Robotics
Estimation and Learning
with Dan Lee
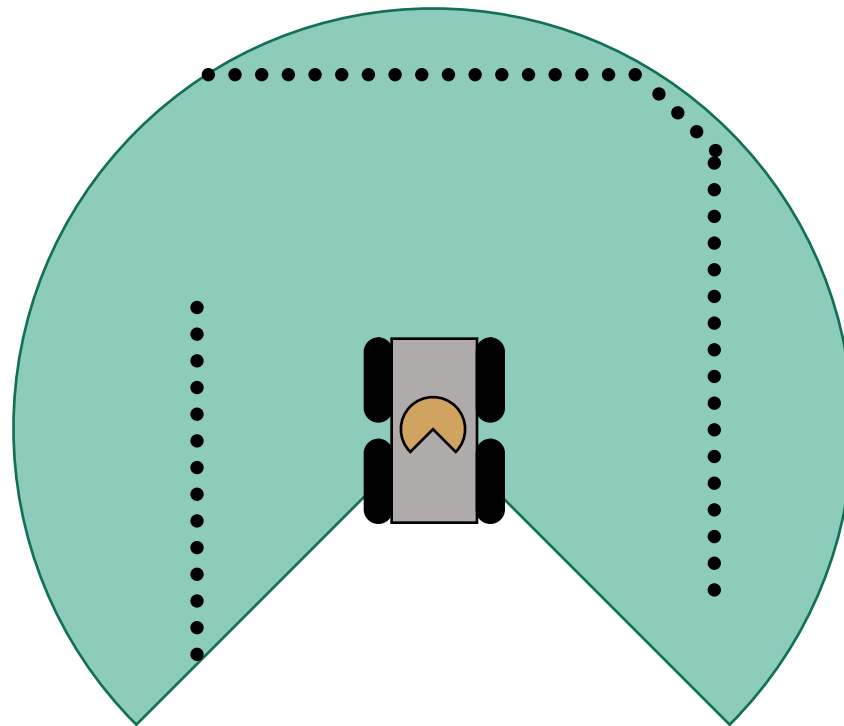
Week 4.
Localization

