segmentfault 思否 | HACK

大赛主题合作方 Google Developer Summit China 2022

CODE FOR BETTER _

Hackathon

SHANDONG UNIVERSITY

【Google 开发者大会】
2022 Code for Better _ Hackathon

Manipulation and Skill Learning and Generalizing

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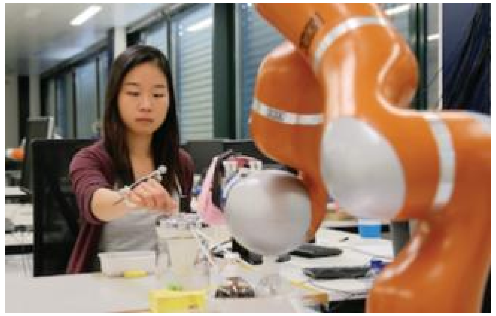
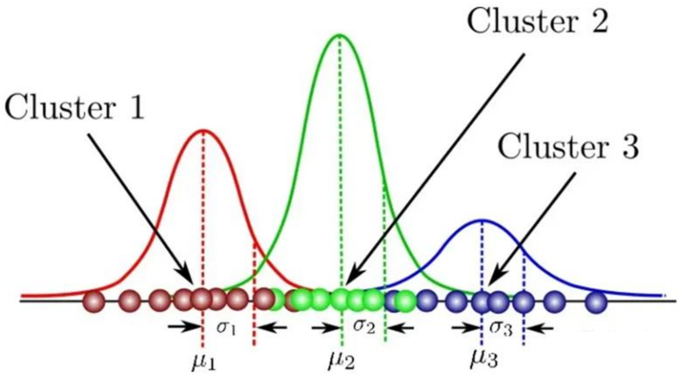
Learning from Demonstration

Definition: Learning from demonstration (LfD) is the paradigm in which robots acquire new skills by learning to imitate an expert in the context of robotics and automation.

- Kinesthetic teaching
- Teleoperation
- Passive observation
- Active and Interactive Demonstrations



LfD in trajectory
- Movement Primitives: DMP, KMP; ProMP
- Function Approximator: GMM, GMR; HMM,GP



Learning from Demonstration

Dynamic Movement Primitive

– **Nonlinear Dynamic System:**

$$\tau\begin{bmatrix}\ddot{z}\\ \dot{x}\end{bmatrix}=\begin{bmatrix}\alpha_z(\beta_z(g-z)-\dot{z})+f(x,g)\\ -\alpha_x x\end{bmatrix}$$

– **Forcing Function:**

$$f(x,g)=\left(\sum_{i=1}^{N}\psi_i\cdot\frac{\omega_i}{\sum_{i=1}^{N}\psi_i}\right)x(g-z_0)$$

– **Basis Function Weight:**

$$\omega_i=\frac{s\psi_i f_{target}}{s\psi_i s^T}$$

Gaussian Mixture Model and Gaussian Mixture Regression (GMM-GMR)

