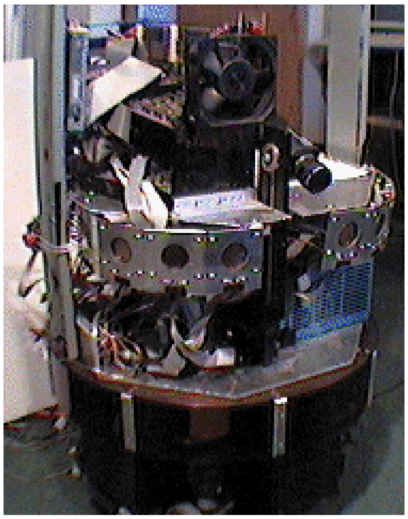
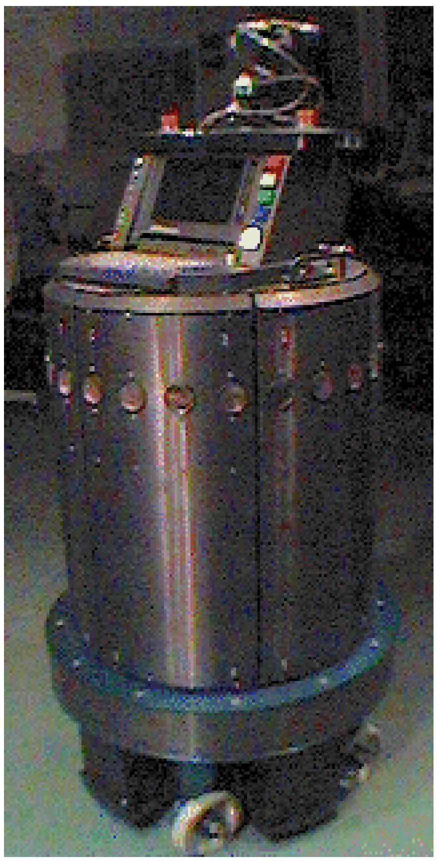
Occupancy Grids for Robot Navigation

