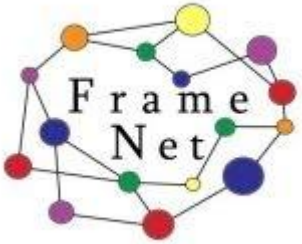


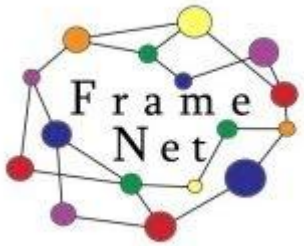
Semantic Alignments across Languages

Cross-linguistic Frame Alignment Tutorial

LREC 2022 Marseille

Overview of Tutorial

- FrameNet and Frame Semantics (Miriam R. L. Petruck, presented by Collin F. Baker)
  - FrameNet Background
  - Cognitive Linguistics
  - Construction Grammar
- Multilingual FrameNet and Cross-linguistic Frame Alignment (Arthur Lorenzi)
  - English-Spanish
  - English-German
  - Visualizing Frame Alignments (ViToXF)
- Evaluating Frame Alignments (Michael Ellsworth)



FrameNet

Miriam R. L. Petruck
miriamp@icsi.berkeley.edu

Road Map

- Background: Frame Semantics
  - Frame Semantics
  - Cognitive Linguistics
- The FrameNet Project (1997-present)
  - FrameNet (“the original”)
  - The FrameNet Constructicon
  - Multilingual FrameNet
- Building FrameNet-like resources in non-English languages
  - Languages
  - Specialized Domains

Background: Frame Semantics

Fillmore 1968:

"The Case for Case"

…began developing the conceptual infrastructure to answer the Q: who did what to whom?

…where the semantic roles in a scene were primary laid the groundwork for Frame Semantics, where the situations are primary

Background: Frame Semantics

Fillmore 1975

"Against Checklist theories of Meaning" (BLS)

vs. feature-based semantics
vs. truth-conditional semantics
for semantics of understanding

frame

experience-based schematization of speaker's world against which meaning is defined

Background: Frame Semantics

Fillmore 1978

On the Organization of Semantic Information in the Lexicon

characterized the semantic frame as “the most powerful kind of domain structure”

cf. taxonomy (kind of), partonomy (part of), etc.

What is Frame Semantics?

- an approach to the description and analysis of meaning that emphasizes the continuities between language and experience
- focuses on the ways that language users understand what their language communicates (Fillmore and Baker 2010)
- FS = empirical, cognitive, and ethnographic research

Basic Concepts

- frame: experience-based schematization of the speaker's world that allows inferences about participants and objects in and across situations and events
- frame element: identifies participants and props in the frame

Frames and Lexical Semantics

- Frames provide the structured background knowledge that allows speakers of a language to use and understand the words in their language.
  - *breakfast*
    - time of day – morning
    - after (night's) sleep
    - menu – eggs, cereal, toast, coffee, etc.
      - cf. American breakfast, French breakfast

breakfast

- Ed ate fish and chips for breakfast.
- Sam woke up that evening for his regular eggs and toast breakfast.
- “Breakfast served all day”

Prototype: breakfast

petit déjeuner

…a fairly large slice of the surrounding culture against which the meaning of a word is defined and understood, including that culture's institutions and practices

breakfast

Frames and Text Semantics

- lexical items can be seen as very small texts
- the meaning of any single lexical item plays an important role in the construction of the meaning of any (longer) text

Frames and Text Semantics

- The kids played on the bus.
- The kids played in the bus.

- We'll call you back within an hour.
- We'll call you back within the hour.

Cognitive Linguistics

- language as instance of cognitive process
- empirical study of language
  - vs. relying on intuition
- meaning as usage
  - cf. feature-based; vs. (strict) compositionality
- usage as a reflection of the mind
  - metaphor: mapping from source to target (G. Lakoff)
- conceptual structure ~ cognitive structure (L. Talmy)

FrameNet

- The FrameNet Lexicon (“the original”)
- The FrameNet Constructicon

The FrameNet Project

- Founder – Charles J. Fillmore
- 1997 – ongoing
- Early Phases
  - FrameNet I (1997-2000)
  - FrameNet++ (2000-2003)

- Funding
  - U.S. Federal Funding
    - NSF
    - DARPA
  - Commercial
    - DAC (gov't contractor) -> Whitney, Bradley & Brown
    - Siemens
    - Northside
    - Google

What is FrameNet?

…a corpus-based computational lexicography research and resource development project based on the principles of Frame Semantics (Fillmore 1982, 1985 *inter alia*) whose goal is to provide the valence descriptions (i.e., semantic-syntactic combinatorial possibilities for each item analyzed.

FrameNet

- Conceptual infrastructure
  - Instantiate Frame Semantics in development of lexicon
    - frames
    - frame elements
    - lexical units: pairing of lemma and its frame
    - frame-to-frame relations
  - Representation of Frame Semantic phenomena in MYSQL database (Baker et al. 2003)
    - links within and across tables in database
- Computational infrastructure
  - FN DeskTop – develop lexicon

create frame-to-frame relations
annotate example sentences

Example Frame: Revenge

- Frame Definition: An AVENGER performs some PUNISHMENT on an OFFENDER as a response to an INJURY, inflicted on an INJURED_PARTY.
- Frame Elements: AVENGER, PUNISHMENT , OFFENDER , INJURY , INJURED_PARTY
- Lexical Units (LU): pairing of lemma and frame

  avenge, retaliate, revenge, get back (at), get even avenger, retaliation, revenge, retribution, vengeance, retaliatory, revengeful, vengeful

Annotation

[The monkey AVENGER] **avenged**

[himself INJURED_PARTY] [by growing to the size of a giant and setting fire to the city PUNISHMENT].

[El Cid AVENGER] **avenged** [the death of his son INJURY].

[Hook AVENGER] **avenged** [himself

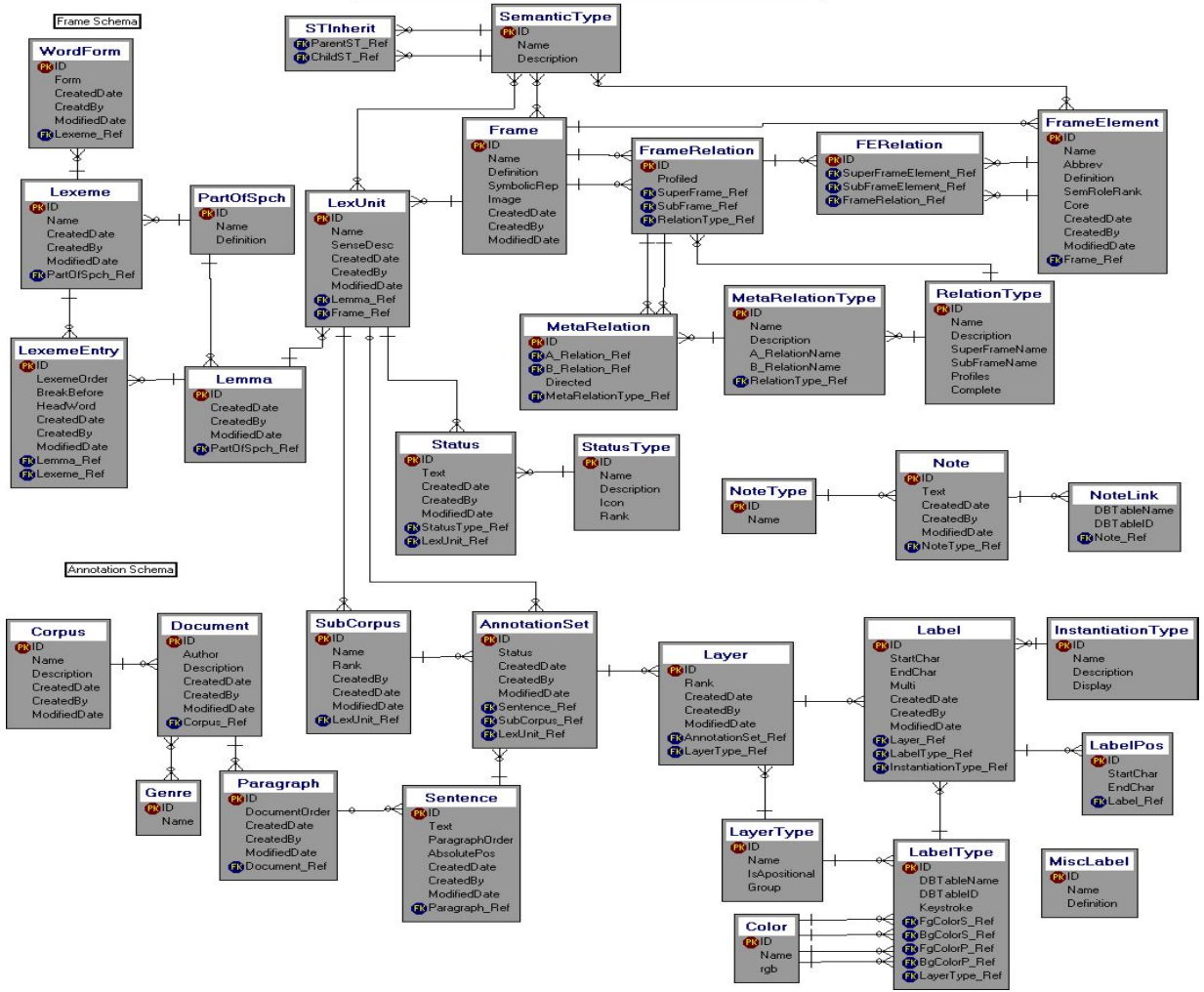
Valence Patterns: **avenge**.v

Valence Patterns:

