Occupancy Grids

Course 4, Module 2, Lesson 1

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

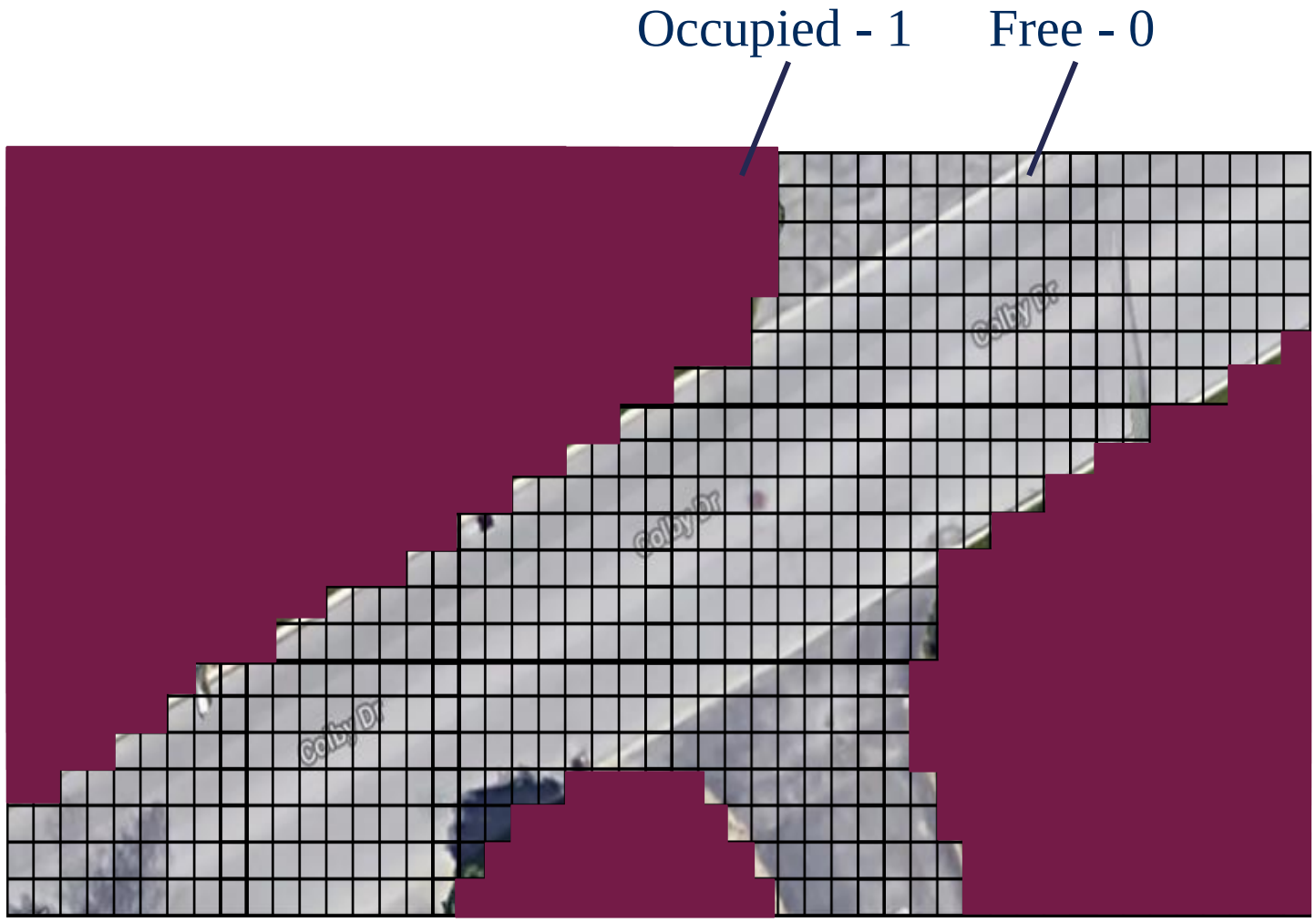
Learning Objectives

