LT2 - Localization

Where am I?

- Knowing where you are is a key problem in robotics.
- Hard in mobile platforms because
  - No direct way of knowing where you are Indirect methods involve unreliable data
- The problem is (mostly) addressed by probabilistic frameworks.

Combining evidence

- Start with a belief (all possible locations)
- Cut down belief by combining it with new data to form a new belief
- Repeat process. reducing overall belief and hence, number of possible places for agent
- This is non-probabilistic and relies on all candidates acting independently

Combining uncertain evidence

- Instead of yes/no, return a number between [0, 1]
- This is the certainty of matching the data set
- Data is now called the "data likelihood", in contains the likelihood of the agent being in that space
- To find a new belief: multiply current belief cell value with data cell value
- Belief is a probability distribution, add values sum to 1
- Data is a likelihood as the values don't sum to 1
- New belief is no longer a probability distribution so needs to be converted back
- To do this add up all cell values and divide each by the sum of the cell values
- As probability accumulates, more likely areas gain higher probabilities
- This allows possibility to recover from a failed sensor (given a good sensor model)
- This is a recursive bayesian filter

Bayes' rule

- Recall the conditional probability rule

$$P(A\&B) = P(B|A)P(A) = P(A|B)P(B) \tag{1}$$

- Rearranged this gives

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \tag{2}$$

$$P(Hypothesis|Data) = \frac{P(Data|Hypothesis)P(Hypothesis)}{P(Data)} \tag{3}$$

Bayes' rule recap

- Now we imagine a set of possible hypotheses which are
  - Mutually exclusive (one and only one can be true)
  - Exhaustive (one must be true)
- In this case

$$P(Data) = \sum_{i=1}^{N} P(Data|H_i)P(H_i) \tag{4}$$

- Hence

$$P(H_i|D) = \frac{P(D|H_i)P(H_i)}{\sum_{j=1}^{N} P(D|H_i)P(H_i)} \tag{5}$$