These frame elements occur in the following syntactic patterns:

Number Annotated	Patterns				
1 TOTAL	Avenger	Depictive	Injured_party	Offender	Punishment
(1)	NP Ext	AJP Dep	NP Obj	PP[on] Dep	INI --
5 TOTAL	Avenger	Injured_party	Injury	Offender	Punishment
(1)	CNI --	NP Ext	2nd --	INI --	INI --
(1)	NP Ext	2nd --	NP Obj	INI --	INI --
(1)	NP Ext	NP Obj	2nd --	INI --	INI --
(1)	NP Ext	NP Obj	PPing[for] Dep	PP[on] Dep	INI --
(1)	PP[by] Ext	2nd --	NP Obj	INI --	INI --
2 TOTAL	Avenger	Injured_party	Offender	Punishment	
(1)	CNI --	NP Ext	INI --	INI --	
(1)	NP Ext	NP Obj	INI --	INI --	

FrameNet II Entity Relationship Diagram (ver. 2.0)



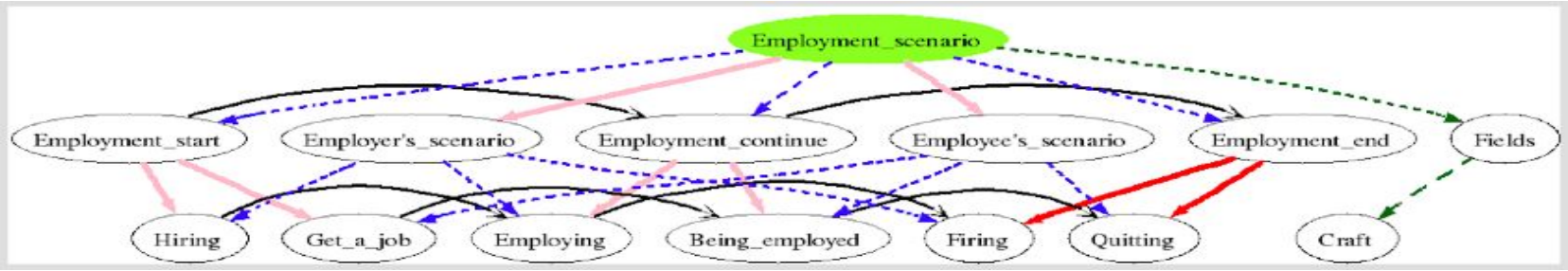
Frame-to-Frame Relations

frame-to-frame relations

Relation	Super_frame	Sub_frame
Inheritance	Parent	Child
Subframes	Complex	Component
Precedes	Earlier	Later
Using	Parent	Child
Perspective_on	Neutral	Perspectivized
See_also	Main Entry	Referring Entry
Metaphor	Source	Target
Inchoative_of	Inchoative	State
Causative_of	Causative	Inchoative/State

lexical relations

FrameGrapher



- Allows interactive exploration of frame-frame relations
- Technically a forest of lattices

FrameNet: Current Status

- Frames: > 1,200 semantic frames
- Frame Elements (FEs): ~10,500, defined frame-specifically
- Lexical Units (LUs): 13,685 pairings of lemmas with frames
- Frame-to-Frame relations: > 1,878 of 9 types
  - which include ~10,750 FE-to-FE relations
- Annotations: ~ 203,000 manually annotated instances of frames
  - “gold-standard”, used for training NLP systems for semantic role labeling, question-answering, information extraction, etc.

FrameNet

- The FrameNet Lexicon (“the original”)
- The FrameNet Constructicon

Lexicon and Constructicon

A lexicon should specify the grammatical affordances of its entries; a grammar should specify the kinds of lexical units capable of occurring in specifiable positions within grammatical constructions. The most consistent way to represent such mutual dependencies would be to provide both kinds of information in a well articulated grammar + lexicon

Fillmore 2006:35

The FrameNet Constructicon

"Beyond the Core" project (2011-2012)

- extending FrameNet to FrameNet Constructicon
- collection of approximately 80 analyzed and annotated grammatical constructions

- Fillmore, Lee-Goldman, Rhomieux (2012):

  "The kinds of constructions being collected and analyzed in the FrameNet Constructicon are mainly those that cannot be explained simply as instances of familiar constructions with ordinary lexical items."

Beyond the Core

- Fillmore et al. 2012:
  - based on Construction Grammar (Fillmore 1988, *inter alia*)
  - proof-of-concept; “add-on” to lexicon
  - inspired development of constructicons in numerous languages
- Lee-Goldman and Petruck 2018: defined and illustrated construction analysis and annotation for a construction, demonstrating the (step-by-step) process of development
  - “be friends with”

Lexicon-Constructicon Analogues

FrameNet Frames	FrameNet Constructicon
Frame	Construction
Instantiations of Valence Patterns	Construct
Frame Evoking Element (Lexical Unit, LU)	Construction Evoking Element (CEE)
Frame Element (FE)	Constructional Element
lexicographic annotation	constructicographic annotation

FrameNet-like Resources in “other” Languages

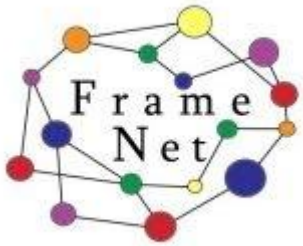
- Motivation: Why?
  - Why not?
    - Frame Semantics is a language-independent theory about meaning
  - Are semantic frames universal or merely language-specific lexical phenomena?
- Methodology: How?
  - FrameNet “the original” – frames, FEs, analogous LUs, etc., manual annotation
  - Automate different parts of development process
    - Projection of annotation from English to “other” languages
    - Semantic Role Labeling (a.k.a frame-semantic parsing)
      - Gildea and Jurafsky (2000), Das et al. (2014), Swayamdipta et al. (2018), etc.
    - Frame Induction
      - Cheung et al. (2013); QasemiZadeh et al. (2019), Yamada et al. (2021)

FrameNet-like Resources in “other” Languages

- Brazilian Portuguese
- Chinese
- Danish
- Dutch
- Emirati Arabic
- English (“the original”)
- French (ASFALDA)
- German (SALSA)
- Greek
- Hebrew
- Hindi/Urdu
- Italian
- Japanese
- Korean
- Spanish
- Swedish

FrameNet-like Resources for Specialized Domains

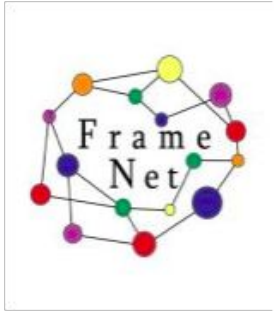
- Domains
  - BioFrameNet (Dolbey et al. 2006)
  - Kictionary (Schmidt 2009): English, French, German (soccer terminology)
  - Football World Cup (Torrent et al. 2014): English, Spanish, Br. Portuguese
  - Environmental Terminology (L'Homme et al. 2014, 2020)
  - Tourism and Sports (da Costa et al. 2018): English, Spanish, Br. Portuguese



Thanks!

Miriam R. L. Petruck

miriamp@icsi.berkeley.edu



Creating Frame Alignments

Arthur Lorenzi
arthur.lorenzi@estudante.ufjf.br

and

Collin Baker
collinb@icsi.berkeley.edu

Curated and Distributional Methods in NLP resources

- All FrameNets are basically curated resources
- All FrameNets use computational tools for curation
  - corpus searches
  - pattern matching/induction, e.g. Corpus Workbench
  - machine translation, computer-assisted translation
  - parsers
  - annotation tools, with computer assistance, e.g. WebAnno
- Most distributional methods incorporate substantial linguistic knowledge

FrameNet to FrameNet Relations

- All use semantic frames as basic structure
  - Most have adopted the Berkeley FrameNet frames to a considerable degree.
  - All projects have reported the BFN frames are "generally applicable".
  - Spanish, Japanese, and Brazilian Portuguese FNs have followed BFN closely
  - SALSA (German), French FN, Swedish FrameNet++, and Chinese FN have diverged more, adding many new frames and/or modifying the BFN frames.
- Similarity is not the only possible cross-linguistic frame relation.
- Frames in other languages can be broader or narrower than the nearest English frame

Research question and applications

- How similar are semantic frames across languages and cultures?
- Applications
  - machine translation
  - Crosslingual question answering
  - Crosslingual information extraction
- We need objective measures of how similar frames are across languages
- Some differences in point of view/choice of frames, are regular and extensive, e.g. satellite-framed languages like English and German vs. verb-framed languages like Spanish and Japanese (Slobin 1996;Ellsworth et al. 2006).

