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Children's
National Medical Center

Multimodal Affective Analysis Using Hierarchical Attention Strategy with Word-Level Alignment

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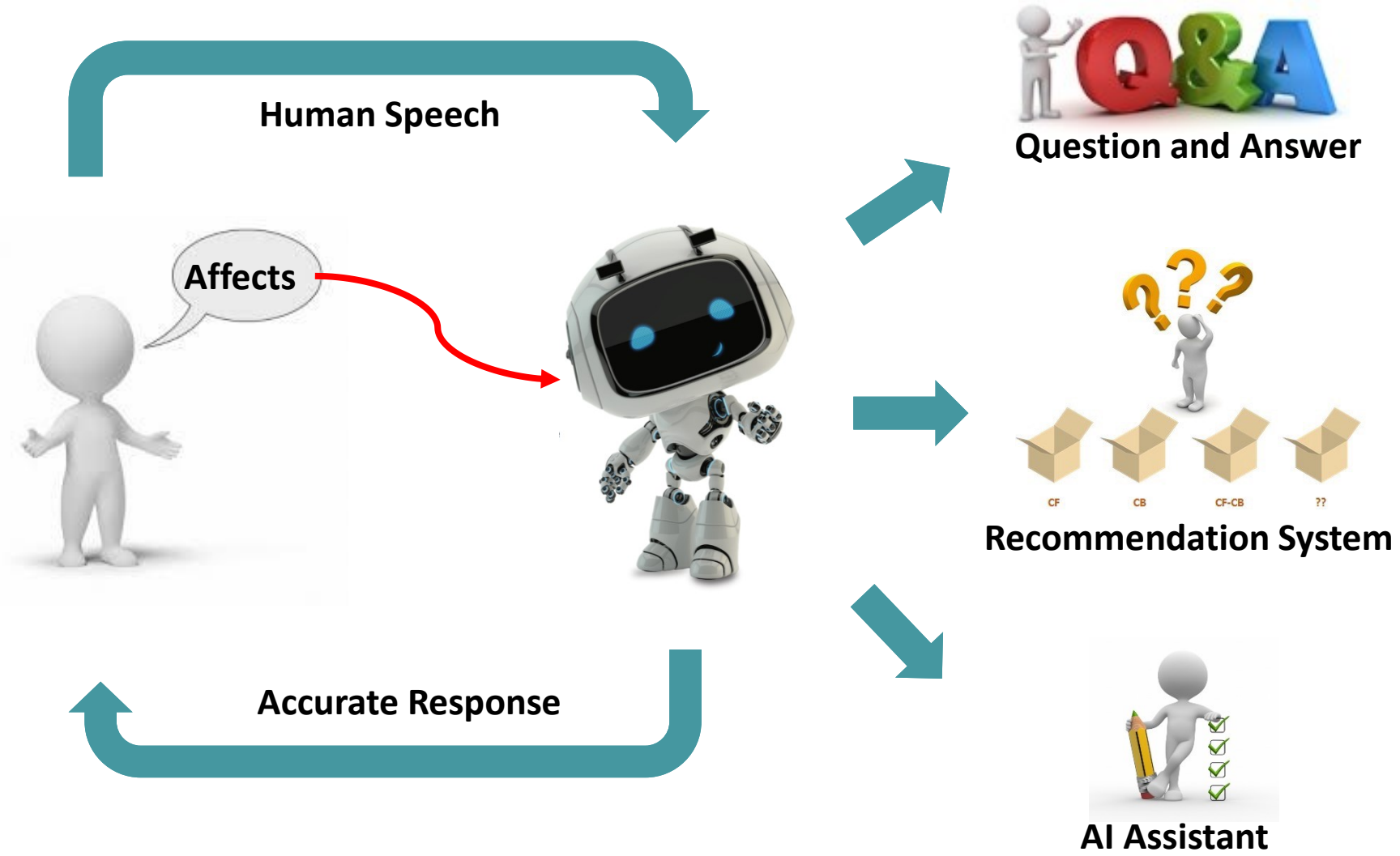
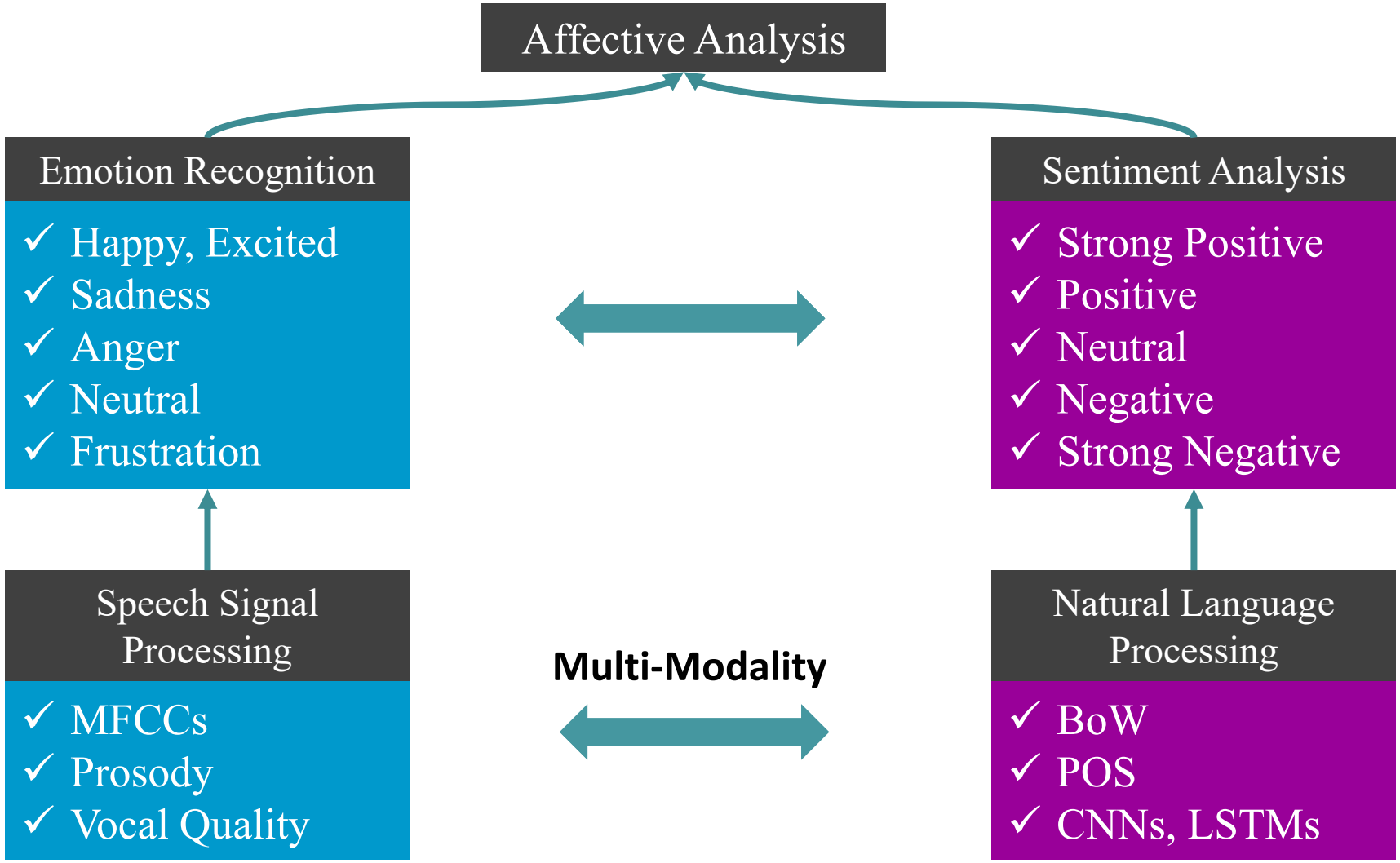
Why the affective analysis is necessary?

