

An Introduction to Quantum Natural Language Processing and a Study Case

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Overview

Abstract This document provides essential concepts, materials, and examples in Quantum Natural Language Processing (QNLP). QNLP is a relatively recent topical area of research, and the literature is limited. However, to reinforce this emerging literature, we review here main concepts fundamental to QNLP. Aligning applied quantum computing with NLP, with a focus on illustrating basic concepts and implementations, will provide a strong foundational framework for exercising future growth areas and exposing potential QNLP applications.

Introduction Classical computing relies on the Turing Machine model, which is sufficient for contemporary computing machinery. However, the proposal articulated by Feynman, and formalized by D. Deutsch, referred to commonly as Quantum computing (QC), is expanding daily to different computing areas. In particular, we discuss here some concepts, implementations, and examples of Quantum Natural Language Processing (QNLP). In concert with other QC subdisciplines, QNLP represents one way in which QC will improve classical computing and support areas related to communications, cybersecurity, health, and finance, among others. Quantum NLP is based on mathematical theories to connect the semantic information of words with the syntactic structure of a sentence.

Materials and Methods

DisCoCat model means Distributional Compositional Category, and was proposed by <https://arxiv.org/abs/1003.4394>. The model combines embedded words along the sentence's grammatical structure to encode its meaning. This framework enables mappings onto quantum circuits. This is useful since we can implement quantum computation <https://arxiv.org/abs/2202.11766>. These gates are reversible transformations applied to a quantum mechanical system known as a n -qubit register. The graphical depiction of quantum circuit elements is described using a variant of the Penrose graphical notation.

Results

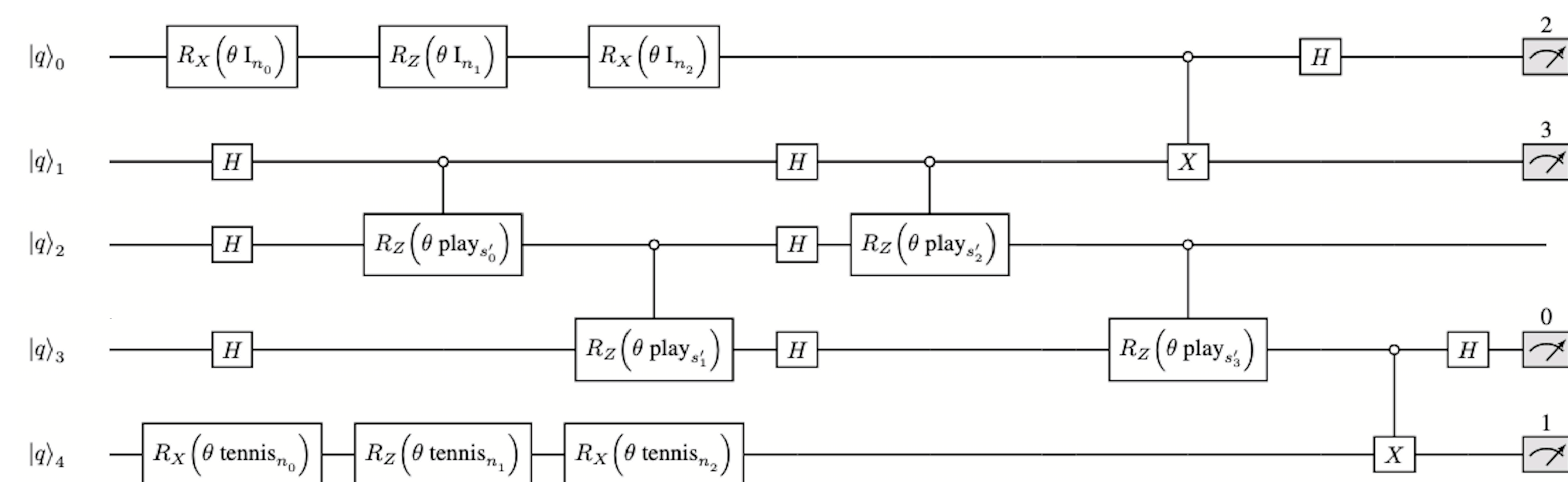


Figure 1: Quantum circuit for the sentence I play tennis.

We expect to incorporate some applications in the subsequent tests and implement new concepts and solutions in the next stage. In addition, we expect this field can be explored in the next years and provides new areas of knowledge.

Additional

References Revise our references in the paper.

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Discussions

Potential QNLP applications are numerous.

Language translation: A strong literature exists in machine translation.

Exploration of fake news: Fake news detection is an emerging research area, yet challenging due to the explosion of information on online platforms.

Pre-processing of database: Machine learning models require preprocessing techniques to convert raw data into machine-compatible and structured form.

Speech Recognition: Introduced a quantum neural network for speech recognition.

This is a research in progress, and more examples and applications will be reported soon elsewhere.

