

Artificial Intelligence Based Assimilation Of Childhood Impairment

HENNA ABDUL AZEEZ

BIG DATA ANALYTICS

SRM UNIVERSITY

Chennai

henna_abdulazeezv@srmuniv.edu.in

S.DEEPANJALI

INFORMATION TECHNOLOGY

SRM UNIVERSITY

Chennai

Deepanjali.s@ktr.srmuniv.ac.in

Abstract: Speech and Language impairment among children is defined as a genre of communication disorder which hinders not only the child's educational performance, but also makes it onerous for a standard communication. The problem in grasping others thoughts, ideas and feelings is categorized as Receptive Language Impairment and the trouble in expressing one's own idea is characterized as Expressive Language Impairment. Both of this Impairment are grouped together and termed as Language Impairment. The main challenging hurdle for the kids with impairment is their incompetency in social interaction. Therefore there is a crucial need to develop NLP applications to support impaired kids by detecting the disorder at an earlier stage. The goal of this article is to Predict whether the child is impaired or not. Classification of the impairment type and intensity computation in terms of percentage

Keywords: speech impairment, expressive language impairment, receptive language impairment.

I. INTRODUCTION

Discovery of impairment at a preliminary phase might lead to comparatively painless rectification of the disorder. Speech-Language impairments are the most common childhood deficits which affect about every 1 in 12 children. Children are classified in to two categories. Typically Developing (TD) children who perform according to the expected norm and impaired children who are lagging in some aspect of communication disorder, which can be either speech impairment or language impairment. The consequences of untreated Speech-Language impairment in children might lead to behavioral challenges, mental health complications, reading difficulty and even academic failure. Therefore an adequate model is to be evolved for a binary classification which primarily classifies the kids as either TD (Typically Developing), Speech Impaired or LI (Language Impaired). The identification of LI can be extended with fine grained classification on type of Impairment the kid is affected with namely Receptive or Expressive. Given below are the various scenarios in which a kid is impaired or not can be suspected. Expeditious identification of impairment results in easy rectification of the disorder.

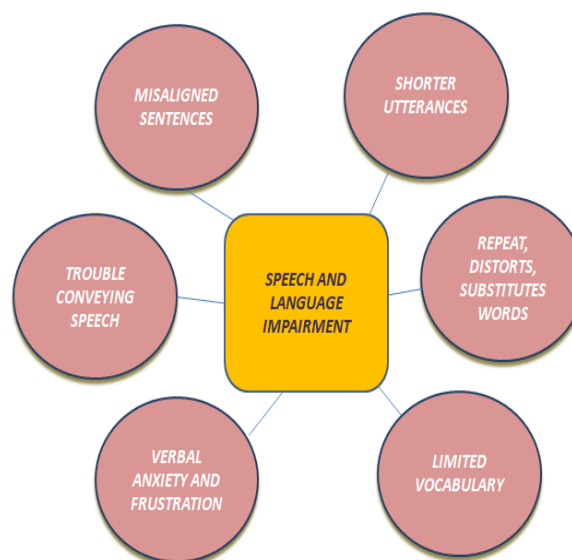


Fig. 1. Speech and Language Impairment Symptoms

SPEECH IMPAIRMENT

Speech is the main mode through which we communicate. Speech impairment is an infirmity in which the ability to produce speech sounds that are mandatory to communicate with others are impaired. Speech impediments are disordered diction which is different from language disorders. The level of Speech disorder varies from mild to severe, such as mispronouncing occasionally to not being able to pronounce at all. Some of the main reasons for speech impairment are proven to be weakening of speech muscles caused by injured nerves, throat cancer, upward movement of stomach's acid etc. Speech impairment can produce a negative impression on social development of the child which may lead to social isolation, humiliation and embarrassment. The most common speech disorders are articulation, disfluency and voice disorders.

ARTICULATION DISORDER:

Articulation Disorders are designated as the distortion and deprivation of speech sounds where the child experiences trouble pronouncing blended sounds. An articulation disorder may be accredited to neurological disorders, hearing loss, physical disorders such as cleft lip or pitfall with the location of articulators. Children that are obscure to others at the age of 'three' or older might be exhibiting an Articulation Disorders. Additionally, if they are inadequate to vocalize sounds that the preponderance of their peers has acquired they may be showing signs of Articulation Disorders. Features of children with Articulation Disorders are:

- Delete sounds: The child says "PLAI" instead of "PLAIN"
- Substitute sounds: The child says "FIROR" instead of "MIRROR"
- Add sounds: The child says "BLANFITI" instead of "BLANKET"
- Distort sounds: The child says "TFOON" instead of "SPOON"

If the idiosyncratic sounds thrived by certain ages is not as expected, then the child could have an Articulation Disorder.

