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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edinburgh	jeju

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7	departure

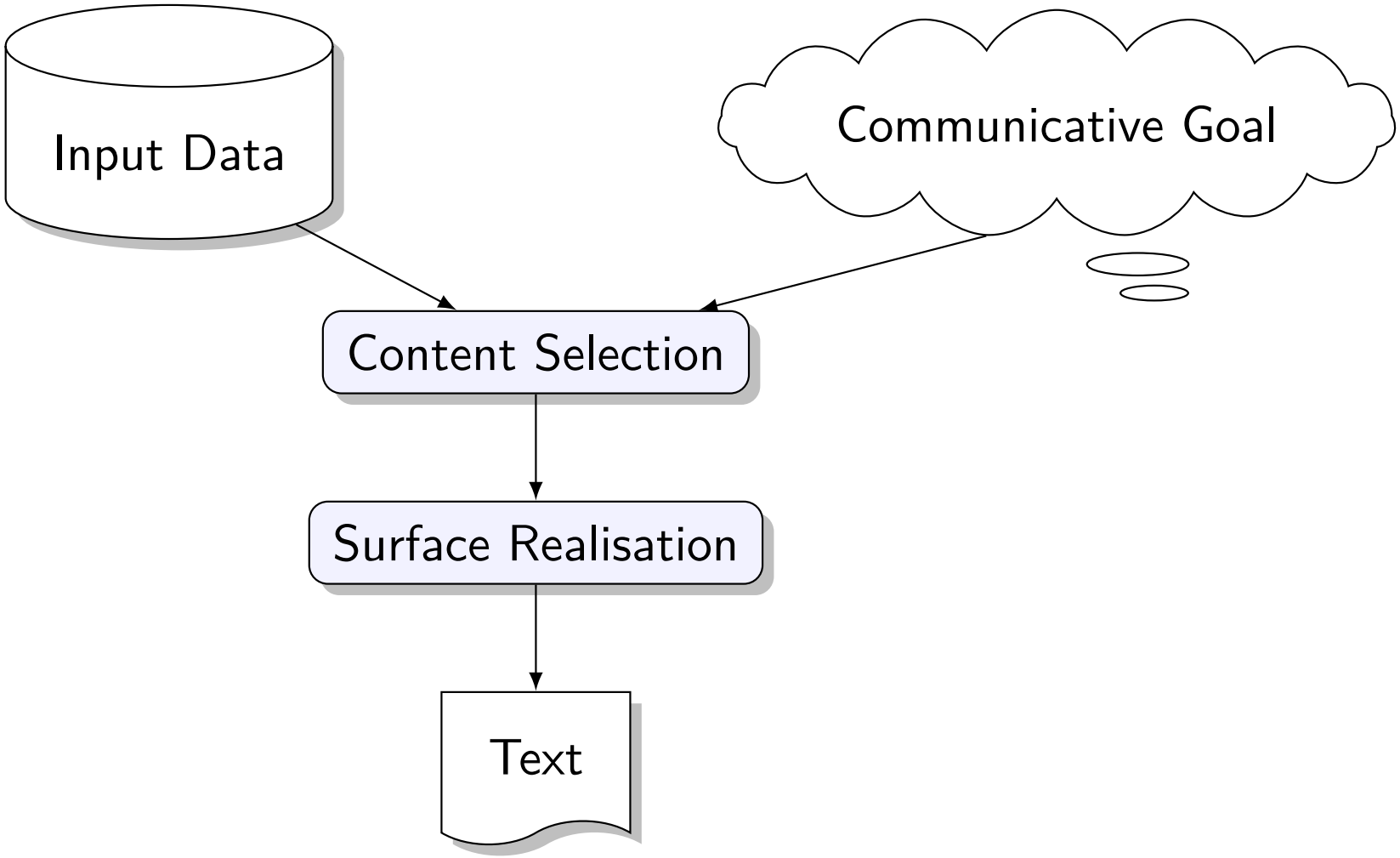
Month	
month	**dep/ar**
july	departure

Condition		
arg1	**arg2**	**type**
arrival_time	1600	$<$

Search	
type	**what**
query	flight

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

Traditional NLG Pipeline



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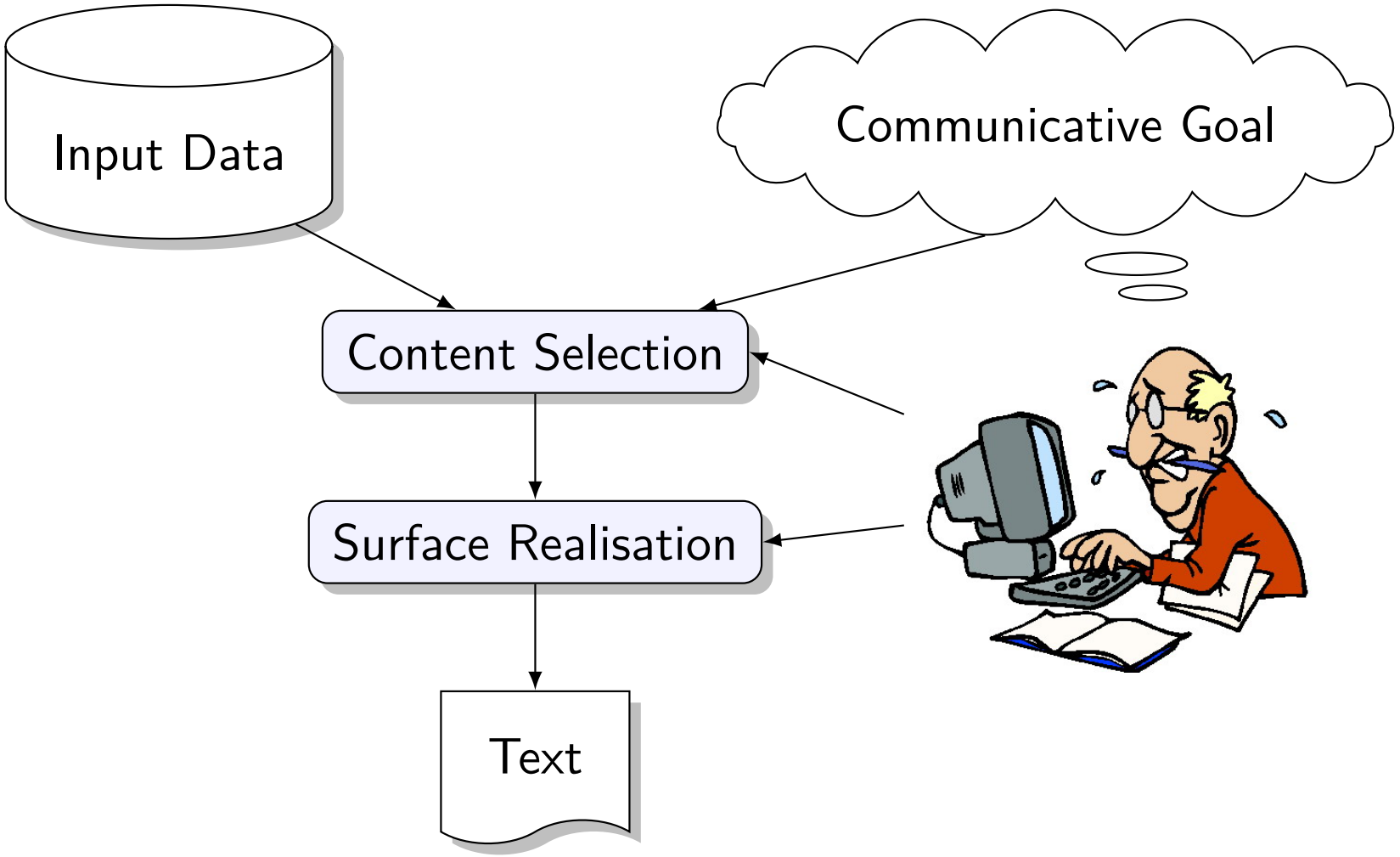

