IndoWordnet Visualizer: A Graphical User Interface for Browsing and Exploring Wordnets of Indian Languages

Devendra Singh Chaplot **Sudha Bhingardive** **Pushpak Bhattacharyya**
Department of Computer Science and Engineering,
IIT Bombay, Powai,
Mumbai, 400076.
{chaplot,sudha,pb}@cse.iitb.ac.in

Abstract

In this paper, we are presenting a graphical user interface to browse and explore the IndoWordnet lexical database for various Indian languages. IndoWordnet visualizer extracts the related concepts for a given word and displays a sub graph containing those concepts. The interface is enhanced with different features in order to provide flexibility to the user. IndoWordnet visualizer is made publically available. Though it was initially constructed for making the wordnet validation process easier, it is proving to be very useful in analyzing various Natural Language Processing tasks, *viz.*, Semantic relatedness, Word Sense Disambiguation, Information Retrieval, Textual Entailment, *etc.*

1 Introduction

IndoWordnet (Bhattacharyya, 2010) is a linked lexical knowledge base consisting of wordnets of various Indian languages, where each wordnet is composed of synsets and semantic relations. This resource is very useful for various NLP applications *viz.*, Machine Translation, Word Sense Disambiguation, Sentimental Analysis, Information Retrieval, *etc.* But to use this knowledge in an effective way, a set of tools are required to query, retrieve and visualize information from this knowledge base. Data visualization is the study of the visual representation of data, meaning "information that has been abstracted in some schematic form, including attributes or variables for the units of information" (Michael Friendly, 2008). The main goal of visualization is to organize information clearly and effectively through graphical means. We have developed a user interface that provides a graphical representation of IndoWordnet. Till date, no such tool was developed for visualizing the wordnet database for Indian languages. The visualizer we developed takes a word from a specific language as an input and displays the related concepts of that word depending upon its semantic and lexical relations with other words in the wordnet.

This paper is organized as follows. Section 2 covers a related work. Section 3 gives an overview of IndoWordnet. Section 4 describes IndoWordnet visualizer. Section 5 gives implementation details. Conclusion and future work are covered in section 6.

2 Related Work

There are many wordnet visualizers available for browsing and exploring wordnets to better understand the concepts and semantic relations between them. Some of them include BabelNet explorer, AndreOrd, Visuwords, Nodebox, WordTies *etc*. BabelNet explorer (Navigli, 2012) is designed for visualizing the lexical database BabelNet (Navigli and Ponzetto, 2010). It uses the tree layout for visualization which allows intuitive navigation. It covers English, Italian, Catalan, Spanish, German and French languages. AndreOrd (Johannsen and Pedersen, 2011) is the wordnet browser developed for the Danish wordnet, DanNet. It uses the open source framework Ruby on Rails and the graphing toolkit Protovis[1]. Visuwords[2] is the online graphical dictionary designed for accessing Princeton WorNet. It uses a force-directed graph layout for visualizing the synset structure. Nodebox[3] visualizer provides the static layout. It does not use any color or shape encoding in the graph. WordTies (Pedersen et. al 2013) is the wordnet visualizer designed for Nordic and Baltic wordnets. It covers seven monolingual and four bilingual word-

[1] http://vis.stanford.edu/protovis/
[2] http://www.visuwords.com/
3 http://nodebox.net/code/index.php/WordNet

nets. It has been made available via META-SHARE[4] through the META-NORD project.

