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Assignement.3: Using LLMs for Entity Extraction

MS DSP 453 – Natural Language Processing

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Introduction

In this project, we aimed to leverage natural language processing (NLP) techniques to extract insights from user reviews of *The Batman* movie, focusing on two key tasks: entity recognition and relationship extraction. Our goal was to identify entities (characters, actors, films, locations) and the relationships between them, ultimately constructing a knowledge graph from the extracted data. We explored two approaches for this task: one using spaCy's pre-trained models and another by combining spaCy with Transformer (BERT), which offered more advanced relationship extraction capabilities.

Data

The data consisted of a set of user reviews of *The Batman*, each containing Review, UserID, Post Date, Source, URL of the Review, Word Count, and Keywords. We only use Review columns for our assignment. These reviews were rich in named entities, with mentions of actors, characters, films, and locations, making it an ideal dataset for entity and relationship extraction tasks. The dataset was not pre-structured, meaning we had to apply pre-process the text and then apply NLP techniques to identify entities and relationships, and then organize the data into a format suitable for further analysis.

Research Design and Modeling Methods

We used two approaches for entity and relation extraction:

1. **spaCy-based Approach**:
    - **Entity Recognition**: We first applied spaCy's Named Entity Recognition (NER) models to extract standard entities such as actors, characters, and locations. spaCy's pre-trained models are designed to recognize general

entities, so we adapted them to the movie domain by fine-tuning certain parameters and using custom rules for disambiguation.

- **Relation Extraction**: For relation extraction, we used spaCy's dependency parsing and syntactic analysis. We employed custom rules to capture simple relationships such as "Actor X plays Character Y," "Character X interacts with Character Y," and more.

2. **spaCy + Transformer-based Approach**:
    - To improve the extraction of complex relationships (e.g., "Batman is compared to Joker"), we enhanced the spaCy approach with Huggingface Transformer(BERT model). These models provided more nuanced understanding by capturing semantic relations and contextual references that spaCy's rule-based system might have missed, especially for figurative language and more sophisticated relationship types (e.g., character comparisons or sentiment-based connections).

Knowledge Graph Creation: Using the results from both methods, we constructed knowledge graphs. The graphs represented entities (actors, characters, locations, and films) as nodes, while relationships such as "Actor X portrays Character Y" or "Character X is compared to Character Y" were captured as edges between these nodes.

Challenges Encountered

1. **Entity Ambiguity**: Many entities, like "Batman," could refer to both the character and the movie. Differentiating between these contexts was challenging, especially when entities were mentioned in ambiguous or shorthand.
2. **Complex Relationships**: Extracting nuanced relationships such as comparisons (e.g., "Riddler vs. Joker") or emotional evaluations (e.g., "Batman is too dark") was

difficult. While spaCy handles basic relationships well, it struggles with more complex, context-dependent connections.

3. **Informal Language**: User reviews often included slang, sarcasm, and informal expressions that were not always recognized by the models. The hybrid spaCy + Transformer approach helped, but still missed some subtleties in tone and sentiment.
4. **Entity Overlap**: Multiple characters or actors were mentioned in the same sentence, requiring careful disambiguation. For instance, mentions of "Pattinson" and "Keaton" could refer to different Batman portrayals, complicating entity extraction.

To address these challenges:

- We used fine-tuning and added custom post-processing rules to disambiguate terms like "Batman" (distinguishing between the character and the movie). We also used spaCy for straightforward entity extraction and LLMs to improve understanding of nuanced relationships.

Results

Entity Extraction:

- **spaCy** identified key entities such as character names, movie titles, and cardinal numbers with good accuracy, capturing entities like "Robert Pattinson," "Batman," "Penguin," and "Gotham." However, spaCy struggled with ambiguous references (e.g., "Batman" could refer to the character or the film) and informal language (e.g., "emo Batman").
- The **spaCy + Transformer** approach improved entity recognition, particularly in understanding context and resolving ambiguity. For example, it was better at distinguishing between Batman as a character and as a movie title.

Relation Extraction:

- **spaCy** performed well in simple relationships, such as linking characters to actions or descriptors (e.g., "Robert Pattinson as Batman"), but often missed more complex relationships, such as comparing performances or indicating emotional tones in the reviews.
- **spaCy + Transformer** excelled in extracting relationships, like actor comparisons (e.g., "Robert Pattinson vs. Christian Bale") and sentiment-based connections (e.g., "the Riddler's performance is terrifying"). The LLM's ability to capture the subtleties of natural language helped in identifying more abstract relationships like "Batman is too dark" or "the movie is a masterpiece."