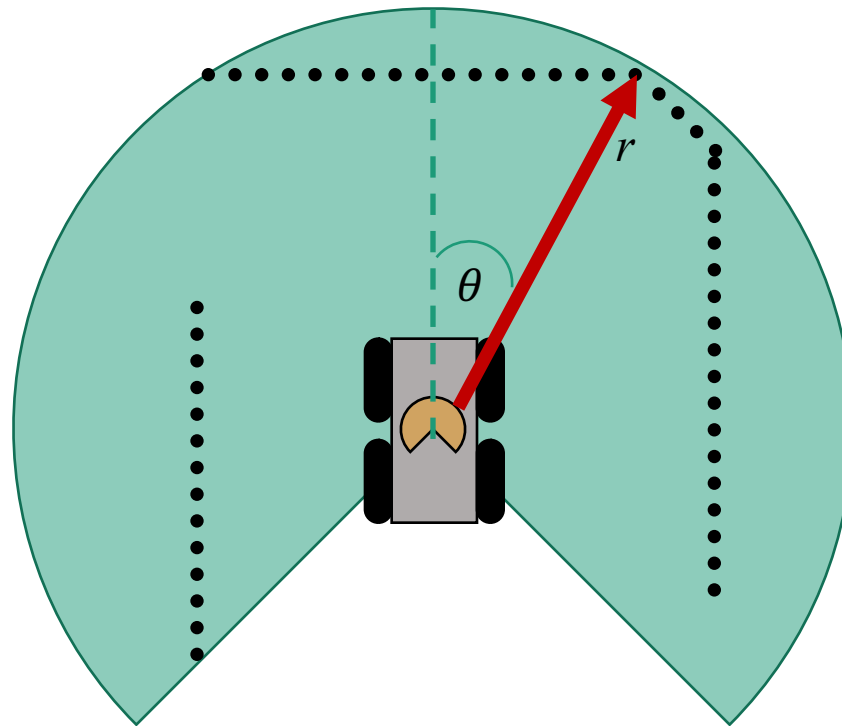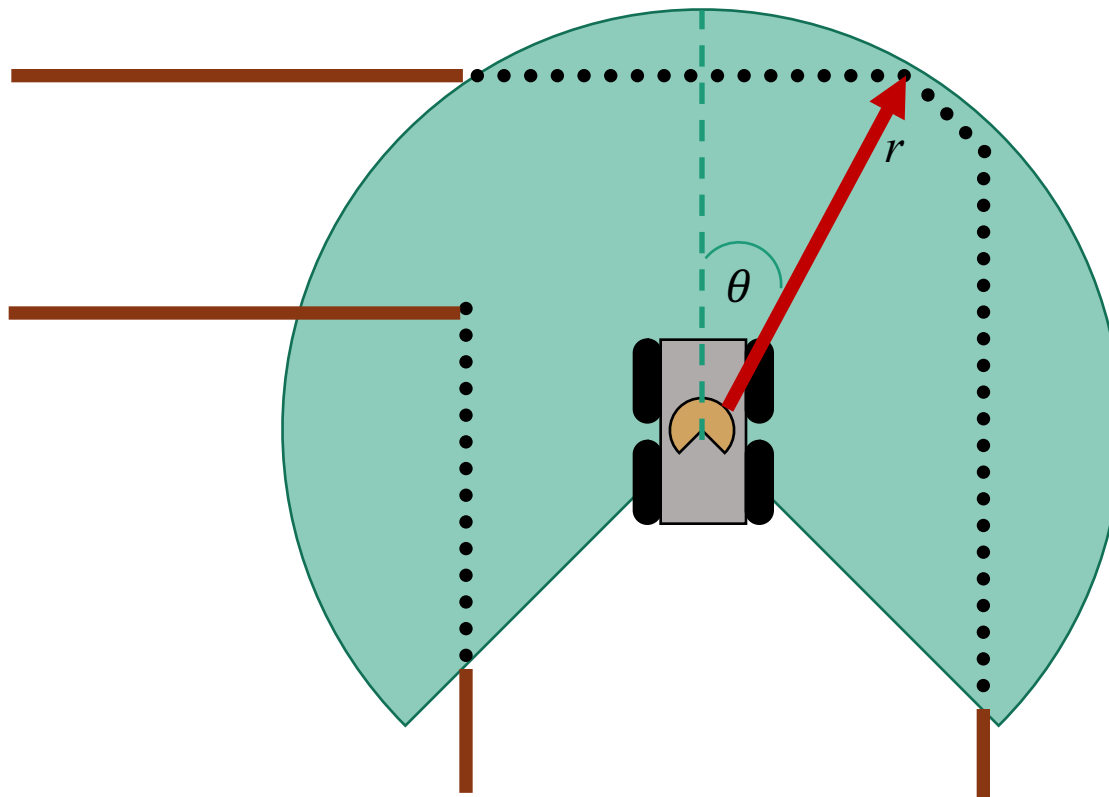# 4.2 Map Registration
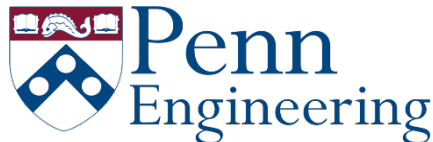
Penn Engineering

LIDAR Depth Sensor

- Depth measurements made in polar coordinates
- Continuous readings, r, at discrete angles, θ

