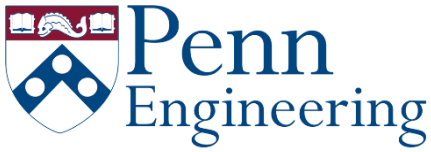
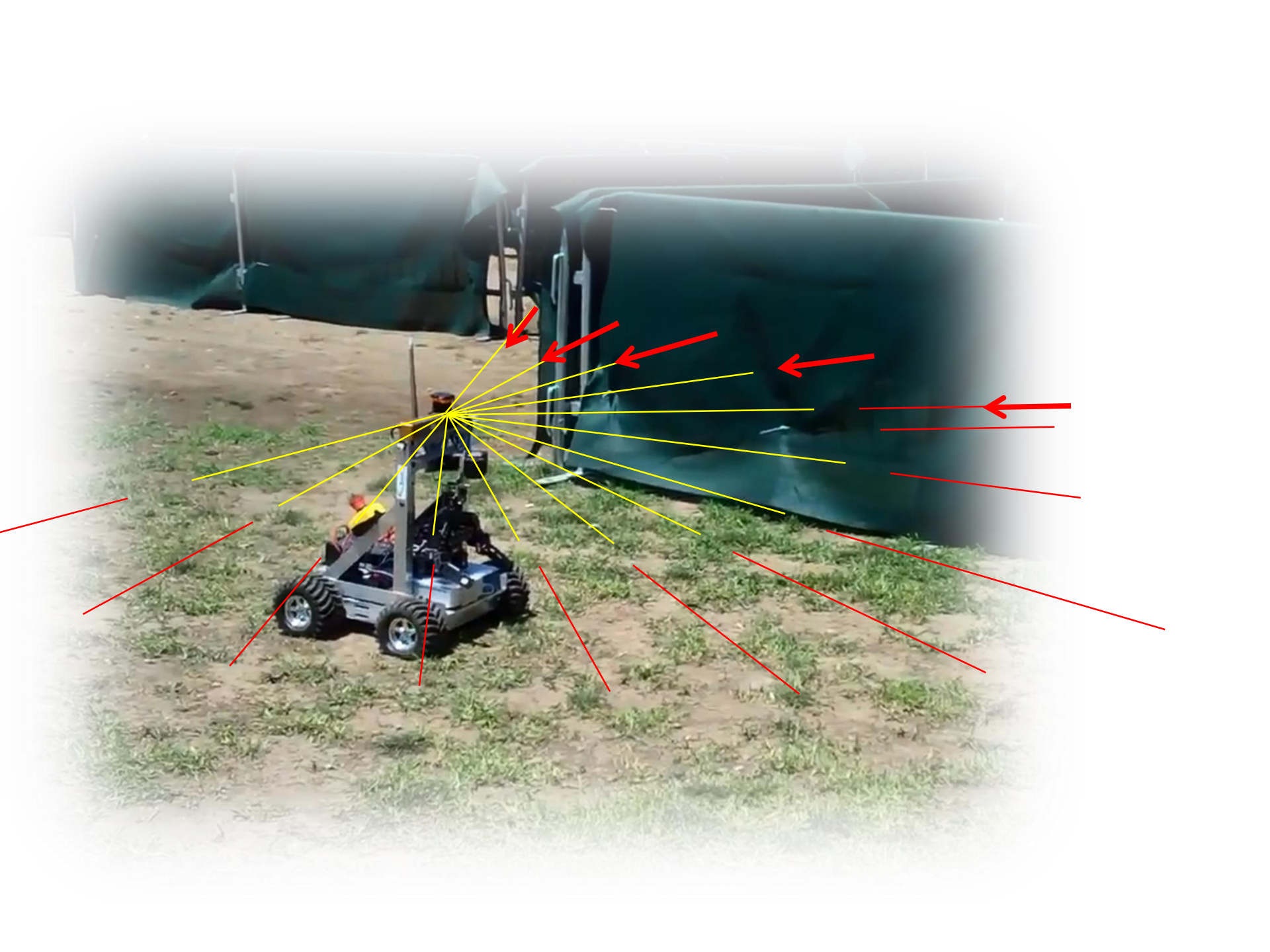
Robotics