- 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

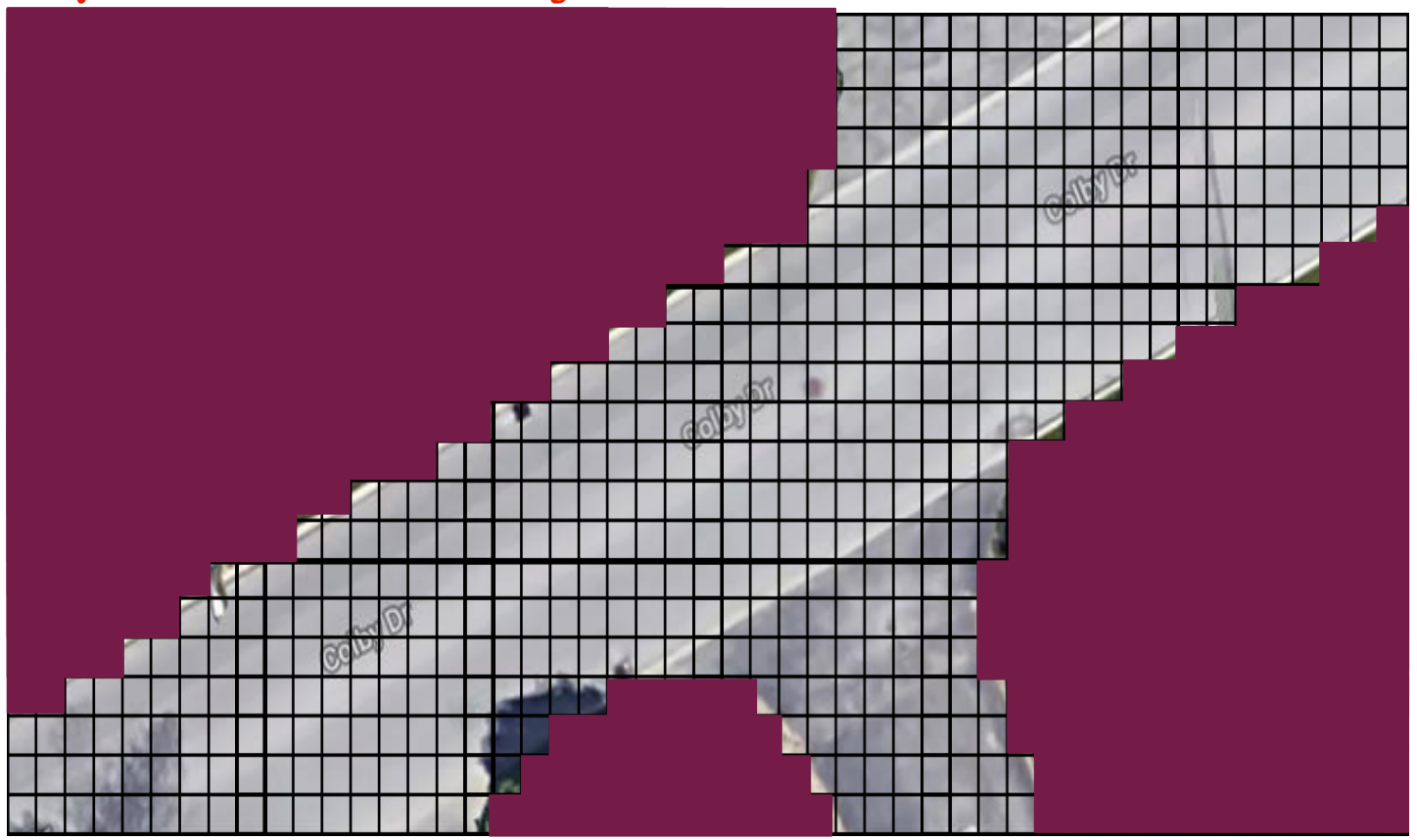
$$m^i \in \{0,1\}$$



Assumption of Occupancy Grid

