MALORCA

Machine Learning of Speech Recognition Models for Controller Assistance

MALORCA 2nd Stakeholder Meeting

Gap Analysis and Next Challenges

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SESAR JOINT UNDERTAKING

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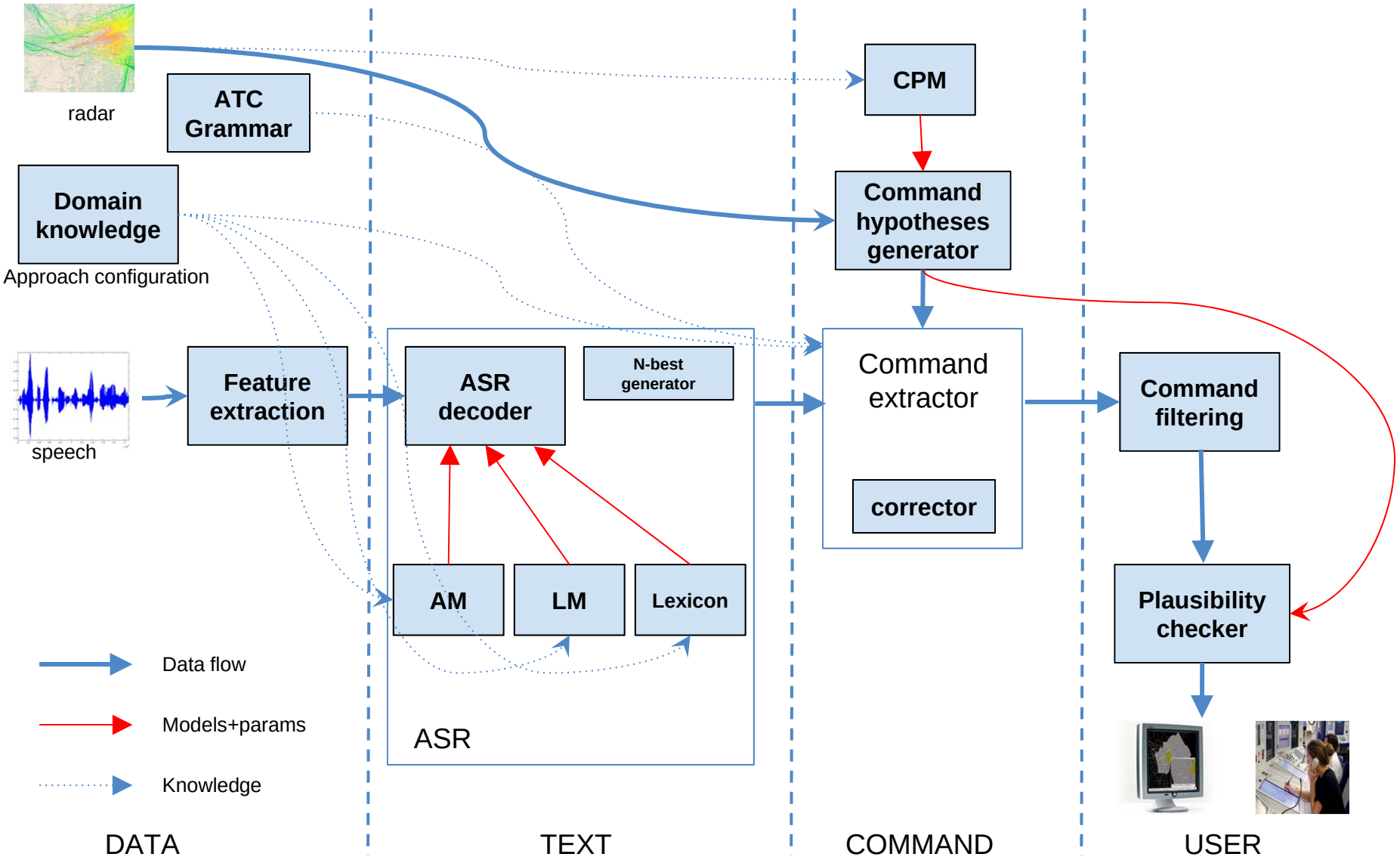
EUROPEAN UNION EUROCONTROL

Gap Analysis

General Block Diagram (MALORCA system)



