TRABALHO 3

Tópicos Especiais em Sistemas Autônomos

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Agenda

- Modelo Baseado em Velocidade
- Distribuições
- Modelo Baseado em Velocidade - Sample
- Modelo Baseado em Odometria
- Modelo Baseado em Odometria - Sample

Modelo Baseado em Velocidade

Algorithm motion_model_velocity(x_t, u_t, x_{t-1}):

$$\mu = \frac{1}{2} \frac{(x - x')\cos\theta + (y - y')\sin\theta}{(y - y')\cos\theta - (x - x')\sin\theta}$$

$$x^* = \frac{x + x'}{2} + \mu(y - y')$$

$$y^* = \frac{y + y'}{2} + \mu(x' - x)$$

$$r^* = \sqrt{(x - x^*)^2 + (y - y^*)^2}$$

$$\Delta\theta = \mathrm{atan2}(y' - y^*, x' - x^*) - \mathrm{atan2}(y - y^*, x - x^*)$$

$$\hat{v} = \frac{\Delta\theta}{\Delta t}\, r^*$$

$$\hat{\omega} = \frac{\Delta\theta}{\Delta t}$$

$$\hat{\gamma} = \frac{\theta' - \theta}{\Delta t} - \hat{\omega}$$

return $\mathbf{prob}(v - \hat{v}, \alpha_1 v^2 + \alpha_2 \omega^2) \cdot \mathbf{prob}(\omega - \hat{\omega}, \alpha_3 v^2 + \alpha_4 \omega^2)$
$\cdot\ \mathbf{prob}(\hat{\gamma}, \alpha_5 v^2 + \alpha_6 \omega^2)$

Distribuições

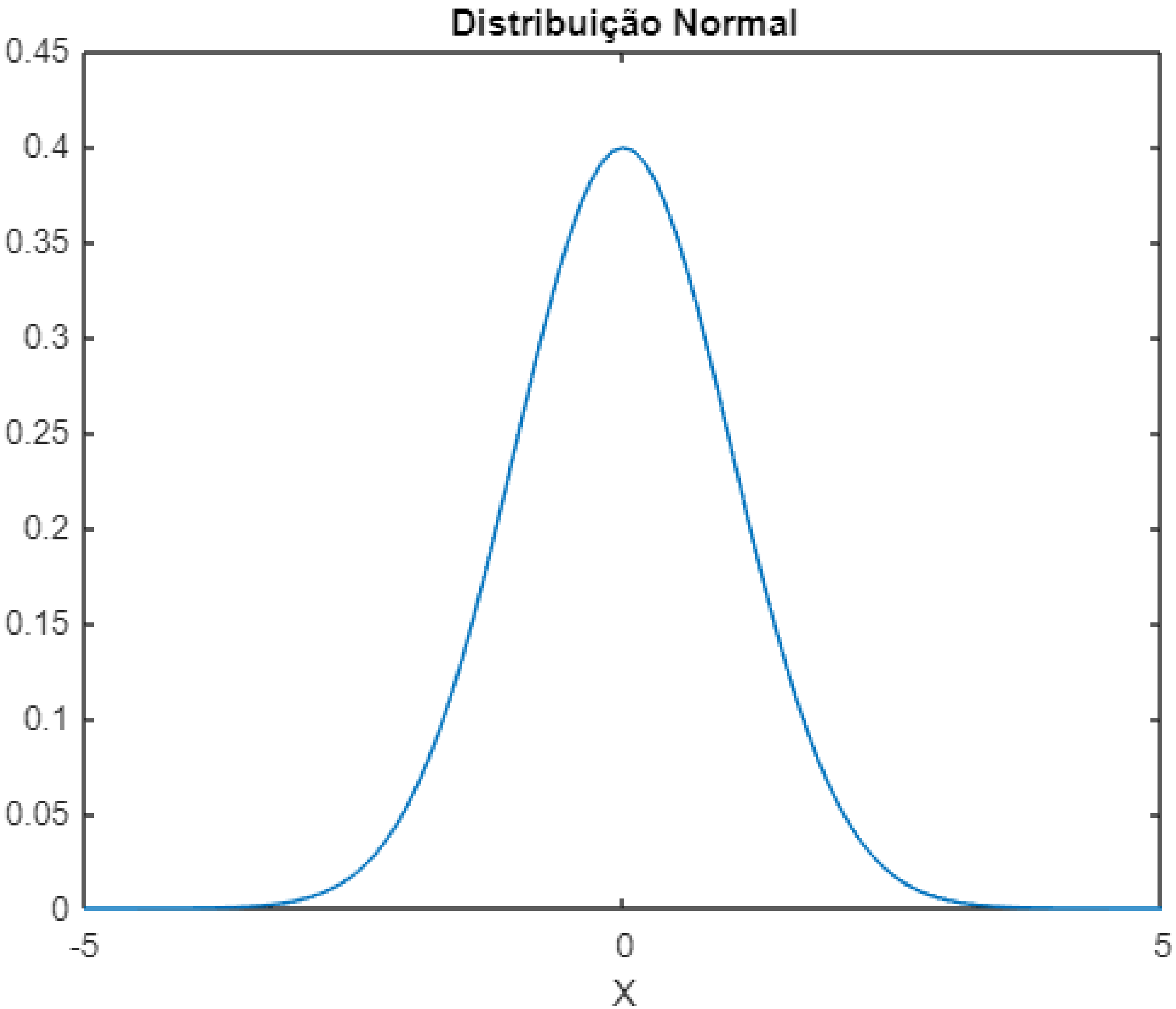
Algorithm prob_normal_distribution(a, b^2):

$$\textit{return}\ \frac{1}{\sqrt{2\pi\, b^2}}\ \exp\left\{-\frac{1}{2}\frac{a^2}{b^2}\right\}$$

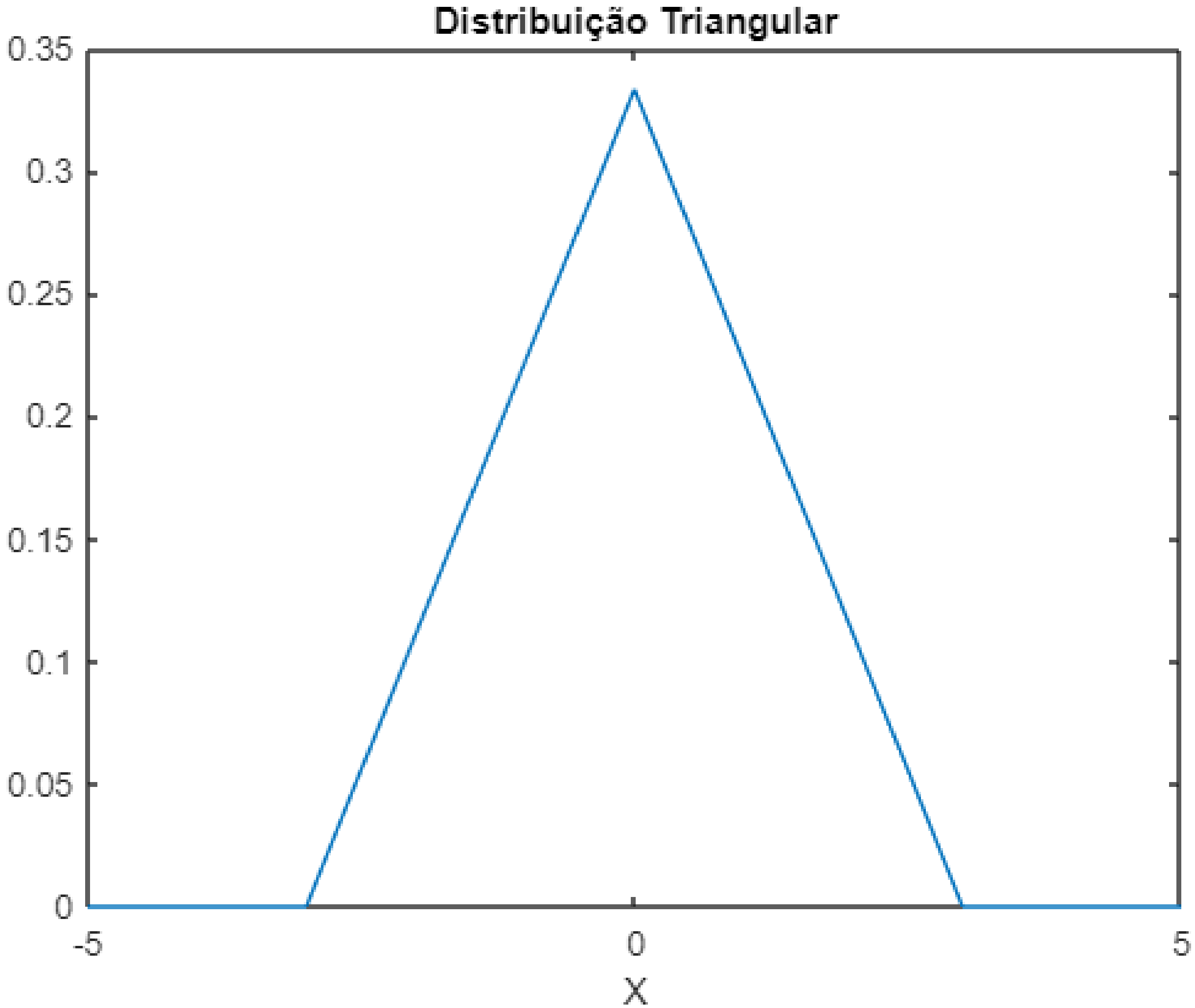
Algorithm prob_triangular_distribution(a, b^2):

$$\textit{return}\ \max\left\{0, \frac{1}{\sqrt{6}\, b} - \frac{|a|}{6\, b^2}\right\}$$

