Identifying Interchangeabilities Between ICE and EV Manufacturing Processes

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Introduction

- The Knudsen Institute is a 501(c)(3) non-profit organization which works to advance America's defense industrial base surge capacity, with a focus on small & medium manufacturers.
- This project aims to identify interchangeable and non-interchangeable manufacturing capacities for emerging EV production from traditional ICE production.

Acknowledgements

Web Scraping and Model Training of Manufacturer Sites
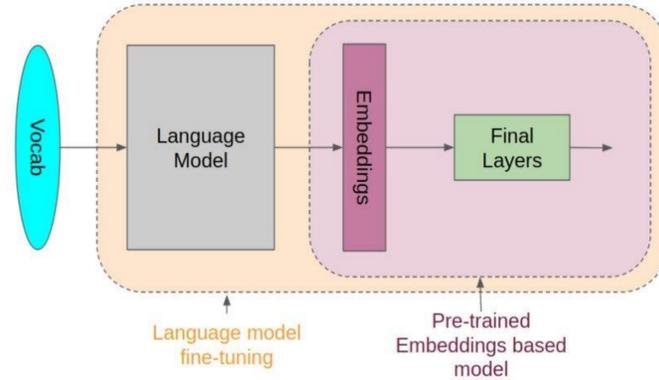

Figure 1. This figure shows how an NLP model is trained

1. Web scraped 34 small and medium scale manufacturers sites (ONEDA, Sphere Brake Defense, MIASA, and more)
   o Utilized Beautiful Soup and Selenium
2. Passed in text data to train NER (Natural Entity Recognition) Models.
   1. Flair, Bert, Camembert, and more as these were the most popular and fastest Hugging Face models) to detect manufacturing capabilities for each website)
3. Tested and improved model using machine learning metrics.

Future Goals

- Dynamically generate testing data through using popular text generation models, including scraping other automotive manufacturers' websites and test the model's performance on these data sources
- Test the model's performance on data scraped from the 30+ websites during the first semester and on unstructured and faulty data
- Use the insights gained from the processes above to continuously retrain and retest the model.
- Convert the project into an open-source effort, and eventually develop a custom LLM that The Knudsen Institute can use to gain insights into automotive manufacturer capabilities.
- Further steps would include converting the model's functionality to detect capabilities of non-automotive manufacturers.
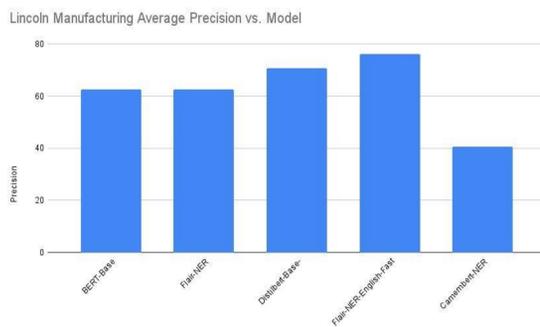
Insights into Model Metrics

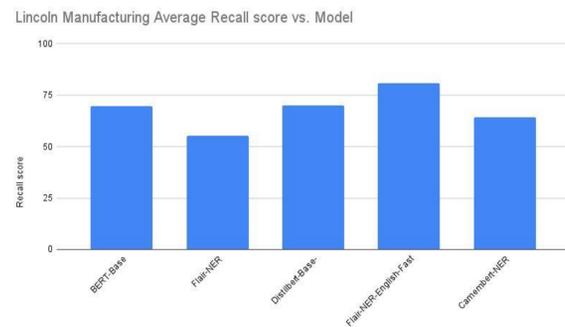*Figure 2.* This figure shows the Precision scores of various NER models

Precision
The number of correctly labeled items divided by the total number of correct items.

$$Precision = \frac{True\ Positive}{True\ Positive + False\ Positive}$$

Figure 3. This figure shows the Recall scores of various NER models

Recall Score
Measures how many correct items it labels relative to total items.

$$Recall = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

Figure 4. This figure shows the F1 scores of various NER models

F1 Score
Measures accuracy by combining both precision and recall into a single value.

$$F1\ Score = \frac{2 \times (Precision \times Recall)}{Precision + Recall}$$

Conclusions and Findings

Targeted three specific key components of the automotive supply chain to find similarities between ICE and EV processes:
  o Aluminum Die Casting
    ▪ EVs use aluminum for the body panels to counteract the weight of the powertrain. ICE vehicles are also switching to aluminum body panels for weight savings and improving fuel efficiency
  o 5 axis CNC Machining – A sophisticated tool used in aluminum die casting that does so in 5 directions, the 3 cartesian axes and 2 more for rotation, used in both vehicle manufacturing processes
  o Certifications – Some EV-specific certifications for the manufacturing of lithium-ion batteries
    ▪ Examples: IATF 16949, ISO 14001, **ISO 9001**

Figure 5. 5-Axis CNC Machining

Figure 6. Aluminum Die Casting