Current Model:

0.1 Goal

Estimate a function of the form:

$$f(x, y, \text{command}, \text{world}) = \frac{1}{z(\lambda, \text{command}, \text{world})} \exp\left(\sum_{i=1}^{c} \lambda_i T_i(x, y, \text{command}, \text{world})\right)$$

0.2 Naive Gaussian

Mean Estimation

For a given command and world, let ref be the reference from the command, dir be the direction of the command, from the set $\{left, right, in\ front, behind\}$, and $distance$ be the distance specified. Then

$$\hat{x}, \hat{y} = \begin{cases} ref.center + \frac{ref.height}{2} + distance, & dir = behind \\ ref.center - \frac{ref.height}{2} - distance, & dir = in\ front \\ ref.center + \frac{ref.width}{2} + distance, & dir = right \\ ref.center - \frac{ref.width}{2} - distance, & dir = left \end{cases}$$

Covariance Estimation

Covariance in the direction of the command is estimated based on a linear fit of the distance of the command vs. the covariance of the data. Covariance in the orthogonal direction is fixed to an arbitrary constant.

$$\hat{\Sigma} = \begin{cases} \begin{bmatrix} 0.5 & 0 \\ 0 & \max(0.43distance - 0.59, 0.5) \end{bmatrix}, & dir = behind, in\ front \\ \begin{bmatrix} \max(0.43distance - 0.59, 0.5) & 0 \\ 0 & 0.5 \end{bmatrix}, & dir = left, right \end{cases}$$

This outputs a multivariate normal pdf with parameters $\mu = (\hat{x}, \hat{y}), \Sigma = \hat{Sigma}$.

0.3 Object Distance Estimation

This is a distribution that penalizes estimated locations that are closer to a different object in the world than they are to the reference object. It takes the form of an exponential distribution. The parameter was found via grid search.

$$p(x, y|command, world) = \frac{1}{2.7} e^{\frac{1}{2.7}(||(x,y)-(x_{ref},y_{ref})||-\min_{obj \in world}||(x,y)-(x_{obj},y_{obj})||)}$$

0.4 Wall Distance Estimation

This is a distribution that penalizes estimated locations that are closer to a wall than they are to the reference object. It takes the form of an exponential distribution. The parameter was found via grid search. Note: edges of tables count as walls.

$$p(x, y|command, world) = \frac{1}{1.2} e^{\frac{1}{1.2}(||(x,y)-(x_{ref},y_{ref})||-\min_{walls}||(x,y)-(x_{wall},y_{wall})||}$$