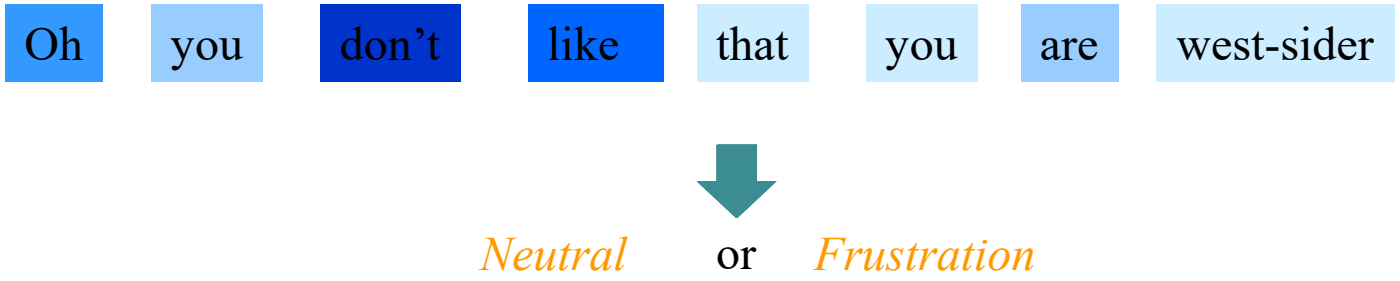


Progress of Affective Computing



Is multi-modality needed?

- Vocal signal prominence



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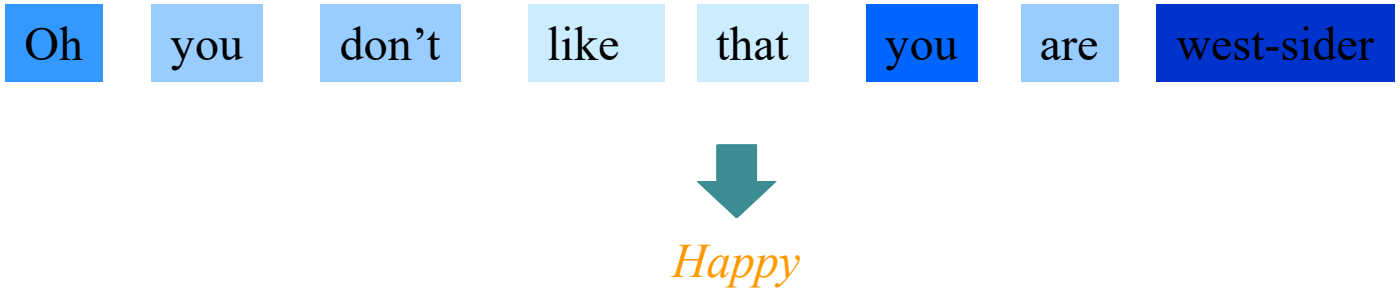


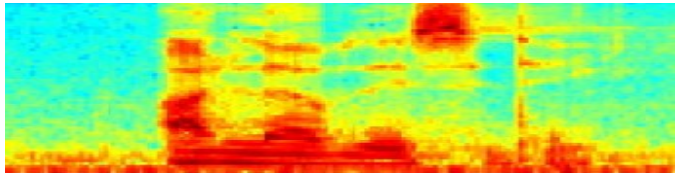
Is multi-modality needed?

