

# Enriching Word Usage Graphs with Cluster Definitions

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1 What are word usage graphs (WUGs)?

2 Contributions

3 WUGs we use

4 Definition generation methods

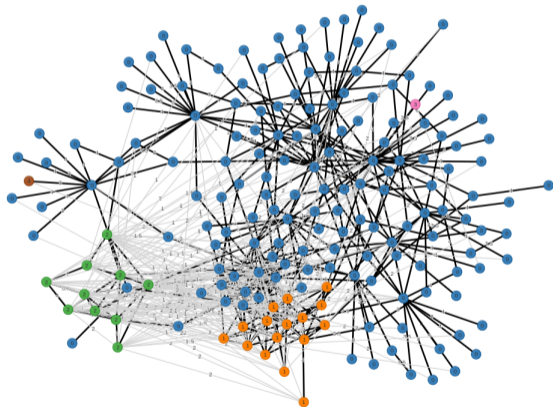
5 Evaluation setup

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# What are word usage graphs (WUGs)?



Inferred senses of the English noun 'record'



Usage examples of the first largest 3 senses

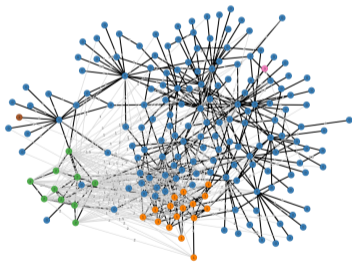
- ▶ **0:** *The church **records** having been consumed when the parsonage house was burned*
- ▶ **1:** *...a camera aboard the craft has surveyed the sky in the extreme ultraviolet and identified a **record** 385 bright sources in this wavelength band...*
- ▶ **2:** *I was making **records**, but they weren't getting played because there was no place to play them.*

Schlechtweg et al. (2020)

# How to make a word usage graph interpretable?



WUG of the word **record**, Schlechtweg et al. (2020)



- ▶ **0: Context:** *The church **records** having been consumed when the parsonage house was burned*  
**Definition:** A book or other piece of writing which contains information about past events.
- ▶ **1: Context:** *...a camera aboard the craft has surveyed the sky in the extreme ultraviolet and identified a **record** 385 bright sources in this wavelength band...*  
**Definition:** Of a historical highest level or achievement.
- ▶ **2: Context:** *I was making **records**, but they weren't getting played because there was no place to play them.*  
**Definition:** A medium for recording sound, especially a vinyl phonograph and gramophone disc.



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## Contributions

- ▶ updated dataset: [enriched \(labeled\) WUGs with cluster definitions](#) are released



- ▶ definition generation (DefGen) models for [Norwegian](#), [English](#), and [Russian](#) are released on Huggingface Hub



- ▶ useful for NLP practitioners, lexicographers, linguists



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## Word usage graphs that we use

Language	Time periods	Words	Clusters	Clusters annotated	Diachronic?
English <a href="#">Schlechtweg et al. (2020)</a>	1810-1860, 1960-2010	46	819	120	True
German <a href="#">Schlechtweg et al. (2020)</a>	1800–1899, 1946–1990	50	488	95	True
Norwegian-1 <a href="#">Kutuzov et al. (2022)</a>	1929-1965, 1970-2013	40	99	23	True
Norwegian-2 <a href="#">Kutuzov et al. (2022)</a>	1980-1990, 2012-2019	40	78	17	True
Russian <a href="#">Aksenova et al. (2022)</a>	modern	24	90	39	False

Main statistics of the enriched WUGs. We labeled and annotated only clusters which feature at least three usage examples.





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## Definition generation methods

- ▶ Lesk algorithm ([Lesk, 1986](#)): choice from WordNet
- ▶ GlossReader ([Rachinskiy and Arefyev, 2021](#)): choice from WordNet
- ▶ DefGen: fine-tuned multilingual mT0-xl ([Giulianelli et al., 2023](#)): generation from scratch

## GlossReader (Rachinskiy and Arefyev, 2021)

- ▶ multilingual word sense disambiguation system
- ▶ consists of a context encoder and a gloss encoder trained jointly

## To select a definition for a cluster:

1. gloss embeddings for all WordNet definitions are built with the gloss encoder;
2. for each usage from the cluster:
  - 2.1 its contextualized embedding is built with the context encoder,
  - 2.2  $k$  most similar glosses<sup>a</sup> are retrieved from English WordNet <sup>b</sup>;
3. the definition retrieved for the largest number of usages in this cluster is selected to represent the cluster.

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<sup>a</sup>as measured by the dot product

<sup>b</sup>we select glosses among all 117K glosses, this makes the method applicable for target words absent in WordNet, including words in other languages

## DefGen

Encoder-decoder Transformer-based language model fine-tuned on the task of contextualized definition generation [Giulianelli et al. \(2023\)](#).