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Please show me the flights from Edinburgh on July seventh to Jeju Island before 16:00

Joint Discriminative Reranking with Hypergraphs

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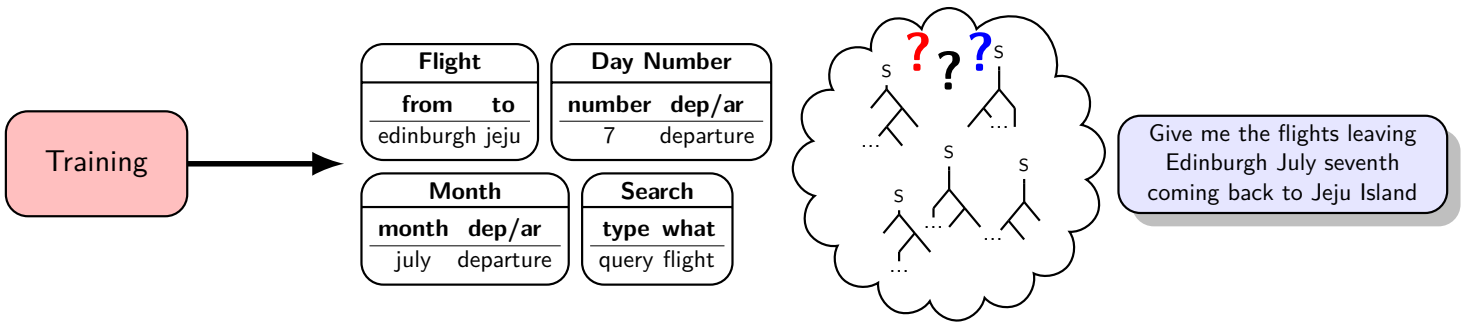

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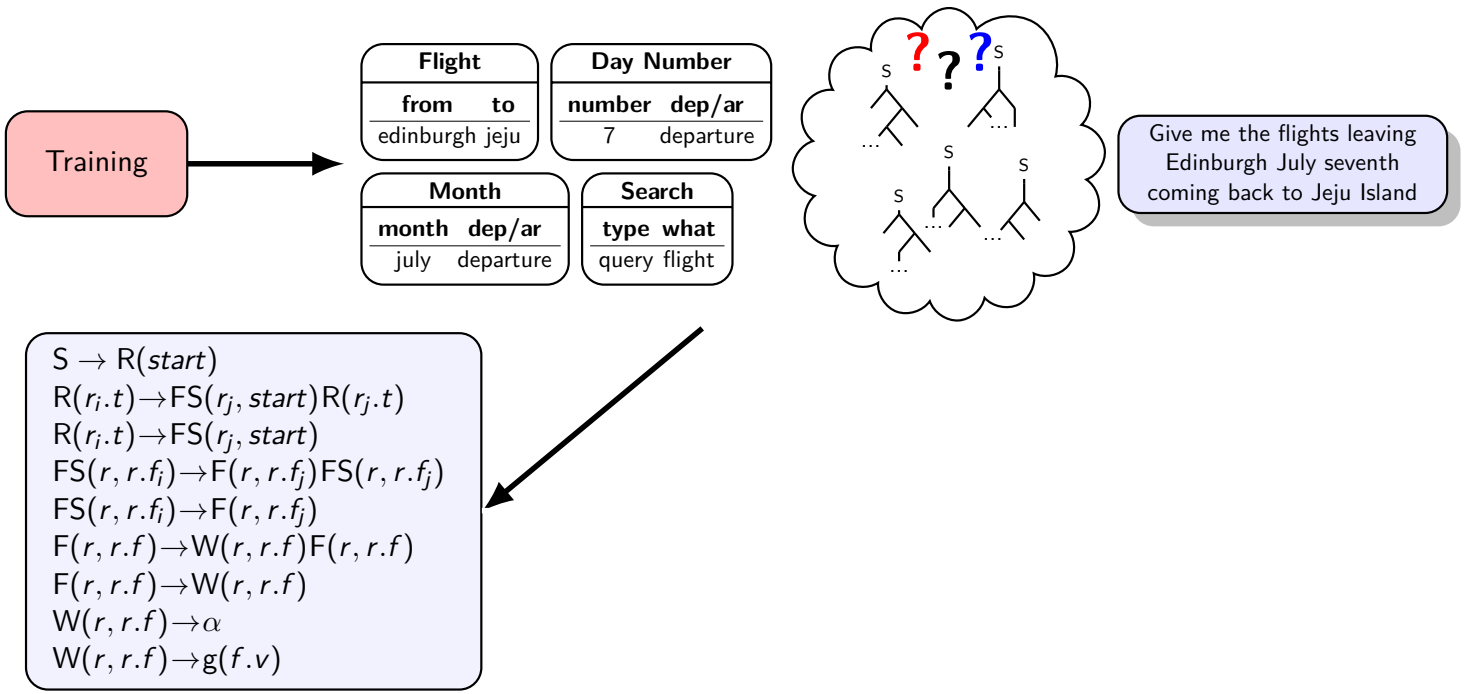