3 Overview of IndoWordnet

IndoWordnet is the most useful multilingual lexical resource in Indian languages. Hindi wordnet is created manually using lexical knowledge from various dictionaries. Wordnets other than Hindi have been created by using expansion approach with Hindi as a pivot language. It includes 18 Indian languages [5] *viz.,* Assamese, Bengali, Bodo, Gujarati, Kannada, Kashmiri, Nepali, Kashmiri, Konkani, Malayalam, Manipuri, Marathi, Nepali, Odiya, Punjabi, Sanskrit, Tamil, Telugu, Urdu, *etc.* Expansion approach makes use of the fact that there are several 'universal concepts' which are independent of the language. If one language has synsets for universal concepts, then it makes sense to borrow this work for some other language. For such universal concepts, the semantic relations remain same across the languages. Hence one can directly borrow them for other languages. This principle is used in the creation of IndoWordnet. All the semantic relations for universal synsets are defined in Hindi and are borrowed by other languages. Expansion approach works very well for closely related languages like 'Hindi and Marathi'. The current statistics of the IndoWordnet is shown in table 1**.**

Languages	**Synset count**
Assamese	14258
Bodo	15785
Bengali	36345
Gujarati	35581
Hindi	38283
Kashmiri	29466
Konkani	32370
Kannada	14674
Malayalam	12108
Manipuri	16315
Marathi	28055
Nepali	11713
Punjabi	32364
Sanskrit	22912
Tamil	20297
Telugu	20057
Urdu	31008

Table 1: Current statistics of the IndoWordnet

IndoWordnet stores various relations among words and synsets. These relations give an important knowledge about the language structure. These are categorized under two labels *viz.*, lexical relations and semantic relations.

3.1 Lexical Relations

Lexical relations are present between the words. IndoWordnet contains different types of lexical relations listed below,

- Gradation (state, size, light, gender, temperature, color, time, quality, action, manner) (for all parts-of-speech)
- Antonymy (action, amount, direction, gender, personality, place, quality, size, state, time, color, manner) (for all parts-of-speech)
- Compound (for nouns)
- Conjunction(for verbs)

3.2 Semantic Relations

Semantic relations are present between the synsets. Different types of semantic relations are given below,

- Hypernymy (for noun and verbs)
- Holonymy (nouns)
- Meronymy (component object, member collection, feature, activity, place, area, face, state, portion, mass, resource, process, position, area)
- Troponymy (for verbs)
- Similar Attribute (between noun and adjective)
- Function verb (between noun and verb)
- Ability verb (between noun and verb)
- Capability verb (between noun and verb)
- Also see
- Adverb modifies verb (between adverb and verb)
- Causative (for verb)

4 http://www.meta-share.org

[5] Wordnets for Indian languages are developed in IndoWordNet project. Wordnets are available in following Indian languages: Assamese, Bodo, Bengali, English, Gujarati, Hindi, Kashmiri, Konkani, Kannada, Malayalam, Manipuri, Marathi, Nepali, Punjabi, Sanskrit, Tamil, Telugu and Urdu. These languages cover 3 different language families, Indo Aryan, Sino-Tebetian and Dravidian. http://www.cfilt.iitb.ac.in/indowordnet

- Entailment (for verb)
- Near synset
- Adjective modifies noun (between adjective and noun)

IndoWordnet provides extra relations (Narayan *et. al.*, 2002) in comparison with Princeton wordnet, *e.g.*, gradation, causative form, nominal and verbal compounds, conjunction *etc.* All these relations are covered in IndoWordnet Visualizer. User can see these relations and understand them better visually. All these relations are used while finding the related concepts of a given word. The need to make entirely different explorer for IndoWordnet lies in its difference from other wordnets in terms of the structure and relations. The entirely different format makes it difficult to import other visualizers directly. Manually going through the wordnet relations takes very large time. Visualizer makes this process extremely efficient and intuitive. This motivated us to create a new visualizer for IndoWordnet. Developed GUI is enriched with various facilities as explained in section 4.

4 IndoWordnet Visualizer

IndoWordnet visualizer is designed for visualizing the IndoWordnet database. It is made publically available on IndoWordnet website[6]. Related concepts of a given input word are extracted at different levels and a sub graph is displayed on a screen. The user interface layout and its features are described below.

4.1 User Interface Layout

The interface of the visualizer consists of following I/O features.