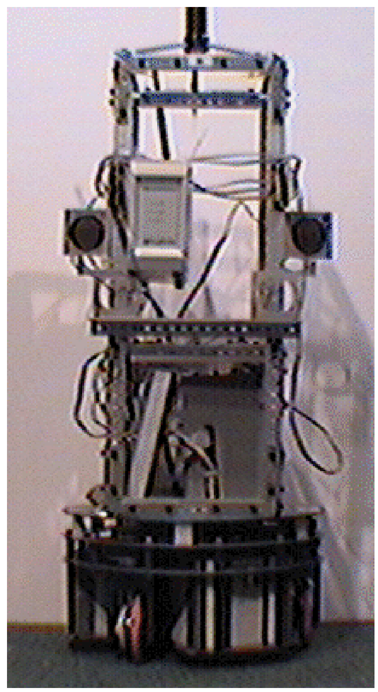
Gort



Ramona

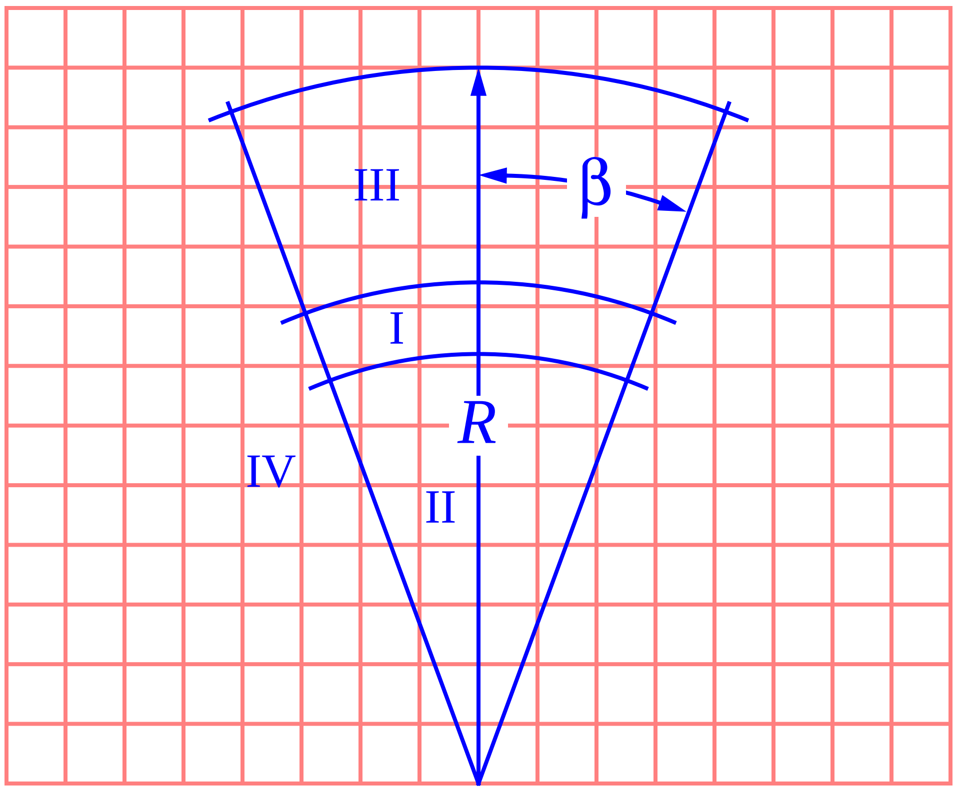


Louie



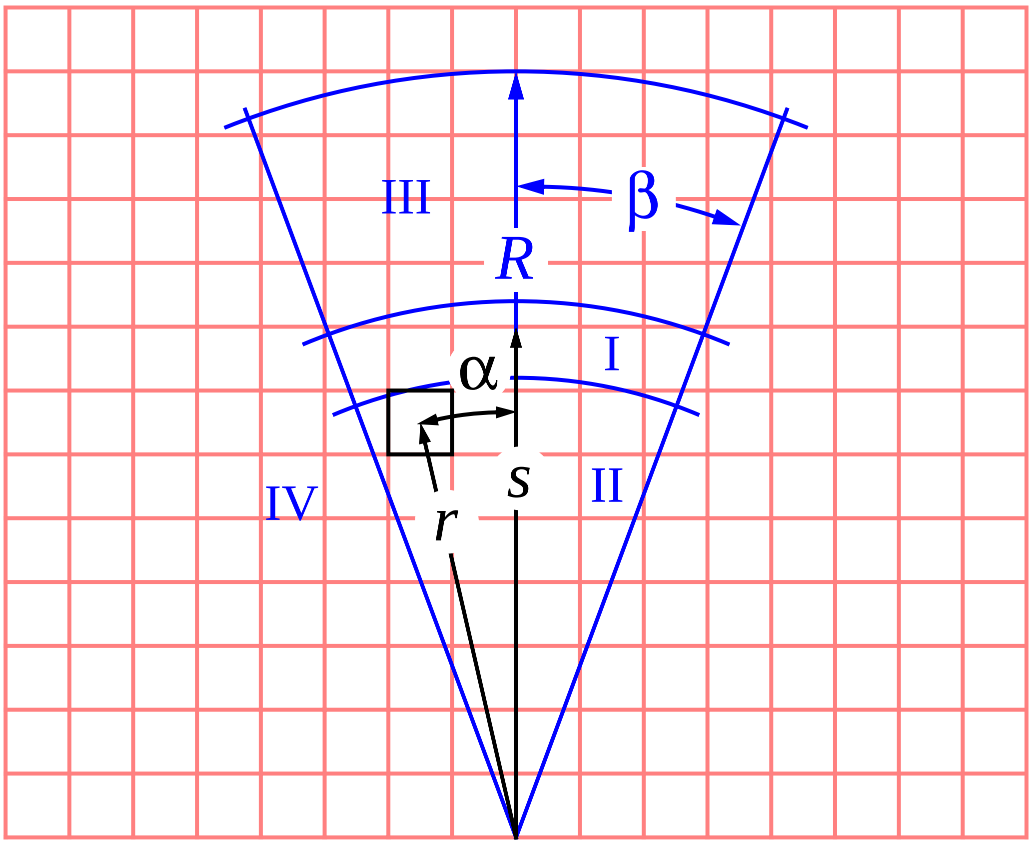
Basic Sensor Model

- A model for the occupancy of cells in a grid



Basic Sensor Model (continued)

