Visualizing Child-Adult engagement in preschool classrooms using Chord Diagrams

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Visualizing Child-Adult Speech Engagement using Chord Diagrams for Audio Recorded in Preschool Classroom

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Abstract

The ability to assess conversational interactions creates a challenge in assessing speaker turns over time, including frequency of occurrence, duration of each turn, and connecting speakers in a multispeaker context. This is of particular interest in the analysis of teacher-student or adult-child interactions in learning spaces. The creation of a visualization mechanism capable of providing a high-level representation of the overall conversational interactions without overburdening educators in reviewing student/child learning engagement would be of great significance. Chord diagrams can visualize such complex and disparate information in compact form. In this study, we explore the creation of ‘Chord Diagrams’ as a way to analyze talk time between a child and adult speakers in learning spaces. The proposed illustration provides an opportunity to study the variations in speech duration and the interaction among speakers that are involved in the communication with each other over a certain time learning duration.

Description

Motivation

The development of speech and language is a very critical aspect for a child’s long term learning ability and educational growth. If a child is not exposed to a multitude of language environments, then there is a risk that it could have a negative impact on the child’s language growth[1]. Recent studies [2-4] have shown that the LENA recorder (see figure 1) allows for the collection and initial analysis of these interactions between the parents and children. Chord diagrams are visual mapping tools to present the density of conversations among speakers. The speakers involved in each conversation can be seen from the chord connecting them (within the circle) and so they are referred as Chord Diagrams. This tool was previously used on NASA Apollo conversational audio data[5-6] to study the interactions between astronauts and CAPCOM. In this study we hypothesize that the
creation of Chord diagrams would help visualize the engagement between teachers and children as such conversations are characterized by quick turn taking of short duration talk.

Figure 1. Violet Colored Lena Device in pocket of a jacket worn by children/adults.

Figure 2. Illustrative Example of a day in a Preschool Classroom.

**Dataset**

The dataset in this study contains a spontaneous conversational speech which was recorded with aid of the LENA device. This device is a digital audio recorder which is lightweight and compact. This device was attached to children aged 3-5 years. The purple-colored device shown in the figure is used only to capture voice of naturalistic conversations, the audio was analyzed offline using human
transcriptions to develop further on speech technology advancements. Multiple sessions were recorded in a U.S. childcare center (see figure 2) across 2 classrooms, and some of the sessions have LENA recorders being worn by the adults. A total of 208 hours of speech and non-speech audio were transcribed by the UT Dallas-CRSS transcription team except the break, sleep and play times. Conversations having engagements were marked for some of the sessions (in addition to the text transcription), to visualize them as proposed before.

Method

Programs were developed to calculate the total talk time duration of the conversations with existing engagements among the speaker categories (also referred to as speakers), and this was achieved using the engagement specific transcribed text. The Primary Child (PC) was the child that was wearing the LENA recording device, the other children were known as the Secondary Children (SC), and the adult teachers were known as Adults (AD). The talktime information from the engagement transcripts are compiled using python programs to show the amount of talk time between the speaker categories and are visualized here using Chord Diagrams from the tool plotapi [7]. The circumference of the circle represents the conversations among the speaker categories in terms of arcs comprising of arc islands. Red arc is used to represent the AD category, blue arc is used to represent the SC category, and lastly green arc is shown to represent the PC category. Each arc island along the circumference represents a specific conversational exchange. The width of the arc island represents the total duration of the talk time between the related speakers in that exchange. The chords connecting the arc islands represent the duration of interactions among two of the connected speaker categories.

Analysis

Figure 3 illustrates the proposed Chord Diagram which consists of the following three speaker categories: PC, SC, AD. We can see that the last exchange among the three speakers (referred from now as conversation A) has an arc island of good width and is the highlighted one having a total duration of 49.1 seconds of engagement between the speakers. However, the individual speaker talk times are different as in this example SC has lesser talktime with AD as compared to PC, which can be perceived from the width of the connecting chord. Thus, the duration of interaction among 2 speaker categories can be described by the thickness of each individual chord. The length of the circumference of each arc in the Diagram represents the total talktime duration for the concerned speaker in the recording (e.g., 525 seconds by PC in this example).
Conclusion

This study has proposed the use of Chord Diagrams as a viable tool to visualize communications within child-adult learning spaces from a broad perspective. Such interactions among speakers can reflect conversational engagement given that speaker ID tag as well as transcriptions with text are provided. A natural next step in this study would be to assess educator’s ability to interpret Chord Diagrams. Further we would like to utilize speech diarization/recognition technology for automating the transcript generation process as well as child-adult tagging, and thereby allowing for conversational engagement-based Chord Diagram generation as a visualization tool for studying child/student to adult/teacher learning interaction.
References


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As an assistant research professor at Juniper Gardens Children’s Project (JGCP) at the University of Kansas, Dr. Dwight Irvin's research interests center on developing/refining measurement approaches to: 1) capture movement and location in young children at-risk for or with intellectual and developmental disabilities; 2) better understand and enhance the language environments that these children experience in school, home, and community settings. He directs and codirects several research projects from federal agencies. For example, he leads an Institute for Education Sciences project titled, Validity Studies of the Classroom Code for Interactive Recording of Children’s Learning Environments; this project focused on validating the use of the CIRCLE, an observational instrument designed to close the literacy gap for all learners. He also directs a National Science Foundation project focused on using existing wearable technology and advanced speech recognition/diarization algorithms to monitor student engagement over time in science activity areas in classroom and community-based settings.

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