

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 16 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

$$x_1' = \frac{1 - (-16)}{0 - 16} = \frac{-16}{-16} = -1$$

$$y_1' = \frac{0 - (-16)}{0 - 16} = \frac{16}{-16} = -1$$

$$z_1' = \frac{0 - (-16)}{0 - 16} = \frac{16}{-16} = -1$$

$$P_1' = (-1, -1, -1)$$

$$P_1 = (1, 0, 0)$$

$$P_2 = (0, 0, 1)$$

$$P_3 = (0, 1, 0)$$

$$P_4 = (1, 0, 0)$$

$$P_5 = (0, 1, 0)$$

$$P_6 = (0, 0, 1)$$

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$$P_{300} = (0, 0, 1)$$

→ Curva de Bézier

→ Algumas propriedades da curva de Bézier são:

- A curva de Bézier é uma curva polinomial expressa como interpolação linear entre alguns pontos representativos, chamados "pontos de controle";
- É uma curva utilizada em diversas aplicações gráficas como o Illustrator, Freehand, etc, e em formatos de imagem vetorial como o SVG;
- Esse tipo de curva também pode originar "Superfícies de Bézier", bastante utilizadas em modelagem tridimensional, animação, design de produtos, etc.

→ Curva de Bézier Quadrática

P₀, P₁, P₂

→ utiliza-se a equação quadrática quando se tem 3 pontos.

$$P_k = (1-t)^2 \cdot p_0 + 2t(1-t) \cdot p_1 + t^2 \cdot p_2$$

Ex: 5 pontos da linha OZ

$$\begin{aligned} P_0 &= (0, 0, 3) \\ P_1 &= (0, 4, 0) \\ P_2 &= (2, 0, 0) \end{aligned}$$

$$x(t) = (1-t)^2 \cdot 0 + 2t(1-t) \cdot 0 + t^2 \cdot 2 = 2t^2$$

$$y(t) = (1-t)^2 \cdot 0 + 2t(1-t) \cdot 4 + t^2 \cdot 0 = 8t(1-t)$$

$$z(t) = (1-t)^2 \cdot 3 + 2t(1-t) \cdot 0 + t^2 \cdot 0 = 3(1-t)^2$$

$$x(0) = 0, y(0) = 0, z(0) = 3$$

$$x(1) = 2, y(1) = 0, z(1) = 0$$

$$x(0.5) = 0.5, y(0.5) = 2, z(0.5) = 0.75$$

$$x(0.25) = 0.125, y(0.25) = 1.5, z(0.25) = 1.875$$

$$x(0.75) = 1.125, y(0.75) = 1.5, z(0.75) = 0.125$$

$$x(0.125) = 0.03125, y(0.125) = 1.25, z(0.125) = 2.46875$$

$$x(0.875) = 1.5625, y(0.875) = 1.25, z(0.875) = 0.03125$$

$$x(0.375) = 0.28125, y(0.375) = 1.125, z(0.375) = 1.5625$$

$$x(0.625) = 0.76875, y(0.625) = 1.125, z(0.625) = 0.46875$$

$$x(0.1875) = 0.076875, y(0.1875) = 1.03125, z(0.1875) = 2.25$$

$$x(0.8125) = 1.328125, y(0.8125) = 1.03125, z(0.8125) = 0.076875$$

$$x(0.4375) = 0.37890625, y(0.4375) = 0.96875, z(0.4375) = 1.87890625$$

$$x(0.5625) = 0.62109375, y(0.5625) = 0.96875, z(0.5625) = 0.12109375$$

$$x(0.21875) = 0.09765625, y(0.21875) = 0.890625, z(0.21875) = 2.109375$$

$$x(0.78125) = 1.20234375, y(0.78125) = 0.890625, z(0.78125) = 0.09765625$$

$$x(0.390625) = 0.3125, y(0.390625) = 0.8125, z(0.390625) = 1.6875$$

$$x(0.609375) = 0.6875, y(0.609375) = 0.8125, z(0.609375) = 0.3125$$

$$x(0.15625) = 0.046875, y(0.15625) = 0.75, z(0.15625) = 2.34375$$

$$x(0.84375) = 1.153125, y(0.84375) = 0.75, z(0.84375) = 0.046875$$

$$x(0.265625) = 0.140625, y(0.265625) = 0.6875, z(0.265625) = 2.0625$$

$$x(0.734375) = 0.859375, y(0.734375) = 0.6875, z(0.734375) = 0.140625$$

$$x(0.328125) = 0.2109375, y(0.328125) = 0.625, z(0.328125) = 1.8125$$

$$x(0.671875) = 0.7890625, y(0.671875) = 0.625, z(0.671875) = 0.2109375$$

$$x(0.1953125) = 0.076171875, y(0.1953125) = 0.5625, z(0.1953125) = 2.21875$$

$$x(0.8046875) = 1.223828125, y(0.8046875) = 0.5625, z(0.8046875) = 0.076171875$$