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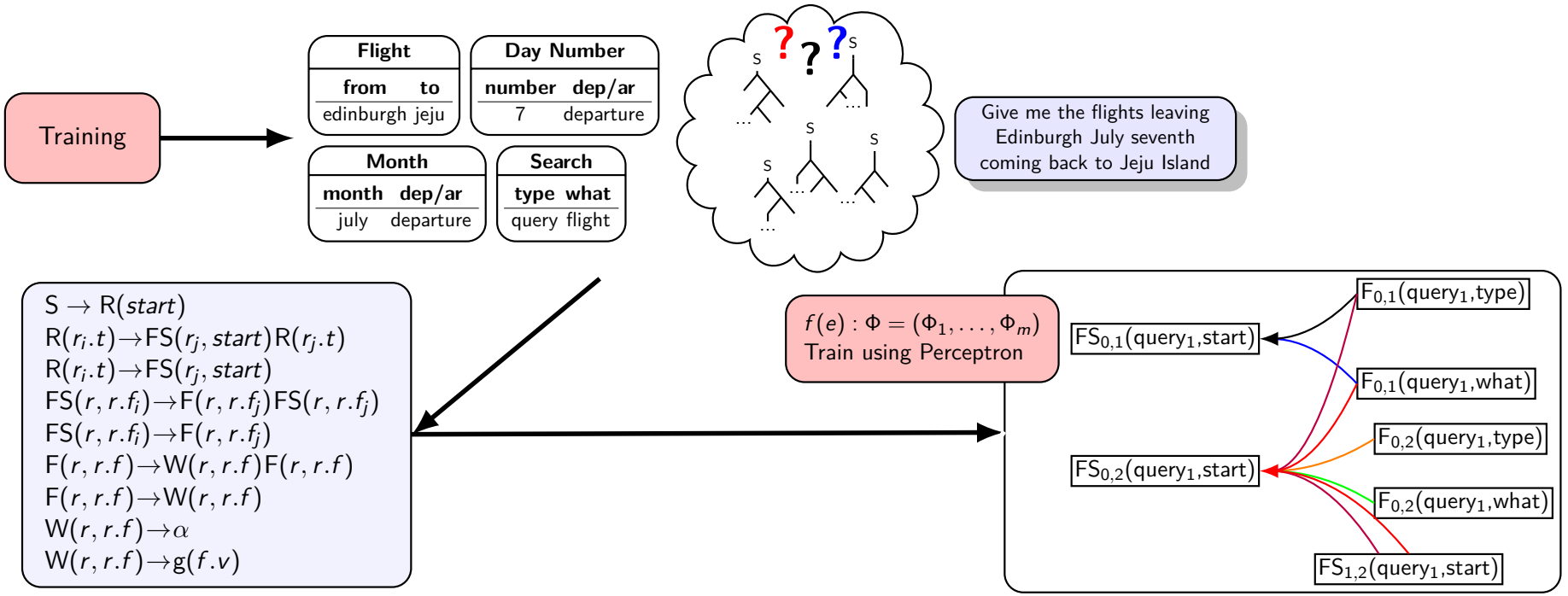

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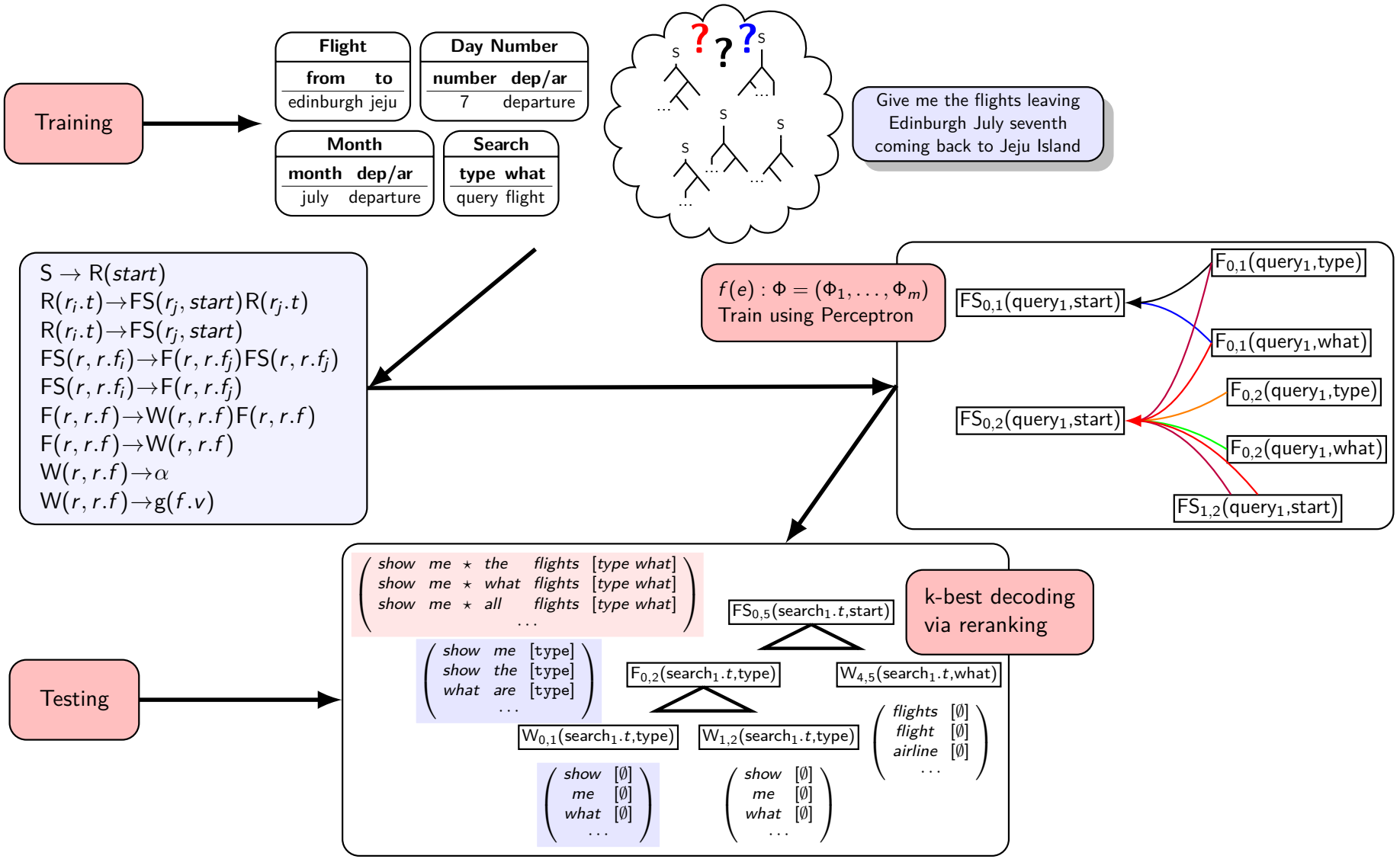

Related Work

Angeli et al., 2010

- Unified content selection and surface realisation
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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 **d**
- Output: words **w** corresponding to some records of **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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day of week	**dep/ar/ret**
sunday	departure
thursday	return

leaving on sunday

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Grammar Definition

1. $S \rightarrow R(start)$
2. $R(r_i.t) \rightarrow FS(r_j, start)R(r_j.t)$
3. $R(r_i.t) \rightarrow FS(r_j, start)$
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. $W(r, r.f) \rightarrow \alpha$
9. $W(r, r.f) \rightarrow g(f.v)$

