Aleksander Lempinen

Automatic speech recognition in physics teacher education

Master's Thesis in Information Technology

February 25, 2019

University of Jyväskylä

Faculty of Information Technology

Author: Aleksander Lempinen

Contact information: aleksander.lempinen@outlook.com

Supervisors: Tommi Kärkkäinen, Daniela Caballero, and Jouni Viiri

Title: Automatic speech recognition in physics teacher education

Työn nimi: Automaattinen puheentunnistus fysiikan opettajakoulutuksessa

Project: Master's Thesis

Study line: Educational Technology

Page count: 15+0

Abstract: TODO: Abstract

Keywords: TODO: Keywords

Suomenkielinen tiivistelmä: TODO: Tiivistelmä

Avainsanat: TODO: Avainsanat

Glossary

TODO	TODO: Glossary

Contents

1 Introduction

abrakadabra

2 Literature review

The method for literature review is to start from a small set of relevant literature and continue the search for previous literature using their references and newer literature from "cited by" list provided by Google Scholar.

TODO: Automatic speech recognition (Hirsimaki, Pylkkonen, and Kurimo 2009; Mansikkaniemi, Smit, and Kurimo 2017)

TODO: Natural language processing (Gambhir and Gupta 2017; Tuhkala, Kärkkäinen, and Nieminen 2018)

Social network analysis is a popular network and graph theory based technique used in social sciences (Borgatti et al. 2009) and can be used to study relationships between people or other entities. It has been applied in physics education to study the effects of collaboration between students and their academic performance (Vargas et al. 2018). Techniques from social network analysis have also been applied to study relationships between other entities than people such as concepts or topics (McLinden 2013). A proof of concept has already been done using the same QuIP data and Aalto ASR using social network analysis to visualize the relationships between physics keywords (Caballero et al. 2017).

3 Research topic

TODO: ?

4 Research questions

The aim of the research is to develop a method for automatic feedback of lesson quality from automatic speech recognition data. Due to the nature of automatically generated transcripts, feature engineering and feature extraction is a critical preprocessing step which will affect everything down the data analysis pipeline.

This research has the following research questions:

1. What preprocessing steps can improve the results of network analysis?
2. Can unsupervised machine learning such as association rule mining provide additional insight?

5 Research strategy

The research strategy is learning analytics/data analytics.

6 Dataset

The dataset is from QuIP project (Fischer et al. 2014) consisting of 25 Finnish lesson transcripts generated by Aalto ASR (Hirsimaki, Pylkkonen, and Kurimo 2009; Mansikkaniemi, Smit, and Kurimo 2017) and data from 756 students. The topic of the lesson is related to electricity and students were tested before and after the lesson with a standard tests. Transcript output from Aalto ASR has 5 second splits and there is a set of physics related keywords available.

7 Data analysis

The bulk of data analysis will be to expand existing network analysis on QuIP data with different kinds of preprocessing to obtain different features and relationships for the graph measures. In addition the results will be compared to unsupervised machine learning methods such as association rule mining.

8 Results

The expected results of this research would be improved preprocessing approaches for network analysis of physics lesson transcripts after automatic speech recognition and alternative machine learning based approaches to network analysis.

9 Conclusions

Research is being done in collaboration with the Department of Teacher Education at University of Jyväskylä and Centro de Investigación Avanzada en Educación (CIAE) at Univeristy of Chile.

Bibliography

Borgatti, Stephen P, Ajay Mehra, Daniel J Brass, and Giuseppe Labianca. 2009. "Network analysis in the social sciences". *science* 323 (5916): 892–895. doi:10.1126/science.1165821.

Caballero, Daniela, Roberto Araya, Hanna Kronholm, Jouni Viiri, André Mansikkaniemi, Sami Lehesvuori, Tuomas Virtanen, and Mikko Kurimo. 2017. "ASR in classroom today: automatic visualization of conceptual network in science classrooms". In *European Conference on Technology Enhanced Learning,* 541–544. Springer. doi:10.1007/978-3-319-66610-5_58.

Fischer, Hans E, Peter Labudde, Knut Neumann, and Jouni Viiri. 2014. *Quality of instruction in physics: Comparing Finland, Switzerland and Germany.* Waxmann Verlag.

Gambhir, Mahak, and Vishal Gupta. 2017. "Recent automatic text summarization techniques: a survey". *Artificial Intelligence Review* 47 (1): 1–66. doi:10.1007/s10462-016-9475-9.

Hirsimaki, Teemu, Janne Pylkkonen, and Mikko Kurimo. 2009. "Importance of high-order n-gram models in morph-based speech recognition". *IEEE Transactions on Audio, Speech, and Language Processing* 17 (4): 724–732. doi:10.1109/TASL.2008.2012323.

Mansikkaniemi, André, Peter Smit, and Mikko Kurimo. 2017. "Automatic Construction of the Finnish Parliament Speech Corpus". In *Proc. Interspeech 2017,* 3762–3766. doi:10.21437/Interspeech.2017-1115.

McLinden, Daniel. 2013. "Concept maps as network data: analysis of a concept map using the methods of social network analysis". *Evaluation and program planning* 36 (1): 40–48. doi:10.1016/j.evalprogplan.2012.05.001.

Tuhkala, Ari, Tommi Kärkkäinen, and Paavo Nieminen. 2018. "Semi-automatic literature mapping of participatory design studies 2006–2016". In *Proceedings of the 15th Participatory Design Conference: Short Papers, Situated Actions, Workshops and Tutorial-Volume 2,* 6. ACM. doi:10.1145/3210604.3210621.

Vargas, David L, Ariel M Bridgeman, David R Schmidt, Patrick B Kohl, Bethany R Wilcox, and Lincoln D Carr. 2018. “Correlation between student collaboration network centrality and academic performance”. *Physical Review Physics Education Research* 14 (2): 020112. doi:10.1103/PhysRevPhysEducRes.14.020112.