

Inducing Document Plans for Concept-to-Text Generation

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EMNLP 2013, Seattle
20 October 2013

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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Desktop

Cmd	Name	Type
left-click	start	button

Start

Cmd	Name	Type
left-click	settings	button

Location

Name	Type
start menu	button
control panel	window

Start Target

Cmd	Name	Type
left-click	control panel	button

Navigate Window

Cmd	Name	Type
left-click	accounts and users	window

Context Menu

Cmd	Name	Type
left-click	advanced	tab

Action Context Menu

Cmd	Name	Type
left-click	advanced	button

Window Target

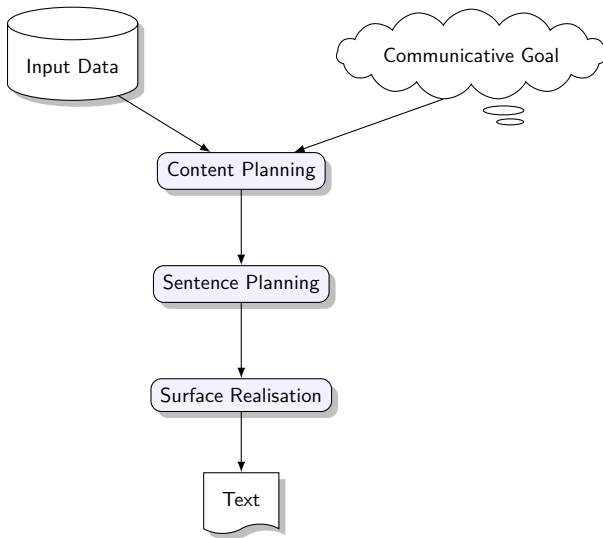
Cmd	Name	Type
double-click	users and passwords	item

Click start, point to settings, and then click control panel.

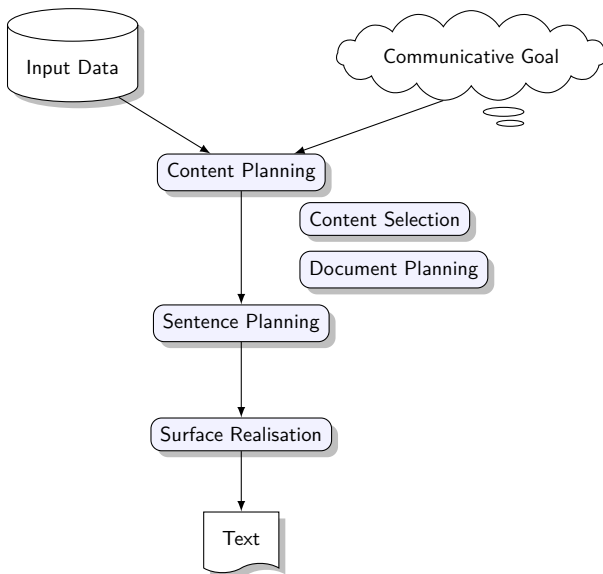
Double-click users and passwords.

On the advanced tab, click advanced.

