



Universität Hamburg  
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Alexander Panchenko

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**FROM UNSUPERVISED INDUCTION OF  
LINGUISTIC STRUCTURES FROM TEXT  
TOWARDS APPLICATIONS IN DEEP  
LEARNING**

# In close collaboration with ...



**Chris Biemann**



**Dmitry 'Tsar' Ustalov**



**Stefano Faralli**



**Simone P. Ponzetto**

**GRAPHS**  
~~**PUNKS**~~  
**NOT DEAD**

## In collaboration with ...

- **Andrei Kutuzov**
- **Eugen Ruppert**
- **Fide Marten**
- **Nikolay Arefyev**
- **Steffen Remus**
- **Martin Riedl**
- **Hubert Naets**
- **Maria Pelevina**
- **Anastasiya Lopukhina**
- **Konstantin Lopukhin**

# Motivation

# Levels of Linguistic Analysis

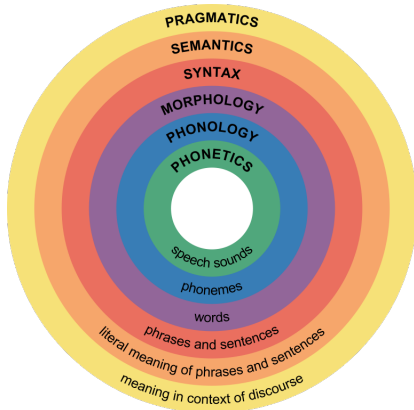


Image source: [https://commons.wikimedia.org/wiki/File:Major\\_levels\\_of\\_linguistic\\_structure.svg](https://commons.wikimedia.org/wiki/File:Major_levels_of_linguistic_structure.svg)

# Levels of Linguistic Analysis

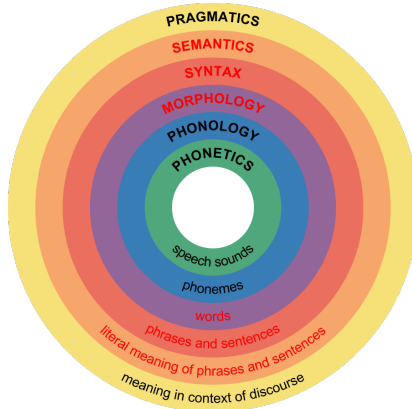
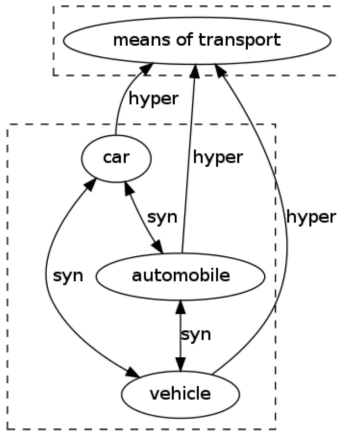


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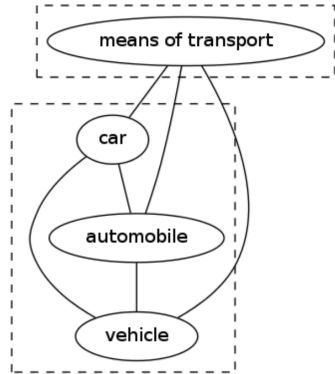
# Linguistic Structures and Graphs

- (Written) language is a **symbolic system**
- **Semantic level:** typed weighted graphs of concepts
  - Co-occurrence networks
  - Lexical databases, e.g. WordNet
  - Thesauri, e.g. NLM
  - Ontologies, e.g. DBPedia
  - Associative networks, e.g. Edinburgh Associative Thesaurus
  - ...