LIDAR Depth Sensor

- Depth measurements made in polar coordinates
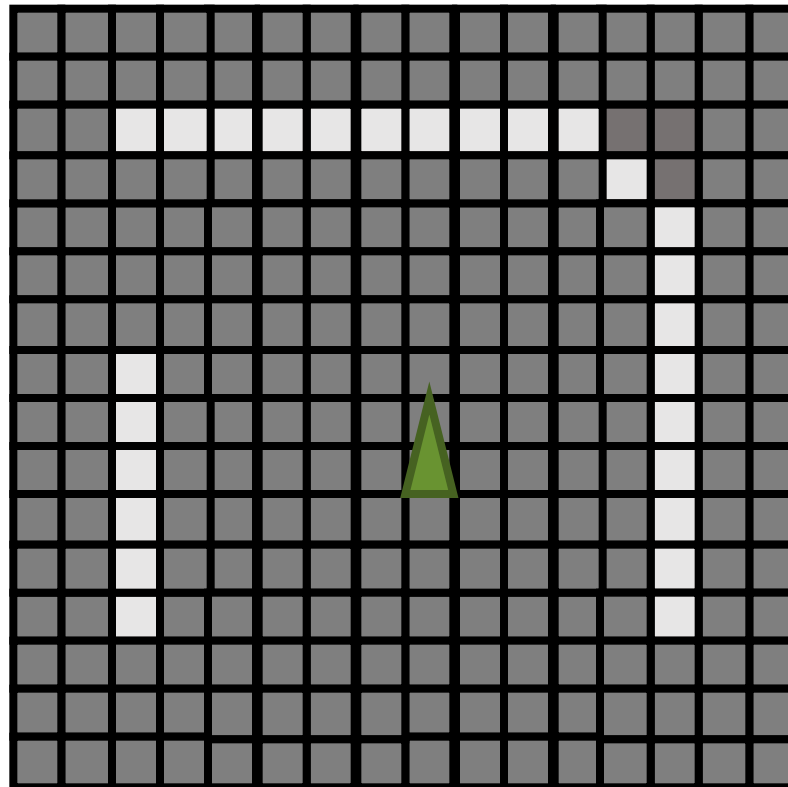- Continuous readings, r, at discrete angles, θ

LIDAR Depth Sensor

- Depth measurements made in polar coordinates
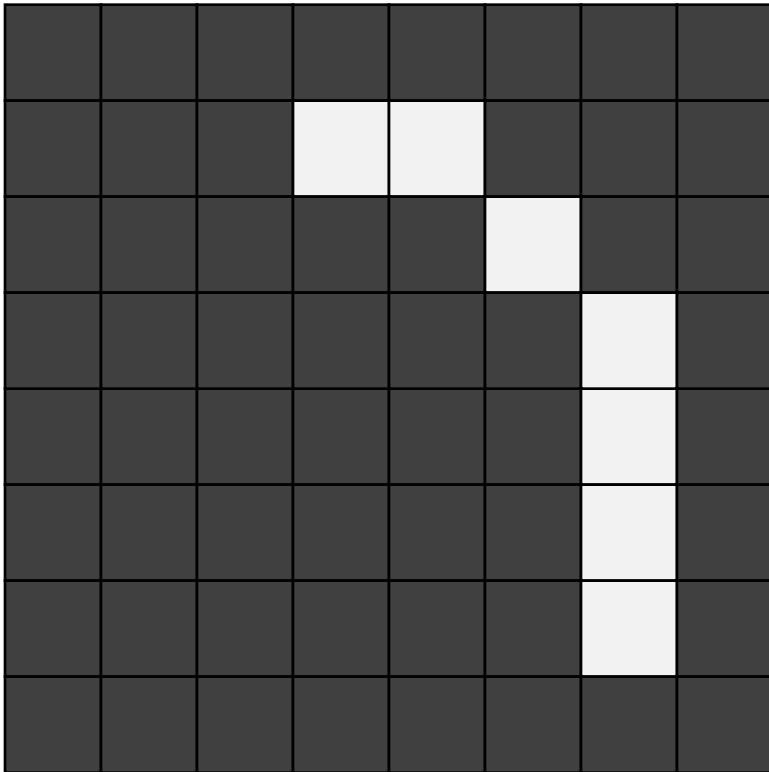- Continuous readings, r, at discrete angles, θ

