

Computer Graphics

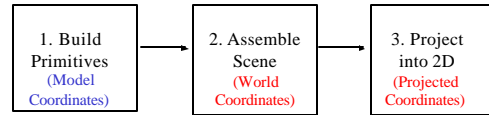
Z Sweedyk
Lecture 7

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Graphics Pipeline



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2D Transformations

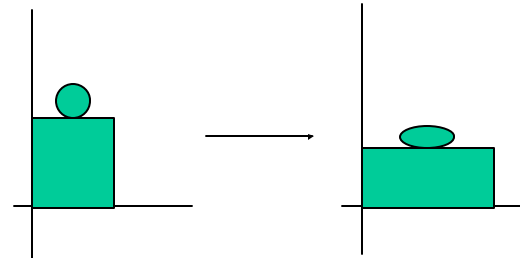
- Translate
- Rotate
- Scale

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Scale

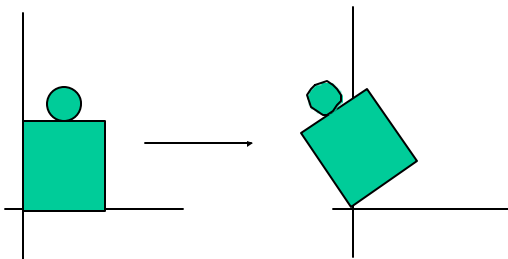


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Rotate

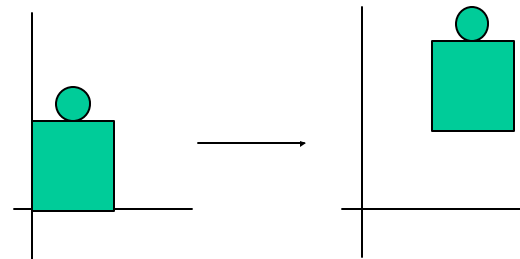


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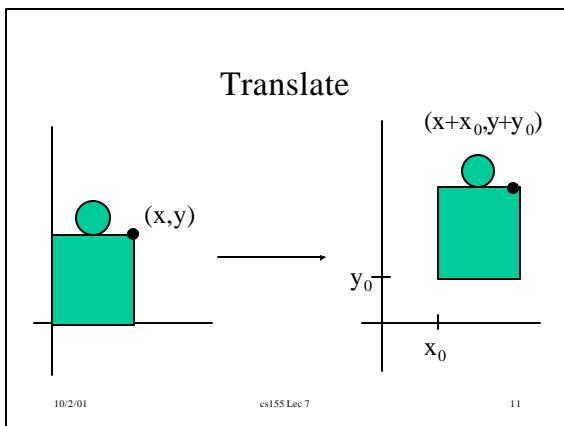
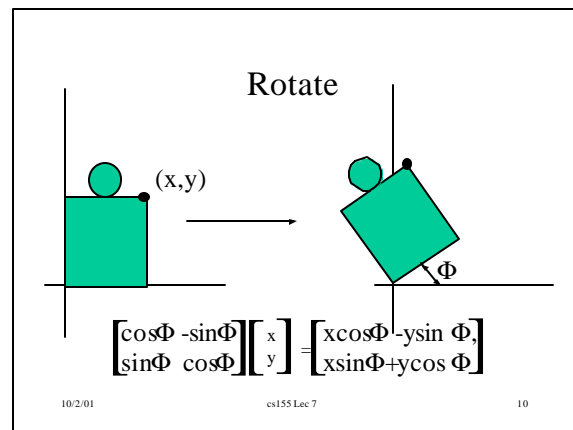
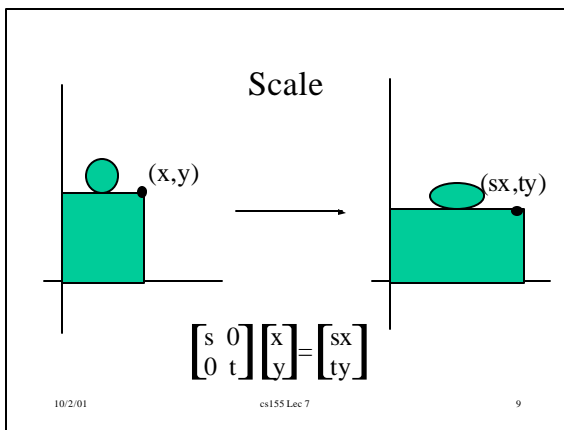
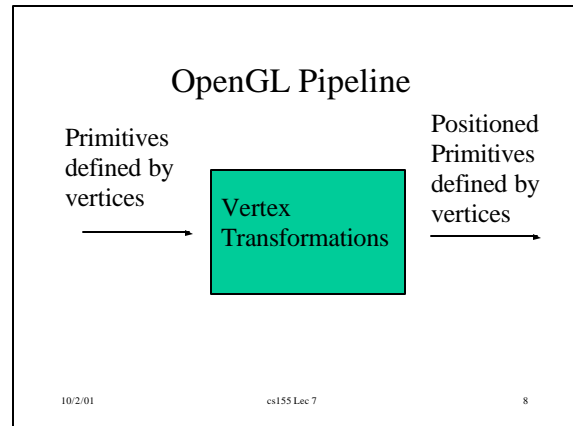
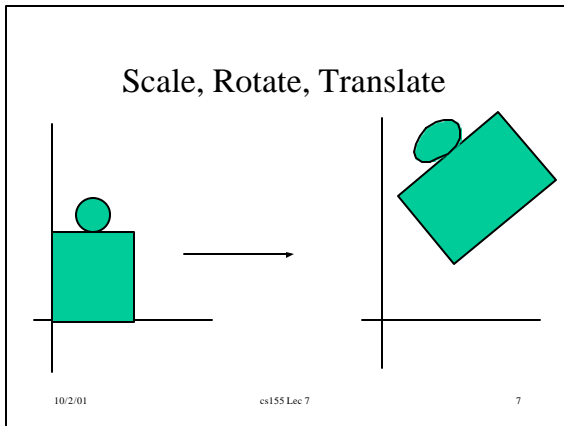
Translate



