Occupancy Grids

Course 4, Module 2, Lesson 1

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

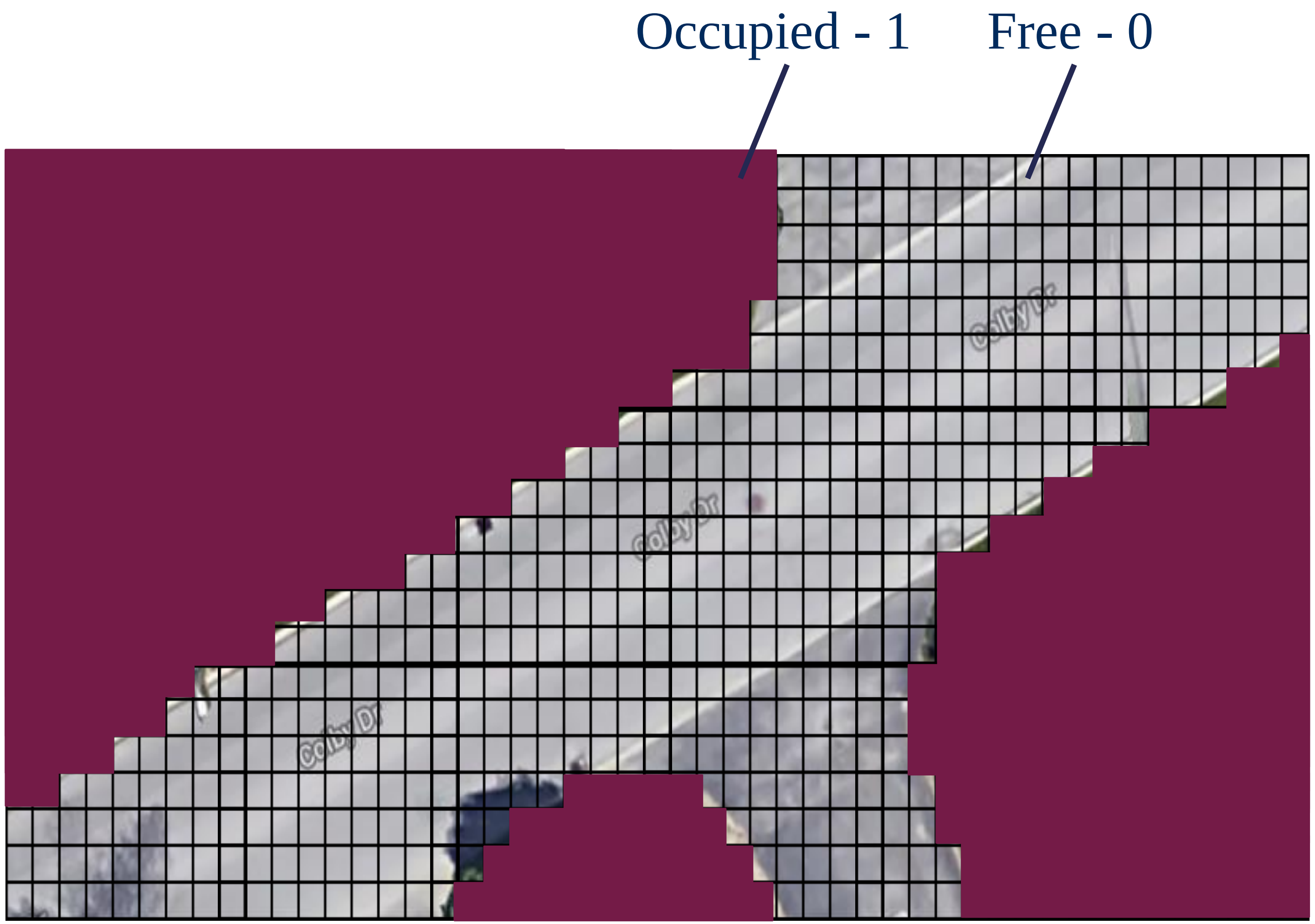
Learning Objectives

- Define occupancy grid
  - Creation of occupancy grid using autonomous car sensors
- Noise inherent to measurement data used to construct occupancy grid
- Handling noisy data by using Bayesian updates