- Vocal signal prominence

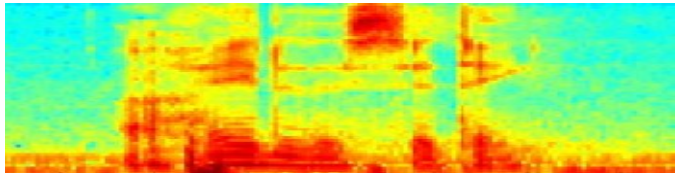
Oh you don't like that you are west-sider

Happy

- Acoustic ambiguity



"I love this city!"



"I hate this city!"

Challenges: Feature Extraction

- Gap between features and actual affective states
  - Lack of high-level associations
  - Not all parts contribute equally

Challenges: Modality Fusion

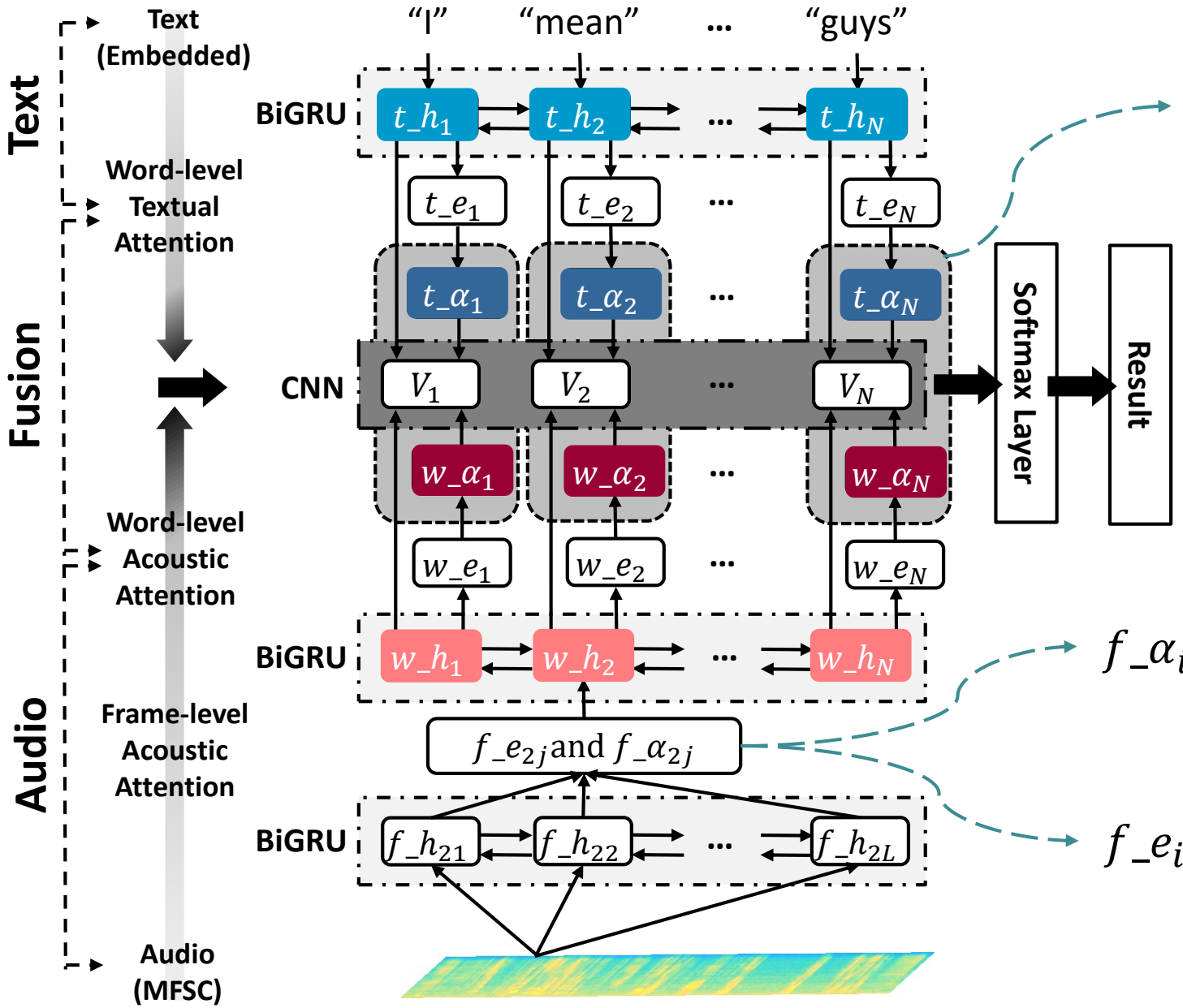
- Decision-level Fusion
  - Lack of mutual association learning
- Feature-level Fusion
  - Fail to learn time-dependent interactions
  - Lack of consistency

Proposed Solutions

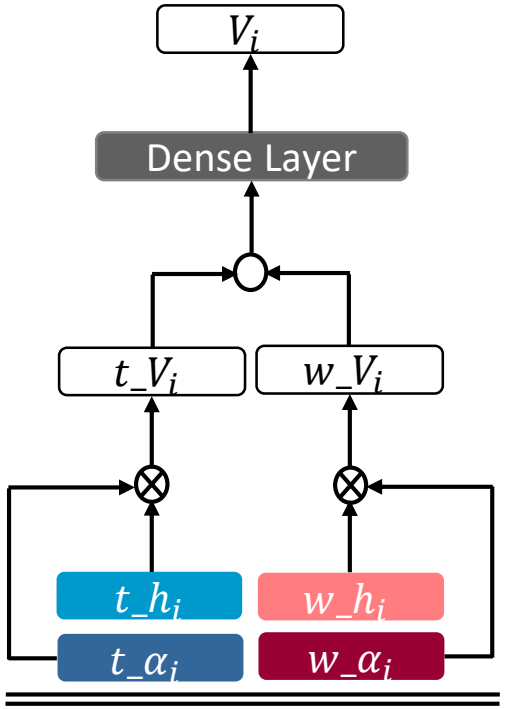
- Feature Extraction
  - Hierarchical attention based bidirectional GRUs
- Modality Fusion
  - Word-level fusion with attention
  - An End-to-End multimodal network