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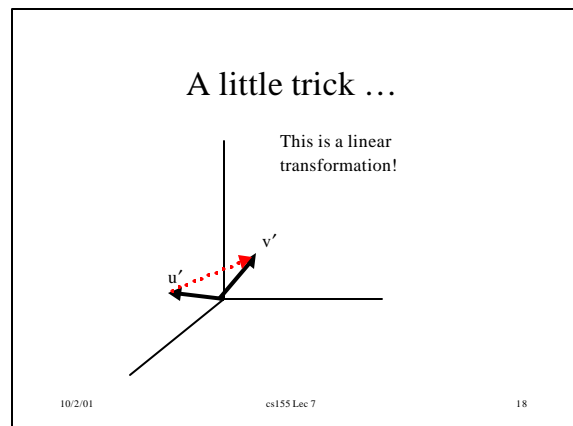
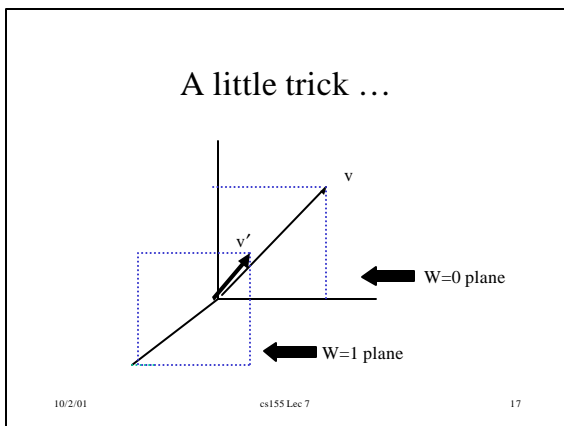
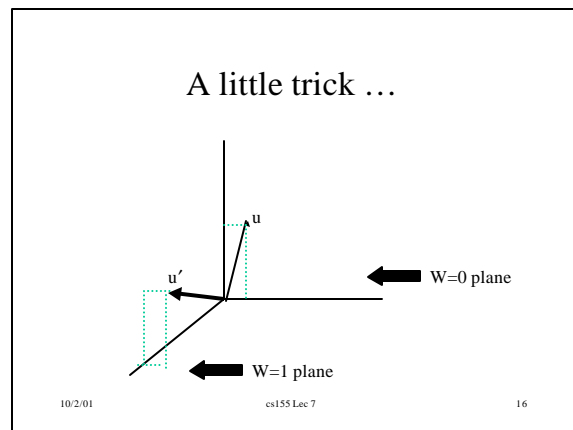
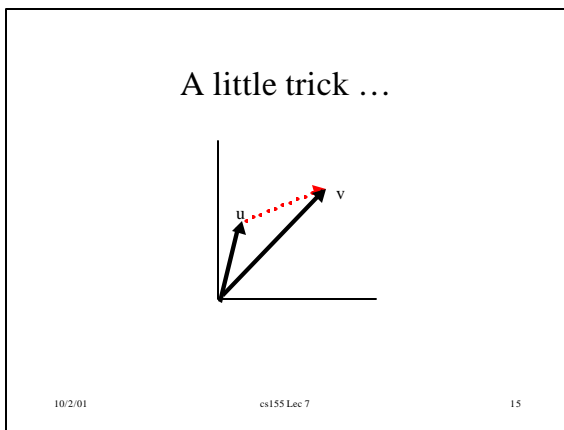
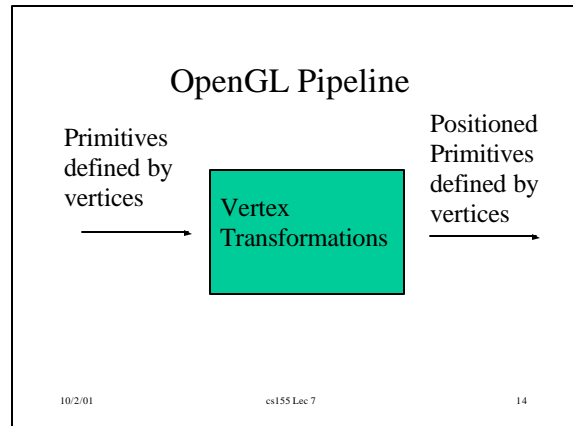
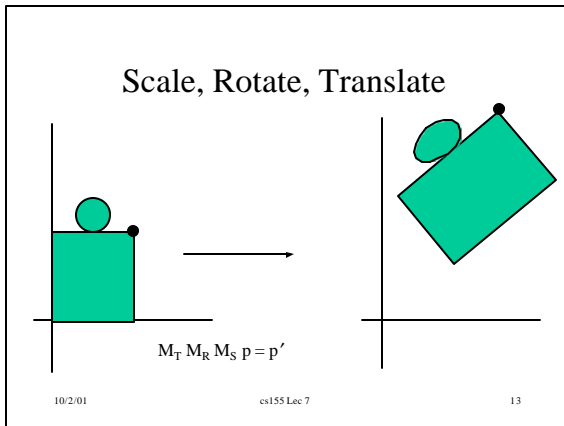
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Linear Transformation

