

Concept-to-text Generation via Discriminative Reranking

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ACL 2012, Jeju Island

Introduction

Concept-to-text generation refers to the task of automatically producing textual output from nonlinguistic input (Reiter and Dale, 2000)

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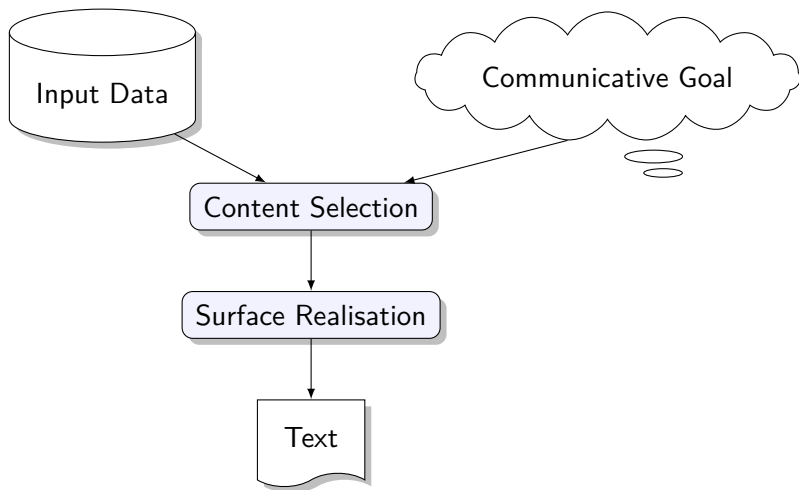
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Flight		Day Number		Month	
from	to	number	dep/ar	month	dep/ar
edinburgh	jeju	7	departure	july	departure

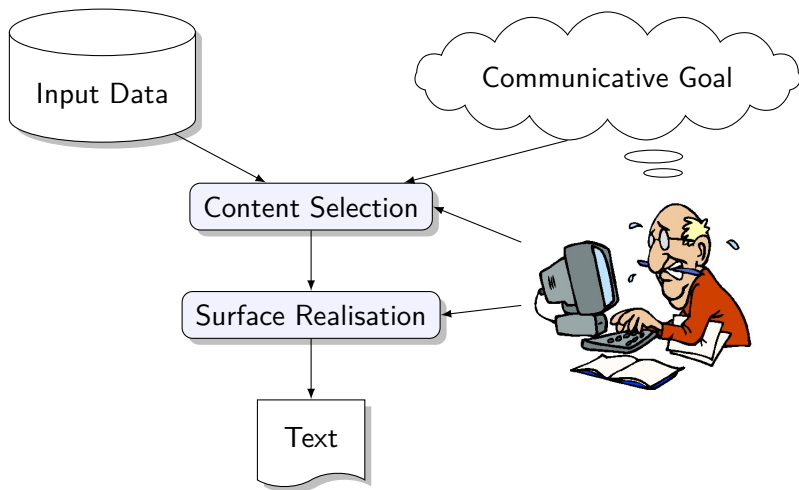
Condition			Search	
arg1	arg2	type	type	what
arrival_time	1600	<	query	flight

Give me the flights leaving Edinburgh July seventh coming back to Jeju Island before 4pm