FLUENCY DISORDER:

Fluency is the aspect of articulation that indicates to the smoothness, continuity, rate and effort of the speech. Sluttering and Cluttering are the major two types of fluency disorders. Sluttering, the most common inarticulacy, is an obtrusion in the flow of articulation characterized by recapitulation. Sluttering routinely has its origin in the childhood. Most of the children who slutters set the root to it are at around the age of two and half years. Sluttering can greatly interfere with school, work or social interactions. Children who slutters may report agitation or dismay about social speaking and humiliation or resentment with the effort and time required to speak. Cluttering, another fluency disorder is characterized by haphazard speech rate which results in breakdown in the clarity of the speech.

VOICE DISORDER:

Voice impediments are medical conditions involving quality of the sound constructed, abnormal pitch or loudness. The sound created by the vocal cords is passed through the throat, nose and mouth, resulting in the sound "resonance". The sound of each individual voice is determined by the shape and size of the vocal cords and the shape and size of the throat, nose, and mouth. Voice Disorders are often caused due to vocal abuse or misuse, such as superabundant use of voice when singing, talking and in such activities.

LANGUAGE IMPAIRMENT

Language Impairment are language disorders that interfere with communication which makes it harder to find the right words and form clear sentences while speaking. Trouble in either understanding or expressing contents is the indication of language impairment. Language impairment is classified as two types:

RECEPTIVE LANGUAGE IMPAIRMENT:

Receptive language is the calibre to grasp. Impairment which involves brain hitch is classified as Receptive Language Impairment. Reading and listening skills comes under this category. Children will have difficulty in understanding what others are saying. The kids even find it strenuous to follow simple instructions or in organizing the information they perceive. Receptive Language Impairment is hard to spot in young children.

EXPRESSIVE LANGUAGE IMPAIRMENT:

Expressive language is the mastery to communicate. Impairment which involves arduous in expressing the content which they imbibe and with proper functioning of brain is classified as receptive LI. This type of disorder involves difficulty in expressing ideas. This kind of Impairment is easier to identify at an early stage since most of the children with Expressive Language Impairment start talking late.

II. PROPOSED RESEARCH

The primary task of the proposed system is a binary classification problem which prognosticates whether the child is impaired or not. This can be done by comparing the input text framed by the child for the image generated by the system and the sentence automated by the model using deep learning. If both the sentences are matching semantically and structurally, the system stratifies the child as Typically Developing or else the child is classified as Impaired. If the child is impaired, the next task is to spot the type of impairment possessed. Following the fine-grained classification of the disorder, therapy is given to the kid via pictures for the identified impairment to overcome it.

Proposed system design:

The main challenge of the intended system is text classification.

Different stages of text classifications for a sentence generator are:

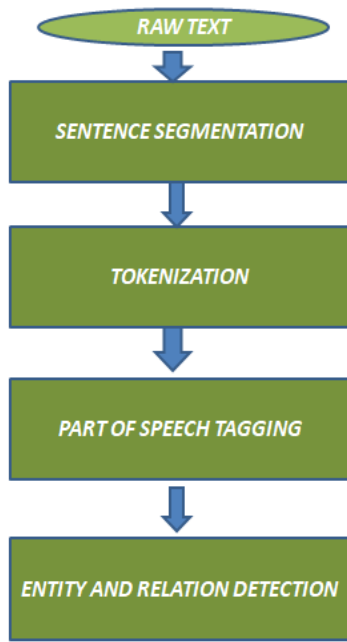


Fig. 2. Sentence generator flow chart

The input text which is in string format is subjected firstly to segmentation which results in a list of strings. The list of strings is then tokenized which gives a list of lists of strings. The current output is submitted to part of speech tagging where each word in the sentence is classified in to its parts of speech and are labelled accordingly. The list of lists of tuples outputted by the pos tagger then undergoes entity and relation detection. Final output of the sentence generator will be a list of tuples defining the relation.

