AA 274: Principles of Robotic Autonomy
Algos for Lecture 11

Data: $\{p_{k,t-1}\}, u_t, z_t$
Result: $\{p_{k,t}\}$
$\eta \leftarrow 0$;
foreach k **do**
    $\overline{p}_{k,t} = \sum_i \tilde{\eta}\, |x_{k,t}|\, p(\hat{x}_k \,|\, u_t, \hat{x}_i)\, p_{i,t-1}$;
end

foreach k **do**
    $p_{k,t} = \eta\, p(z_t \,|\, \hat{x}_k,\, m)\, \overline{p}_{k,t}$;
    $\eta \leftarrow \eta + p_{k,t}$;
end

foreach k **do**
    $p_{k,t} = \eta^{-1}\, p_{k,t}$;
end

Return $\{p_{k,t}\}$

Data: $\mathcal{X}_{t-1}, u_t, z_t$
Result: $\mathcal{X}_t$
$\overline{\mathcal{X}}_t = \mathcal{X}_t = \emptyset$;
for $i = 1$ **to** M **do**
  Sample $x_t^{[m]} \sim p(x_t \,|\, u_t,\, x_{t-1}^{[m]})$;
  $w_t^{[m]} = p(z_t \,|\, x_t^{[m]})$;
  $\overline{\mathcal{X}}_t = \overline{\mathcal{X}}_t \cup \left(x_t^{[m]}, w_t^{[m]}\right)$;
end
for $m = 1$ **to** M **do**
  Draw i with probability $\propto w_t^{[i]}$;
  Add $x_t^{[i]}$ to $\mathcal{X}_t$;
end
Return $\mathcal{X}_t$

Data: $bel(x_{t-1}), u_t, z_t, m$
Result: $bel(x_t)$
foreach x_t **do**
  $\overline{bel}(x_t) = \int p(x_t \mid u_t, x_{t-1}, m)\, bel(x_{t-1})\, dx_{t-1}$;
  $bel(x_t) = \eta p(z_t \mid x_t, m)\, \overline{bel}(x_t)$;
end
Return $bel(x_t)$

Data: $\mathcal{X}_{t-1}, u_t, z_t$
Result: $\mathcal{X}_t$
$\overline{\mathcal{X}}_t = \mathcal{X}_t = \emptyset$;
for $i = 1$ **to** M **do**
  Sample $x_t^{[m]} \sim p(x_t \,|\, u_t,\, x_{t-1}^{[m]})$;
  $w_t^{[m]} = p(z_t \,|\, x_t^{[m]})$;
  $\overline{\mathcal{X}}_t = \overline{\mathcal{X}}_t \cup \left(x_t^{[m]}, w_t^{[m]}\right)$;
end
for $i = 1$ **to** M **do**
  Draw i with probability $\propto w_t^{[i]}$;
  Add $x_t^{[i]}$ to $\mathcal{X}_t$;
end
Return $\mathcal{X}_t$

Data: $\{p_{k,t-1}\}, u_t, z_t$
Result: $\{p_{k,t}\}$
foreach k **do**
  $\overline{p}_{k,t} = \sum_i p(X_t = x_k \mid u_t, X_{t-1} = x_i)\, p_{i,t-1}$;
  $p_{k,t} = \eta p(z_t \mid X_t = x_k)\overline{p}_{k,t}$;
end
Return $\{p_{k,t}\}$