Methods for Creating Frame Alignments

- Discrete methods
  - Frame name/ID matching
  - FE matching (all or core only)
  - LU translation (Jaccard set matching)
    - Translation issues
- Distributional methods
  - Computed/continuous data
  - Lexical units (MUSE or BERT)
  - Frame definitions (MUSE or BERT)
  - FE definitions (all or core only x MUSE or BERT)

Alignment by Discrete Methods

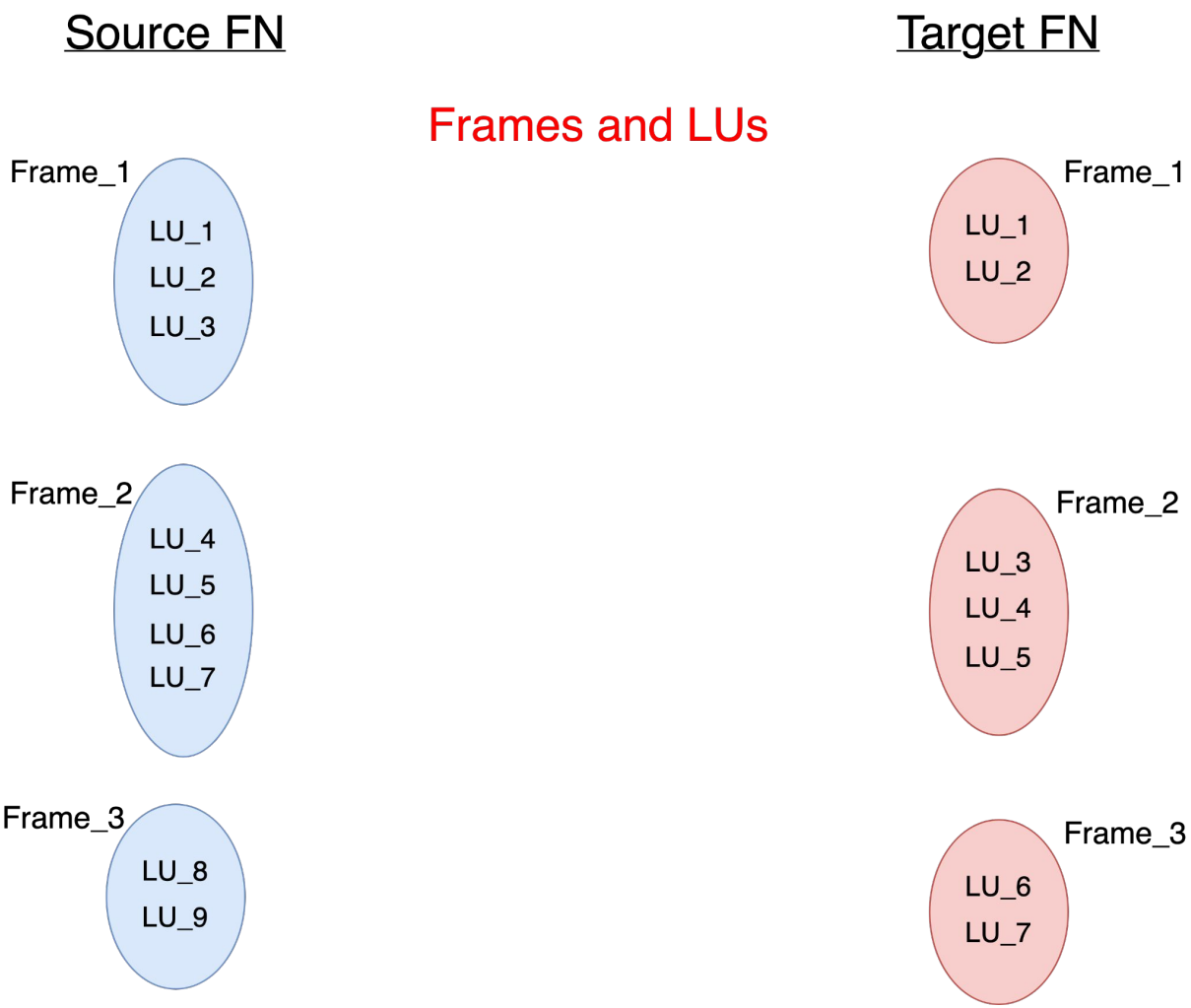
Frame name/ID matching

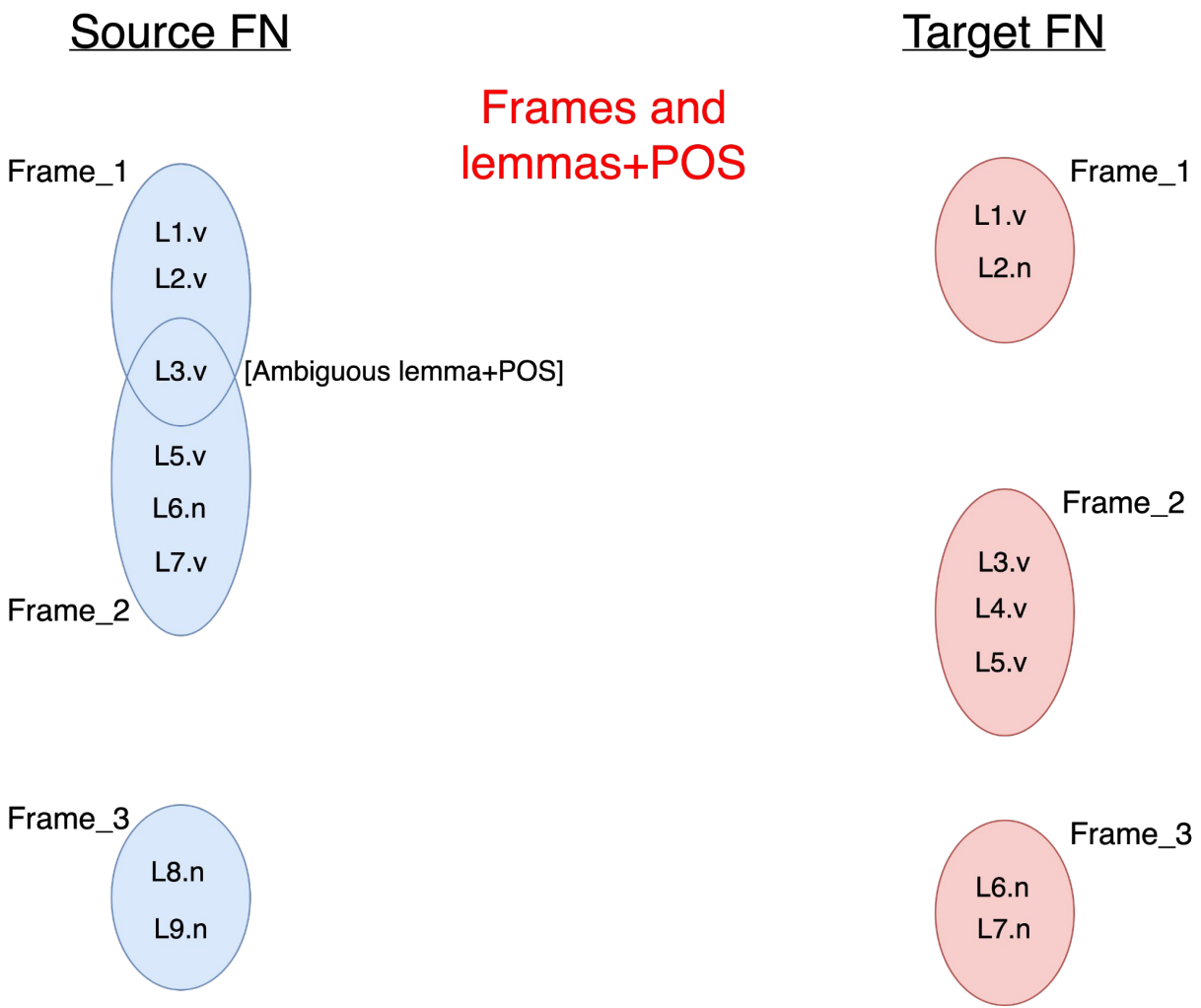
- Why not just assume that a frame in another language with the same name as a BFN frame represents the same concept, and ignore any that don't match?
- Translate non-English frame names?
- Sometimes, their frame names are not in English, but the data includes the BFN name or BFN ID, which can be used to align
- Even when the names (or IDs) match, frames may be defined differently or have more or fewer core frame elements than BFN