dynamic objects removed before mapping

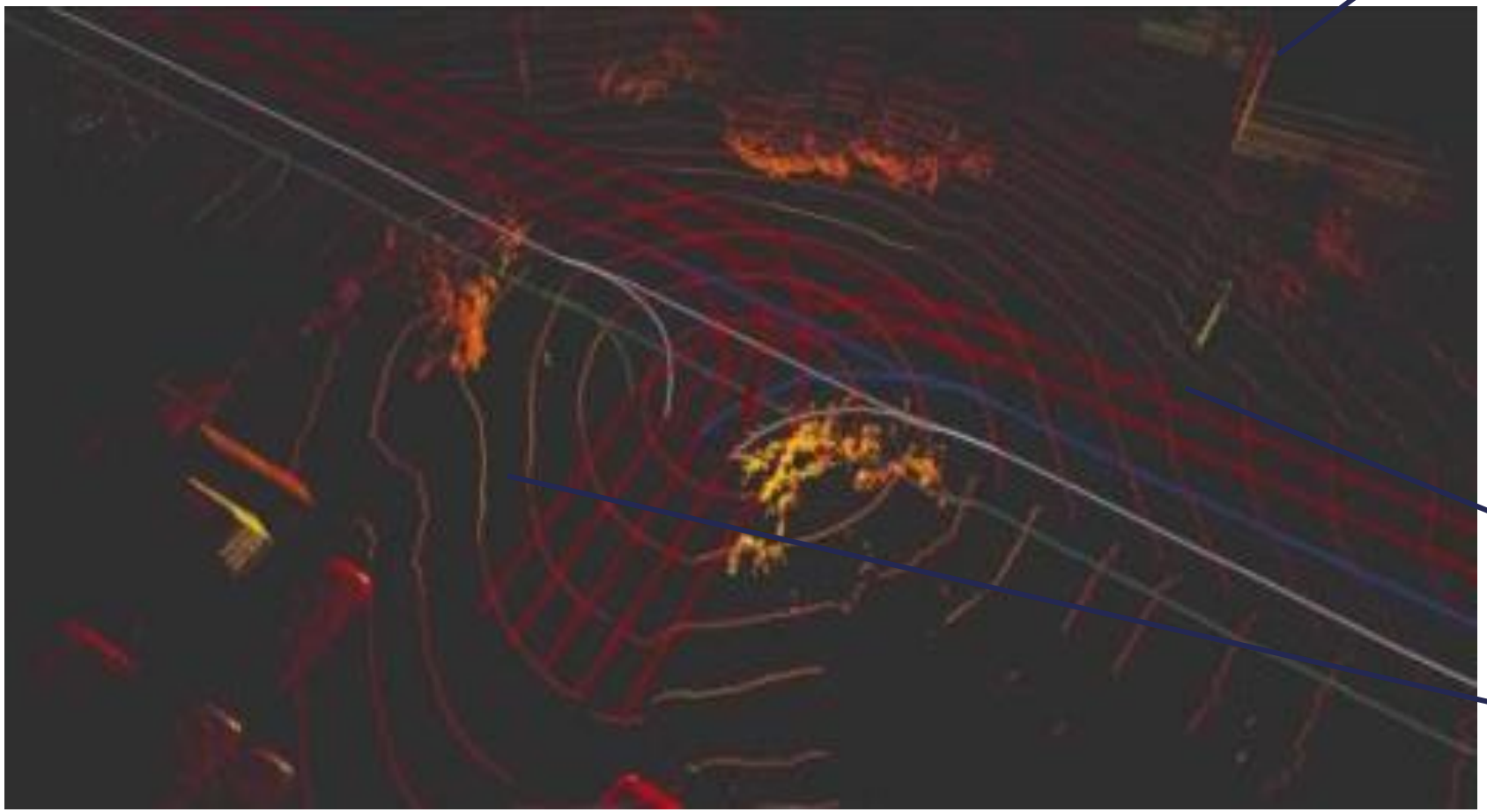
- Static environment
- Independence of each cell
- Known vehicle state at each time step



