1 Lecture 1

$$\frac{X_w - WX_{min}}{WX_{max} - WX_{min}} = \frac{X_d - DX_{min}}{DX_{max} - DX_{min}} \tag{1}$$

$$X_d = \frac{(X_w - WX_{min})(DX_{max} - DX_{min})}{WX_{max} - WX_{min}} + DX_{min} \tag{2}$$

$$[x', y', z'] = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} \tag{3}$$

$$x' = 2x \ , \ y' = 2y \ , \ z' = 2z \tag{4}$$

$$[x', y', z', 1] = [x, y, z, 1] \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 2 & 0 & 0 & 1 \end{bmatrix} \tag{5}$$

$$[x, y, z, 1] \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ t_x & t_y & t_z & 1 \end{bmatrix} = [x + t_x, y + t_y, x + t_z, 1] \tag{6}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ t_x & t_y & t_z & 1 \end{bmatrix} \text{has inversion} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -t_x & -t_y & -t_z & 1 \end{bmatrix}$$

$$[x, y, z, 1] \begin{bmatrix} s_x & 0 & 0 & 0 \\ 0 & s_y & 0 & 0 \\ 0 & 0 & s_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = [s_x x, s_y y, s_z z, 1] \tag{7}$$

$$\begin{bmatrix} s_x & 0 & 0 & 0 \\ 0 & s_y & 0 & 0 \\ 0 & 0 & s_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \text{has inversion} \begin{bmatrix} 1/s_x & 0 & 0 & 0 \\ 0 & 1/s_y & 0 & 0 \\ 0 & 0 & 1/s_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$[x', y', z', 1] = [x, y, z, 1] \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 5 & 5 & 20 & 1 \end{bmatrix}$$

$$[x', y', z', 1] = [x, y, z, 1] \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 5 & 5 & 20 & 1 \end{bmatrix}$$

$$R_x = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & Cos\theta & Sin\theta & 0 \\ 0 & -Sin\theta & Cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_y = \begin{bmatrix} Cos\theta & 0 & -Sin\theta & 0 \\ 0 & 1 & 0 & 0 \\ Sin\theta & 0 & Cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_z = \begin{bmatrix} Cos\theta & Sin\theta & 0 & 0 \\ -Sin\theta & Cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{aligned} [x, y] &= [\ rCos\phi\ ,\ rSin\phi\ ] \\ [x_t, y_t] &= [\ rCos(\phi + \theta)\ ,\ rSin(\phi + \theta)\ ] \\ &= [\ rCos\phi Cos\theta - rSin\phi Sin\theta\ ,\ rCos\phi Sin\theta + rSin\phi Cos\theta\ ] \\ &= [\ xCos\theta - ySin\theta\ ,\ xSin\theta + yCos\theta\ ] \\ &= [x, y] \begin{bmatrix} Cos\theta & Sin\theta \\ -Sin\theta & Cos\theta \end{bmatrix} \end{aligned}$$

$$\begin{bmatrix} Cos\theta & Sin\theta & 0 & 0 \\ -Sin\theta & Cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \text{ has inversion } \begin{bmatrix} Cos\theta & -Sin\theta & 0 & 0 \\ Sin\theta & Cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

2 Lecture 2

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -C_x & -C_y & -C_z & 1 \end{bmatrix}$$

$v = \sqrt{d_x^2 + d_z^2}$

$Cos\theta = d_z/v$

$Sin\theta = d_x/v$

$$B = \begin{bmatrix} d_z/v & 0 & d_x/v & 0 \\ 0 & 1 & 0 & 0 \\ -d_x/v & 0 & d_z/v & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$v = \sqrt{d_x^2 + d_z^2}$

$Cos\phi = v/|d|$

$Sin\phi = d_y/|d|$

$$C = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & v/|d| & d_y/|d| & 0 \\ 0 & -d_y/|d| & v/|d| & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$M_o = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$M_p = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1/f \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$[x, y, z, 1] \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1/f \\ 0 & 0 & 0 & 0 \end{bmatrix} = [x, y, z, z/f]$$

$$\begin{bmatrix} q_x & q_y & q_z & 0 \\ r_x & r_y & r_z & 0 \\ s_x & s_y & s_z & 0 \\ C_x & C_y & C_z & 1 \end{bmatrix}$$

$$[1,0,0,0]\begin{bmatrix} q_x & q_y & q_z & 0 \\ r_x & r_y & r_z & 0 \\ s_x & s_y & s_z & 0 \\ C_x & C_y & C_z & 1 \end{bmatrix} = [q_x, q_y, q_z, 0]$$