- The parameters for reasoning about a cell



- Model for Region I

$$\Pr(C) = \frac{\left(\frac{R-r}{R}\right) + \left(\frac{\beta-\alpha}{\beta}\right)}{2} \times M$$

$$\Pr(\bar{C}) = 1 - \Pr(C)$$

Basic Sensor Model (continued)

- Model for Region II

$$\Pr(C) = 1 - \Pr(\bar{C})$$

$$\Pr(C) = \frac{\left(\frac{R-r}{R}\right) + \left(\frac{\beta-\alpha}{\beta}\right)}{2}$$

- Example update for a cell in Region I

$$\Pr(C) = \frac{\left(\frac{10-6}{10}\right) + \left(\frac{15-5}{15}\right)}{2} \times 0.98 = 0.52$$

$$\Pr(\bar{C}) = 1 - 0.52 = 0.48$$

Bayes Rule

$$\Pr(H|d) = \frac{\Pr(d|H)\Pr(H)}{\Pr(d)} =$$

$$\frac{\Pr(d|H)\Pr(H)}{\Pr(d|H)\Pr(H) + \Pr(d|\neg H)\Pr(\neg H)}$$

- Application to occupancy grids

$$\Pr(C|s) = \frac{\Pr(s|C)\Pr(C)}{\Pr(s|C)\Pr(C) + \Pr(s|\bar{C})\Pr(\bar{C})}$$

$$\Pr(C|s_1, s_2, \ldots, s_n) =$$

$$\frac{\Pr(s_1, s_2, \ldots, s_n|C)\Pr(C)}{\Pr(s_1, s_2, \ldots, s_n|C)\Pr(C) + \Pr(s_1, s_2, \ldots, s_n|\bar{C})\Pr(\bar{C})}$$