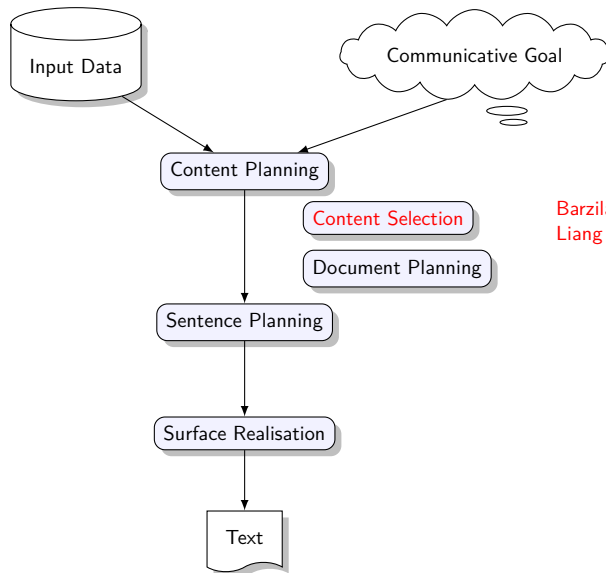
Traditional NLG Pipeline



Traditional NLG Pipeline

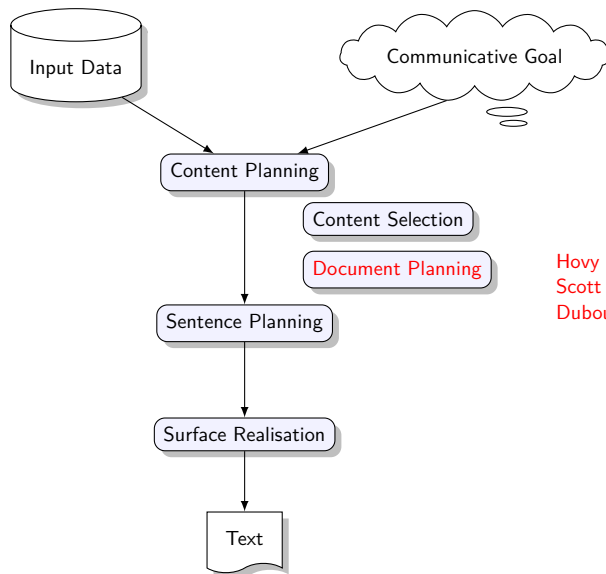


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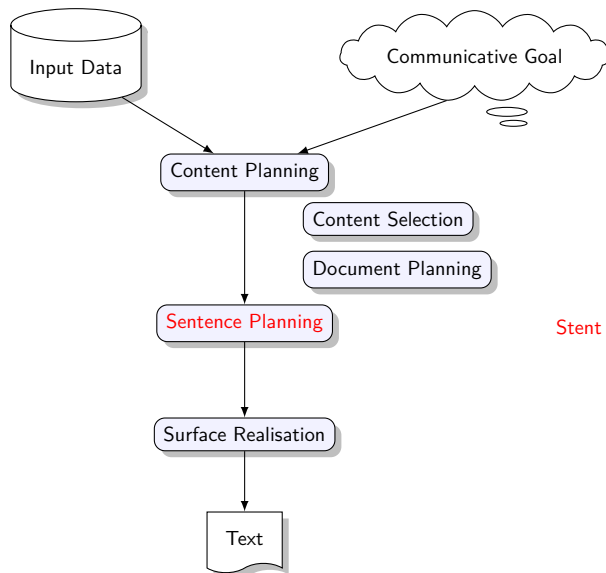
Barzilay and Lapata (2005)
Liang et al. (2009)

Traditional NLG Pipeline



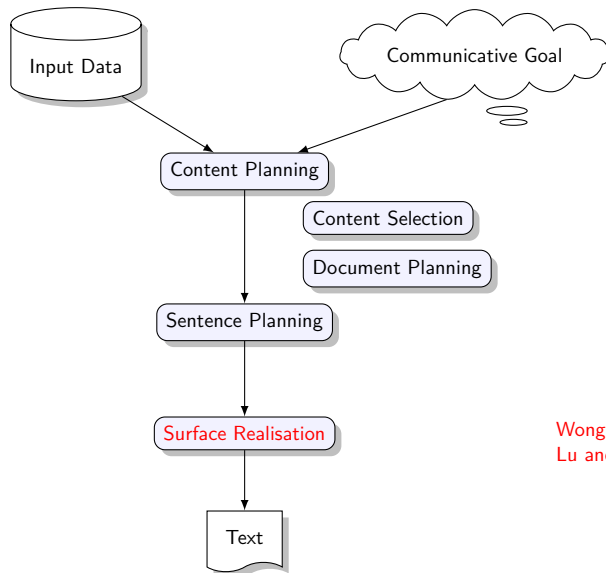
Hovy (1993)
Scott and de Souza (1990)
Duboue and Mckeown (2002)

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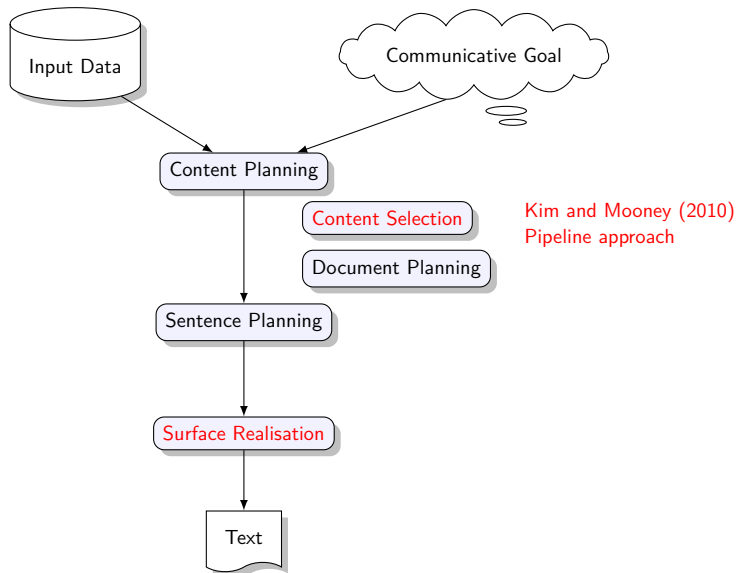
Stent et al. (2004)

Traditional NLG Pipeline

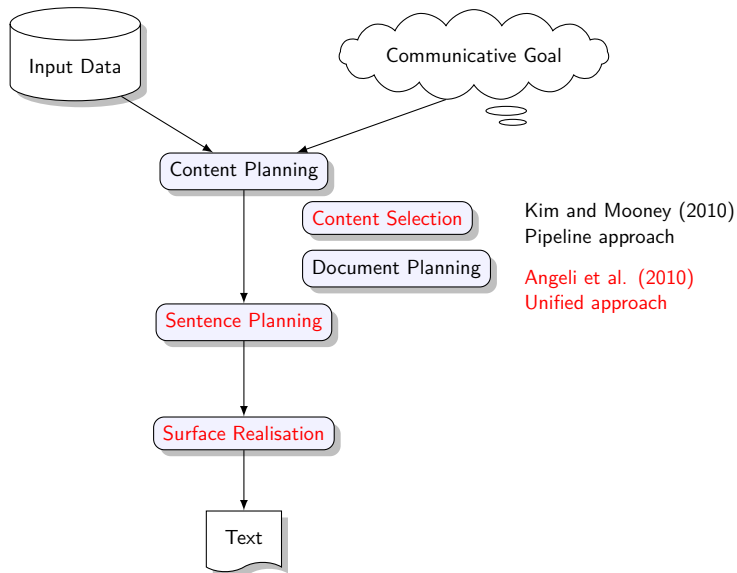


Wong and Mooney (2007)
Lu and Ng (2011)

