Measuring Adaptation Between Dialogs

Svetlana Stoyancheva
Amanda Stent

SUNY, Stony Brook

Adaptation in Dialog

Change in the communication pattern over time

- Shortening of referential expressions
- Prosody
- Accent
- Hand-gestures
- Convergence on lexical and syntactic choices

"*lexical choice variability is high between conversations while it is relatively low within a conversation*"
(Brennan 1996)

Examples of Lexical Variation

- "Teacher"
- "Instructor"
- "Professor"
- "Lecturer"

- "Dog"
- "Irish Setter"
- "Red Irish Setter"
- "Creature"

Examples of Lexical Variation

- ○ "Teacher"
- ○ "Instructor"
- ○ "Professor"
- ○ "Lecturer"

Examples of Syntactic Variation

Dative/benefactive

- "He gave the book to Mary"
- "He gave Mary the book"

Evidence of Adaptation in Dialog

Evidence from controlled experiments:

- "lexical choice variability is high between conversations while it is relatively low withing a conversation"

- Referring expressions

- Syntactic choices

(Bortfeld and Brennan 1997; Brennan and Clark 1996; Garrod and Anderson 1987)

Causes of Adaptation

○ Recency

(Brown and Dell, 1987; Pickering and Garrod, 2004; Chartrand and Bargh, 1999).

○ Partner adaptation

(Brennan and Clark, 1996; Horton and Gerrig, 2002)

These theories are competing but not necessarily contradicting

Recency

- Words are *activated* during language production
- Also called: convergence, priming, alignment

output/input coordination principle

(Garrod and Anderson's 1987)

"people formulate their current utterance according to the same model and semantic rules used to interpret their partner's most recent utterance"

Partner Adaptation

- Based on the model of a partner
- Also called: entrainment, audience design

Conceptual pact *(Brennan)*

"a temporary agreement about how the referent is to be conceptualized".

New addressee:

- new conceptual pacts
- may not be the same as with previous addressees

Corpus Studies On Recency Adaptation

- [Church 2000] measured lexical adaptation "within document" in corpora of written news
- [Dubey et.al.2006] applied this measure to study syntactic adaptation in dialogs and written text
- [Reitter et.al 2006] studies short-term priming effect in Maptask using logistic regression
- In our work we identify and compare partner-specific and recency adaptation

Setup

3 speakers: A, B, and C

1. A -> B   B is primed by A
2. B -> C   B may show **recency** effect
3. B -> A   B may show **partner** effect

○ Compare B in 2 to A in 1
○ Compare B in 3 to A in 1

Maptask Corpus Structure

Dlg#	giver	follower	set1	set2
1	a1	b1	prime	
2	b2	a2		prime
3	a2	a1		recency
4	b1	b2	recency	
5	a2	b2		partner
6	b1	a1	partner	
7	a1	a2		
8	b2	b1		

Hypothesis:
recency adaptation happens between (1-4) and (2-3)
partner adaptation happens between (1-6) and (2-5)

Church's measure for adaptation

$$f_{w_{p,t}} = \text{\# of times } w \text{ occurs in prime set and target set}$$

$$f_{w_{\bar{p},t}} = \text{\# of times } w \text{ occurs in target set but not prime set}$$

$$f_{w_{p,\bar{t}}} = \text{\# of times } w \text{ occurs in prime set but not target set}$$

$$f_{w_{\bar{p},\bar{t}}} = \text{\# of times } w \text{ does not occur in either target set or prime set}$$

Prior $\quad P_{\text{prior}}(w) = \dfrac{f_{w_{p,t}} + f_{w_{\bar{p},t}}}{N}$

Positive Adaptation $\quad P_+(w) = \dfrac{f_{w_{p,t}}}{f_{w_{p,t}} + f_{w_{p,\bar{t}}}}$

Church's measure for adaptation

- With small datasets random fluctuation of the values. The measure is reliable only for "large" datasets

- High probability features "the", "a", occure in almost all documents

if $f_{w_{p,t}}$ = N, then Prior = Positive Adapt = 1

Proposed Adaptation Measure

1. **Adaptation ratio** - measures adaptation prevalence.