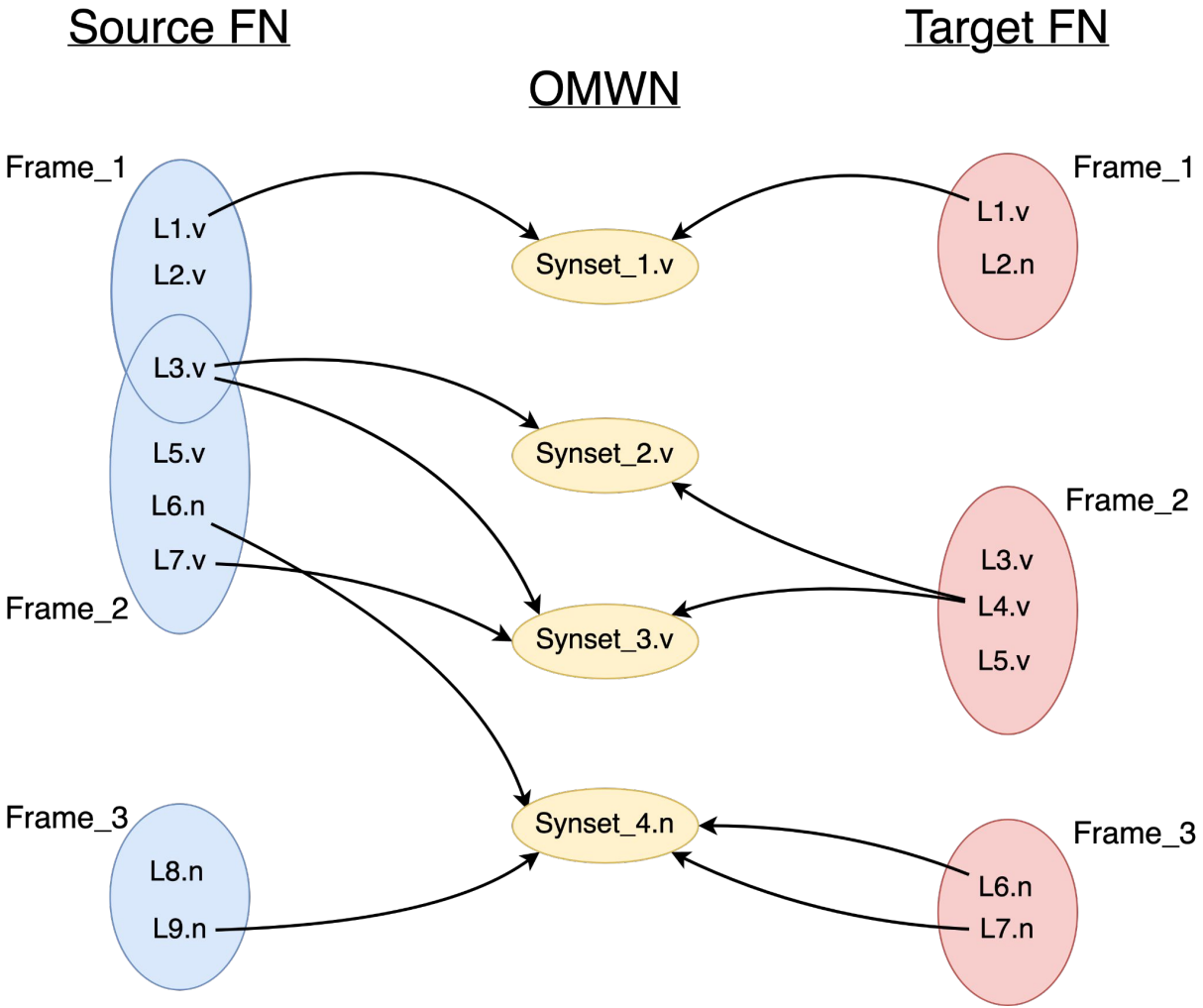
Alignment by LU translation

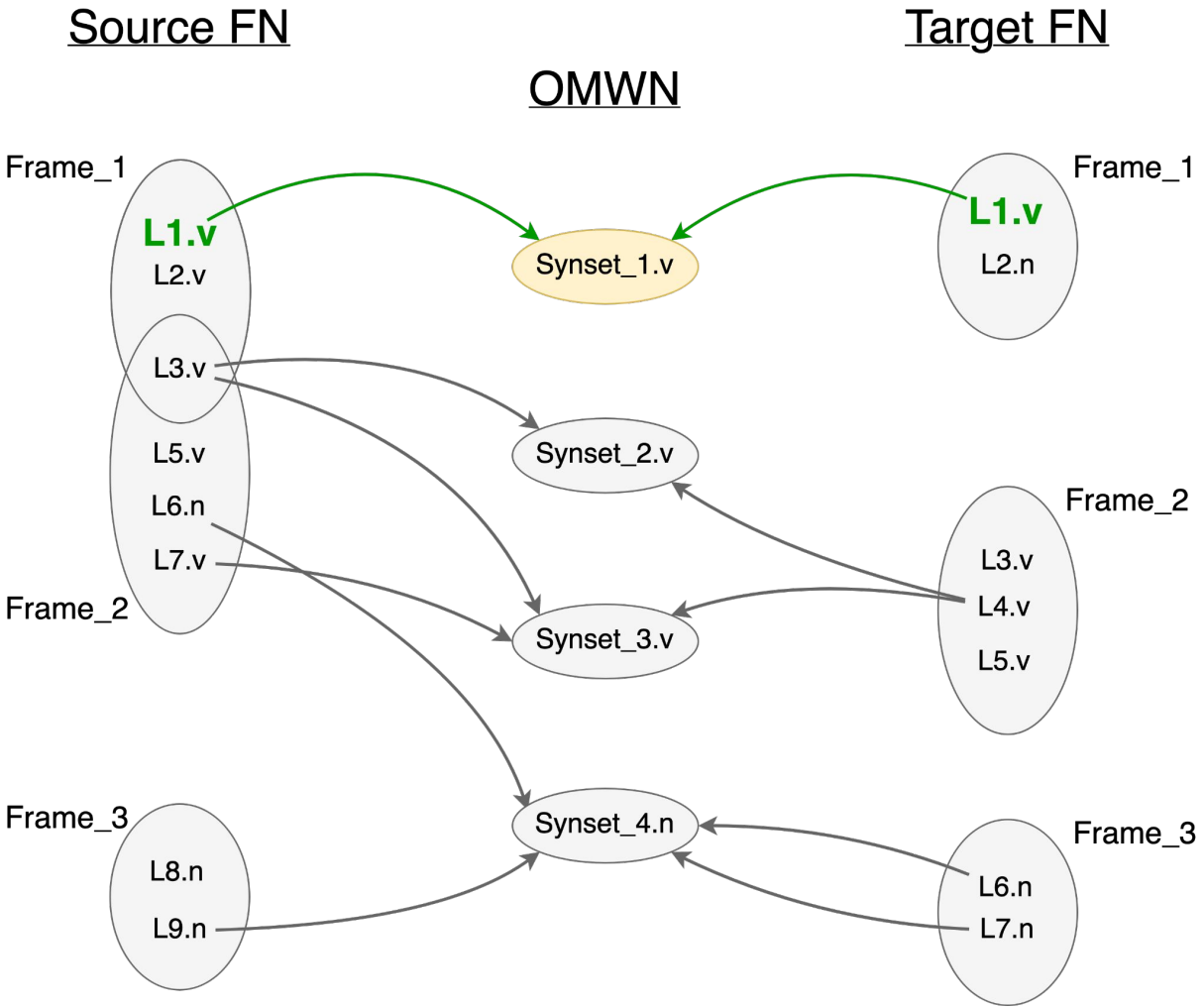
- Basic principle: If frames are equivalent across languages, we expect all the translations of LUs in one source language frame to fall into the same target language frame
- Depends on accuracy of translations
- An LU in a frame ≈ one sense of a lemma; this should restrict the range of possible translations
- How to use frames, frame relations in translation?
- We use Open Multilingual Wordnet (Bond & Foster 2013)
  - multilingual synsets, each containing words from dozens of languages, for translation
- Scores based on number of matches

