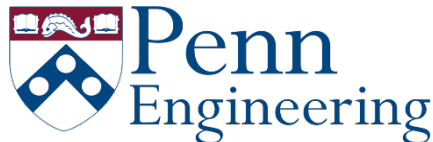


Robotics

Estimation and Learning
with Dan Lee

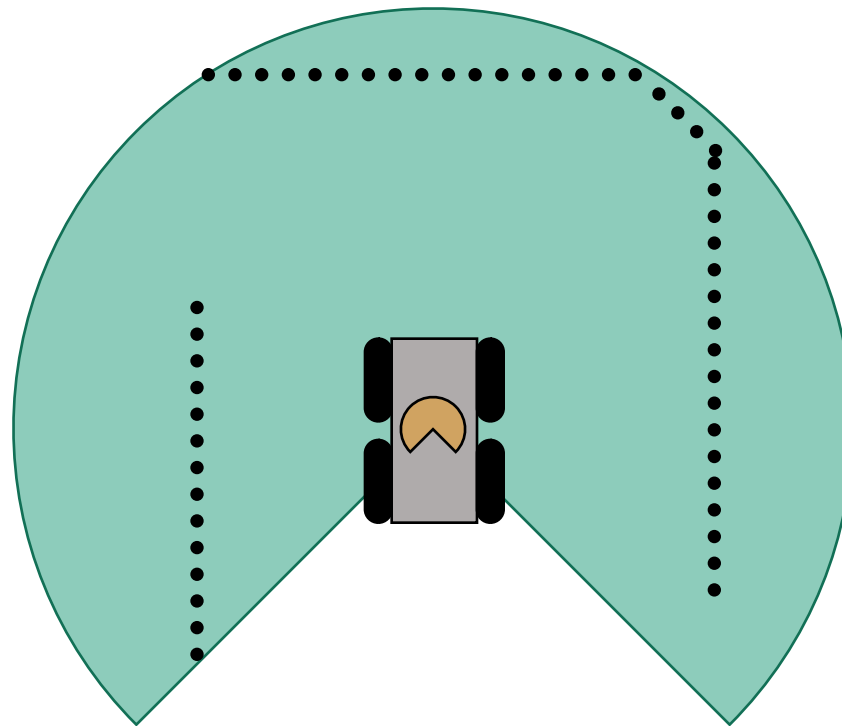
Week 4. Localization

4.2 Map Registration



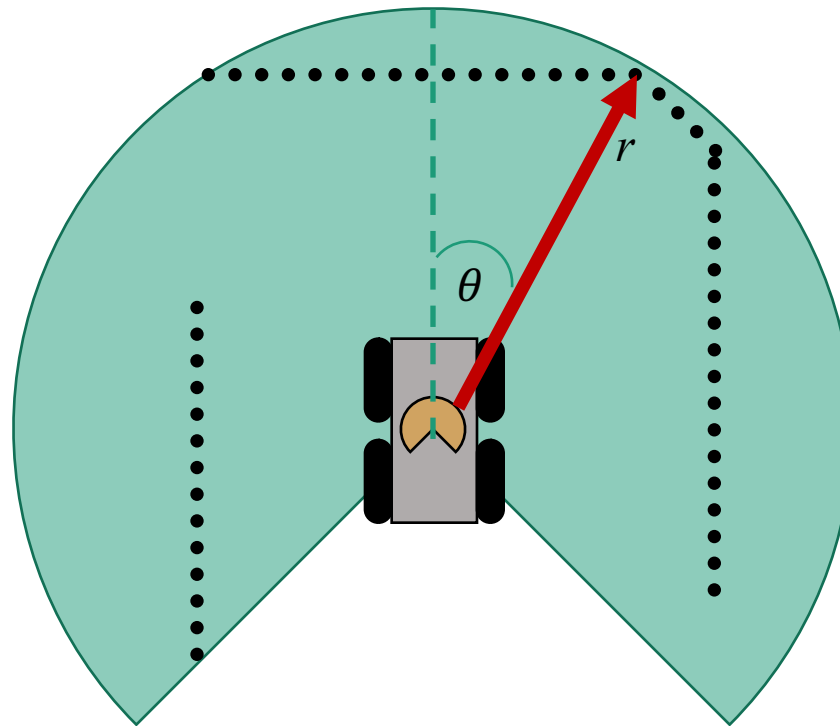
LIDAR Depth Sensor