Gap Analysis

Collection Process Problems

ASR Errors & Advanced Training

Overlooked Commands & Advanced Methods

User System Interaction

DATA	TEXT	COMMAND	USER

Gap Analysis: DATA

- Collect audio → Transcribe → Train Models

- Laborius Task → Incorrect Transcriptions
- Inconsitent Transcriptions

  TURN_RIGHT_HEADING 10 HEADING 010 RIGHT
  - Harder to learn from different teachers
- Noise Robust System
- **Machine Learning in presence of noise!**

Gap Analysis

DATA | TEXT | COMMAND | USER

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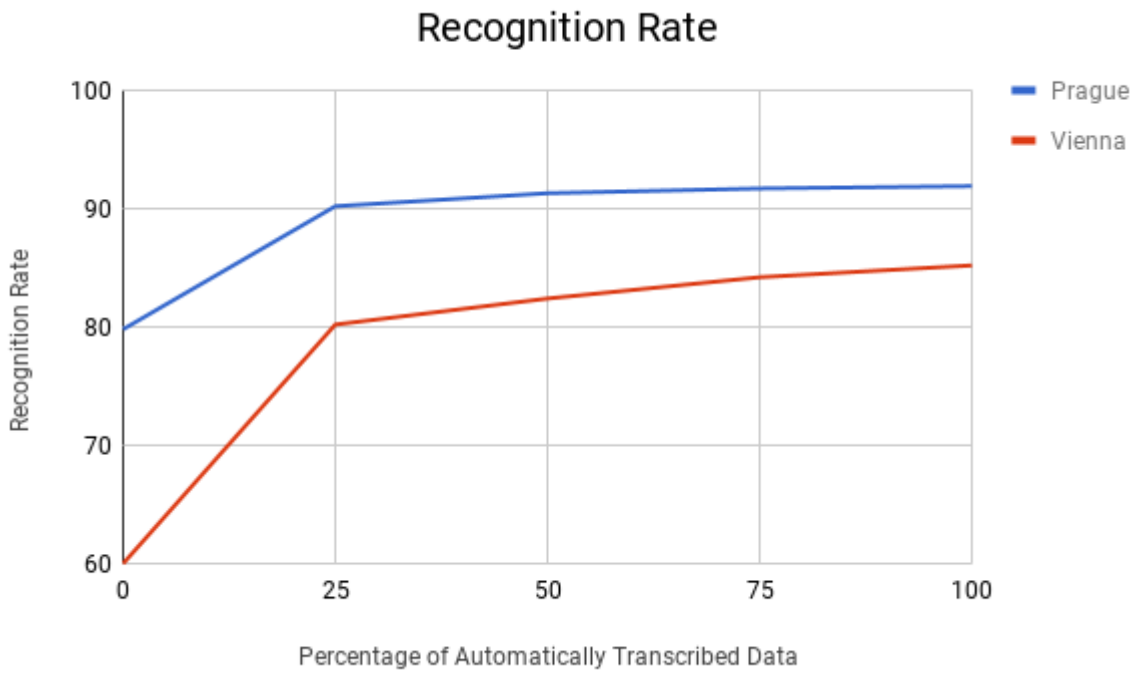
Gap Analysis: TEXT