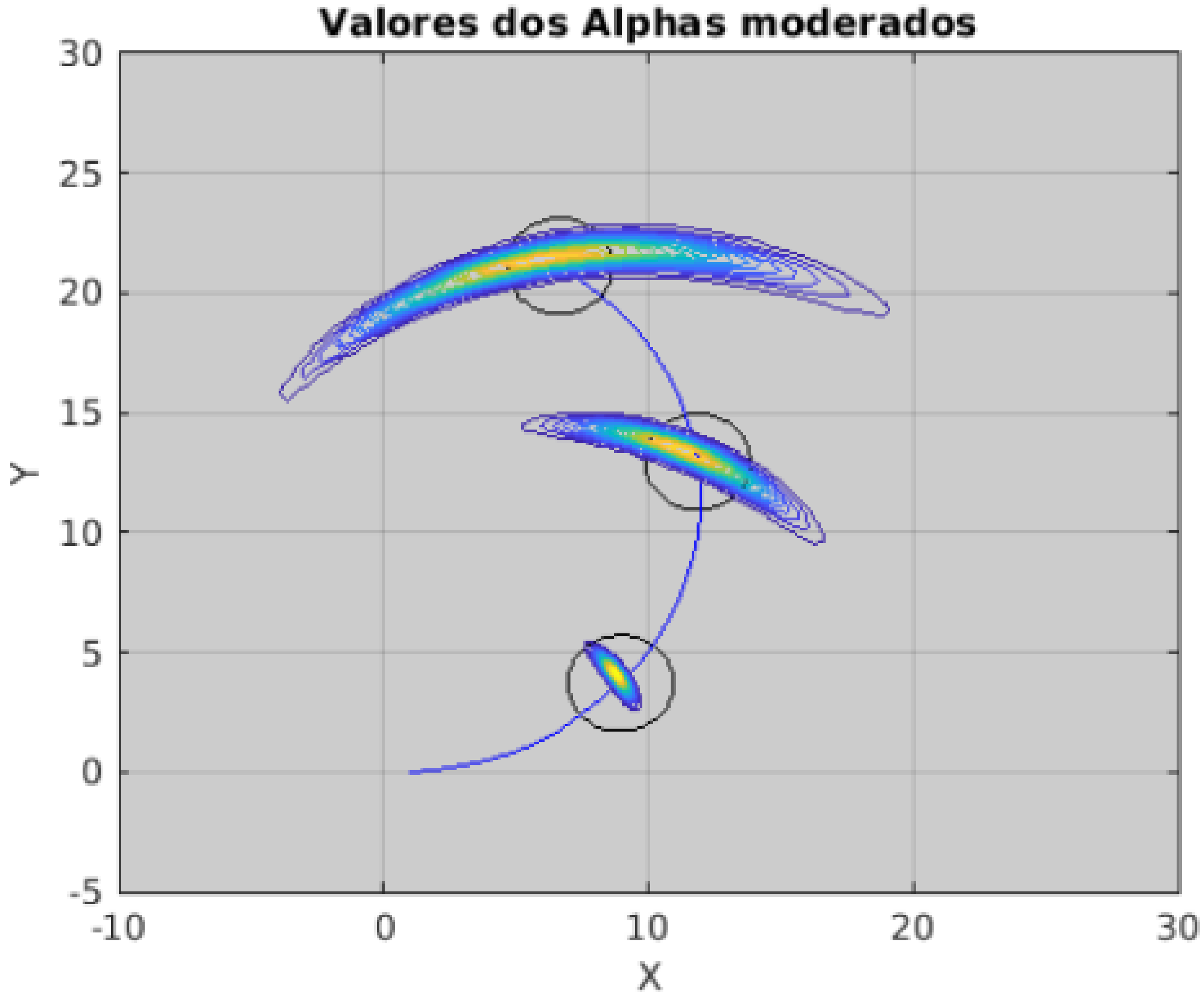
Distribuição Normal



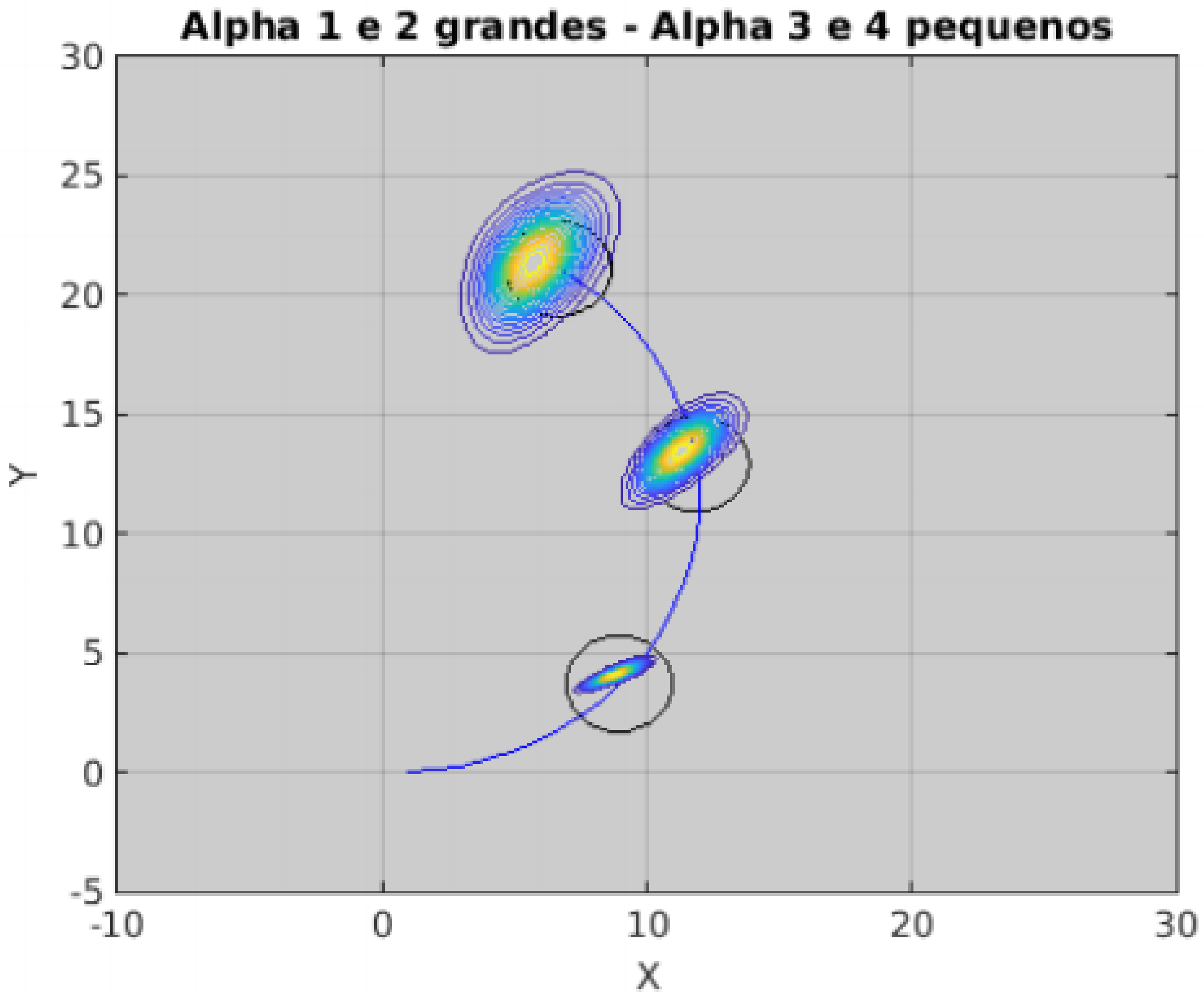
Distribuição Triangular



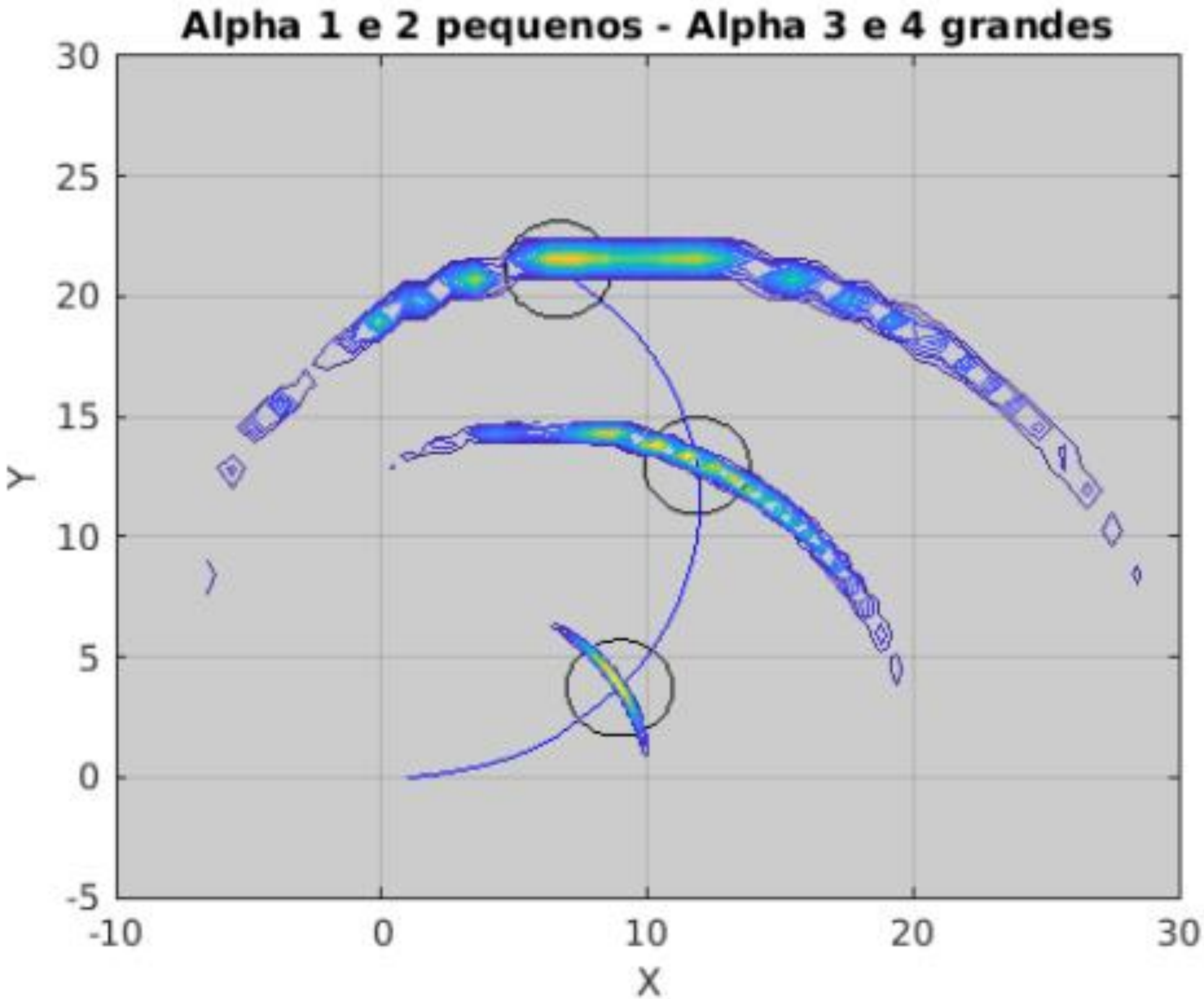
Modelo Baseado em Velocidade



Modelo Baseado em Velocidade



Modelo Baseado em Velocidade



Modelo Sample Velocidade

Algorithm motion_model_velocity(x_t, u_t, x_{t-1}):

$$\mu = \frac{1}{2} \frac{(x - x')\cos\theta + (y - y')\sin\theta}{(y - y')\cos\theta - (x - x')\sin\theta}$$

$$x^* = \frac{x + x'}{2} + \mu(y - y')$$

$$y^* = \frac{y + y'}{2} + \mu(x' - x)$$

$$r^* = \sqrt{(x - x^*)^2 + (y - y^*)^2}$$

$$\Delta\theta = \operatorname{atan2}(y' - y^*, x' - x^*) - \operatorname{atan2}(y - y^*, x - x^*)$$

$$\hat{v} = \frac{\Delta\theta}{\Delta t} r^*$$

$$\hat{\omega} = \frac{\Delta\theta}{\Delta t}$$

$$\hat{\gamma} = \frac{\theta' - \theta}{\Delta t} - \hat{\omega}$$