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



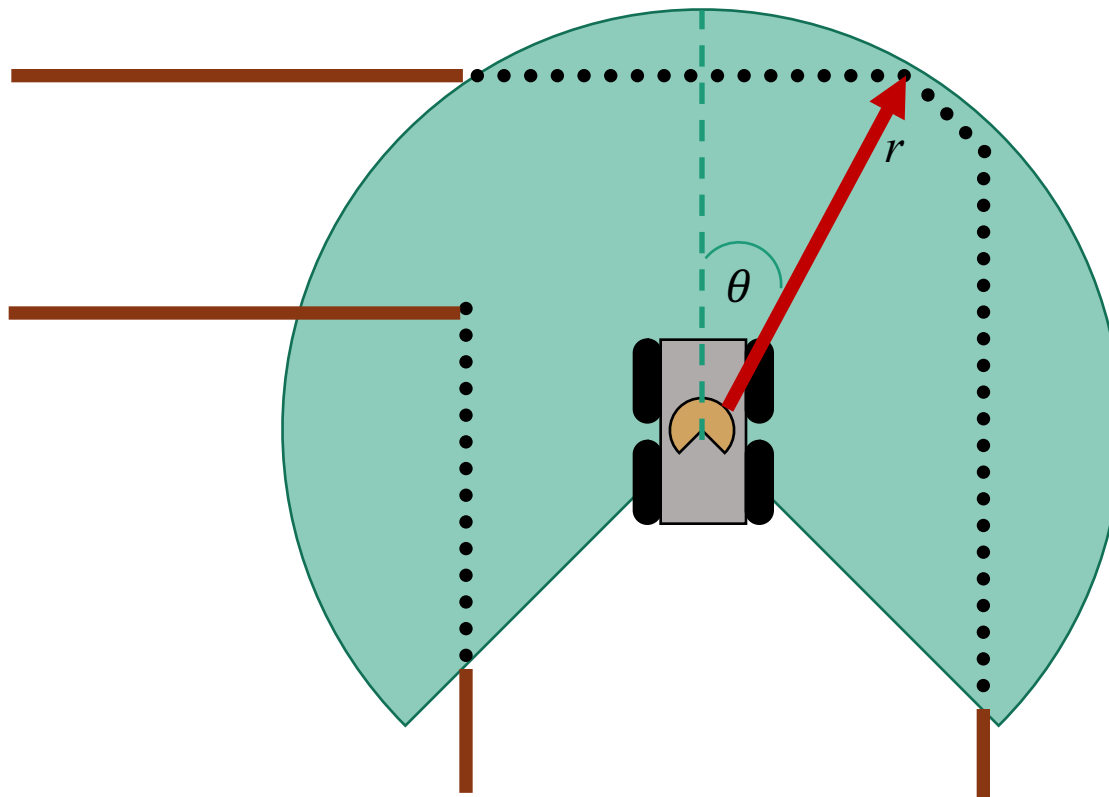
LIDAR Depth Sensor

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



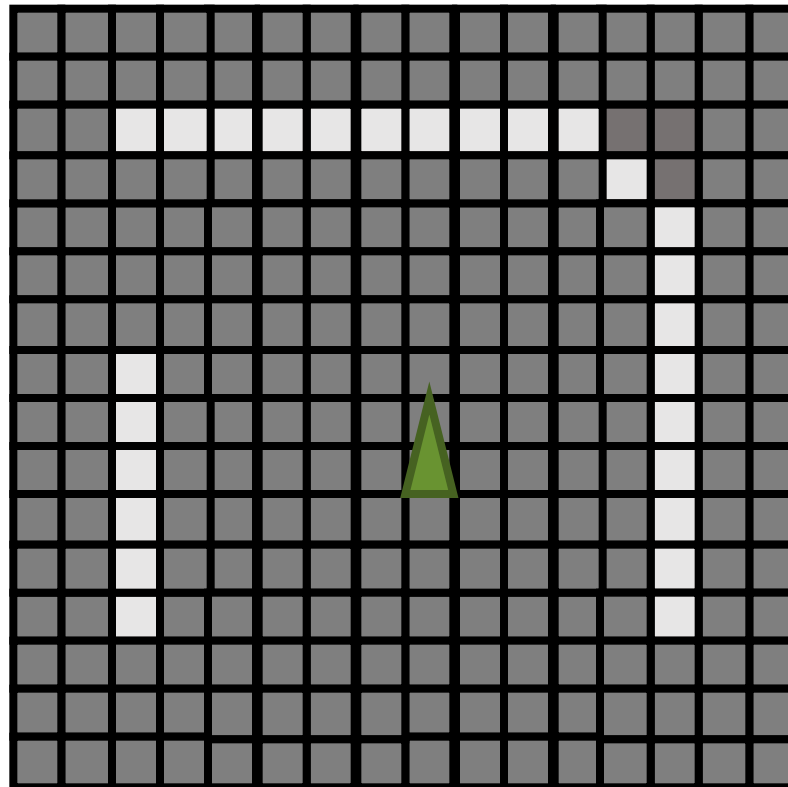
LIDAR Depth Sensor