Data Pre-processing

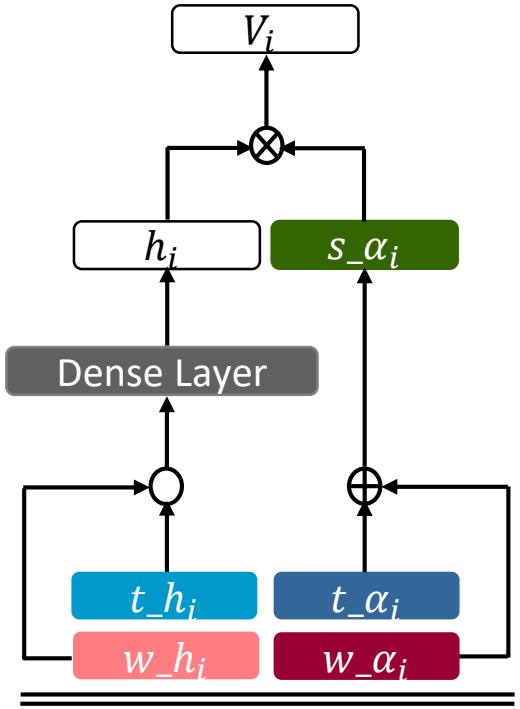
- Text Branch
  - Word Embedding: *word2vec*
- Audio Branch
  - Mel-frequency spectral coefficients (MFSCs)
- Synchronization
  - Word-level forced alignment


Text
(Embedded)
Text
Word-level
Textual
Attention
Fusion
Word-level
Acoustic
Attention
Audio
Frame-level
Acoustic
Attention
Audio
(MFSC)
"I"
"mean"
...
"guys"
BiGRU
t_h_1
t_h_2
t_h_N
t_e_1
t_e_2
t_e_N
t_α_1
t_α_2
t_α_N
CNN
V_1
V_2
V_N
w_α_1
w_α_2
w_α_N
w_e_1
w_e_2
w_e_N
BiGRU
w_h_1
w_h_2
w_h_N
$f_e_{2j}$and f_α_{2j}
BiGRU
f_h_{21}
f_h_{22}
f_h_{2L}
Softmax Layer
Result
Word-level
Fusion
$f\_\alpha_{ij} = \frac{exp(f\_e_{ij}{}^{\top} v_f)}{\sum_{k=1}^{L} exp(f\_e_{ik}{}^{\top} v_f)}$
$f\_e_{ij} = tanh(W_f f\_h_{ij} + b_f)$

