Incorporating Discourse Features into Confidence Scoring of Intention Recognition Results in Spoken Dialogue Systems

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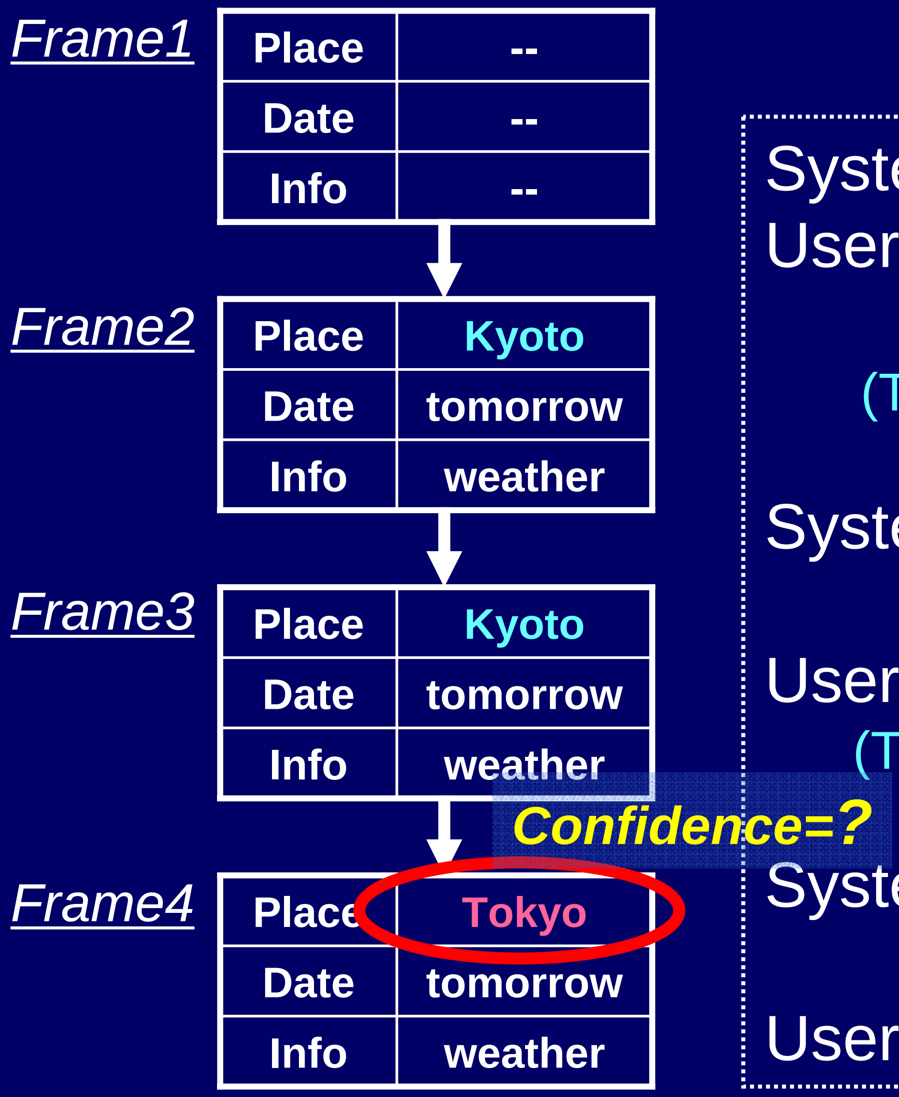
Overview

- A new confidence scoring method for intention recognition results in spoken dialogue systems
  - Intention means the information that the user wants to convey to the system
  - Uses *discourse features* in addition to acoustic and language model features
  - Useful for dialogue management
    e.g., avoid unnecessary confirmations

Intention Recognition : an example



Frame1

Place	--
Date	--
Info	--

Frame2

Place	Kyoto
Date	tomorrow
Info	weather

Frame3

Place	Kyoto
Date	tomorrow
Info	weather

Confidence=?

Frame4

Place	Tokyo
Date	tomorrow
Info	weather

Example Dialogue

System : “May I help you?”

User : “Tell me *Tokyo*’s weather for tomorrow”

(Tokyo was misrecognized as *Kyoto*)

System : “Kyoto’s weather for tomorrow?”