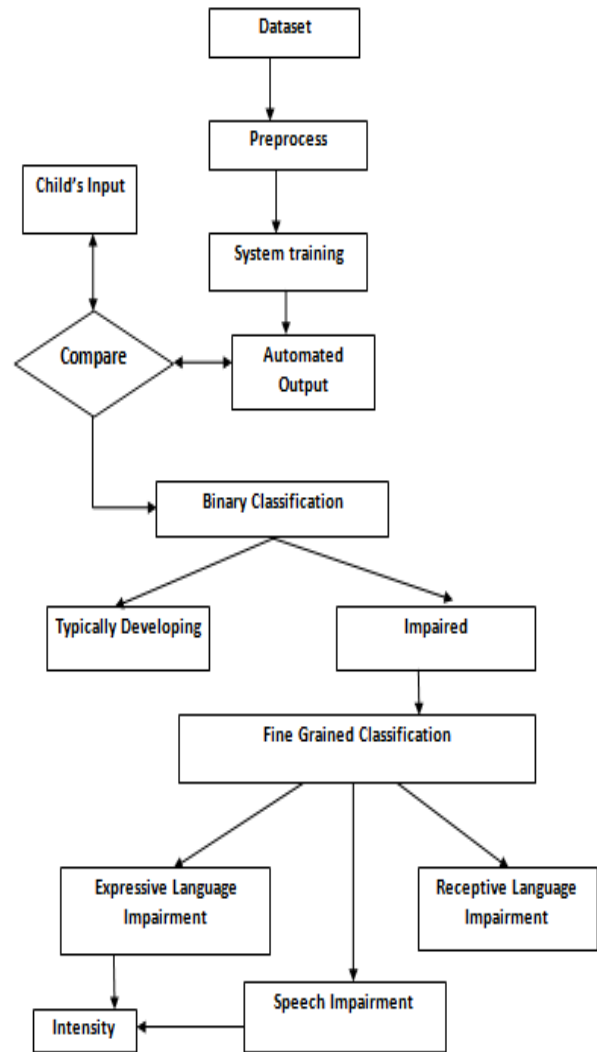


Fig. 3. Architectural diagram of proposed system

The proposed system uses image dataset. The entire dataset is subjected to pre-processing stage in which each and every single image in the dataset is resized to a particular scale. Convolutional Neural Network (CNN) is the deep learning approach used to train the entity which is a multi-layered feed forward neural network. CNN are made up of neurons which have learnable weights and biases. Each neuron accepts some inputs, calculates a dot product operation. A CNN consists of an input layer, 'n' number of hidden layers and an output layer. The input layer receives normalized images with same sizes. A set of units in the local receptive field in the input layer will be processed by a convolution kernel to form a unit in a feature map of the subsequent convolutional layer. In

the feature map, one pixel can be calculated by using the formula:

$$C_k = f(x * W + b)$$

“C_k” is the value of the k-th pixel in the feature map, “x” is the pixel-value of the units in, “W” is the coefficient vector and “b” is the bias value respectively, determined by the feature map. “f” is the activation function also known as sigmoid function.

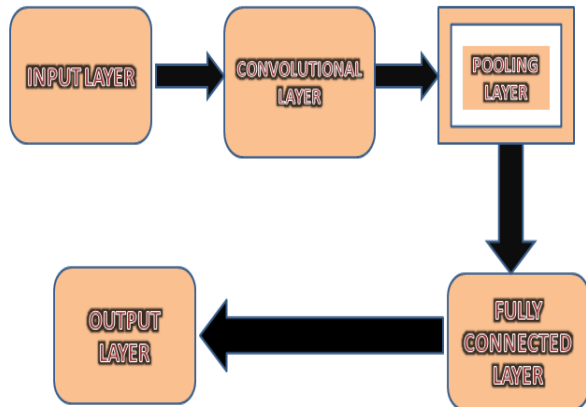


Fig. 4. Flow diagram of CNN for Image Classification

Convolution is the act of creating feature map from original dataset. Pooling is the second stage followed by the convolution process which is normally termed as “max-pooling” where we take the maximum value from a selected region and that becomes the new value for the entire region. Fully Connected Layers are typical neural networks where all the nodes are “fully connected”. The convolutional layers are not fully connected like typical neural networks.

For the given input image, an automated output will be generated by the system which is compared with the input of the child. Based upon the similarity measurement, the binary classifier classifies the child either as typically developing or impaired. Following the binary classification, if the output is “impaired” then a fine grain classification is performed diagnosing the type of impairment possessed. The fine grain classification is done implementing various context free grammar rules. A context-free grammar is defined as a finite set of grammar rules which is quadruple (N, T, P, S) where

N is a set of non-terminal symbols.

T is a set of terminals, where $N \cap T = \text{NULL}$.

P is a set of rules, $P: N \rightarrow (N \cup T)$

S is the start symbol.