Occupancy Grid

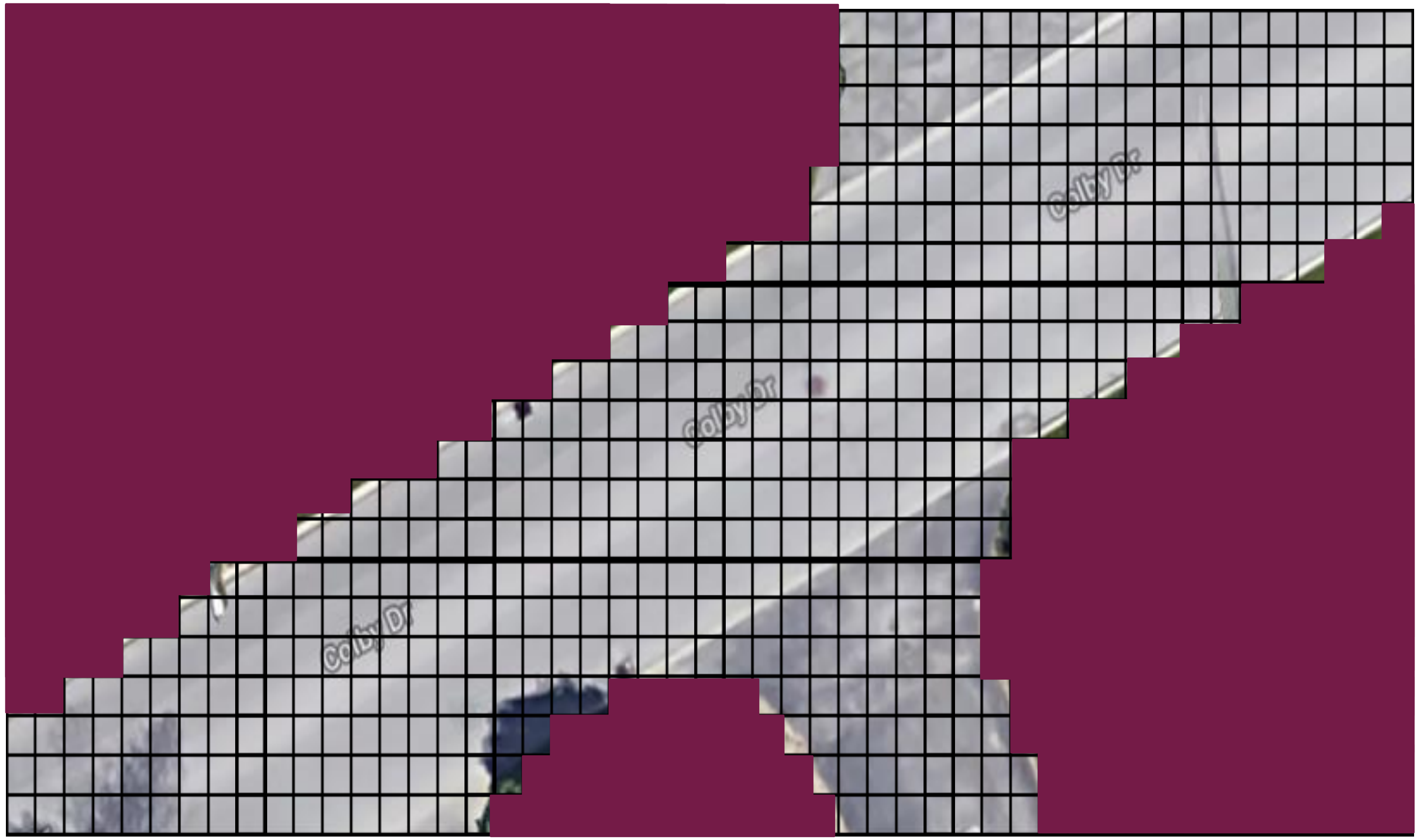
- Discretized fine grain grid map
  - Which can be 2D or 3D
- Occupancy by a static object
  - Trees and buildings
  - Curbs and other non drivable surfaces
- Each cell is a binary value