return **prob**($v - \hat{v}, \alpha_1 v^2 + \alpha_2 \omega^2$) $\cdot$ **prob**($\omega - \hat{\omega}, \alpha_3 v^2 + \alpha_4 \omega^2$) $\cdot$ **prob**($\hat{\gamma}, \alpha_5 v^2 + \alpha_6 \omega^2$)

Sample Velocidade

Algorithm sample_motion_model_velocity(u_t, x_{t-1})**:**

$\hat{v} = v + \textbf{sample}(\alpha_1 v^2 + \alpha_2 \omega^2)$

$\hat{\omega} = \omega + \textbf{sample}(\alpha_3 v^2 + \alpha_4 \omega^2)$

$\hat{\gamma} = \textbf{sample}(\alpha_5 v^2 + \alpha_6 \omega^2)$

$x' = x - \frac{\hat{v}}{\hat{\omega}} \sin\theta + \frac{\hat{v}}{\hat{\omega}}\ sin(\theta + \hat{\omega}\Delta t)$

$y' = y + \frac{\hat{v}}{\hat{\omega}} \cos\theta - \frac{\hat{v}}{\hat{\omega}}\ cos(\theta + \hat{\omega}\Delta t)$

$\theta' = \theta + \hat{\omega}\Delta t + \hat{\gamma}\Delta t$

return $x_t = (x', y', \theta')^T$

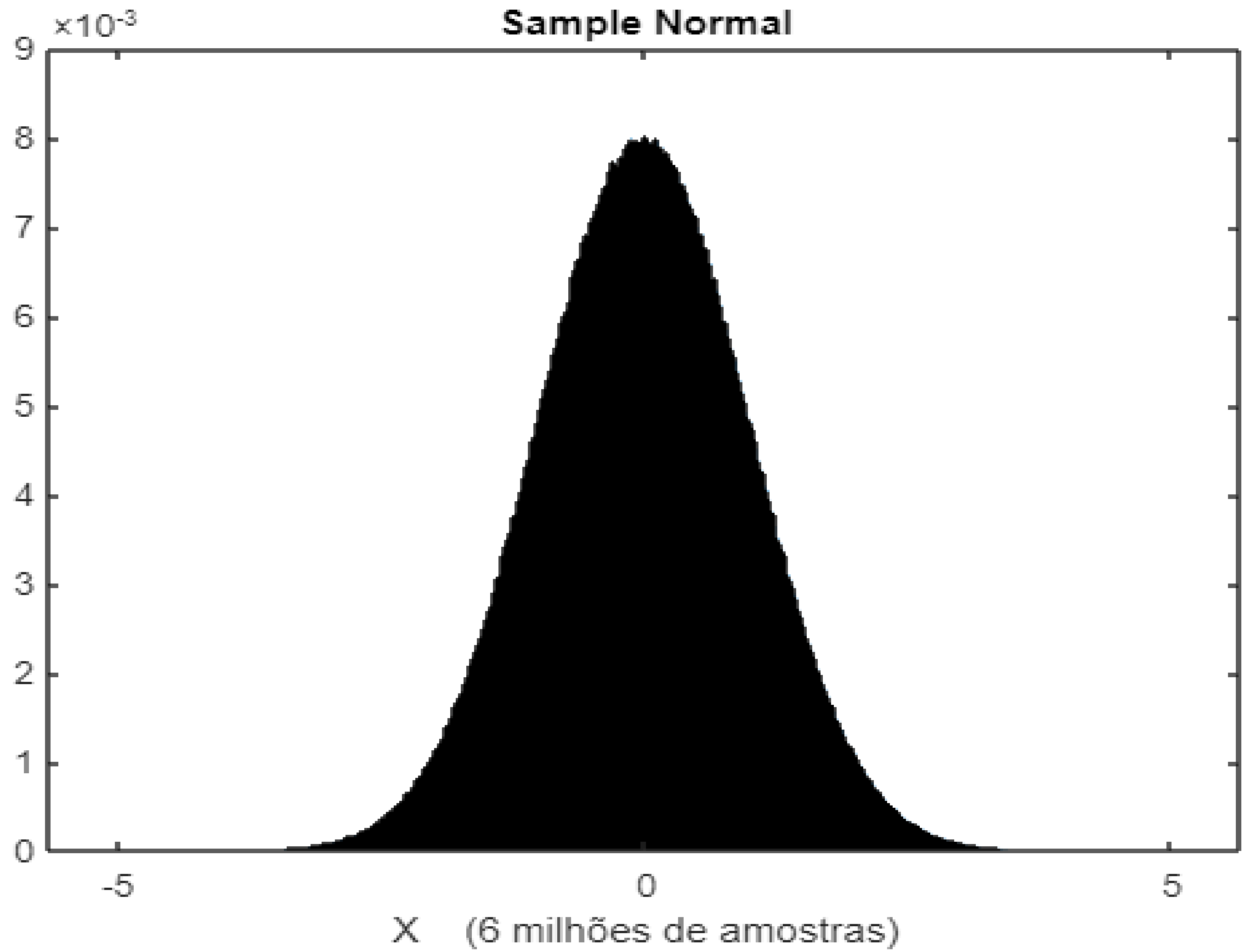
Algorithm sample_normal_distribution(b^2)**:**