- $F(x)$ is linear if $F(ax+by) = aF(x)+bF(y)$
- Translation by x_0 : $T(x) = x+x_0$ is not linear
 $T(s+t) = s+t+x_0$
 $T(s)+T(t) = s+t+2x_0$

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Translation

$$\begin{bmatrix} 1 & 0 & x_0 \\ 0 & 1 & y_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x+x_0 \\ y+y_0 \\ 1 \end{bmatrix}$$

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Homogenous Coordinates

$$(x,y) \longleftrightarrow (x,y,1)$$

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Scale

$$\begin{bmatrix} s & 0 & 0 \\ 0 & t & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} sx \\ ty \\ 1 \end{bmatrix}$$

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Rotate

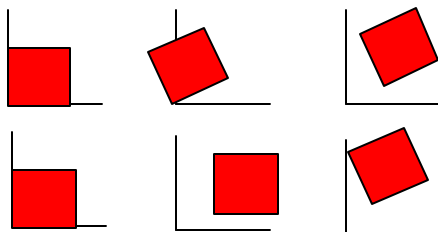
$$\begin{bmatrix} \cos\Theta & -\sin\Theta & 0 \\ \sin\Theta & \cos\Theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x\cos\Theta - y\sin\Theta \\ x\sin\Theta + y\cos\Theta \\ 1 \end{bmatrix}$$

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Order, order, order ...

