Dual Inference for Machine Learning

1 Introduction

Two AI tasks are of structure duality if the goal of one task is to learn a function mapping from space X to Y, the other’s goal is to learn a reverse mapping from Y and X.

To better illustrate the high effectiveness of dual inference, we apply it into dual AI tasks in three particular domains:

(1)Neural Machine Translation (NMT): Translation from a source language into a target language naturally yields a dual task of inverse translation from the target to the source. NMT, emerging as widely-used approach, employs a Recurrent Neural Network based encoder-decoder framework to model the probability of a sentence in target language conditioned on the sentence in source one.

(2) Sentiment Analysis: Sentiment classification, aiming at predict the sentiment label of sentences, is a popular primal task in the domain of sentiment analysis. The corresponding dual task, is indeed sentence generation, whose objective is to automatically generate sentences based on a pre-designed

sentiment.

(3) Image Processing: Image classification, the goal of which is to predict the label of an image, is one of major AI tasks in the domain of image processing. The dual task of image classification is obviously image generation, which is an emerging AI task to automatically generate images based on category labels.

2 Dual Inference Framework

3 Neural Machine Translation

NMT models the conditional probability P(y|x; theta) of a sentence y in target language given a sentence x in source language, and the parameter \_ is learned based on the training data consisting

of a set of bilingual sentence pairs. During the typical inference step, given a source sentence x, NMT finds the target sentence y with largest conditional probability P(y|x; theta) as the translation of x.

4 Sentiment Analysis

Particularly, sentiment classification and sentence generation comprise two AI tasks in the dual

form. On one hand, the goal of the primal task, i.e. sentiment classification, is to classify the polarity of given natural language sentences. The dual task, on the other hand, aims at automatically generating sentences with the certain polarity class of sentiment.

5 Image Processing

In particular, image classification aims at predicting the semantic category label of an image. On the other hand, the corresponding dual task, image generation, targets automatically generating images based on category labels.

6 Discussions

We observe that the performance of dual inference does not highly depend on the model structures of the two dual tasks: (1) In NMT, the network structures of f and g are the same, i.e., bidirectional GRUs; (2) In sentiment analysis, the classifier (i.e., LSTM+sigmoid) and the sentence generator (i.e.,

LSTM+softmax) share some basic structures; (3) In image processing, the classifier (i.e., ResNet) and the image generator (i.e., PixelCNN++) are quite different. Dual inference works well on all these three situations.

7 Conclusion