return $\frac{1}{2} \sum_{i=1}^{12} \textbf{rand}(-b, b)$

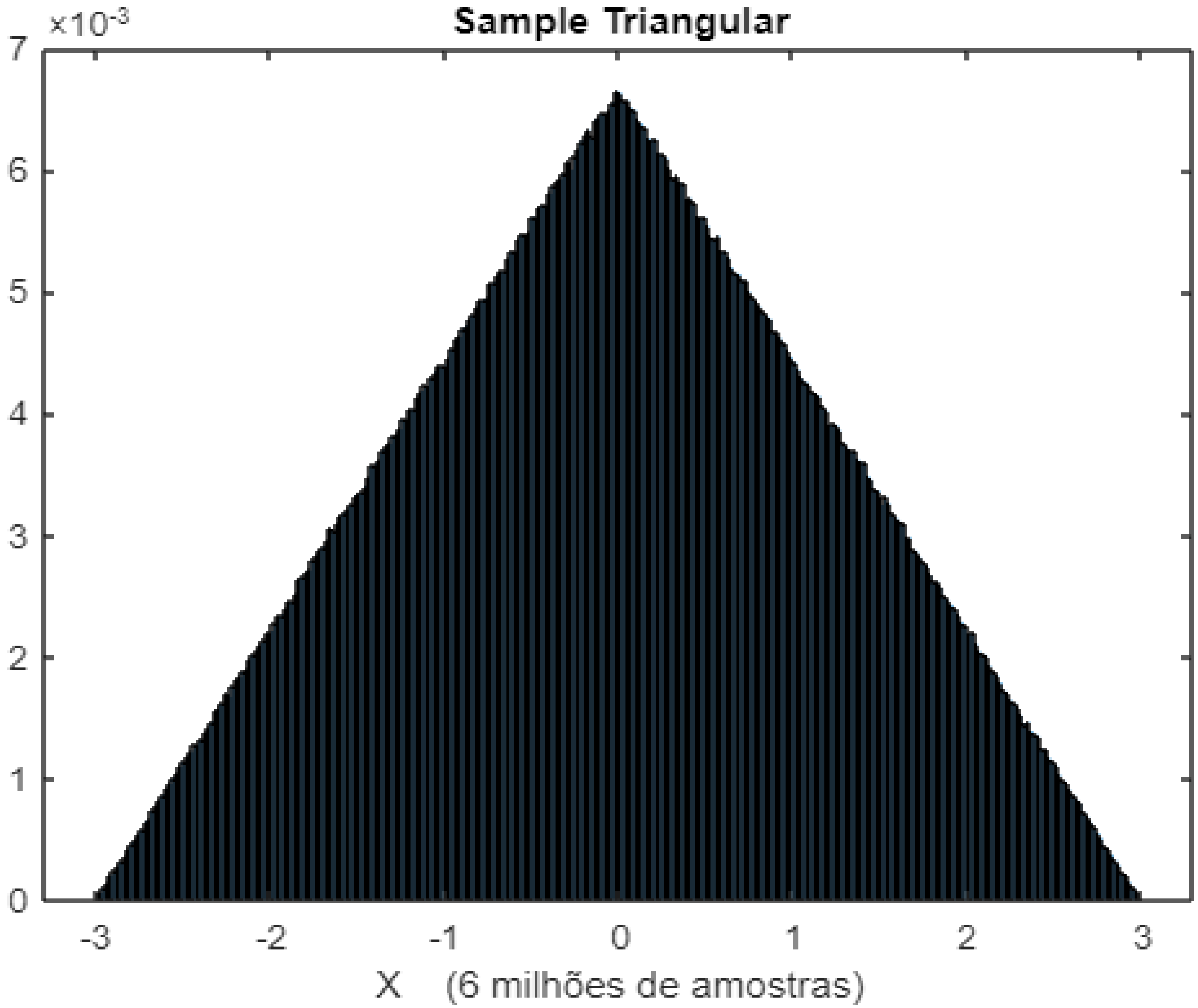
Algorithm sample_triangular_distribution(b^2)**:**

