Independent Study Report - CB + DMPs

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1 Introduction

So far we

2 Mixture of Experts - Softmax

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3 Dynamic Movement Primitives

Dynamic Movement Primitives (DMPs) provide a general approach for learning robotic motor skill from demonstration. Given a sample trajectory with start state x_0 and goal state g, a DMP generates a trajectory by integrating the following equations:

$$\tau \dot{v} = K(g - x) - Dv - K(g - x_0)s + Kf(s)$$
$$\tau \dot{x} = v$$

In these equations, τ refers to a time scaling term, K and D refer on system specific constant that work as in a PD controller and $f(s)$ corresponds to a non-linear function composed of several Gaussian basis functions:

$$f(s) = \frac{\sum_i w_i \psi_i(s) s}{\sum_i \psi_i(s)}$$

where $\psi_i(s) = \exp(-h_i(s - c_i)^2)$ are the basis functions with center c_i and width h_i. w_i are the parameters to be found to minimize the objective function J.

The variable s is a phase variable which encompases the duration of the

trajectory and monotonically decreases from 1 to 0. This variable obtained by the canonical system:

$$\tau \dot{s} = -\alpha s$$

When observing a demonstration, a movement $x(t)$ is recorded and from that its derivative $v(t)$ and $\dot{v}$ are obtained. Using this, we can compute the target function:

$$f_{target}(s) = \frac{\tau \dot{v} + Dv}{K} - (g - x) + (g - x_0)s$$

and solve the objective function $J = \sum_s (f_{target}(s) - f(s))^2$ via gradient descent or least-squares.

Once trained, a new trajectory can be generated by setting s to 1, updating the positions and velocities and intergrating the canonical system to obtained the new s.