Traditional NLG Pipeline



Traditional NLG Pipeline



Our Approach

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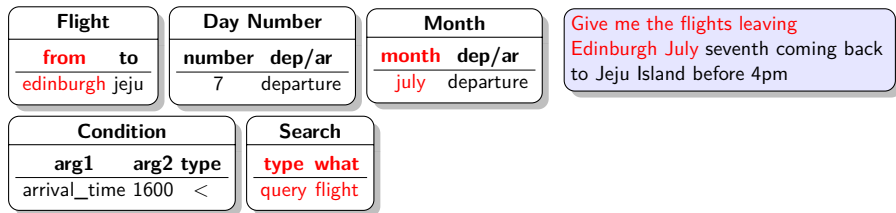
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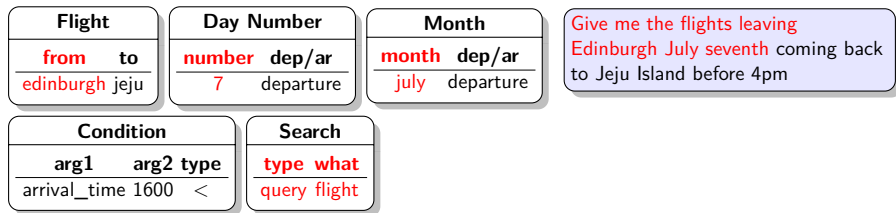
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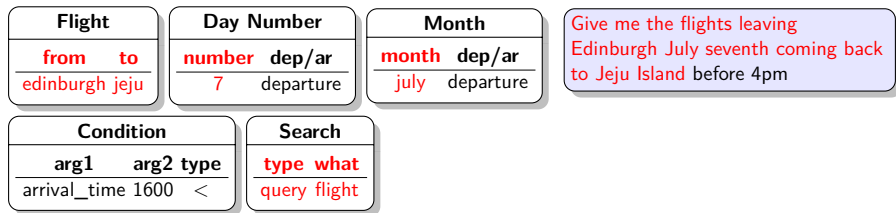
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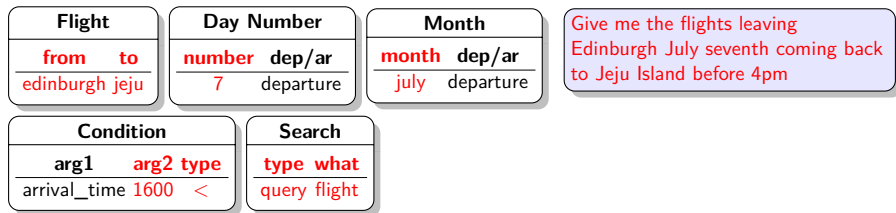
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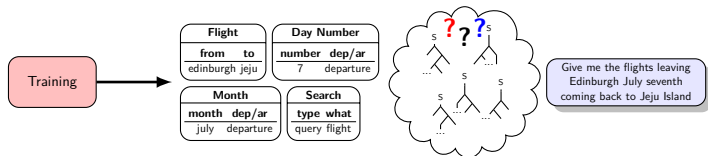
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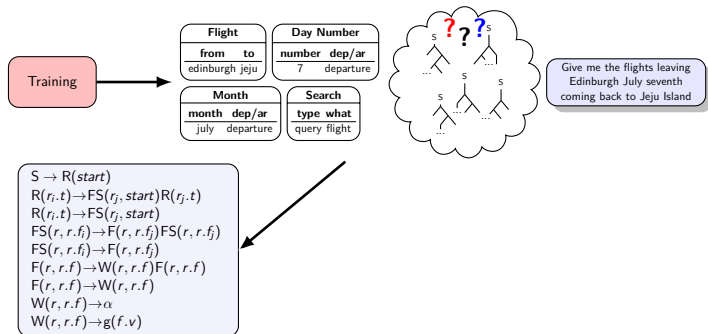
Please show me the flights from
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Joint Discriminative Reranking with Hypergraphs