return $\frac{\sqrt{6}}{2} [\textbf{rand}(-b, b) + \textbf{rand}(-b, b)]$

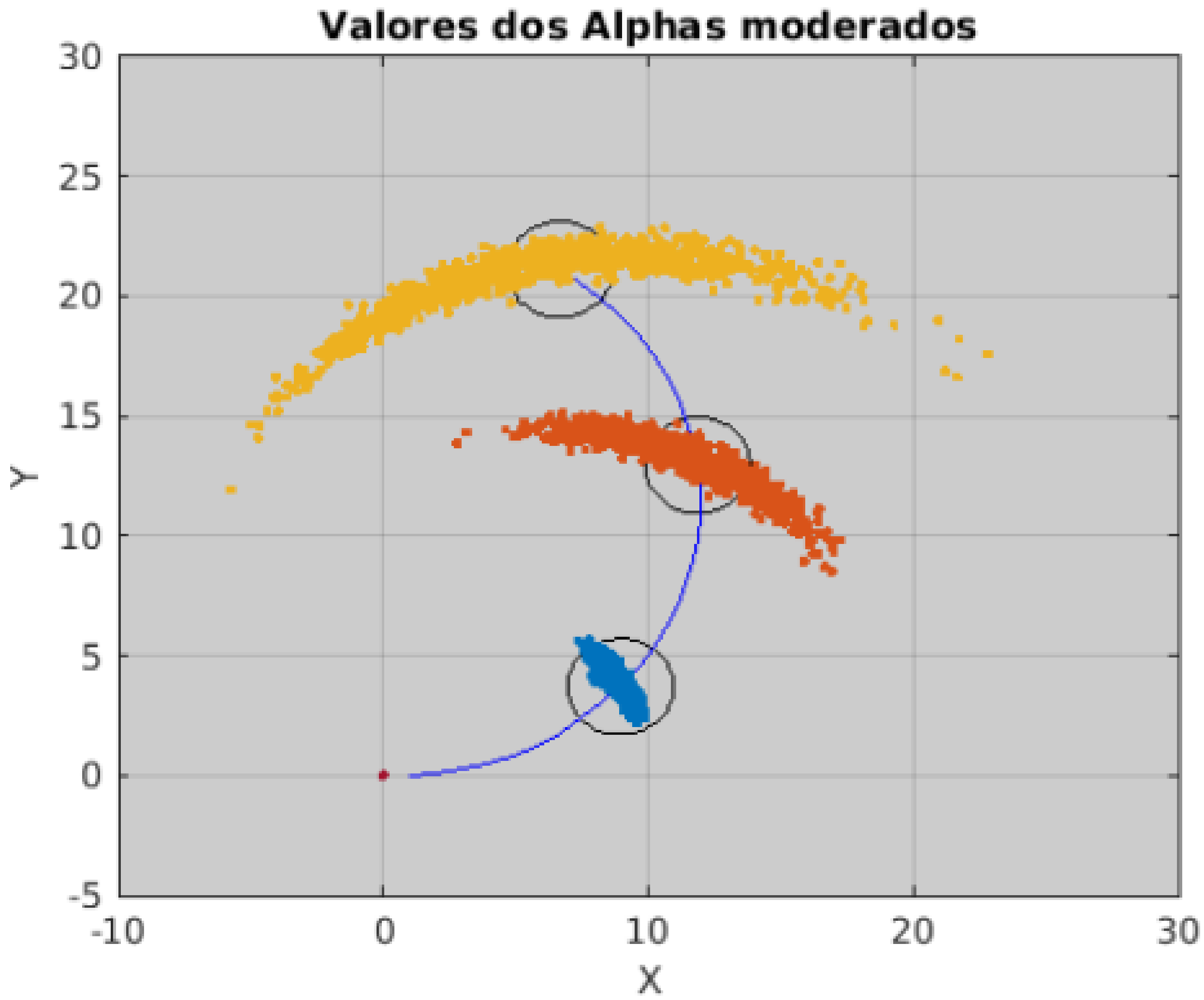
Sample Normal



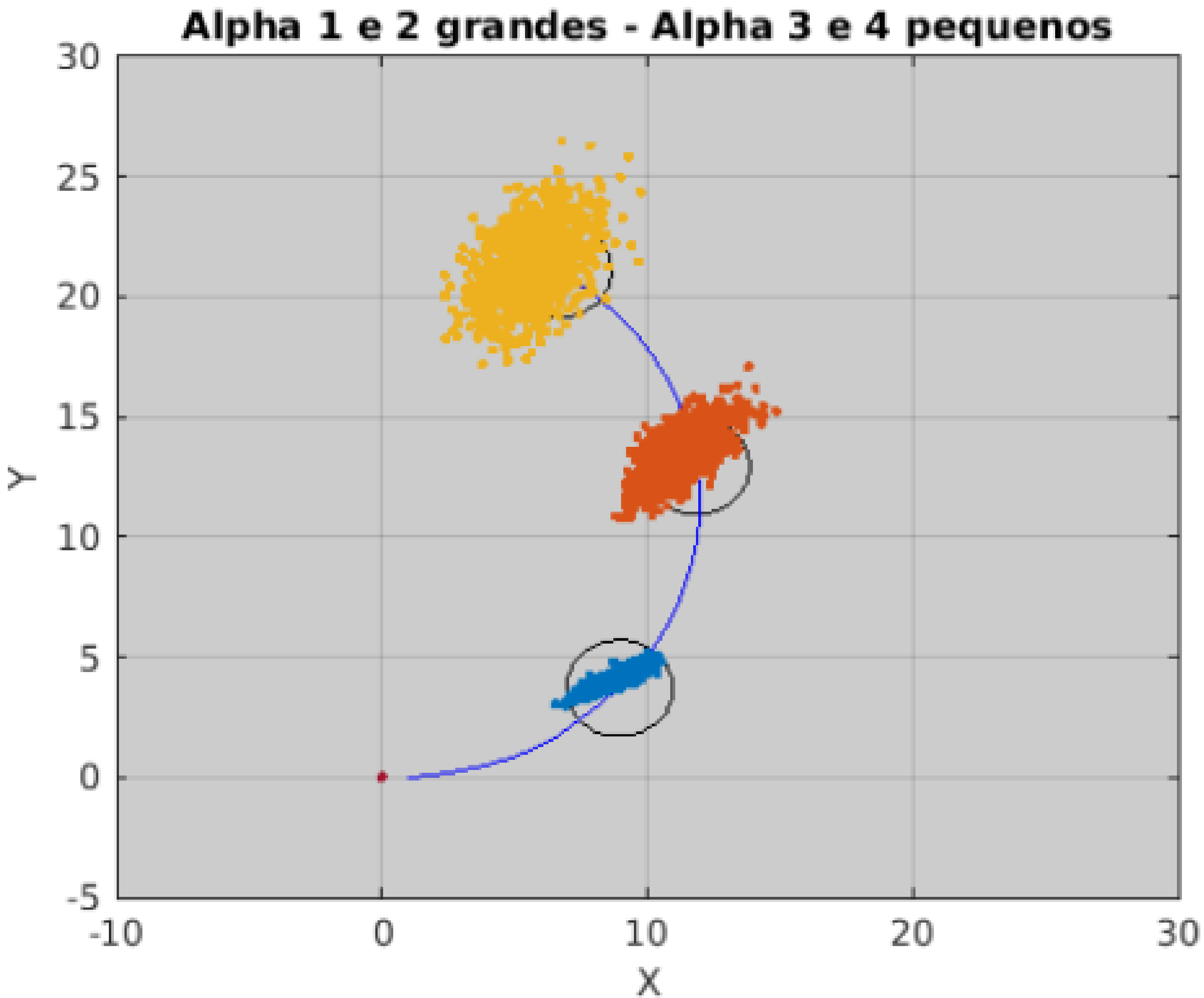
Sample Triangular



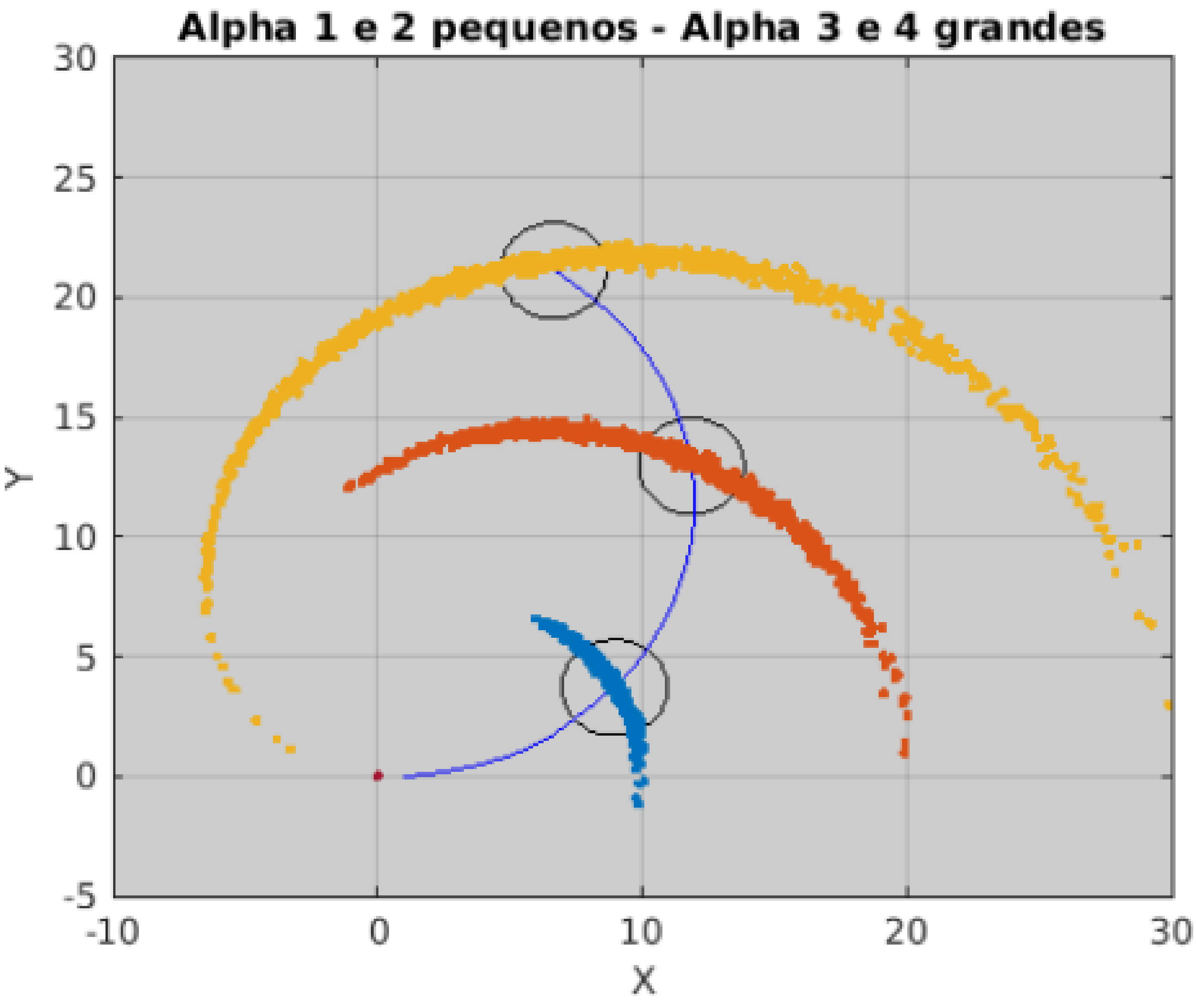
Modelo Sample Velocidade



Modelo Sample Velocidade



Modelo Sample Velocidade



Modelo Baseado em Odometria

Algorithm motion_model_odometry(x_t, u_t, x_{t-1})**:**

Medida:

$$\delta_{\text{rot1}} = \text{atan2}(\bar{y}' - \bar{y}, \bar{x}' - \bar{x}) - \bar{\theta}$$

$$\delta_{\text{trans}} = \sqrt{(\bar{x} - \bar{x}')^2 + (\bar{y} - \bar{y}')^2}$$

$$\delta_{\text{rot2}} = \bar{\theta}' - \bar{\theta} - \delta_{\text{rot1}}$$

Modelo:

$$\hat{\delta}_{\text{rot1}} = \text{atan2}(y' - y, x' - x) - \theta$$

$$\hat{\delta}_{\text{trans}} = \sqrt{(x - x')^2 + (y - y')^2}$$

$$\hat{\delta}_{\text{rot2}} = \theta' - \theta - \hat{\delta}_{\text{rot1}}$$

$$p_1 = \mathbf{prob}(\delta_{\text{rot1}} - \hat{\delta}_{\text{rot1}}, \alpha_1 \hat{\delta}^2_{\text{rot1}} + \alpha_2 \hat{\delta}^2_{\text{trans}})$$

$$p_2 = \mathbf{prob}(\delta_{\text{trans}} - \hat{\delta}_{\text{trans}}, \alpha_3 \hat{\delta}^2_{\text{trans}} + \alpha_4 \hat{\delta}^2_{\text{rot1}} + \alpha_4 \hat{\delta}^2_{\text{rot2}})$$

$$p_3 = \mathbf{prob}(\delta_{\text{rot2}} - \hat{\delta}_{\text{rot2}}, \alpha_1 \hat{\delta}^2_{\text{rot2}} + \alpha_2 \hat{\delta}^2_{\text{trans}})$$

return $p_1 \cdot p_2 \cdot p_3$

$$u_t = \begin{pmatrix} \bar{x}_{t-1} \\ \bar{x}_t \end{pmatrix}$$

$$\bar{x}_t = (\bar{x}' \;\; \bar{y}' \;\; \bar{\theta}')$$

$$\bar{x}_{t-1} = (\bar{x} \;\; \bar{y} \;\; \bar{\theta})$$

Sample Odometria

Algorithm sample_motion_model_odometry(u_t, x_{t-1})**:**

$$\delta_{\text{rot1}} = \text{atan2}(\bar{y}' - \bar{y}, \bar{x}' - \bar{x}) - \bar{\theta}$$
$$\delta_{\text{trans}} = \sqrt{(\bar{x} - \bar{x}')^2 + (\bar{y} - \bar{y}')^2}$$
$$\delta_{\text{rot2}} = \bar{\theta}' - \bar{\theta} - \delta_{\text{rot1}}$$

