Konkani WordNet Visualizer as a Concept Teaching-Learning Tool

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Abstract

The Visualizer is a tree-structure designed to browse and explore the Konkani Wordnet lexical database. We propose to utilise this tool as a concept teaching and learning resource for Konkani, to be used by both teachers and students. It can also be used to add the missing semantic and lexical relations, thus enhancing the Wordnet. It extracts related concepts for a given word and displays them as a sub-tree. The interface includes various features to offer users greater flexibility in navigating and understanding the word relationships. We attempted to enrich the Konkani Wordnet qualitatively with a Visualizer that offers an improved usability and is incorporated in the Konkani Wordnet website for the public use. The Visualizer is designed to provide graphical representations of words and their semantic relationships, making it easier to explore connections and meanings within the lexical database.

Keywords— Konkani Wordnet, Visualizer Tool

1 Introduction

The Konkani WordNet (Walawalikar et al., 2010; Desai et al., 2017) is a lexical resource developed to support various NLP tasks in the Konkani language (Wikipedia, 2024). Also known as Konkani Shabdamalem, it was created as part of the Indradhanush WordNet Project Consortium between August 2010 and October 2013. In this project, along with the Konkani language WordNet, six other Indian languages—Bengali, Gujarati, Kashmiri, Odia, Punjabi, and Urdu WordNet were constructed using the expansion approach, with the Hindi WordNet serving as the source. Later, these WordNets were connected to the IndoWordNet (Bhattacharyya, 2010; Dash et al., 2017). The current version of the Konkani WordNet contains approximately 32,370 synsets and 37,719 unique words.

Konkani WordNet is a lexical database that provides detailed semantic relations between words like synonymy, hypernymy, hyponymy, meronymy, holonymy, etc. These relationships help in understanding word meanings and their interconnections, which is crucial for tasks in Natural Language Processing (NLP) and Machine Translation.

To effectively utilise this knowledge, a set of tools is necessary for querying, retrieving, and visualising information from the knowledge base. Data visualisation involves representing information schematically, including attributes or variables of the data units. The primary objective of visualisation is to present information clearly and effectively through graphical means. Our developed user interface provides a visual representation of the Konkani WordNet, allowing users to input a Konkani word and view related concepts based on its semantic and lexical relationships within the WordNet. Additionally, the Konkani WordNet Visualizer features speech pronunciations from the Shabdocchar corpus, an audio corpus enhanced by feature techniques, as discussed in another paper.

This paper is organised as follows. Section 2 presents related work. Section 3 offers an overview of the Konkani WordNet. Section 4 explains the Konkani WordNet Visualizer in detail. Section 5 outlines the implementation specifics. Section 6 explains the multilingualism of the visualizer. Section 7 explores using visualizer as a teaching-learning tool. Section 8 speaks about the future work. The conclusion and discussion are presented in Section 9.

2 Related Work

There are various tools for browsing and exploring WordNets (Miller, 1995) to better understand concepts and their semantic relations. One such tool, BabelNet Explorer (Navigli, 2013), is specifically designed to visualise the BabelNet lexical database (Navigli and Ponzetto, 2012). It uses a tree layout for intuitive navigation and covers languages such as English, Italian, Catalan, Spanish, German, and French.

The IndoWordNet Visualizer (Chaplot et al., 2014)[1] offers a graphical user interface for exploring WordNets across Indian languages, including Konkani. IndoWordnet's diverse lexical and semantic relations significantly deepen the understanding of word meanings and their intricate connections, making it an essential resource for linguistic analysis. Lexical relations include gradation (covering aspects like state, size, and color for all parts of speech), antonymy (addressing various attributes such as action and quality), compounds (for nouns), and conjunctions (for verbs). Semantic relations involve hypernymy and holonymy (for nouns and verbs), meronymy (which includes components, members, and features), troponymy (for verbs), and various relationships between nouns, adjectives, and verbs like similar attributes, function verbs, ability verbs, and capability verbs. Additional relations such as causative forms and nominal and verbal compounds are also provided. IndoWordnet Visualizer allows users

[1] https://www.cfilt.iitb.ac.in/indowordnet/

to visually explore these relationships, offering a clearer understanding of their interactions. One of the visualization implementation for english language is made available by Visuwords[2]. This implementation is interactive and visually appealing, making it suitable for learning concepts and semantic relations.

