Named Entity Recognition and Entity Linking System

IE 7500 APPLIED NATURAL LANGUAGE PROCESSING

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Aim

Develop a NER and EL system to identify entities in text and link them to Wikipedia

Enhance text understanding and improving search engines and NLP applications

Importance of NER and EL

NER identifies entities like people, organizations, and locations for information retrieval and question answering

EL links entities to Wikipedia for deeper context understanding

Building on Existing Research

Leveraging machine learning advancements, like BERT, RoBERTa, and ALBERT, our work improves entity recognition accuracy across datasets and languages

Approach

NER: ML and DL with transformers for accuracy

EL: Embeddings and knowledge bases for precise linking

Both use LSTM for capturing long-range dependencies

Focus

Efficiently handling complex text data, advancing NER and EL research.

Corpus Used

All datasets used are sourced from NLTK and TensorFlow

- CoNLL 2002 Dataset: https://www.cnts.ua.ac.be/conll2002/ner/
- CoNLL 2000 Dataset: https://www.cnts.ua.ac.be/conll2000/chunking/
- CoNLL 2003 dataset: https://www.tensorflow.org/datasets/catalog/conll2003
- (ACE) 2004/2005 Datasets: https://raw.githubusercontent.com/nltk/nltk_data/gh-pages/packages/chunkers/maxent_ne_chunker.zip

Methodology

Data Preparation

- Downloaded and prepared datasets using NLTK, including CoNLL 2002 and CoNLL 2000

Named Entity Recognition (NER)

- Implemented NER using NLTK's pre-trained classifier and a custom LSTM model

```
# Example usage
text = "Google was founded by Larry Page and Sergey Brin while they were students at Stanford University."
Chunked = extract_entities(text)
print(Chunked)
```

Output:

```
[Tree('S', [Tree('PERSON', [('Google', 'NNP')]), ('was', 'VBD'), ('founded', 'VBN'), ('by', 'IN'),
Tree('PERSON', [('Larry', 'NNP'), ('Page', 'NNP')]), ('and', 'CC'), Tree('PERSON', [('Sergey', 'NNP'),
('Brin', 'NNP')]), ('while', 'IN'), ('they', 'PRP'), ('were', 'VBD'), ('students', 'NNS'), ('at', 'IN'),
Tree('ORGANIZATION', [('Stanford', 'NNP'), ('University', 'NNP')]), ('.', '.')])]
```

Entity Linking (EL):

- Linked extracted entities to Wikipedia using a custom function

```
Google: https://en.wikipedia.org/wiki/Google
Larry Page: https://en.wikipedia.org/wiki/Larry_Page
Sergey Brin: https://en.wikipedia.org/wiki/Sergey_Brin
Stanford University: https://en.wikipedia.org/wiki/Stanford_University
```