Grammar Definition

$\mathrm{R}(search_1.t) \rightarrow \mathrm{FS}(flight_1, start)\mathrm{R}(flight_1.t)$

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Grammar Definition

$\mathrm{FS}(\mathit{flight}_1, \mathit{from}) \rightarrow \mathrm{F}(\mathit{flight}_1, \mathit{to})\mathrm{FS}(\mathit{flight}_1, \mathit{to})$

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$$\mathrm{F}(search_1, what) \rightarrow \mathrm{W}(search_1, what)\mathrm{F}(search_1, what)$$

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Grammar Definition

$W(search_1, type) \rightarrow \text{show } [type.v = \text{`query'}]$

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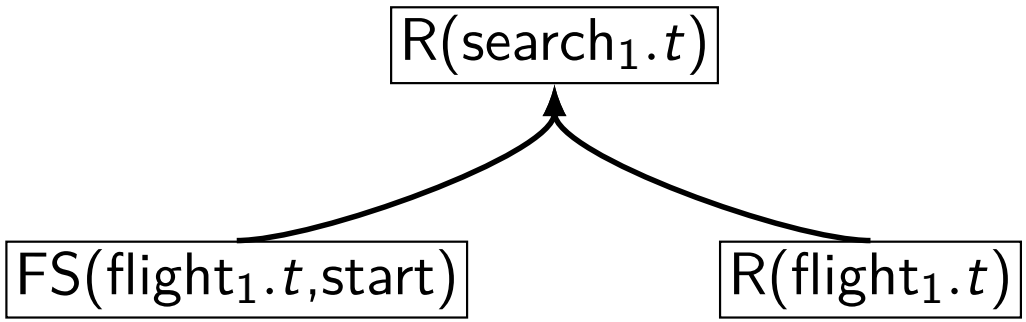
Hypergraph Construction

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



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

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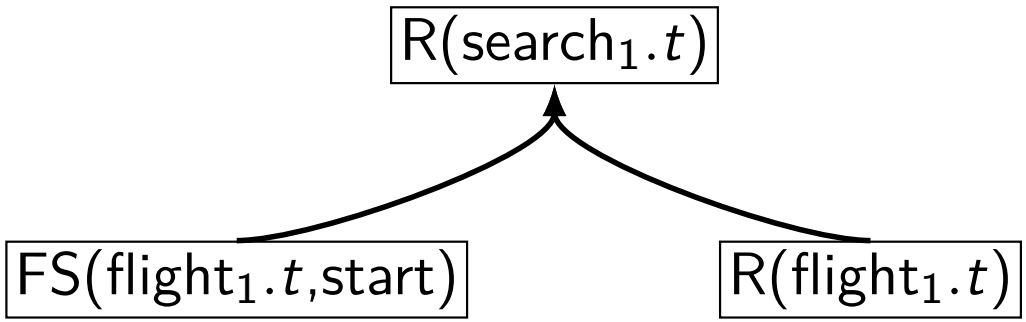

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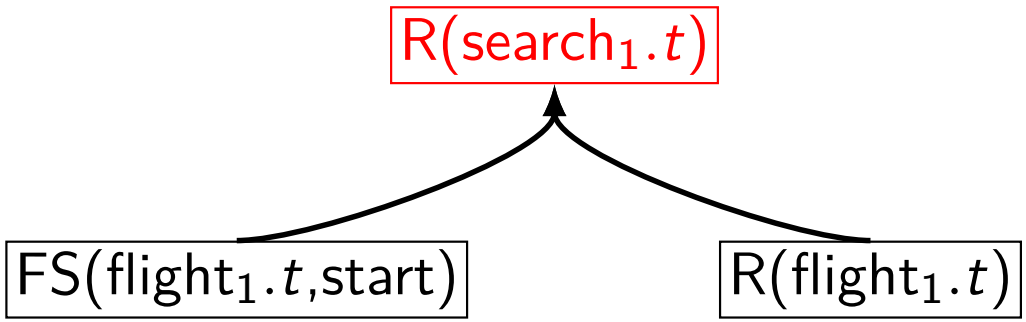

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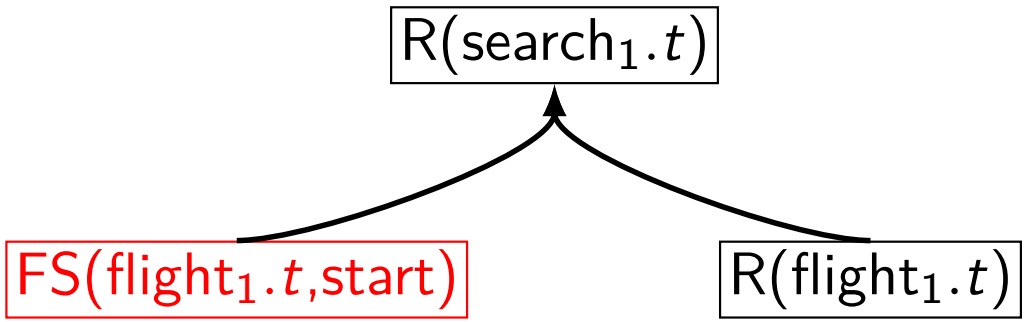

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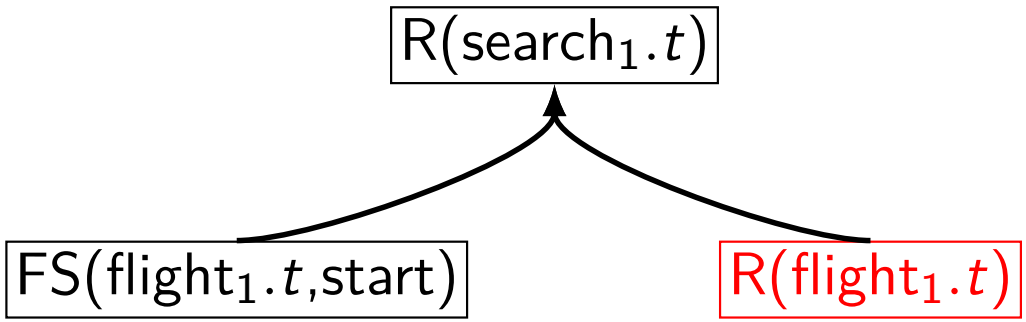

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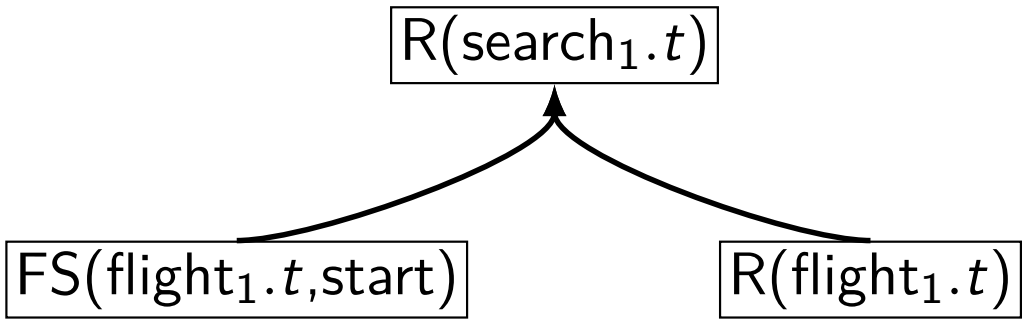