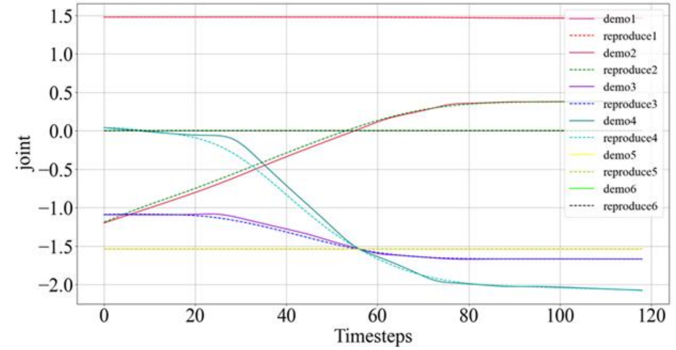
– **Joint Probability Distribution:**

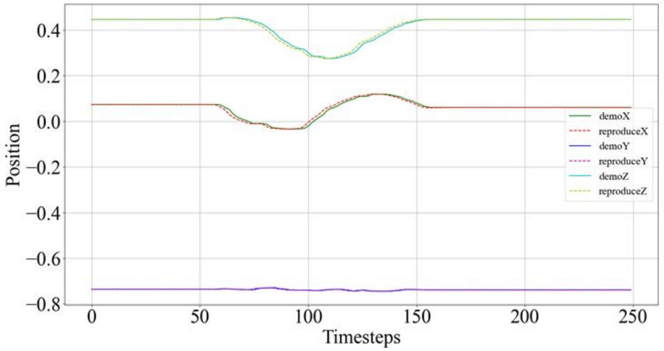
$$P(s,\xi)\sim\sum_{c=1}^{C}\pi_c N\left(\mu_c,\sum_c\right)$$

– **Gaussian Component:**

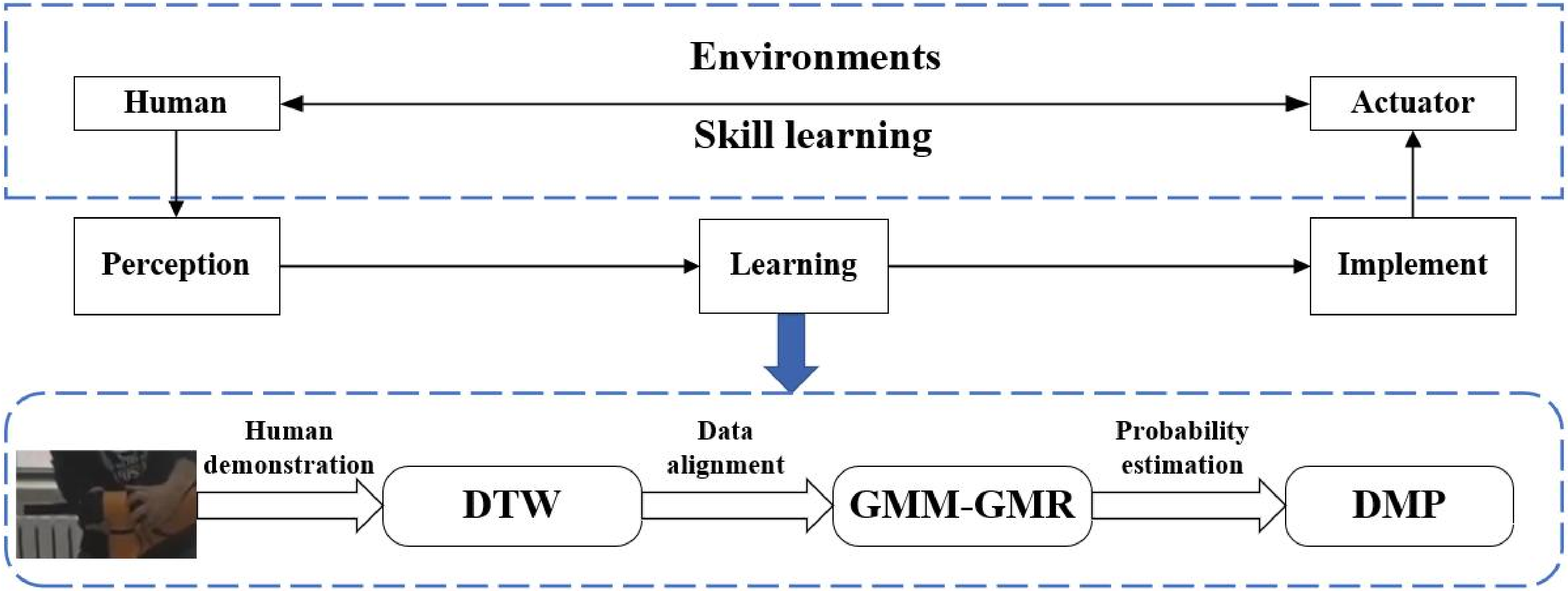
$$\mu_c=\begin{bmatrix}\mu_{s,c}\\ \mu_{\xi,c}\end{bmatrix}$$

$$\sum_c=\begin{bmatrix}\sum_{ss,c} & \sum_{s\xi,c}\\ \sum_{\xi s,c} & \sum_{\xi\xi,c}\end{bmatrix}$$