Map Representation

- Discrete Grid representing 2D space *(see Week 3)*
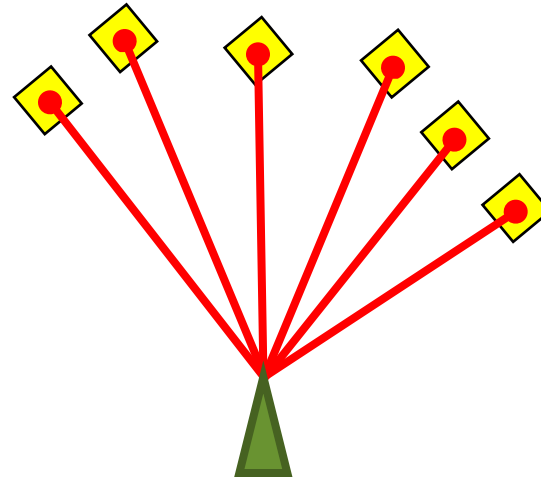- White cells represent the presence of an obstacle
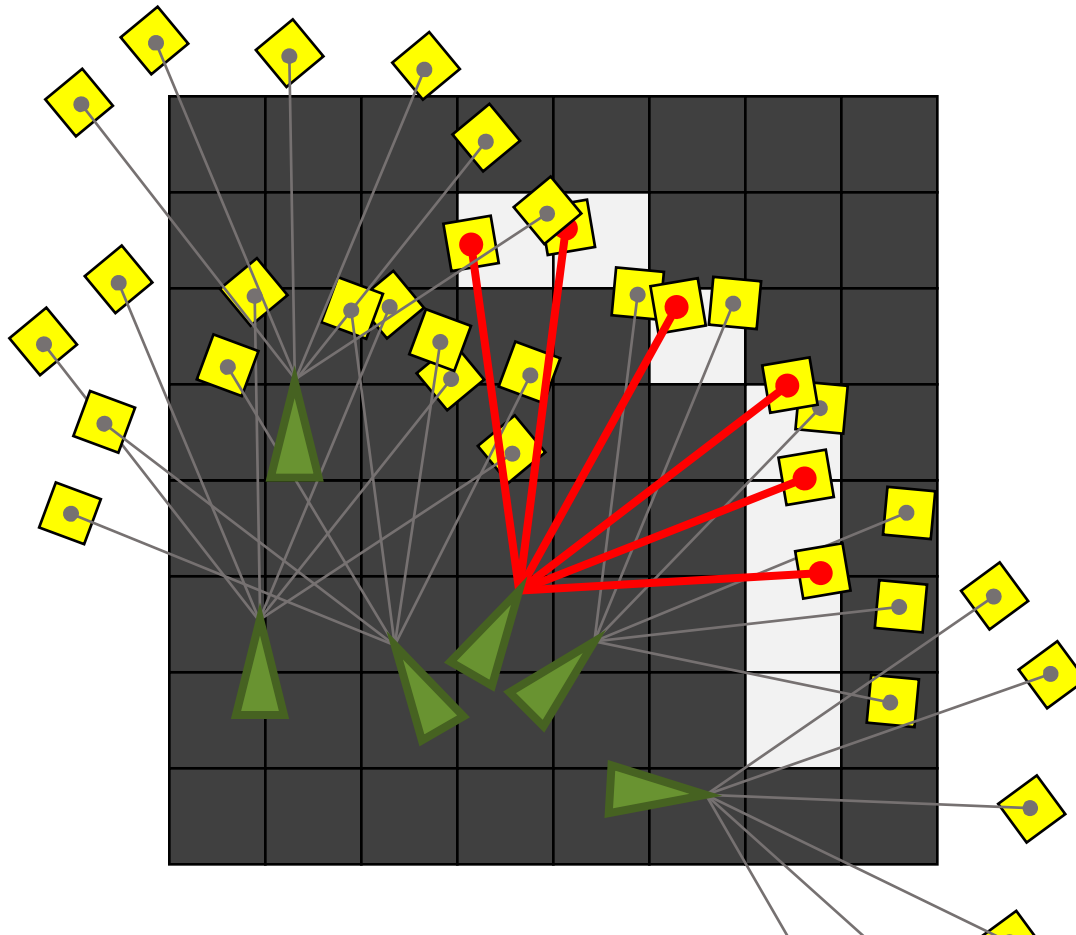
Map Measurements
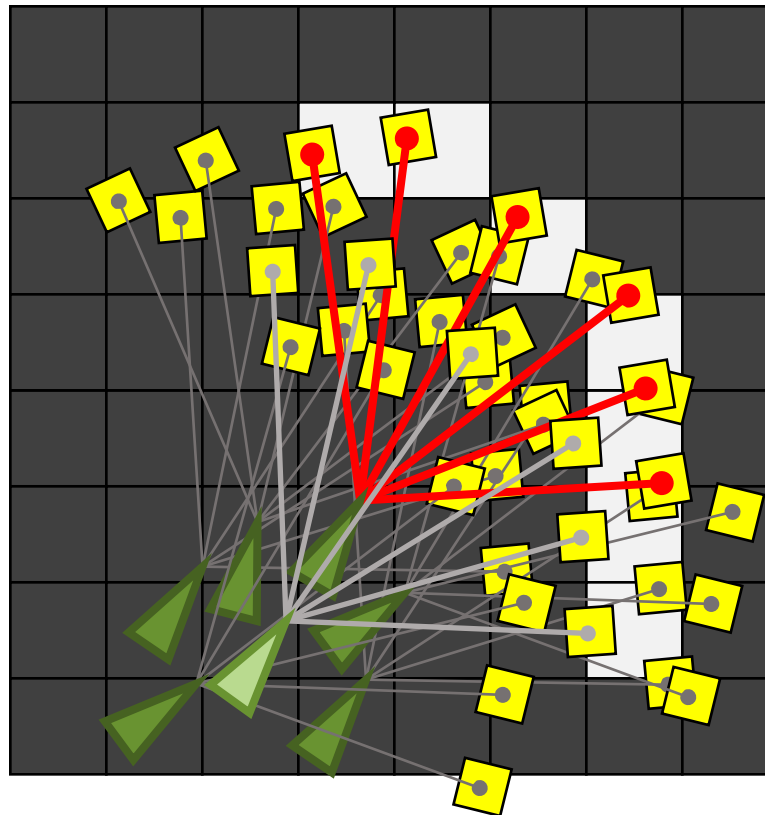
Map