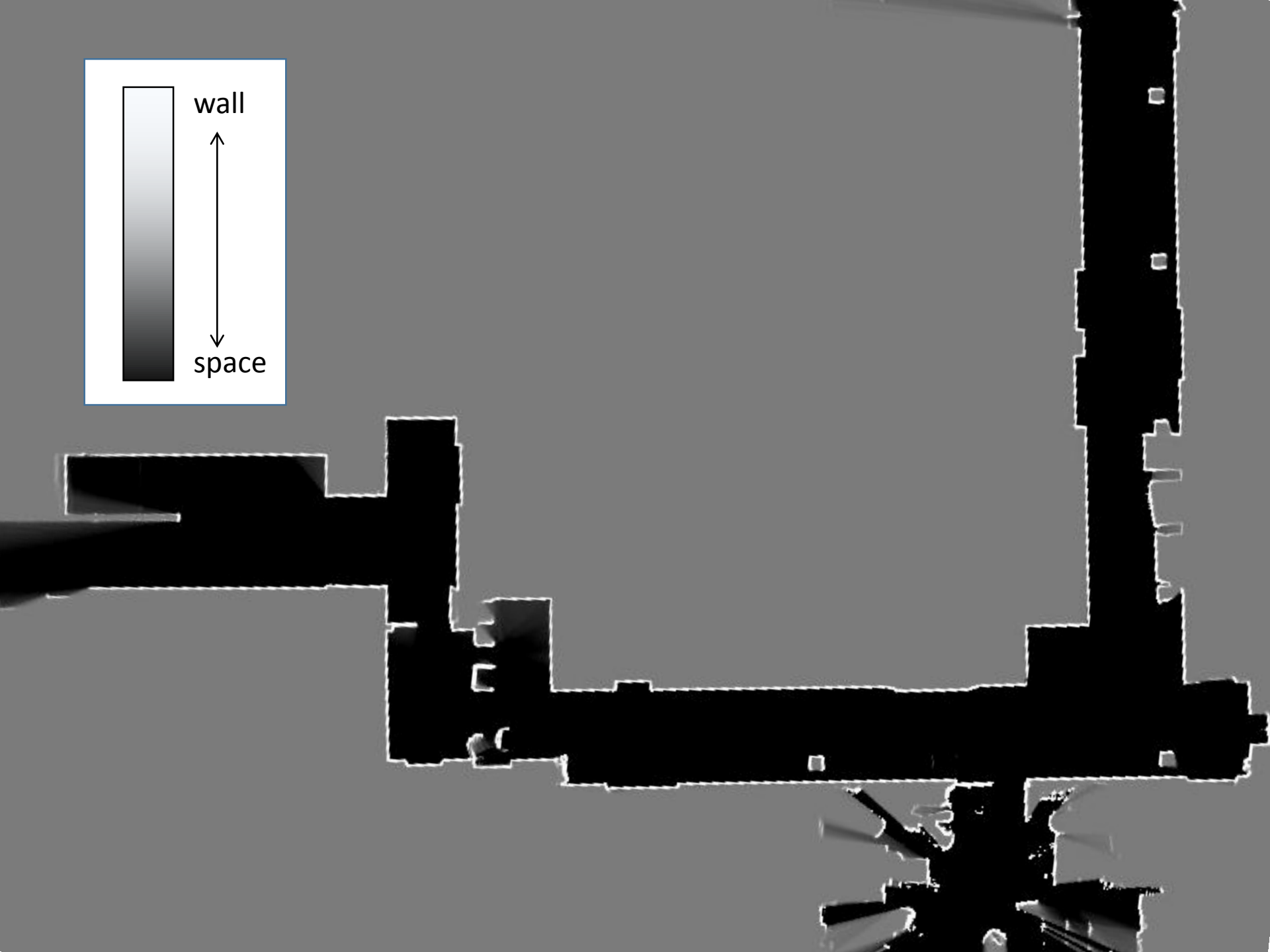
Estimation and Learning
with Dan Lee

Week 3.
Robotic Mapping

3.2 Occupancy Grid Mapping
3.2.1 Occupancy Grid Map






wall
space

Occupancy Grid Mapping

- Occupancy: binary R.V.

