Learning priors for multi-task representation learning

Representation learning for insufficient training data

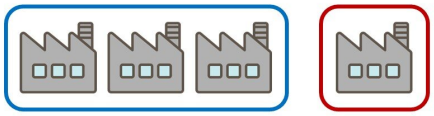
Abstract

Representation learning, which obtains effective features and patterns from data, is widely used in machine learning. However, it does NOT perform well with insufficient training data. To solve this problem, we focus on the prior knowledge used in representation learning. We reveal that the commonly used simple prior knowledge is one cause of performance degradation and propose a new prior knowledge that is learned by using data from the related tasks. Experiments show that even with only a few hundred data points, representation learning with our prior knowledge improves machine learning performance by up to 15%. We will apply this approach to real-world anomaly detection problems with insufficient data, such as new cars or factories under development.

Abstract

- Representation learning, which obtains effective features and patterns from data, is widely used in machine learning.
- However, it does NOT perform well with insufficient data, which prevents us from applying it to real-world problems.
- We propose a technique for learning representations using data from the related tasks, which performs well with insufficient data such as anomaly detection in new factories.

Ex: anomaly detection in new factories

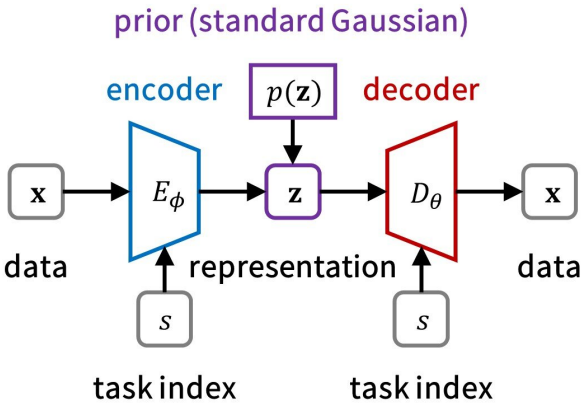


old factories: large data

new factory: small data

Existing Method

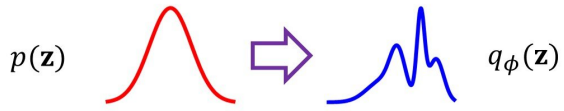
- The conditional variational autoencoder (CVAE) learns representation $\mathbf{z}$ of data point $\mathbf{x}$ thorough data reconstruction.



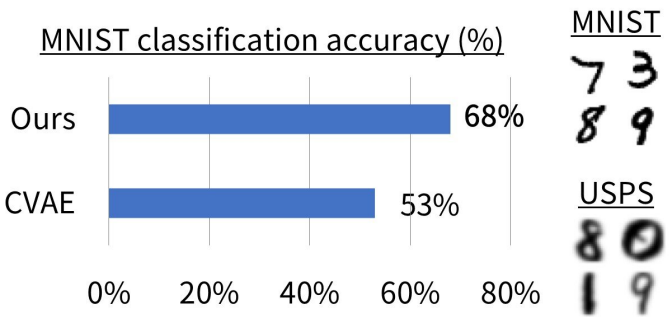
- Although representation $\mathbf{z}$ is regularized by the standard Gaussian prior $p(\mathbf{z})$, this simple prior is one cause of performance degradation.

Proposed Method

- We propose a new prior $q_\phi(\mathbf{z})$ that is learned by using data from the related tasks, which performs well with insufficient data.



- Our approach improved accuracy by 15% on a class classification task (MNIST) with only 100 data, using data from a similar task (USPS).



References

[1] H. Takahashi, T. Iwata, A. Kumagai, S. Kanai, M. Yamada, Y. Yamanaka, H. Kashima, "Learning Optimal Priors for Task-Invariant Representations in Variational Autoencoders," in Proceedings of the 28th ACM SIGKDD Conference on Knowledge Discovery and Data Mining, 2022.

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