The input to the interface consists of:

- Text-box for the word to browse and explore
- Drop-box to select a language (Indian languages)
- Drop-box to select visualization options

The output of the interface consists of:

- A graphical view of all related words and concepts in a respective language for a given input word.
- Download option is provided for retrieving related words and concepts which can act as a good context clue for a given input word.

4.2 Features

Interface is enhanced with the following features which provide flexibility to the user to visualize the wordnet database.

- Nodes are automatically arranged on the screen according to physics and depending on the total number of nodes. The repulsion between the nodes and the link distance is optimally calculated so as to display all nodes clearly. Here, nodes are nothing but the concepts from IndoWordnet. For a given input word, all related concepts are extracted from IndoWordnet and are displayed at appropriate positions on the screen.
- The size of the node varies according to the number of its immediate neighbor. A node consisting large number of neighbors is bigger in size than a node with less number of neighbors. This highlights more frequent words against less frequent ones.
- When a user moves a mouse pointer over a particular node, it highlights all its immediate neighbors along with that node.
- When a user moves a mouse pointer over a particular edge, it highlights the type of relation exist between the nodes. Different color encodings are used for displaying the lexical and semantic relations.
- User can click, drag, expand and fix nodes for better visibility.
- Zoom in and zoom out facilities are also provided.
- When a user clicks on a node all its semantic information is displayed on the screen. It includes synset id, synset words, gloss, and example sentence.
- Download option is provided in order to get all the information displayed on a screen which is helpful for different NLP applications.

[6] http://www.cfilt.iitb.ac.in/indowordnet/

4.3 Visualization Schemes

In an interface, we provided two types of visual schemes.

1. By the number of levels
2. By the number of nodes

In the first scheme, for a given concept, related concepts are extracted according to different levels *e.g.*, immediate neighbors, neighbors of immediate neighbors and so on. Sometimes due to large number of neighboring concepts user may face difficulty in visualization. For example, for the Hindi concept 'मानवकृति' (man-made) given below, the number of extracted related concepts at different levels are shown in table 2.

Hindi concept:

Synset:
मानव कृति, **मानवकृति**, मानव-कृति, मानव निर्मित वस्तु, मानव-कृत वस्तु, कृत्रिम वस्तु (Human work, man-made object, human - integrated object, artificial object)

Gloss/example:
मानव द्वारा बनाई या तैयार की हुई वस्तु "यह मुगलकालीन मानव कृति है"
(An object made or produced by man - A masterpiece of Mughal's era.)

As number of levels increases, number of nodes (related concepts) for the concept also increases drastically. It is very difficult to render such kind of concepts on a screen. That's why we provided a second visualization scheme in which user has been given a facility to choose number of nodes to be displayed on the screen.

Level	Number of related concepts
1	432
2	2019
3	5213
4	11597
5	16409
6	18983

Table 2: Number of related concepts for the word 'मानव कृति' (manavakruti) (man-made) at different levels

5 Implementation details

The front-end of the IndoWordnet Visualizer uses Data Driven Documents (D3) JavaScript library, which allows us to present the data of nodes and edges from the back-end, graphically. This library allows us to define geometry for nodes and edges so as to automatically arrange them efficiently, while also allowing the user to click, drag and fix any node for better visibility. The library uses Scalable Vector Graphics (SVG), which allows us to zoom into the graph without pixelating the nodes, links or labels. The superiority of D3 lies in its support for dynamic behavior allowing user-friendly interaction and animation.

6 Conclusion and Future Work

We have presented the IndoWordnet visualizer which can be used for browsing and exploring IndoWordnet lexical database. It is enhanced with various functionalities in order to provide flexibility to the user. It is very useful for wordnet validation process. It can be used in various Natural Language Processing applications *viz.*, Word Sense Disambiguation, Information Retrieval, Semantic Relatedness *etc.* IndoWordnet visualizer is under development and some more features are yet to be included like generating the minimum sub graph between two given concepts.

