



Inverse Text Normalization of Air Traffic Control System Command Center Planning Telecon Transcriptions

Kevin H. Guo

University of Southern California

Stephen S. B. Clarke

Flight Research Aerospace

Krishna M. Kalyanam

NASA Ames Research Center

AIAA Aviation Forum, August 1st, 2024



Agenda



- What are Planning Telecons?
- Research Motivation and Context
- Hybrid Inverse Text Normalization (ITN) Framework
 - Neural Network
 - Rule Based Methods
- Results



Planning Telecons



Air Traffic Control System Command Center (ATCSCC)

- Manages air traffic flow across the National Airspace (NAS)
- Continuously meets with Air Traffic Managers across NAS facilities to issue Traffic Management Initiatives (TMIs)
- Hosts bihourly **planning telecons** with air traffic managers and stakeholders.



Context and Motivation



- At the ATCSCC:
 - Text transcriptions do not currently exist
 - Quality Control (QC) of ATC Management currently requires listening through hours of audio to find target information
- Digitized transcriptions allow the use of downstream language tools
 - Text searchability, information extraction
- Created using Speech2Text and refined using ITN



Inverse Text Normalization



Inverse Text Normalization (ITN) is the process of converting unformatted *text normalized* (TN) text into a readable written form.

TN:

jump down to atlanta touch
base with them it looks like
charlottes calling sixty eight this
morning not too many concerns
there i gotta hundred rate for
atlanta little compacted demand
and this twelve zulu hour plenty
recovering a thirteen zulu hour

ITN:

Jump down to Atlanta touch
base with them. It looks like
Charlottes calling 68 this
morning. Not too many
concerns there. I gotta 100 rate
for Atlanta, little compacted
demand and this 12Z hour.
Plenty recovering a 13Z hour.



Inverse Text Normalization



Inverse Text Normalization (ITN) is the process of converting unformatted *text normalized* (TN) text into a readable written form.

TN:

jump down to atlanta touch
base with them it looks like
charlottes calling sixty eight this
morning not too many concerns
there i gotta hundred rate for
atlanta little compacted demand
and this twelve zulu hour plenty
recovering a thirteen zulu hour

ITN:

Jump down to Atlanta touch
base with them. It looks like
Charlottes calling 68 this
morning. Not too many
concerns there. I gotta 100 rate
for Atlanta, little compacted
demand and this 12Z hour.
Plenty recovering a 13Z hour.

Key:

Punctuation
Capitalization
Locations
Numbers



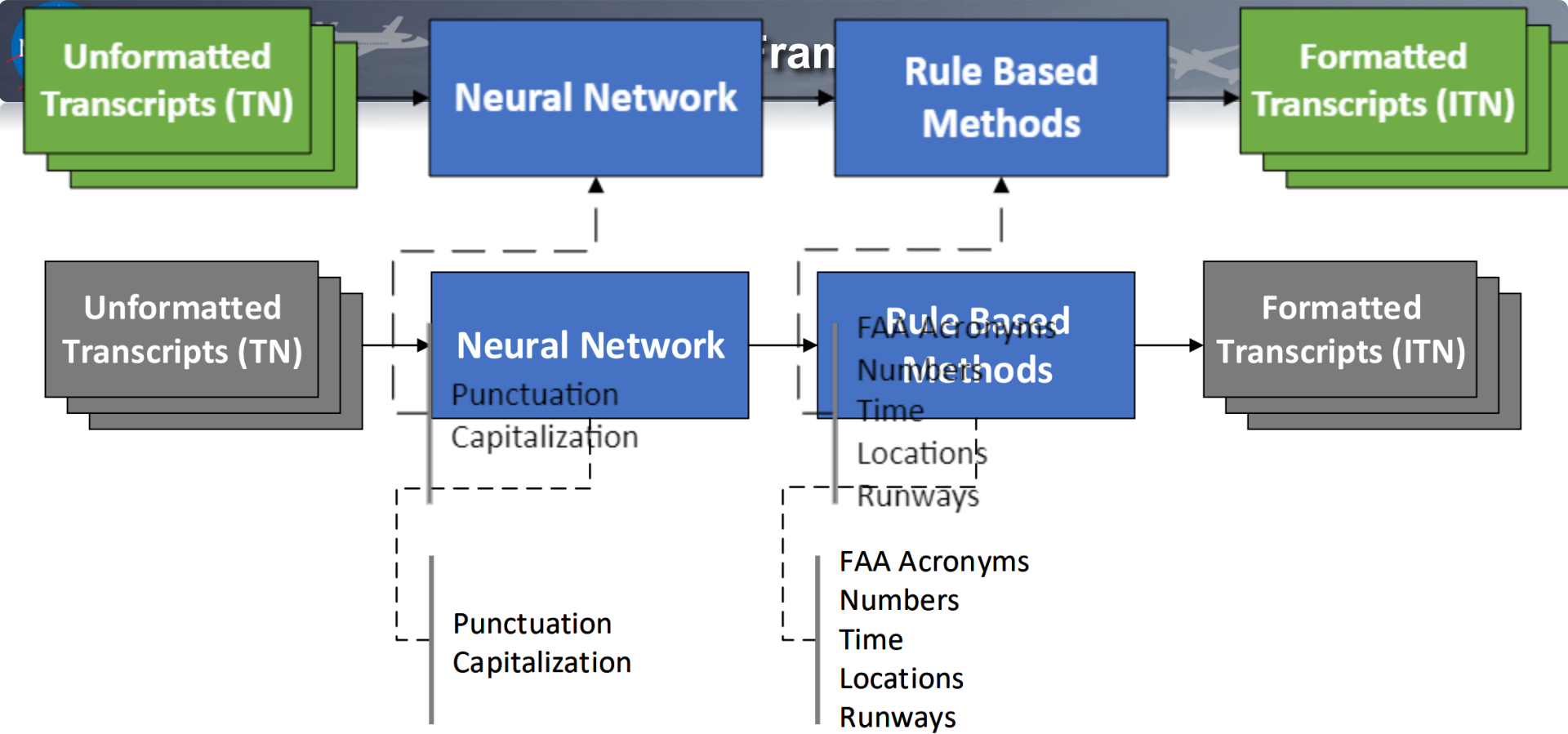
Training and Validation Data



2018 Webinar ITN Dataset - 5 hours of transcriptions or 57,478 words

- Speech transcripts manually created from ATCSCC planning telecons
- ITN dataset created from ground truth TN speech transcripts
- Punctuation/Capitalization labels created by comparing ITN and TN

Audio	Unformatted Transcript (TN)	Formatted Transcript (ITN)
	updating advisory twenty nine	Updating advisory 29.





- Targets conversational English (non-domain-specific)
 - Periods, commas, interrogatives, basic capitalization
- ***bert-base-uncased*** fine-tuned for Punctuation/Capitalization

TN text	ITN text	token
alright	Alright,	Upper,
any	any	lower_
other	other	lower_
f	F	Upper_
a	A	Upper_
a	A	Upper_
en	en	lower_
route	route	lower_
facilities	facilities	lower_
with	with	lower_
items	items	lower_
to	to	lower_
bring	bring	lower_
forward	forward?	lower?



Rule-Based Methods



Capture Group Recipes target specific character patterns (domain-specific)