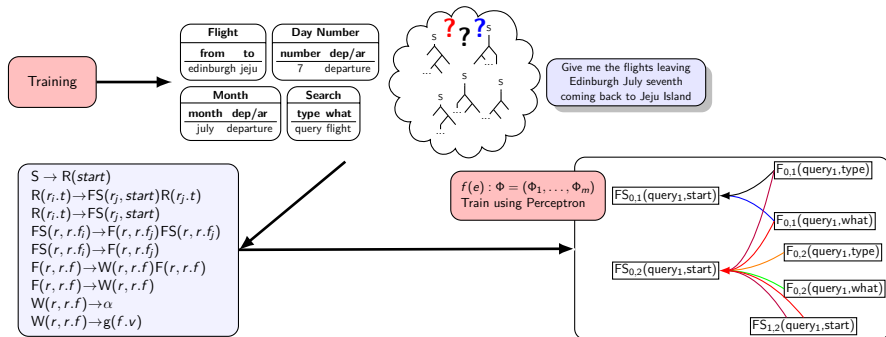
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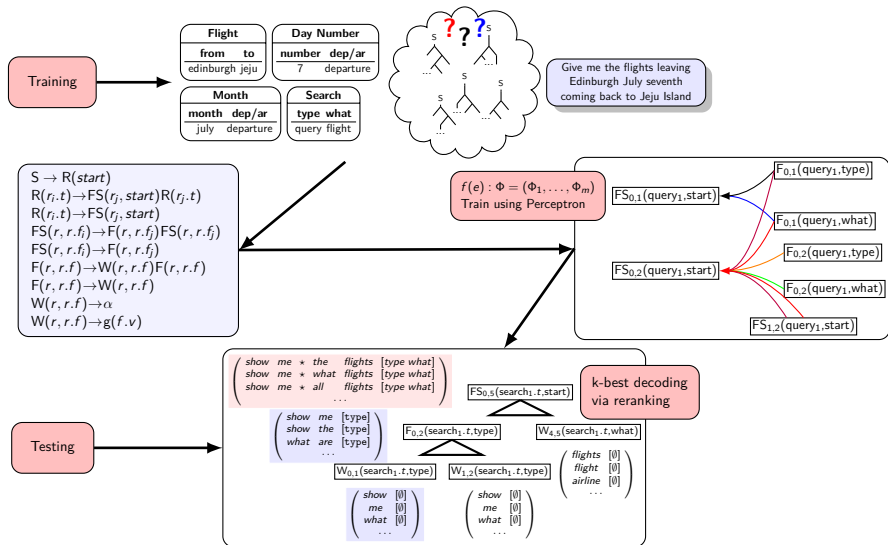
Joint Discriminative Reranking with Hypergraphs



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Joint Discriminative Reranking with Hypergraphs



Related Work

Angeli et al., 2010

- Unified content selection and surface realisation
- Obtain alignments from Liang et al. (2009)
- Sequence of discriminative (log-linear) local decisions (records - fields - templates)

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Our approach

- **Joint** model allows for more global decisions
- **Hypergraphs** are a compact representation and allow for efficient inference (k-best decoding via cube pruning)
- **Discriminative reranking** reranks k-best trees at all internal nodes

Input

- Input: database records \mathbf{d}
- Output: words \mathbf{w} corresponding to some records of \mathbf{d}
- Each record $r \in \mathbf{d}$ has a type $r.t$ and fields f
- Fields have values $f.v$ and types $f.t$ (integer, categorical)

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thursday	return

leaving on sunday

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Grammar Definition

- 1 $S \rightarrow R(\text{start})$
- 2 $R(r_i.t) \rightarrow FS(r_j, \text{start})R(r_j.t)$
- 3 $R(r_i.t) \rightarrow FS(r_j, \text{start})$
- 4 $FS(r, r.f_i) \rightarrow F(r, r.f_j)FS(r, r.f_j)$
- 5 $FS(r, r.f_i) \rightarrow F(r, r.f_j)$
- 6 $F(r, r.f) \rightarrow W(r, r.f)F(r, r.f)$
- 7 $F(r, r.f) \rightarrow W(r, r.f)$
- 8 $W(r, r.f) \rightarrow \alpha$
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$$R(\text{search}_1.t) \rightarrow \text{FS}(\text{flight}_1, \text{start})R(\text{flight}_1.t)$$

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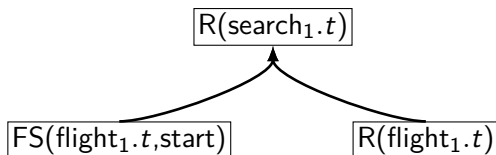
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$W(\text{search}_1, \text{type}) \rightarrow \text{show} [\text{type.v} = \text{'query'}]$

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Hypergraph Construction

Map standard weighted CYK algorithm to hypergraph $H : \langle N, E, t, \mathbf{R} \rangle$

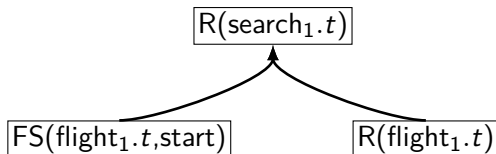


$$f(e) = f(\text{FS}_{5,7}(\text{flight}_1.t, \text{start})) \otimes f(\text{R}_{7,9}(\text{flight}_1.t)) \otimes w(\text{R}(\text{search}_1.t) \rightarrow \text{FS}(\text{flight}_1.t, \text{start}) \text{R}(\text{flight}_1.t))$$