Sample CFG productions:

- S -> NP VP | VP | AUX NP VP
- VP -> V NP | V NP PP
- PP -> P NP
- NP -> Det N | Det N PP
- Det -> "a" | "an" | "the" | "my"
- P -> "in" | "on" | "by" | "with"

S is the sentence which can contain either the combination of noun phrase and verb phrase or the combination of auxiliary, noun phrase and verb phrase or just the verb phrase. PP is preposition phrase. “In”, “On”, “By”, “With” are various prepositions. Det is determinor. “A”, “An”, “The”, “My” are various determinors. Aux is Auxiliary. “Do”, “Does” are some auxiliary terms. VP is the verb phrase consisting of the verb and the noun phrase or verb, noun phrase and preposition phrase. NP is the noun Phrase which includes determinor and the noun or determinor, noun and the preposition phrase.

For the analyzed Expressive LI and Speech impairment, the severity of the disorder is calculated in terms of percentage.

III. ENVISAGED RESEARCH

The proposed research work “Artificial Intelligence Based Assimilation of Childhood Impairment” would envisage the following:

- Binary Classification System detecting whether a child is Impaired or typically developing.
- Recognition of impairment type.
- Tracking the intensity of disorder in percentage.

IV. CONCLUSION AND FUTURE WORK

From this proposal, we came across several deep natural language processing features including syntactic and semantic, probabilistic and situational model features, various impairment features. In the future, we plan to extend as a therapy for both speech and language impairment.

V. REFERENCES

- [1] U.S. Preventive Services Task Force. Screening for Speech and Language Delay in Preschool Children: Recommendation Statement. Pediatrics. 2006;117:497–501. Available at: <http://www.ahrq.gov/clinic/uspstf06/speech/speechchs.htm> Accessed May 9, 2008. [PubMed]
- [2] Boudreau DM, Hedberg NL. A comparison of early literacy skills in children with specific language impairment and their typically developing peers. Am J Speech-Lang Pathol. 1999;8:249–260.
- [3] Shonkoff JP, Phillips DA. From Neurons to Neighborhoods: The Science of Early Childhood Development. Washington, DC: National Academies Press; 2000.

- [4] Sices L, Feudtner C, McLaughlin J, Drotar D, Williams M. How do primary care physicians identify young children with developmental delays? A national survey. *J Dev Behav Pediatr.* 2003;24:409–417. [PubMed]
- [5] American Speech-Language Hearing Association. Definitions of communication disorders and variations. ASHA. 1993;35(Suppl 10):40–41. [PubMed] Wei Zheng, Dale F. McLerran, Betsy Rolland, Xi-anglan Zhang, Manami Inoue, Keitaro Matsuo, Jiang He, Prakash Chandra Gupta, Kunnambath Ramadas, and Shoichiro Tsugane, “Association between body-mass index and risk of death in more than 1 million Asians,” *New England Journal of Medicine*, vol. 364, no. 8, pp. 719–29, 2011
- [6] Lubker BB. Language learning disorders in children with chronic health conditions: epidemiologic perspectives. *Perspectives in Language Learning and Education.* 1997;4:2–5.
- [7] Markowitz J, Carlson E, Frey W, et al. Preschoolers' Characteristics, Services, and Results: Wave 1 Overview Report from the Pre-Elementary Education Longitudinal Study (PEELS) Rockville, Md: Westat; 2006.
- [8] Glascoe FP. Can clinical judgment detect children with speech language problems? *Pediatrics.* 1991;87:317–322. [PubMed]
- [9] Olswang L, Rodriguez B, Timler G. Recommending intervention for toddlers with specific language learning difficulties: We may not have all the answers, but we know a lot. *Am J Speech-Lang Pathol.* 1998;7:29.
- [10] Glascoe FP. The value of parents' concerns to detect and address developmental and behavioral problems. *J Paediatr Child Health.* 1999;35:1–8. [PubMed]
- [11] Bates E. Commentary: Comprehension and production in early language development. *Monogr Soc Res Child Dev.* 1993;58:222–242. [PubMed]
- [12] Fails, J. A., Druin, A., & Guha, M. L. (2010). Mobile Collaboration: Collaboratively Reading and Creating Children's Stories on Mobile Devices. The 9th International Conference on Interaction Design and Children, 20-2.
- [13] McLeskey, J., & Waldron, N. (2007). Making differences ordinary in inclusive classrooms. *Intervention in School and Clinic*, 42(3), 162–168.
- [14] Sutton, S., & Olivier, P. (2013). Speech and Language Therapists, Their Patients and Mobile Apps.
- [15] H. Korhonen and E. M. I. Koivisto, “Mobile Entertainment: Playability heuristics for Mobile Games”, *Proc. of MobileHCI*, ACM Press, 2006, 9-16.