References

Roberto Navigli and Simone Paolo Ponzetto, 2012. "BabelNetXplorer: A Platform for Multilingual Lexical Knowledge Base Access", France.

Pushpak Bhattacharyya, 2010. "IndoWordnet", Lexical Resources Engineering Conference (LREC 2010), Malta.

Christiane Fellbaum, 1998 "WordNet: An Electronic Database", MIT Press, Cambridge, MA.

Steven Vercruysse and Martin Kuiper, 2011. "WordVis: JavaScript and Animation to Visualize the WordNet Relational Dictionary" in Proceedings of the Third International Conference on Intelligent Human Computer Interaction (IHCI 2011), Prague, Czech Republic, August, 2011

Michael Friendly, 2008. "Milestones in the history of thematic cartography, statistical graphics, and data visualization", National Sciences and Engineering Research, Council of Canada, Grant OGP0138748

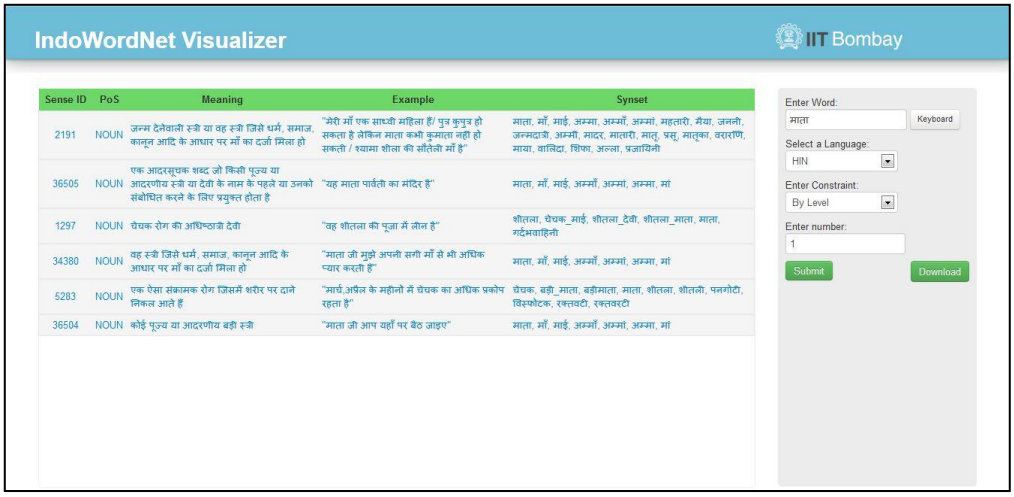
Roberto Navigli, 2013. "A Quick Tour of BabelNet1.1", CICLing 2013, Part I, LNCS 7816, pp. 25–37.

Dipak Narayan, Debasri Chakrabarty, Prabhakar Pande and P. Bhattacharyya, 2002. " An Experience in Building the IndoWordNet - a WordNet for Hindi", International Conference on Global WordNet (GWC), Mysore, India, January, 2002.