$$m^i \in \{0,1\}$$

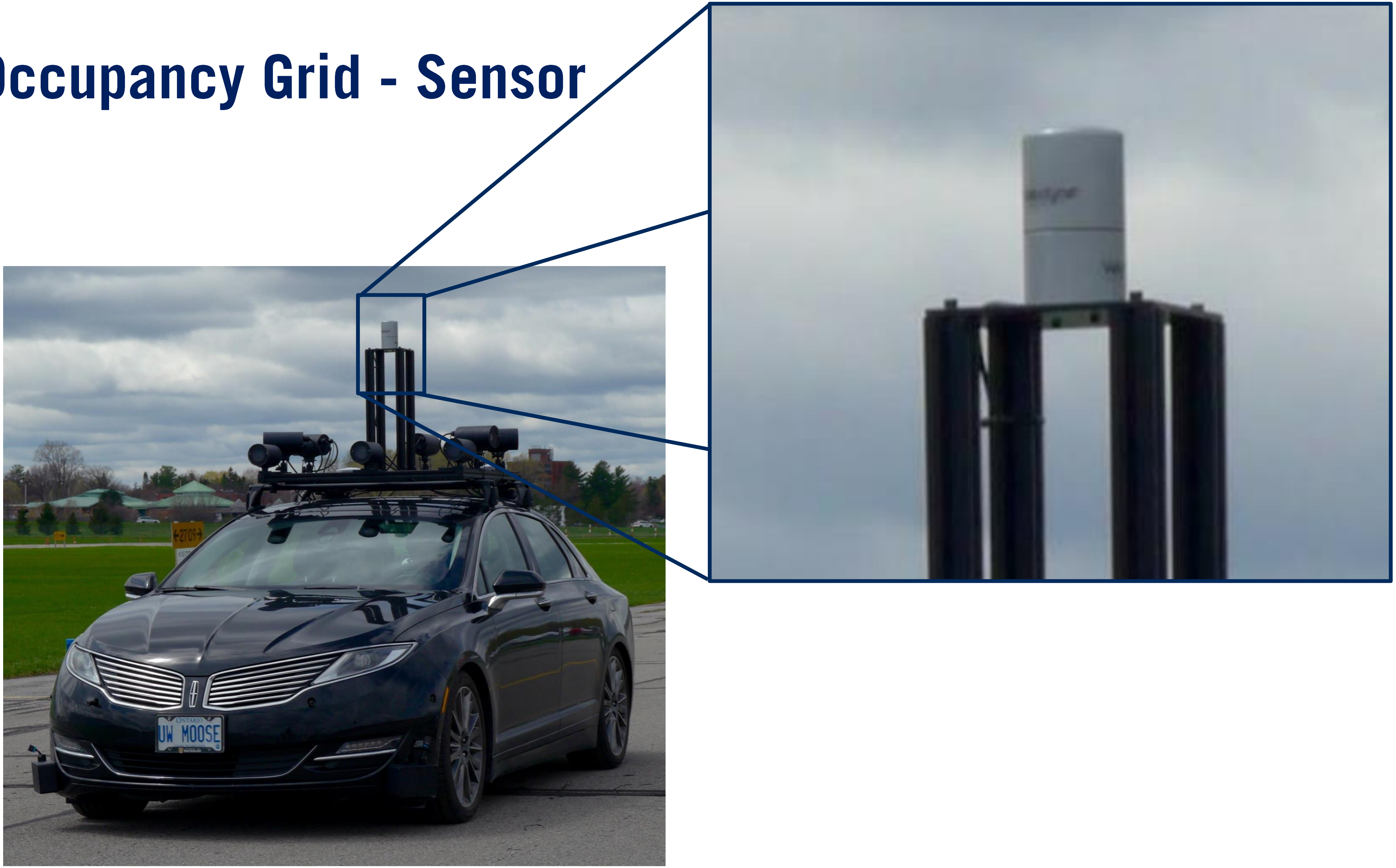


Assumption of Occupancy Grid

- Static environment
- Independence of each cell
- Known vehicle state at each time step