User : “Tokyo”

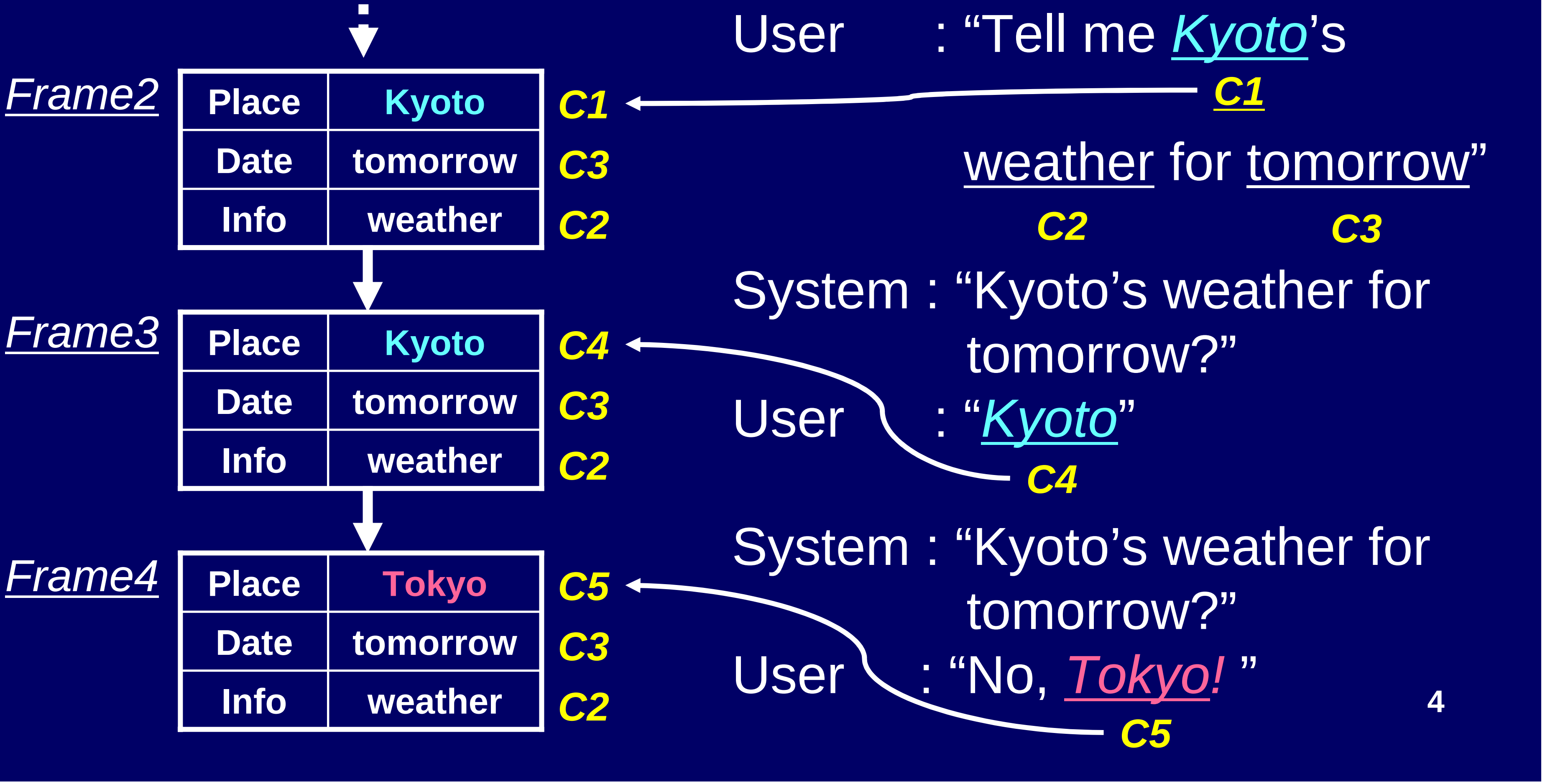
(Tokyo was misrecognized as *Kyoto again*)

System : “Kyoto’s weather for tomorrow?”