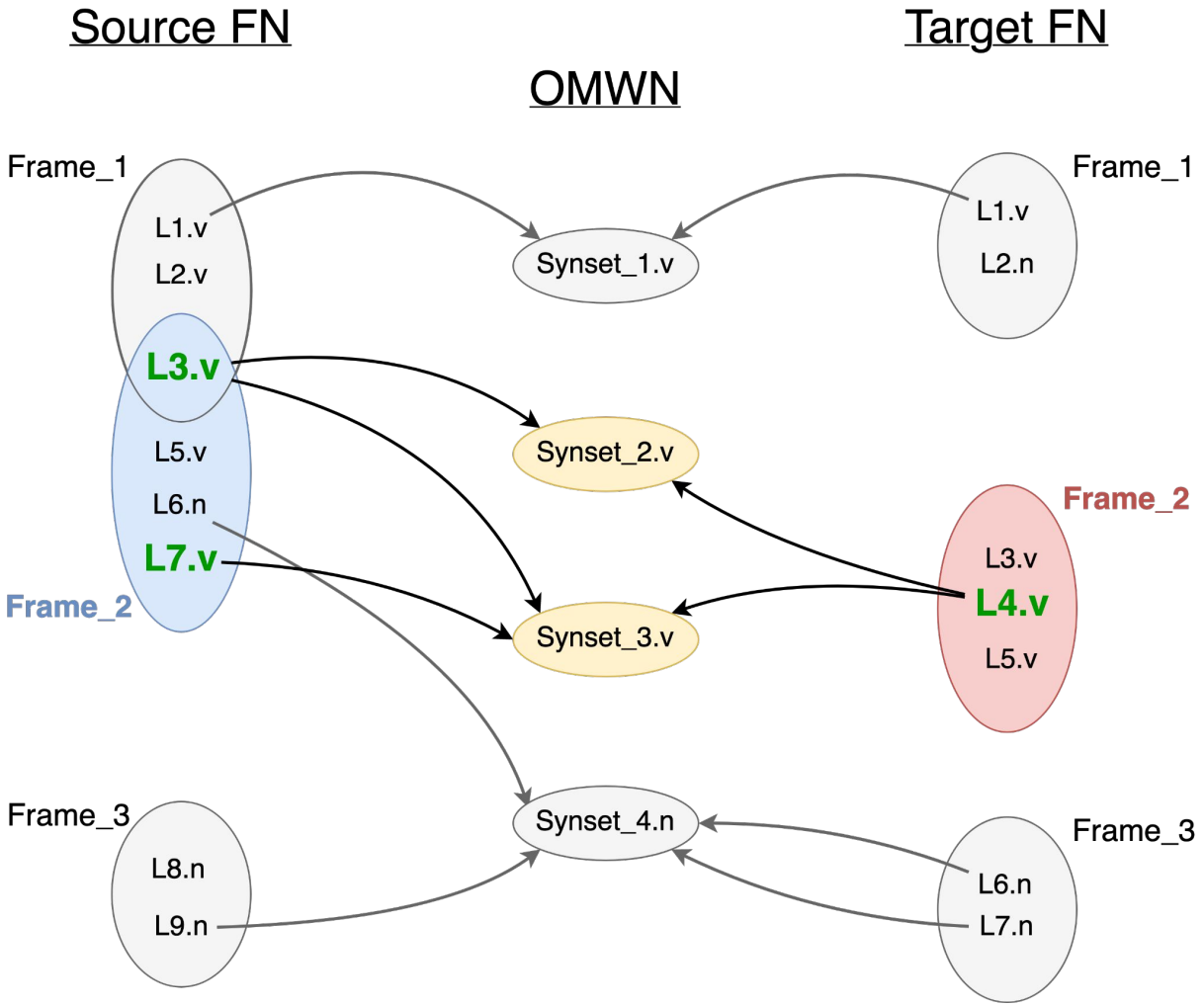
Frames and LUs




Source FN
Target FN
Frames and lemmas+POS
Frame_1
L1.v
L2.v
L3.v
[Ambiguous lemma+POS]
L5.v
L6.n
L7.v
Frame_2
Frame_3
L8.n
L9.n
Frame_1
L1.v
L2.n
Frame_2
L3.v
L4.v
L5.v
Frame_3
L6.n
L7.n


Source FN
Target FN
OMWN
Frame_1
L1.v
L2.v
L3.v
L5.v
L6.n
L7.v
Frame_2
Frame_3
L8.n
L9.n
Synset_1.v
Synset_2.v
Synset_3.v
Synset_4.n
Frame_1
L1.v
L2.n
Frame_2
L3.v
L4.v
L5.v
Frame_3
L6.n
L7.n


Source FN
Target FN
OMWN
Frame_1
L1.v
L2.v
L3.v
L5.v
L6.n
L7.v
Frame_2
Frame_3
L8.n
L9.n
Synset_1.v
Synset_2.v
Synset_3.v
Synset_4.n
Frame_1
L1.v
L2.n
Frame_2
L3.v
L4.v
L5.v
Frame_3
L6.n
L7.n


Source FN
Target FN
OMWN
Frame_1
L1.v
L2.v
L3.v
L5.v
L6.n
L7.v
Frame_2
Frame_3
L8.n
L9.n
Synset_1.v
Synset_2.v
Synset_3.v
Synset_4.n
Frame_1
L1.v
L2.n
Frame_2
L3.v
L4.v
L5.v
Frame_3
L6.n
L7.n

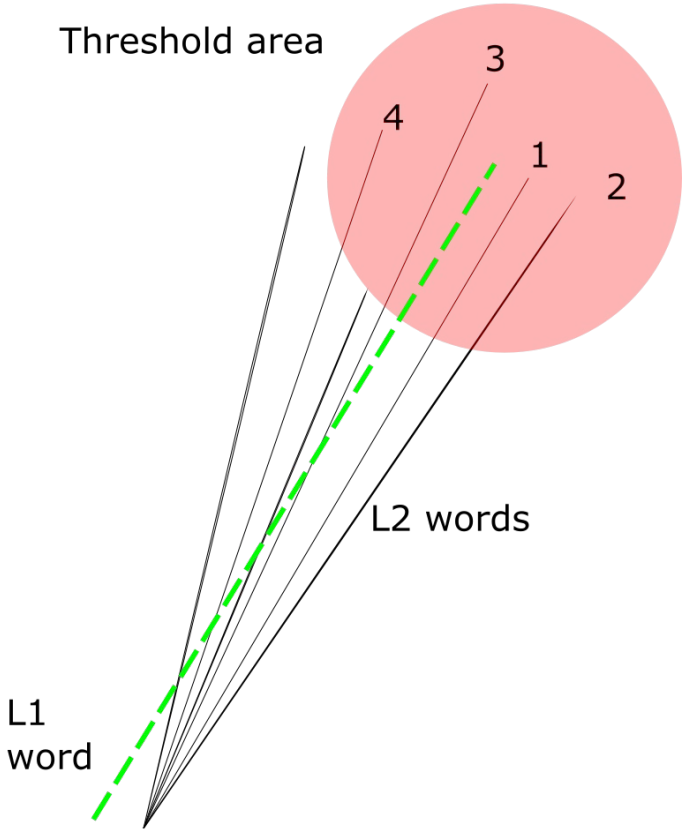
Alignment by Frame Element Similarity

- By definition, for two frames to be the same, they must have the same number and types of FEs
- Some FrameNets copied BFN FEs and definitions
- Others have translated names or created new FEs; align using cross-lingual vectors?
- FN Brasil and SALSA (German) have FEs in both languages

Alignment by Distributional Similarity of LUs

Translation by Cross-lingual Word Embedding

- Get translation equivalents by using transformed FastText vectors (Bojanowski et al. 2017) of many languages mapped to a shared space using the MUSE library
- Define the neighborhood n in the shared space around the vector embedding of a source language word v as $\vec{n}(v, k, t)$ where t is a similarity threshold