$m_{x,y}: \{free, occupied\} \rightarrow \{\, 0\, , 1\, \}$

[Review – Into Probability]

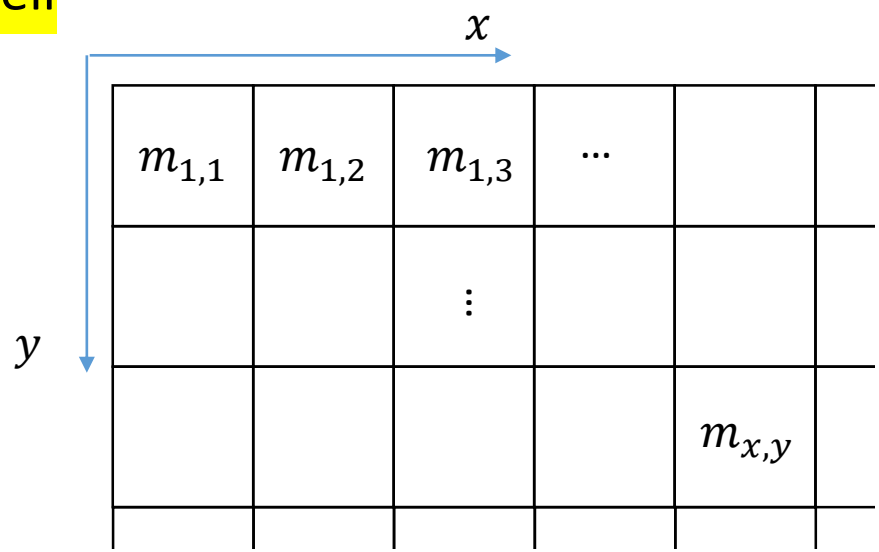
Given some probability space (Ω, P),
a **random variable** $X: \Omega \rightarrow R$ is a *function* that maps the sample space to the reals.

Occupancy Grid Mapping

- Occupancy: binary R.V.

  $m_{x,y}: \{free, occupied\} \rightarrow \{\, 0\,, 1\,\}$

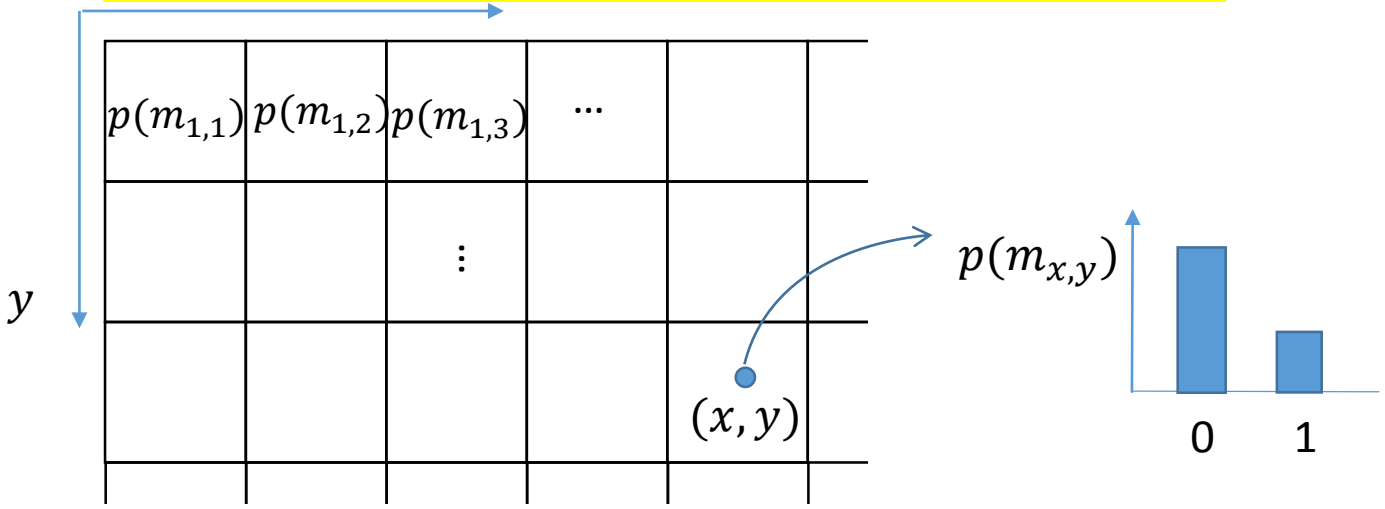
- Occupancy grid map
  : fine-grained grid map where an occupancy variable associated with each cell