Analysis and Interpretation

Why Results Were Not Optimal:

- **Complex Relations**: Even with the combined spaCy + Transformer approach, extracting deeper semantic relationships required more context than what the models provided. For instance, while comparisons like "Riddler compared to Joker" were identified, their deeper emotional or thematic connections were not fully captured.
- **Entity Overlap and Ambiguity**: In some cases, entities were misclassified, especially when references to "Batman" as a movie or character were involved. This was particularly challenging because spaCy's NER model did not distinguish well between these contexts without additional tuning.
- **Contextual Nuance**: While LLMs helped address some of the nuanced relationships, they still struggled with certain types of informal or figurative language, such as sarcasm or metaphor, that are common in movie reviews.

Suggested Improvements:

- **Fine-Tuning**: Further fine-tuning on a more specific movie review corpus could improve the model's ability to handle informal language and domain-specific terms.
- **Contextual Understanding** : Incorporating sentiment analysis could help capture subjective relationships between characters and their performances, enhancing both relation precision and recall.
- **Hybrid Approach Refinement**: The combination of spaCy with LLMs worked well, but integrating more specialized models for relation extraction, particularly for comparisons or emotional assessments, would lead to more accurate results.

Conclusions

In this project, we applied spaCy and spaCy + Transformers to extract entities and relations from movie reviews, focusing on characters, actors, and sentiments. The results demonstrated that spaCy + Transformers outperformed spaCy alone in entity extraction, achieving perfect recall and high precision. However, the relation extraction performance revealed a significant discrepancy between precision and recall, with missed relationships limiting the overall results. Challenges stemmed from the complexity and nuance of movie reviews, such as ambiguous references and implicit relationships. To improve, fine-tuning the model on domain-specific data, enhancing entity disambiguation, and incorporating sentiment analysis would help capture more accurate relations and improve overall performance. Ultimately, this project highlighted the potential of combining spaCy and Transformers for more robust extraction tasks, while also identifying key areas for refinement in both entity and relation extraction.

Appendix – Performance Evaluation of both Methods

Feedback for each document

Document: 1

spaCy Entities: [('batman', 'WORK_OF_ART', None, None), ('robert pattinson', 'PERSON', None, None), ('dc', 'PERSON', None, None), ('2022', 'DATE', None, None), ('the batman', 'WORK_OF_ART', None, None), ('bruce waynes', 'PERSON', None, None), ('wayne', 'PERSON', None, None), ('two years', 'DATE', None, None), ('gotham city', 'GPE', None, None), ('batman', 'PERSON', None, None), ('march 4', 'DATE', None, None), ('christopher nolan', 'PERSON', None, None), ('zack snyder', 'PERSON', None, None), ('joker', 'PERSON', None, None), ('13', 'CARDINAL', None, None), ('dark knight', 'WORK_OF_ART', None, None), ('marvel', 'PERSON', None, None), ('three hours', 'TIME', None, None), ('christian bales', 'PERSON', None, None), ('one', 'CARDINAL', None, None), ('matt reeves', 'PERSON', None, None), ('michael giacchino', 'PERSON', None, None), ('selina', 'PERSON', None, None), ('nirvana', 'ORG', None, None), ('march 4 2022', 'DATE', None, None)]

Transformer Entities: [('bruce waynes', 'PERSON', None, None), ('matt reeves', 'PERSON', None, None), ('dark knight', 'WORK_OF_ART', None, None), ('three hours', 'TIME', None, None), ('marvel', 'PERSON', None, None), ('two years', 'DATE', None, None), ('christian bales', 'PERSON', None, None), ('joker', 'PERSON', None, None), ('13', 'CARDINAL', None, None), ('the batman', 'WORK_OF_ART', None, None), ('dc', 'PERSON', None, None), ('batman', 'PERSON', None, None), ('wayne', 'PERSON', None, None), ('2022', 'DATE', None, None), ('selina', 'PERSON', None, None), ('michael giacchino', 'PERSON', None, None), ('christopher nolan', 'PERSON', None, None), ('gotham city', 'GPE', None, None), ('march 4 2022', 'DATE', None, None), ('batman', 'WORK_OF_ART', None, None), ('march 4', 'DATE', None, None), ('robert pattinson', 'PERSON', None, None), ('one', 'CARDINAL', None, None), ('nirvana', 'ORG', None, None), ('zack snyder', 'PERSON', None, None)]