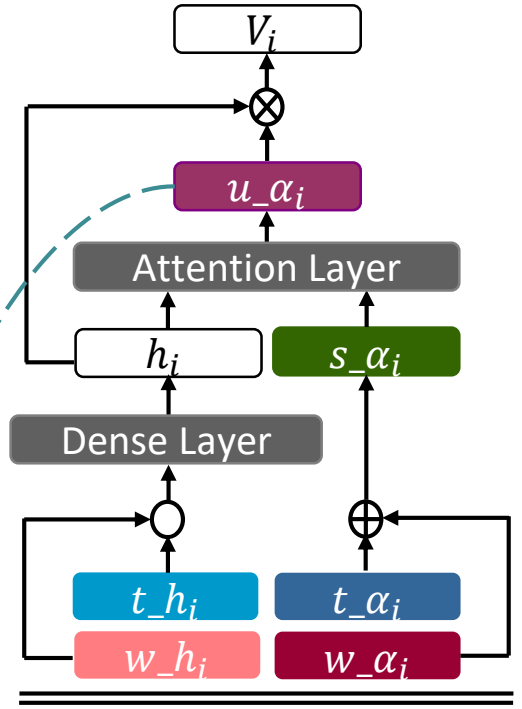
Word-level Fusion



(a) Horizontal Fusion



(b) Vertical Fusion



(c) Fine-tuning Attention Fusion

w_α_i **Word-level acoustic attention distribution**

t_α_i **Word-level textual attention distribution**

w_h_i **Word-level acoustic contextual state**

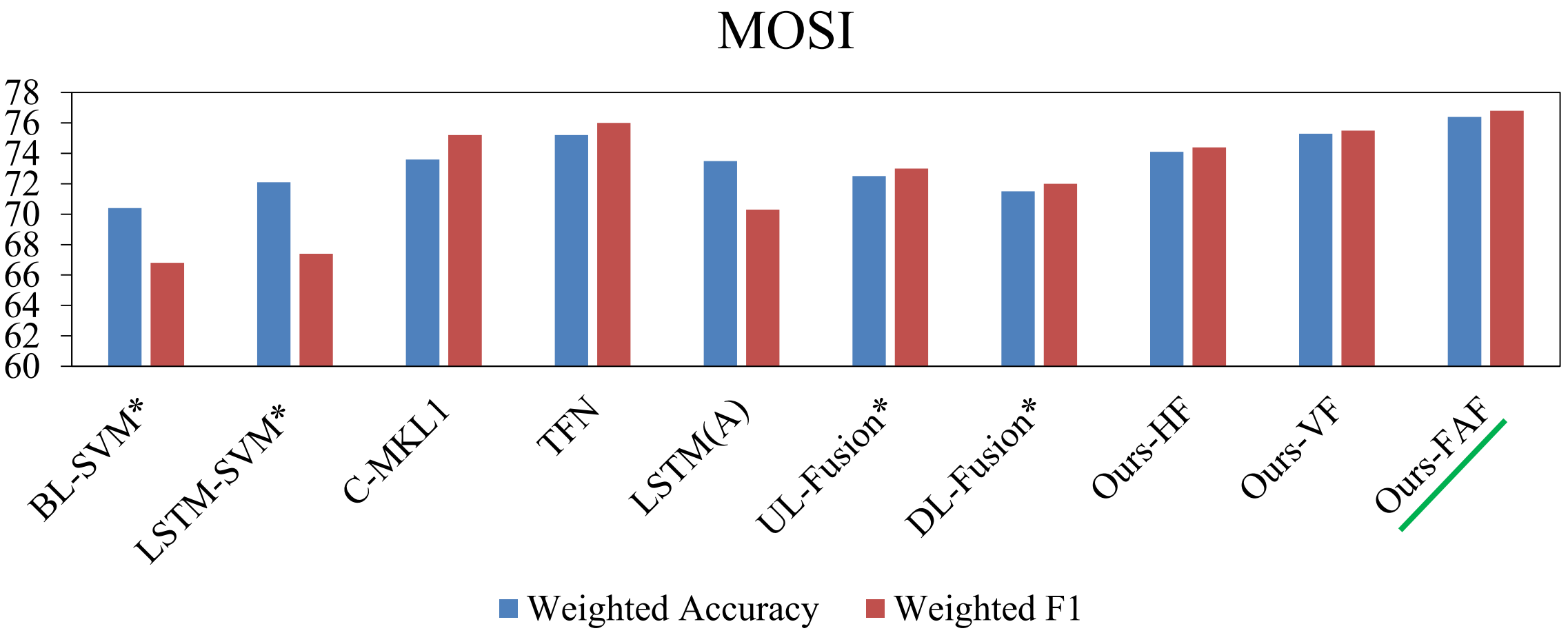
t_h_i **Word-level textual contextual state**

$$u\_\alpha_i = \frac{exp(u\_e_i^{\top} v_u)}{\sum_{k=1}^{N} exp(u\_e_k^{\top} v_u)} + s\_\alpha_i$$

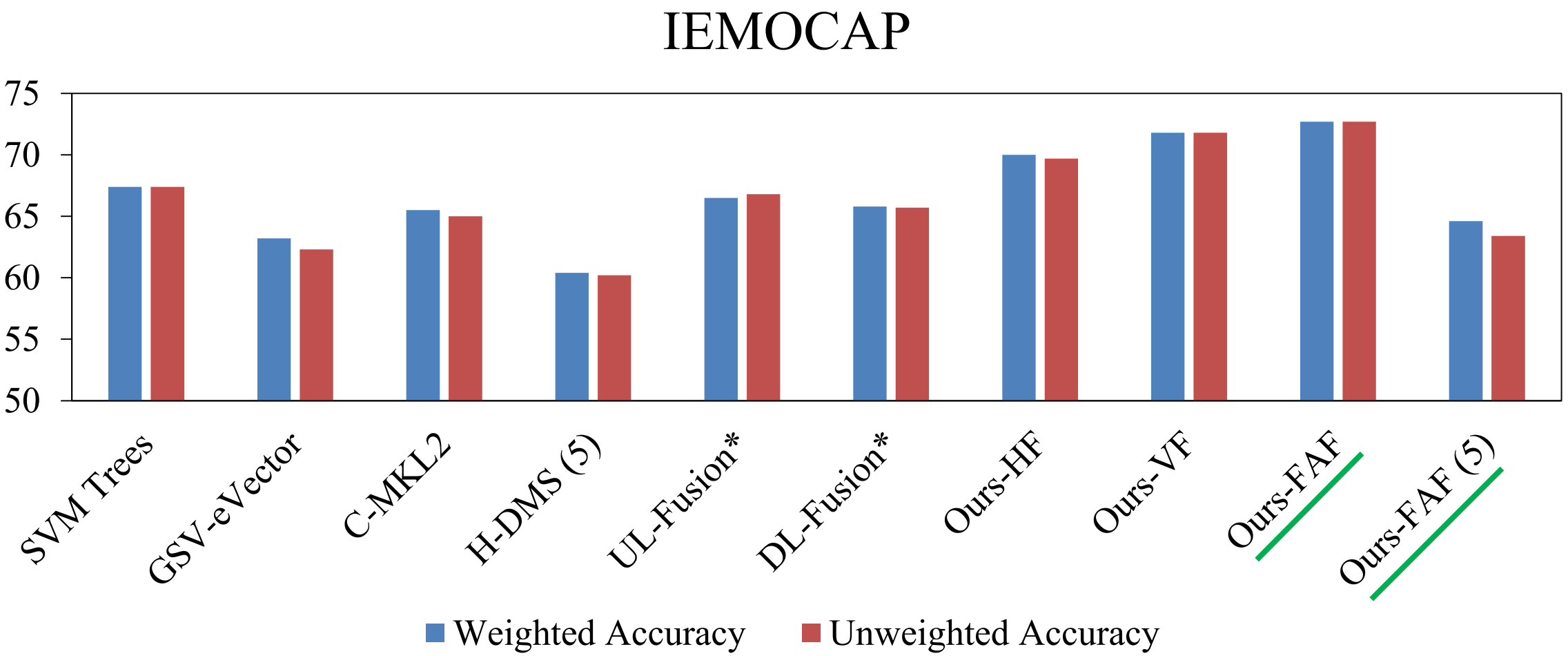
Baselines

- Sentiment Analysis
  - BL-SVM, LSTM-SVM
  - C-MKL, TFN, LSTM(A)
- Emotion Recognition
  - SVM Trees, GSV-eVector
  - C-MKL, H-DMS
- Fusion
  - Decision-level, Feature-level (utterance-level)