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



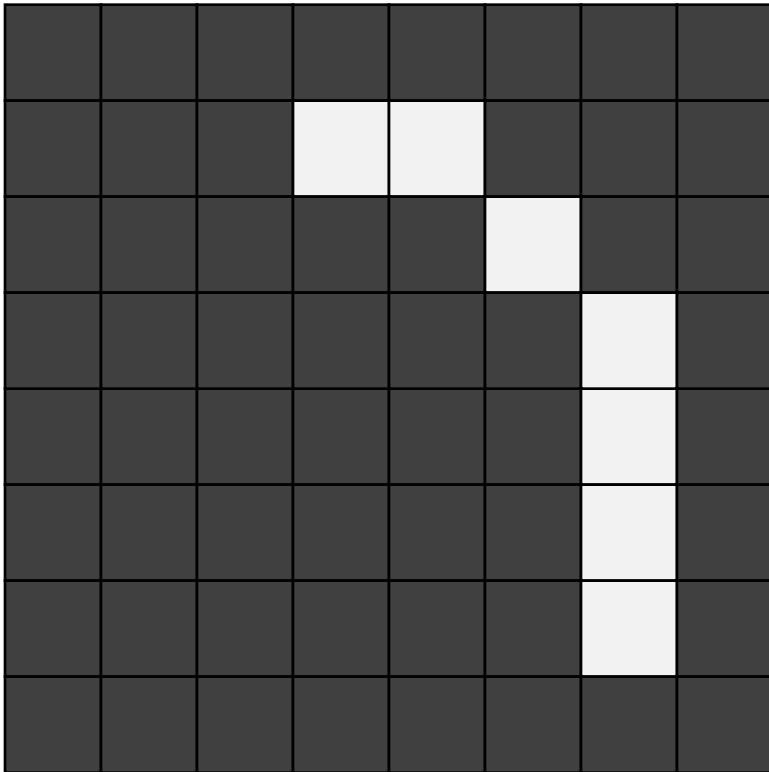
Map Representation

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

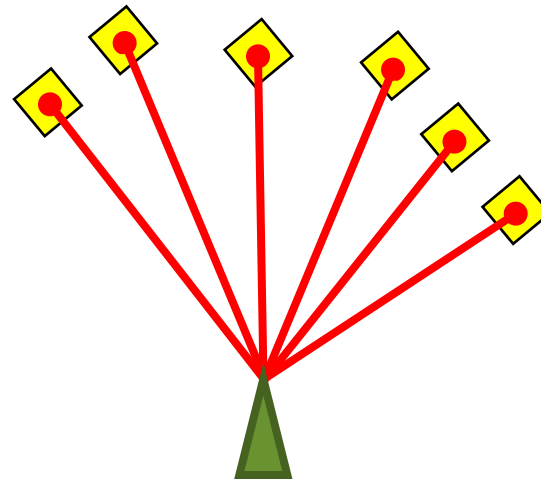


Map Measurements

Map

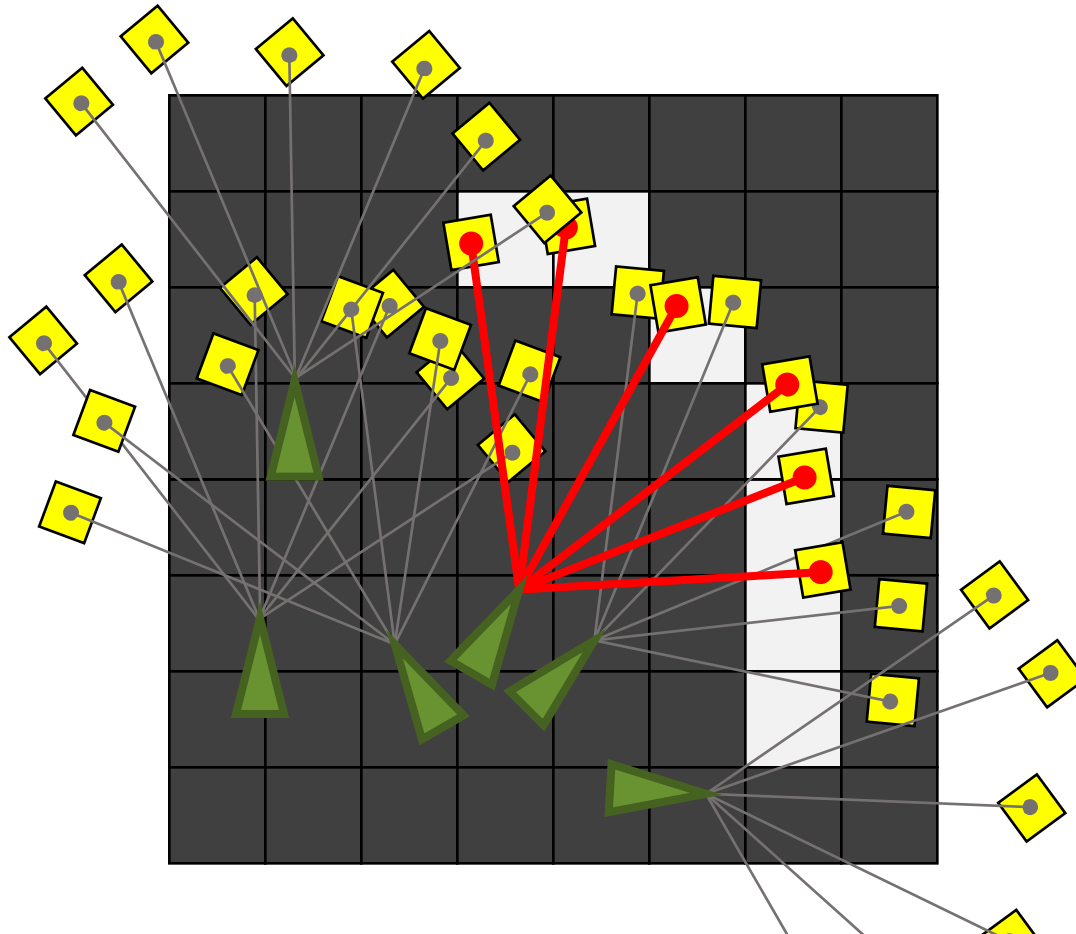