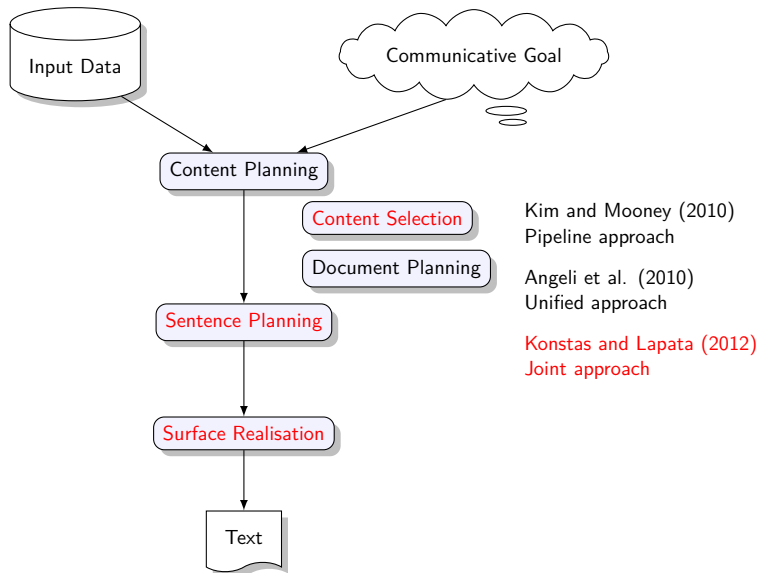
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Traditional NLG Pipeline

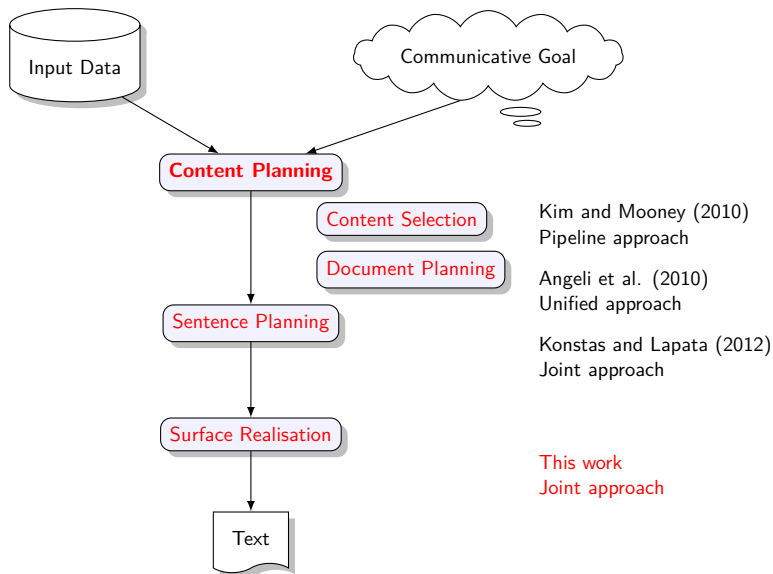


Kim and Mooney (2010)
Pipeline approach

Angeli et al. (2010)
Unified approach

Konstas and Lapata (2012)
Joint approach

Traditional NLG Pipeline



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, string)

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click start,

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Key Idea

Desktop

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Context Menu

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Action Context Menu

Cmd	Name	Type
left-click	advanced	button

Window Target

Cmd	Name	Type
double-click	users and passwords	item

Click start, point to settings, and then click control panel.

Double-click users and passwords.

On the advanced tab, click advanced.

Key Idea

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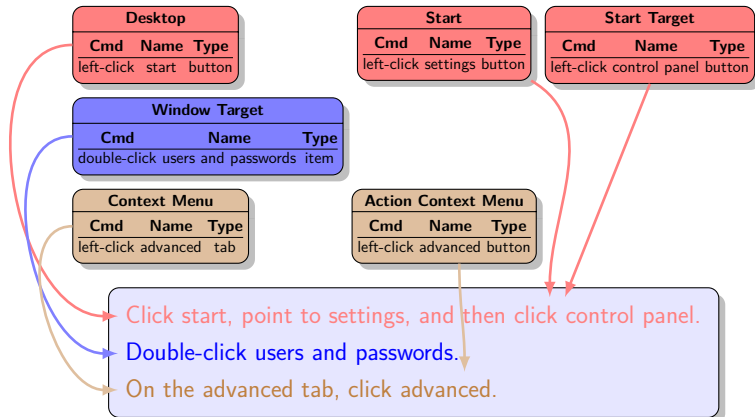
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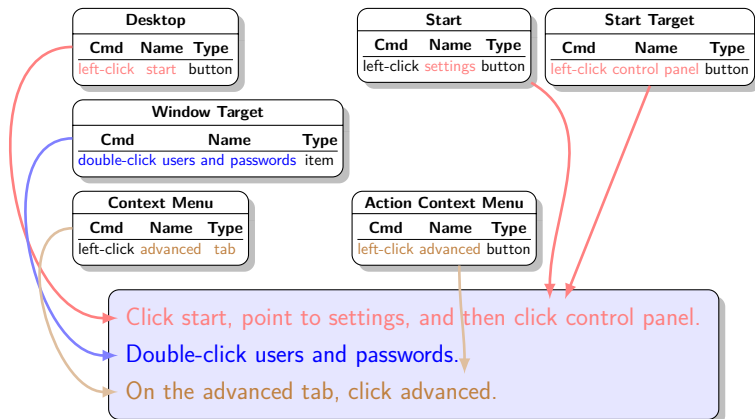
Action Context Menu		
Cmd	Name	Type
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Key Idea



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Patterns of record sequences *within* a sentence and *among* sentences

Rhetorical Structure Theory (Mann and Thompson, 1988) inspired plans

Grammar

Grammar

① $S \rightarrow R(\textit{start})$

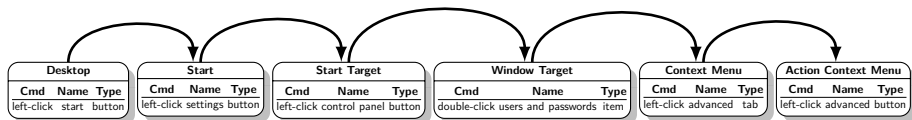
Grammar

1 $S \rightarrow R(\textit{start})$

2 $R(r_i.t) \rightarrow FS(r_j, \textit{start})R(r_j.t) \mid FS(r_j, \textit{start})$

$$R(\textit{desktop}_1.t) \rightarrow FS(\textit{start}_1, \textit{start})R(\textit{start}_1.t)$$