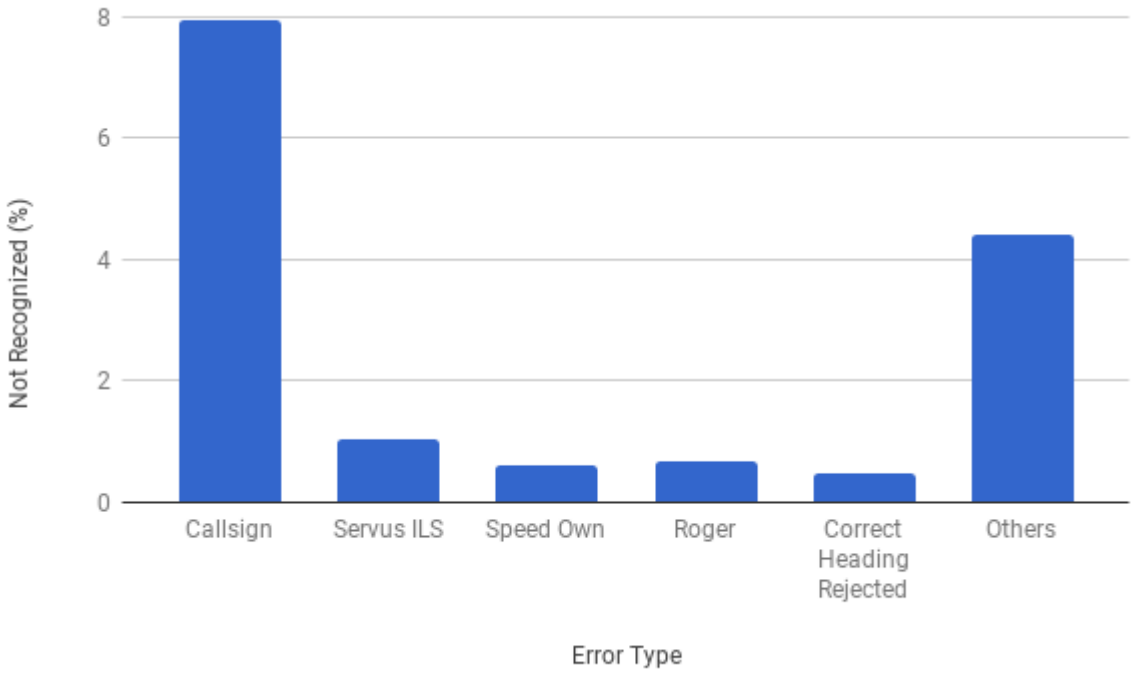
- Transcribing Data is Expensive → Lack of Data
- MALORCA: Automatically Transcribe
- Use automatic transcriptions for Training

Add Automatic Transcriptions



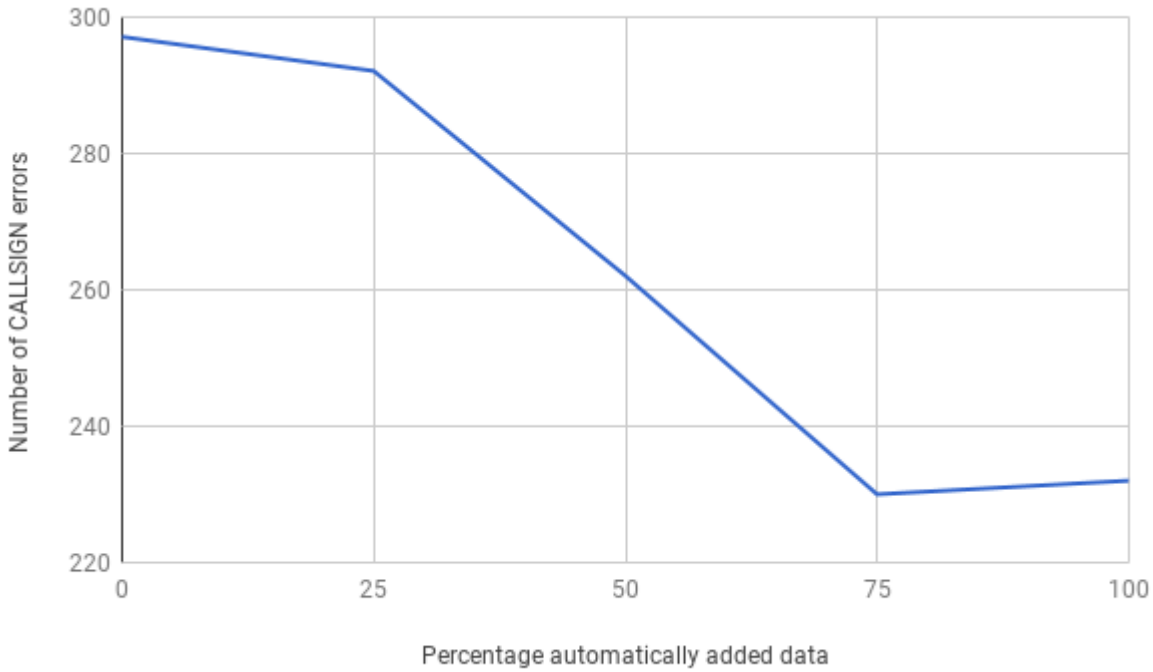
Lack of training data alleviated by using cheaply available automatic transcriptions