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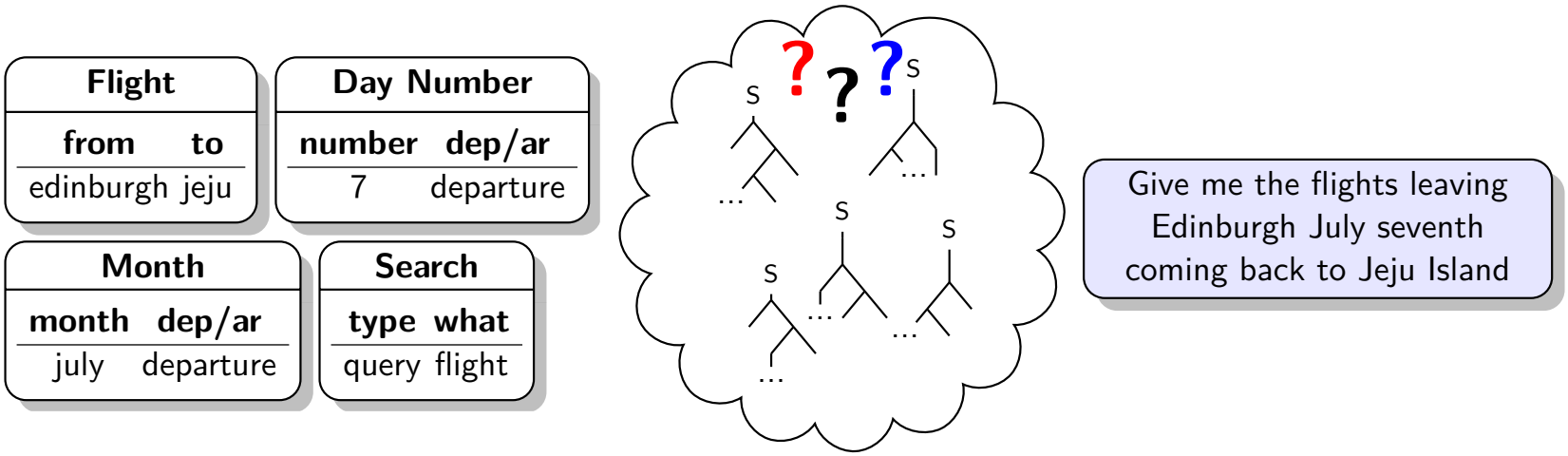

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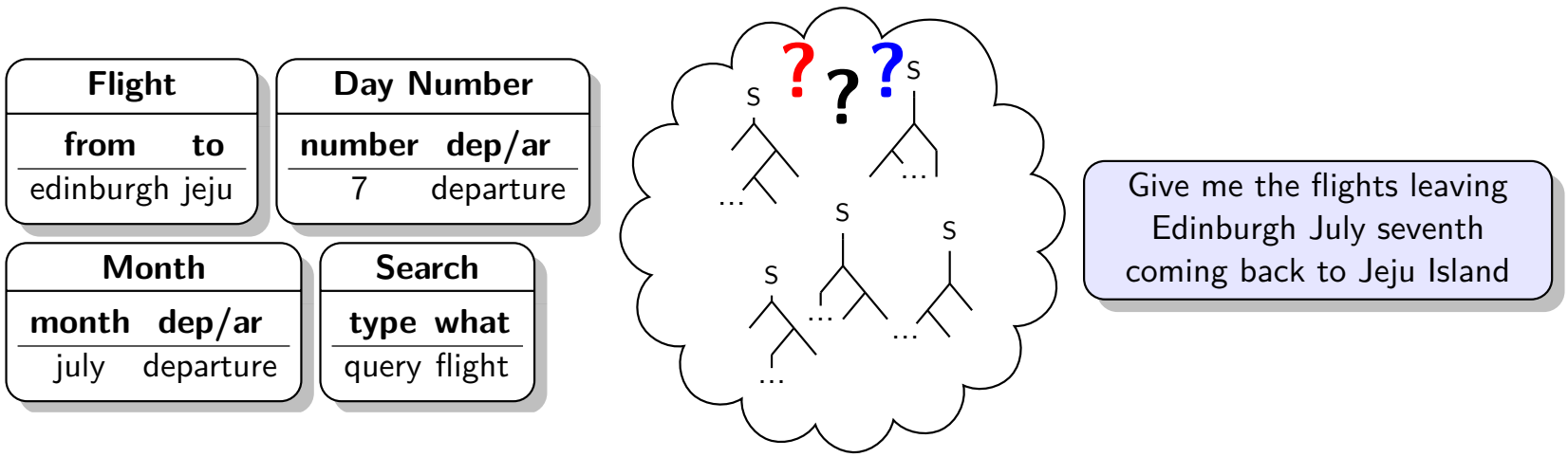

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- α : weight vector
- Learn α with averaged structured perceptron (Collins, 2002)

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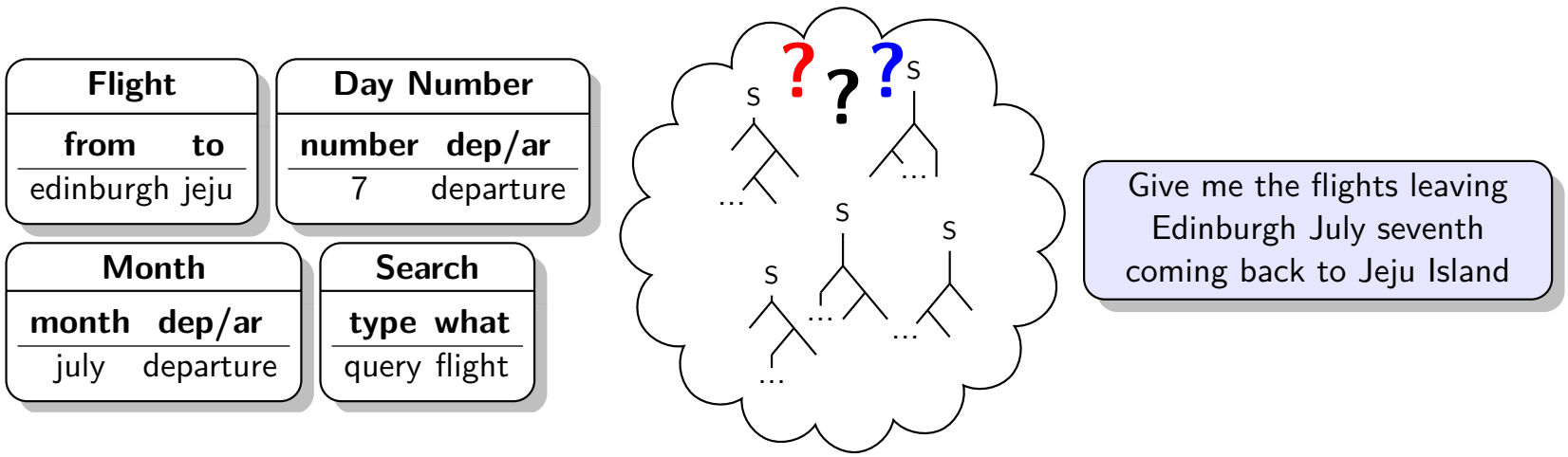