> **Define: Feature is 'adapted' if its adaptation ratio > 1**
> or if a feature is more likely to occur frequently after it was 'primed' than without priming

- Allows comparison of adaptation between features and between dialog pairs
- Applicable to small datasets

2. **Distance measure**

- Investigate how frequency in the prime affects the frequency in the target

Proposed Adaptation Measures

1. **Adaptation ratio**
2. **Distance measure**

Terminology

Document: maptask dialog

Baseline for feature f: average frequency of feature f in all documents

Feature f is primed if it occurs in prime dialog with frequency greater than the baseline

$$f \in D$$

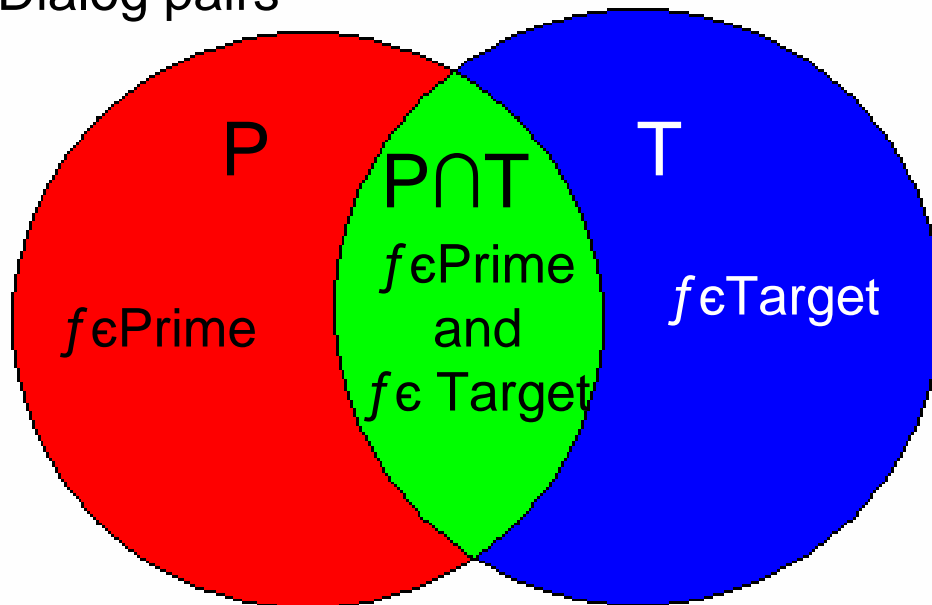A shortcut for: Frequency of feature f in document D is greater than the baseline

Adaptation Ratio

Chance:
probability that f co-occurs in prime and target by chance:

$$P(f \in prime \cap f \in target) =$$

$$P(f \in prime) * P(f \in target)$$

All Dialog pairs

N

P

P∩T

*f*ϵPrime
and
*f*ϵ Target

T

*f*ϵTarget

*f*ϵPrime

$$chance = (P/N) * (T/N)$$

N – total number of (prime, target) dialog pairs
P – number of *prime* dialogs where freq of f > b
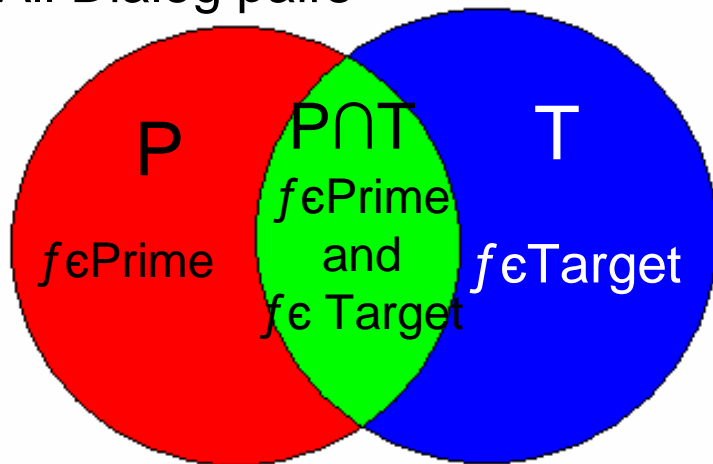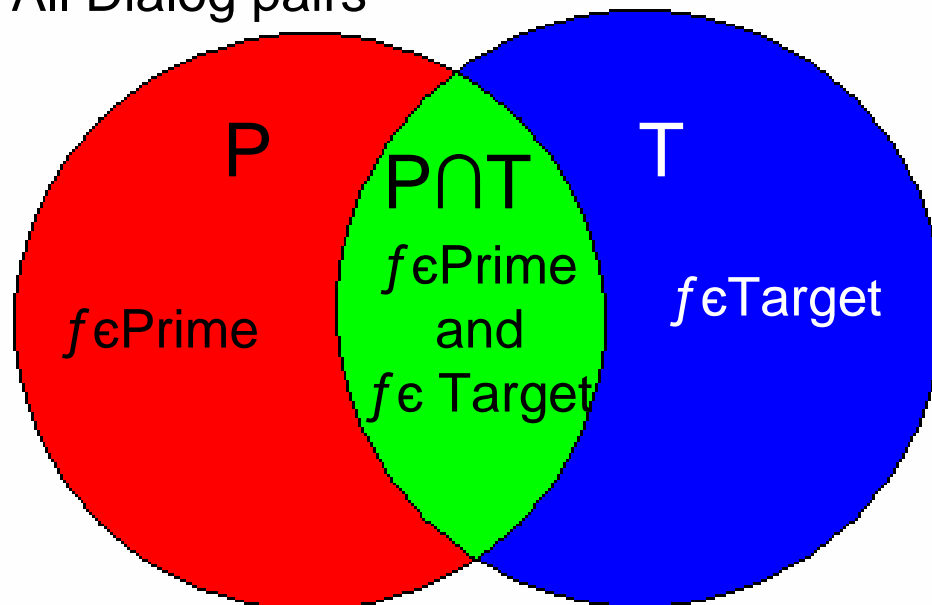T – number of *target* dialogs where freq of f > b