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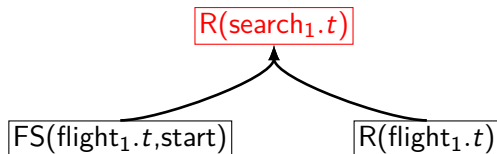


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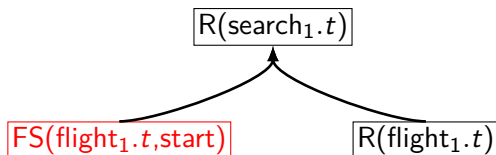


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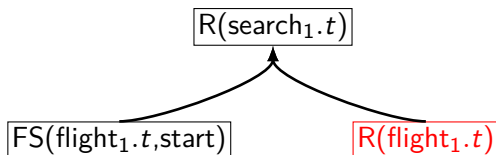


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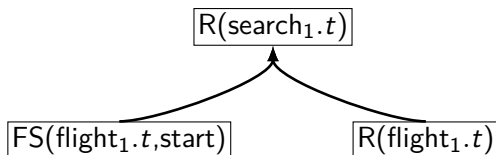


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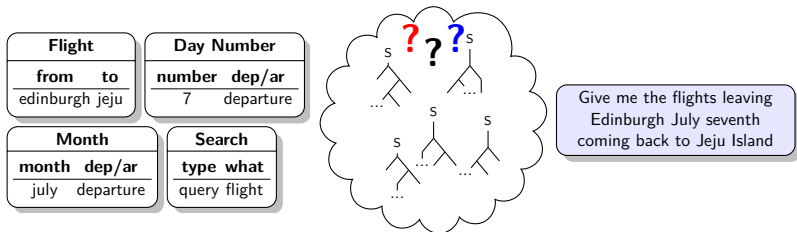
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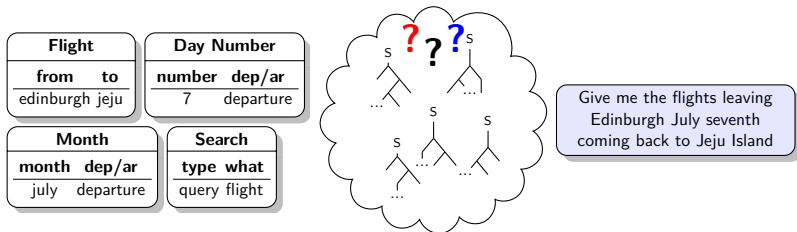
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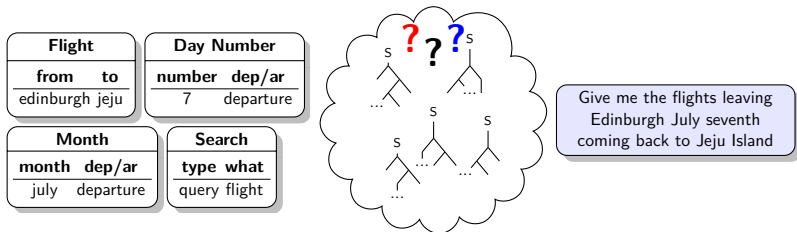


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- Learn α with averaged structured perceptron (Collins, 2002)

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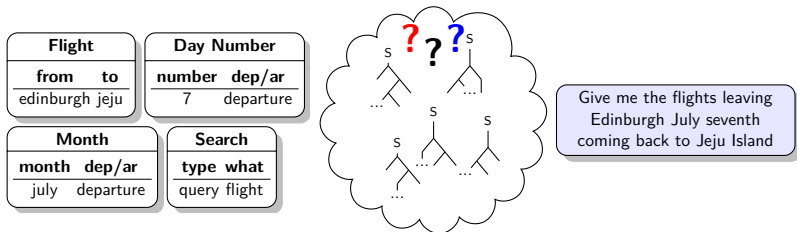


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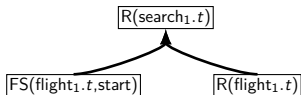
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- Baseline Model Feature (local) : Log score of unsupervised generative decoder (Konstas and Lapata, 2012a)

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- Alignment Features (local) : Count of each PCFG rule



