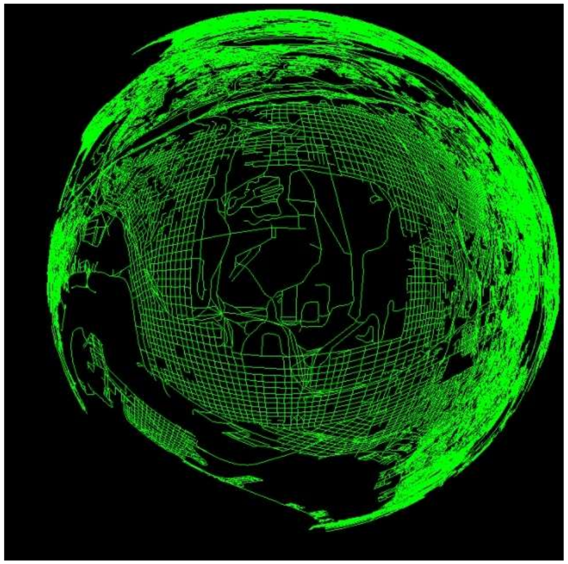
# Zooming and Panning Around a Complex 2D Display

• Standard (Euclidean) geometry zooming forces much of the information off the screen

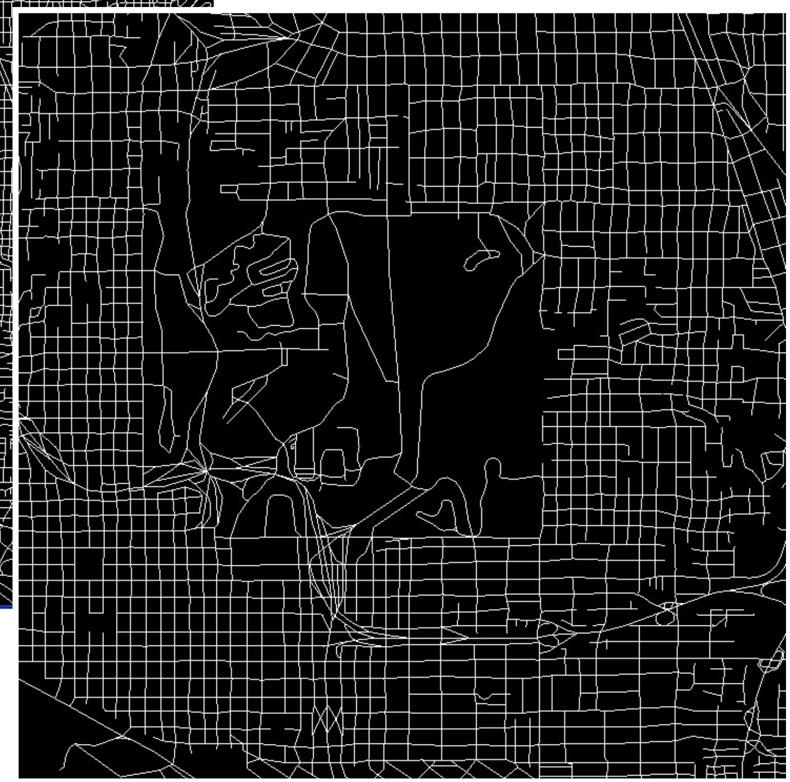
• This eliminates the context from the zoomed-in display

• This problem can be solved with *hyperbolic methods* if we are willing to give up Euclidean geometry

• At one time, this would have also meant severely giving up graphics performance, but not now (thanks to shaders)