**Input:** *'The church **records** having been consumed when the parsonage house was burned. What is the definition of **record**?'*

**Output:** **'A book or other piece of writing which contains information about past events.'**

## Fine-tuning data

Language	Datasets
Norwegian	<a href="#">Bokmålsordboka</a>
English	Oxford dictionary <a href="#">Gadetsky et al. (2018)</a> , Wordnet <a href="#">Ishiwatari et al. (2019)</a> , CoDWoe (Wiktionary) <a href="#">Mickus et al. (2022)</a>
Russian	CoDWoe (Wiktionary) <a href="#">Mickus et al. (2022)</a>

## WordNet choice vs generation from scratch

- ▶ **Context:** *The church **records** having been consumed when the parsonage house was burned*  
**Lesk:** anything (such as a document or a phonograph record or a photograph) providing permanent evidence of or information about past events  
**GlossReader:** anything (such as a document or a phonograph record or a photograph) providing permanent evidence of or information about past events  
**DefGen:** A book or other piece of writing which contains information about past events.
- ▶ **Context:** *...a camera aboard the craft has surveyed the sky in the extreme ultraviolet and identified a **record** 385 bright sources in this wavelength band...*  
**Lesk:** sound recording consisting of a disk with a continuous groove; used to reproduce music by rotating while a phonograph needle tracks in the groove  
**GlossReader:** establish as the highest level or best performance  
**DefGen:** Of a historical highest level or achievement.

prompted with English for German without fine-tuning

**Input:** *'Ist eine Prüfung erforderlich, so erfolgt eine **Entscheidung** über den Antrag durch die zuständige Behörde. What is the definition of **Entscheidung**?' ('If an examination is necessary, a **decision** on the application will be made by the responsible authority. What is the definition of **decision**?)*

**Output:** *'The act of making up your mind about something; a **decision**.'*



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## Human evaluation as the only choice

- ▶ no existing benchmarking datasets for the task of WUG cluster labeling
- ▶ we invented and used a novel task: **guess the cluster by definition**

HEAD\_NN: THE UPPER PART OF THE HUMAN BODY OR THE FRONT PART OF THE BODY IN ANIMALS; CONTAINS THE FACE AND BRAINS

Select the best cluster of examples for this definition:

- The **head** or lord of the manor called forth his attendants to his hall.
- The leaders of the poaching rings are in Nairobi, some 185 miles to the south of here, according to Mannasses Keiler, **head** of Kenya's Anti-Poaching Mobile Unit, a fiveyearold body that has more than 50 employees.
- This, of course, shifts the relative influence of faculty, department **heads**, and college- and university-level administrators.
- But there was no common **head** to regulate commerce.
- Mixer wasn't there, in part because of his own suggestion that the invitations go to the **heads** of major gay organizations.
- 
- Dessa turned her **head** under Carrie's hands and looked at her mother.
- For the last several miles, until I sat up to write this, I've had my **head** resting on the shoulder of a skinny young creature named Roy, half angel, half animal.
- Lucia could as yet only sob and utter inarticulate expressions of thanks: but she soon raised her **head**, and looked at Ellie with her sad smile.
- And they said it was so far from according with the nature of things and the order of the universe to have the **head** always uppermost, that the most approved and received theories of the motion of the planets and the diurnal rotation of the earth showed that mankind ought to be heels over head at least half the time.
- He thumbed up one eyelid and saw nothing but white, the eyeball rolled up into the **head**.
- 
- This definition describes none of the clusters
- 
- This definition fits both clusters

Krippendorff's  $\alpha = 0.314$ , fair agreement according to (Landis and Koch, 1977).





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## Methods comparison

System	Accuracy, %	Fits both, %	Fits none, %
<b>English</b> DWUG, English definitions			
<b>Lesk</b>	21.67	5.00	53.33
<b>GlossReader</b>	50.00	9.17	37.50
<b>DefGen</b>	<b>69.17</b>	10.83	11.67
<b>German</b> DWUG, English definitions			
<b>GlossReader</b>	53.68	13.68	27.37
<b>DefGen</b>	<b>57.89</b>	16.84	12.63
<b>Russian</b> WUG RuDSI, English definitions			
<b>GlossReader</b>	64.10	10.26	17.95
<b>DefGen</b>	<b>71.79</b>	15.38	2.56

## DefGen only

Dataset	Definitions	Accuracy, %	Fits both, %	Fits none, %
Norwegian-1 DWUG	English	60.87	13.04	21.74
	Norwegian	73.91	4.35	21.74
Norwegian-2 DWUG	English	88.24	5.88	5.88
	Norwegian	76.47	11.76	11.76
Russian WUG RuDSI	Russian	48.72	7.69	15.38

## Again links to the models and enriched DWUGs

- ▶ definition generation (DefGen) models for [Norwegian](#), [English](#), and [Russian](#) on Huggingface Hub



- ▶ [enriched WUGs with cluster definitions](#)





- Aksenova, A., Gavrishina, E., Rykov, E., and Kutuzov, A. (2022). RuDSI: Graph-based word sense induction dataset for Russian. In *Proceedings of TextGraphs-16: Graph-based Methods for Natural Language Processing*, pages 77–88, Gyeongju, Republic of Korea. Association for Computational Linguistics.
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