Error Analysis



Preliminary Analysis: Unrecognized CALLSIGN errors

Adding Data: CALLSIGN Errors



Adding automatically transcribed data reduces the number of CALLSIGN errors

CALLSIGN Recognition Accuracy

- CALLSIGN = AIRLINE + NUMBER
- Speech Recognition with one set of AIRLINES
- If AIRLINE missing in data: it is not recognized

- BMS: Blue Messenger is missing in our training data
- Not recognized at demo time

- Manually adding BMS to ABSR Lexicon solves the problem
- **Combine multiple sources of AIRLINE names!**

Adding Data: Key Observations

- Prague: 8x data → 92.6% (recognition rate)
- Vienna: 8x data → 90.2 %

- Obtain more data
- Gathering more data is expensive

- Presently, Prague and Vienna treated separately
- **Explore combining the data from two airports!**

Gap Analysis

DATA | TEXT | COMMAND | USER

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Gap Analysis: COMMAND

- Command corrections by ATCs

lufthansa one correction two one four ...

lufthansa one two three descend flight level four correction altitude four thousand feet.

- CORRECTION occurs 0.7 % in all Vienna automatic transcripts.

Gap Analysis: COMMAND

- Disregard the previous command by ATC
- E.g. *austrian nine seven zero uniform sorry disregard*
- DISREGARD occurs **0.005 %** (Vienna)

- Important to model for a Deployable System
- **Update Command Extractor Module to include these commands**!

Gap Analysis: COMMAND

- Command Extraction: raw TEXT → COMMAND
- Rule-based System
    - Lufthansa → AIRLINE
    - Descend → DESCEND_COMMAND

- Expert to maintain these rules
    - Correct, Update, Additions
- Expert identify many correlations
    - Rule-based interface has limited expression
- **Minimize dependencies to build a flexible system!**

Gap Analysis

DATA | TEXT | COMMAND | USER

Collection Process Problems

ASR Errors & Advanced Training

Overlooked Commands & Advanced Methods

User System Interaction

Gap Analysis: Interaction with the Controllers

- Real-time Recognition speed was a concern with ATCs
- Trials: Pilot readbacks not available

- MALORCA: we focused on accuracy
- **Increase recognition speed for deployment!**

- Focus on real-time online speech recognition
- Guarantee: performance remains same

