Affordance Learning Math

Soft Affordances

Our aim is to develop an algorithm for learning a distribution over actions given a current state and lifted goal description:

$$P(a|s, LGD) \tag{1}$$

Process Overview

To learn Equation **??**, we assume the distribution takes the following form:

$$P(a|s, LGD) = dirichelte \tag{2}$$

1) **World Generation:** Generate M random worlds, each annotated with a Lifted Goal Description (LGD)

2) **Solve Policies:** Form a policy π_i for each of the M worlds using RTDP and null affordances. Some worlds will be too hard to solve without affordances; ignore worlds that cannot be solved.

3) **Compute distribution over actions, α:** Use each policy π_i, with the corresponding LGDs and predicates that "light up" (hand crafted) to get counts, α. Use α as the parameter for the Multinomial-Dirichlet distribution

4) **Compute action set size parameter, β:** Sample trajectories from each policy π_i, use the size of the set of actions used in each trajectory to get counts β. Use β as the parameters to a Dirichlet distribution.

5) Each time we use an affordance, sample its action set size (so we choose the number of actions to select, k), then sample k actions from that affordances distribution to get the pruned action set. Use as normal.

Math

$$Pr(\lambda \mid \alpha, \beta) = Pr(\lambda = \{a_1, \ldots, a_k\} \mid n = k, \alpha) \cdot Pr(k \mid \beta) \tag{3}$$

Where the number of actions to select k is distributed as follows:

$$k \sim Dir(\beta) \tag{4}$$

And the probability of select any k actions is given by the dirichlet-multinomial distribution:

$$Pr(\lambda = \{a_1, \ldots, a_k\} \mid n = k, \alpha) = \frac{\Gamma(A)}{\Gamma(k + A)} \prod_{i=1}^{|actions|} \frac{\Gamma(\delta(a_i \in \lambda) + \alpha_i)}{\Gamma(a_i)} \tag{5}$$