Measurements

Map Registration

- Find robot pose that best explains the measurements

Map Registration

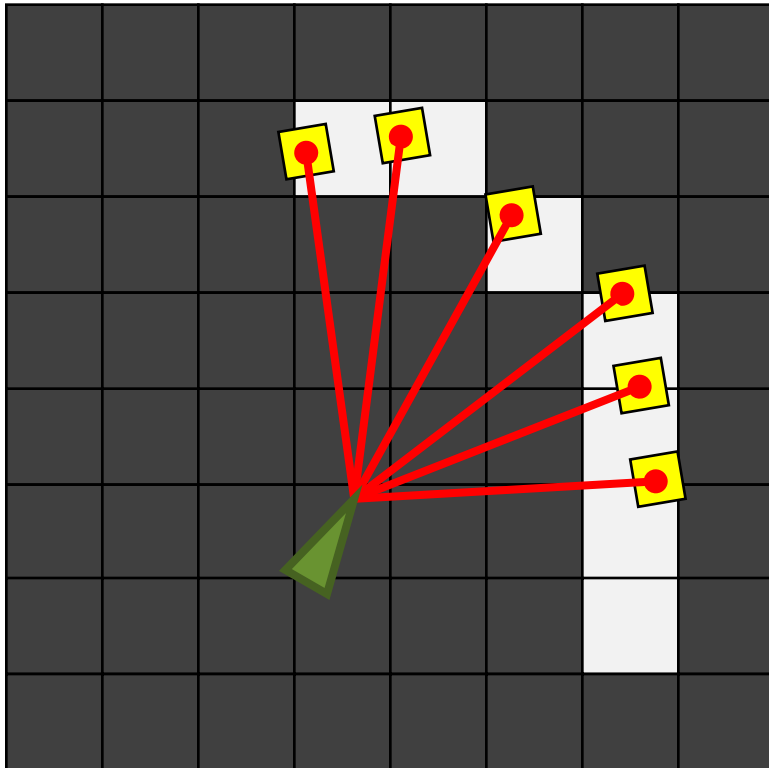- Find robot pose that best explains the measurements

