CS354

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Monte-Carlo Localization aka Particle Filter

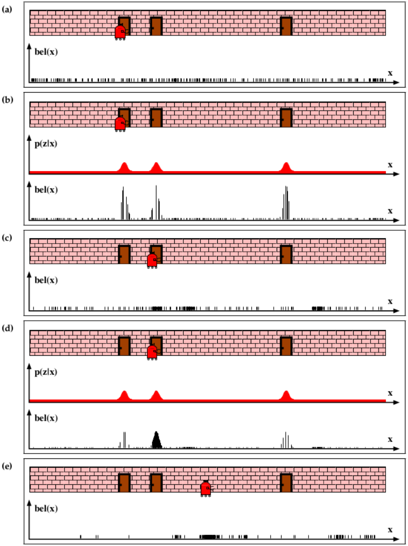

Figure 8.11 Monte Carlo Localization, a particle filter applied to mobile robot localization.

Probabilistic Robotics. Thrun, Burgard, Fox, 2005

Particle Filter Algorithm

procedure PARTICLE_FILTER($\mathcal{X}_{t-1}, u_t, z_t$)
  Inputs
    $\mathcal{X}_{t-1}$ – The previous set of particles
    u_t – The control signal
    z_t – The sensor value
  Output
    $\mathcal{X}_t$ – The updated set of particles

  $\bar{\mathcal{X}}_t = \mathcal{X}_t = \emptyset$
  $M = |\mathcal{X}_{t-1}|$
  for $m = 0$ to $M - 1$ **do**
    sample $x_t^{[m]} \sim p(x_t \mid u_t, x_t^{[m]})$ ▷ Predict
    $w_t^{[m]} = p(z_t \mid x_t^{[m]}) w_{t-1}^{[m]}$ ▷ Correct
    $\bar{\mathcal{X}}_t = \bar{\mathcal{X}}_t \cup \{\langle x_t^{[m]}, w_t^{[m]} \rangle\}$
  for $m = 0$ to $M - 1$ **do** ▷ Resampling
    draw i with probability $\propto w_t^{[i]}$
    $\mathcal{X}_t = \mathcal{X}_t \cup \{\langle x_t^{[i]}, 1/M \rangle\}$

Based on Algorithm in Table 4.3 in Probabilistic Robotics. Thrun, Burgard, Fox, 2005

Sampling From the Motion Model

- $x_t^{[m]} \sim p(x_t \mid u_t, x_t^{[m]})$

Measurement Models for Laser Range Finders

- $p(z_t \mid x_t^{[m]})$

Issues

- Not a good idea to run the particle filter while the robot is stationary
  - Resampling will deplete the set of particles
- If we've resampled, the $w_{t-1}^{[m]}$ term in: $w_t^{[m]} = p(z_t \mid x_t^{[m]}) w_{t-1}^{[m]}$ will be the same for every particle.
  - Could use $w_t^{[m]} = p(z_t \mid x_t^{[m]})$ instead.
- May not be necessary to resample on every update.

Extracting a Single State Estimate

- Possibilities:
  - Average over all particles
  - Cluster the algorithms, average within the “best” cluster
  - Something fancier...