1. Introduction

Semantic frame
- A conceptual structure describing an event, relation, or object along with its participants
- Several resources, such as FrameNet (Baker,+98), VerbNet (Kipper,+00), and PropBank (Palmer,+08), have been manually elaborated
- Various systems have been proposed for automatic construction of frame knowledge from raw corpora (Kawahara,+06, Kawahara,+14)

FrameNet
- A representative frame resource
- Providing rich semantic representations
- Including 200K+ frame-annotated sentences
- Being extended to roughly a dozen languages

Kyoto University Case Frame (KCF)
- Example-based Japanese semantic frames (Kawahara,+06)
- Constructed by clustering examples of predicates and their arguments according to semantic similarity

Manual Development of Frame Resources
- Labor-intensive process
- Especially associating with frames in other languages is difficult
- Japanese FrameNet (JFN) (Ohara,+18) has been developed for 20 years, but its coverage is still limited
- The process can be facilitated if there is a base frame resource associated with FrameNet

2. Related Work

Linking frame knowledge
- SemLink (Palmer,+09) manually connects PropBank, VerbNet, and FrameNet (Ohara,+18) linked KCF with JFN using crowdsourcing
- Linking automatically constructed lexicalized frames to manually crafted knowledge
- Similar to our setting, but not cross-lingual

Annotation projection
- Popular framework for transferring frame knowledge to other languages such as FPlace,Kabita,+13, data (Yama,+18, Matsui,+19)
- Exploiting the structural equivalences present in parallel corpora

3. Cross-lingual Frame Linking

Overview
- We link each KCF frame to one of the FrameNet frames
- KCF frames included in JFN (Aida,+19) and PropBank (Palmer,+08), have been manually elaborated

Candidate Frame Extraction
- Extracting candidate frames by only considering the verb
- Given a KCF frame \( CF_{K} \), we calculate \( \text{sim}(v, LU) \), a cross-lingual similarity between verb \( v \) and each of the LUs of FrameNet frame \( LU \)
- We use the top three cosine similarities of supervisely aligned cross-lingual word embeddings (https://github.com/facebookresearch/MoSE) as \( \text{sim}(v, LU) \)

Ranking the FrameNet frames
- By the similarity score and extract the top 100 frames as the candidate frames for the given KCF frame \( CF_{K} \)
- \( \text{sim}(CF_{K}, LU) = \text{Cause} \) frame, \( \text{Cause} \) to fragment, impact, ...

Frame Alignment
- For each candidate FrameNet frames \( LU \), we calculate the frame alignment score against the given KCF frame \( CF_{K} \)
- We use five Japanese surface cases as the target of the alignment, \{は(pas),が(ga),を(to),に(ni), and で(de)\}
- As for the FEs, we examined two settings
  1. CORE-ONLY: Considering only the core FEs as the target of the alignment
  2. ALL-FES: Considering both core and non-core FEs as the target of the alignment

We calculate the alignment score for all combination of the pairs of target FEs and cases, with the following constraints
- The ‘ガ’ is always associated with one of the FEs
- Two different cases are not allowed to be aligned to the same FE
- Alignment score is calculated as the product of \( \text{sim}(v, LU) \) and the sum of the individual case alignment scores \( \text{score}(LU) \)

4. Experiments

Evaluation
- No evaluation data for the link between KCF and FrameNet
- We use data from Japanese FrameNet, in which FrameNet frames are manually annotated to words in Japanese text
- KNP, a Japanese predicate argument structure analyzer, can assign a KCF frame to each verb in Japanese text...
- If the frame to which the assigned KCF frame is linked matches the manually annotated frame, the link can be considered correct
- In this study, 1182 verbs from the annotated sentences in JFN were used for evaluation
- We exclude those appearing as passive or compound verbs, so that the accuracy of the link itself could be evaluated

Overview of the procedure for evaluation
1. Analyze predicate argument structure with KNP
2. Convert the KCF frame and its cases to a FrameNet frame and FEs

Frame ranking results
- We evaluated link accuracy by recall@k, the percentage of manually annotated frames that were ranked in the top k-th
- Vero-DBX considers the ranking for candidate frame extraction
- This result shows that taking FEs, including non-core FEs, into account was beneficial for ranking the FrameNet frames
- ALL-FES ranked the annotated frame in the top 5 for 65.7% and the top 10 for 72.6%, which would help the manual expansion of the frame-annotated sentences in JFN

5. Conclusion and Future Work

Automatic linking of KCF and FrameNet
- To support the development of cross-lingual frame resources
- Both core and non-core FEs should be taken into account

Future work
1. Using other kinds of cross-lingual word embeddings
2. Exploring the machine learning-based approach with additional features such as FrameNet hierarchy
3. Extending the scope of linking to non-verbal case frames
4. Exploiting our approach for manual expansion of JFN