User : “No, *Tokyo!* ”

Conventional Methods

Use ***confidence of words*** in speech recognition results for the confidence of slot values



Frame2

Place	**Kyoto**	*C1*
Date	**tomorrow**	*C3*
Info	**weather**	*C2*

Frame3

Place	**Kyoto**	*C4*
Date	**tomorrow**	*C3*
Info	**weather**	*C2*

Frame4

Place	**Tokyo**	*C5*
Date	**tomorrow**	*C3*
Info	**weather**	*C2*

User : "Tell me *Kyoto*'s weather for tomorrow"

System : "Kyoto's weather for tomorrow?"

User : "*Kyoto*"

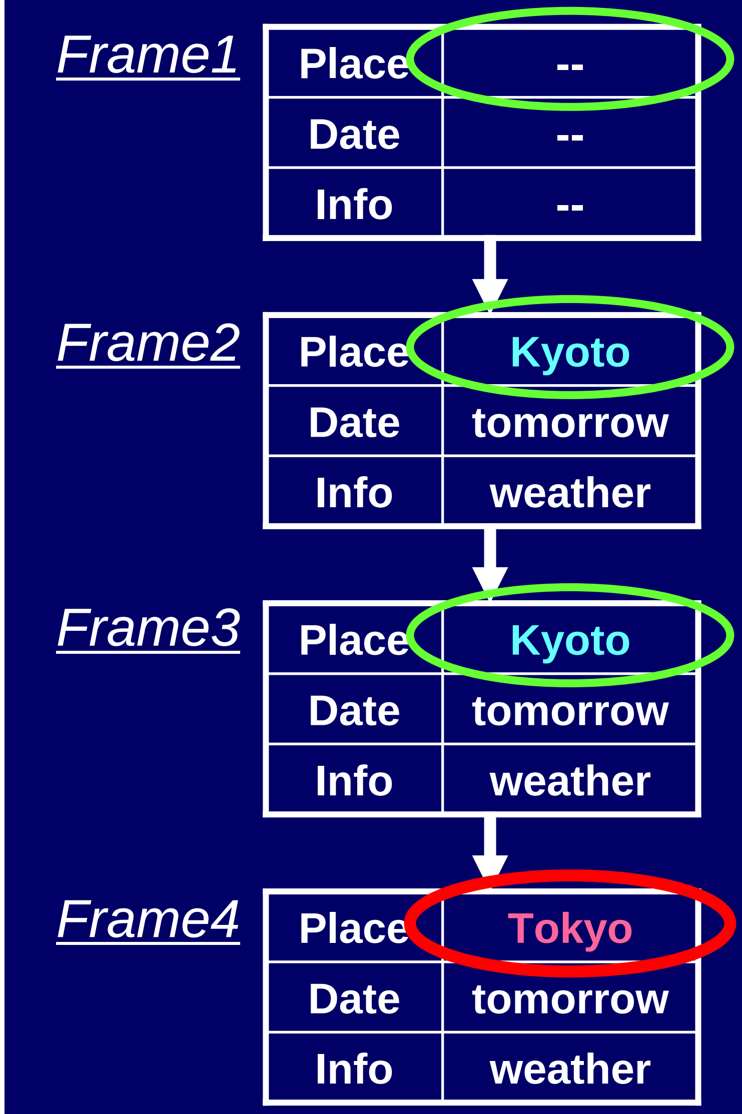
System : "Kyoto's weather for tomorrow?"

User : "No, *Tokyo!* "

Proposed Method

- Slot value is not a result of a single utterance but the entire discourse
  → Use discourse information to improve accuracy of confidence scoring
- Train a confidence model that outputs confidence scores based on both
  - acoustic and language model features of a word filling the slot and
  - discourse features for the slot value

Discourse Features



Frame1

Place	--
Date	--
Info	--

Frame2

Place	Kyoto
Date	tomorrow
Info	weather

Frame3

Place	Kyoto
Date	tomorrow
Info	weather

Frame4

Place	Tokyo
Date	tomorrow
Info	weather

System : "May I help you?"
User : "Tell me *Tokyo* *(Kyoto)* 's weather for tomorrow"
System : "Kyoto's weather for tomorrow?"
User : "Tokyo (Kyoto)"
System : "Kyoto's weather for tomorrow?"
User : "No, *Tokyo!* "

Discourse features encode the relationship between a slot value and the discourse

Discourse Features (cont'd)

- We enumerated 11 discourse features
  - How many times the same slot value is found in previous frames
  - Ratio of the slot value in all frames
  - How many times the slot value was deleted or overwritten by other values
  - How many times the slot value has appeared in user and system utterances
  - etc.