3 Overview of Konkani WordNet

The Konkani WordNet is a linguistic resource created to aid NLP tasks in the Konkani language. Known as Konkani Shabdamalem, it was developed under the Indradhanush WordNet Project Consortium from August 2010 to October 2013. The current version of Konkani WordNet comprises approximately 32,370 synsets and 37,719 unique words. The table below shows the POS category-wise break-up of Konkani WordNet Synsets

POS Category	Synset Count
Noun	23144
Verbs	3000
Adjectives	5744
Adverbs	482
Total synsets	**32370**

Table 1: POS Category-wise break-up of Konkani WordNet Synsets

The Konkani WordNet stores various relationships between words and groups of words, providing important insights into the language's structure. These relationships are divided into two main categories: lexical and semantic.

3.1 Lexical Relations

These are connections between individual words and include:

- **Gradation:** Differences in state, size, color, etc., for all types of words.
- **Antonymy:** Opposites for attributes like action, quality, and size.
- **Compound:** Combinations of nouns.
- **Conjunction:** Connections between verbs.

3.2 Semantic Relations

These are connections between concepts or synsets and include:

- **Hypernymy:** General terms for nouns and verbs.
- **Holonymy:** Whole-part relationships for nouns.
- **Meronymy:** Various part-whole relationships, like components and features.
- **Troponymy:** Specific types of actions for verbs.
- **Similar Attributes:** Relationships between nouns and adjectives with similar qualities.
- **Function, Ability, and Capability Verbs:** Different ways verbs relate to nouns.
- **Adverb Modifies Verb:** Relationships between adverbs and verbs.
- **Causative and Entailment:** How verbs influence each other.
- **Near Synsets:** Similar groups of words.
- **Adjective Modifies Noun:** Relationships between adjectives and nouns.

The Konkani WordNet Visualizer lets users see these relationships visually, making them easier to understand.

4 Konkani WordNet Visualizer

The Konkani WordNet Visualizer[3] is designed to visualise the words and its relationships in Konkani WordNet. It is publicly accessible on the Konkani WordNet website. Konkani is a low-resource language, and there has been a limited amount of work regarding tools and technology development. This scarcity underscores the need to accelerate the development process for the overall advancement of the Konkani language. This tool extracts related concepts for a given input word at various levels and presents a sub-tree on the screen. This visualizer is further modified as per the user-specific requirements. One such user requirement is to develop a teaching-learning tool for understanding language-specific concepts. For example, hypernymy-hyponymy relations can be used to make them understand the type-of relations between Konkani concepts. Similarly, holonymy-meronymy relations can be used to explain the part-of relationship between various Konkani concepts. Below is a description of the user interface layout and its features.

The visualizer interface offers various input and output features to facilitate exploration.

- **Input Features**:
  - Users can input a word to browse and explore.
  - Specify the number of child nodes per relation.
  - Set the maximum depth of the tree through designated textboxes.
- **Output Features**:
  - The interface provides a graphical representation of all related words and concepts in Konkani for the given input word.
  - Additionally, users can click on any node to play the pronunciation of the word, enhancing the interactive experience.

The next subsection elaborates the interactive features.

4.1 Interactive Features of Visualizer

- **Tree Format Display:** Word relations are visualised in a radial tree structure, with the root node at the centre and various child nodes branching out to represent different semantic relationships.

[2] https://visuwords.com/genus_cnemidophorus

[3] https://konkaniwordnet.unigoa.ac.in/

- **Root Node Representation:** The root node represents the searched word. It serves as the top point of the visualisation, with all other nodes linked to it to depict semantic relations.
- **Child Nodes for Semantic Relations:** The child nodes of the root node illustrate various semantic relations associated with the searched word. Each type of relation is depicted by different node colours.
- **Colour Coding for Semantic Relations:**
  - **Root Word:** Displayed in red to distinguish it as the primary or searched word.
  - **Holonyms:** Represented by yellow nodes, indicating whole-part relationships (e.g., "car" as a holonym for "wheel").
  - **Meronyms:** Shown in brown, representing part-whole relationships (e.g., "wheel" as a meronym of "car").
  - **Hypernyms:** Displayed in green, representing more general terms (e.g., "vehicle" as a hypernym of "car").
  - **Hyponyms:** Shown in blue, indicating more specific terms (e.g., "sedan" as a hyponym of "car").
- **Node Size for Hierarchical Importance:** The size of the root node is always larger than its child nodes, emphasising its central role. Holonyms of the root node are represented by larger nodes and positioned higher in the hierarchy, signifying their broader scope.
- **Solid-Colored Nodes:** Nodes filled with solid colour indicate the presence of child nodes or the ability to expand further. This feature helps users understand that there are additional relations or sub-trees available for exploration.
- **Pronunciation Playback:** Clicking on any node allows users to hear the pronunciation of the associated word in Konkani, enhancing the interactive and educational experience.
- **Path Highlighting:** When users hover over any child node, the path back to the root node is highlighted. This functionality allows users to follow the relationship paths and gain insight into how various nodes are connected to the words they are searching for.

