A Diagnostic Tool for Speech Disorders based on NLP with Ontological Reasoning

Authors:

María Somodevilla García, Stephanie Vázquez González, Ivo Pineda Torres, Concepción Pérez de Celis Herrero

Benemérita Universidad Autónoma de Puebla, Facultad de Ciencias de la Computación. Puebla, México

Motivation

- 0.45 million people with some type of speech disorder
- Twice or four times higher in kids and young people
- Worse socioeconomic outcomes and poverty than persons without disabilities
- Importance of early detection
- An ontology is proposed to organize and to look up information
- Conformation of a Corpus for the ontology

State of the art

- Tools for the formation of professionals in training process

- Focus on some specific ailments

- Classify quality of pronunciation

- Therapy activities for children that uses colloquial language

- Not made for less specialized users, focused in a single or a very specific disorder, targeting only repetition

Corpus building

- Build a corpus $\rightarrow$ obtain a data source for a expanded taxonomy and validate the classes and subclasses mainly

- Representative amount of those documents $\rightarrow$ cleaned up and standardized

Corpus building tasks

- Establish a primary dictionary

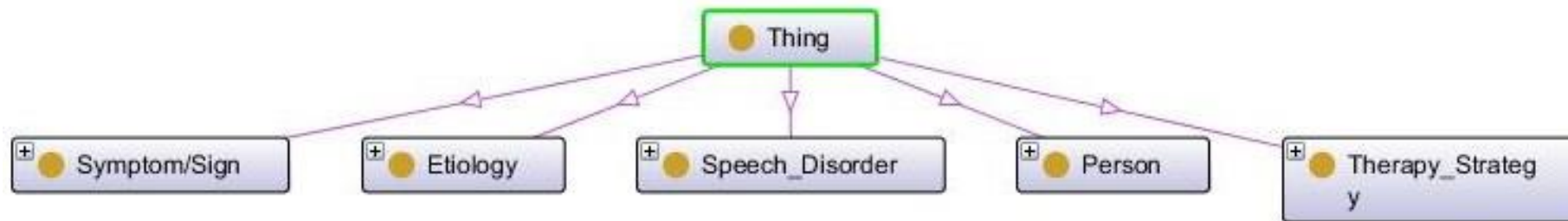- Include synonyms, hyponyms and hypernyms

Corpus building(2)

Taxonomy design

▶ Expand the taxonomy to include all the speech disorders referred by the retrieved documents

▶ Include taxonomies about etiologies, therapy strategies, persons, and signs and symptoms

Number of initial terms used in the gathering of documents.	15
Number of offline documents added to the corpus.	250
Number of documents obtained at the end of web crawling.	1097
Corpus size of plain text in bytes.	8,416,391

Ontology development

▶ Define main classes and competency questions:

  ▶ Which is the most common speech disorder in children?

  ▶ Which are the symptoms of a speech disorder?

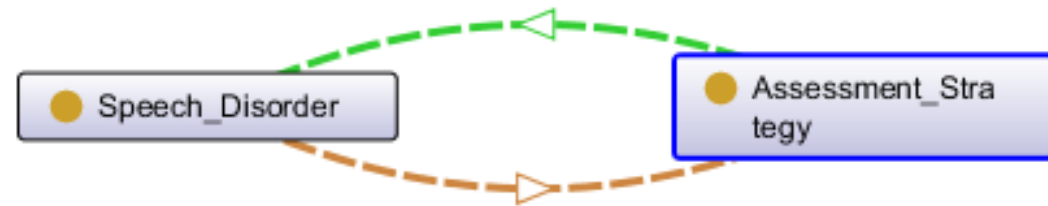 ▶ How many types of speech disorder exist?

Class Definition

Class	Definition
Speech_Disorder	This class contains the whole taxonomy of speech disorders.
Etiology	This class includes the taxonomy of the speech disorders' different causes.
Person	This class includes the different individuals that are diagnosed with (Patient) or diagnose a speech disorder (Therapist).
Symptom/Sign	Class including the different symptoms or signs that are presented by a patient with a speech disorder.
Therapy_Strategy	Class containing the two main parts of the therapy actions applied to patients.
Articulation_Disorder	Subclass of Speech_Disorder, consists in the difficulty to pronounce sounds.
Rythm_and_Fluency_Disorder	Subclass of Speech_Disorder, refers to an alteration in the speech rhythm.
Voice_and_Resonance_Disorder	Subclass of Speech_Disorder, is a voice alteration in the volume, tone or timbre.

Relations description

Relation	Domain	Range	Inverse	Cardinality
Affects_to	Speech_Disorder	Patient	Suffers_a	N:1
Applies_a	Therapist	Therapy_Strategy	Is_applied_by	1:N
Evaluates_a	Assess-ment_Strategy	Speech_Disorder	Is_Evaluated_By	1:1
Gives_therapy_to	Therapist	Patient	Re-ceives_therapy_from	1:N
Has_Cause	Speech_Disorder	Etiology	Is_cause_of	1:N
Intervenes_a	Interven-tion_Strategy	Speech_Disorder	Is_Intervened_by	1:1
Is_manifestation_of	Symptom/Sign	Speech_Disorder	Is_manifested_by	N:1
Is_shown_by	Symptom/Sign	Patient	Shows_a	N:1

▶ The axioms -rules for the ontology- set by the characteristics and the existential restrictions of the non-taxonomic relations

Relations description (2)

- Consistency Test → Probe class technique

- Primitive and defined classes → Necessary and sufficient conditions

Relations description (3)

- Characteristics and restrictions defining and describing the classes → ontology answer the competency questions and infer knowledge

- Population → data gathered from therapists working in public institutions such as elementary schools

- Evaluation work along a group of therapists to test the efficiency and usefulness of this ontology as a diagnosis tool is in progress

Results and conclusions

- First version of the ontology that is consistent
- Taxonomy with five main classes, and more than one hundred sub-classes
- 18 relations between individual, existential restrictions and characteristics for the classes were set and definition of primitive and defined classes
- Tool for information description, answer questions related to the competence area
- Helpful:
  - theoretical information for diagnose
  - formulate a therapy plan
  - report of characteristics, symptoms and signs

Future Work

- Audio transcription tool

- Analysis of transcript text by metrics like Levenshtein distance

- Google Cloud Speech-to-text $\rightarrow$ variation in pronunciation less word correction

▶ Any Questions?

A Diagnostic Tool for Speech Disorders based on NLP with Ontological Reasoning

Authors:
 María Somodevilla García, Stephanie Vázquez González, Ivo Pineda Torres, Concepción Pérez de Celis Herrero

{mariajsomodevilla, stephanie.vazquez, ivopinedatorres, mpcelish}@gmail.com