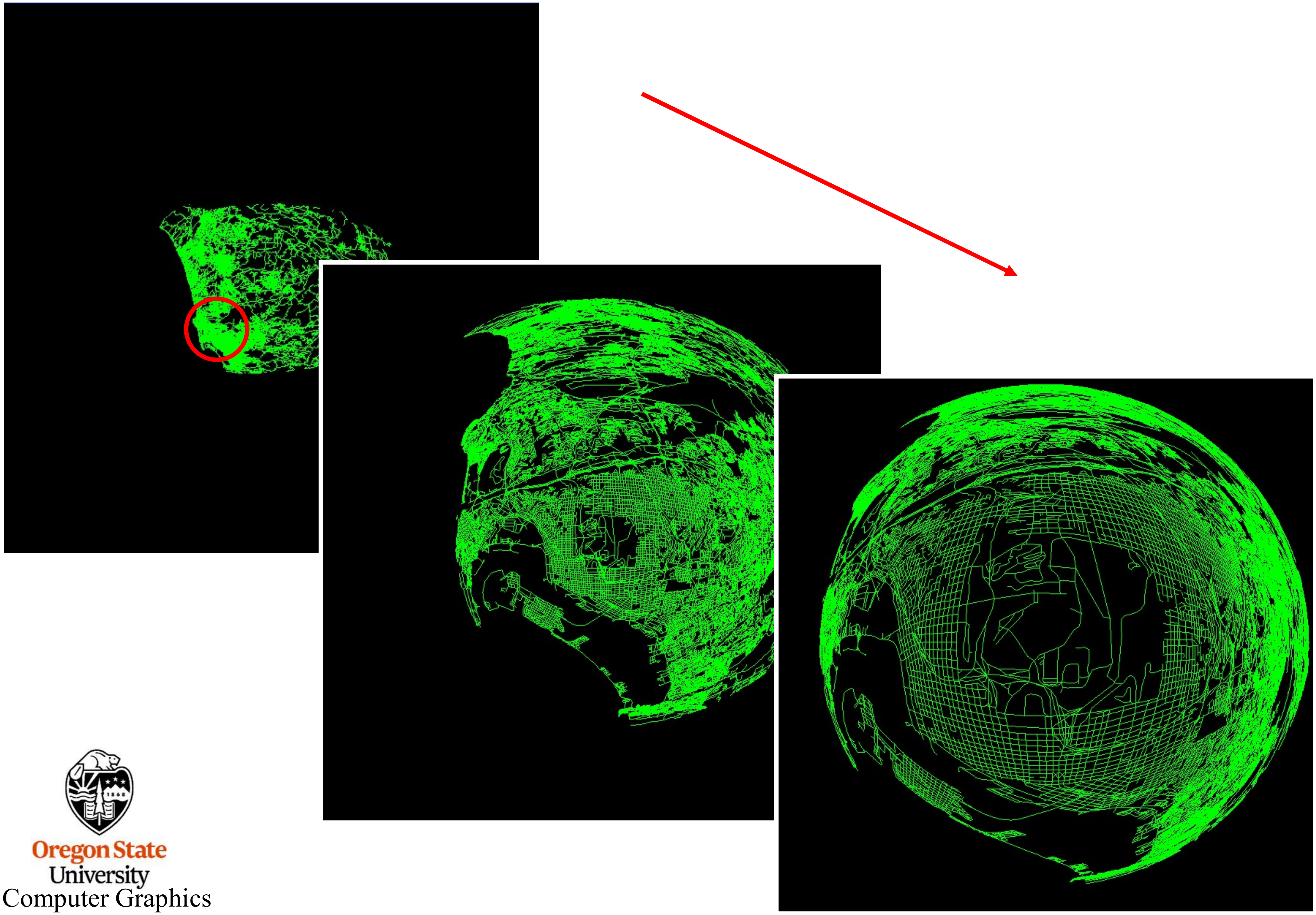


# Zooming in *Euclidean* Hyperbolic Space

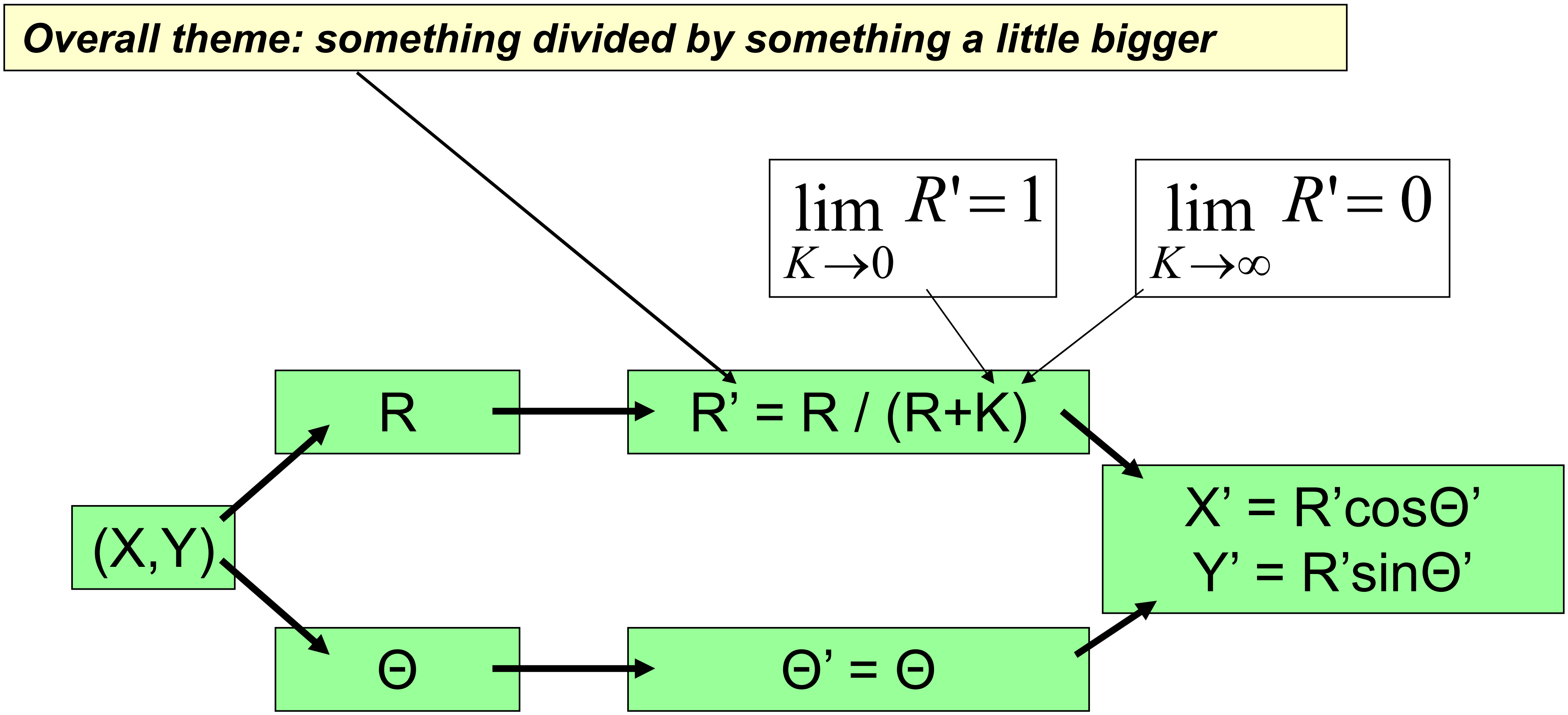


**123,101 line strips**
**446,585 points**

# Zooming in *Polar* Hyperbolic Space



# Polar Hyperbolic