4.2 Research Contributions

This tool can be used to identify the concepts in the WordNet which do not have any semantic relationships as well as synsets with semantic relationships under or above a given threshold. This will help linguistic researchers in:

1. Identifying concepts in WordNet where the semantic relationships are missing.
2. Identifying standalone concepts which do not relate to any other concepts semantically.
3. Identifying highly connected concepts which connect semantically to multiple concepts in the language.
4. Understanding the underlying ontology and extracting examples from the WordNet.
5. The above will help linguists compare and contrast language concepts in languages semantically.

In addition, the visualizer will work as a teaching-learning tool for understanding language. For example, hypernym-hyponym relations can be used to make them understand the 'type-of' relations between Konkani concepts. Similarly, holonym-meronym relations can be used to explain the 'part-of' or 'whole-part' relationship between various Konkani concepts.

Figure 1 shows hypernym-hyponym relationship('type-of') where hypernym is the generalized concept and hyponym depicts the specific concept. This concept is explained with the visualizer which is as shown in the figure 2. Similarly whole-part and part-whole relationships are explained with the visualizer example in figure 3 and 4.

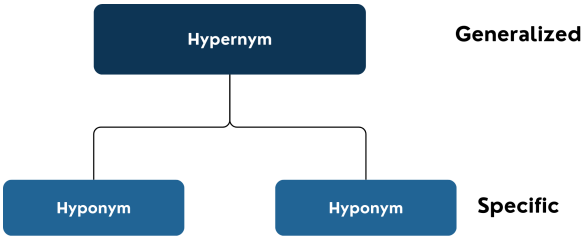

Figure 1: hypernym-hyponym relationship

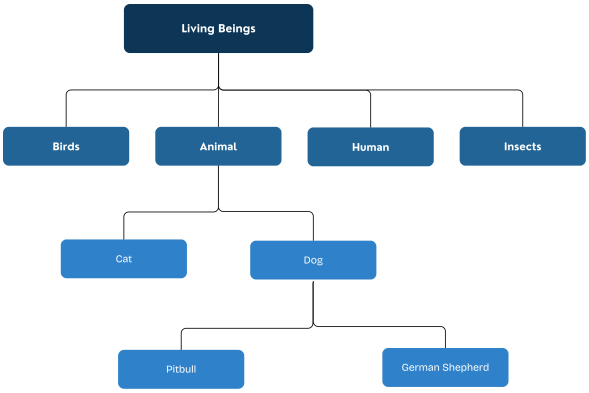

Figure 2: hypernym-hyponym relationship example

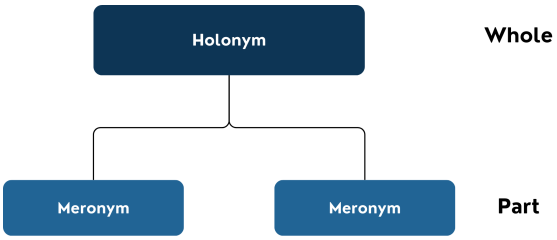

Figure 3: holonym-meronym relationship

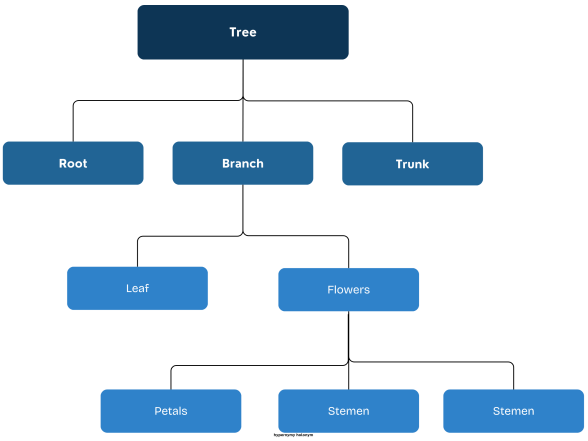

Figure 4: holonym-meronym relationship example

5 Visualizer Implementation details

The front-end of the Konkani WordNet Visualizer is developed using Vue.js, a JavaScript framework, along with the Vue-ECharts library to create an interactive radial tree structure. This setup enables the graphical representation of nodes and edges, fetched from the back-end, to be displayed dynamically.