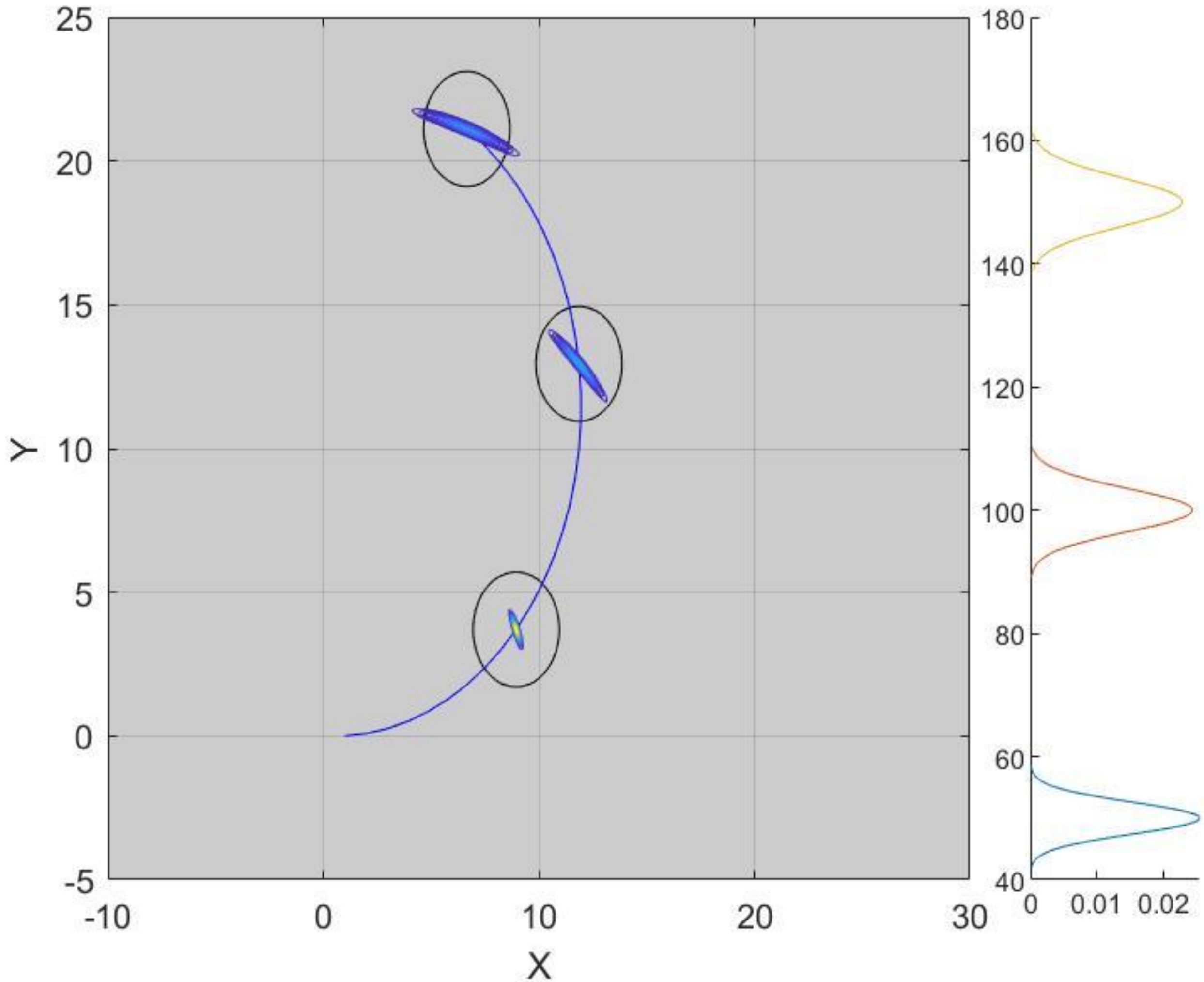
$$\hat{\delta}_{\text{rot1}} = \delta_{\text{rot1}} - \textbf{sample}(\alpha_1 \delta_{\text{rot1}}^2 + \alpha_2 \delta_{\text{trans}}^2)$$
$$\hat{\delta}_{\text{trans}} = \delta_{\text{trans}} - \textbf{sample}(\alpha_3 \delta_{\text{trans}}^2 + \alpha_4\ \delta_{\text{rot1}}^2 + \alpha_4\ \delta_{\text{rot2}}^2)$$
$$\hat{\delta}_{\text{rot2}} = \delta_{\text{rot2}} - \textbf{sample}(\alpha_1 \delta_{\text{rot2}}^2 + \alpha_2 \delta_{\text{trans}}^2)$$

$$x' = x + \hat{\delta}_{\text{trans}}\ \cos(\theta + \hat{\delta}_{\text{rot1}})$$
$$y' = y + \hat{\delta}_{\text{trans}}\ \sin(\theta + \hat{\delta}_{\text{rot1}})$$
$$\theta' = \theta + \hat{\delta}_{\text{rot1}} + \hat{\delta}_{\text{rot2}}$$