Equations

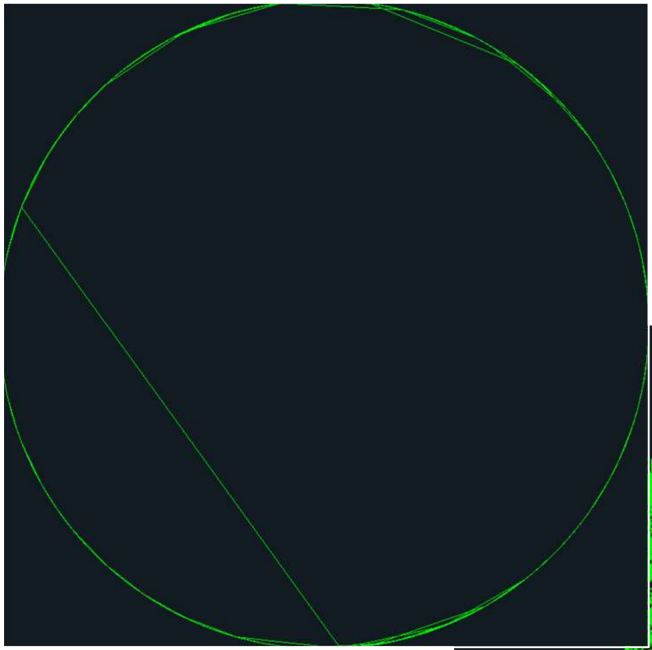


# The Effect of K

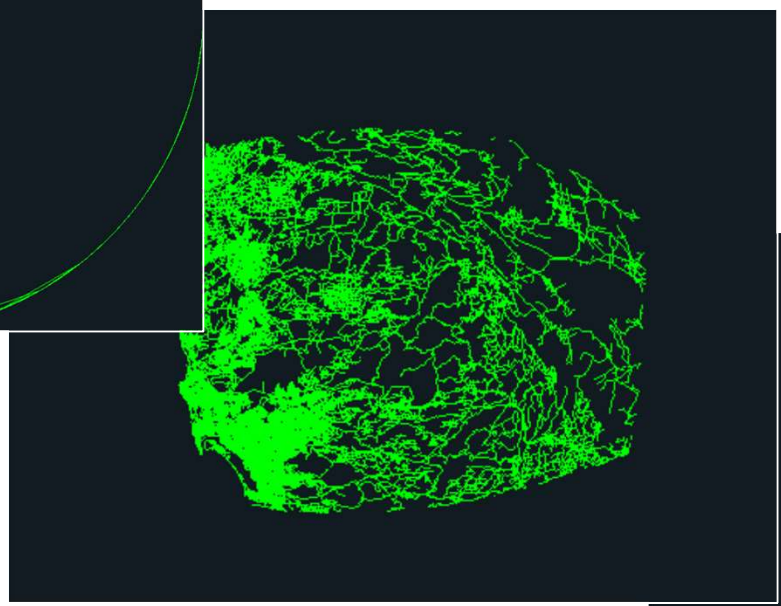
$$\lim_{K \to 0} R' = 1$$

$$\lim_{K \to \infty} R' = 0$$

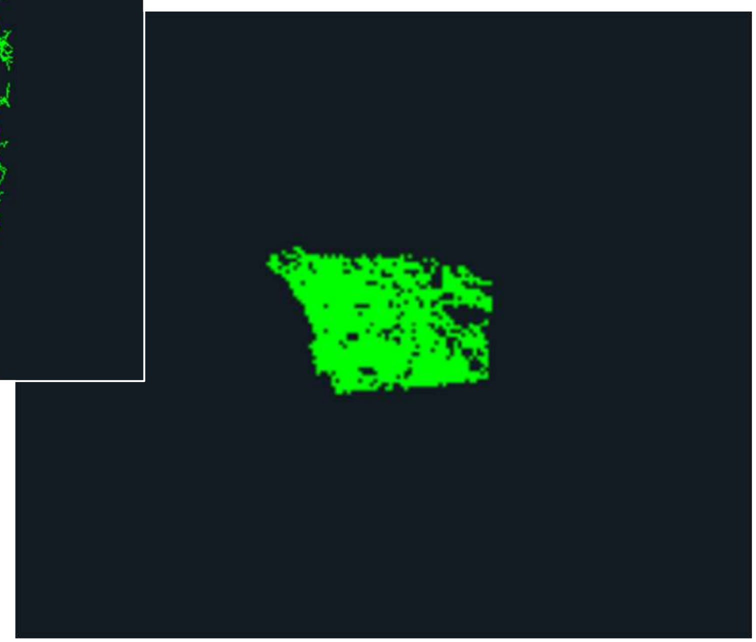
K = 0.



K = 1.



K = 10.



# Polar Hyperbolic Equations

$$R = \sqrt{X^2 + Y^2}$$

$$\Theta = \tan^{-1}\left(\frac{Y}{X}\right)$$

**But fortunately, we don't actually need to ever call the atan( ) function because there are shortcuts to get what we need:**