The back-end of the visualizer is built using Node.js and Express JS, the JavaScript frameworks, which efficiently handles data processing and communication with the front-end to provide seamless interaction.

6 Multilingualism of the Visualization Approach

Since the Konkani WordNet was developed as part of the Indradhanush WordNet Project, which included seven Indian languages i.e. Konkani, Bengali, Gujarati, Kashmiri, Oriya, Punjabi, and Urdu. The Konkani WordNet Visualizer can be adapted to create visualizers for the other six languages using a similar approach. Although efforts have been made in the past to develop an IndoWordNet Visualizer, it is currently not publicly available for use or reuse. To explore the multilingual expansion of the Konkani WordNet Visualizer, we have developed a Hindi WordNet Visualizer using a sample database available to us, which can be seen in Figure 8. This initiative leverages the fact that the Konkani WordNet database structure was initially designed based on the Hindi WordNet. We have made this implementation available on GitHub[4] to facilitate the development of WordNet visualizers for other languages in the future.

7 Visualizer Utility as a Teaching Learning Tool

To utilize the Konkani WordNet Visualizer as an effective teaching-learning tool, a structured approach is designed to emphasize its various functionalities. The process begins with navigation and exploration, where learners are guided to search for specific words, such as 'फूल' (flower), and identify associated hypernyms, hyponyms, or related semantic relations. This allows learners to interactively explore and understand the connections between words. Additionally, they can delve into meronymy relationships by identifying the components of words like 'घड्याळ' (clock), thereby gaining insights into "part-of" connections.

The teaching approach further incorporates activities focusing on semantic relationships, such as "part-of" and "type-of" hierarchies. For example, learners can use the visualizer to identify the holonym of 'पान' (leaf) as 'झाड'(tree) or to list hyponyms for 'प्राणी'(animal), helping them grasp categorical relationships. This structured method ensures a hands-on, interactive learning experience that fosters a deeper understanding of lexical and semantic connections in the Konkani language.

To further evaluate the Konkani WordNet Visualizer as a teaching-learning tool, we conducted empirical testing with a small group of linguists and language educators. This study aimed to assess the tool's effectiveness in enhancing the understanding of lexical relationships in the Konkani language. Initially, participants were introduced to the concept of WordNets and the various types of semantic and lexical relations it encompasses. This foundational explanation provided the participants with the necessary background to engage with the tool effectively.

Following the introduction, participants were given a pre-test questionnaire comprising multiple-choice questions. These questions were designed to assess their baseline understanding of lexical relationships and included tasks like identifying synonyms for a word, choosing the correct meronym, or suggesting a top-level hypernym, etc. After completing the pre-test, participants were encouraged to interact with the Konkani WordNet Visualizer on its website. They were asked to explore the lexical database by searching for specific words and examining their semantic relationships.

After this exploratory session, a post-test was conducted using a similar set of multiple-choice questions. The purpose of the post-test was to measure any improvements in their understanding of the lexical relationships as facilitated by the visualizer. The results indicated a noticeable improvement in participants' ability to correctly identify and analyze lexical relations, demonstrating the tool's potential as an effective resource for teaching and learning linguistic concepts.

Building on our initial study, we have initiated the process of conducting the same experiment with students across various academic levels, including language learners, to further evaluate the Konkani WordNet Visualizer's effectiveness as a teaching-learning tool. This expanded study aims to verify the visualizer's capability to help students grasp linguistic concepts more quickly and effectively. Additionally, we plan to assess whether the tool aids in improving their memory retention, comprehension, and reflexive abilities. By analyzing these aspects, we seek to establish the visualizer's broader educational value and its potential to enhance cognitive learning processes in language education.