Spacy Relation: [('robert pattinson', 'dc'), ('one', 'matt reeves'), ('christopher nolan', 'zack snyder'), ('bruce waynes', 'two years'), ('bruce waynes', 'wayne'), ('2022', 'the batman'), ('wayne', 'two years'), ('gotham city', 'batman'), ('two years', 'gotham city'), ('matt reeves', 'christopher nolan'), ('robert pattinson', 'batman'), ('robert pattinson', '2022'), ('dc', '2022'), ('batman', 'selina')]

Transformer Relation: [('robert pattinson', 'batman'), ('batman', 'selina')]

Feedback : Spacy exhibited strong recall in entity and relation extraction, identifying most key entities and many relations, but with some irrelevant pairings that reduced precision. The Transformer model, while missing a few entities, provided more accurate relations with fewer false positives, emphasizing central relationships like "robert pattinson" and "batman." Both models could benefit from refinement in entity classification consistency and improved recall for complex, narrative-based relations.

Document: 2

Spacy Entities: [('batman', 'PERSON', None, None), ('the chiefs of', 'PERSON', None, None), ('gordon', 'PERSON', None, None), ('zoe kravitz', 'PERSON', None, None), ('pattinson', 'PERSON', None, None), ('bruce wayne', 'PERSON', None, None), ('alfred', 'PERSON', None, None)]

Transformer Entities: [('gordon', 'PERSON', None, None), ('zoe kravitz', 'PERSON', None, N one), ('bruce wayne', 'PERSON', None, None), ('batman', 'PERSON', None, None), ('pattinson ', 'PERSON', None, None), ('alfred', 'PERSON', None, None), ('the chiefs of', 'PERSON', Non e, None)]

Spacy Relation: [('pattinson', 'bruce wayne'), ('pattinson', 'batman'), ('the chiefs of', 'gordon'), ('batman', 'the chiefs of'), ('batman', 'bruce wayne'), ('bruce wayne', 'alfred')]

Transformer Relation: [('pattinson', 'bruce wayne')]

Feedback : Both Spacy and the Transformer model accurately identified primary characters, i ncluding "batman," "gordon," and "zoe kravitz," with few false positives. Spacy identified mo re relations overall, though it occasionally paired entities with weaker contextual relevance, s uch as "batman" and "the chiefs of." The Transformer model, while more conservative, captu red the essential "pattinson" to "bruce wayne" relationship with high precision. Both models demonstrated strength in detecting characters but could improve on distinguishing meaningfu l interactions among secondary characters.

Document: 3

Spacy Entities: [('batman', 'PERSON', None, None), ('d c', 'ORG', None, None), ('1989', 'DA TE', None, None), ('batman', 'WORK_OF_ART', None, None), ('matt reeves', 'PERSON', No ne, None), ('gotham', 'GPE', None, None), ('robert pattinson', 'PERSON', None, None), ('zoe k ravitz', 'PERSON', None, None), ('selina kyle', 'PERSON', None, None), ('colin farrell', 'PER SON', None, None), ('carmine falcone', 'PERSON', None, None), ('the dark knight returns', ' WORK_OF_ART', None, None), ('the long halloween', 'WORK_OF_ART', None, None)]

Transformer Entities: [('colin farrell', 'PERSON', None, None), ('the dark knight returns', 'W ORK_OF_ART', None, None), ('matt reeves', 'PERSON', None, None), ('zoe kravitz', 'PERS ON', None, None), ('the long halloween', 'WORK_OF_ART', None, None), ('1989', 'DATE', None, None), ('z', 'B-PER', None, None), ('batman', 'WORK_OF_ART', None, None), ('selina kyle', 'PERSON', None, None), ('robert pattinson', 'PERSON', None, None), ('d c', 'ORG', No ne, None), ('carmine falcone', 'PERSON', None, None), ('batman', 'PERSON', None, None), (' gotham', 'GPE', None, None)]

Spacy Relation: [('batman', 'matt reeves'), ('batman', 'd c'), ('batman', 'batman'), ('the dark kni ght returns', 'the long halloween')]

Transformer Relation: [('batman', 'batman'), ('batman', 'd c'), ('the dark knight returns', 'the lo ng halloween')]

Feedback : Both Spacy and the Transformer model accurately identified key entities like "bat man," "matt reeves," and "robert pattinson," as well as essential works such as "the dark knig ht returns." Spacy created additional thematic relationships, enhancing depth but introducing slight over-associations, while Transformer provided a more streamlined output, capturing th e essential connections without extra links.