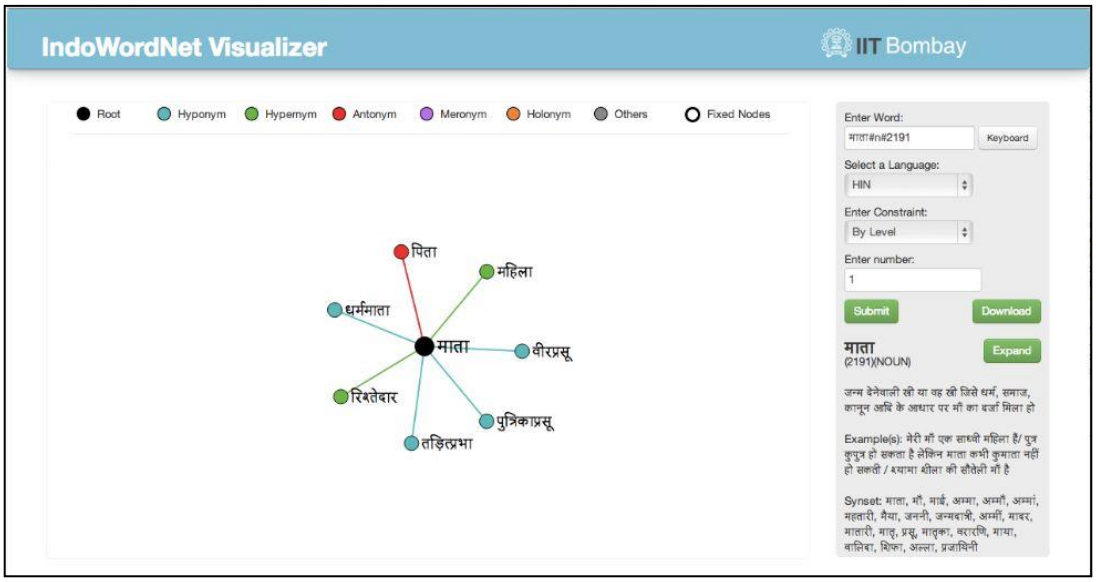
Anders Johannsen and Bolette S. Pedersen "Andre ord" – a Wordnet Browser for the Danish Wordnet, DanNet, NODALIDA 2011 Conference Proceedings, pp. 295–298.

Bolette Pedersen, Lars Borin, Markus Forsberg, Neeme Kahusk, Krister Lindén, Jyrki Niemi, Niklas Nisbeth, Lars Nygaard, Heili Orav, Eirikur Rögnvaldsson, Mitchel Seaton, Kadri Vider, Kaarlo Voionmaa, 2013. "Nordic and Baltic wordnets aligned and compared through WordTies", Proceedings of the 19th Nordic Conference of Computational Linguistics (NODALIDA), 2013.

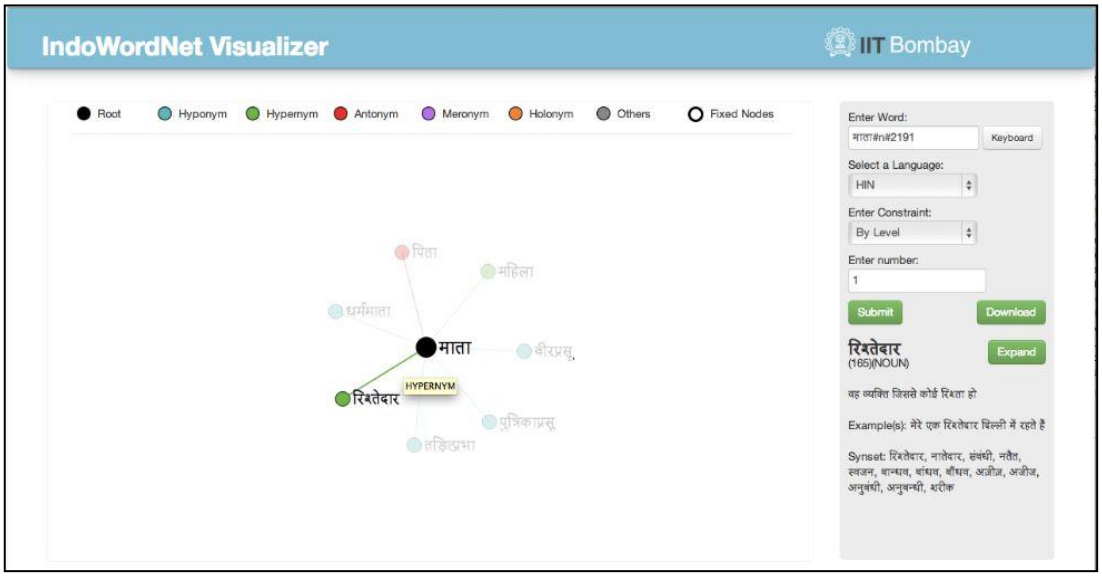
Screenshots



Screenshot 1: For a given Hindi word '*maata*' (mother), all its senses are displayed on a screen. User can see the graph of a particular sense by clicking on it.