Measurements



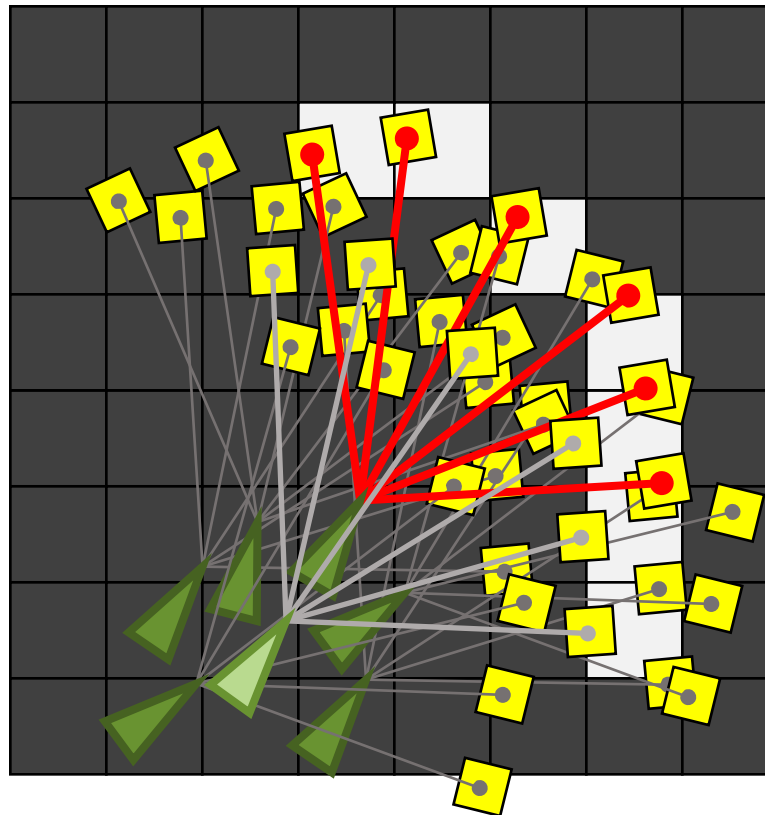
Map Registration

- Find robot pose that best explains the measurements



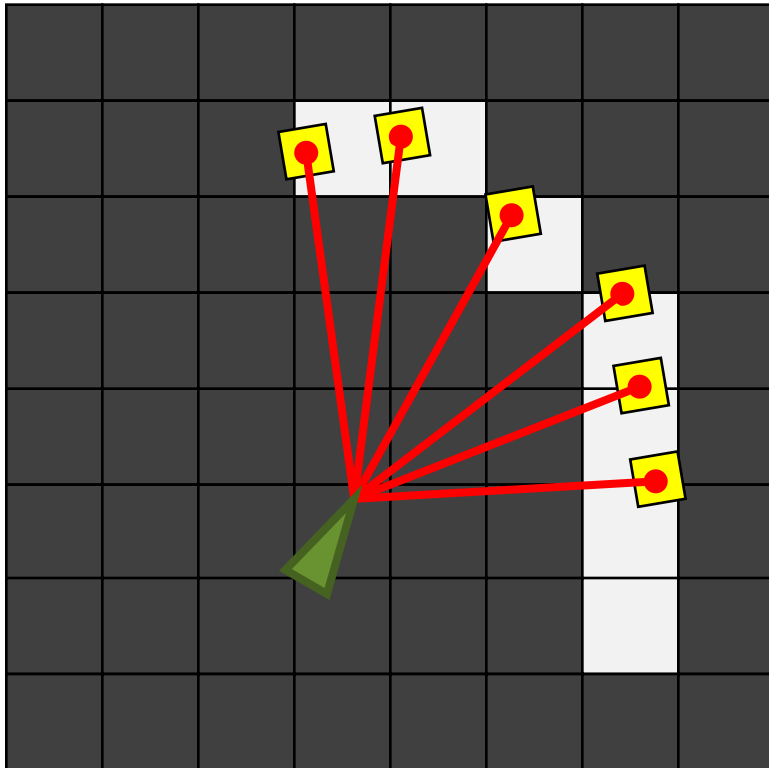
Map Registration

- Find robot pose that best explains the measurements