$$[0,0,0,1]\begin{bmatrix} q_x & q_y & q_z & 0 \\ r_x & r_y & r_z & 0 \\ s_x & s_y & s_z & 0 \\ C_x & C_y & C_z & 1 \end{bmatrix} = [C_x, C_y, C_z, 1]$$

$$[P_x^t, P_y^t, P_z^t, 1] = [P_x, P_y, P_z, 1]\begin{bmatrix} u_x & v_x & w_x & 0 \\ u_y & v_y & w_y & 0 \\ u_z & v_z & w_z & 0 \\ -C\cdot u & -C\cdot v & -C\cdot w & 1 \end{bmatrix}$$

3 Tutorial 2

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -10 & 1 \end{bmatrix} \begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 10 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & -8 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 10 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 2 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -10 & 1 \end{bmatrix} \begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0.97 & -0.26 & 0 & 0 \\ 0.26 & 0.97 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 10 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & -8 & 1 \end{bmatrix} \begin{bmatrix} 0.97 & -0.26 & 0 & 0 \\ 0.26 & 0.97 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 10 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0.776 & -0.208 & 0 & 0 \\ 0.208 & 0.776 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 2 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 2 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0.5 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0.4 \\ 0 & 0 & 2 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ -10 & -10 & 50 & 1 \end{bmatrix}$$

4 Lecture 8

	$\mathbf{P_0}$	$\mathbf{P_1}$	$\mathbf{P_2}$
μ	0	1/2	1

	$\mathbf{P_0}$	$\mathbf{P_1}$	$\mathbf{P_2}$
μ	0	1	1/2

	$\mathbf{P_0}$	$\mathbf{P_1}$	$\mathbf{P_2}$
μ	1/2	0	1

	$\mathbf{P_0}$	$\mathbf{P_1}$	$\mathbf{P_2}$
μ	0	1	1/4

5 Lecture 9

$$\mathbf{P}(\mu,\nu) = [\mu^3\ \mu^2\ \mu\ 1] \begin{bmatrix} \mathbf{a} & \mathbf{b} & \mathbf{c} & \mathbf{d} \\ \mathbf{b} & \mathbf{e} & \mathbf{f} & \mathbf{g} \\ \mathbf{c} & \mathbf{f} & \mathbf{h} & \mathbf{i} \\ \mathbf{d} & \mathbf{g} & \mathbf{i} & \mathbf{j} \end{bmatrix} \begin{bmatrix} \nu^3 \\ \nu^2 \\ \nu \\ 1 \end{bmatrix}$$

6 Lecture 18

$$\begin{bmatrix} u_x & u_y & u_z & 0 \\ v_x & v_y & v_z & 0 \\ w_x & w_y & w_z & 0 \\ C_x & C_y & C_z & 1 \end{bmatrix}$$

$$\begin{bmatrix} u_x & u_y & u_z & 0 \\ v_x & v_y & v_z & 0 \\ w_x & w_y & w_z & 0 \\ C_x & C_y & C_z & 1 \end{bmatrix} \begin{bmatrix} u_x & v_x & w_x & 0 \\ u_y & v_y & w_y & 0 \\ u_z & v_z & w_z & 0 \\ -C\cdot u & -C\cdot v & -C\cdot w & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_i^{i-1} = \begin{bmatrix} u_x^i & u_y^i & u_z^i & 0 \\ v_x^i & v_y^i & v_z^i & 0 \\ w_x^i & w_y^i & w_z^i & 0 \\ C_x^i & C_y^i & C_z^i & 1 \end{bmatrix}$$

$$T_n^0 = \prod_{i=n}^{0} T_i^{i-1}$$

$$\begin{bmatrix} Cos(\theta) & Sin(\theta) & 0 & 0 \\ -Sin(\theta) & Cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & Cos(\phi) & Sin(\phi) & 0 \\ 0 & -Sin(\phi) & Cos(\phi) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} Cos(\psi) & Sin(\psi) & 0 & 0 \\ -Sin(\psi) & Cos(\psi) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$-\frac{1}{2}log_2|\Sigma|$$

$$-\frac{1}{2}log_2\frac{|\Sigma_i|}{|\Sigma_{i+1}|}$$

$$-\frac{1}{N}\sum_{j-1}^{N}p(x_{t-j})$$