Data: $(\mu_{t-1}, \Sigma_{t-1}), u_t, z_t$
Result: (μ_t, Σ_t)
$\mathcal{X}_{t-1} = (\mu_{t-1} \quad \mu_{t-1} + \gamma\sqrt{\Sigma_{t-1}} \quad \mu_{t-1} - \gamma\sqrt{\Sigma_{t-1}})$;
$\mathcal{X}_t^* = g(u_t,\, \mathcal{X}_{t-1})$;
$\overline{\mu}_t = \sum_{i=0}^{2n} w_m^{[i]}\, \overline{\mathcal{X}}_t^{*\,[i]}$;
$\overline{\Sigma}_t = \sum_{i=0}^{2n} w_c^{[i]}\, (\overline{\mathcal{X}}_t^{*\,[i]} - \overline{\mu}_t)\, (\overline{\mathcal{X}}_t^{*\,[i]} - \overline{\mu}_t)^T + R_t$;
$\overline{\mathcal{X}}_t = (\overline{\mu}_t \quad \overline{\mu}_t + \gamma\sqrt{\overline{\Sigma}_t} \quad \overline{\mu}_t - \gamma\sqrt{\overline{\Sigma}_t}$;
$\overline{\mathcal{Z}}_t = h(\overline{\mathcal{X}}_t)$;
$\hat{z}_t = \sum_{i=0}^{2n} w_m^{[i]}\, \overline{\mathcal{Z}}_t^{[i]}$;
$S_t = \sum_{i=0}^{2n} w_c^{[i]}\, (\overline{\mathcal{Z}}_t^{[i]} - \hat{z}_t)\, (\overline{\mathcal{Z}}_t^{[i]} - \hat{z}_t)^T + Q_t$;
$\overline{\Sigma}_t^{x,z} = \sum_{i=0}^{2n} w_c^{[i]}\, (\overline{\mathcal{X}}_t^{[i]} - \overline{\mu}_t)\, (\overline{\mathcal{Z}}_t^{[i]} - \hat{z}_t)^T$;
$K_t = \overline{\Sigma}_t^{x,z}\, S_t^{-1}$;
$\mu_t = \overline{\mu}_t + K_t(z_t - \hat{z}_t)$;
$\Sigma_t = \overline{\Sigma}_t - K_t S_t K_t^T$;
Return (μ_t, Σ_t)

Data: $(\mu_{t-1}, \Sigma_{t-1}), u_t, z_t$
Result: (μ_t, Σ_t)
$\overline{\mu}_t = g(u_t, \mu_{t-1})$;
$\overline{\Sigma}_t = G_t \Sigma_{t-1} G_t{}^T + R_t$;
$K_t = \overline{\Sigma}_t H_t^T (H_t \overline{\Sigma}_t H_t^T + Q_t)^{-1}$;
$\mu_t = \overline{\mu}_t + K_t(z_t - h(\overline{\mu}_t))$;
$\Sigma_t = (I - K_t H_t)\overline{\Sigma}_t$;
Return (μ_t, Σ_t)

Data: $(\mu_{t-1}, \Sigma_{t-1}), u_t, z_t$
Result: (μ_t, Σ_t)
$\overline{\mu}_t = A_t \mu_{t-1} + B_t u_t$;
$\overline{\Sigma}_t = A_t \Sigma_{t-1} A_t^T + R_t$;
$K_t = \overline{\Sigma}_t C_t^T (C_t \overline{\Sigma}_t C_t^T + Q_t)^{-1}$;
$\mu_t = \overline{\mu}_t + K_t(z_t - C_t \overline{\mu}_t)$;
$\Sigma_t = (I - K_t C_t)\overline{\Sigma_t}$;
Return (μ_t, Σ_t)

Data: $bel(x_{t-1}), u_t, z_t$
Result: $bel(x_t)$
foreach x_t **do**
  $\overline{bel}(x_t) = \int p(x_t \mid u_t, x_{t-1})\, bel(x_{t-1})\, dx_{t-1}$;
  $bel(x_t) = \eta p(z_t \mid x_t)\overline{bel}(x_t)$;
end
Return $bel(x_t)$

Data: Set S containing N points
Result: Line fitting the points in S
Initialize $n_\alpha \times n_r$ accumulator H with zeros;
foreach $(x_i, y_i) \in S$ **do**
    foreach $\alpha \in \{\alpha_1, \ldots, \alpha_{n_\alpha}\}$ **do**
        compute $r = x_i \cos\alpha + y_i \sin\alpha$;
        $H[\alpha, r] \leftarrow H[\alpha, r] + 1$;
    end
end
Choose (α^*, r^*) that corresponds to largest count in H;
Return line defined by (α^*, r^*)