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Adaptation Ratio

Chance probability that f co-occurs in prime and target by chance

$$chance = (P/N) * (T/N)$$

Positive Adaptation: $+adapt = Pr(f \in target \mid f \in Prime)$

N - All Dialog pairs

$$+adapt = T \cap P/P$$

Adaptation Ratio =
+adapt / chance

N – total number of (prime, target) dialog pairs
P – number of *prime* dialogs where freq of f > b
T – number of *target* dialogs where freq of f > b

Adaptation Ratio

Positive Adaptation:

$$+adapt = Pr(f \in target \mid f \in Prime)$$

N - All Dialog pairs

P
P∩T
T

fϵPrime

fϵPrime
and
fϵ Target

fϵTarget

$$+adapt = T \cap P/P$$

Adaptation Ratio =
+adapt / chance

N – total number of (prime, target) dialog pairs
P – number of *prime* dialogs where freq of f > b
T – number of *target* dialogs where freq of f > b

Adaptation Ratio

measures adaptation prevalence

Define: Feature is 'adapted' if its adaptation ratio > 1
or if a feature is more likely to occur frequently after it was 'primed' than without priming

- Allows comparison of adaptation between different features
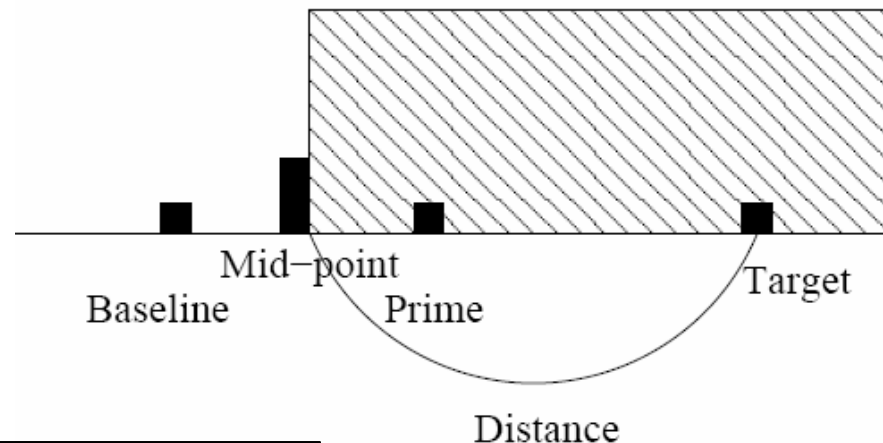- Applicable to features of various frequencies

Distance Measure

- Investigate how priming affects the frequency in the target:

If a feature is primed and adapted, what is its expected frequency in the target?

Distance Measure

For a feature f in a dialog pair (Prime, Target):

$$distance = t - (p + b)/2$$

t – frequency of feature *f* in target dialog
p – frequency of feature *f* in prime dialog
b – average frequency of *f*

Feature f is "adapted" in a pair of dialogs if distance >0
Strength of adaptation is proportional to the distance

Experimental Questions

1. Identify features that exhibit partner and recency adaptation. Can they be clustered?

2. Which type of adaptation is more prevalent: partner or recency?

3. Does the feature frequency in the prime dialog affect the feature frequency in the target?

Features

- Word stemmed with POS tags – to help distinguish between senses
- Bigrams stemmed with POS tags
- Syntactic (from Maptask annotations)

Word-Stems with Adaptation Ratio > 1 and significant χ^2

	partner	recency
ADJ	right-hand	bottom, right-hand
ADV	when, diagonal	right, well, about
CONJ	if	till, that, so
DET	you, across, on, what, that	my, i, just, that
INTJ	Sorri, err	uh
NOUN	bottom	map
PREP	across, through, along, from	from, by, to
VERB	know, got, take, pass	say