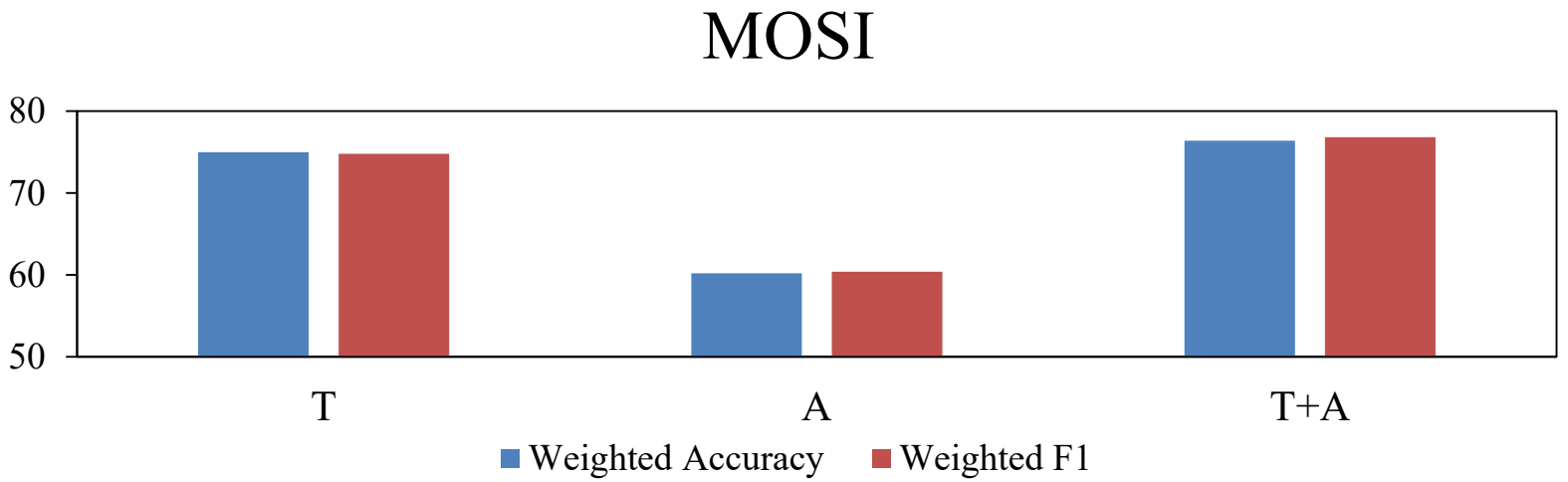
Sentiment Analysis Result

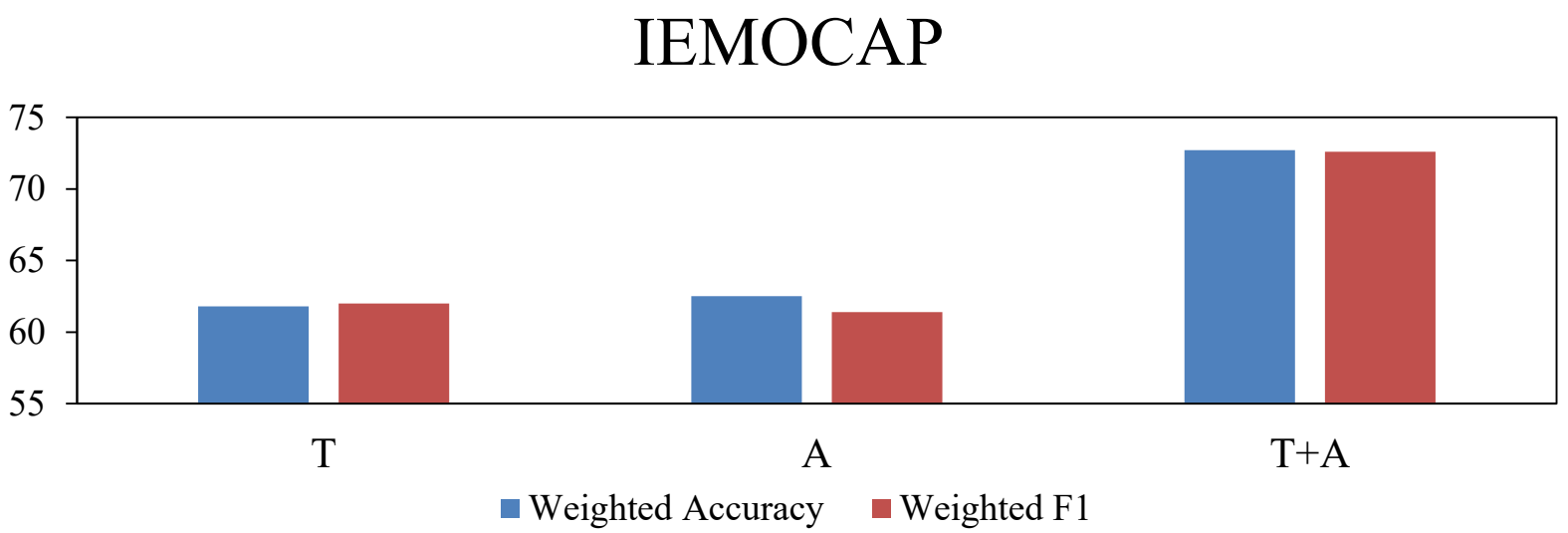


Emotion Recognition Result

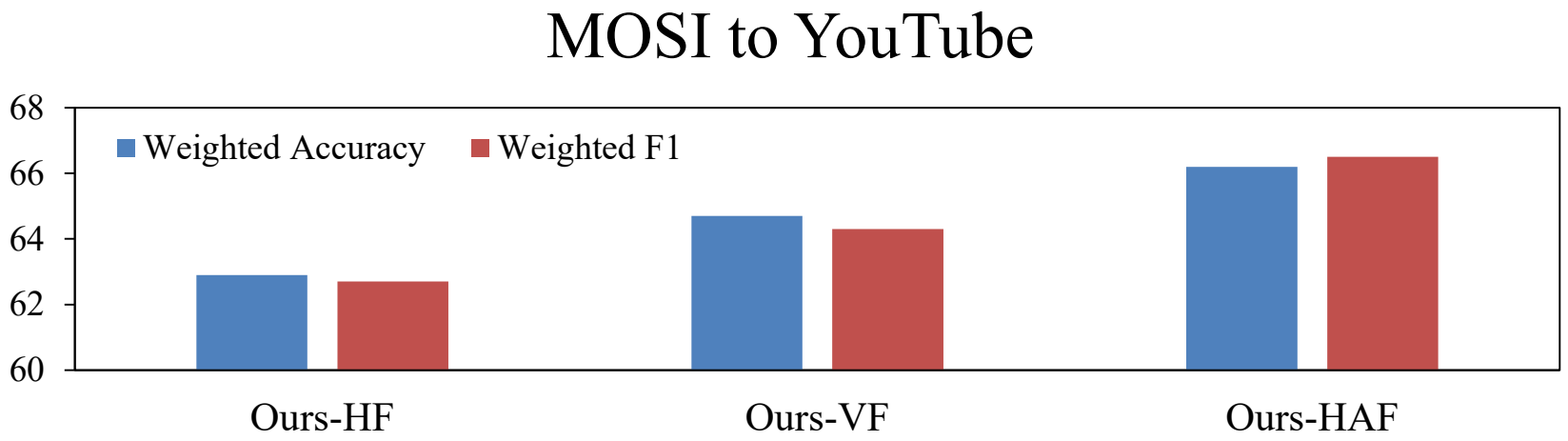


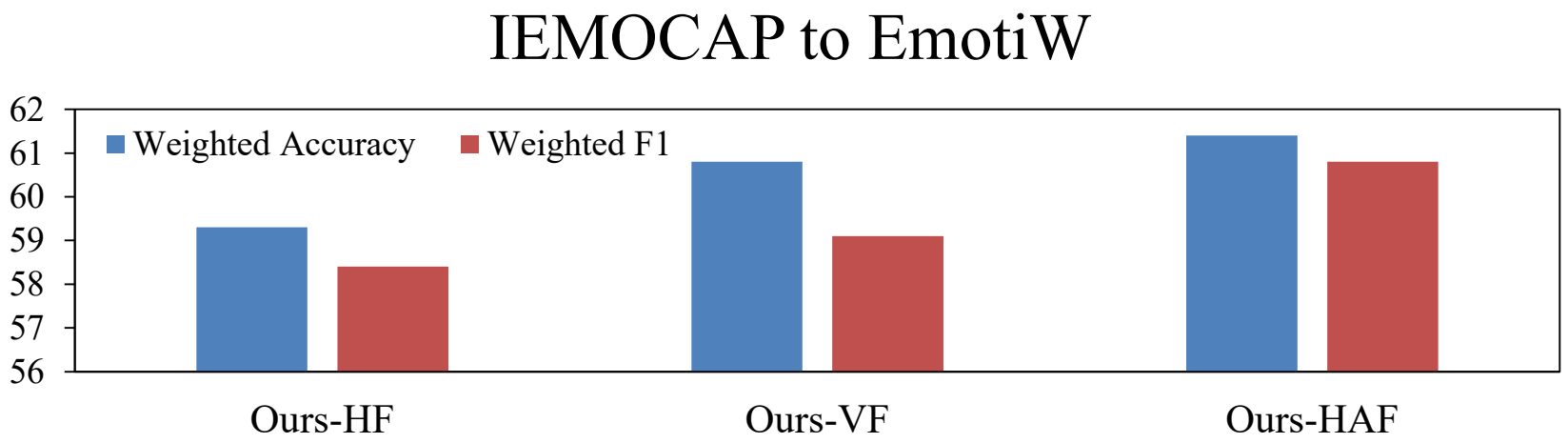
Multimodal architecture is needed





Generalization

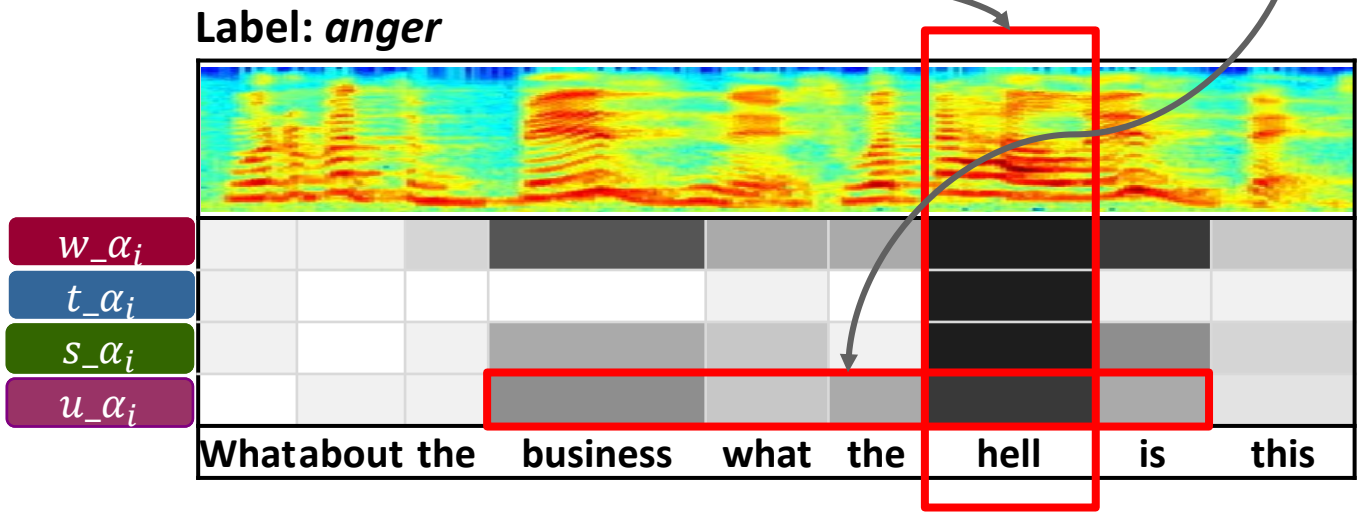




Attention Visualization