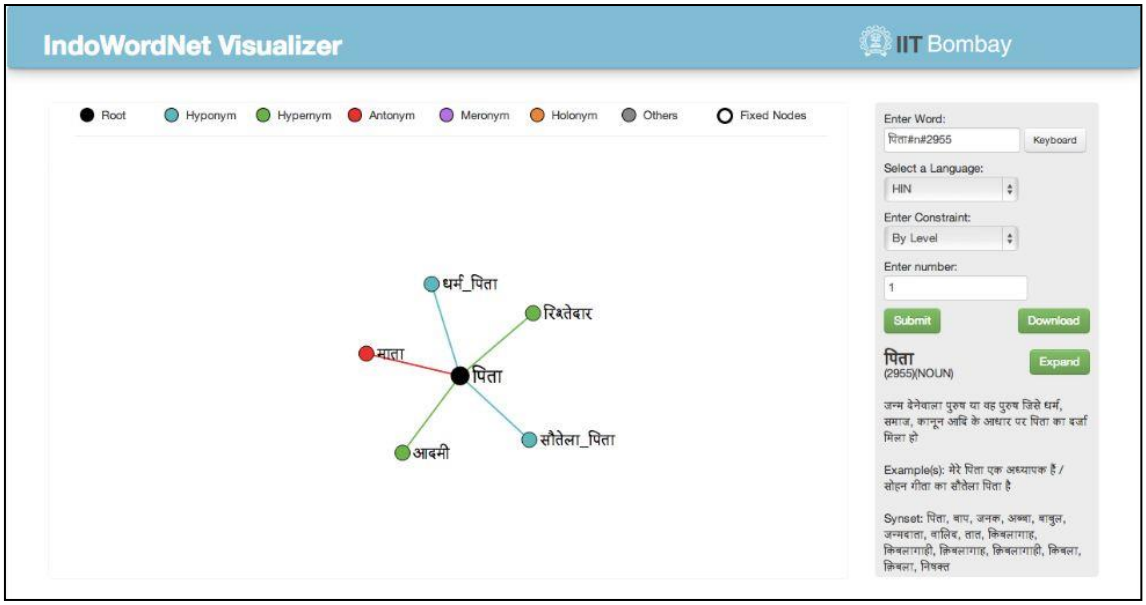


Screenshot 2: Graph for a Hindi word '*maata*' (mother) with level 1
All related concepts of '*maata*' are displayed in a graph along with its semantic information on right side