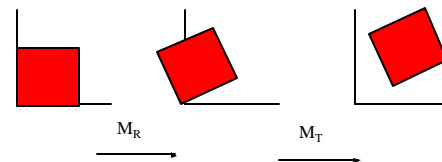


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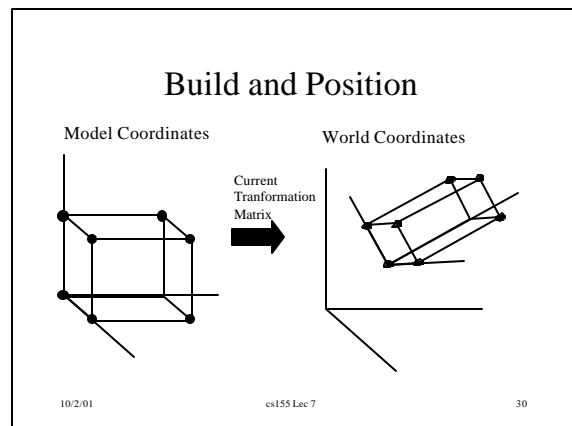
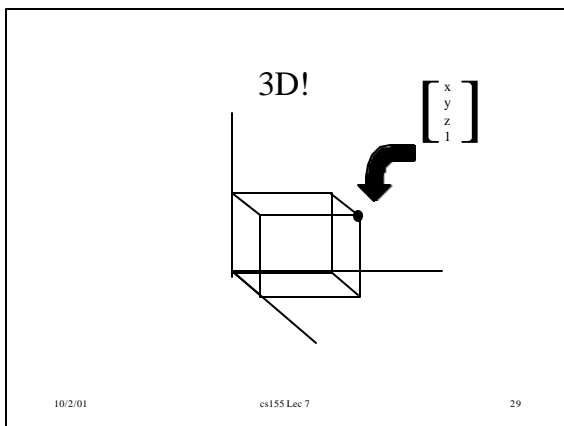
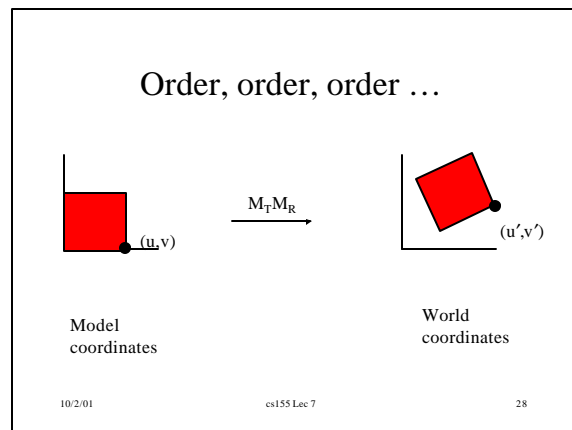
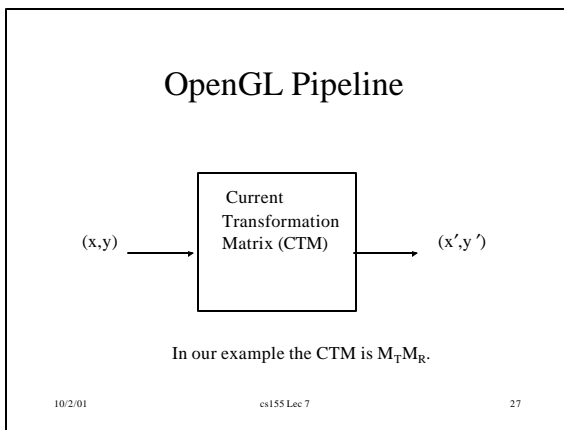
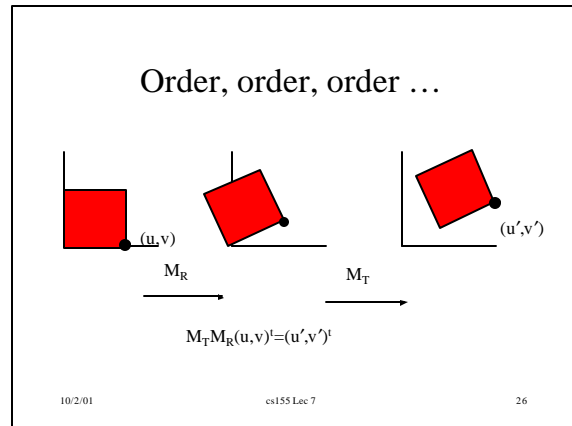
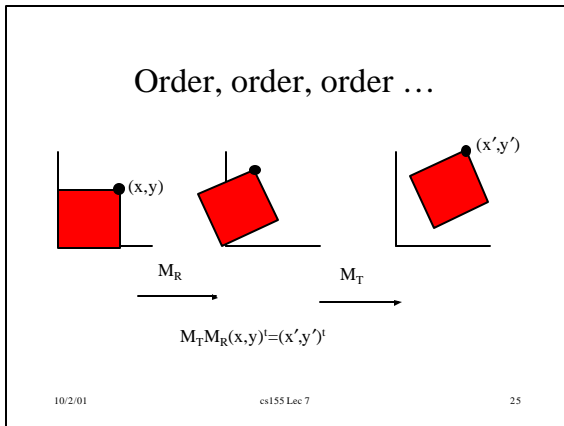
Order, order, order ...