return $x_t = (x', y', \theta')^T$

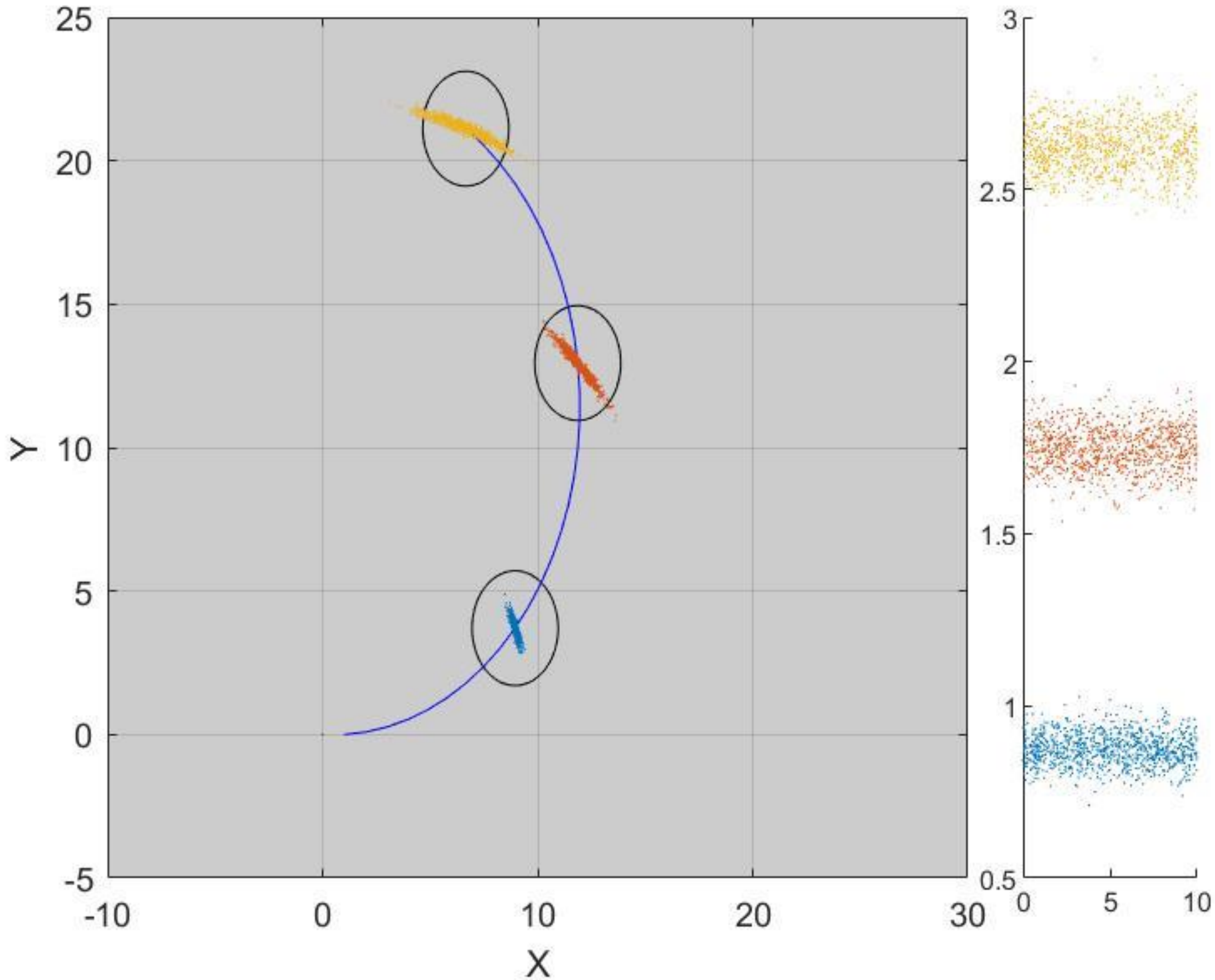
Modelo Baseado em Odometria

α com valores intermediários



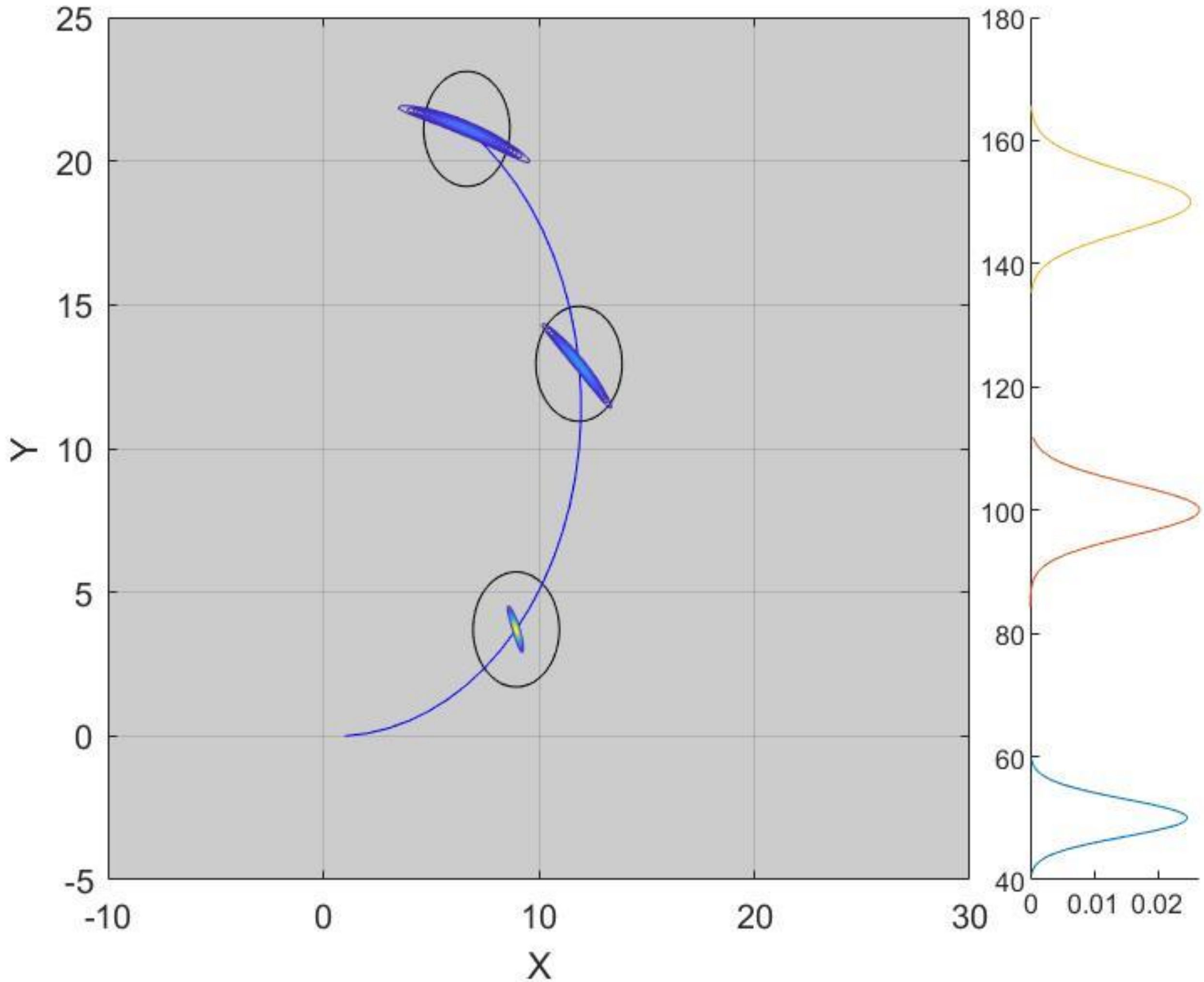
Sample Odometria

α com valores intermediários



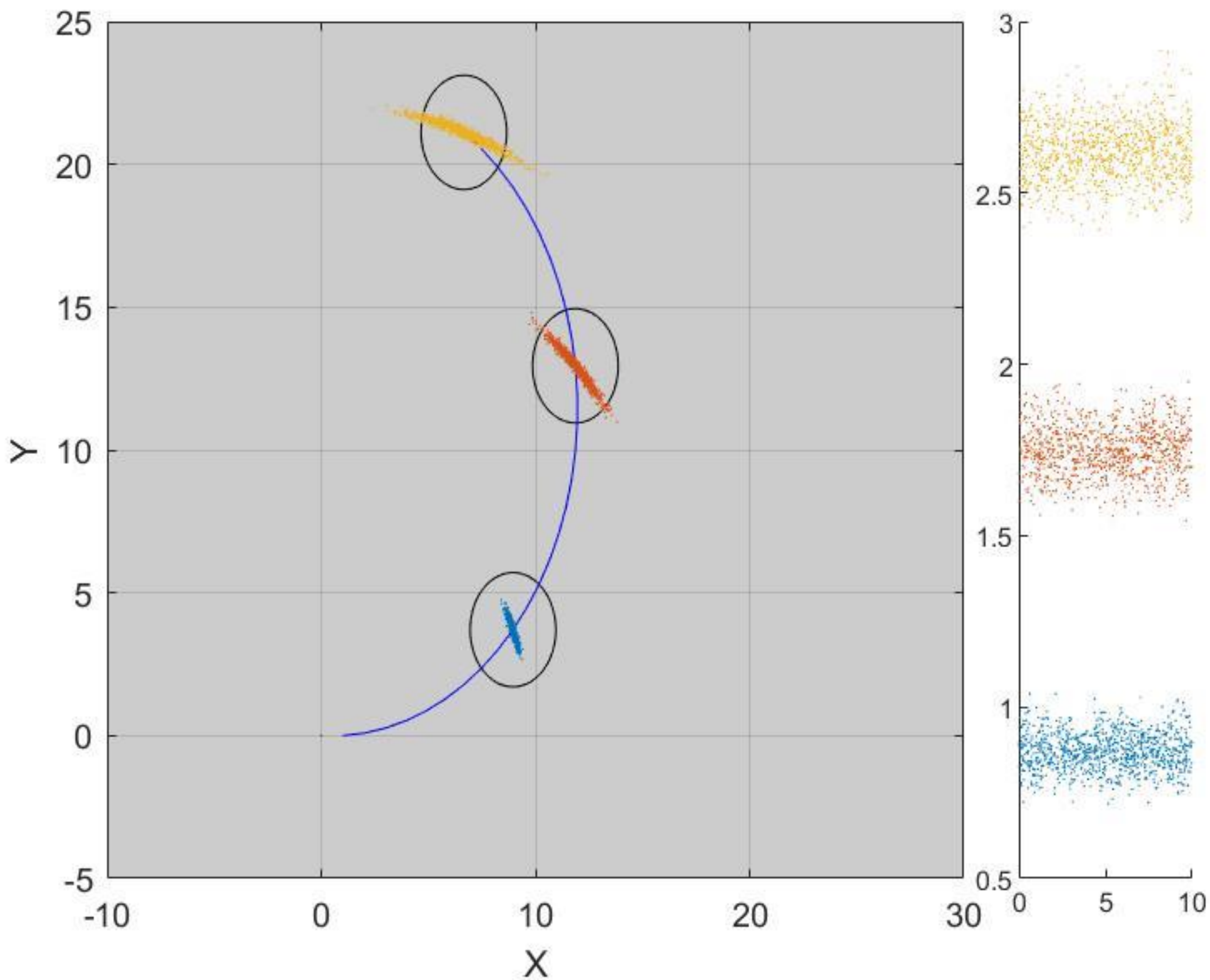
Modelo Baseado em Odometria

α 1 com valor maior –rotação/pose



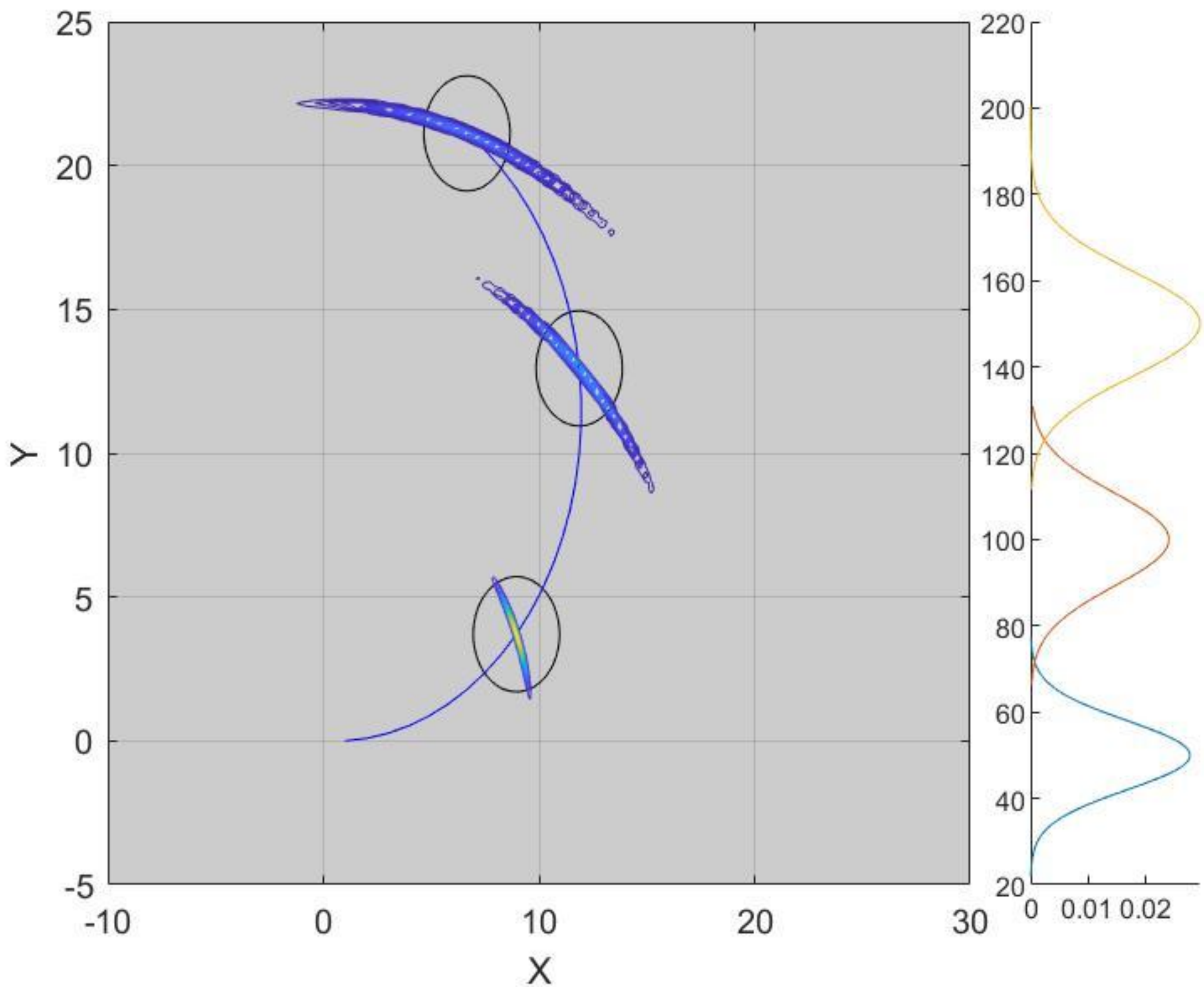
Sample Odometria

