

Natural Language Processing (NLP) Analysis of NOTAMs for Air Traffic Management Optimization

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Research Motivation and Background

- **Background**
 - Natural Language Processing (NLP)
- **Objective**
 - Use NLP to understand NOTAMs
 - Explore AI/ML to digitize NOTAMs
- **Justification**
 - Increased volume of NOTAMs
 - Only 70% of NOTAMs are digitized
 - Better understanding of airspace constraints
 - Safer & Efficient NAS operations

Notice To Airmen (NOTAM)

!EWR 10/371 EWR RWY 04L FICON 5/5/5 100 PCT
WET OBS AT 1910300331. 1910300331-1910310331

Plain English Translation

Issuing Airport: (EWR) Newark Liberty Intl

NOTAM Number: 10/371

Effective Time Frame

Beginning: Wednesday, October 30, 2019 0331 (UTC)

Ending: Thursday, October 31, 2019 0331 (UTC)

Affected Areas

Runway: 04L

Condition: 5/5/5 100 PCT WET

Observation Time: Wednesday, October 30, 2019
0331



Our Approach to using NLP

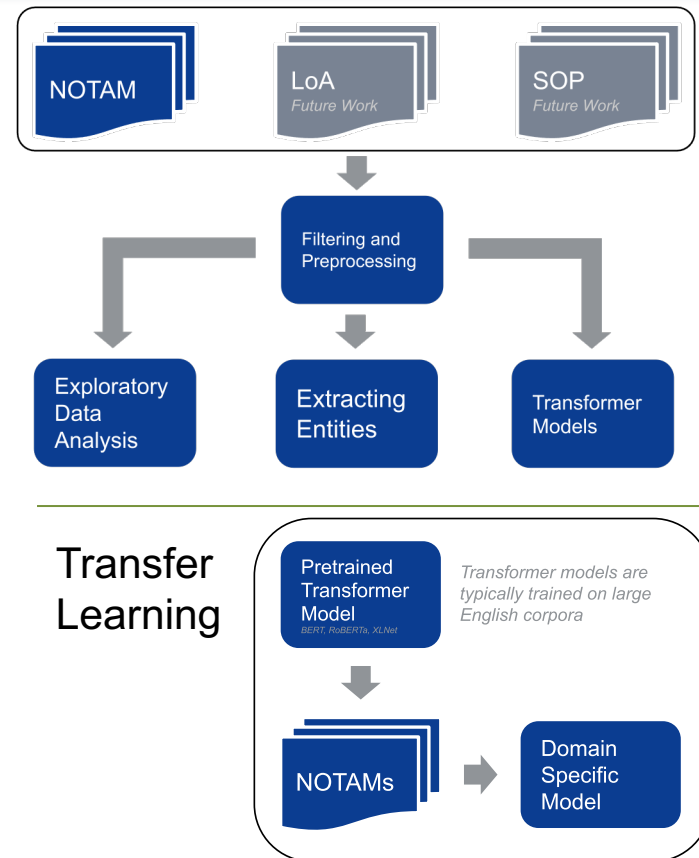
- **Prior NLP Research in Aviation**

- Analysis of safety events (ASRS*)
- Analyze aircraft maintenance issues

- **Our Approach**

1. Exploratory Data Analysis
2. Extract Entities
3. Evaluate Transfer Learning Techniques

*ASRS – Aviation Safety Reporting System



- Understand distribution of published NOTAMs
- Understand & Analyze
 - NOTAM Similarity
 - Anomaly detection