Grammar

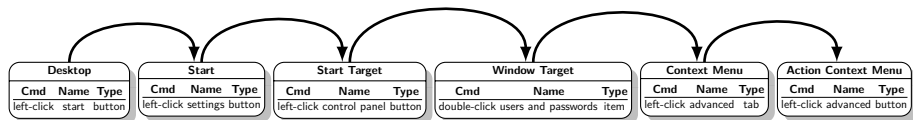


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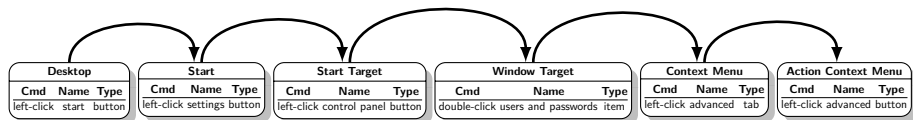
Grammar



- 1 $S \rightarrow R(start)$
- 2 $R(r_i.t) \rightarrow FS(r_j, start)R(r_j.t) \mid FS(r_j, start)$
- 3 $FS(r, r.f_j) \rightarrow F(r, r.f_j)FS(r, r.f_j) \mid F(r, r.f_j)$

$FS(desktop_1, cmd) \rightarrow F(desktop_1, name)FS(desktop_1, name)$

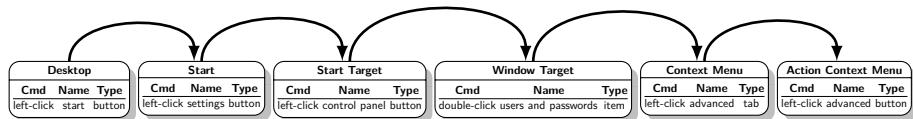
Grammar



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- 4 $F(r, r.f) \rightarrow W(r, r.f)F(r, r.f) \mid W(r, r.f)$

$F(desktop_1, cmd) \rightarrow W(desktop_1, cmd)F(desktop_1, cmd)$

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$W(desktop_1, cmd) \rightarrow \text{click } [cmd.v = \text{'left-click'}]$

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EM Training: dynamic program similar to the inside-outside algorithm

Planning with Record Sequences

Key idea: Grammar on sequences of record types (G_{RSE})

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- 1 Click start, point to settings, and then click control panel. || Double-click users and passwords. || On the advanced tab, click advanced. ||

Split a document into sentences, each terminated by a full-stop.

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Then split a sentence further into a sequence of record types.

Planning with Record Sequences

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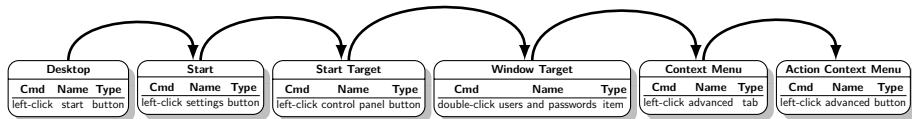
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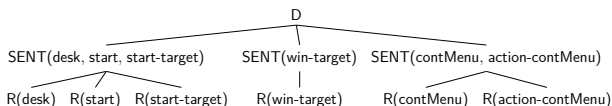
- 3 Goal: Learn patterns of record type sequences **within** and **among** sentences

Extended Grammar



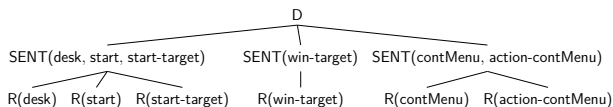
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Extended Grammar



- 1 $D \rightarrow SENT(t_i, \dots, t_j) \dots SENT(t_l, \dots, t_m)$
- 2 $SENT(t_i, \dots, t_j) \rightarrow R(r_a.t_i) \dots R(r_k.t_j) \cdot$
- 3 $R(r_i.t) \rightarrow FS(r_j, \text{start})$
- 4 $FS(r, r.f_i) \rightarrow F(r, r.f_j)FS(r, r.f_j) \mid F(r, r.f_j)$
- 5 $F(r, r.f) \rightarrow W(r, r.f)F(r, r.f) \mid W(r, r.f)$
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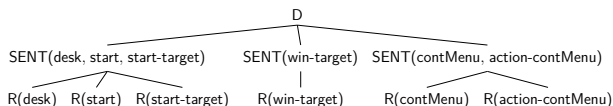
Extended Grammar



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Straightforward solution: Embed the parameters with the original grammar and train using EM

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Plan B: Extract grammar rules from training data

Grammar Extraction

desktop	start	start-target	window-target
Click start,	point to settings,	and then click control panel.	Double-click users and passwords.
contextMenu	action-contextMenu		
On the advanced tab ,	click advanced.		

