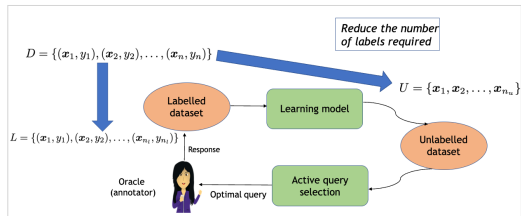


Active Metric Learning and Classification using Similarity Queries

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Active learning

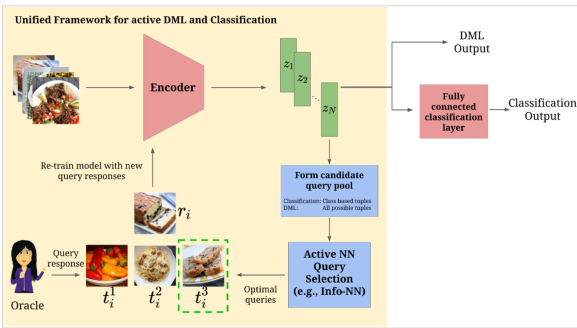
Involves adaptively querying labels for the most informative data points to improve label efficiency



Most active learning strategies are designed to either learn a representation of the data or perform well on a task on the data – but many machine learning tasks involve a combination of both representation learning and a task-specific goal

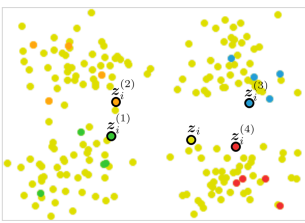
Our method

We propose a novel **unified query framework** that can be applied to any problem which involves learning a representation of the data that reflects similarity



Label selection is modeled as a **nearest neighbor (NN)** query, which, given a reference point r_i , asks an oracle (e.g., a human expert) to select the most similar point among a set of M neighbors $\{t_1^1, t_1^2, \dots, t_1^M\}$

Classification as an NN query



unlabeled samples
Class 1
Class 2
Class 3
Class 4

$$z_i^{(c)} = \arg \min_{z_c \in \mathcal{L}_c} \|z_c - z_i\|_2$$

Assumption:

For any class c , let $z_i : y_i = c$. Then, we have

$$\|z_j - z_i\|_2 \leq \|z_k - z_i\|_2 \\ \forall z_j \in \mathcal{L}_c, z_k \in \mathcal{L}_m, \\ \forall m \neq c \in \mathbb{C}$$

Query:

$$z_i \cup \{z_i^{(1)}, z_i^{(2)}, \dots, z_i^{(M)}\}$$

Label:

$$y_i = \arg \min_{c \in \mathbb{M}} \|z_i^{(c)} - z_i\|_2$$

Query selection

Probability model

$$P(Y_i = c) = \frac{(D_{ic}^2 + \mu)^{-1}}{\sum_{j=1}^M (D_{ij}^2 + \mu)^{-1}}$$

Y_i - query response
 D_{ij} - distance between r_i and t_i^j
 μ - parameter

Smaller the distance is, higher the probability of being the most similar point

Selection criterion

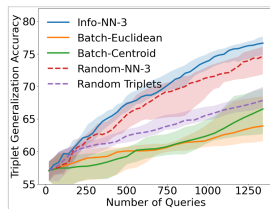
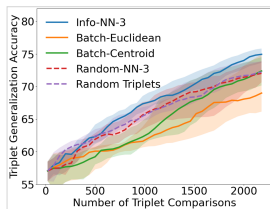
Info-NN

$$\mathbb{I}(Y_i; \mathcal{Z} | y^{i-1}) = \mathbb{H}[Y_i | y^{i-1}] - \mathbb{E}_{\mathcal{Z}}(\mathbb{H}[Y_i | \mathcal{Z}, y^{i-1}])$$

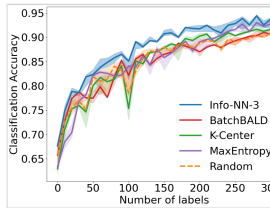
Select queries that provide **maximum information** about the embedding $\mathcal{Z}$, given the response to previous queries

Experiment results

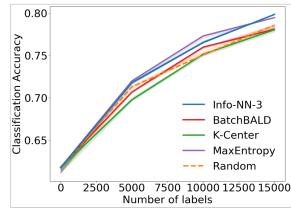
Deep metric learning - food dataset



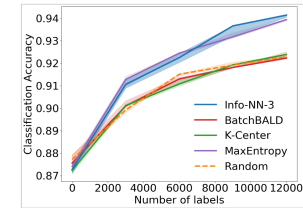
Baseline comparison



MNIST



CIFAR-10



SVHN

Info-NN-M: M denotes the number of neighbors considered