Document: 4

Spacy Entities: [('billionth', 'ORDINAL', None, None), ('batman', 'PERSON', None, None), (' batman', 'WORK_OF_ART', None, None), ('3 hours', 'TIME', None, None), ('robert pattinson ', 'PERSON', None, None), ('jeffrey wright', 'PERSON', None, None), ('gordon', 'PERSON', N one, None), ('zoe kravitz', 'PERSON', None, None), ('selena kyle', 'PERSON', None, None), (' catwoman', 'PERSON', None, None), ('paul dano riddler', 'PERSON', None, None), ('zodiac', ' NORP', None, None), ('colin farrell', 'PERSON', None, None), ('gotham', 'NORP', None, Non e), ('matt reeves', 'PERSON', None, None), ('pg 13', 'LAW', None, None), ('one', 'CARDINA L', None, None)]

Transformer Entities: [('lena', 'B-PER', None, None), ('matt reeves', 'PERSON', None, None), ('billionth', 'ORDINAL', None, None), ('gordon', 'PERSON', None, None), ('colin farrell', 'PE RSON', None, None), ('zoe kravitz', 'PERSON', None, None), ('selena kyle', 'PERSON', None , None), ('batman', 'PERSON', None, None), ('3 hours', 'TIME', None, None), ('jeffrey wright', 'PERSON', None, None), ('zodiac', 'NORP', None, None), ('paul dano riddler', 'PERSON', No ne, None), ('catwoman', 'PERSON', None, None), ('gotham', 'NORP', None, None), ('pg 13', ' LAW', None, None), ('batman', 'WORK_OF_ART', None, None), ('co', 'B-PER', None, None), ('se', 'B-PER', None, None), ('robert pattinson', 'PERSON', None, None), ('one', 'CARDINA L', None, None), ('go', 'B-PER', None, None)]

Spacy Relation: [('batman', 'one'), ('jeffrey wright', 'paul dano riddler'), ('billionth', 'batman'), ('catwoman', 'paul dano riddler'), ('gordon', 'zoe kravitz'), ('selena kyle', 'paul dano riddler'), ('s elena kyle', 'catwoman')]

Transformer Relation: [('billionth', 'batman'), ('jeffrey wright', 'paul dano riddler'), ('selena ky le', 'catwoman')]

Feedback : Spacy and the Transformer model both accurately captured significant entities, su ch as "robert pattinson," "jeffrey wright," and "catwoman." Spacy generated more complex re lations, some of which were slightly extraneous, like linking "selena kyle" with "paul dano ri ddler." Transformer, however, produced a cleaner and more precise set of relationships, align ing well with the main narrative elements.

Document: 5

spaCy Entities: [('batman', 'PERSON', None, None), ('emo batman', 'PERSON', None, None) , ('pattinson', 'PERSON', None, None), ('riddler', 'PERSON', None, None), ('penguin', 'PERS ON', None, None)]

Transformer Entities: [('penguin', 'PERSON', None, None), ('emo batman', 'PERSON', None, None), ('tin', 'B-PER', None, None), ('riddler', 'PERSON', None, None), ('batman', 'PERSON', None, None), ('pattinson', 'PERSON', None, None)]

spaCy Relation: [('riddler', 'penguin')]

Transformer Relation: [('riddler', 'penguin')]

Feedback : both Spacy and Transformer models successfully identified the core entities, incl uding "batman," "pattinson," "riddler," and "penguin." Both models also captured a relevant r elationship, linking "riddler" with "penguin." However, they both labeled "emo batman" as a

separate entity, which, though technically correct, could be improved to reflect contextually a s an attribute or descriptor rather than an entity

Document: 6

Spacy Entities: [('batman', 'PERSON', None, None), ('the night', 'TIME', None, None), ('noir', 'NORP', None, None), ('gotham', 'GPE', None, None), ('catwoman', 'PERSON', None, None), ('riddler', 'PERSON', None, None), ('penguin', 'PERSON', None, None), ('penguin gordon', 'P ERSON', None, None), ('nolan', 'PERSON', None, None), ('one', 'CARDINAL', None, None)]

Transformer Entities: [('penguin', 'PERSON', None, None), ('penguin gordon', 'PERSON', No ne, None), ('catwoman', 'PERSON', None, None), ('noir', 'NORP', None, None), ('riddler', 'PE RSON', None, None), ('batman', 'PERSON', None, None), ('one', 'CARDINAL', None, None), ('gotham', 'GPE', None, None), ('the night', 'TIME', None, None), ('nolan', 'PERSON', None, None)]