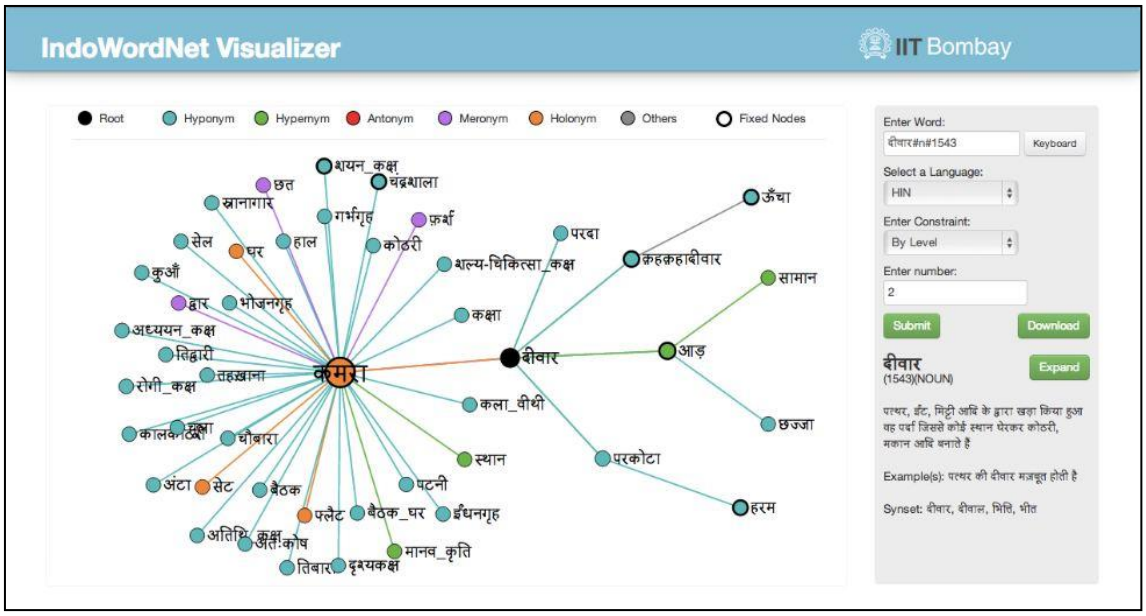
Screenshot 3: Graph for a Hindi word '*maata'* (mother) with level 1

When we move mouse pointer over the edge its relation is displayed.



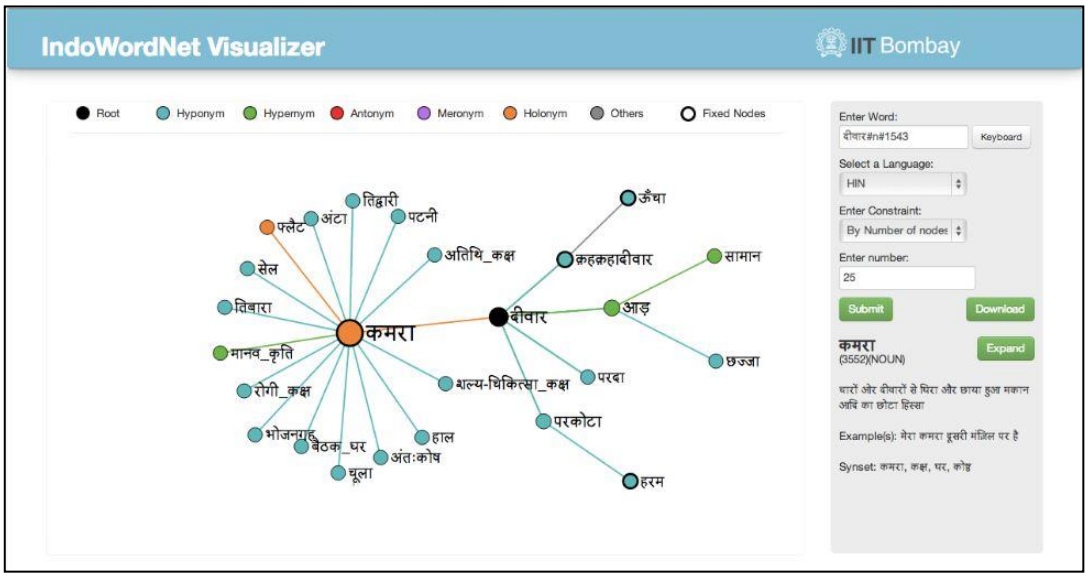
Screenshot 4: Graph for a Hindi word '*pita'* (father) with level 1

(In screenshot 2, if we expand node *'pita'* then this graph is generated)



Screenshot 5: Graph for a Hindi word '*diwar'* (wall) with level 2

Screenshot 6: Graph for a Hindi word '*diwar'* (wall) with level 2. On mouse hover it highlights its synsets and only immediate neighbors (concepts)



Screenshot 7: Graph for a Hindi word '*diwar*' (wall) with 25 number of nodes on a screen. This is another type of visual display scheme, where user can specify how many number of nodes he/she wants to display on a screen