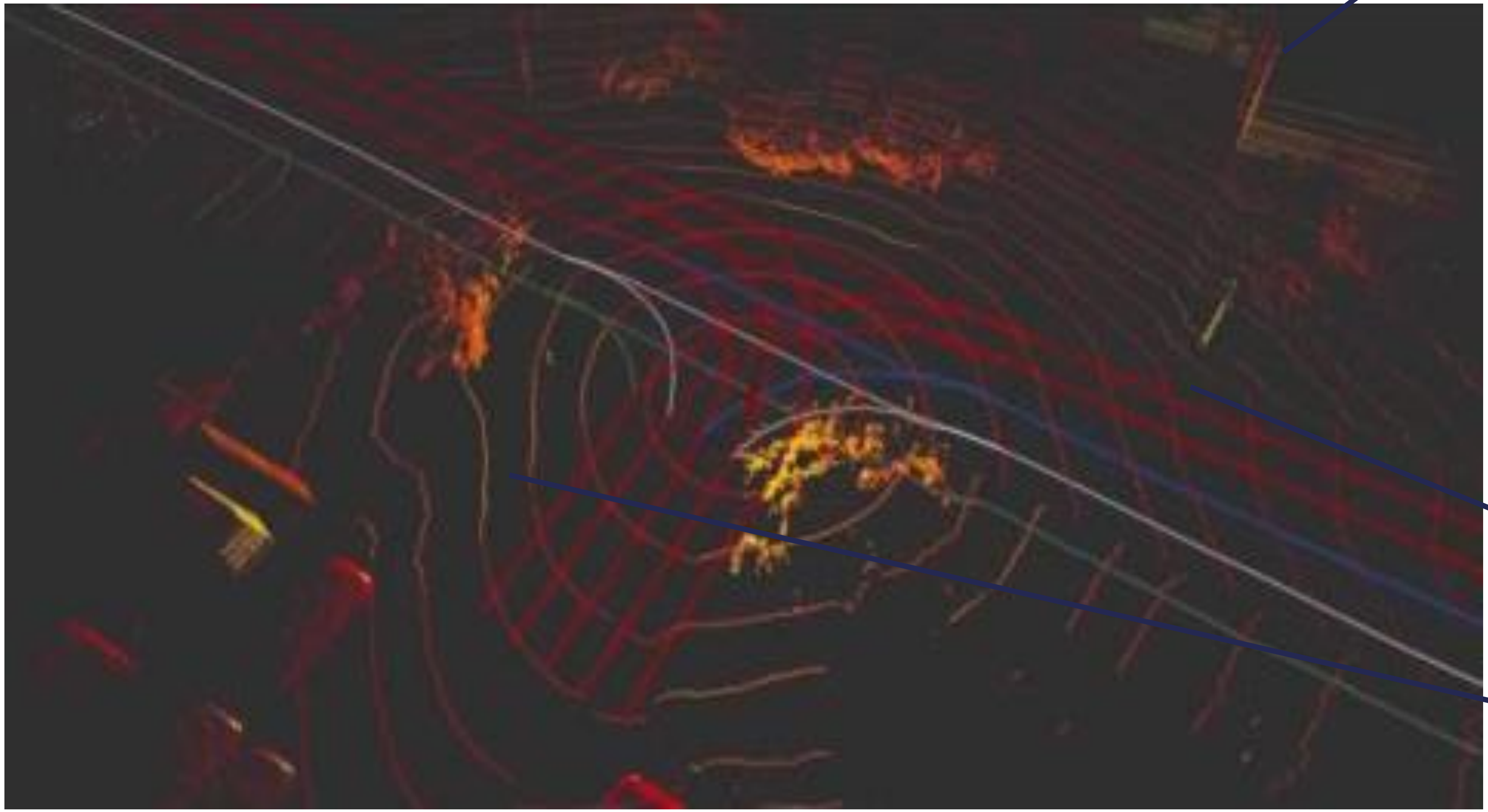


Occupancy Grid - Sensor



LIDAR Data Filtering

Projection onto a 2D plane



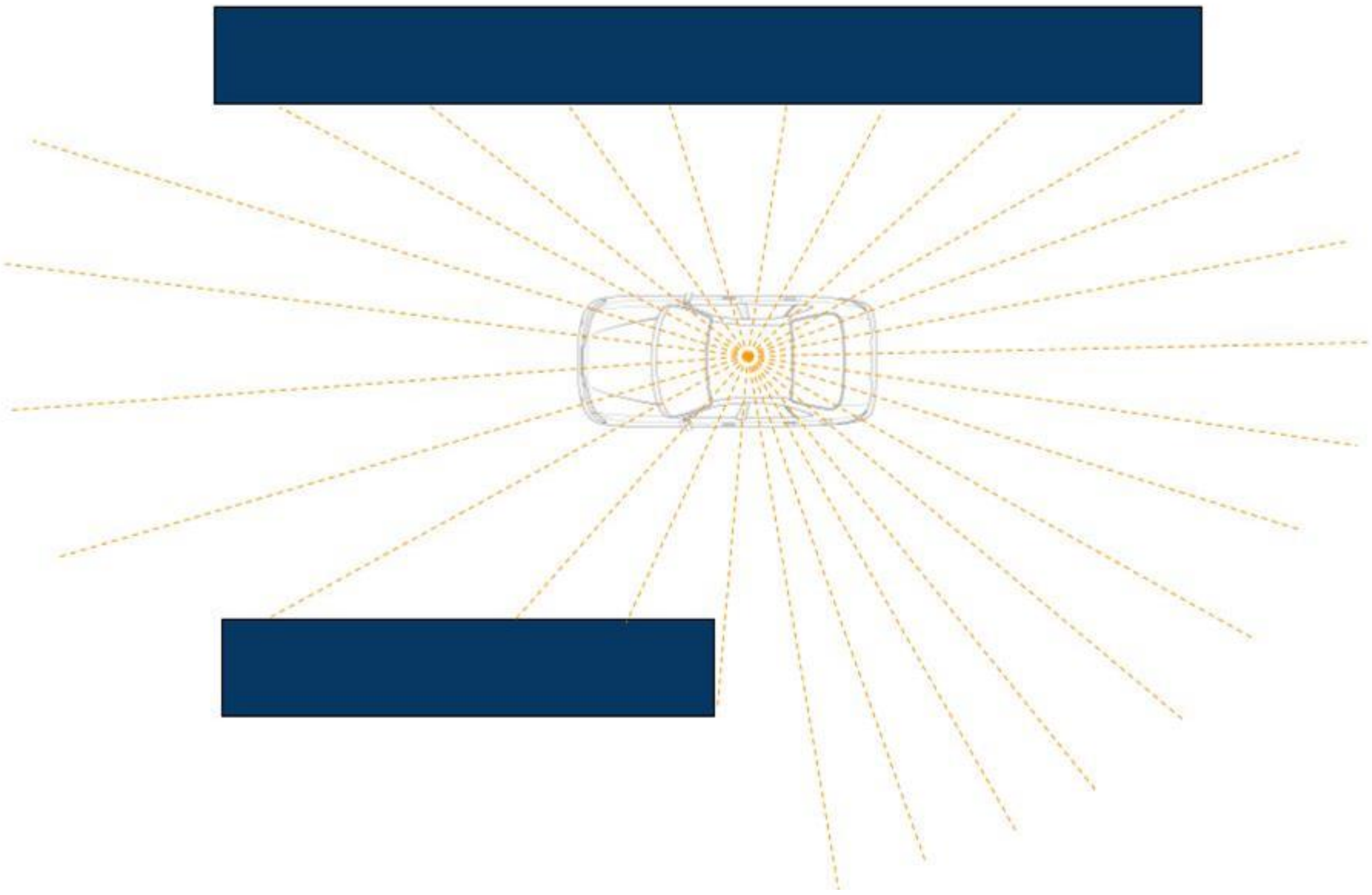
Objects above car height

Ground Plane

Dynamic Objects

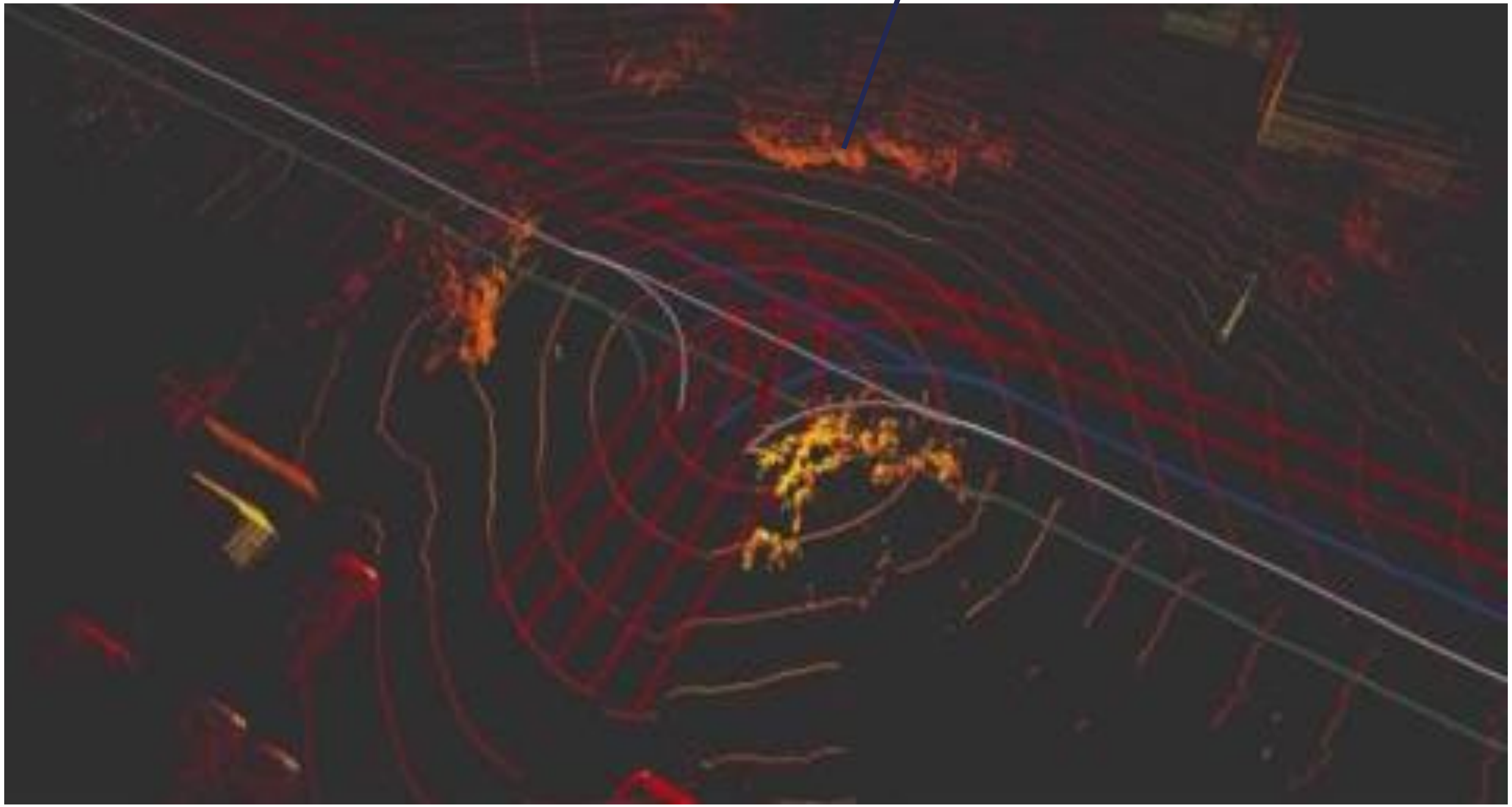
Range Sensor