Discourse Features (cont'd)

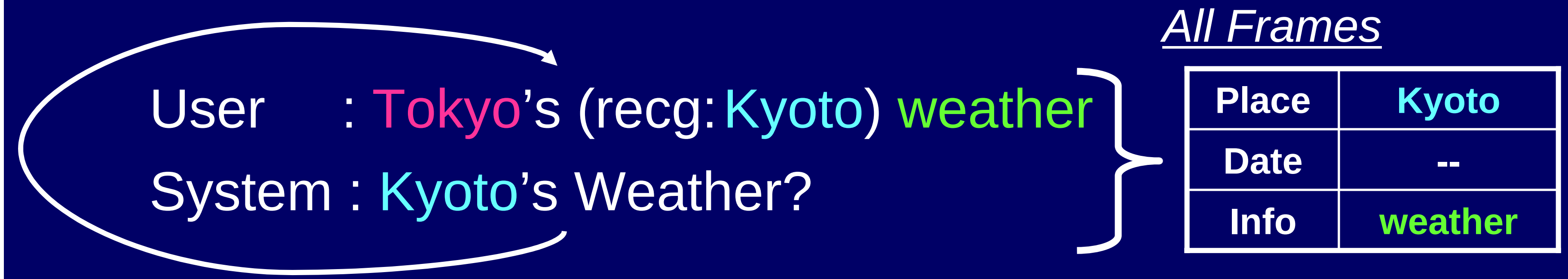
- Same keyword pair count
  - The number of times the slot value is confirmed by the system and then uttered by the user immediately afterwards
  - System : "*Kyoto*'s weather for tomorrow?"
    User : "*Kyoto*"
  - Grice's maxim of quantity states that user utterances have to be as informative as necessary
  - Possible penalty to slot values that are related to this less informative interaction

Data Collection

- System
  - – Weather Information Service Domain
  - – Vocabulary of 1,652 words
  - – Has 3 slots (place, date, information-type)
- Collected data
  - – 18 subjects performed 16 dialogues each
  - – 288 dialogues collected
  - – Task completion rate is 95.83% (276/288)
  - – 4812 slot value samples

Data Screening

- Slots that did not have values
- Slots explicitly confirmed by the user
- Slots that have only one value in all frames



User : Tokyo's (recg: Kyoto) weather

System : Kyoto's Weather?