Occupancy Grid - Sensor

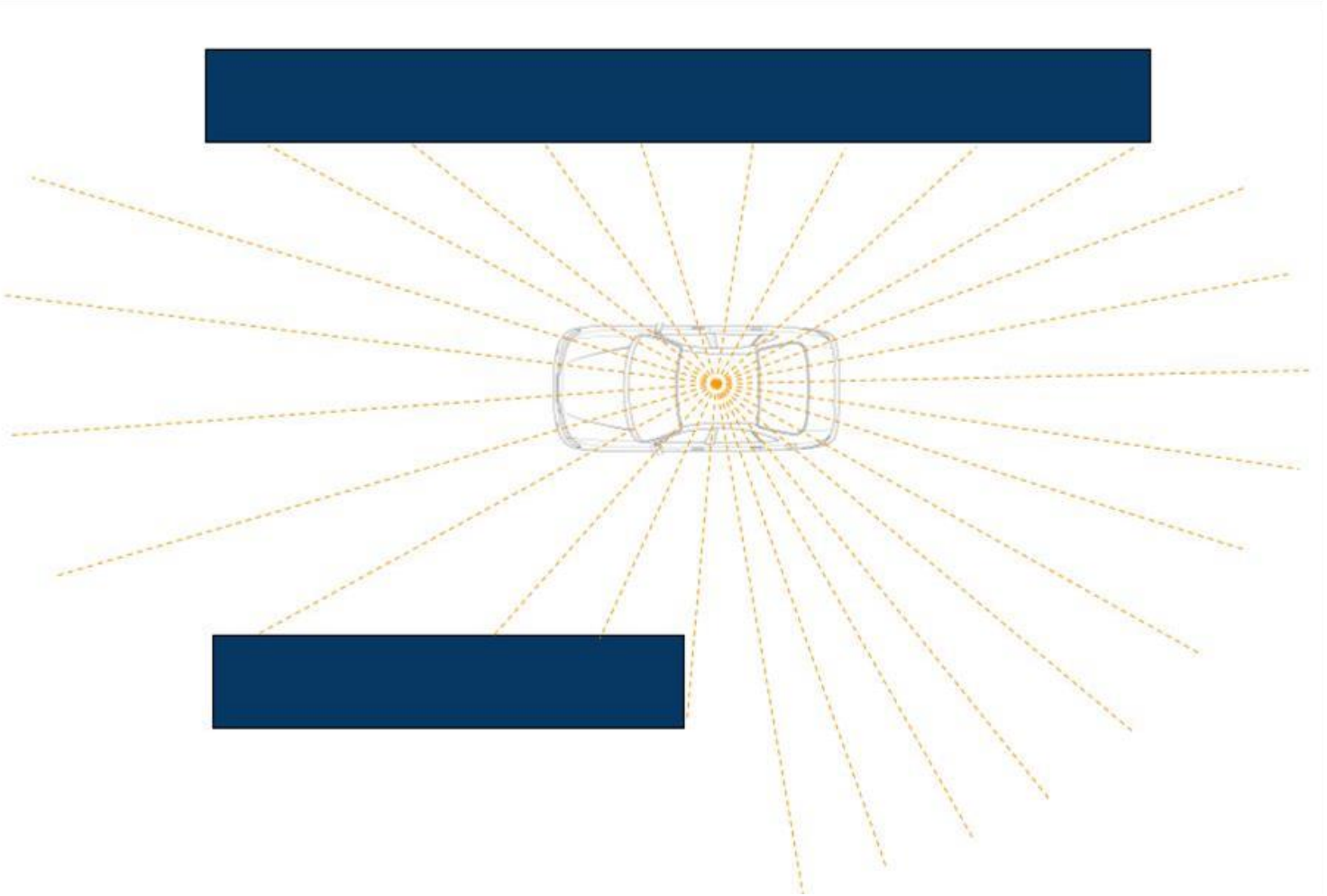
lidar

LIDAR Data Filtering

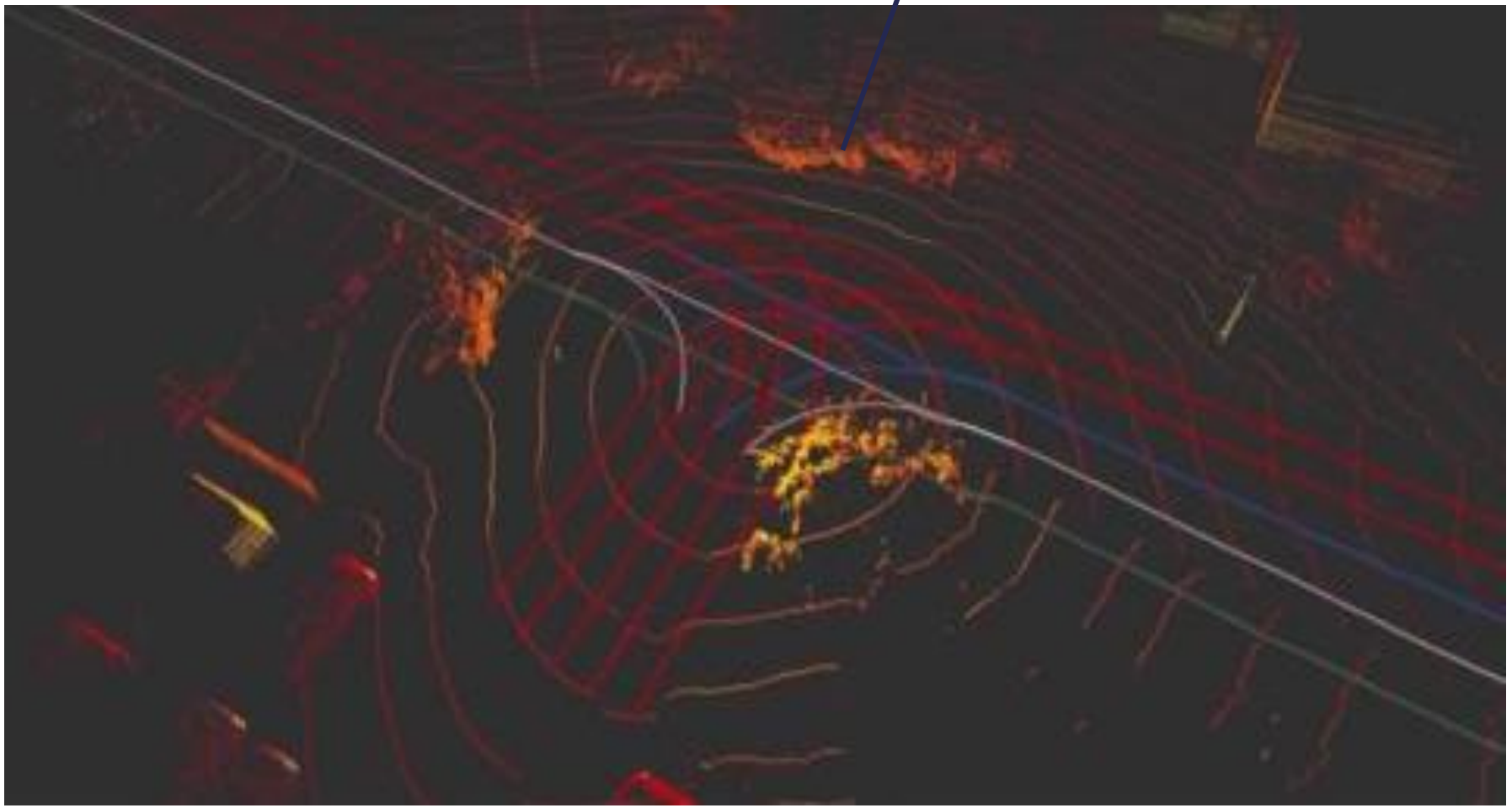


Range Sensor

- 2D range sensor measuring distance to static objects