Map Registration

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

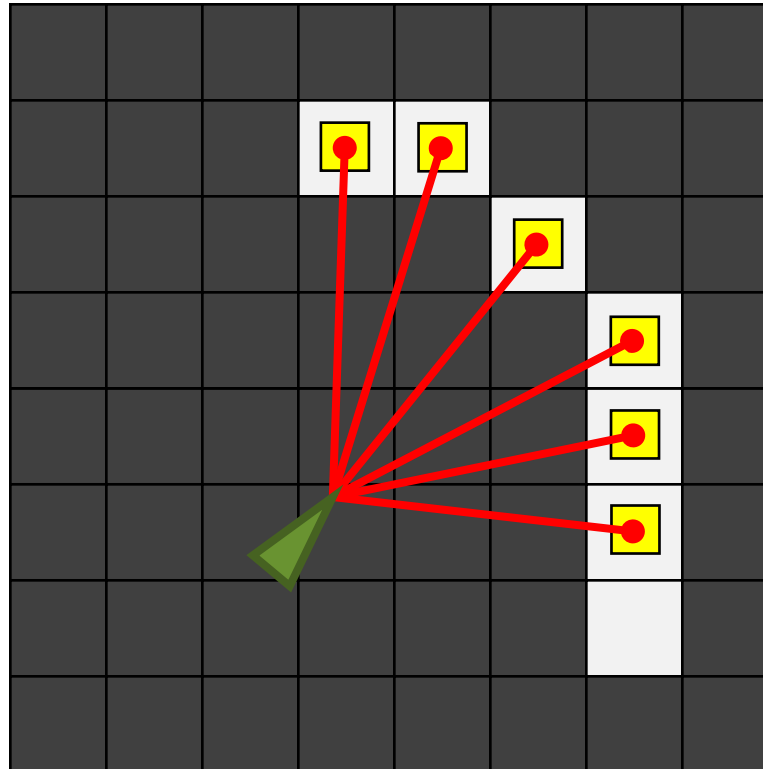


$$\sum_r \delta(p_x + r \cos(p_\theta + r_\theta), p_y + r \sin(p_\theta + r_\theta)) \cdot m(x, y)$$