Carry representative information in both text and audio

Successfully combine both textual and acoustic attentions



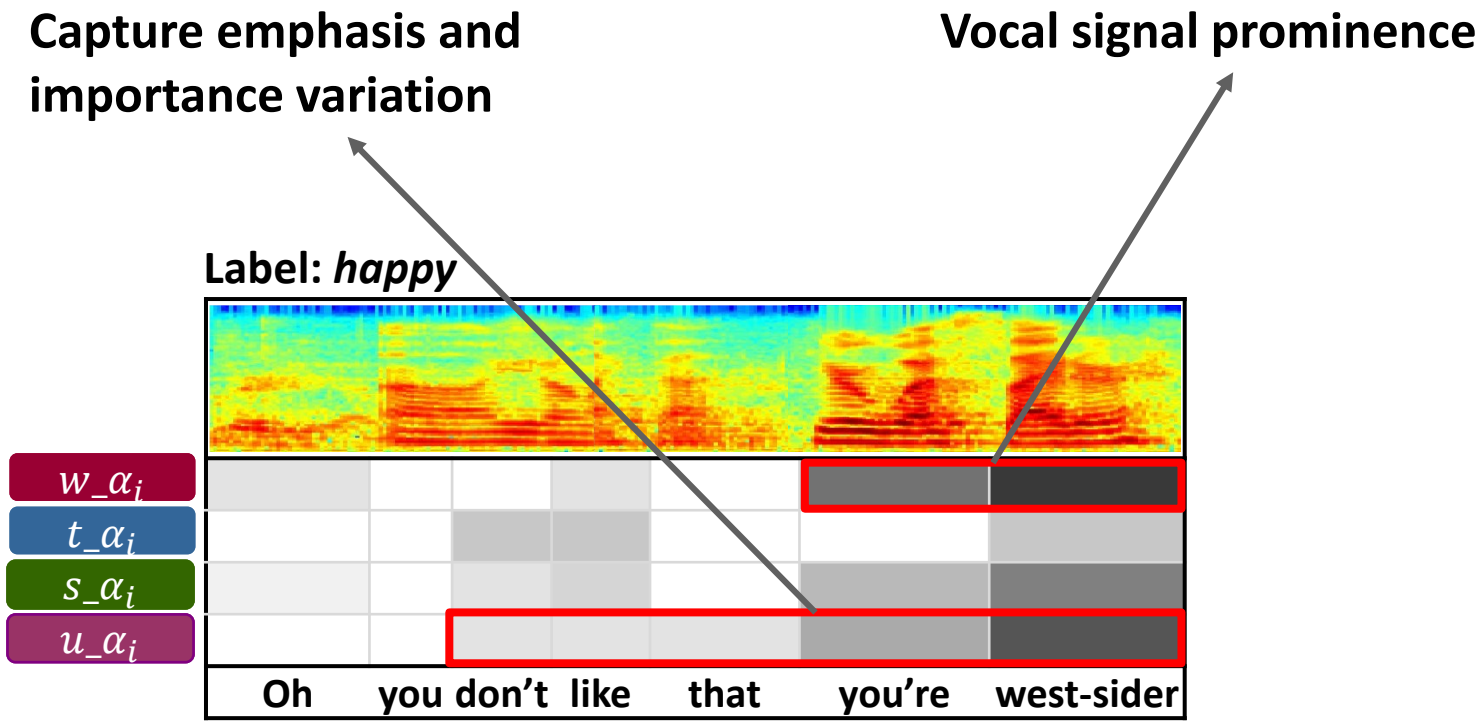
w_α_i Word-level acoustic attention distribution

t_α_i Word-level textual attention distribution

s_α_i Shared attention distribution

u_α_i Fine-tuning attention distribution

Attention Visualization



w_α_i Word-level acoustic attention distribution

t_α_i Word-level textual attention distribution

s_α_i Shared attention distribution

u_α_i Fine-tuning attention distribution

Summary

- A hierarchical attention based multimodal structure
- The word-level fusion strategies
- Word-level attention visualization

Thank you !

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