$$x(0.359375) = 0.2578125, y(0.359375) = 0.5, z(0.359375) = 1.71875$$

$$x(0.640625) = 0.7421875, y(0.640625) = 0.5, z(0.640625) = 0.2578125$$

$$x(0.234375) = 0.11171875, y(0.234375) = 0.4375, z(0.234375) = 2.109375$$

$$x(0.765625) = 1.08828125, y(0.765625) = 0.4375, z(0.765625) = 0.11171875$$

$$x(0.3125) = 0.1953125, y(0.3125) = 0.375, z(0.3125) = 1.609375$$

$$x(0.6875) = 0.8046875, y(0.6875) = 0.375, z(0.6875) = 0.1953125$$

$$x(0.25) = 0.125, y(0.25) = 0.3125, z(0.25) = 1.5625$$

$$x(0.75) = 0.875, y(0.75) = 0.3125, z(0.75) = 0.125$$

$$x(0.375) = 0.5, y(0.375) = 0.25, z(0.375) = 1.375$$

$$x(0.625) = 0.375, y(0.625) = 0.25, z(0.625) = 0.5$$

$$x(0.4375) = 0.37890625, y(0.4375) = 0.1875, z(0.4375) = 1.25$$

$$x(0.5625) = 0.62109375, y(0.5625) = 0.1875, z(0.5625) = 0.37890625$$

$$x(0.21875) = 0.076171875, y(0.21875) = 0.15625, z(0.21875) = 1.171875$$

$$x(0.78125) = 1.223828125, y(0.78125) = 0.15625, z(0.78125) = 0.076171875$$

$$x(0.390625) = 0.2578125, y(0.390625) = 0.125, z(0.390625) = 1.109375$$

$$x(0.609375) = 0.7421875, y(0.609375) = 0.125, z(0.609375) = 0.2578125$$

$$x(0.15625) = 0.046875, y(0.15625) = 0.109375, z(0.15625) = 1.046875$$

$$x(0.84375) = 1.153125, y(0.84375) = 0.109375, z(0.84375) = 0.046875$$

$$x(0.265625) = 0.140625, y(0.265625) = 0.09375, z(0.265625) = 1.015625$$

$$x(0.734375) = 0.859375, y(0.734375) = 0.09375, z(0.734375) = 0.140625$$

$$x(0.328125) = 0.2109375, y(0.328125) = 0.078125, z(0.328125) = 0.984375$$

$$x(0.671875) = 0.7890625, y(0.671875) = 0.078125, z(0.671875) = 0.2109375$$

$$x(0.1953125) = 0.076171875, y(0.1953125) = 0.0625, z(0.1953125) = 0.953125$$

$$x(0.8046875) = 1.223828125, y(0.8046875) = 0.0625, z(0.8046875) = 0.076171875$$

$$x(0.359375) = 0.2578125, y(0.359375) = 0.05, z(0.359375) = 0.91875$$

$$x(0.640625) = 0.7421875, y(0.640625) = 0.05, z(0.640625) = 0.2578125$$

$$x(0.234375) = 0.11171875, y(0.234375) = 0.04166666666666667, z(0.234375) = 0.8888888888888889$$

$$x(0.765625) = 1.08828125, y(0.765625) = 0.04166666666666667, z(0.765625) = 0.11171875$$

$$x(0.3125) = 0.1953125, y(0.3125) = 0.035, z(0.3125) = 0.859375$$

$$x(0.6875) = 0.8046875, y(0.6875) = 0.035, z(0.6875) = 0.1953125$$

$$x(0.25) = 0.125, y(0.25) = 0.03, z(0.25) = 0.8375$$

$$x(0.75) = 0.875, y(0.75) = 0.03, z(0.75) = 0.125$$

$$x(0.375) = 0.5, y(0.375) = 0.025, z(0.375) = 0.8125$$

$$x(0.625) = 0.375, y(0$$

$$(0, 0, -16) \quad d = 16 \in \text{SEMPRL} +!$$

$$P_0 = \begin{bmatrix} 16 & 0 & 0 & 0 \\ 0 & 16 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 16 \end{bmatrix} \cdot \begin{bmatrix} -1 \\ 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} -16 + 0 + 0 + 0 \\ 0 + 0 + 0 + 0 \\ 0 + 0 + 0 + 0 \\ 0 + 0 + 0 + 16 \end{bmatrix} = \begin{bmatrix} -16 \\ 0 \\ 0 \\ 16 \end{bmatrix}$$

$$P_1 = \begin{bmatrix} 16 & 0 & 0 & 0 \\ 0 & 16 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 16 \end{bmatrix} \cdot \begin{bmatrix} 1 \\ 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} x \cdot d \\ y \cdot d \\ z \cdot d \\ z + d \end{bmatrix} = \begin{bmatrix} 16 \\ 0 \\ 0 \\ 16 \end{bmatrix}$$

$$P_2 = \begin{bmatrix} 16 & 0 & 0 & 0 \\ 0 & 16 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 16 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ 0 \\ -1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 + 0 + (-1) + 16 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 15 \end{bmatrix}$$

\downarrow
 $\nearrow z \neq 0 \quad \begin{cases} w = z + d \\ w = (-1) + 16 \\ w = 15 \end{cases}$

$$P_3 = \begin{bmatrix} 16 & 0 & 0 & 0 \\ 0 & 16 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 16 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ 2 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 32 \\ 0 \\ 16 \end{bmatrix}$$

$P_0' = (-1, 0)$

$$y_{P^0} = \frac{x \cdot d}{z + d} = \frac{(-1) \cdot 16}{0 + 16} = \frac{-16}{16} = -1$$

$$y_{P^0} = \frac{y \cdot d}{z + d} = \frac{0 \cdot 16}{0 + 16} = \frac{0}{16} = \emptyset$$