- 2D range sensor measuring distance to static objects



LIDAR Data Noise

Sensor Noise



Map
Uncertainties

Probabilistic Occupancy Grid

- Probability of occupancy will be stored

$$m^i \in \{0,1\}$$

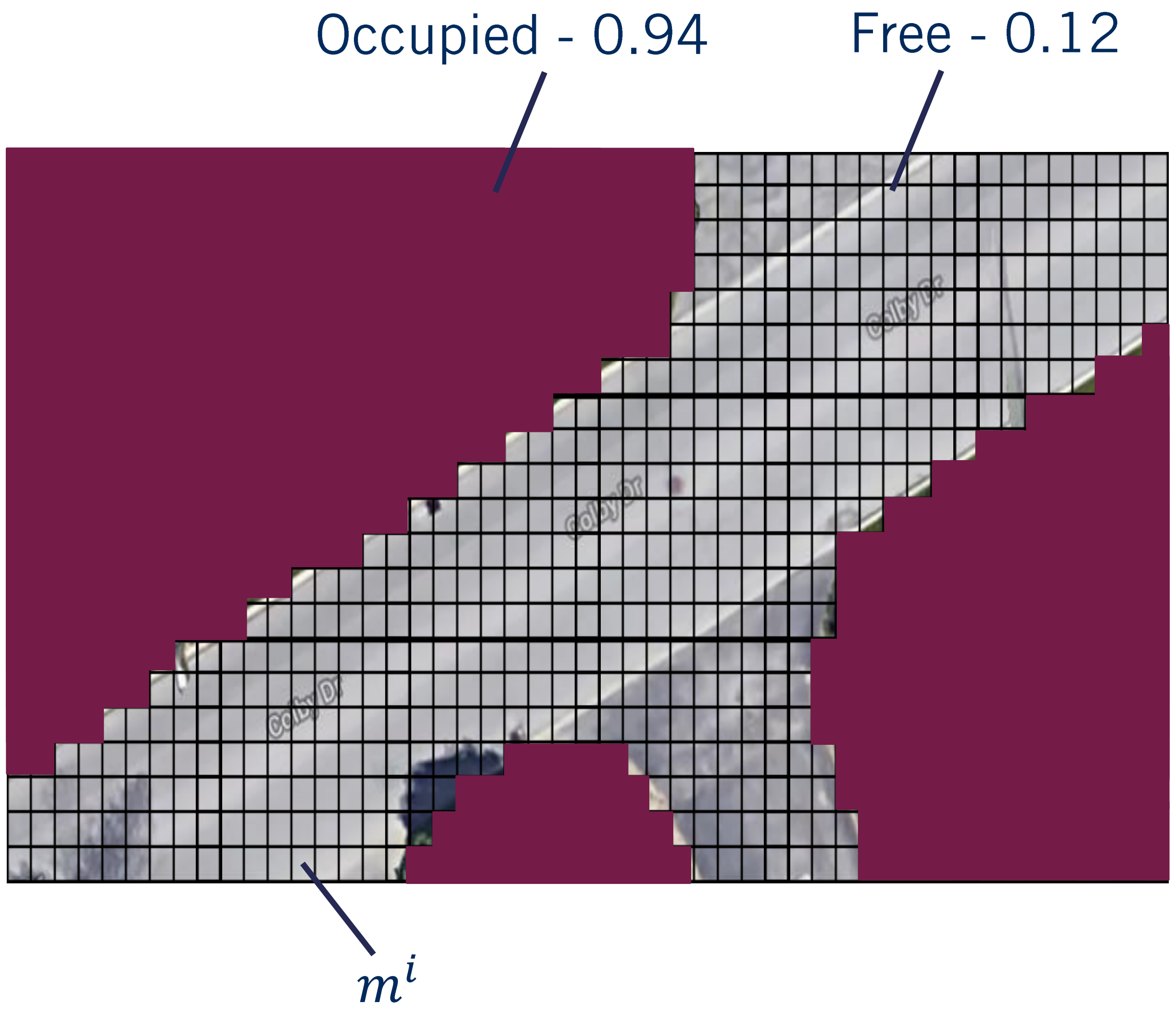
- A belief map is built

