An I-vector Based Approach to Compact Multi-Granularity Topic Spaces Representation of Textual Documents

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SUPPORTED BY ANR
Research supported under contract ANR-10-CORD-007 and ANR-09-CORD-005

Context

Conversations agent/customer customer care service of the Paris transportation system

Agent: Hello
Customer: Hello
Agent: Speaking ...
Customer: I call you because I was fined today, but I still have an imagine card suitable for zone 1 [...] I forgot to use my navigo card for zone 2
Agent: You did not use your navigo card, that is why they give you a fine not for a zone issue [...]
Customer: Thanks, bye
Agent: bye

Difficulties

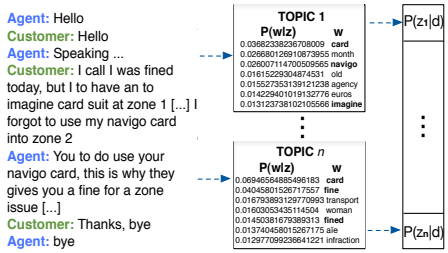
- A dialogue may contain **a major and other semantically related themes** (e.g: transportation card, lost and found, infractions)
- **Transcriptions** obtained from an Automatic Speech Recognition (**ASR**) system are **error prone** ⇨ **Use astract features** (latent Dirichlet allocation)
- Abstract representation involves **selecting** the **right number** of **classes** composing the topic space

Solution

- 2 **drawbacks** by using a **compact** representation from **multiple** topic spaces
- But, multi-view representation introduces:
  - **relevant** variability needed to represent different contexts of the document
  - **noisy** variability related to topic space mapping
- **Reduction** of the **noisy variability** with **factor analysis** technique
- **Extraction** of a **compact** representation containing **useful** information named *i*-vector

Theme Identification Methods

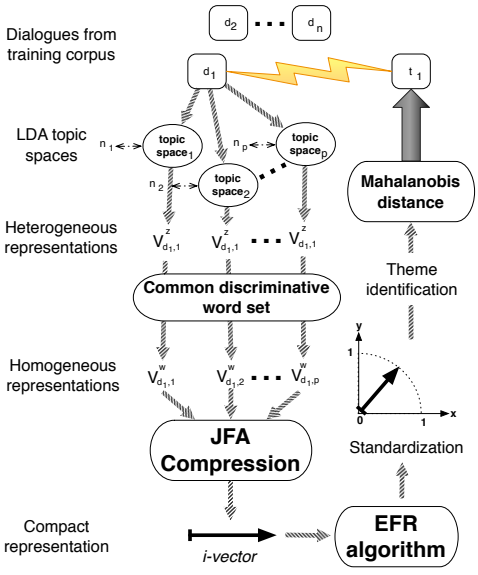
Semantic representation with a Latent Dirichlet Allocation (LDA) model



Gaussian based Bayes classification

Based on two simple assumptions :
- distributions of theme classes are Gaussian
- the covariances of these classes are equal

$$k_{\text{Bayes}} = \arg\max_k \left\{ -\frac{1}{2}||x - \overline{x_k}||^2_{\mathbf{W}^{-1}} + a_k \right\}$$



Experiments and Results

Experimental protocol

- **DECODA project corpus** of conversations:
  - Train = 740 / Dev=175 / Test = 327
- Automatic Speech Recognition (**ASR**) system: **Speeral**
  - Word Error Rate (**WER**) with stop-list of 126 words:
    - train = **33.8%** / dev = **45.2%** / test = **49.5%**
- **8 conversation themes**
  TRS: manual transcriptions - **ASR:** automatic transcriptions
- **3,000 hidden topic spaces** with a **different topic number** was built using the train corpus

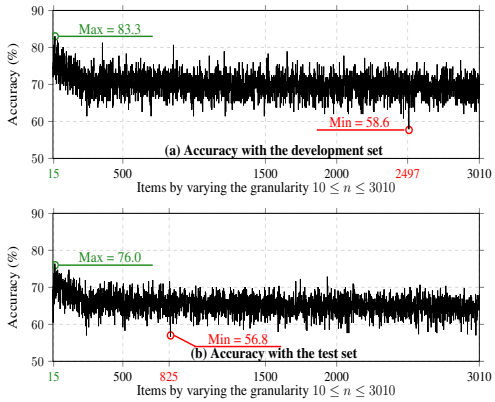
Theme hypothesization accuracies using different c-vectors and GMM-UBM sizes

c-vector size	DEV				TEST			
	Number of Gaussians in GMM-UBM							
	32	64	128	256	32	64	128	256
60	88.8	86.5	91.2	90.6	85.0	82.6	83.5	84.7
100	91.2	**92.4**	92.4	87.7	86.0	**85.0**	83.5	84.7
120	89.5	92.2	89.5	87.7	85.0	83.5	85.4	84.1

→ Classification **performance** is **stable** (**5.9 points** difference for dev)

→ Using **comparable training and testing** configurations allows to achieve the best classification performance

Theme Identification using various topic-based representations



→ Best reached **classification** accuracy: 83% dev and 76% test

→ Classification **performance** is **unstable** (Difference of **25 points** on the dev.)

Conclusion

- In spite of very high WER, possible to classify effectively documents with the proposed compact representation (*c*-vector) with an **accuracy of 85%** + allows us to both solve the difficult choice of the right number of topics and the theme proximity
- **Future work** will seek to find the best combination of LDA hyper-parameters and evaluate effectiveness in other NLP tasks