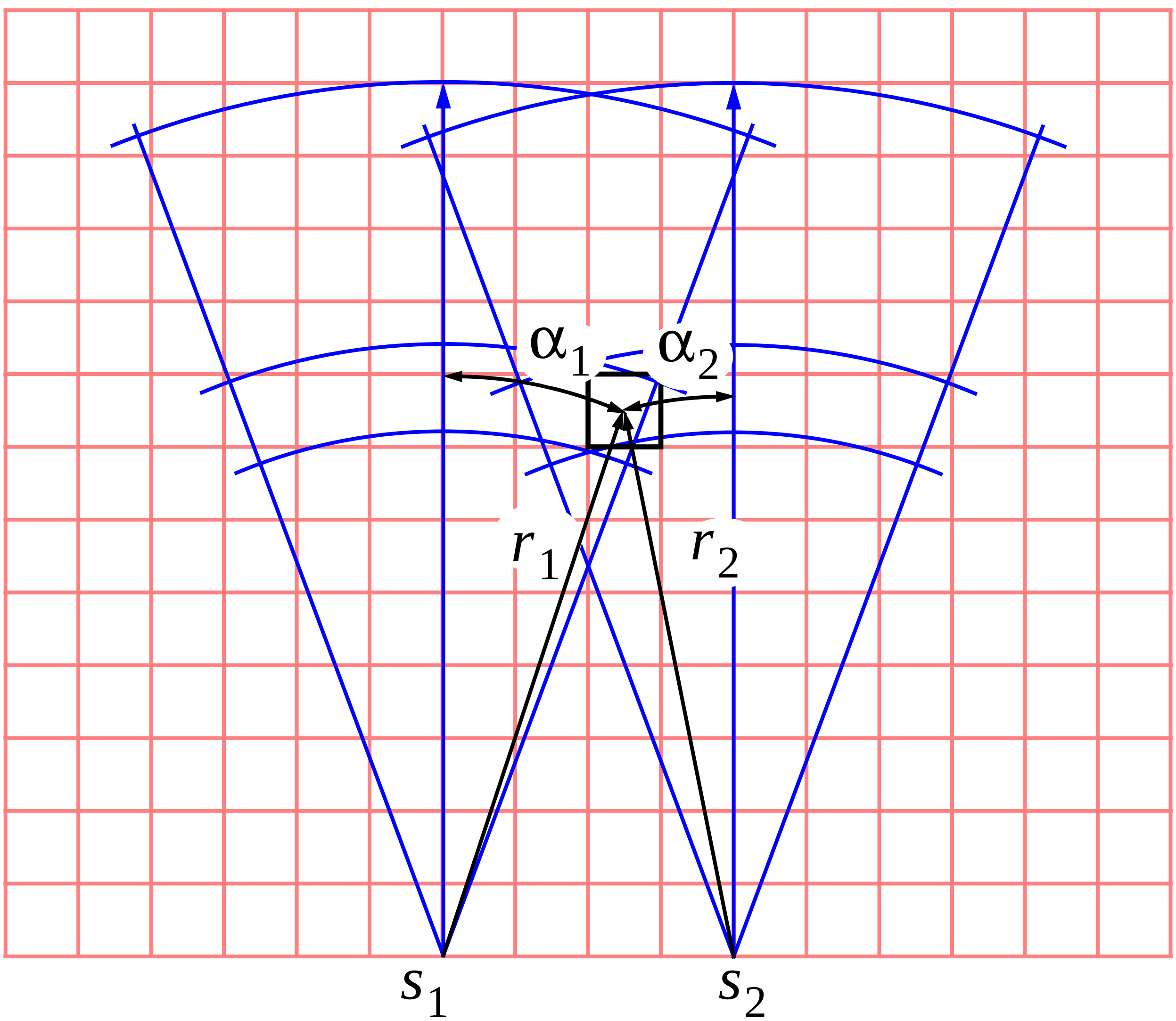
- Recursive form of Bayes Rule

$$\Pr(C|s_n) =$$

$$\frac{\Pr(s_n|C)\Pr(C|s_{n-1})}{\Pr(s_n|C)\Pr(C|s_{n-1}) + \Pr(s_n|\bar{C})\Pr(\bar{C}|s_{n-1})}$$

Sensor Fusion

- Fusing the information from two readings



Sensor Fusion (continued)

- Initialization and adding the first reading

$$s_1 = (r_1, \alpha_1) = (6, 5)$$

$$\Pr(C) = \Pr(\bar{C}) = 0.5$$

- From the sensor model for cells in Region I

$$\Pr(s_1|C) = \frac{\left(\frac{10-6}{10}\right) + \left(\frac{15-5}{15}\right)}{2} \times 0.98 = 0.52$$

$$\Pr(s_1|\bar{C}) = 0.48$$

- Applying Bayes Rule to update posterior

$$\Pr(C|s_1) = \frac{\Pr(s_1|C)\Pr(C)}{\Pr(s_1|C)\Pr(C) + \Pr(s_1|\bar{C})\Pr(\bar{C})} =$$

$$\frac{0.52 \times 0.5}{0.52 \times 0.5 + 0.48 \times 0.5} = 0.52$$

$$\Pr(\bar{C}|s_1) = 0.48$$

Sensor Fusion (continued)

- Adding the second reading

  $s_2 = (r_2, \alpha_2) = (6, 4)$

- From the sensor model for cells in Region I

$$\Pr(s_2|C) = \frac{\left(\frac{10-6}{10}\right) + \left(\frac{15-4}{15}\right)}{2} \times 0.98 = 0.56$$

$$\Pr(s_2|\bar{C}) = 0.44$$

- Applying Bayes Rule to update posterior

$$\Pr(C|s_2) = \frac{\Pr(s_2|C)\Pr(C|s_1)}{\Pr(s_2|C)\Pr(C|s_1) + \Pr(s_2|\bar{C})\Pr(\bar{C}|s_1)} =$$

$$\frac{0.56 \times 0.52}{0.56 \times 0.52 + 0.44 \times 0.48} = 0.58$$

$$\Pr(\bar{C}|s_1) = 0.42$$