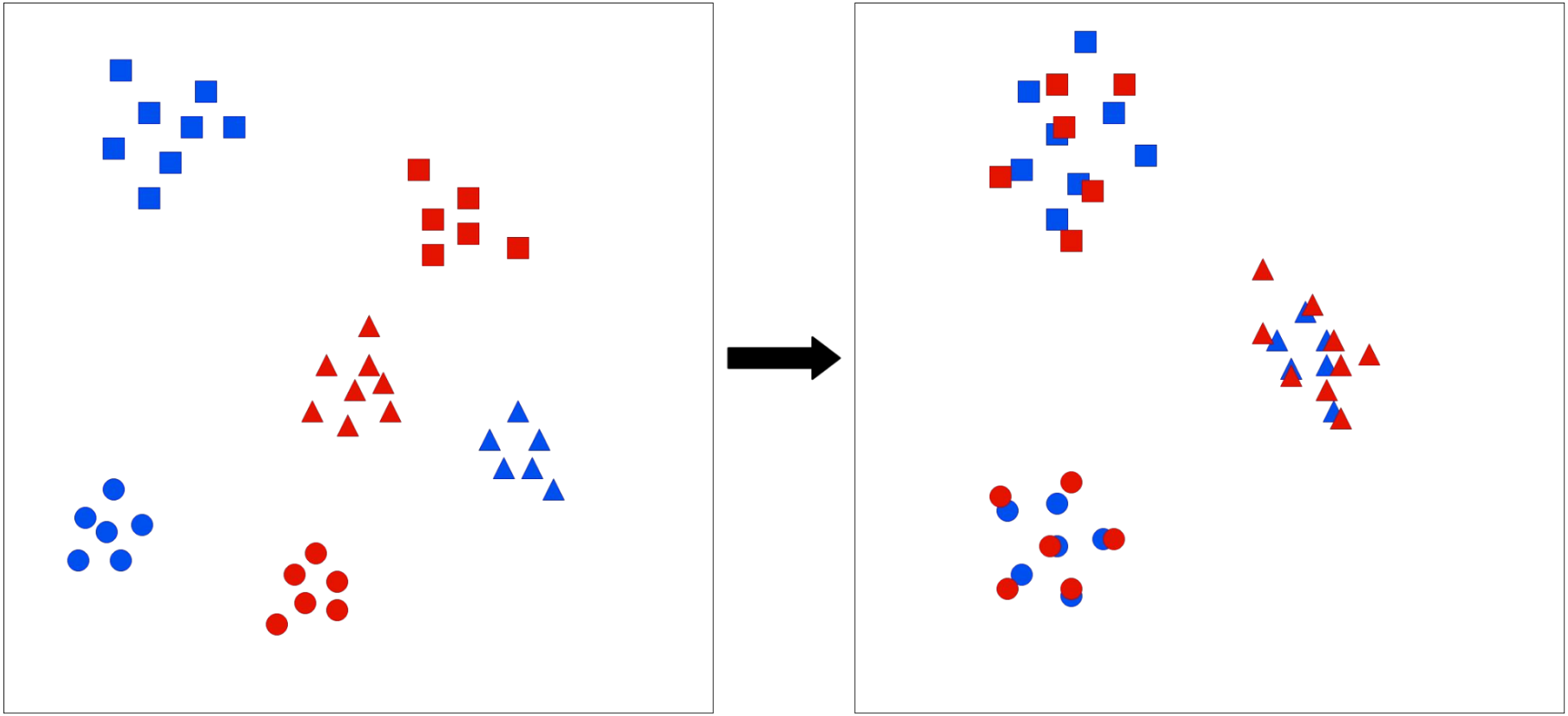


LU centroid similarity using MUSE vectors

- Find the average of the vectors of the LUs of each frame (i.e. the centroid vector of each frame)
- Compute the cosine similarity of each pair of centroids from each pair of frames to measure frame similarity, (cf. Sikos & Padó 2018)

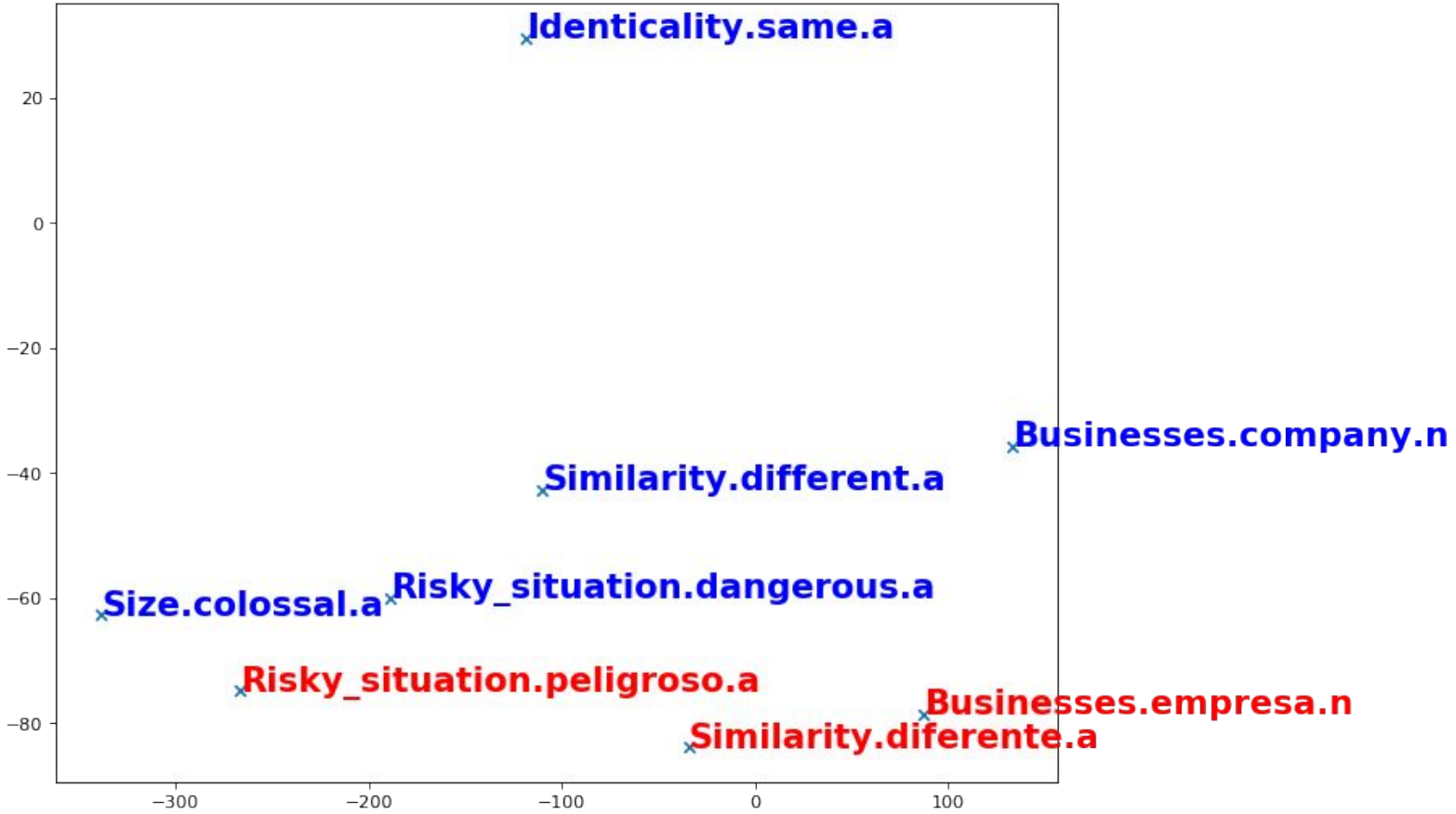
LU-specific BERT vectors

- We also used word vectors from Multilingual BERT
- Multilingual BERT pre-training doesn't guarantee cross-language alignment
- We fine-tuned the model to enforce alignment at word level on the Europarl corpus (*cf*. Cao *et al.* 2020)
- Then we used the fine-tuned BERT model to obtain LU contextual vectors from annotated sentences
- Then we averaged the contextual vectors of each LU.

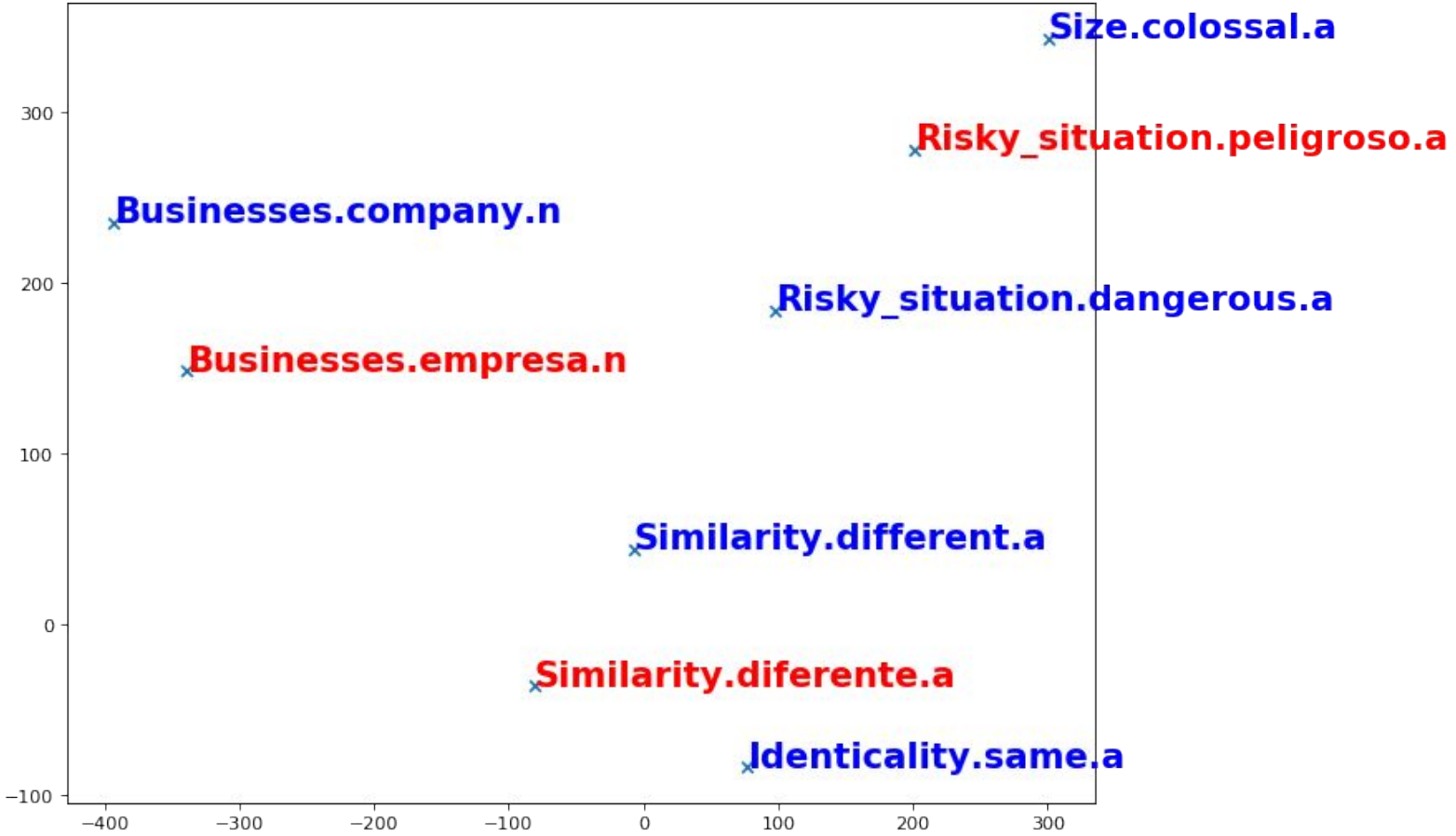


Fine tuning transformation: each point represents a contextual vector and each shape a word. The color of the point identifies its language