α 1 com valor maior –rotação/pose



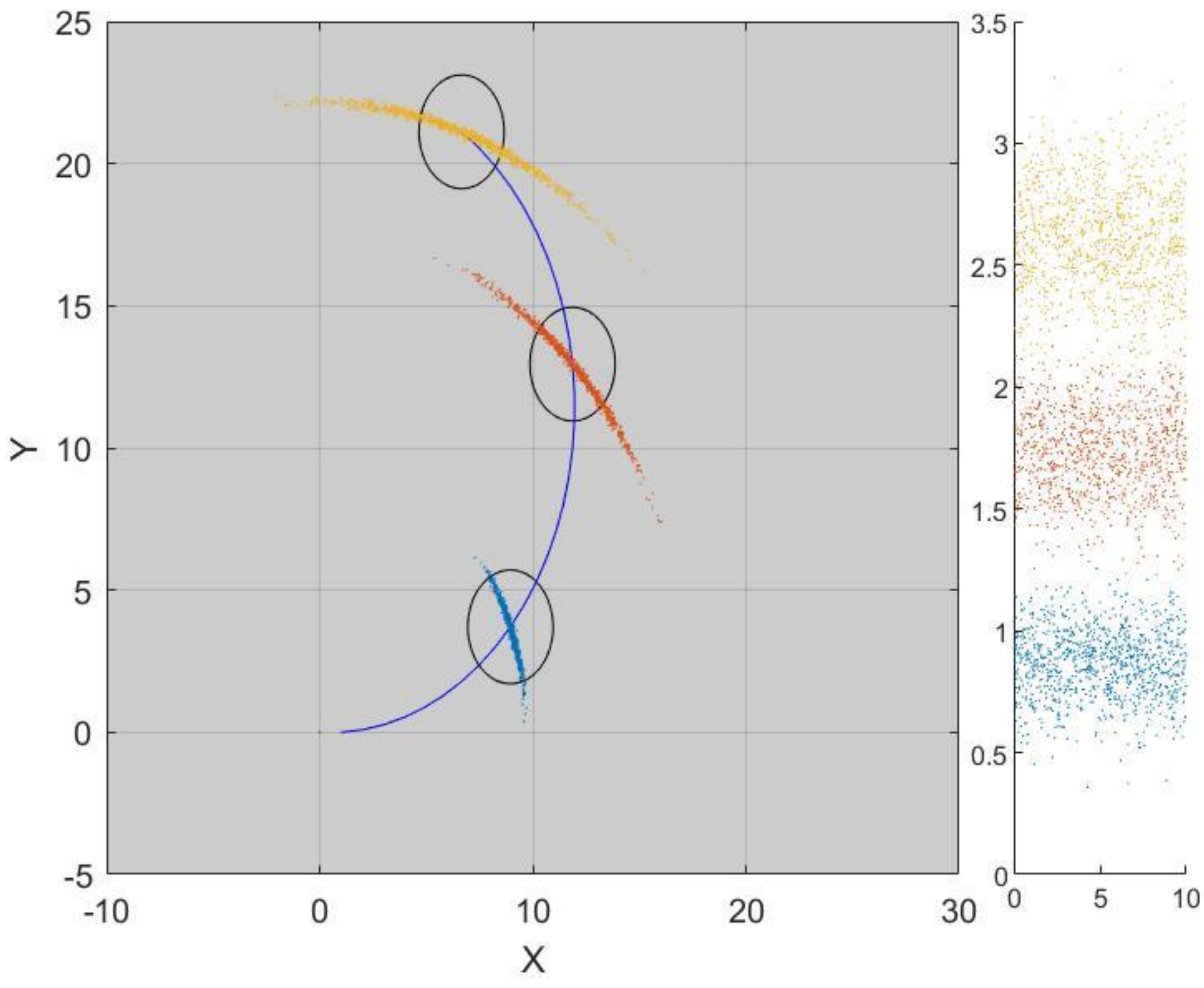
Modelo Baseado em Odometria

α 2 com valor maior –rotação/posição



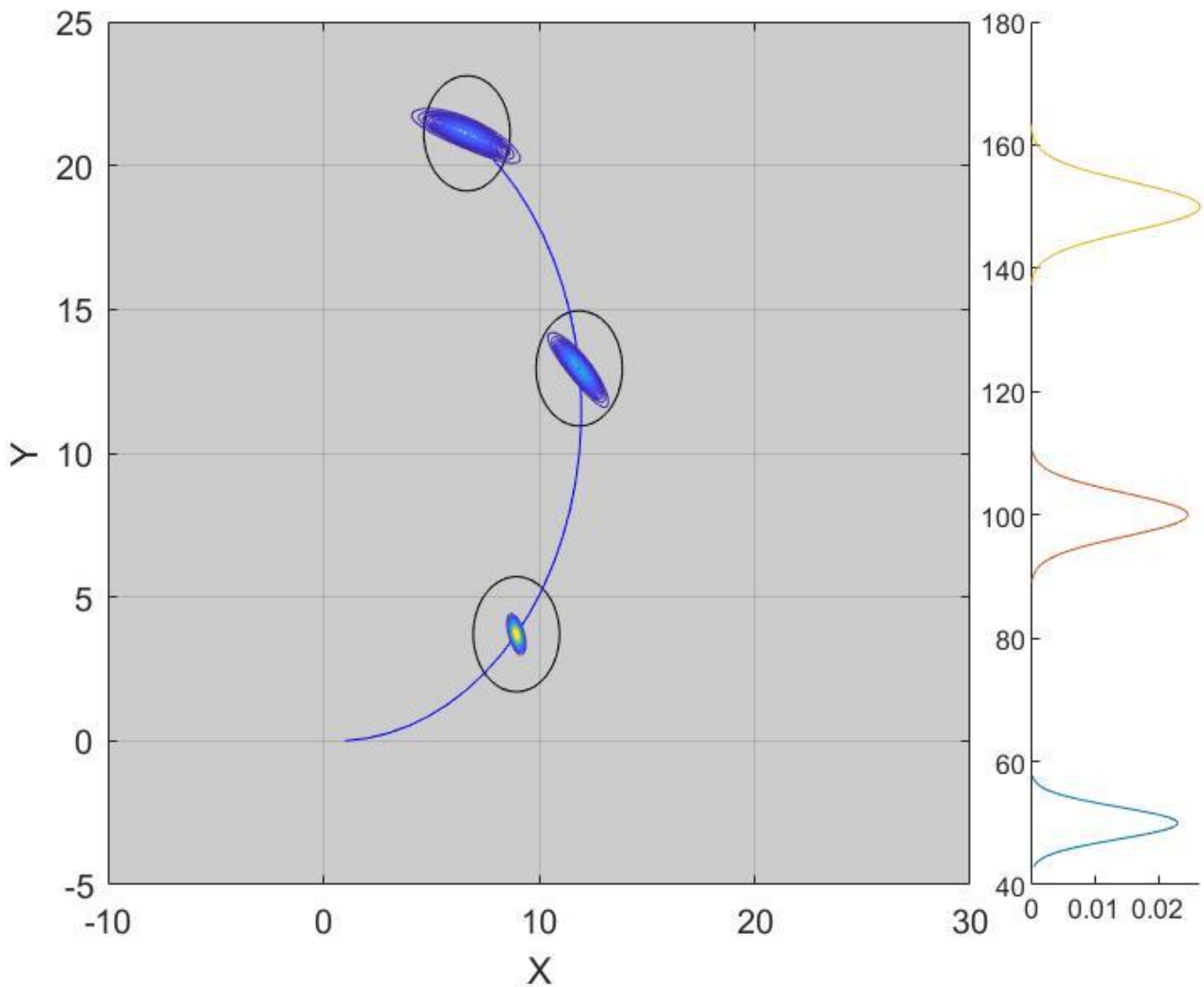
Sample Odometria

α 2 com valor maior –rotação/posição



Modelo Baseado em Odometria

α 3 com valor maior –translação/posição (XY)



Sample Odometria

α 3 com valor maior –translação/posição (XY)