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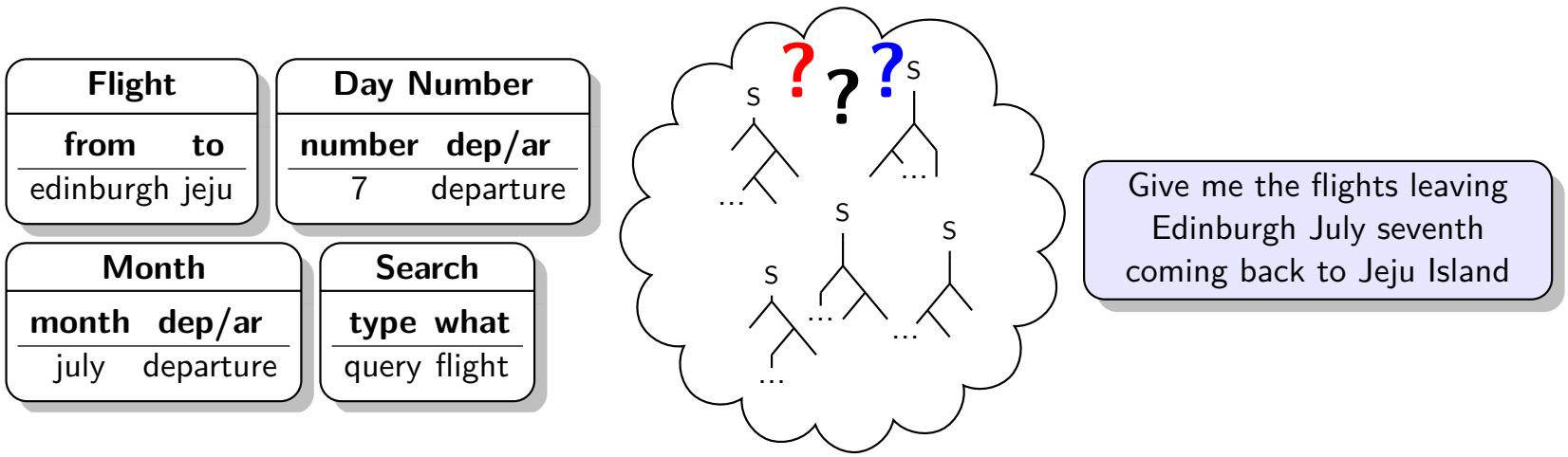

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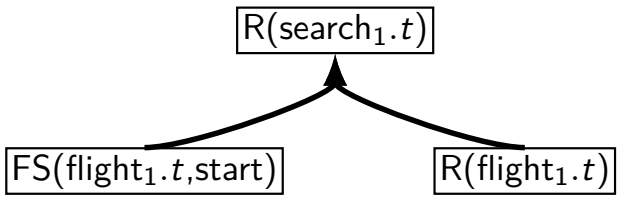
- Alignment Features (local) : Count of each PCFG rule



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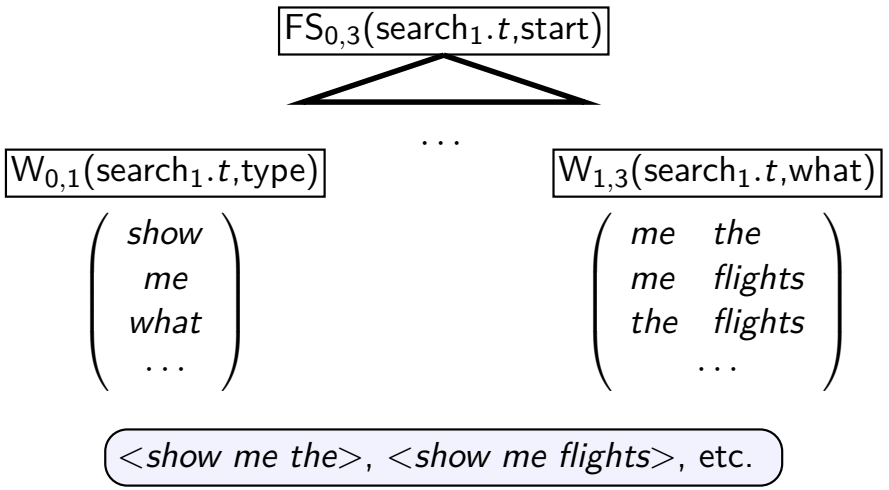

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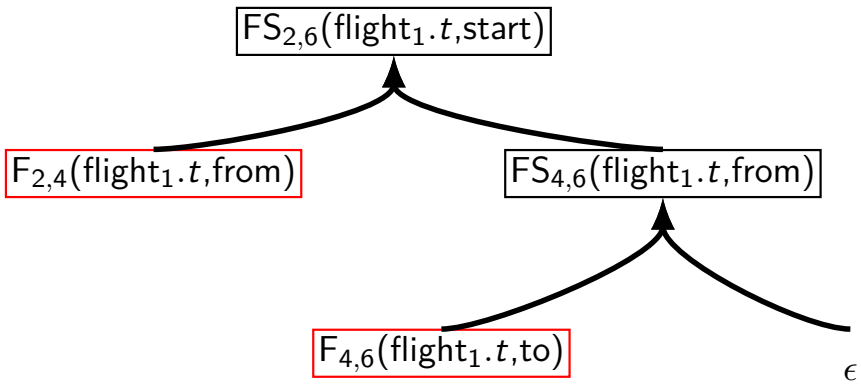