8 Future Work

The Konkani WordNet Visualizer can be enhanced both in terms of functionality and visual appeal to improve interactivity. These improvements can be achieved by leveraging our publicly available implementation on GitHub. Additionally, a gloss definition for each word can be incorporated into the visualizer in future iterations, similar to the implementation in Vi-

[4] https://github.com/VidyaapatiGU/KonkaniWordnetVisualizer

suwords[5]. This integration of gloss definitions, where users retrieve explanations for words like 'वेळ' and analyze their contextual relevance. Although this tool has been tested by a small group of language experts, a broader empirical evaluation is currently underway. This involves actual users, specifically students, engaging with the visualizer tool. Their performance will be assessed more systematically to gain deeper insights into the tool's effectiveness as a teaching and learning resource. More user-focused applications are in development, with a particular emphasis on word pronunciations for spoken Konkani language learning. Looking ahead, we plan to incorporate an image module into the Visualizer to create more interactive learning tools for individuals who are not familiar with reading or typing in Konkani.

9 Conclusion

We have worked towards enhancing the Konkani WordNet by integrating a Visualizer specifically designed to simplify the browsing and exploration of its lexical database. The Visualizer incorporates features that make it user-friendly and flexible, allowing users to easily interact with and understand the data. Additionally, we have utilized the tree-structured representation of the WordNet to create a small application that helps Konkani language teachers and learners. This application is particularly effective for understanding semantic relationships, such as whole-part (holonymy-meronymy) and type-of (hypernymy-hyponymy) connections between Konkani words and concepts.

The Visualizer serves as both a tool for linguistic exploration and a teaching aid for understanding key language concepts. By providing a clear and interactive graphical interface, it supports users in learning and remembering linguistic structures more effectively. Ongoing testing and evaluation, including trials with students and educators, aim to assess its potential for improving language learning outcomes. This initiative contributes to the development of resources for low-resource languages like Konkani, supporting language preservation efforts and promoting the use of modern tools in linguistic education.

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[5] https://visuwords.com/genus_cnemidophorus