LIDAR Data Noise



Probabilistic Occupancy Grid

- Probability of occupancy will be stored

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

- A belief map is built

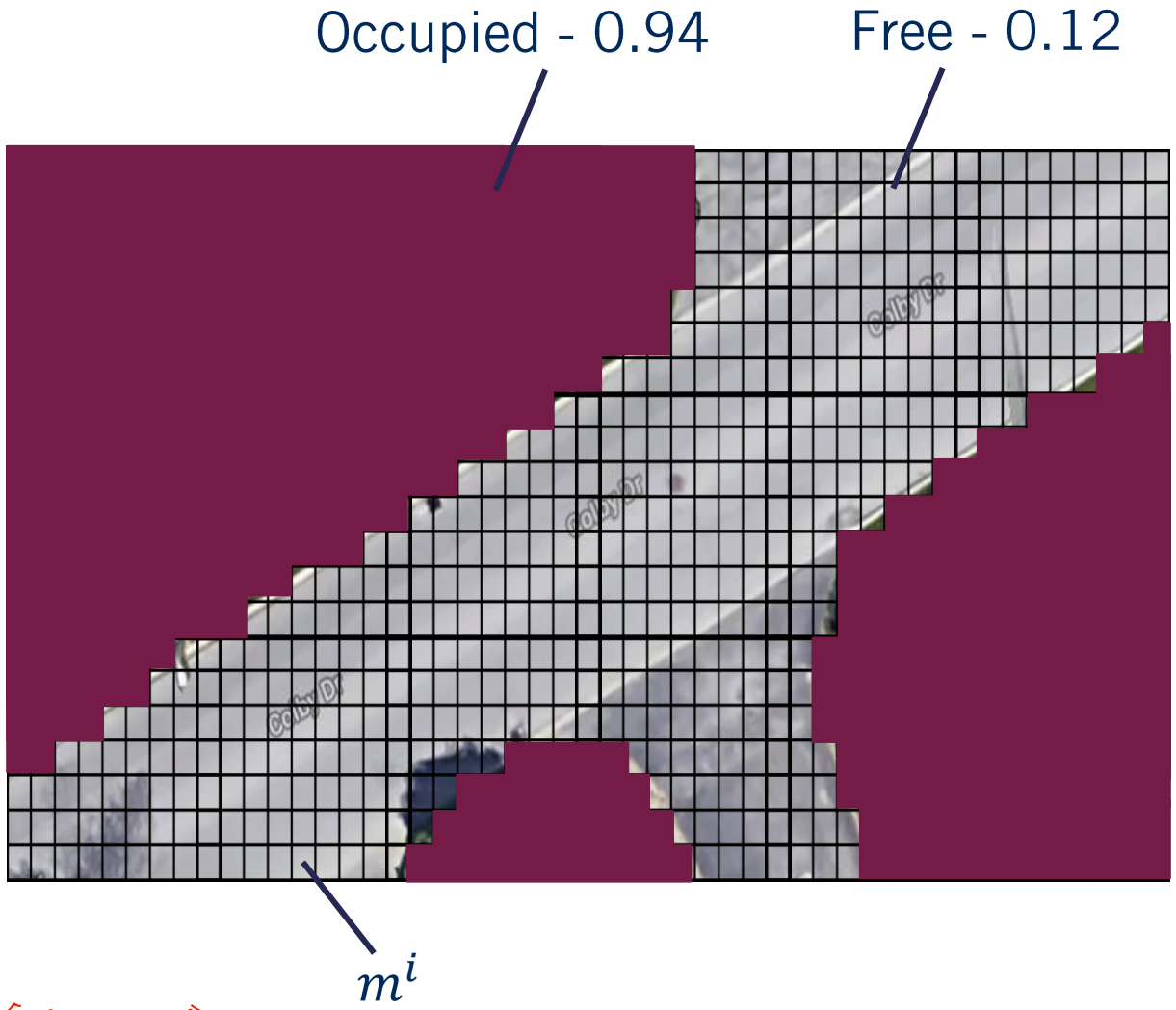
$$bel_t(m^i) = p(m^i | y, x)$$

Current map cell — Sensor measurement for given cell

probability of m^i is occupied given

- Threshold of certainty will be