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Information Extraction for Lightning Strike Related Aircraft Maintenance

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Problem Statement

- **Motivation:**

- Lightning strikes can cause significant damage to aircrafts under certain circumstances and can cause costly delays and disruptions to airlines.
- The extent of damage caused by lightning strikes can range from no damage to severe damage.

- **Objective**

- Understanding the effectiveness of current lightning protection and zoning in aircraft is essential;
- Subject matter experts (SME) use this understanding to develop actionable threat mitigation strategies for improving design and developing efficient post-lightning repair specifications.



Problem Statement

- **Problem:**

- No direct way to identify if lightning struck an aircraft or not.
- Today, we know or come to know about lightning strikes on aircraft from Pilot/crew reports or from maintenance reports.

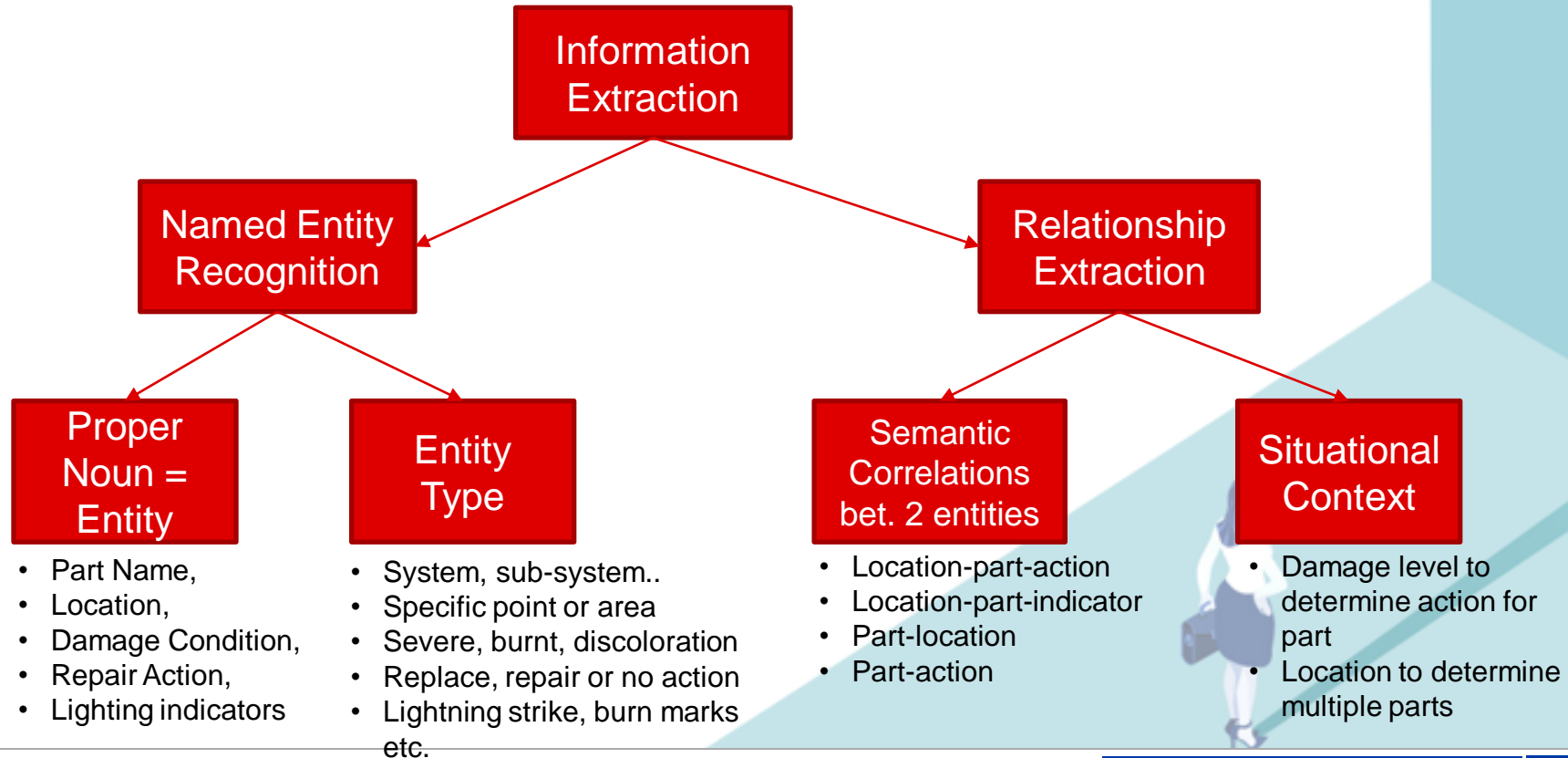
- **How to solve?**

- Data is in the form of reports containing text
- Use natural language processing/text mining to extract information



Your solution approach

- Information extraction using language dependency graphs on a dictionary-based entity extraction algorithm



Your solution approach

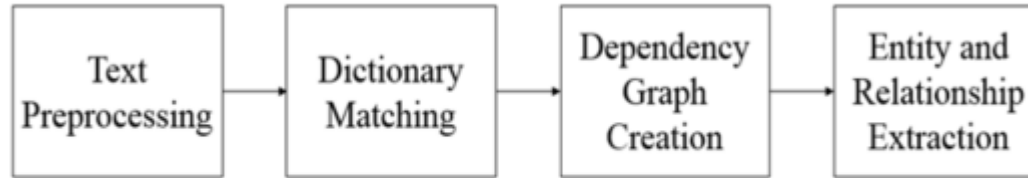


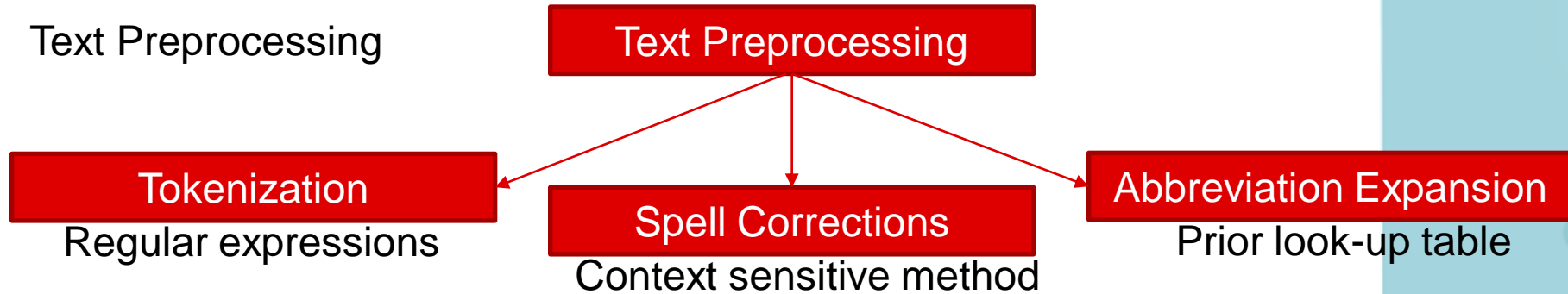
Figure 1 Information Extraction Pipeline

Example data:

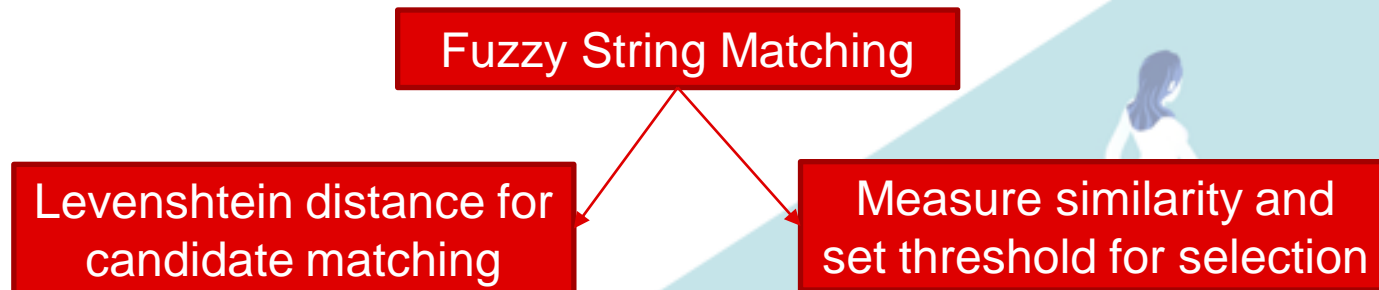
<i>Complaint Text</i>	<i>Maintenance Text</i>
ENG LH REV TRAILING EDGE LIGHTNING STRIKE DAMAGE AT 7 O/C POSN	REPAIR C/O AS PER REPAIR MANUAL. SUBJECT DAMAGE
POSSIBLE LIGHTNING STRIKE NEAR RIGHT- HAND SIDE FUSELAGE	ACTION: FND LIGHTNING STRIKE AT WBL 1184 STA JUST BESIDE THE STATIC DISCHARGER AT THE NAV LT.