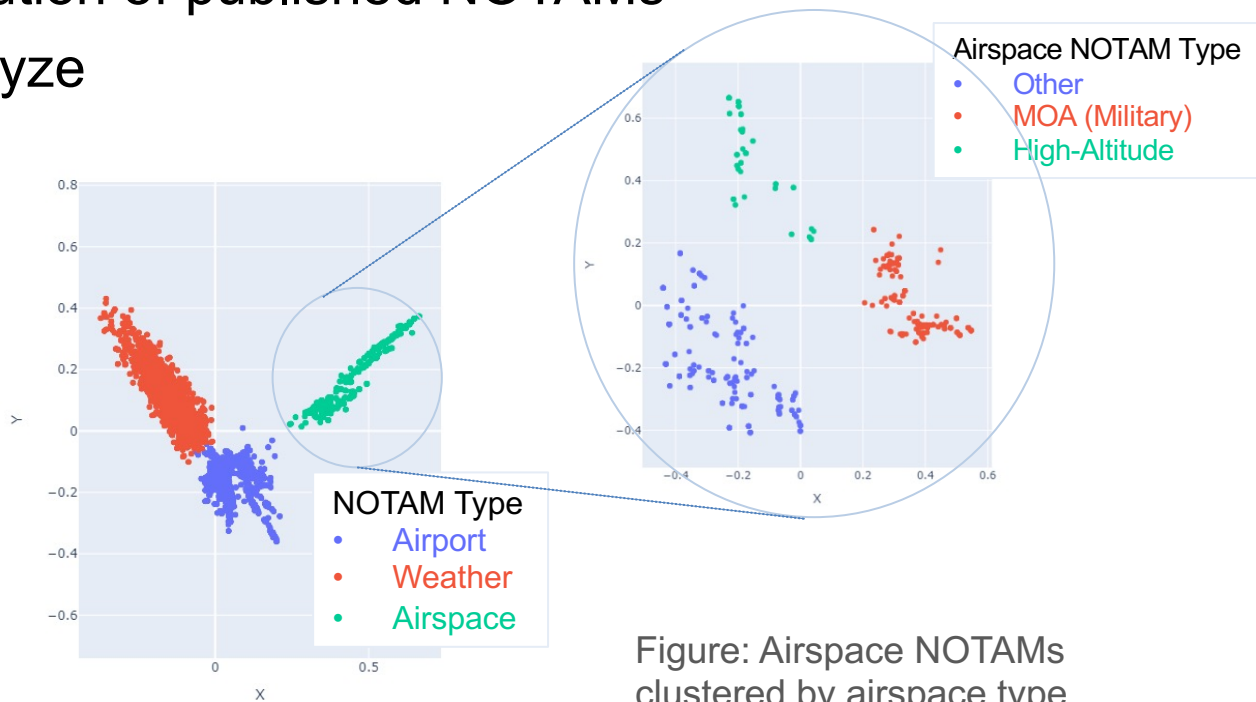
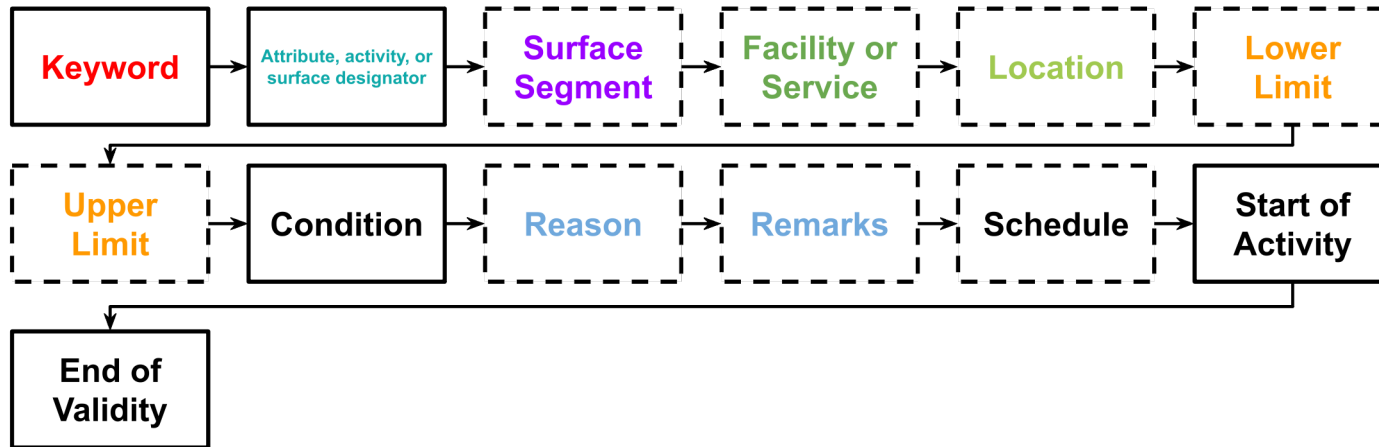