Liang et al. (2009)

Grammar Extraction

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Click start,	point to settings,	and then click control panel.	Double-click users and passwords.
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Liang et al. (2009)



[desktop start start-target || window-target || contextMenu action-contMenu ||]

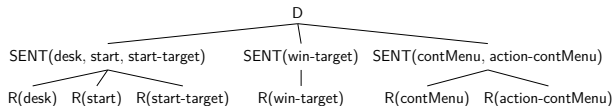
Grammar Extraction

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Click start,	point to settings,	and then click control panel.	Double-click users and passwords.
contextMenu		action-contextMenu	
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Liang et al. (2009)



[desktop start start-target || window-target || contextMenu action-contMenu ||]

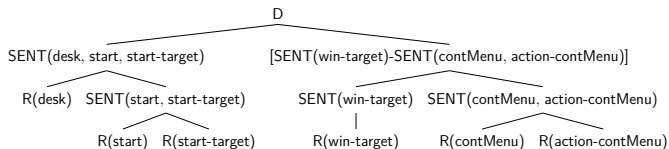
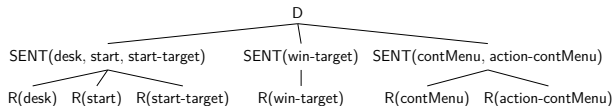


Grammar Extraction

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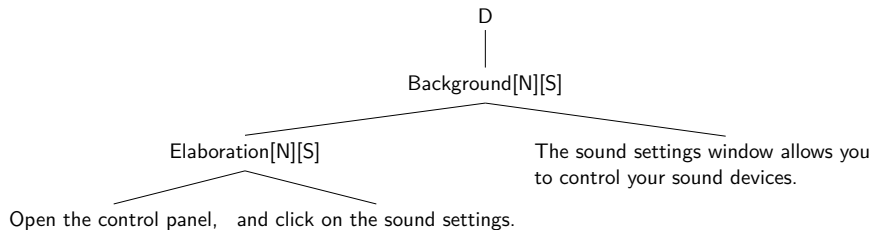
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$$\left[\text{desktop start start-target} \parallel \text{window-target} \parallel \text{contextMenu action-contMenu} \parallel \right]$$


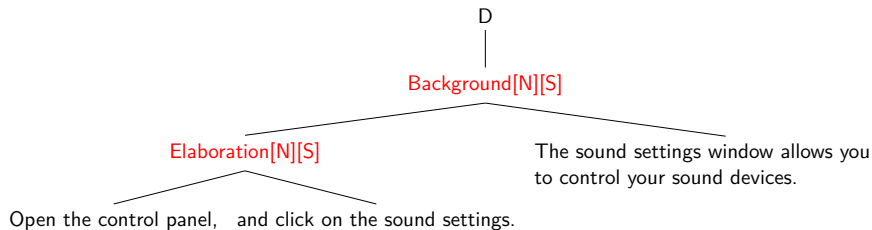
Planning with Rhetorical Structure Theory

RST (Mann and Thompson, 1988)



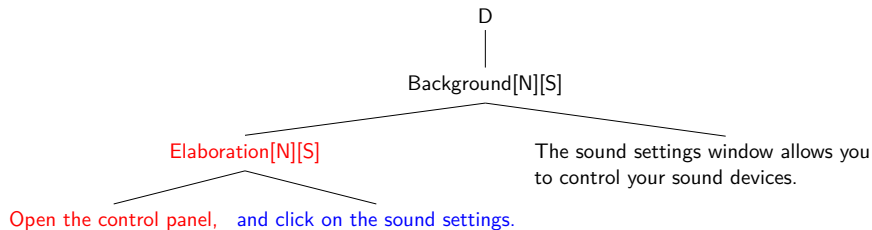
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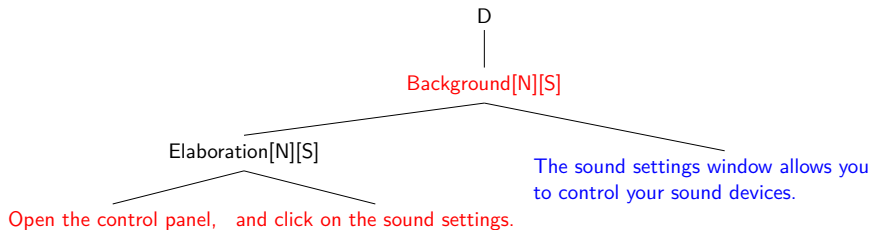
Planning with Rhetorical Structure Theory

RST (Mann and Thompson, 1988)



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Planning with Rhetorical Structure Theory

Key idea: Grammar using RST relations (G_{RST})

Planning with Rhetorical Structure Theory

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Assumption

Each record in the database input corresponds to a unique non-overlapping span in the collocated text, and can be therefore mapped to an EDU.

Grammar Extraction

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Click start,	point to settings,	and then click control panel.	Double-click users and passwords.
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Grammar Extraction

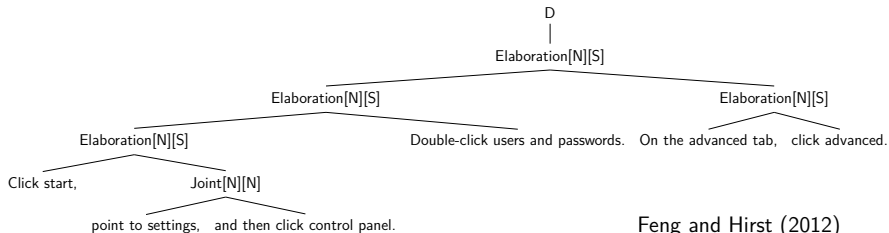
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Click start,	point to settings,	and then click control panel.	Double-click users and passwords.
contextMenu	action-contextMenu		
On the advanced tab ,	click advanced.		

