Visualizing Child-Adult engagement in preschool classrooms using Chord Diagrams

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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 multi-speaker 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. 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 is suggested to provide 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], [3], [4] have shown that the LENA recorder (see figure 2) allows for the collection and initial analysis of these interactions between the parents and children. In this study we would like to suggest that the creation of Chord diagrams would help visualize the engagement of such conversations between teachers and children as such conversations can be captured for fixed duration of time in preschool classrooms (see figure 1)

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 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 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 child was known as the Secondary Child (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 speakers and are visualized here using Chord Diagrams from the tool plotapi [5]. The circumference of the circle represents the conversations of the speakers.

Analysis

Figure 3 illustrates the proposed Chord Diagram which consists of the following three speaker categories: PC, SC, AD/TE. Red is used to represent the adult speaker (or teacher, AD/TE), blue is used to represent the secondary child speaker (SC), and lastly green is shown to represent the primary child speaker (PC). 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. For example, in figure 3 we can see that the last exchange among the three speakers (referred from now as conversation A) has an arc of good width and is the highlighted one having a total duration of 49.1 seconds of engagement between the speakers. The length of the circumference of the Diagram represents the total talktime duration for the concerned speaker in the recording (e.g., 525 seconds by PC in this example).

Figure 1. Illustrative Example of a day in a Preschool Classroom

Figure 2. Violet Colored Lena Device in pocket of a jacket worn by children/adults

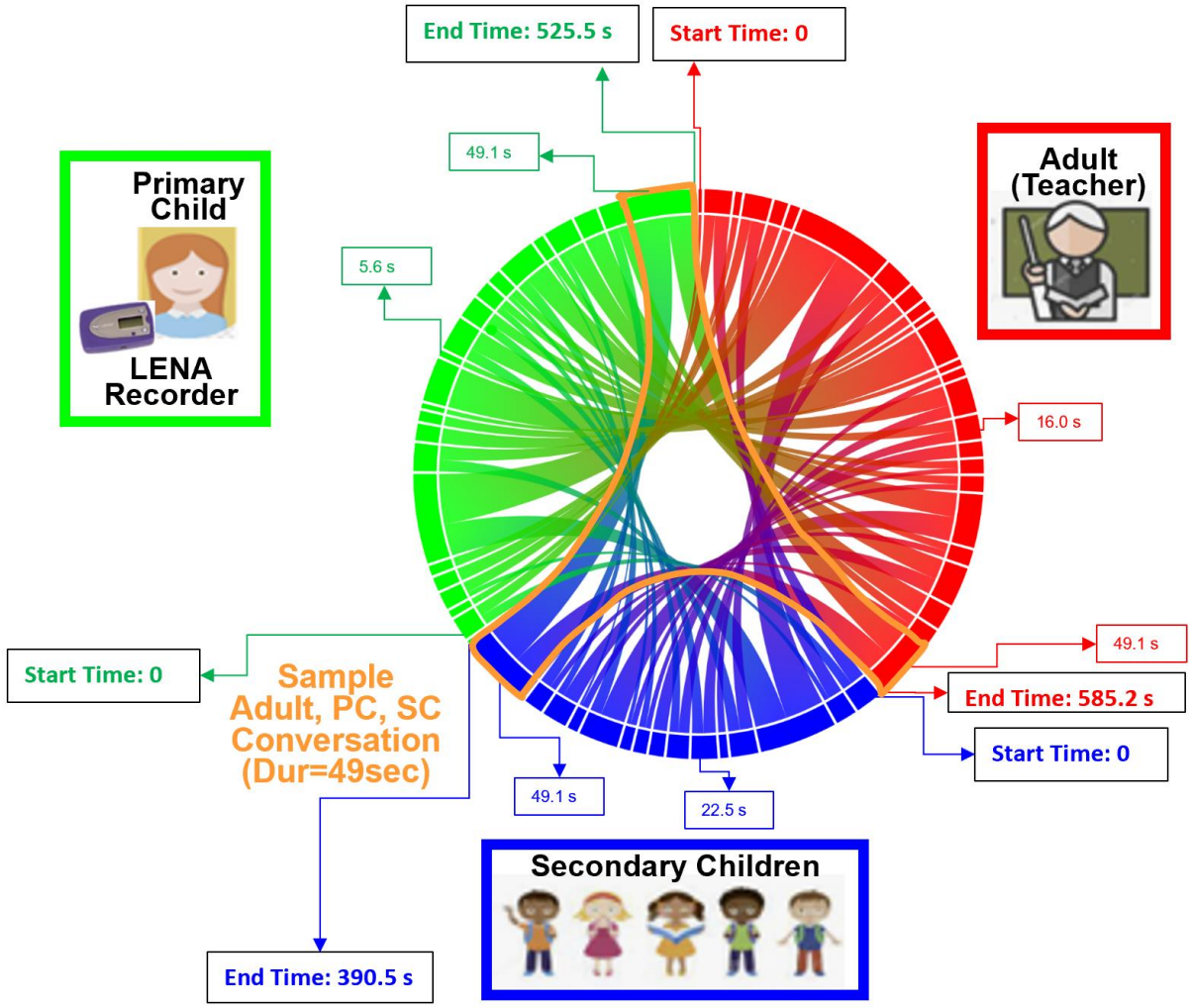

Figure 3. Proposed Chord diagram with highlighted conversation A among the three speakers

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 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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[5] https://plotapi.com/

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Dr. Dwight Irvin, JGCP, University of Kansas, KS, USA

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 co-directs 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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As an Associate Research Professor at the University of Kansas, Dr. Buzhardt's research interests focus on developing and testing technology solutions to support data-driven intervention decision making in early childhood education. At Juniper Gardens Children's Project (JGCP), he leads the Technology Innovation Development & Research (TIDR) Lab, which is a hybrid of onsite fulltime application developers and externally contracted developers, where online and mobile applications are designed, developed, tested, and maintained for nearly all JGCP interventions that utilize technology. Through grants funded through OSEP and IES and led by Dr. Buzhardt, the TIDR Lab developed and currently maintains the MOD and IGDI platform where it is hosted. Additionally, Dr. Buzhardt has led or co-led 10 federal grants from the Department of Education (5 from Office of Special Education Programs, 5 from Institute of Education Sciences) and four from the National Institute on Disability, Independent Living, and Rehabilitation Research. He currently directs a project funded by the Institute of Education Sciences to develop a web application that guides educators' data-driven intervention decision making. He also leads a $2.5M project funded by the Office of Special Education Programs to develop and test strategies and applications grounded in Implementation Science to scale-up sustained use of data-driven decision-making practices by infant-toddler service providers. He recently completed a 2nd successful RCT of the MOD across four states to test web-based decision-making support vs. self-guided decision making in Early Head Start home visiting settings. Other relevant projects include investigations of the construct and predictive validity of infant-toddler IGDI assessments, development of web-based professional development for elementary educators, and a current NSF-funded project to develop technology to automatically measure child and adult language in preschool and informal learning contexts