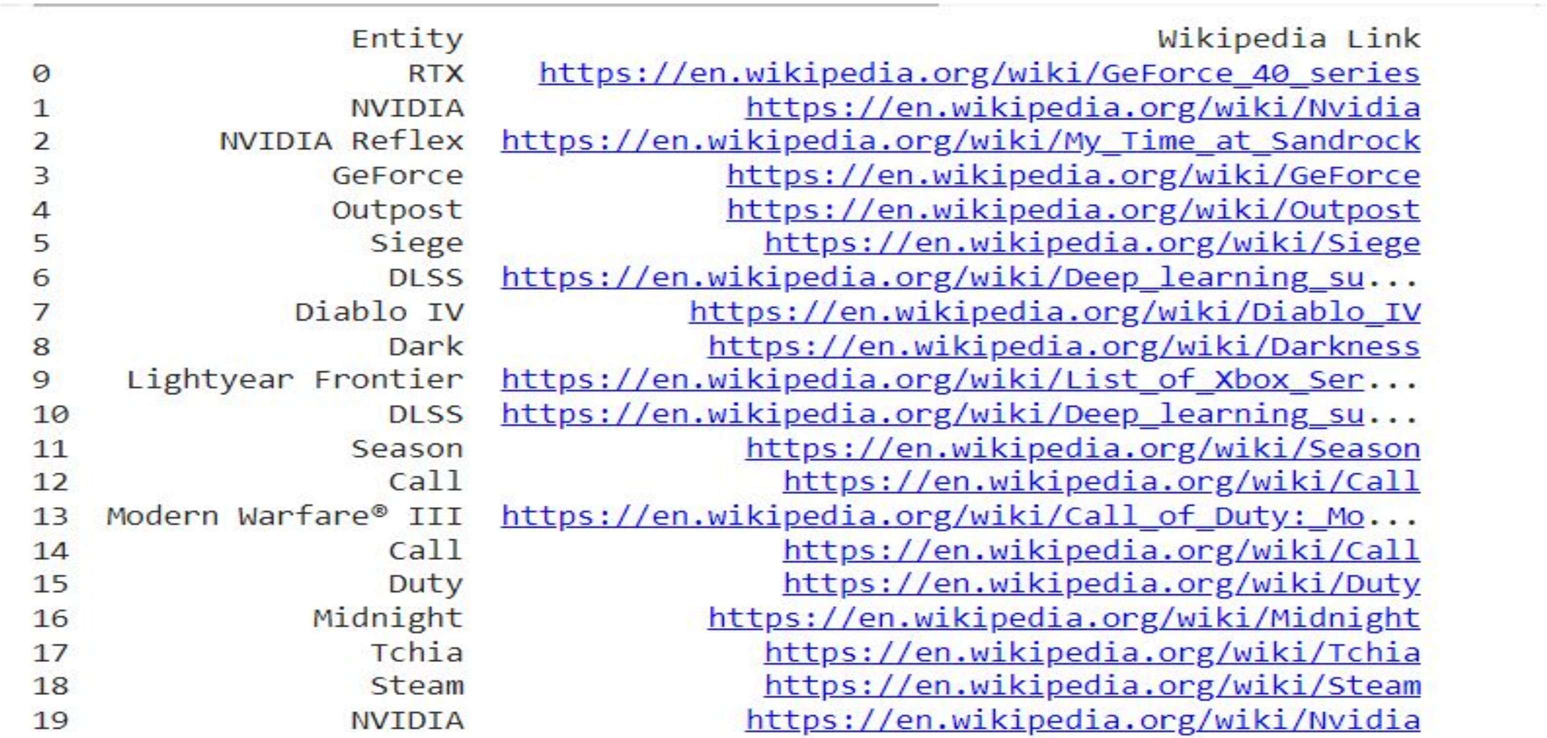
Processing Text:

- Developed a function to process text, extract entities, and link them to Wikipedia

```
# Example text
example_text = "Over 500 games and applications feature RTX technologies, and barely a week goes by without an incredible new game integrating NVIDIA DLSS, NVIDIA Reflex, and advanced ray-traced effects to deliver the definitive PC experience for GeForce RTX players. Last week, Outpost: Infinity Siege launched with DLSS 3, Diablo IV added ray-traced effects, and Alone In The Dark and Lightyear Frontier launched with DLSS 2. This week, we’re highlighting the start of Season 3 in Call of Duty®: Modern Warfare® III and Call of Duty: Warzone™, the 1.0 launch of Midnight Ghost Hunt, and Tchia availability on Steam, all enhanced by NVIDIA DLSS. Read on for all the details. "
Link, NER = process_text(example_text)
print(Link)
```