used to establish occupancy

to convert to a binary map

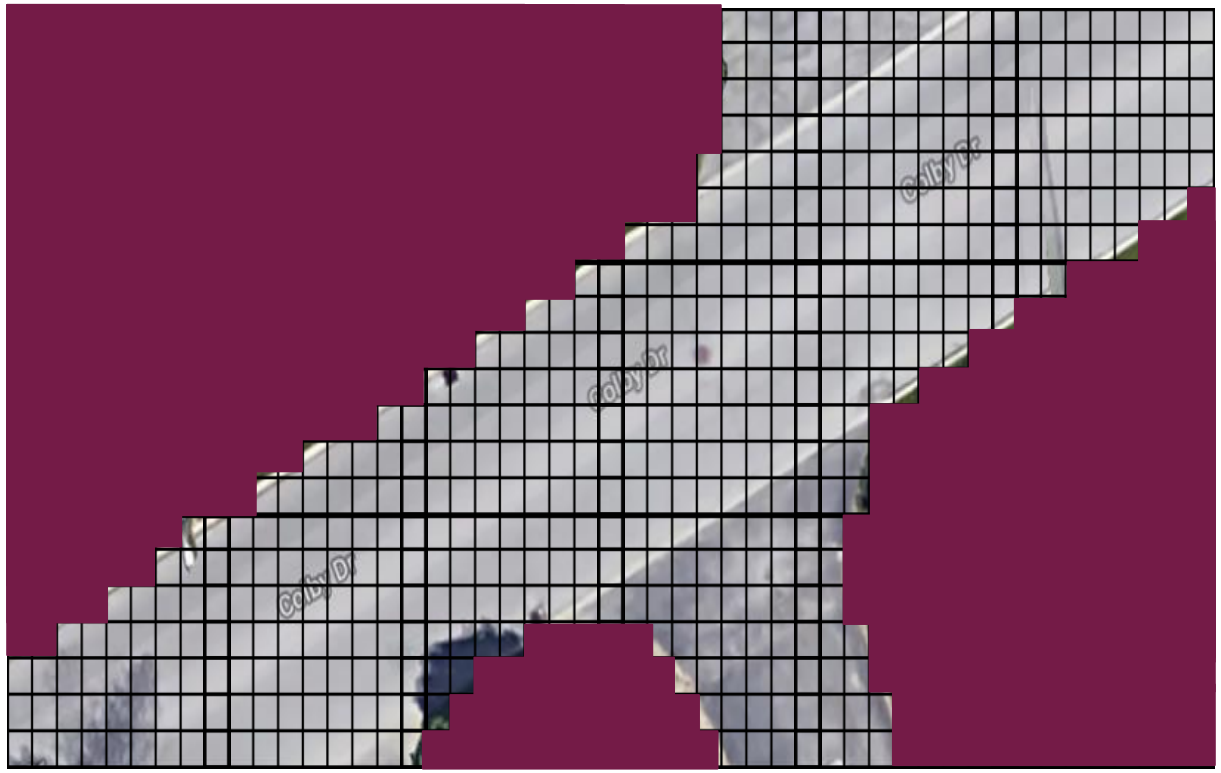


Bayesian Update of the Occupancy Grid

- 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