Spacy Relation: [('batman', 'riddler'), ('penguin', 'penguin gordon'), ('penguin gordon', 'catwo man'), ('batman', 'catwoman')]

Transformer Relation: [('penguin', 'penguin gordon'), ('penguin gordon', 'catwoman')]

Feedback : In this document, both models identified key characters like "batman," "catwoma n," "riddler," and "penguin" accurately. However, they incorrectly combined "penguin gordon " as a single entity, which suggests room for improvement in disambiguating contextually adj acent names. Additionally, Spacy identified some plausible but irrelevant relationships (like li nking "batman" with "riddler" and "catwoman"), while the Transformer model's relationships were more limited but also less accurate. Overall, careful refinement of entity boundaries and relationships would enhance precision here.

Document: 7

Spacy Entities: [('batman', 'WORK_OF_ART', None, None), ('matt reeves', 'PERSON', None , None), ('gotham', 'GPE', None, None), ('robert pattinson', 'PERSON', None, None), ('zoe kra vitz', 'PERSON', None, None), ('jeffrey wright', 'PERSON', None, None), ('colin farrell', 'PER SON', None, None), ('john turturro', 'PERSON', None, None), ('paul dano', 'PERSON', None, None), ('batman', 'PERSON', None, None), ('the dark knight', 'PERSON', None, None)]

Transformer Entities: [('jeffrey wright', 'PERSON', None, None), ('the dark knight', 'PERSO N', None, None), ('colin farrell', 'PERSON', None, None), ('matt reeves', 'PERSON', None, N one), ('zoe kravitz', 'PERSON', None, None), ('robert pattinson', 'PERSON', None, None), ('ba tman', 'PERSON', None, None), ('john turturro', 'PERSON', None, None), ('batman', 'WORK_ OF_ART', None, None), ('paul dano', 'PERSON', None, None), ('gotham', 'GPE', None, None)]

Spacy Relation: [('jeffrey wright', 'john turturro'), ('robert pattinson', 'zoe kravitz'), ('zoe kravi tz', 'colin farrell'), ('zoe kravitz', 'jeffrey wright'), ('colin farrell', 'john turturro'), ('robert pattins on', 'colin farrell'), ('zoe kravitz', 'john turturro'), ('robert pattinson', 'jeffrey wright'), ('robert p attinson', 'john turturro'), ('jeffrey wright', 'colin farrell'), ('john turturro', 'paul dano')]

Transformer Relation: [('robert pattinson', 'zoe kravitz'), ('robert pattinson', 'jeffrey wright'), ('robert pattinson', 'john turturro'), ('zoe kravitz', 'jeffrey wright'), ('zoe kravitz', 'john turturro'), ('jeffrey wright', 'colin farrell'), ('jeffrey wright', 'john turturro'), ('john turturro', 'paul dano')]

Feedback : In this sentence, both Spacy and Transformer models successfully captured most of the key cast members and location references, such as "robert pattinson," "zoe kravitz," "gotham," and "the dark knight." However, both models incorrectly classified "the dark knight" as a person instead of as a work of art. The relations identified were largely character-to-character connections, though many lacked contextual relevance (e.g., linking "zoe kravitz" to "colin farrell"). To enhance accuracy, refining entity classification for titles and better contextual relation filtering would be helpful.

Document: 8

Spacy Entities: [('bayman', 'PERSON', None, None), ('noir', 'PERSON', None, None), ('3 hours', 'TIME', None, None), ('adam west', 'PERSON', None, None), ('at least 10', 'CARDINAL', None, None), ('post', 'ORG', None, None), ('2 hour', 'TIME', None, None), ('zoe kravitz', 'PERSON', None, None), ('john turturro', 'PERSON', None, None), ('jeffrey wright', 'PERSON', None, None)]

Transformer Entities: [('noir', 'PERSON', None, None), ('jeffrey wright', 'PERSON', None, None), ('adam west', 'PERSON', None, None), ('bayman', 'PERSON', None, None), ('post', 'ORG', None, None), ('2 hour', 'TIME', None, None), ('zoe kravitz', 'PERSON', None, None), ('john turturro', 'PERSON', None, None), ('at least 10', 'CARDINAL', None, None), ('3 hours', 'TIME', None, None)]

Spacy Relation: [('noir', '3 hours'), ('2 hour', 'zoe kravitz'), ('zoe kravitz', 'jeffrey wright'), ('zoe kravitz', 'john turturro'), ('john turturro', 'jeffrey wright')]