Screenshots

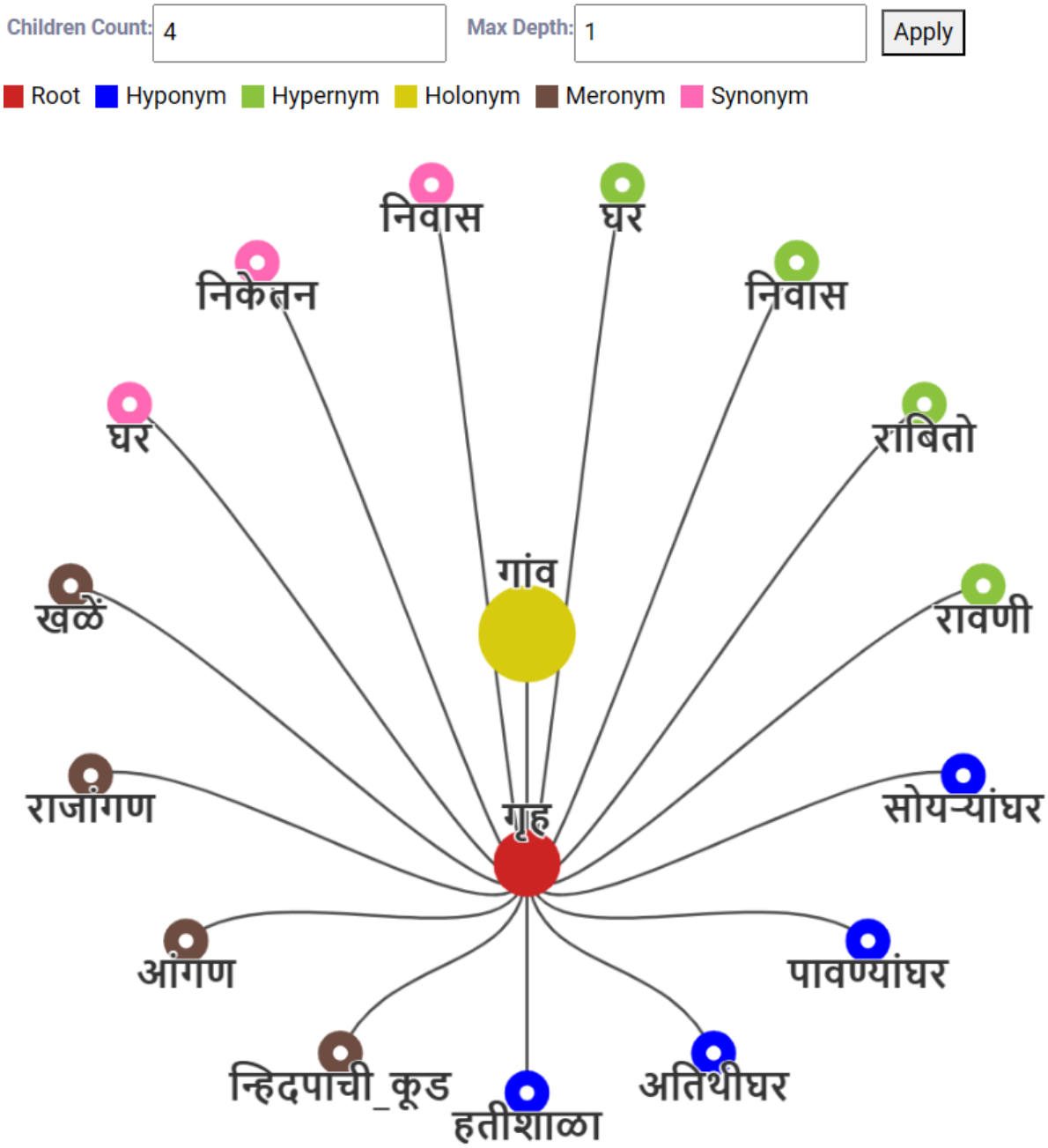

Figure 5: Visualizer for the Konkani root word: 'गृह' with depth 1

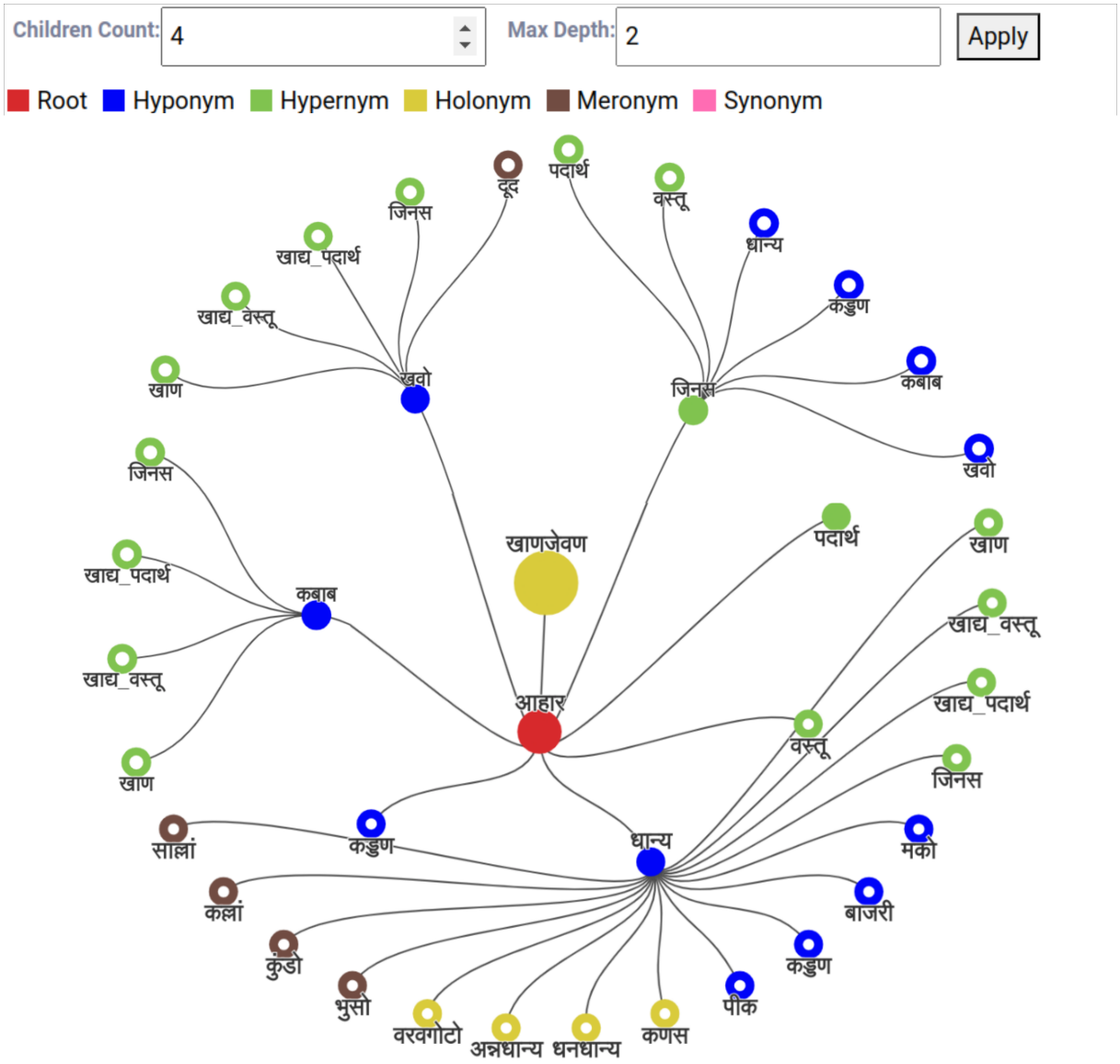