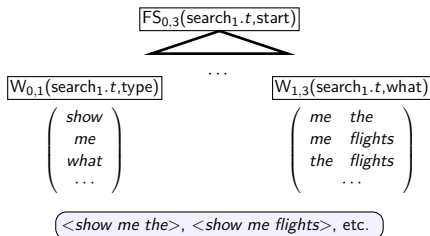
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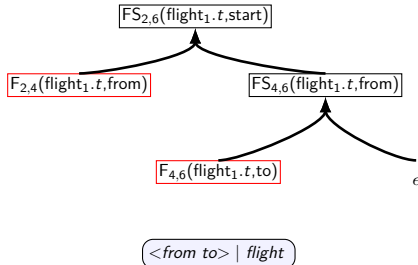


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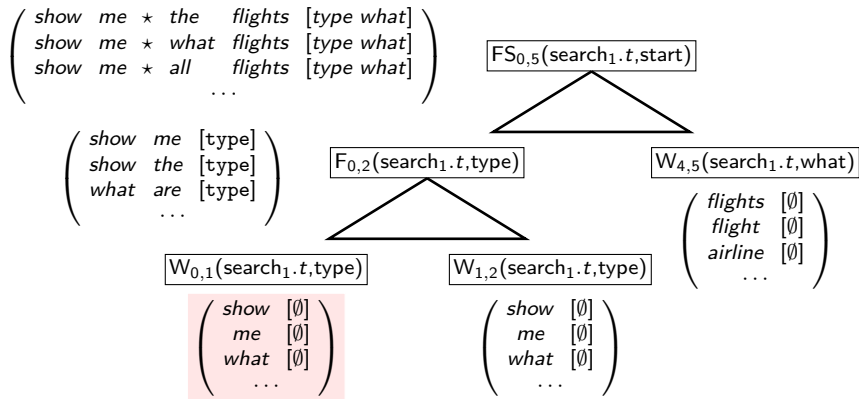
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 e.g. $R_{2,8}(\text{flight}_1.t) \langle \text{one way*to Seoul; direction from*stop-over to} \rangle$

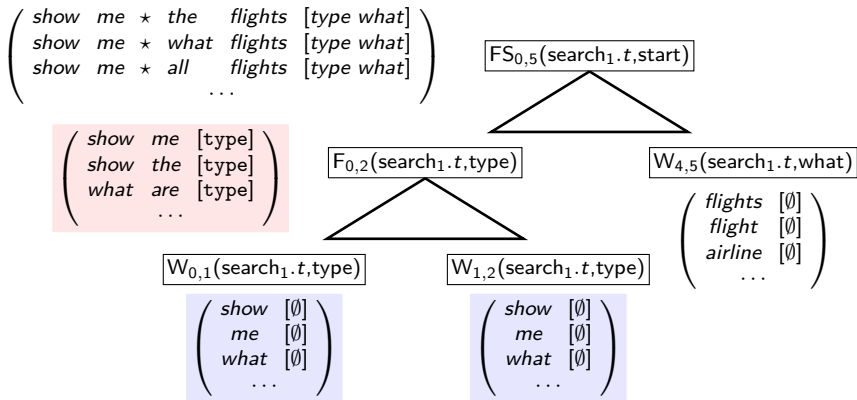
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e.g. $R_{2,8}(\textit{flight}_1.t) \langle \textit{one way*to Seoul; direction from*stop-over to} \rangle$
- Root node: most grammatical and semantically correct derivation

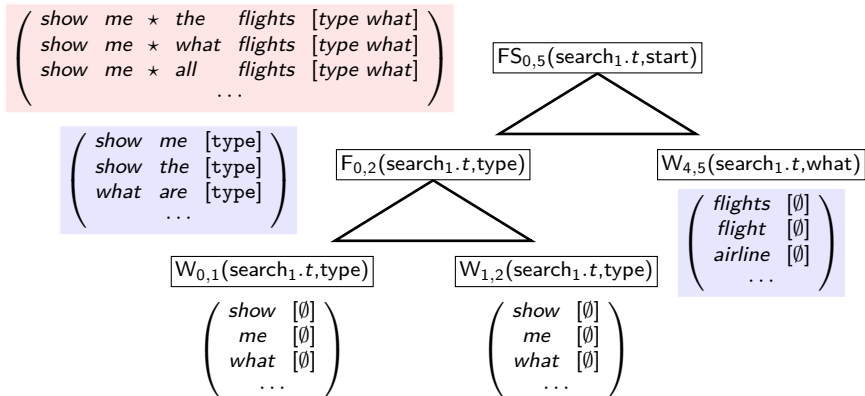
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- Model parameters estimated on dev set (k -best, n -grams)