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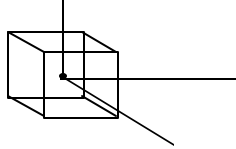
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Hierarchical Coordinates (Cubist Galaxy)

- Sun: 100x100x100 cube centered at the origin and axis-aligned



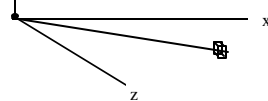
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Hierarchical Coordinates (Cubist Galaxy)

- Earth : 10x10x10 cube; its center is in the x-z plane 10000 from origin. It rotates once per day and revolves around the sun once per year.



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Hierarchical Coordinates (Cubist Galaxy)

- You have a 1x1x1 cube.
- Describe the transforms necessary to construct cubist galaxy.

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Hierarchical Coordinate

- The sun/earth is just one solar system in the cubist galaxy which is centered at the universe in universe coordinates.
- At the moment, the sun/earth lie in the x-y plane at an angle of ϕ from the positive x axis. The sun is 10000000000 from the origin and the earth is 10000 further. The cubist universe is expanding at a rate of 100 per annum.

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Hierarchical Coordinates (Cubist Galaxy)

- You have a 1x1x1 cube.
- Describe the transforms necessary to construct cubist galaxy.

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CTM

- Define the current transformation matrix in terms of the following matrices:
 - Translate by d_x, d_y, d_z : $T(d_x, d_y, d_z)$
 - Rotate by Φ about the vector $\langle v_x, v_y, v_z \rangle$: $R(\Phi, v_x, v_y, v_z)$
 - Scale by s_x, s_y, s_z : $S(s_x, s_y, s_z)$
- To position
 - The sun
 - The earth

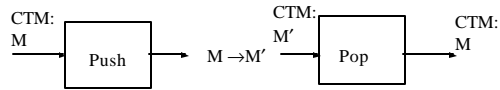
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Matrix Stacks

- Push and Pop



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CTM with push and pop

- Define the current transformation matrix in terms of the following matrices:
 - Translate by d_x, d_y, d_z : $T(d_x, d_y, d_z)$
 - Rotate by Φ about the vector $\langle v_x, v_y, v_z \rangle$: $R(\Phi, v_x, v_y, v_z)$
 - Scale by s_x, s_y, s_z : $S(s_x, s_y, s_z)$
- To position
 - The sun
 - The earth

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Next Time

- Projection

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