Figure 6: Visualizer for the Konkani root word: 'आहार' with depth 2

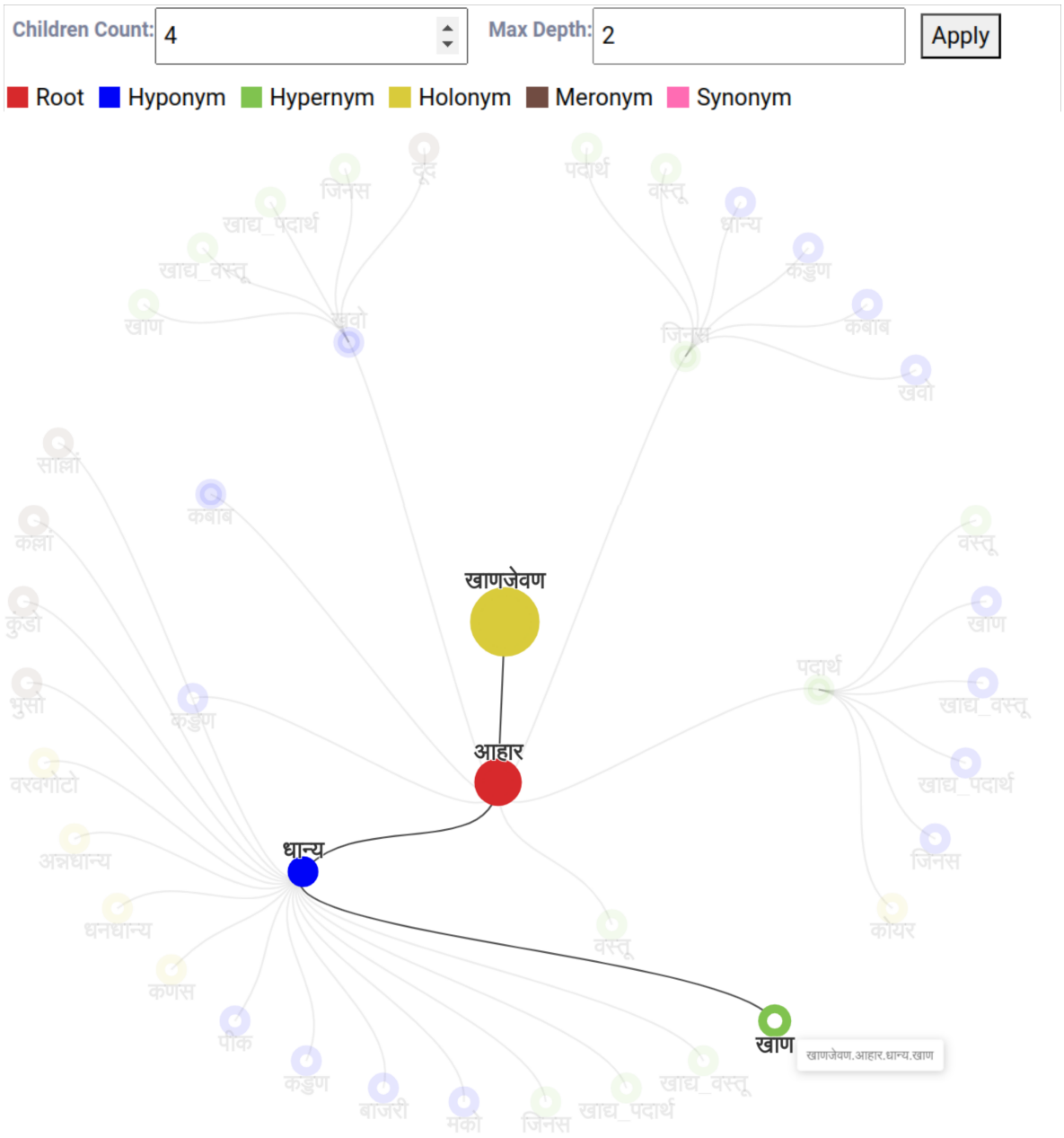

Figure 7: Visualizer for the Konkani root word: 'आहार' with depth 2 with highlighted path when hovered