Transformer Relation: [('zoe kravitz', 'john turturro'), ('john turturro', 'jeffrey wright')]

Feedback : The sentence provides a critical view of the movie, with several characters and concepts identified. Both the Spacy and Transformer models correctly capture key entities like "zoe kravitz," "john turturro," "jeffrey wright," and "adam west." However, the models incorrectly classify "noir" as a person, which could be adjusted for better contextual understanding. Also, the relations such as "zoe kravitz" to "john turturro" and "john turturro" to "jeffrey wright" are valid, but "noir" being linked to "3 hours" and "2 hour" to "zoe kravitz" seem misplaced or irrelevant. Further refinement of entity relations would improve overall accuracy.

Document: 9

Spacy Entities: [('batman', 'WORK_OF_ART', None, None), ('batman', 'PERSON', None, None), ('se7en', 'ORG', None, None), ('first', 'ORDINAL', None, None), ('one', 'CARDINAL', None, None), ('100', 'CARDINAL', None, None), ('pattinson', 'PERSON', None, None), ('collin farrell', 'PERSON', None, None), ('zoe kravitz', 'PERSON', None, None), ('pattinson keaton', 'PERSON', None, None), ('pfeiffer', 'PERSON', None, None), ('paul dano', 'PERSON', None, None), ('arkham', 'GPE', None, None), ('geoffrey wright', 'PERSON', None, None), ('36', 'CARDINAL', None, None)]

Transformer Entities: [('pattinson keaton', 'PERSON', None, None), ('geoffrey wright', 'PERSON', None, None), ('36', 'CARDINAL', None, None), ('se7en', 'ORG', None, None), ('zoe kravitz', 'PERSON', None, None), ('pfeiffer', 'PERSON', None, None), ('arkham', 'GPE', None, None), ('100', 'CARDINAL', None, None), ('batman', 'PERSON', None, None), ('first', 'ORDINAL', None, None), ('batman', 'WORK_OF_ART', None, None), ('one', 'CARDINAL', None, None), ('paul dano', 'PERSON', None, None), ('collin farrell', 'PERSON', None, None), ('pattinson', 'PERSON', None, None)]

Spacy Relation: [('arkham', 'geoffrey wright'), ('se7en', 'batman'), ('batman', 'first'), ('collin farrell', 'zoe kravitz'), ('pattinson keaton', 'pfeiffer'), ('pfeiffer', 'paul dano'), ('pattinson', 'collin farrell')]

Transformer Relation: [('pattinson keaton', 'pfeiffer')]

Feedback : The entity recognition in both models is good at identifying key characters like "Pattinson," "Zoë Kravitz," and "Batman," but some pairings like "Pattinson Keaton" could be clearer, as they refer to separate actors. The relation extraction is accurate in terms of genre comparisons (e.g., "Se7en" and "Batman"), but some connections, like "Arkham" to "Geoffrey Wright," could benefit from more context. Overall, the models are effective, but fine-tuning the relationships between entities would improve clarity.

Document: 10

Spacy Entities: [('ten', 'CARDINAL', None, None), ('dc', 'ORG', None, None), ('matt reeves', 'PERSON', None, None), ('robert pattinson', 'PERSON', None, None), ('paul dano', 'PERSON', None, None), ('heath ledger joker', 'PERSON', None, None)]

Transformer Entities: [('dc', 'ORG', None, None), ('matt reeves', 'PERSON', None, None), ('heath ledger joker', 'PERSON', None, None), ('robert pattinson', 'PERSON', None, None), ('ten', 'CARDINAL', None, None), ('paul dano', 'PERSON', None, None)]

Spacy Relation: [('robert pattinson', 'paul dano')]

Transformer Relation: [('robert pattinson', 'paul dano')]

Feedback : The entity recognition works well in identifying important characters such as "Robert Pattinson," "Paul Dano," and "Matt Reeves." The relationship between "Robert Pattinson" and "Paul Dano" is correctly identified, as they both play key roles in the film. However, the relation extraction could be improved by capturing the comparison between "Paul Dano" and "Heath Ledgers Joker," which is central to the praise for Danos performance. Overall, the models are effective in recognizing key elements but could benefit from further refinement in relational context.

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Transformers+SpaCy Evaluation Results compared with Spacy:
Entity Precision: 0.9571
Entity Recall: 1.0000
Entity F1: 0.9767
Relation Precision: 1.0000
Relation Recall: 0.5258
Relation F1: 0.6323
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