Liang et al. (2009)



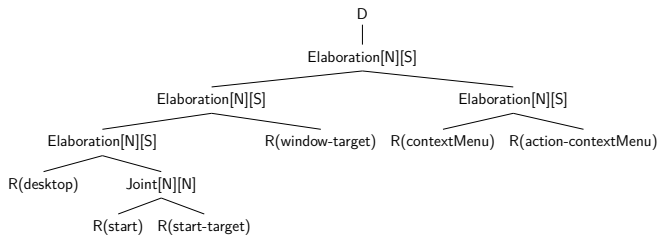
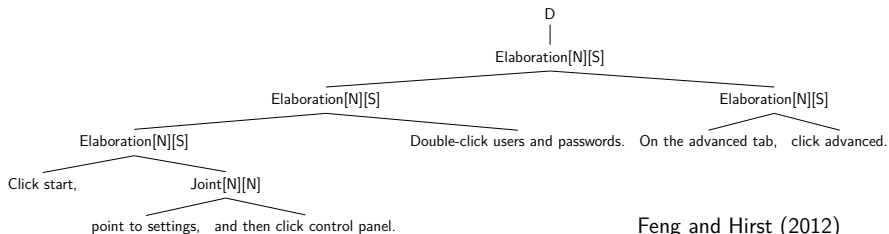
[Click start,]^{desktop} [point to settings,]^{start} [and then click control panel.]^{start-target}
 [Double-click users and passwords.]^{window-target} [On the advanced tab,]^{contextMenu}
 [click advanced.]^{action-contextMenu}

Grammar Extraction



Feng and Hirst (2012)

Grammar Extraction



Extended Grammar

- 1 G_{RST}
- 2 $R(r_i.t) \rightarrow FS(r_j, start)$
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Experimental Setup

Data

- WEATHERGOV : weather reports [4 sents, 345 words]
(Liang et al., 2009)
- WINHELP : troubleshooting guides [4.3 sents, 629 words]
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Experimental Setup

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Evaluation

- Automatic evaluation: BLEU-4
- Human evaluation: Fluency, Semantic Correctness, Coherence

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Data

- WEATHERGOV : weather reports [4 sents, 345 words] (Liang et al., 2009)
- WINHELP : troubleshooting guides [4.3 sents, 629 words] (Branavan et al., 2009)

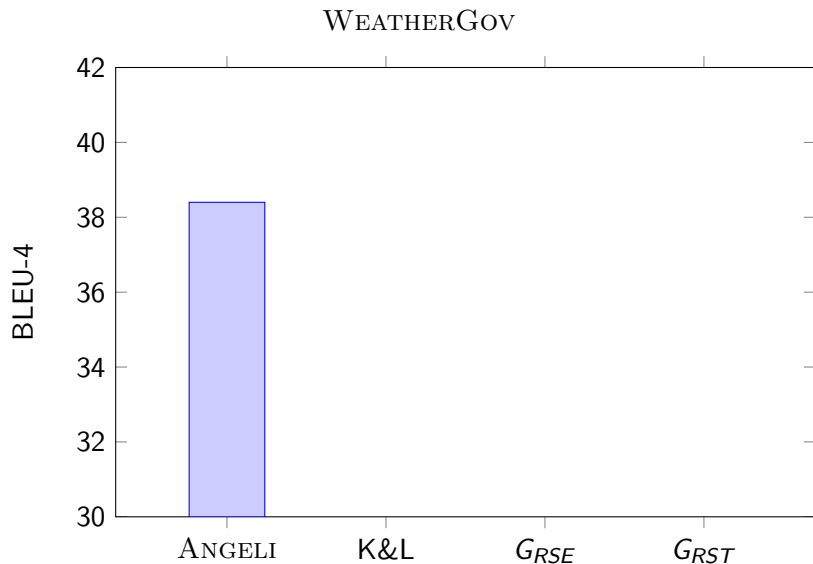
Evaluation

- Automatic evaluation: BLEU-4
- Human evaluation: Fluency, Semantic Correctness, Coherence

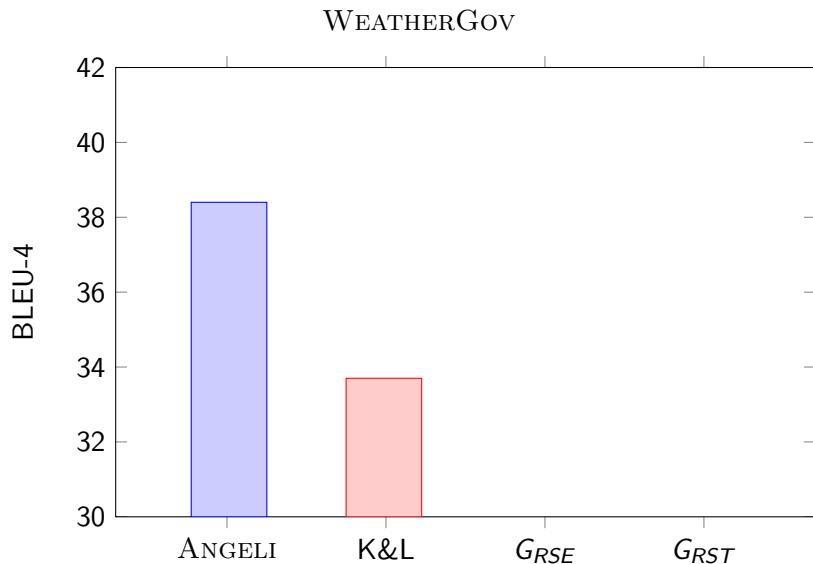
System Comparison

- G_{RSE} , G_{RST}
- Konstas and Lapata (2012)
- Angeli et al. (2010)