$$bel_t(m^i) = p(m^i | (y, x))$$

Current map cell

Sensor measurement for given cell

- Threshold of certainty will be used to establish occupancy

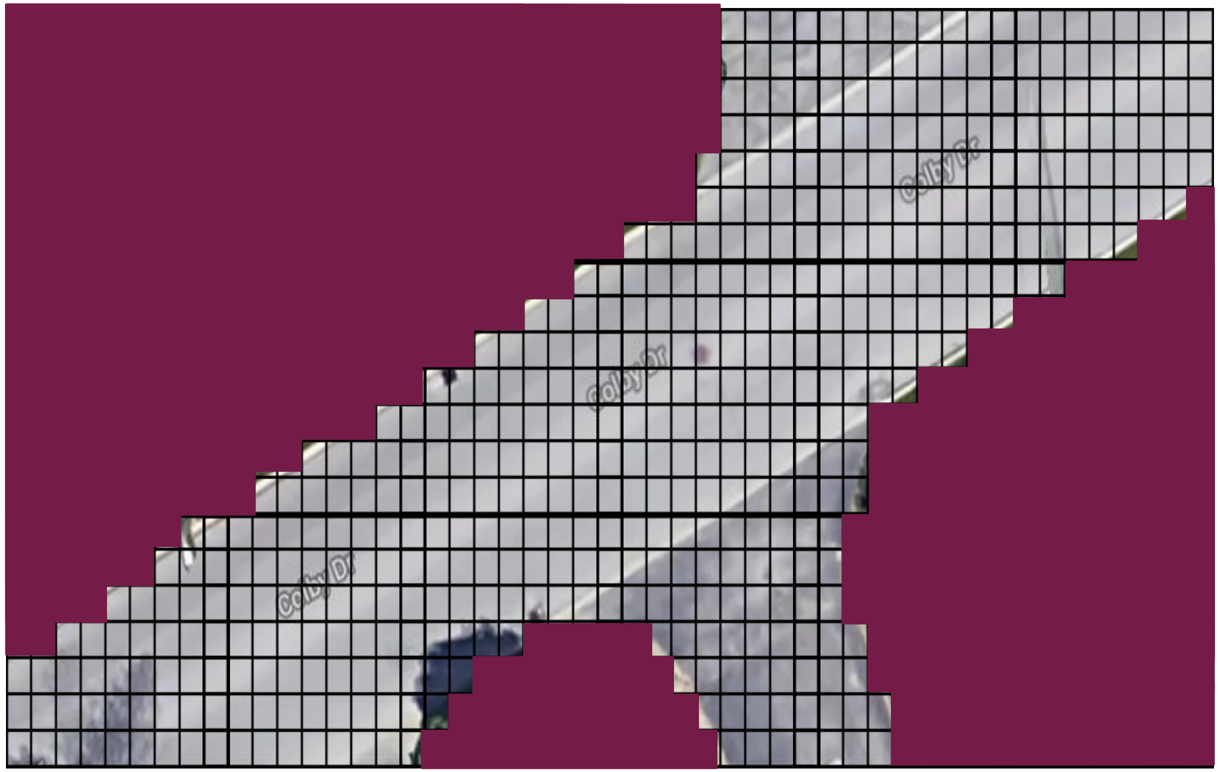


Bayesian Update of the Occupancy Grid

- To improve robustness multiple timesteps are used to produce the current map

