BOSTON UNIVERSITY

GRADUATE SCHOOL OF ARTS AND SCIENCES

Dissertation

**DEEP LEARNING FOR ALZHEIMER’S DISEASE AND DEMENTIA**

**ASSESSMENT WITH CLINICAL RELEVANCE**

by

**SHANGRAN QIU**

B.A., Xi’an Jiaotong University, 2016

Submitted in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

2022

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# DEDICATION

I would like to dedicate this work to my patient spouse Landry, my wonderful children Charlie and Phoenix, and my dog Armani.

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# ACKNOWLEDGMENTS

Sometimes, a dissertation or thesis will have an acknowledgments page. Here's where you thank the people who helped you write this work. Your advisor and committee, archivists and librarians, your best friends, your spouse, your study buddy.

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**DEEP LEARNING FOR ALZHEIMER’S DISEASE AND DEMENTIA ASSESSMENT WITH CLINICAL RELEVANCE**

**SHANGRAN QIU**

Boston University College of Arts and Sciences, 2022

Major Professor: Vijaya B. Kolachalama, Professor of Medicine *(wrap around to this point if name and title are too long for one line)*

# ABSTRACT

The past decade has witnessed rapid advances at the intersection of machine learning and clinical medicine. Aided by the raid digitization of medical records, diagnoses and treatments, artificial intelligence (AI) reveals its potential of reshaping the future of healthcare. However, there remains a large gap between uncountable research papers and translatable AI-aided systems to clinical practice. In this dissertation, the clinical relevance of machine learning-based diagnostic models for Alzheimer’s disease and dementia was investigated. First, I discuss the development of interpretable deep learning models for medical image assessment with a focus on yielding high resolution and easy to interpret saliency maps. Second, I discuss the diagnostic spectrum of dementia in clinical settings and our efforts towards mimicking the complexity of diagnosing dementia using machine learning system. Third, I discuss the knowledge sharing and transferring across different clinical scenarios in the framework of knowledge distillation for dementia assessment. Altogether, this dissertation presents key components of building clinically relevant machine learning diagnostic system for Alzheimer’s disease and dementia.

# PREFACE

It was a dark and stormy night; the rain fell in torrents — except at occasional intervals, when it was checked by a violent gust of wind which swept up the streets (for it is in London that our scene lies), rattling along the housetops, and fiercely agitating the scanty flame of the lamps that struggled against the darkness.

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# LIST OF ABBREVIATIONS

BU Boston University

ISO International Standards Organization

RCMP Royal Canadian Mounted Police

*(The abbreviations must be listed in alphabetical order, NOT by the order in which they appear in the dissertation.)*

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# GLOSSARY

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# INTRODUCTION

## Alzheimer’s disease and dementia

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