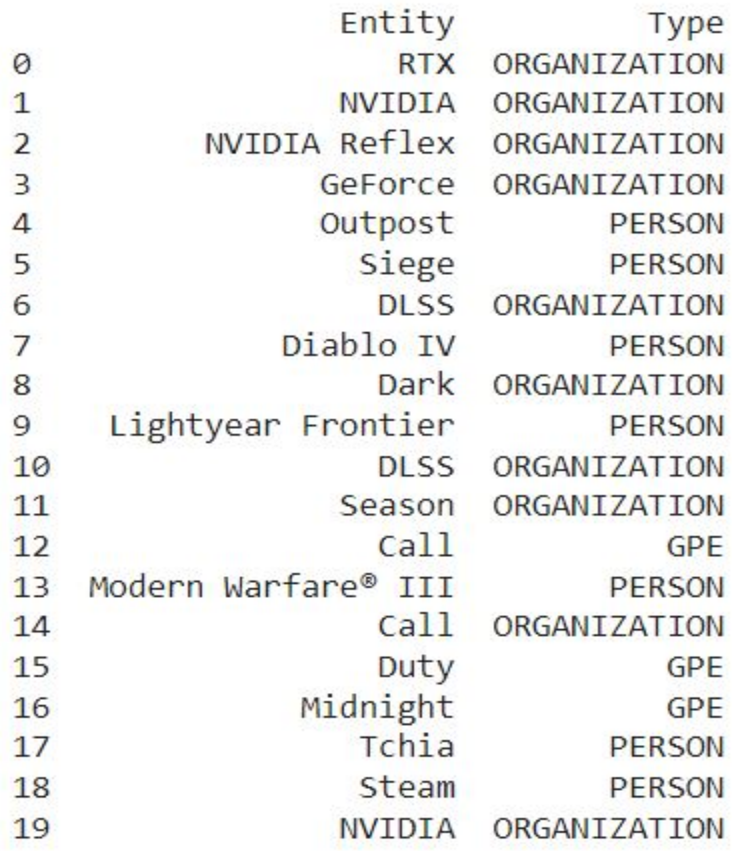
Output

Entity Linking



```
                Entity                                 Wikipedia Link
0                  RTX    https://en.wikipedia.org/wiki/GeForce_40_series
1               NVIDIA              https://en.wikipedia.org/wiki/Nvidia
2        NVIDIA Reflex  https://en.wikipedia.org/wiki/My_Time_at_Sandrock
3              GeForce             https://en.wikipedia.org/wiki/GeForce
4              Outpost             https://en.wikipedia.org/wiki/Outpost
5                Siege               https://en.wikipedia.org/wiki/Siege
6                 DLSS  https://en.wikipedia.org/wiki/Deep_learning_su...
7           Diablo IV           https://en.wikipedia.org/wiki/Diablo_IV
8                 Dark            https://en.wikipedia.org/wiki/Darkness
9   Lightyear Frontier  https://en.wikipedia.org/wiki/List_of_Xbox_Ser...
10                DLSS  https://en.wikipedia.org/wiki/Deep_learning_su...
11              Season              https://en.wikipedia.org/wiki/Season
12                Call                https://en.wikipedia.org/wiki/Call
13   Modern Warfare® III  https://en.wikipedia.org/wiki/Call_of_Duty:_Mo...
14                Call                https://en.wikipedia.org/wiki/Call
15                Duty                https://en.wikipedia.org/wiki/Duty
16            Midnight            https://en.wikipedia.org/wiki/Midnight
17               Tchia               https://en.wikipedia.org/wiki/Tchia
18               Steam               https://en.wikipedia.org/wiki/Steam
19              NVIDIA              https://en.wikipedia.org/wiki/Nvidia
```

Named Entity Recognition



```
                 Entity          Type
0                   RTX  ORGANIZATION
1                NVIDIA  ORGANIZATION
2         NVIDIA Reflex  ORGANIZATION
3               GeForce  ORGANIZATION
4               Outpost        PERSON
5                 Siege        PERSON
6                  DLSS  ORGANIZATION
7             Diablo IV        PERSON
8                  Dark  ORGANIZATION
9    Lightyear Frontier        PERSON
10                 DLSS  ORGANIZATION
11               Season  ORGANIZATION
12                 Call           GPE
13  Modern Warfare® III        PERSON
14                 Call  ORGANIZATION
15                 Duty           GPE
16             Midnight           GPE
17                Tchia        PERSON
18                Steam        PERSON
19               NVIDIA  ORGANIZATION
```

Conclusions

- Successfully implemented a comprehensive NER and EL system using NLTK
- Demonstrated the effectiveness of the system through accurate entity extraction and linking to Wikipedia
- Our NER and EL system accurately extracts and links entities, improving information retrieval and enriching text with semantic context
- By linking entities to a knowledge base, such as Wikipedia, our system enriches text with additional context, improving search relevance and depth
- Future work could focus on enhancing entity linking strategies for improved accuracy and coverage.

References

1. “Named Entity Recognition with Bidirectional LSTM-CNNs" by Lample et al. - This paper introduces a model that combines bidirectional LSTMs and CNNs for NER, showing strong performance.
2. "Entity Linking with a Knowledge Base: Issues, Techniques, and Solutions" by L. Han et al. - This paper provides a comprehensive overview of entity linking techniques, including those using knowledge bases like Wikipedia.
3. "Neural Architectures for Named Entity Recognition" by Guillaume Lample et al. - This paper explores various neural network architectures for NER, including LSTMs and transformers.
4. "End-to-end Sequence Labeling via Bi-directional LSTM-CNNs-CRF" by Ma et al. - This paper presents a model for end-to-end sequence labeling, including NER, using a combination of LSTMs, CNNs, and CRFs.
5. "Improving Named Entity Recognition in Twitter Data with Adaptive Feature Selection" by A. Ritter et al. - This paper discusses techniques for improving NER performance in noisy social media text, which can be relevant for real-world applications.
6. "A Survey of Named Entity Recognition and Classification" by S. Nadeau and S. Sekine - This survey provides an overview of NER techniques, including traditional and machine learning-based approaches.