- **Multimodal information: Track ATC Eyes!**

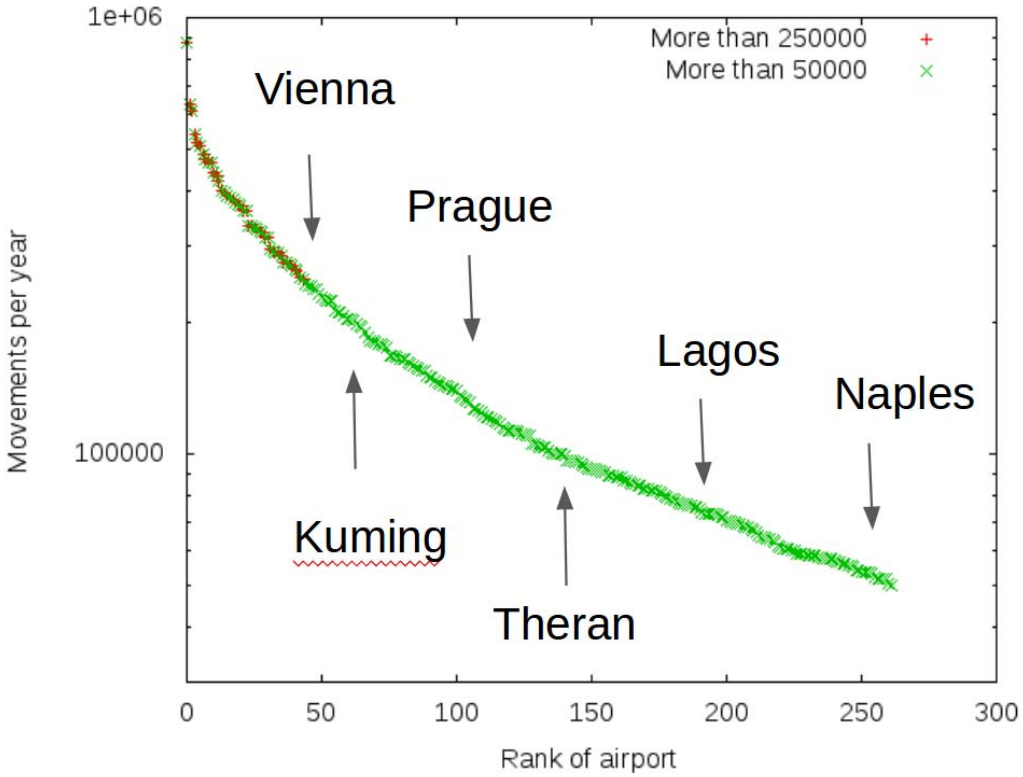
Next Challenges

Challenge: complexity of the air space (e.g. London)

Challenges:

- 5 major airports
- 1 million aircraft movements per year (~2700 per day)

Challenge: adapt from Prague and Vienna to airports of similar size

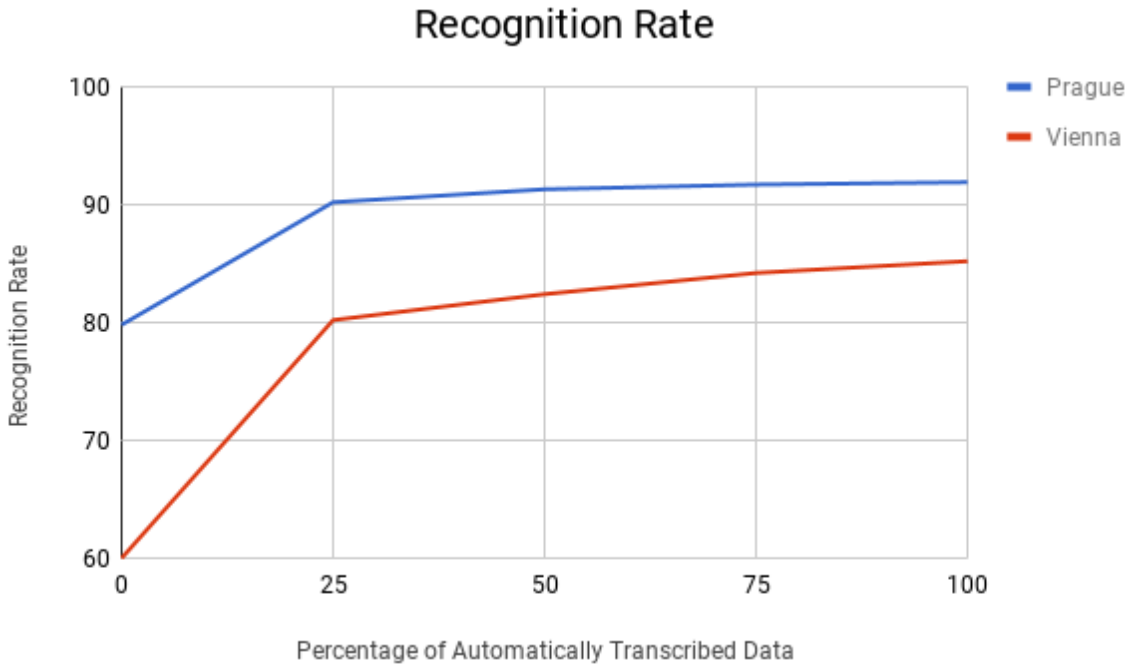


Opportunity: in total 23 million movements of mid-sized airports

Challenges:

- Diverse airport accents?
- Strict phraseology?
- Many small airports at the same time

Challenge: Lots of data



- Prague produces 4000 hours

Challenge: recognizing pilot read back

Challenges:

- Unknown speakers
- Large variety of accents
- Background noise
- Transmission distortions
- Training data for ASR
- Sensitivity of data (data privacy)

Read back e.g.

Summary

- Gap Analysis:
  - DATA: Machine Learning in presence of noise
  - TEXT: Explore combining the data from two airports
  - COMMAND: Minimize dependencies to build a flexible system
  - USER: Increase Recognition Speed
- Next Major Challenges:
  - Handling airport complexity
  - Transfer MALORCA system to similar sized airports
  - Lots of data
  - Recognizing pilot read backs

MALORCA

Machine Learning of Speech Recognition Models for Controller Assistance

DLR

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austro CONTROL

Air Navigation Services of the Czech Republic

Covering the sky...

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