# Semantic Graphs



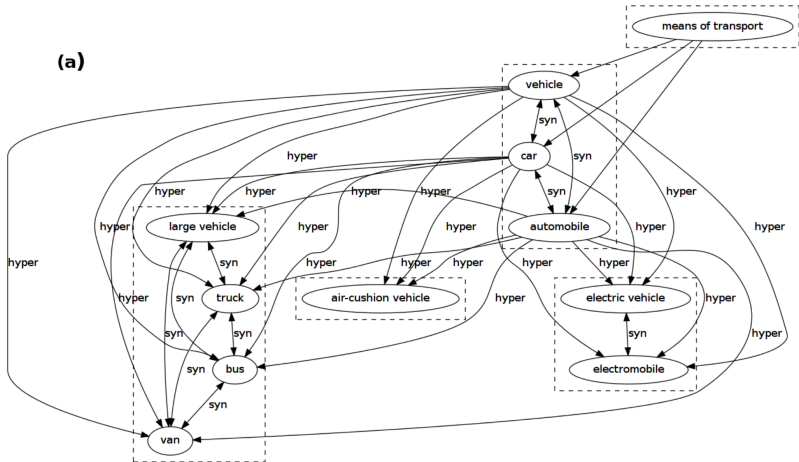
(a)



(b)



# Semantic Graphs



# The new brave world of Deep Learning



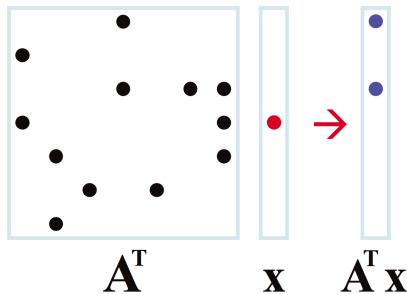
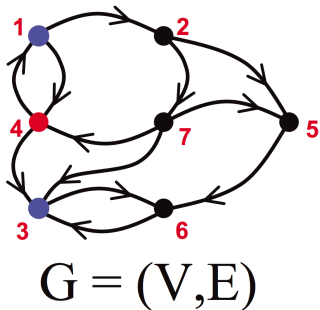
- "Anti-connectivism"
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representations  
aren't needed

# The new brave world of Deep Learning

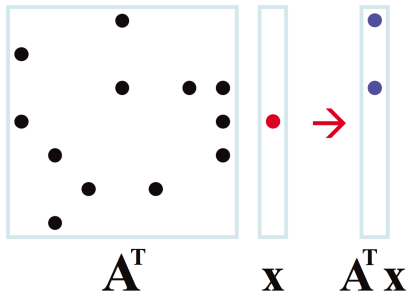
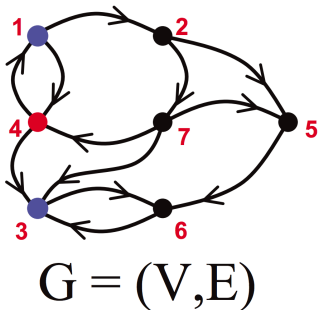


- "Anti-connectivism"
- End-to-end learning:  
symbolic  
representations  
aren't needed
- Word embeddings  
lookup (at most)

# Graph Matrix Duality

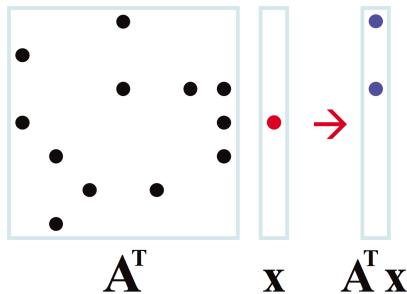
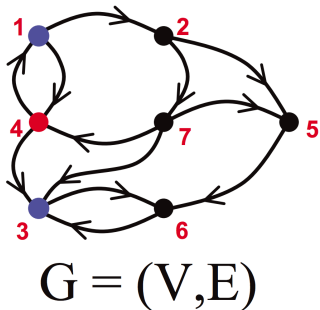


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- Adjacency matrix  $A$  is dual with the corresponding graph  $G$ .
- Vector matrix multiply  $A^T x$  is dual with breadth-first search.

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- 4 More complex structures could improve performance, but also provide **better interpretability of the deep learning models**.