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System Comparison

- Baseline: 1-BEST+BASE+ALIGN
- k -best (+Lexical): k -BEST+BASE+ALIGN+LEX
- k -best (+Structural): k -BEST+BASE+ALIGN+LEX+STR
- Angeli et al. (2010)

Results: Automatic Evaluation

System	BLEU	METEOR
1-BEST+BASE+ALIGN	21.93	34.01
<i>k</i> -BEST+BASE+ALIGN+LEX	28.66	45.18
<i>k</i> -BEST+BASE+ALIGN+LEX+STR	30.62	46.07
ANGELI	26.77	42.41

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<i>k</i> -BEST+BASE+ALIGN+LEX+STR	30.62	46.07
ANGELI	26.77	42.41

Results: Human Evaluation

System	Fluency	SemCor
1-BEST	2.70	3.05
<i>k</i> -BEST	4.02	4.04
ANGELI	3.74	3.17
HUMAN	4.18	4.02

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1-BEST	2.70	3.05
<i>k</i> -BEST	4.02	4.04
ANGELI	3.74	3.17
HUMAN	4.18	4.02

- *k*-BEST significantly better than 1-BEST and ANGELI ($\alpha < 0.01$)
- *k*-BEST and HUMAN are not significantly different

Output

Flight		Time		Day		Search	
from	to	when	dep/ar	day	dep/ar	type	what
phoenix	milwaukee	evening	departure	wednesday	departure	query	flight

1-BEST: On Wednesday evening from from Phoenix to Milwaukee on Wednesday evening

k-BEST: **Please list the flights from Phoenix to Milwaukee on Wednesday evening**

ANGELI: Show me the flights from Phoenix to Milwaukee on Wednesday evening flights from Phoenix to Milwaukee

HUMAN: Give me the flights from Phoenix to Milwaukee on Wednesday evening

Conclusions

- Generation as parsing problem using the hypergraph framework
- Discriminative reranking using the structured perceptron
- Introduced local and non-local features
- Performance better than state-of-the-art
- Future work: dependency relations, discourse

Demo

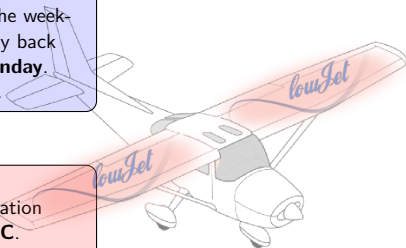
Flight Booking System - lowJet

Scenario 1

Imagine you are in **Los Angeles** for the weekend and you would like to fly directly back home to **Denver** the following **Monday**.
Try to find the **earliest** flight.

Scenario 2

You have won a free **one-way** vacation from **Miami** to **Washington DC**.
Book the **cheapest** tickets for next **Thursday** morning.
Alternatively, just find the **earliest** itinerary.



Thank you

Questions ?



Oracle Derivation

Oracle derivation (\mathbf{w}^* , \mathbf{h}^+)

- Use the existing decoder but observe the training text.
- \mathbf{w}^* : gold standard text
- \mathbf{h}^+ : best latent configuration

Human Evaluation (Mturk)

Table 3

	Category	Fields - Values	
	Flight Info	from: milwaukee	to: phoenix
	Query	type: show	what: flight
	Day	day: saturday	dep/ar/ret: departure

Translation 3

SHOW ME THE FLIGHTS BETWEEN MILWAUKEE AND PHOENIX ON SATURDAY

Fluency
Semantic Correctness

1 2 3 4 5
 1 2 3 4 5

Determining Text Length

- Train a linear regression model
- Idea: The more records and fields that have values in the database → the more facts need to be uttered
- Input to the model: Flattened version of the database input, i.e. each feature is a record-field pair
- Feature values: Values vs Counts of Fields