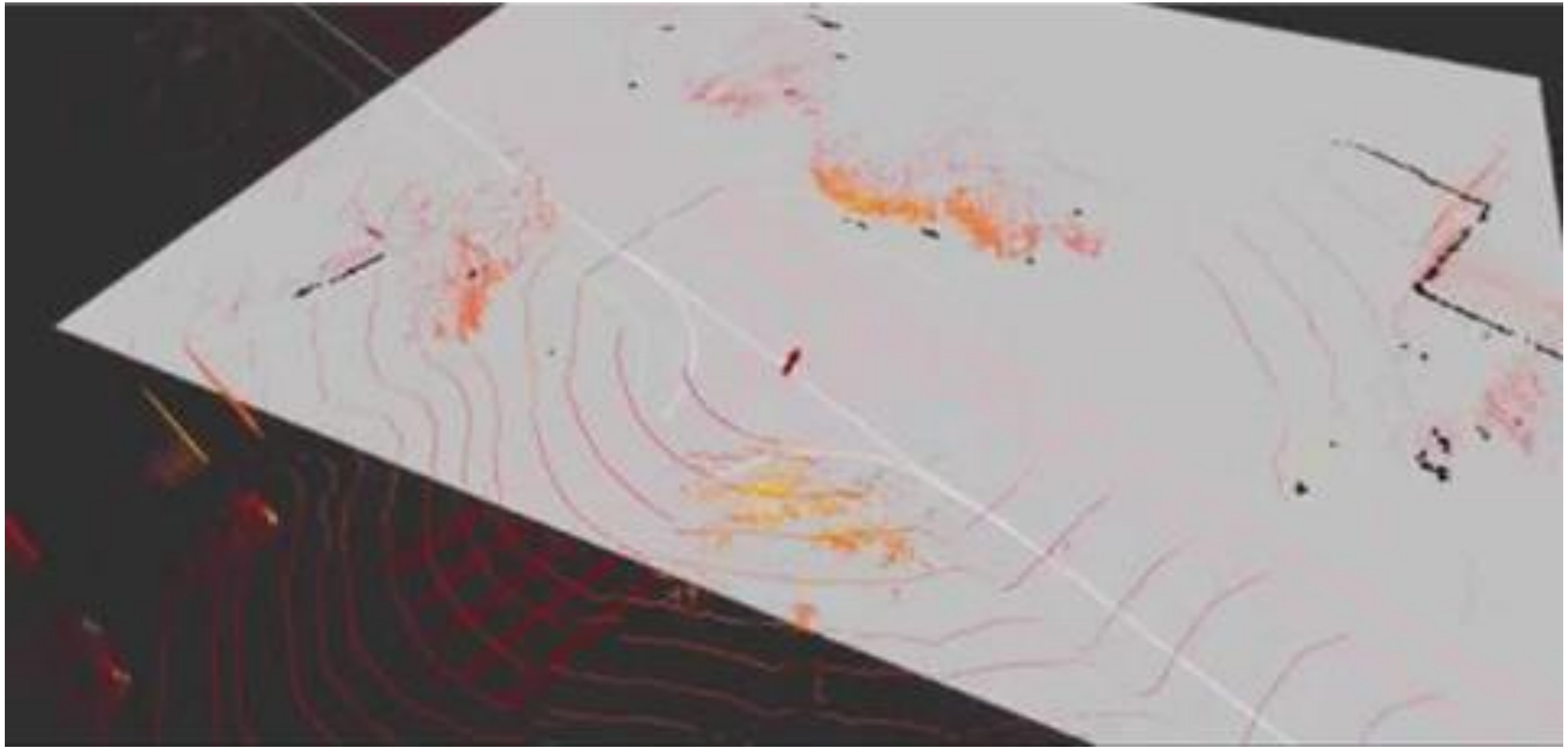
Normalizer constant

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

Markov assumption

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