Pretrained Multi BERT on FN LU instances



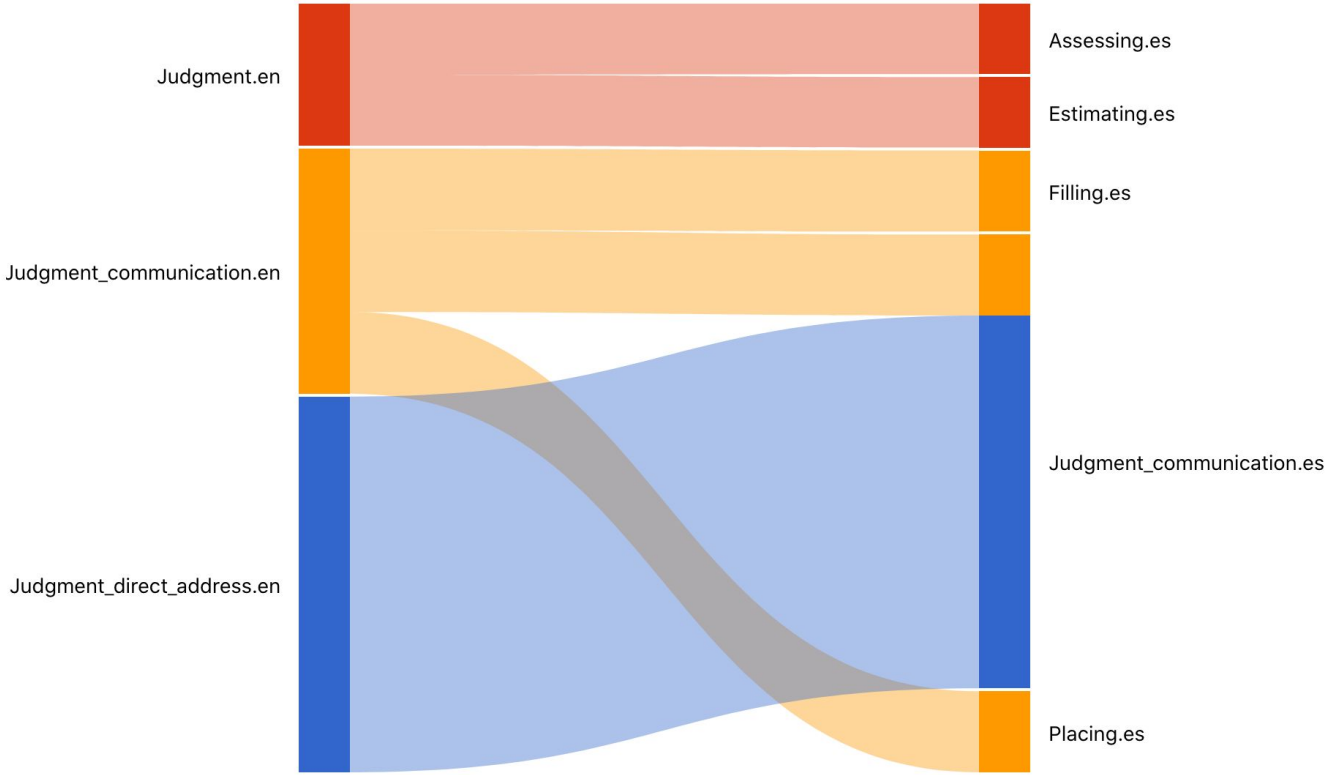
Pretrained Multi BERT on FN LU instances



Synsets vs. vector methods

- Synset-based methods
  - + Large-scale, curated semantic groupings of lemmas
  - − Too many senses, many difficult to distinguish (cf. Hovy *et al.* 2006)
- Vector-based methods (word2vec, GloVe, BERT, FastText)
  - + Measure distances (arguably semantic) between uses
  - + Define math operations to compose them, “logical operations”
  - − Dimensions are not easily interpretable (but Shin *et al.* 2018)
  - − Based on word forms, not lemmas or lexemes, no POS
  - − Most provide only one vector per word form (but Huang *et al.* 2012, Jakubowsk *et al. 2020*)
  - +/− Some encode subwords (usually **not** morphemes)

ViToXF--Alignment Visualization Demo



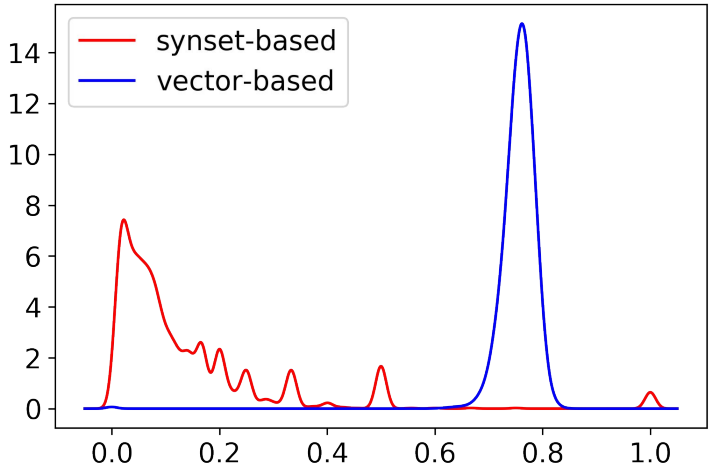
Visualization tool, showing Sankey diagram of English Judgment frames aligned with Spanish Frames using LU translation by linking synsets at a high score threshold.

Quantitative evaluation of alignment techniques

- Identify gold alignments for each language
  - Can the same criteria be used for all databases? (yes)
  - Can we assign perfect scores to all gold alignment pairs a priori?
- Aggregating all scores into one? Problems:
  - Although limited to the (0,1) interval, the distributions vary
  - Scores can differ due to various reasons, e.g. (lexical vs non-lexical frames, incomplete database, incomplete resource, etc.)
  - Should we weight some scores more heavily?
- Evaluate scoring–some possibilities:
  - Simple comparison
  - Correlation
  - Downstream task?

Aggregating scores

- Different types of scores have very different distributions:



- A simple sum or average won't work
- A voting system would only work if we could define appropriate thresholds.

Gold alignment set creation

- Some databases have frame names in their own language, but also store the names in English (*e.g.* Chinese FN, FN Brasil)
- Frames with translated FE names (in Salsa and FN Brasil) were ignored in this procedure.
- When provided, their numerical IDs also had to be similar. (Spanish FN and others).
- **Problem**: Only binary values ("gold" or not).

SALSA: Evaluation Against Manual Alignments

Arthur Lorenzi and Alexander Ziem
with help from Anastasia Neumann-Schneider and
Phillip Marius Sandkühler
Heinrich-Heine-Universität Düsseldorf