zero four left	[zero] \s+ [four] \s+ [left]	04L
	↓ ↓ ↓	
	0 4 L	

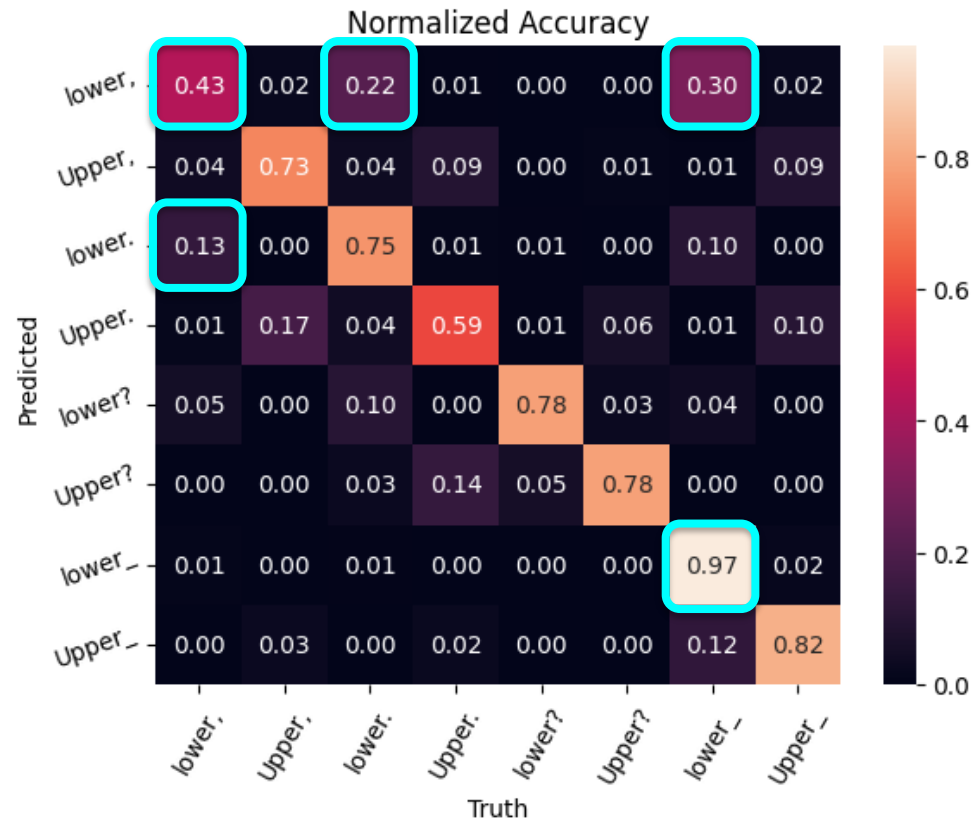
Name: Digit digit left

RegexMatch: (?P<**DIGIT_00**>)\s+(?P<**DIGIT_01**>)\s+(**1|left**)\b

ModificationRecipe: (?P<**DIGIT_00**>)(?P<**DIGIT_01**>)L



Neural Punctuation and Capitalization Confusion Matrix



	BERT-base-uncased + FT		
Label	Precision	Recall	F1-Score
lower,	0.43	0.25	0.32
Upper,	0.73	0.76	0.74
lower.	0.75	0.83	0.79
Upper.	0.59	0.53	0.56
lower?	0.78	0.88	0.83
Upper?	0.78	0.67	0.72
lower_	0.97	0.96	0.97
Upper_	0.82	0.86	0.84
Accuracy			0.91
Macro	0.73	0.72	0.72
Weighted	0.91	0.91	0.91



End to End Results



Method	PER (%)	WER (%)	WER C (%)	WER PC (%)	CER (%)
BERT-base-uncased + FT + RB	25.56	0.68	4.53	5.47	2.00
DistilBERT-base re-punctuate + RB	43.24	1.58	8.05	12.53	4.04
DistilBERT-base re-punctuate + FT + RB	26.05	0.95	4.70	5.61	2.03

TN: very good tracon's here we got some good pilot reports and we're just trying some straight in the four left right now and i believe this is going to work so we'll be four right left with sixty one rate moments from now

ITN Pred: Very good. **TRACON's**, here. We got some good pilot reports and we're just trying some straight in the **4L** right now and I believe this is going to work. So we'll be **4R left** with **61** rate moments from now.

ITN Truth: Very good. TRACON's here, we got some good pilot reports and we're just trying some straight in the 4L right now and I believe this is going to work. So we'll be 4R/L with 61 rate moments from now.



Questions?

Kevin H. Guo

University of Southern California

17kevinguo@gmail.com

Stephen S. B. Clarke

Flight Research Aerospace

stephen.s.clarke@nasa.gov

Krishna M. Kalyanam

NASA Ames Research Center

krishna.m.kalyanam@nasa.gov