Map Registration

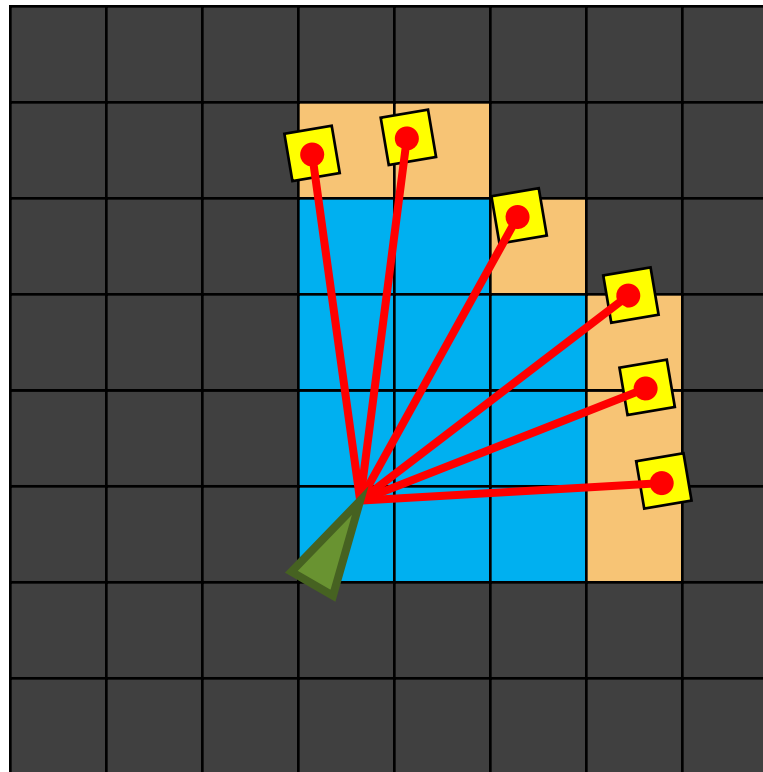
Find the best pose

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



Map Registration

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



Map Registration

- Adding pose uncertainty