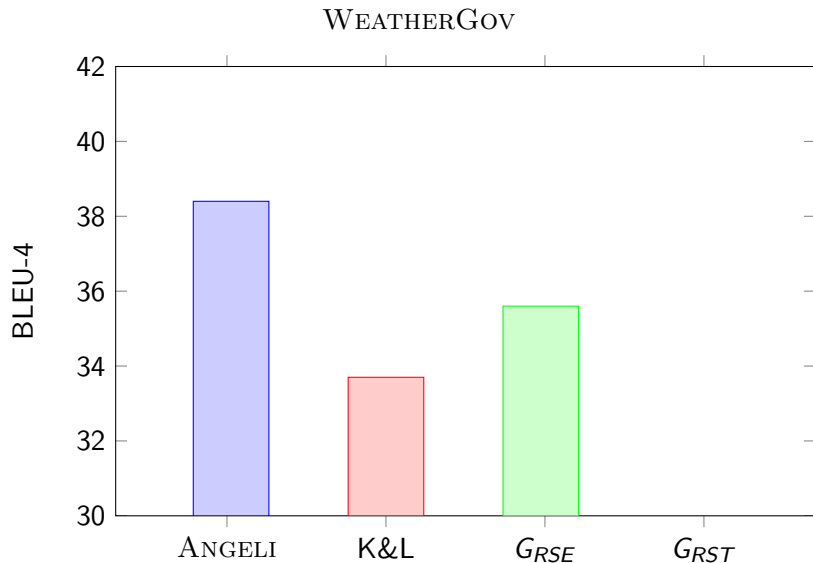
Results: Automatic Evaluation



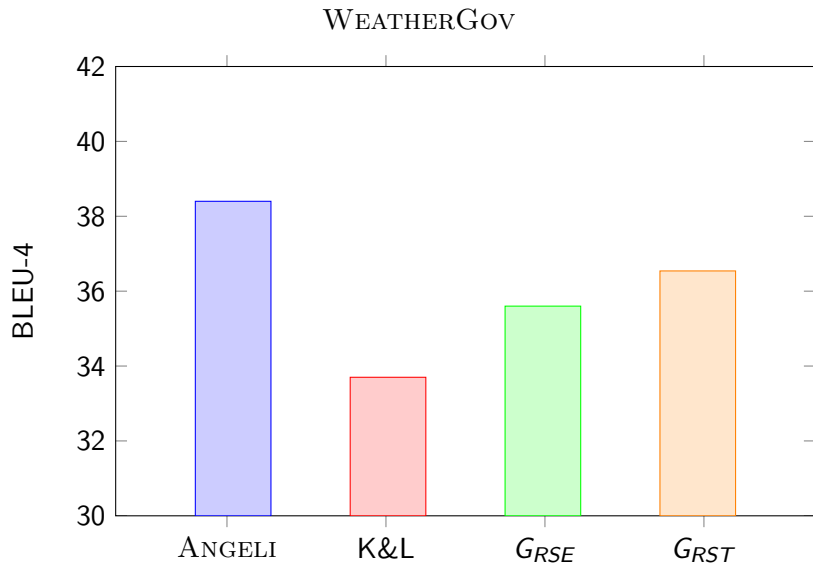
Results: Automatic Evaluation



Results: Automatic Evaluation

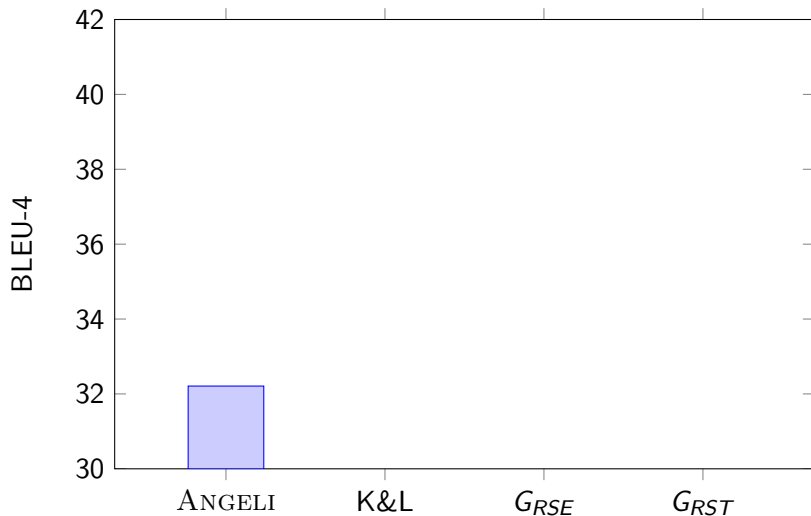


Results: Automatic Evaluation

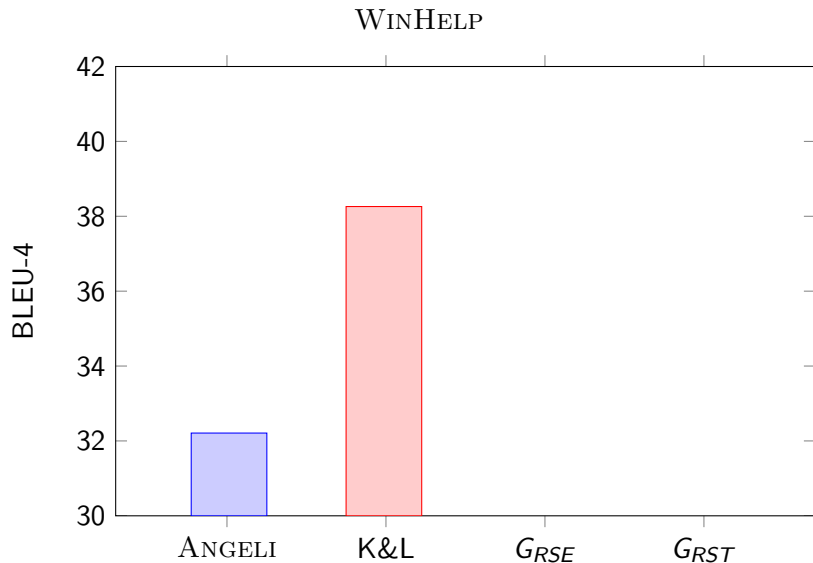


Results: Automatic Evaluation

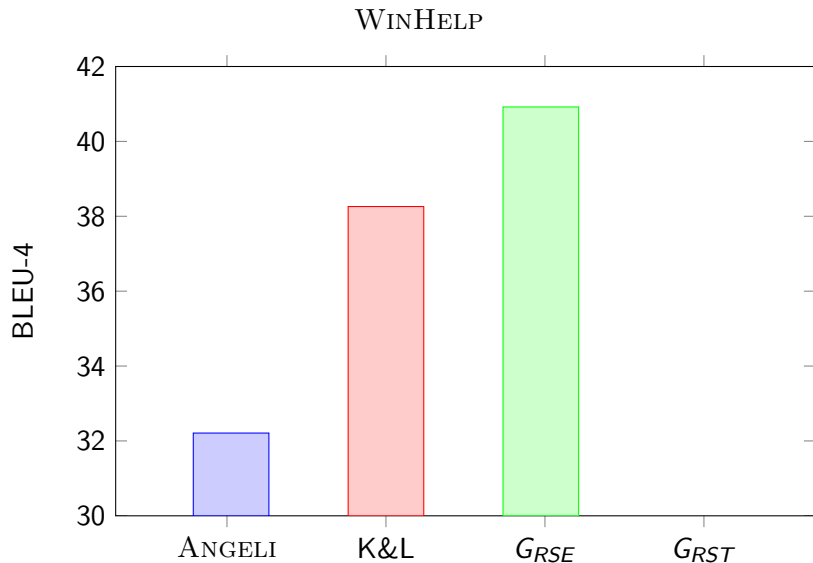
WINHELP



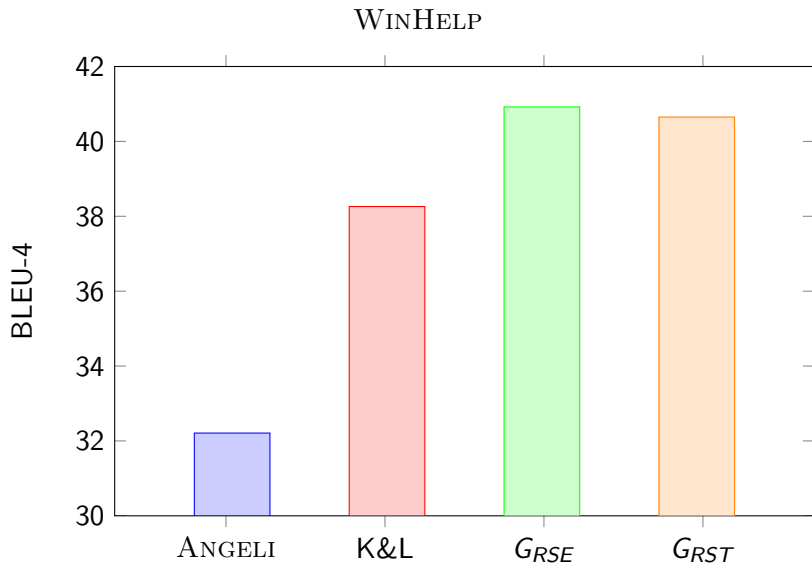
Results: Automatic Evaluation



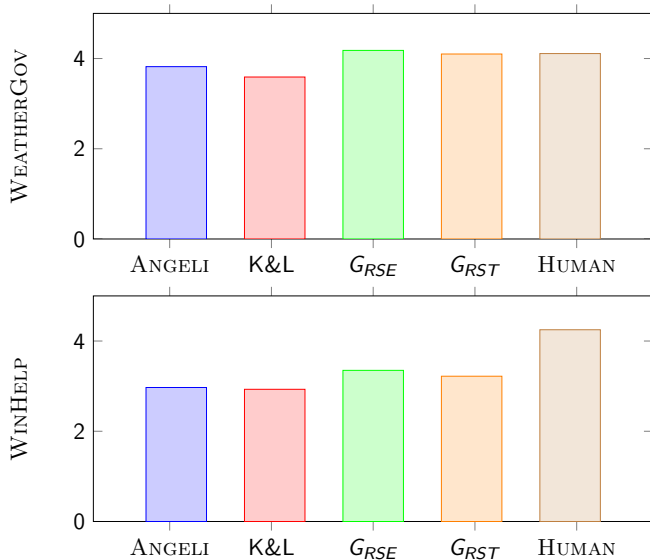
Results: Automatic Evaluation



Results: Automatic Evaluation



Results: Human Evaluation (Coherence)



Output

GRSE

Click start, point to settings, and then click control panel. Double-click network and dial-up connections. Right-click local area connection, and then click properties. **Click install, and then click add.** Click network monitor driver, and then click ok.

K&L

Click start, point to settings, and then click control panel. Double-click network and dial-up connections. Double-click network and dial-up connections. Right-click local area connection, **and then click ok.**

HUMAN

Click start, point to settings, click control panel, **and then** double-click network and dial-up connections. Right-click local area connection, and then click properties. Click install, **click protocol**, and then click add. Click network monitor driver, and then click ok.

Conclusions

- End-to-end generation system that incorporates document planning
- **Grammar-based** approach allows for **document planning** naturally: all we need is a discourse grammar
- Provide two solutions for document plans:
 - Linguistically naive record sequence grammar (G_{RSE})
 - RST-inspired grammar (G_{RST})
- Future work: more challenging domains (financial, biographies)

Thank you

Questions ?



$$\hat{g} = f\left(\arg \max_{g,h} p(g) \cdot p(g, h | \mathbf{d})\right)$$

- Bottom-up Viterbi search
- Keep k-best derivations at each node, cube pruning (Chiang, 2007)
- $p(g)$ rescores derivations using an n-gram language model