Map Registration

- Correlate laser obstacles with map obstacles
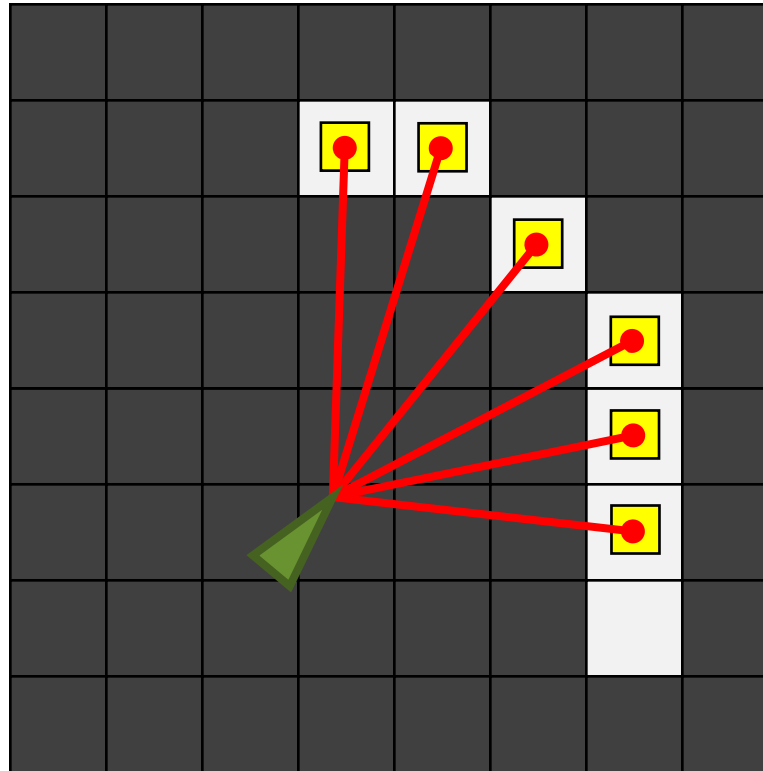- Correlate laser free space with map free space

$$\sum_r \delta\big(p_x + r\cos(p_\theta + r_\theta), p_y + r\sin(p_\theta + r_\theta)\big) \cdot m(x, y)$$
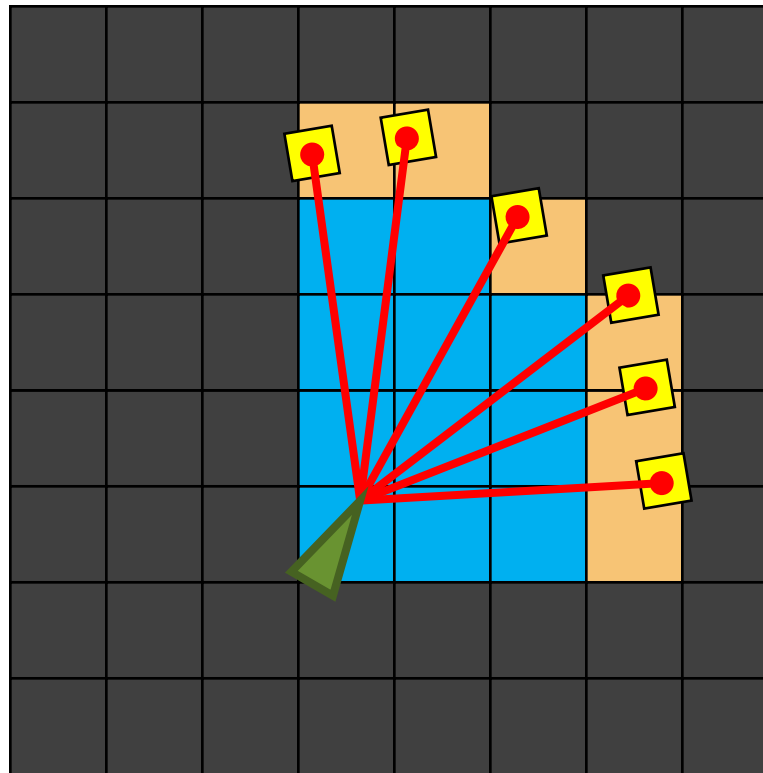
Map Registration

Find the best pose

$$\max_p \sum_r \delta\big(p_x + r\cos(p_\theta + r_\theta), p_y + r\sin(p_\theta + r_\theta)\big) \cdot m(x, y)$$

Map Registration

- Laser scans penetrate free space
- Laser scans return distance to obstacle

Map Registration

- Adding pose uncertainty