Occupancy Grid Mapping

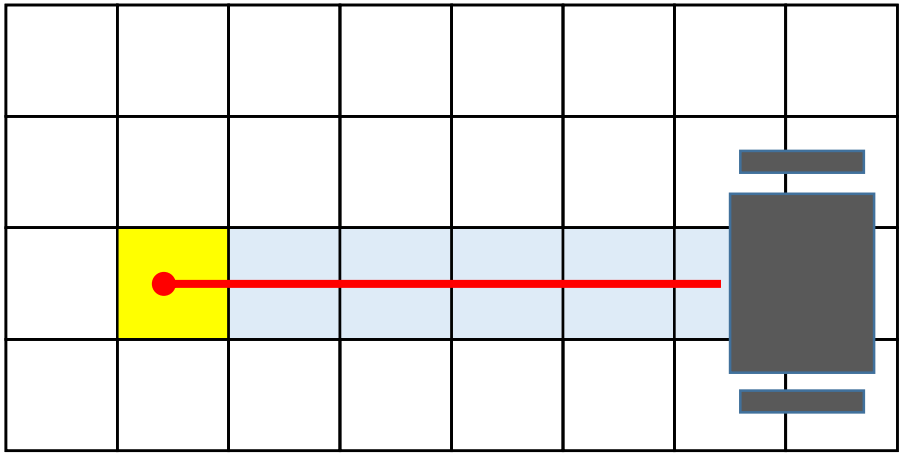
- Occupancy grid mapping
  : A Bayesian filtering to maintain a occupancy grid map.