Universidade Federal de Juiz de Fora

Heinrich Heine Universität Düsseldorf

SALSA: evaluation against manual alignments

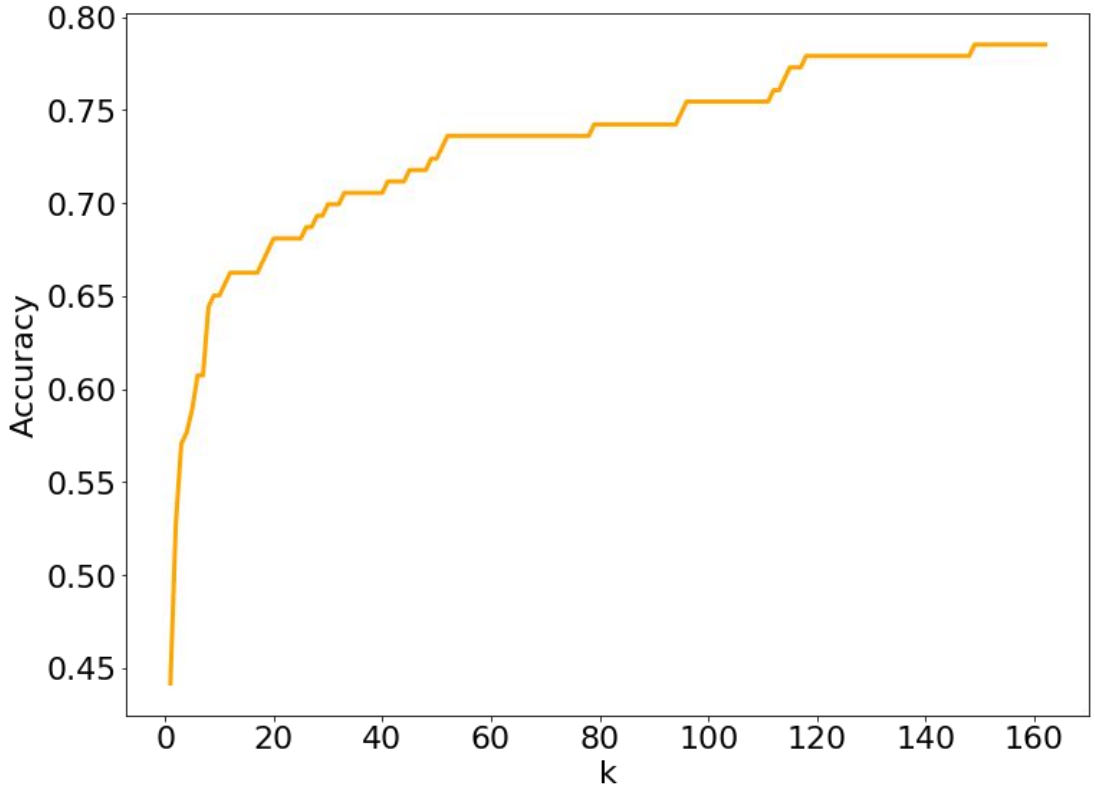
- The German FrameNet group led by Prof. Ziem has been working on the manual alignment of SALSA proto-frames to BFN frames
- Of the 1023 proto-frames, 852 have been evaluated by human curators
- 372 proto-frames exactly aligned to a BFN frame, while the rest could not be mapped directly, *e.g.*, the FEs were different, there was a metaphorical relation between the frames, etc.
- We chose to use only the 372 exact alignment pairs at first, excluding those already included in the training gold set, which left 166 pairs for testing.

SALSA: evaluation against manual alignments (2)

- The SALSA test set was used to reevaluate our classifier for German. We looked at the accuracy over *k*-best predictions.
  - This low accuracy is due to the complexity of the problem,
  - but the results show that the model can aid the alignment process by making suggestions (*k* = 3 seems the best)
  - Even when *k* = 50, the accuracy is far below 1.0, indicating that some alignment pairs are hard for the model to learn

k	**accuracy**
1	0.4417
2	0.5276
3	0.5705
5	0.5889
10	0.6593
50	0.7239

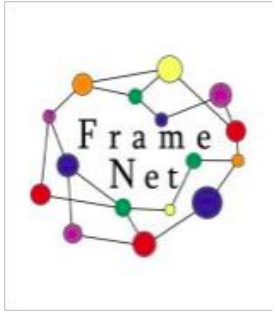
SALSA: accuracy over *k*-best predictions



SALSA: frame family accuracy

- We looked at the accuracy in regards to **frame families**
  - In this setting, a prediction is considered correct if the predicted frame is in the same family as the gold label frame.
  - If “wrong” predictions are mostly within the same frame family, then we have evidence that the family model captures some essential information.
  - There’s an improvement in accuracy, but apparently essential information is still missing or being ignored, since even at higher *k* values accuracy is still below 1.0.

k	**accuracy**
1	0.5364
2	0.6291
3	0.6556
5	0.7350
10	0.8344
50	0.9139



Evaluating Frame Alignments

Michael Ellsworth
infinity@icsi.berkeley.edu
(ICSI FrameNet Project)

Outline

- "Gold standard" alignments
  - What does alignment mean?
  - Dimensions of alignment
- Evaluation results
  - Overall
  - Precision and Recall

What Does Frame Alignment Mean?

- We expect actually equivalent frames to follow the same criteria as we require for lexical units of a single frame
- Member Lexical Units of a frame must match **Entailments**
  - Frame Elements (FEs) must be the same, including number and interrelations
  - Relations to other frames must be the same
- “Tess gave a unicorn to Zelda” =>
  - Tess, a unicorn, Zelda exist in the same context (Existence frame);
  - Tess had a unicorn (Possession frame) before the Giving
  - Zelda had a unicorn (Possession frame) after the Giving
- Compare: “A unicorn was bestowed on Zelda by Tess”

What Frame Alignment Isn’t

- Not the same as general semantic equivalence
  - Lexical Units within a frame may have lots of diversity (grimace.v vs. grin.v vs. frown.v)
- We don’t require perspective matching
  - Active vs. passive can have opposite perspectives
  - But in some cases perspective differences change Frame Element entailments
  - Buy.v and sell.v are in different frames because the Purpose Frame Element is related to the *Buyer* for buy.v and to the *Seller* for sell.v
- Pragmatic matching
  - Mostly not captured by current frames because so much of it isn’t lexical or isn’t related to the kinds of frames that normally depict meanings
  - Thrifty.a vs. stingy.a

Monolingual Entailments Exercise

- List the frame and FE entailments of picnic.v
  - Look at corpus examples to get all the frequent FEs;
    - supplement with intuition and further search
  - How does each FE relate to the others?
  - What do you **know** is true if someone uses the verb picnic?
  - What would you **expect** but not know for sure?
- List the frame and FE entailments of dine.v

- Should dine.v and picnic.v be in the same frame?

Cross-linguistic Entailments Exercise

- List the entailments of German *fahren.v*, Spanish *correr.v*, or another verb in a language you are competent in
- List entailments for possible translation equivalents in English
- Are the English equivalents in Berkeley FrameNet?

- Should frames for the other language be aligned with the English frame?

Cross-linguistic Frame-to-Frame Relations

- In many cases, especially when dealing with typologically different languages, there is no English frame for which entailments line up
- In such cases, vocabulary should be modeled as a new frame not in Berkeley FrameNet
- This new frame should be relatable to the Berkeley FrameNet frame via existing types of Frame-to-Frame relations
    - English Self_motion vs. Spanish Motion_manner

Current Results Using VitoXF

- Gold-standard evaluation requires a human
- The space is too large for exhaustive human comparison:
  - Many frame alignments
  - Several languages
  - Several techniques
  - 0, 1, or 2 continuous value thresholds (depending on technique)
- Exploration of the space at all would be nigh impossible without VitoXF!

Getting gold alignments

- Where frames have the same name or Berkeley FrameNet ID, and same FEs, we can assume intended equivalence

- Produces “Gold” alignments

Gold alignment set creation

	Frames	Name only	Name + FEs	Name+FEs+ID
ICSI FrameNet	1221	-	-	-
FrameNet Brasil	1092	1092	817	7997
French FN	148	78	71	71
Chinese FN	1259	1160	1160	1160
Japanese FN	984	895	675	656
Spanish	1196	1111	969	939
Swedish FN	1195	1058	956	956
Salsa (German)	1023	237	203	203
Dutch FN	1221	1221	1215	1215

What we can do with gold alignments

- VitoXF is then a check in two directions
- Checking distributional techniques:
  - How do distributional techniques hold up to producing these human alignments?
- Checking human proposed frame alignments:
  - Do divergences in distributional values call into question human frame equivalences?
- Determining why putative equivalent frames diverge in joint distributional space requires human assessment

Different Distributions Have Different Strengths

(See https://fnwiki.icsi.berkeley.edu/FNwiki/index.php/Frame_Alignment_Eval)

- 10 frames checked for alignments in English and Spanish
- Some techniques fare well, others poorly:
  - LU centroid based on MUSE gets the one-best answer correct for 8 of 10
  - MUSE based frame definition similarity never works (0/10)

Conclusion

- Each new FrameNet constitutes an experiment in cross-linguistic Frame Semantics. Collectively, they form a basis for research into cross-linguistic semantic framing, and the search for semantic "universals".
- We have devised a suite of methods for measuring the similarity of frames across languages, regardless of the naming conventions of the respective FrameNets.
- We have created and made freely available ViToXF, an intuitive, interactive visualization tool to study these relations across pairs of languages.
- We have evaluated the effectiveness of the developed suite of methods in finding good alignment pair candidates, both on Spanish-English and German-English pairs.
- We hope you will join us in work on this ambitious agenda!

Acknowledgements

This material is based in part upon work supported by the U.S. National Science Foundation under Grant No. 1629989. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

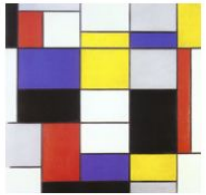
Support for the work on SALSA was also provided by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) - Process number 88887.628831/2021-00.

Acknowledgements to FrameNets

We are especially grateful to the FrameNets who have provided their data for this study. We hope to add more soon.

Spanish FN (Subirats 2009)
SALSA (Burchardt *et al.* 2006)
Japanese FN (Ohara *et al.* 2004)
Chinese FN (You & Liu 2005)
FrameNet Brasil (Torrent *et al*. 2018)
Swedish FN++ (Borin *et al*. 2010)
French FN (Candito *et al*. 2014)
Dutch FN (Vossen *et al.* 2018)

asfalda



SPRÅKBANKENTEXT

KFN

Thanks also,
To you!

Thank you! Stay well! Stay sane!

https://framenet.icsi.berkeley.edu