$$\cos\Theta = \frac{X}{R}$$

$$\sin\Theta = \frac{Y}{R}$$

$$R' = \frac{R}{R + K}$$

**Coordinates moved to the outer edge when K = 0**

**Coordinates moved to the center when K = ∞**

$$X' = R'\cos\Theta = \frac{R}{R+K} \times \frac{X}{R} = \frac{X}{R+K}$$

$$Y' = R'\sin\Theta = \frac{R}{R+K} \times \frac{Y}{R} = \frac{Y}{R+K}$$

# Cartesian Hyperbolic Equations

Polar

$$X' = \frac{X}{R + K}$$

$$Y' = \frac{Y}{R + K}$$

**Coordinates moved to the outer edge when K = 0**

**Coordinates moved to the center when K = ∞**

Cartesian

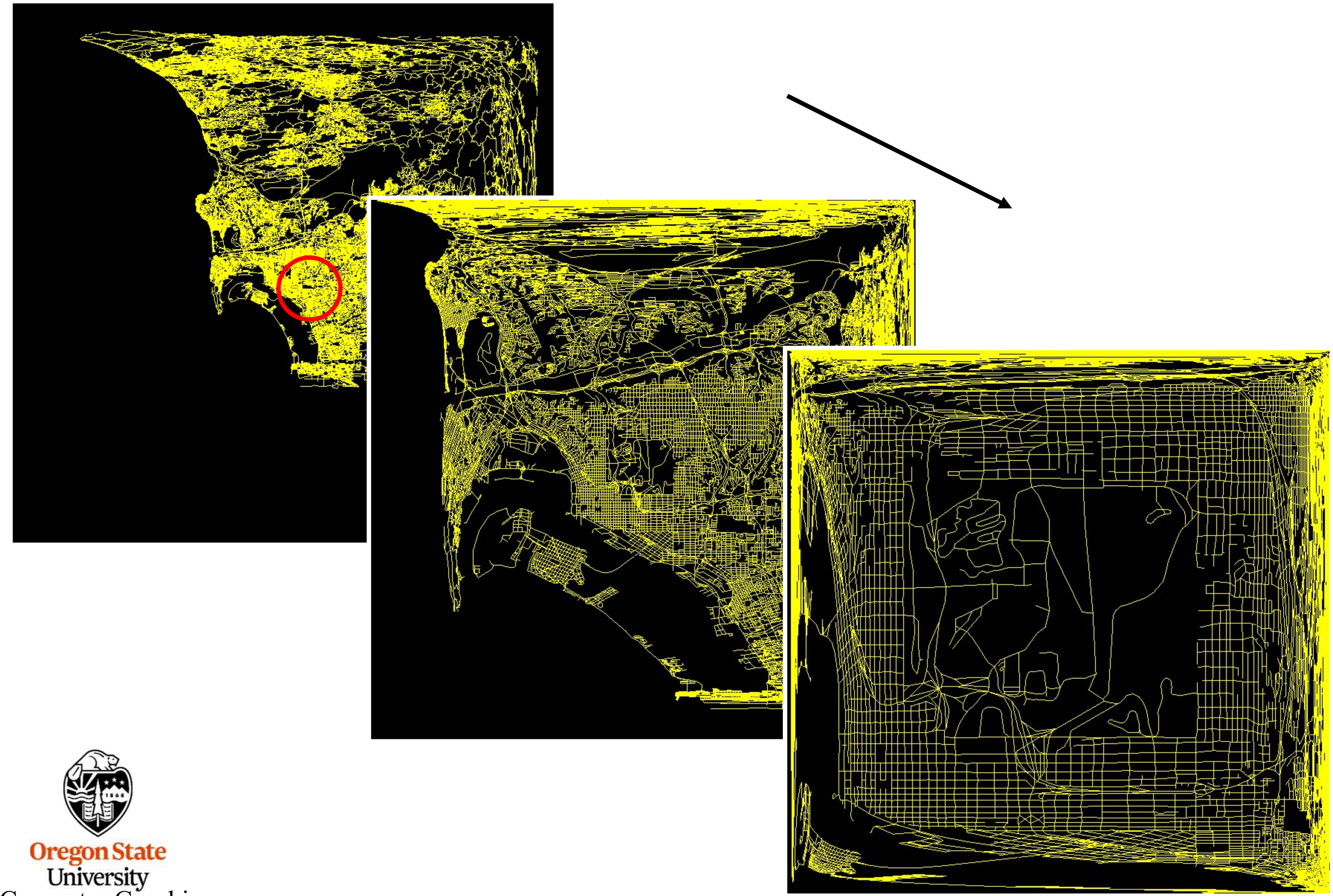
$$X' = \frac{X}{\sqrt{X^2 + K^2}}$$

$$Y' = \frac{Y}{\sqrt{Y^2 + K^2}}$$

**Coordinates moved to the outer edge when K = 0**

**Coordinates moved to the center when K = ∞**

# Zooming in Cartesian Hyperbolic Space



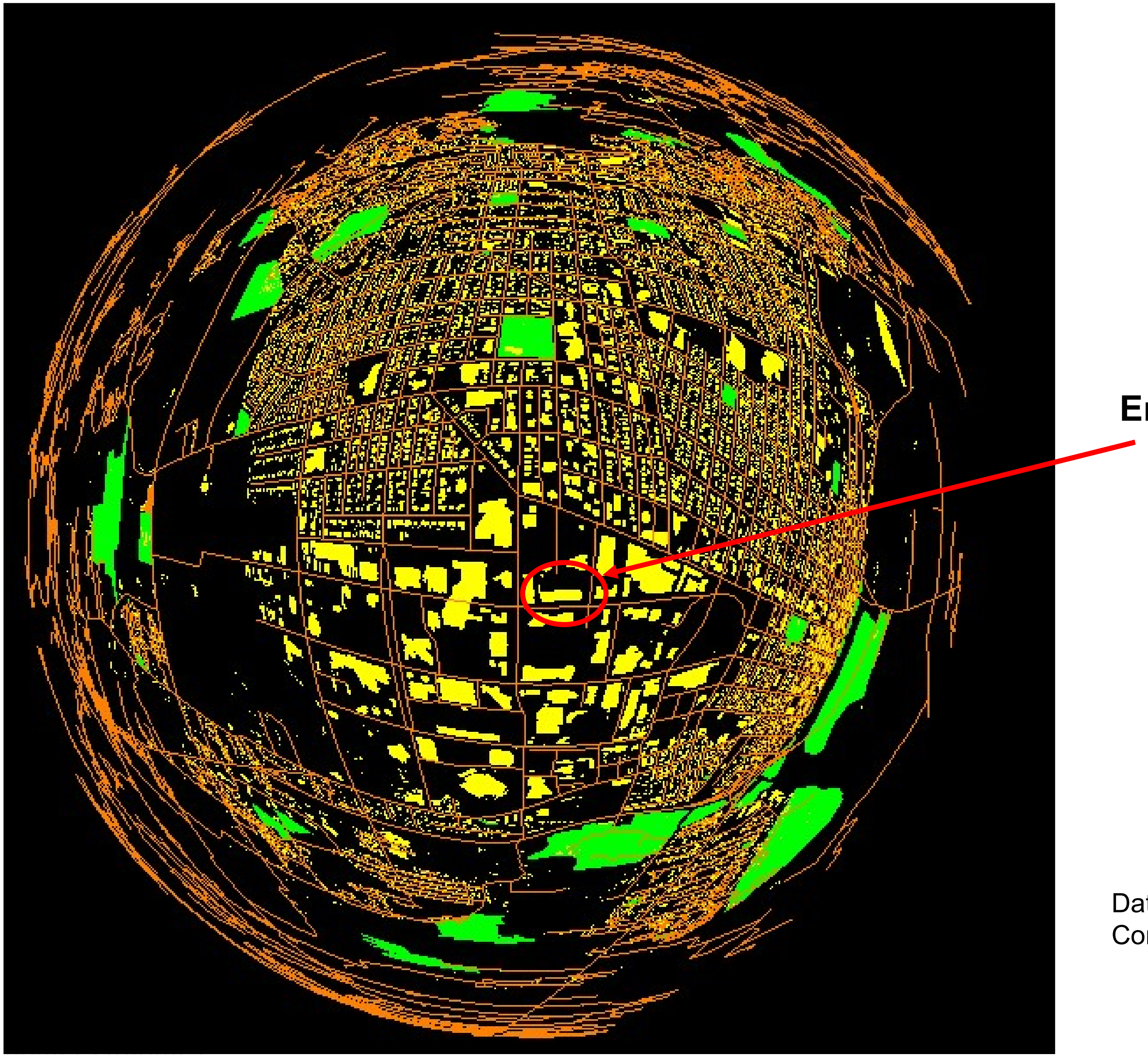
# hyper.vert

```
#version 330 compatibility
uniform bool        uPolar;
uniform float       uK;
uniform float       uTransX;
uniform float       uTransY;
out vec3            vColor;

void
main( )
{
	vColor = gl_Color.rgb;

	vec2 pos = ( gl_ModelViewMatrix * gl_Vertex ).xy;
	pos += vec2( uTransX, uTransY );
	float r = length( pos );

	vec4 pos2 = vec4( 0., 0., -5., 1. );

	if( uPolar )
		pos2.xy = pos / ( r + uK );
	else
		pos2.xy = pos / ( pos*pos + uK*uK );

	gl_Position = gl_ProjectionMatrix * pos2;
}
```

# hyper.frag

```
#version 330 compatibility
in vec3    vColor;

void
main(  )
{
        gl_FragColor = vec4( vColor, 1. );
}
```

# Corvallis Streets, Buildings, Parks





Data courtesy of the
Corvallis Fire Department

# Kelley Engineering Center

Kelley Engineering Center

Data courtesy of the Corvallis Fire Department