Recursively update $p(m_{x,y})$ for each cell



Occupancy Grid Mapping

- Measurement



a range sensor

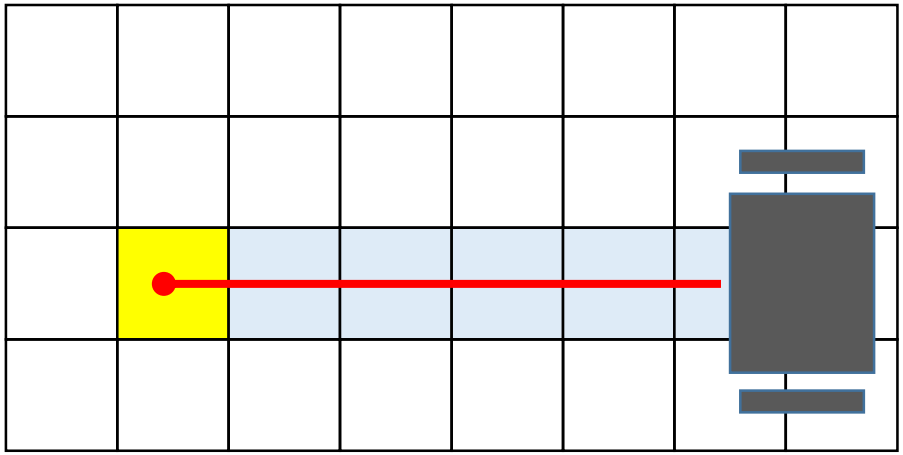
Occupancy Grid Mapping

- Measurement

Free

Occupied

$$z \sim \{0, 1\}$$



a range sensor

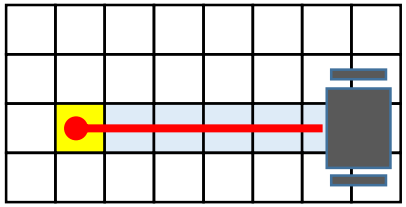
Occupancy Grid Mapping

- Measurement

Free

Occupied

$$z \sim \{0, 1\}$$



- Measurement model

$$p(z|m_{x,y})$$

$p(z = 1|m_{x,y} = 1)$: True **occupied** measurement

$p(z = 0|m_{x,y} = 1)$: False **free** measurement

$p(z = 1|m_{x,y} = 0)$: False **occupied** measurement

$p(z = 0|m_{x,y} = 0)$: True **free** measurement

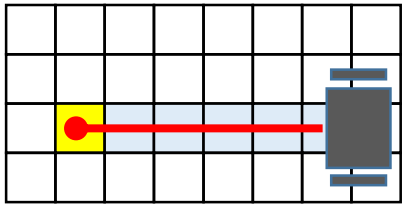
Occupancy Grid Mapping

- Measurement

Free

Occupied

$$z \sim \{0, 1\}$$



- Measurement model

$$p(z|m_{x,y})$$

[Review – Into Probability]

$$P(A^C|B) = 1 - P(A|B)$$

$$p(z = 1|m_{x,y} = 1)$$

$$p(z = 0|m_{x,y} = 1) = 1 - p(z = 1|m_{x,y} = 1)$$

$$p(z = 1|m_{x,y} = 0)$$

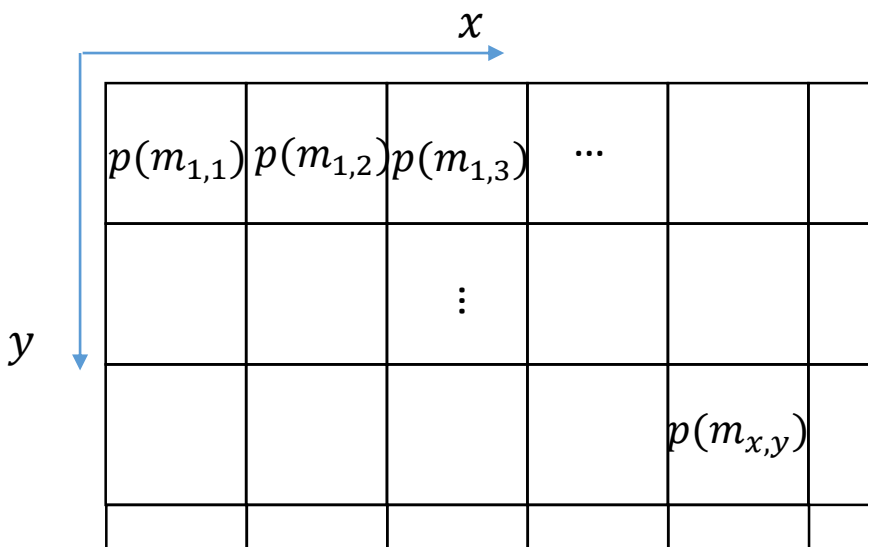
$$p(z = 0|m_{x,y} = 0) = 1 - p(z = 1|m_{x,y} = 0)$$

Occupancy Grid Mapping

Measurement Model

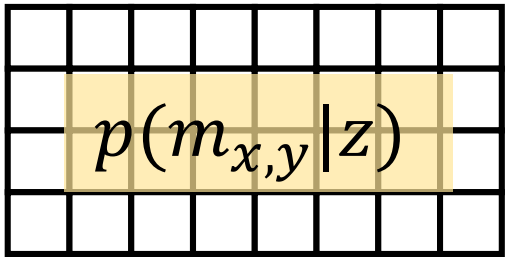
$$p(z|m_{x,y})$$

Map



Occupancy Grid Mapping

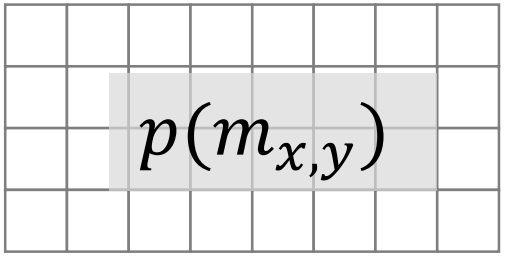
Posterior Map



Measurement Model

$p(z|m_{x,y})$

Prior Map



Likelihood Prior

Posterior

$$p(m_{x,y}|z) = \frac{p(z|m_{x,y})p(m_{x,y})}{p(z)}$$

Evidence