Chapter 7
Challenges and Limitations of Few-Shot and Zero-Shot Learning

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ABSTRACT

Essential to the development of AI and machine learning, this chapter explores the complex areas of few-shot and zero-shot learning. There have been great advancements towards more efficient and adaptive AI systems with few-shot learning and zero-shot learning, respectively, which can learn from minimal data and infer from particular data instances without previous exposure. Nevertheless, there are several limits and difficulties associated with these procedures. This chapter delves deeply into the theoretical foundations of both techniques, explaining how they work and what problems they solve in different ways. It examines the semantic gap, domain adaptation problems, and model bias, as well as the computational restrictions, overfitting, and model generalizability that are intrinsic to few-shot learning and zero-shot learning, respectively. We may better understand the ideas' potential use in different real-world contexts by comparing and contrasting them.

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1. INTRODUCTION

In an era of increasing interest in church the fast developing fields of machine learning and artificial intelligence (AI), one must find a proper solution to missing data. Today, few-shot learning as well as zero shot have become two hot topics. Few-Shot Learning means to used, as little labelled data as possible in training a model. Accuracy with traditional machine learning models must require a huge number of labelled data. Collecting this can be expensive and time consumording. On the other hand, few-shot learning aims to improve efficiency and adaptability by enabling AI models to provide reliable predictions with very few examples (J. Chen, 2023). These are achieved by using contemporary techniques like as meta-learning, embedding learning, and transfer learning that help the model generalize from sparse datasets to new data. On the other hand, Zero-Shot Learning exten ds enormously the frontiers of learning with few data. In the case of zero-shot learning, however, the model has to make predictions on classes it didn't see during training. This is achieved by, during training, learning something from attending one set of classes, and then using it to figure out something about another that was missing (i.e., a completely different class of things). To the end of making inferences based on what it understands from descriptions or attributes, the model usually uses this method of understanding and use. It does not need to have any direct experience.

1.1 Importance in the Field of AI and Machine Learning

Few-shot and zero-shot learning are two important steps on the road to developing AI systems that are more intelligent, flexibleand economical with resources (J. Guan, Z. Lu, T. Xiang 2021). Their importance in the field of AI and machine learning cannot be overstated for several reasons:

Data Efficiency: It overcomes one of the chief limitations common to existing AI models, namely that they must use large sets of labelled data. In applications which lack or whose data is expensive to gather, these methods open up the possibility of learning with few or no direct examples. The degree to which this is true determines how applicable and scalable any given AI application will be.

Generalization Capabilities: These learning paradigms will improve the ability of AI models to deal with missing information, and bring their performance closer to our own. This is particularly important in changing environments where the model must quickly adapt to solve a new task or change its environment.

Broadening AI Applications: Few-shot and zero-shot learning, by giving computers the ability to learn from limited or incomplete data, open up a wide range of applications for fields which possesses data that are either lacking quantity or dynamically changing--for example, medical diagnosis and robotics. They also have many applications in natural language processing.

Ethical and Practical Implications: Besides raising ethical and practical questions about AI, they also stimulate better ways to develop responsible and sustainable AI.

Recognition by human eyesight is a complex interaction of the eyes, retina and brain. First, the human eyes and retina work together to capture the visual scene, forming an image that the human brain subsequently interprets for various recognition tasks (S. Rahman, S. Khan and F. Porikli, 2018). These tasks encompass identifying objects within the scene, pinpointing their locations, and acquiring knowledge about object relationships, among others.

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