Figure: Airspace NOTAMs clustered by airspace type



Entity Extraction and Structure Analysis

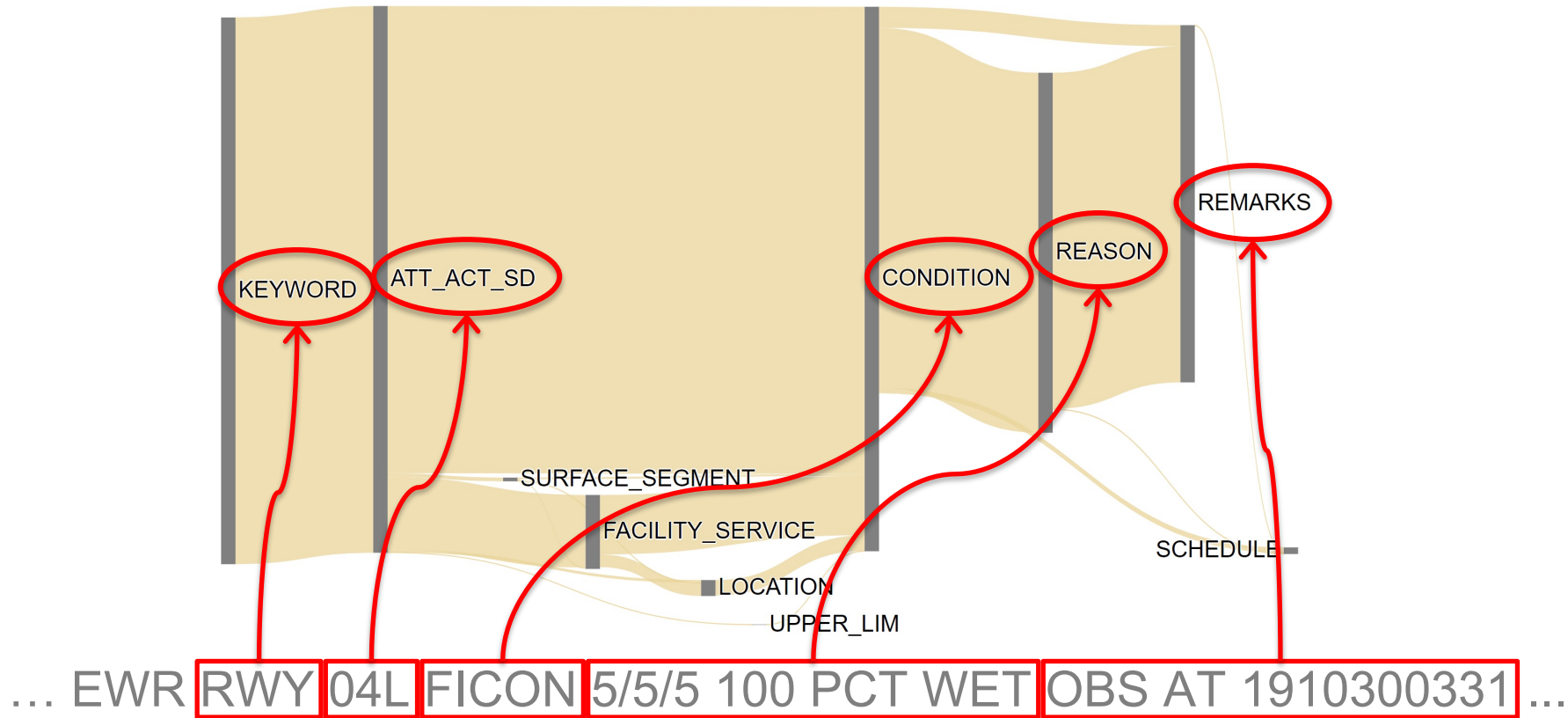
- Creation of a deeply parameterized dataset
 - Using Named Entity Recognition (NER)
- Gain a deep understanding of NOTAM structure