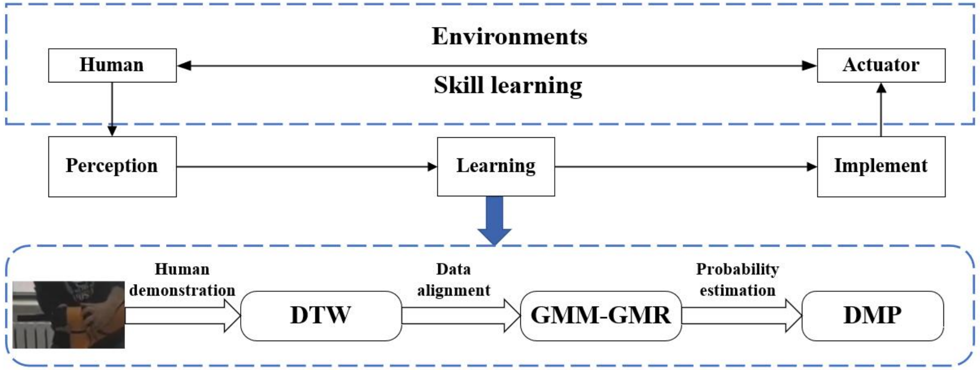
Overview

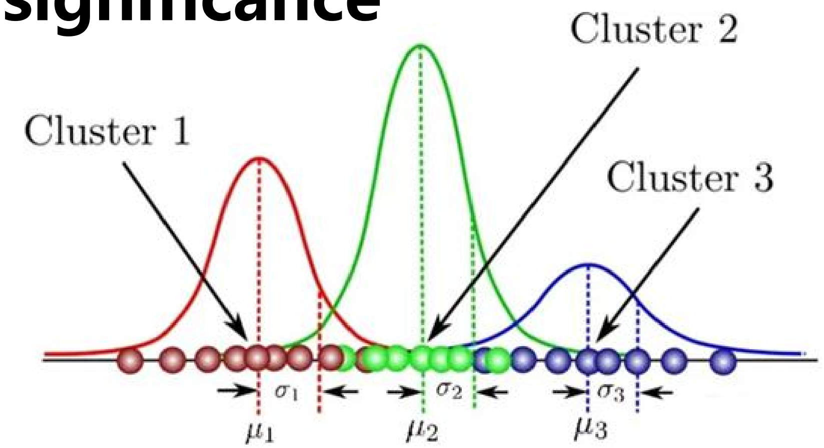


Task I: To accurately learn motor skills from human demonstrations and experiments data, data alignment is performed on the teaching data through Dynamic Time Warping (DTW).

Task II: Then, the data is analyzed using the statistical method Gaussian Mixture Model and Gaussian Mixture Regression (GMM-GMR). Ultimately, Dynamic Movement Primitives (DMPs) learn motor skills from human demonstrations and experiments data.

Applied Google technology and significance





The machine learning model uses **supervised learning** and **deep reinforcement learning**, and the **dynamic motion primitive** algorithm uses **locally weighted linear regression** to learn and generalize the model. GMM-GMR is a set of functions to train a **Gaussian Mixture Model** (GMM) and retrieve generalized data through **Gaussian Mixture Regression (GMR).** It allows to encode efficiently any dataset in Gaussian Mixture Model (GMM) through the use of an Expectation-Maximization (EM) iterative learning algorithms. By using this model, Gaussian Mixture Regression (GMR) can then be used to retrieve partial output data by specifying the desired inputs. It then acts as a generalization process that computes conditional probability with respect to partially observed data.

Through the learning algorithm, the complex tasks can be learned and modeled, the learning and generalization of tasks can be realized, and the skills scenes in life, such as opening the door, locking the screw and other tasks, can be handled, so as to improve the cognition, learning and realization ability of skill operation.

Thanks for your listening!

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