All Frames

Place	**Kyoto**
Date	**--**
Info	**weather**

Kyoto and weather have the same discourse features although one of them is wrong

→ ***causes trouble in confidence model training***

777 slot samples remained

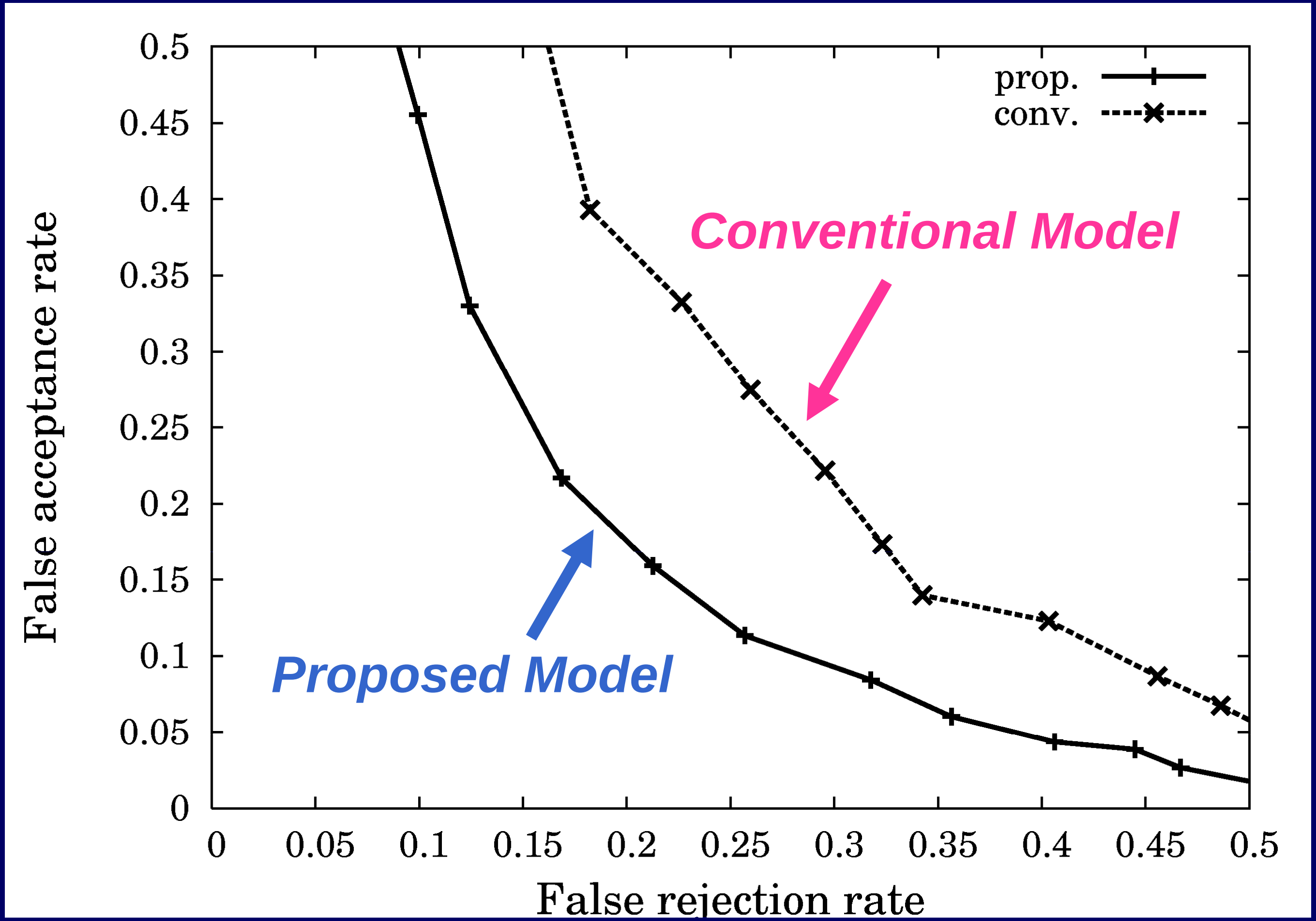
Confidence Model Training

- Feature extraction
  - 27 acoustic and language model features adopted from *(Hazen et al. 2002)*
  - 11 discourse features
- Confidence model
  - Weighted linear combination of the features adopted from *(Hazen et al. 2002)*
  - Weights are optimized using the training data
  - Outputs positive scores for correct slot values and negative scores for incorrect ones

Evaluation

- Comparison of two confidence models
  - Conventional Model (conv.)
    - trained only by acoustic and language model features
  - Proposed Model (prop.)
    - trained by both acoustic and language model features and discourse features
- 6-fold cross validation

Evaluation (cont’d)



Proposed model outperforms conventional model in classification accuracy

Evaluation (cont'd)

- Matrix of counts of correct and incorrect items

	Prop. Correct	Prop. Incorrect
Conv. Correct	***535***	***35***
Conv. Incorrect	***102***	***105***

Statistically significant difference in classification performance (McNemar's test, $p = 8.69 \cdot 10^{-8}$)

Impact of the discourse features

- relatively important features
  - Same keyword pair count
    → *Slot values related to the less informative interaction is likely to be incorrect*
  - Number of slot values in user utterance
    → *The more the slot value is found in user utterances, the more correct the slot value is*
- *less important feature*
  - Ratio of the slot value in all frames
    → *Ratio in frames does not guarantee its correctness*

Conclusion

- A new confidence scoring method for intention recognition results in spoken dialogue systems
  - Uses discourse features in addition to acoustic and language model features
- Experimental Results show validity of our method
- ***Future work:***
  - Verification in other domains
  - Online evaluation of the system