-“7930.2S - Notices to Airmen (NOTAM)”



Sample RUNWAY NOTAM Structure

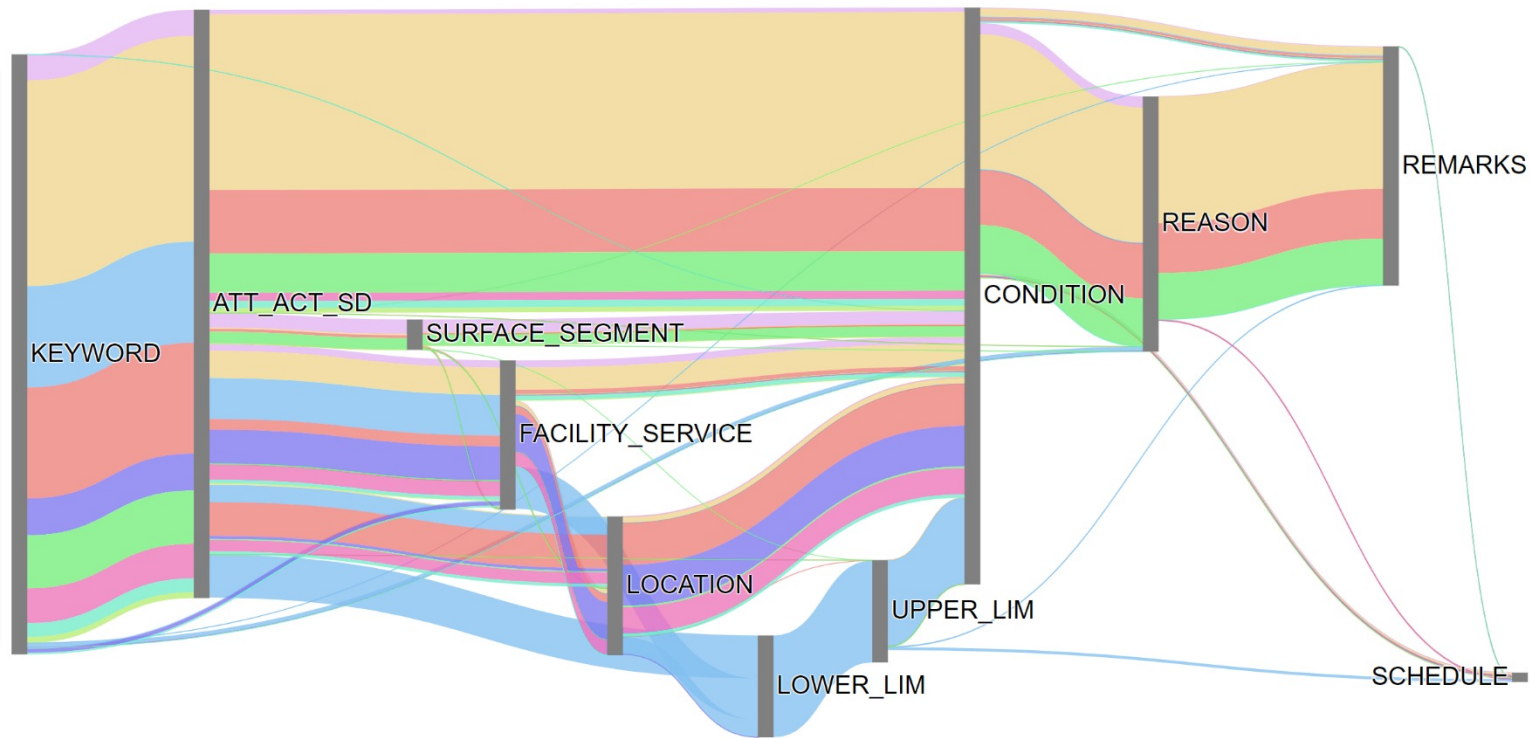




Sample Visualization of Full NOTAM Data Set

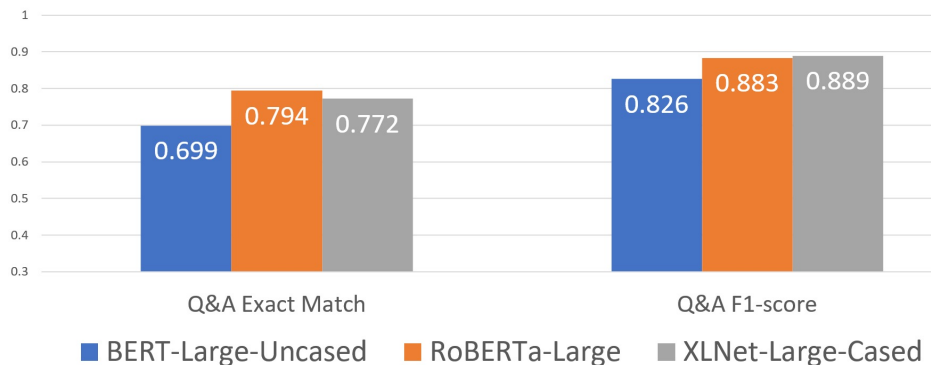
Keyword Legend

- AD
- RWY
- AIRSPACE
- TWY
- OBST
- APRON
- NAV
- SVC
- COM



- Evaluate Transfer Learning

Deep Learning Q&A Results



$$Exact\ Match = \begin{cases} 1, & \text{if } Prediction = Truth \\ 0, & \text{if } Prediction \neq Truth \end{cases}$$

$$F1\text{-score} = \frac{2 * Precision * Recall}{Precision + Recall}$$

Example Context

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Results - XLNet-Large-Cased Model

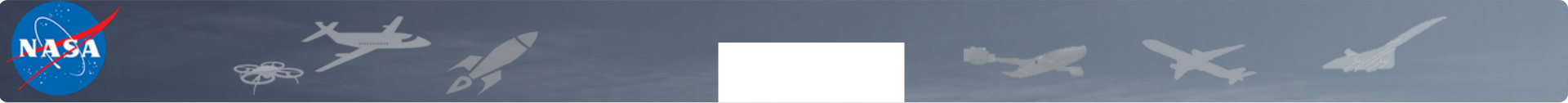
Question: **What is the condition of runway 04L at EWR?**

Answer (No training): **'Thursday, October 31, 2019'**

Answer (Fine-tuned): **'5/5/5 100 PCT WET'**



- Summary & Learnings
 - Explored Analysis of Historical NOTAMs
 - Digitally Extracted Entities in NOTAMs
 - Evaluated transfer learning models
 - ✓ Opportunity to use NLP & **digitize** global NOTAM datasets
 - ✓ Opportunity to provide **holistic view of airspace constraints** for all users
 - ✓ Leading to safer and more efficient NAS operations
- Future Work
 - Expand training of NLP models with **larger NOTAM data sets**
 - Explore adapting similar NLP techniques and workflows for
 - **Letters of Agreement (LoA)**
 - **Standard Operating Procedures (SoP)**



Thank You

Q&A