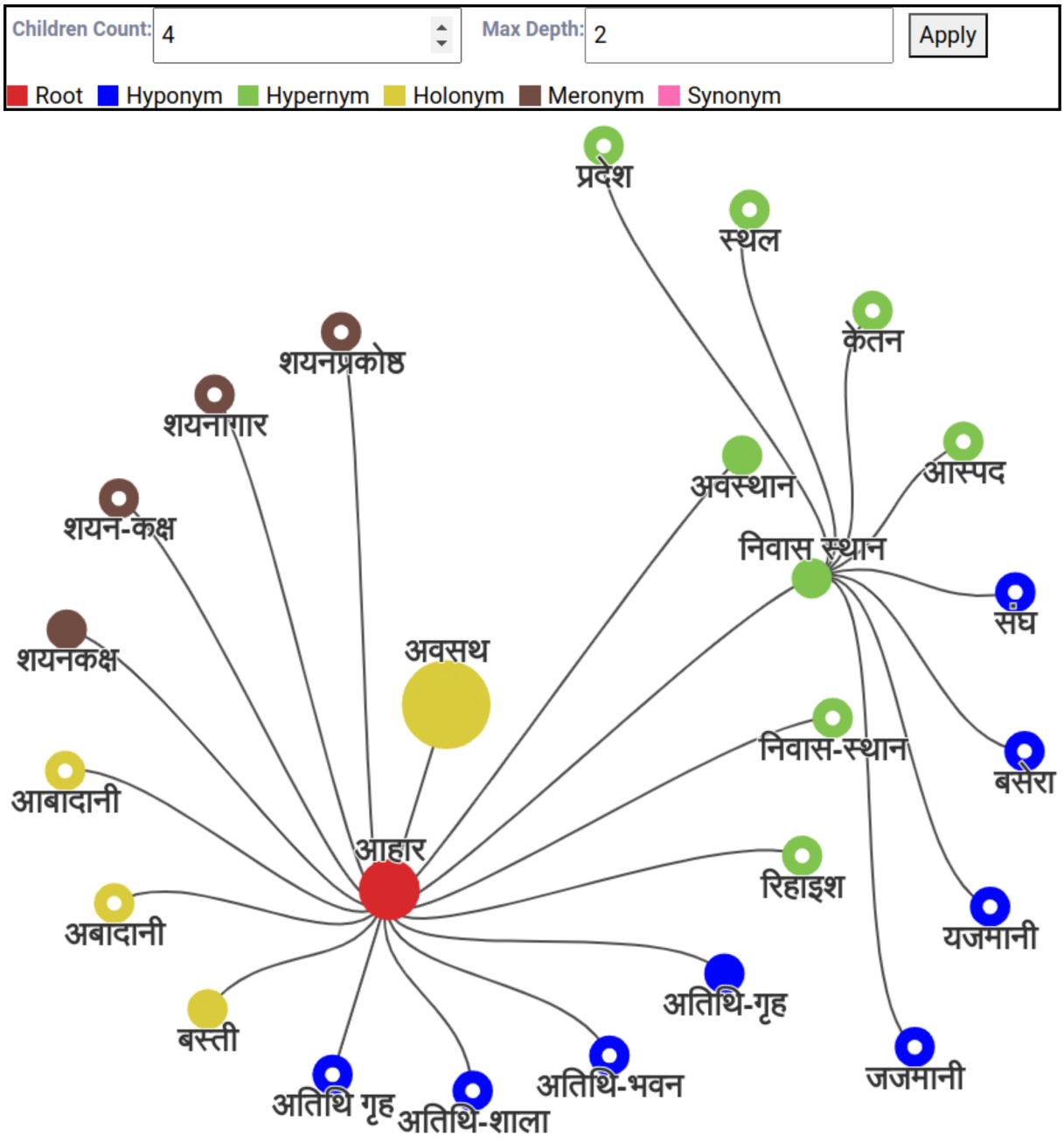

Figure 8: Visualizer for the Hindi root word: 'आहार' with depth 2