<*from to*> | *flight*

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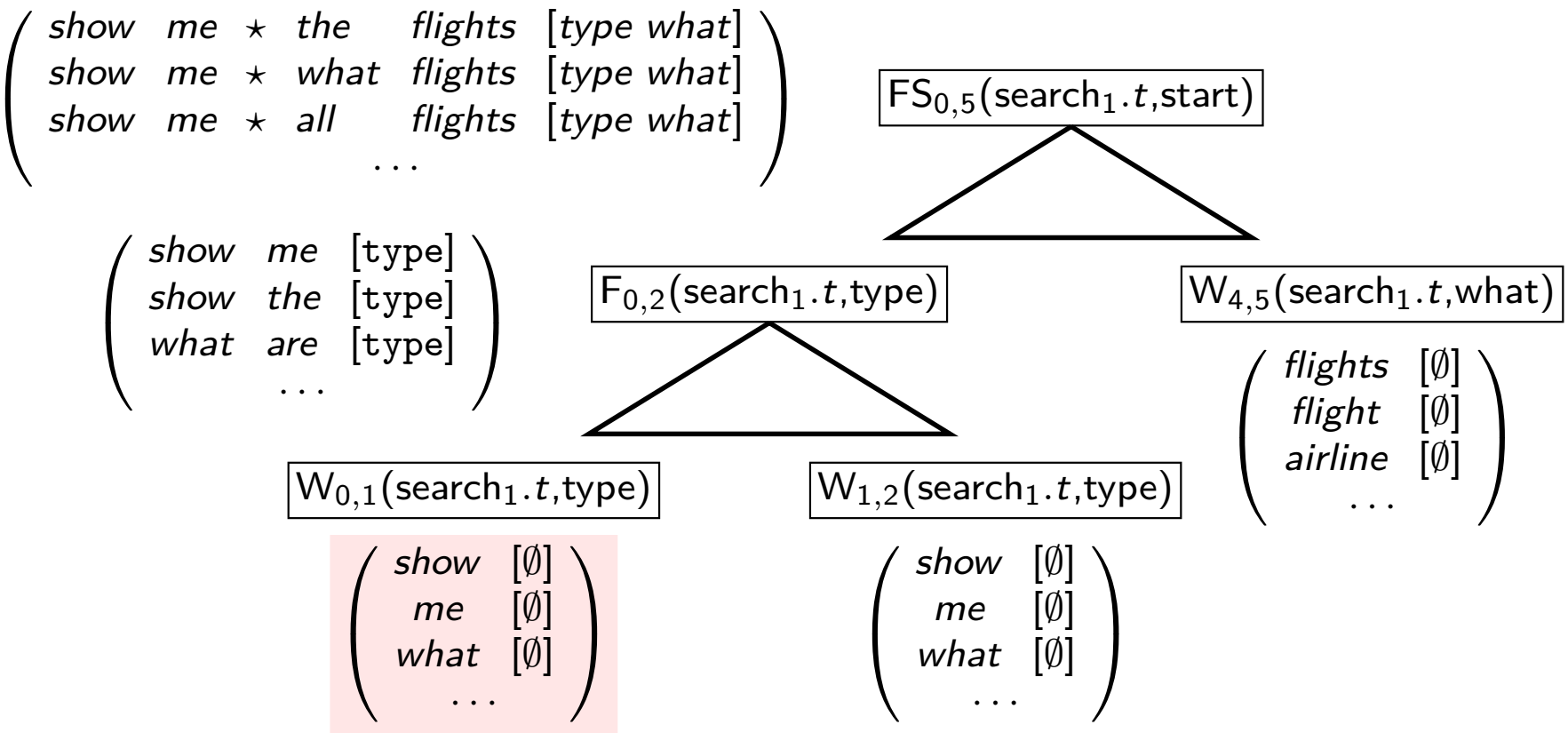
- Score of **j**-th derivation: $\alpha \cdot \Phi_L(e) + \alpha \cdot \Phi_N(< e, \mathbf{j} >)$
- Nodes in hypergraph augmented with lexical and structural sub-strings (Huang and Chiang, 2007)
  e.g. $R_{2,8}(flight_1.t)$<one way⋆to Seoul; direction from⋆stop-over to>

k-best Decoding

- Bottom-up Viterbi search
- Keep k-best derivations at each node, cube pruning (Chiang, 2007)
- Score of **j**-th derivation: $\alpha \cdot \Phi_L(e) + \alpha \cdot \Phi_N(< e, \mathbf{j} >)$
- Nodes in hypergraph augmented with lexical and structural sub-strings (Huang and Chiang, 2007)
  e.g. $R_{2,8}(flight_1.t)$<one way⋆to Seoul; direction from⋆stop-over to>
- Root node: most grammatical and semantically correct derivation

k-best Decoding



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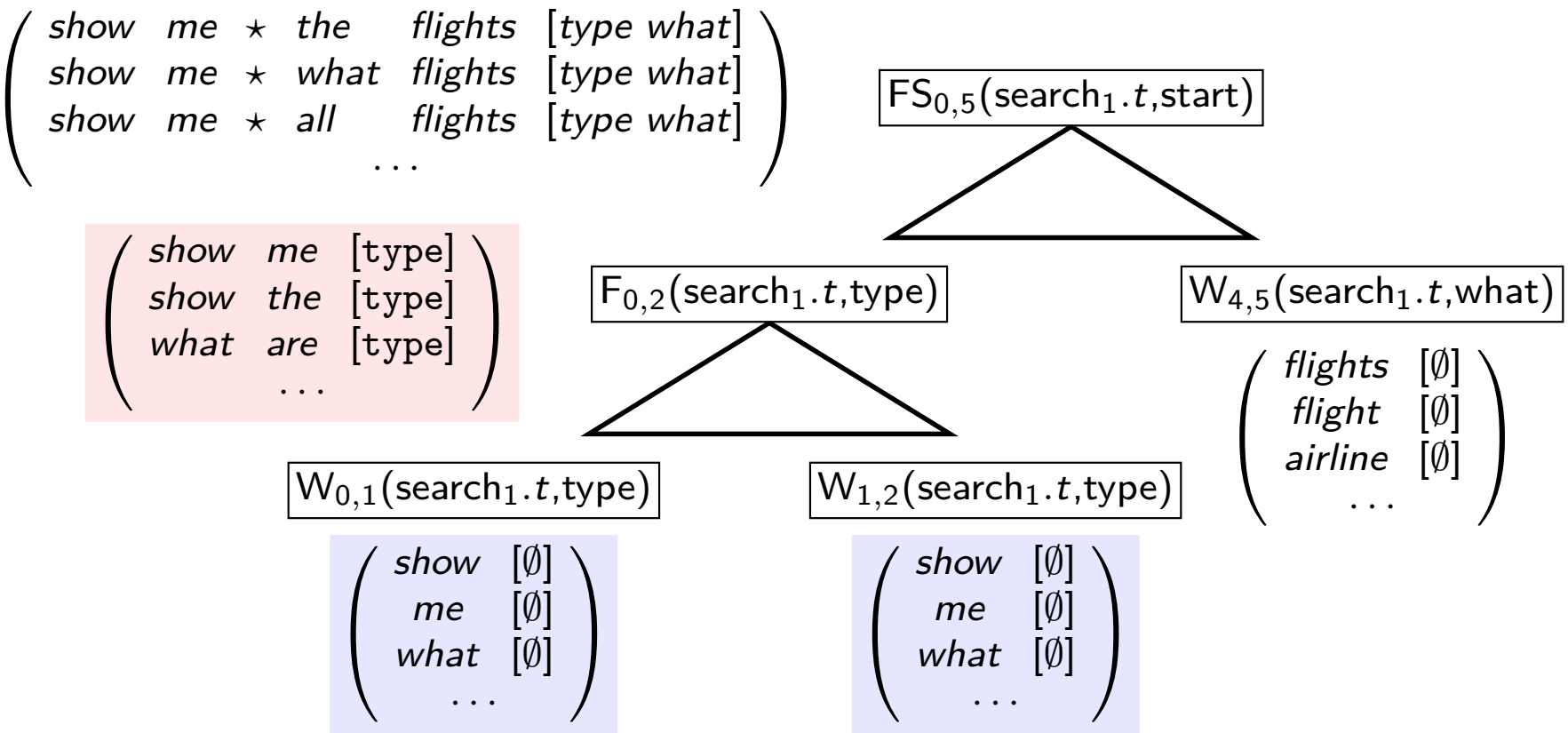