$$bel_t(m^i) = p(m^i|(y,x)_{1:t})$$

- Bayes' theorem is applied for at each update step for each cell

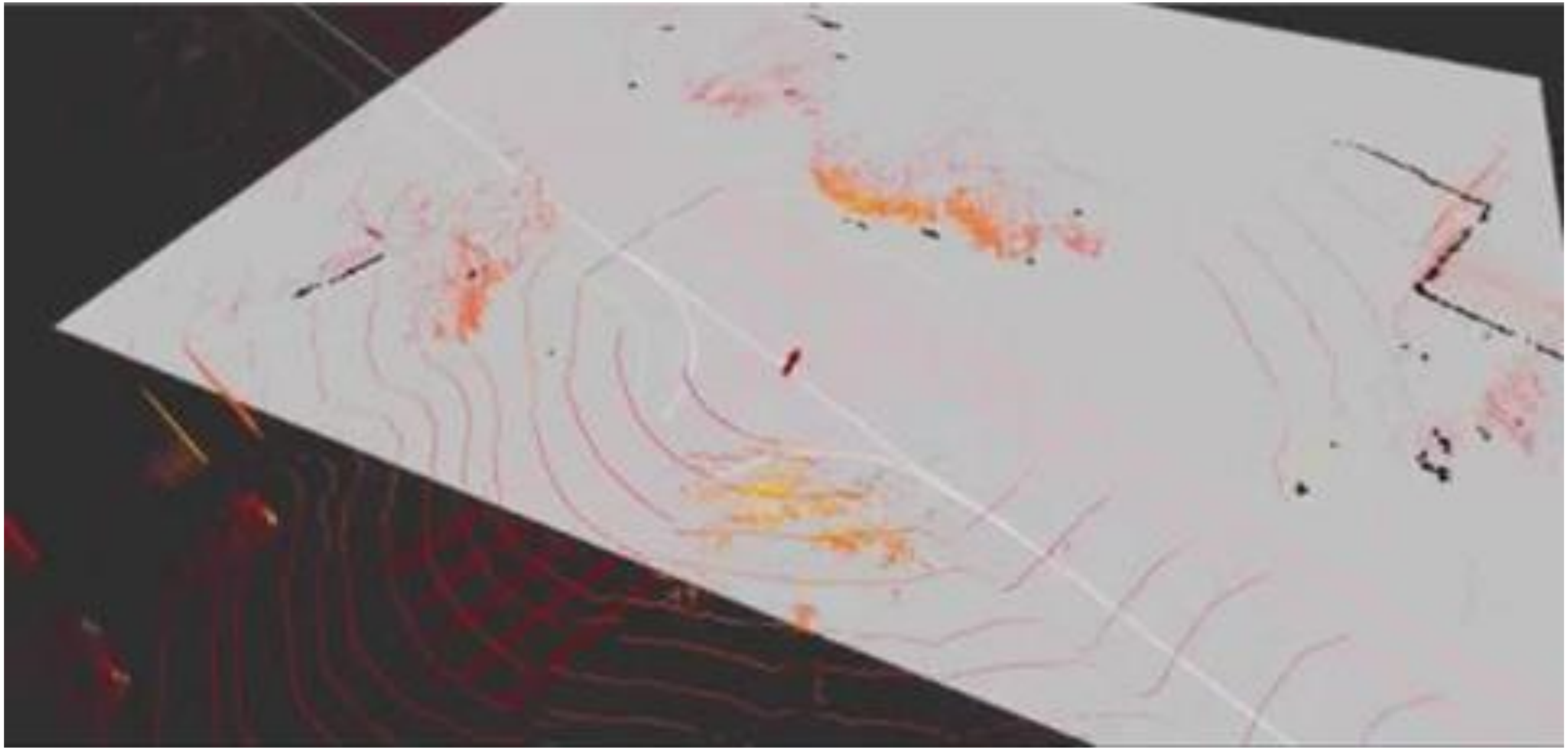


Normalizer constant

$$bel_t(m^i) = \eta p(y_t|m^i) bel_{t-1}(m^i)$$

Current measurement   Previous belief map

Occupancy Grid in Action



Summary

- Define occupancy grid
  - Creation of occupancy grid using lidar data
- Noise inherent to lidar data used to construct occupancy grid
- Creating accurate occupancy grid with noisy data by using Bayesian updates