Your solution approach

- Text Preprocessing



- Dictionary Matching



Your solution approach

- Dependency graph creation

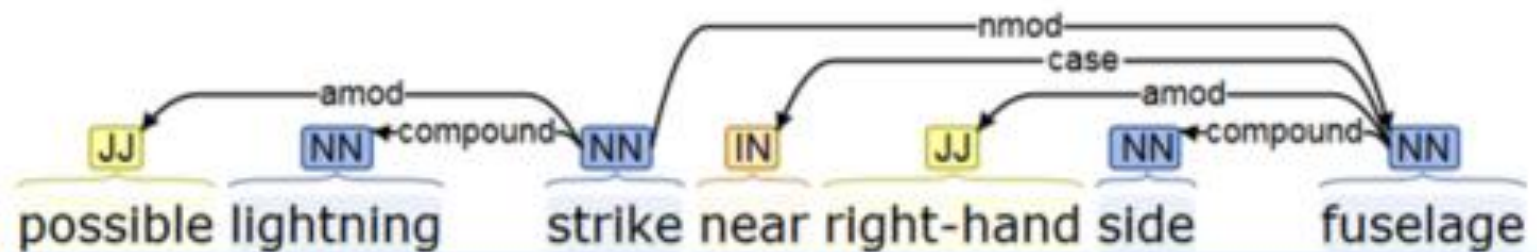


Figure 3 Example of a dependency graph

- Relationship extraction

Shortest path between entities as relations

Frequency based occurrences to assert relationships



Experimental Results

Algorithm performance with and without spell correction

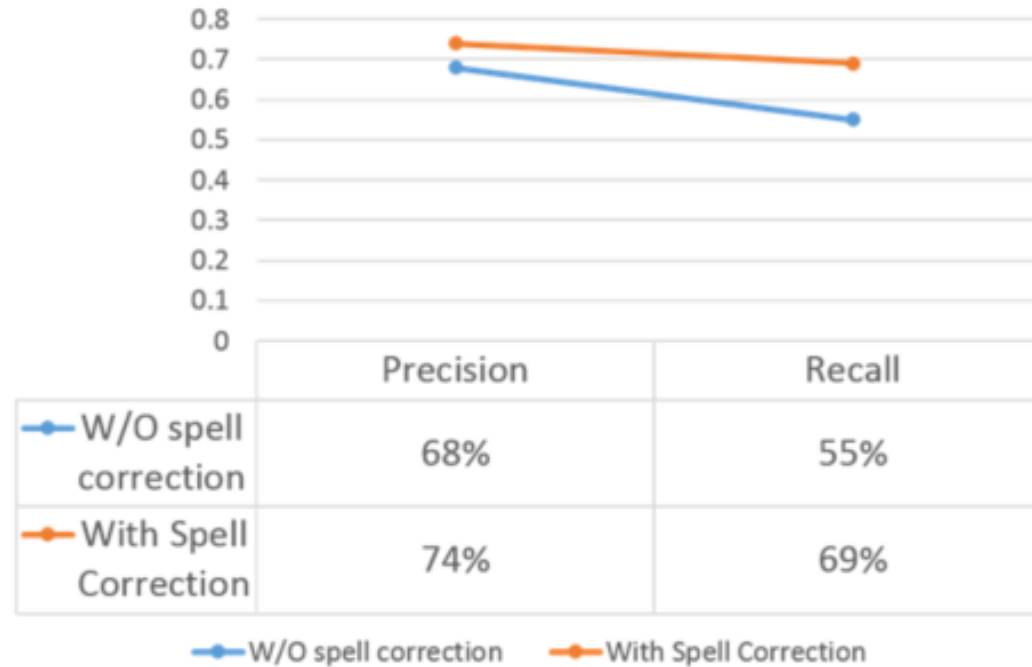


Figure 5 Precision and recall with respect to spell correction

Experimental Results

Algorithm performance for different products with different part groups

Precision and Recall of Part Names

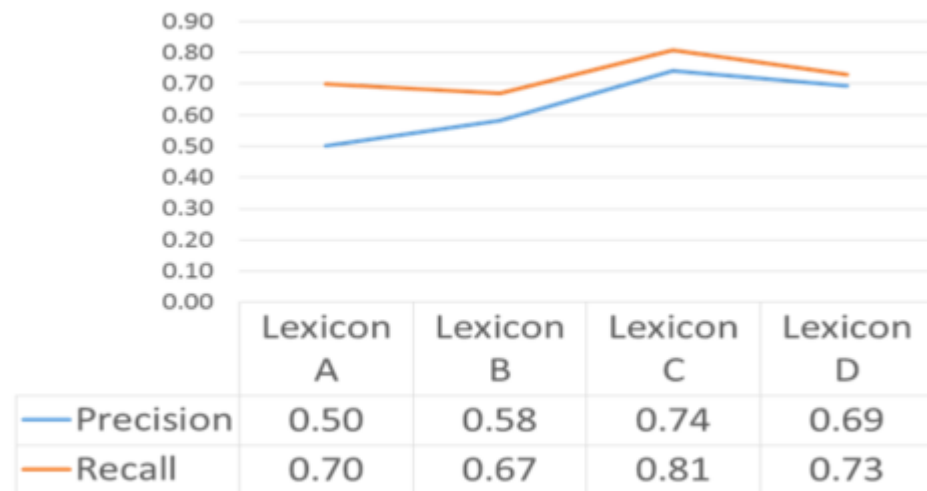


Figure 4 Precision and Recall of Part Names

TABLE I. PRECISION AND RECALL OF VARIOUS ENTITY TYPES

Entity Type	Precision	Recall
Part	0.74	0.69
Location	0.91	0.65
Action	0.92	0.74
Indicator	0.99	0.96



Conclusions

- The information extraction technique used in this paper effectively disentangles an event of lightning strike on an aircraft based on maintenance technician logs.
- The precision and recall numbers not only demonstrates the effectiveness of the technique, but also shows the challenges involved in extracting information from cryptic free-form text contributing to the false negatives, and the drawbacks of a dictionary based approach with a number of false positives.
- The different data sizes used in the experimental study shows marginal effect on better precision and recall as the data size increases.
- The entity based analysis shows that, the technique is working better with high precision and recall numbers when there are relatively lower number of dictionary terms for entity extraction.
- In conclusion, we have shown an information extraction pipeline that can automate finding aircraft lightning strike related damages from unstructured text to improve SME productivity.

References

- G. Sweers, B. Birch and J. Gokcen, "Lightning Strikes: Protection, Inspection, and Repair,," Boeing, 2012. [Online]. Available: http://www.boeing.com/commercial/aeromagazine/articles/2012_q4/4/.
- R. C. Bunescu and R. J. Mooney, "A Shortest Path Dependency Kernel for Relation Extraction," in Proceedings of the Conference on Human Language Technology and Empirical Methods in Natural Language Processing, 2005.
- S. Thenmalar, J. Balaji and T. V. Geetha, "Semi-supervised Bootstrapping approach for Named Entity Recognition," International Journal on Natural Language Computing, pp. 1-14, 2015.

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