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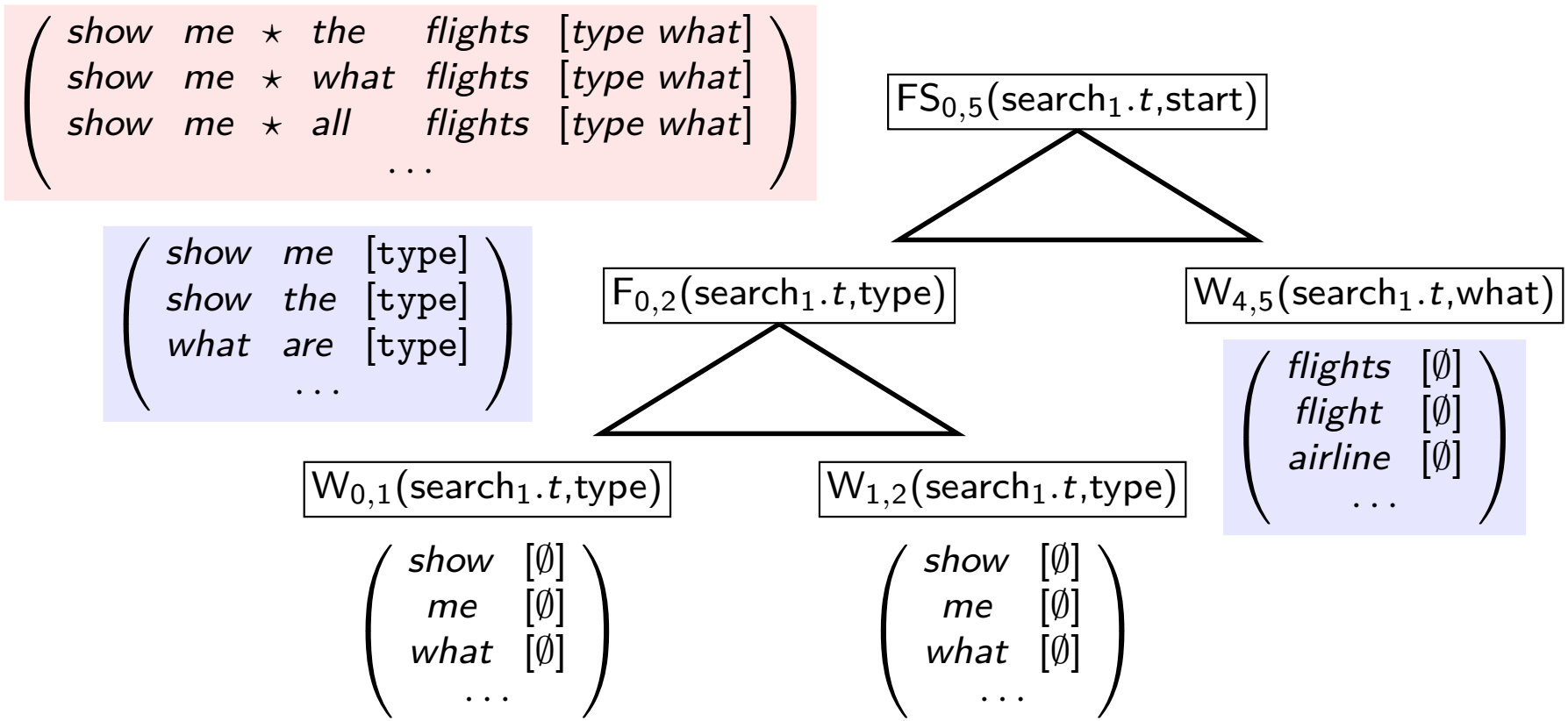

Experimental Setup

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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
k-BEST+BASE+ALIGN+LEX	28.66	45.18
k-BEST+BASE+ALIGN+LEX+STR	30.62	46.07
ANGELI	26.77	42.41

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Results: Human Evaluation

System	Fluency	SemCor
1-Best	2.70	3.05
k-Best	4.02	4.04
Angeli	3.74	3.17
Human	4.18	4.02

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- *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

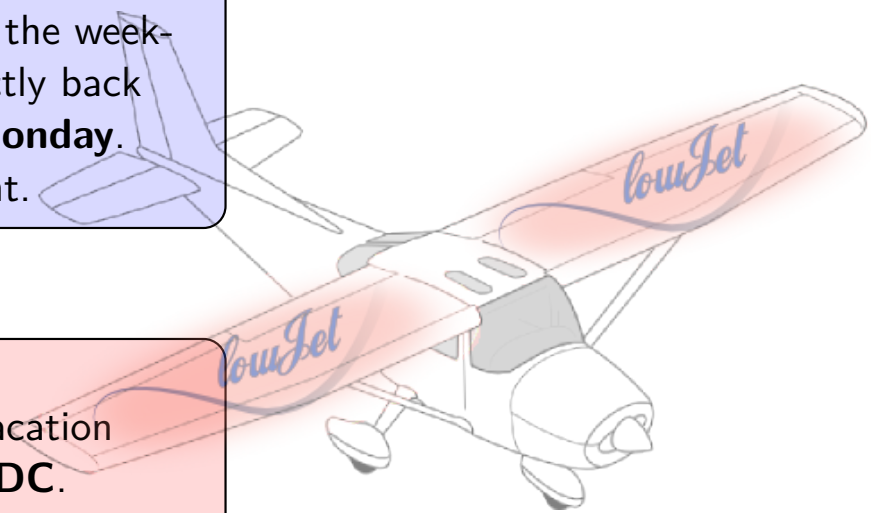
- Generation as parsing problem using the hypergraph framework
- Discriminative reranking using the structured perceptron
- Introduced local and non-local features
- Performance better than state-of-the-art
- Future work: dependency relations, discourse

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 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Semantic Correctness ○ 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 $\rightarrow$ 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