Relative direction   Contains 'you'   Contains 'I' or 'my

Only features occuring in > 30% of prime dialogs with freq > baseline

Bigrams with Adaptation Ratio > 1 and significant χ^2

Partner

your left,   right-hand side,
come to,   you come,
about the,   when you,
go round,   and round,
you got,   if you,
up toward,   a wee,
you just,   round the,
right you,   just abov,
abov the

Recency

no no,   my map,
okay and,   you just,
on my,   down about,
yeah i,   you got,
down to,   have a,
i mean,   'til you,
just below,   just to,
now you,   no you

Relative direction   Contains 'you'   Contains 'I' or 'my

Only features occuring in > 30% of prime dialogs with freq > baseline

Comparing Partner and Recency Adaptation

Adaptation Ratio =
+adapt / chance
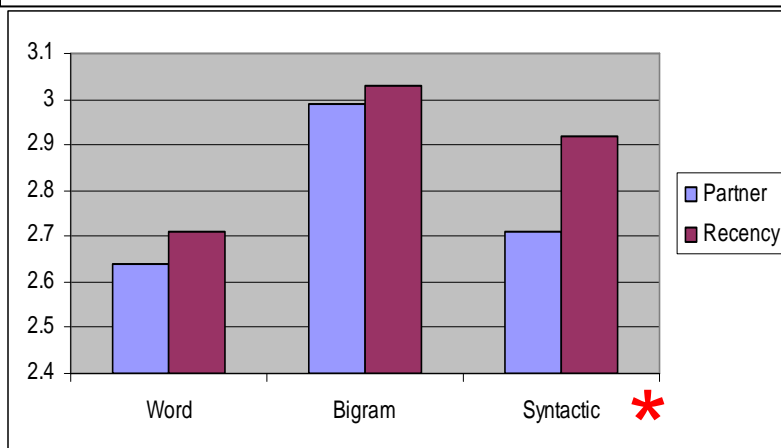
Distance measure ~
Adaptation strength
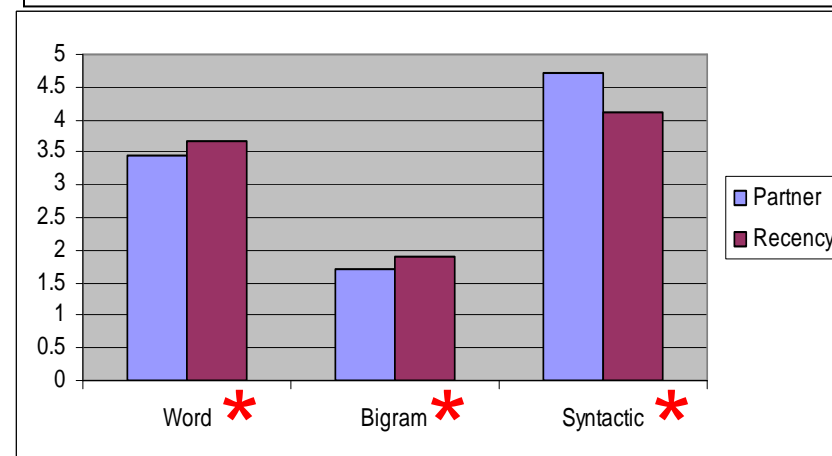
* Indicates significance (p<.05)

adaptation ratio and *adaptation strength are* averaged over all features for each feature type

SS3   "Positive adaptation for recency dialog pairs in
this corpus appears significantly stronger for each
feature type, however the probability of chance cooccurrence
is also significantly stronger for recency."

Doesn't this imply that recency is stronger?

No, it is due to the length of the dialogs:
the second time (partner) the person spoke, the conversations were a lot shorter.
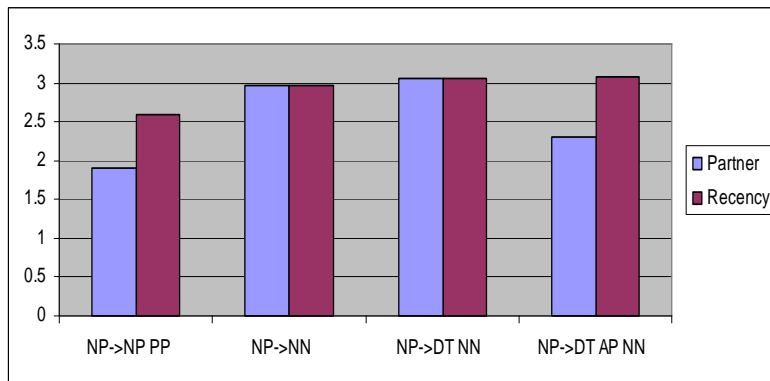Svetlana Stenchikova, 8/20/2007

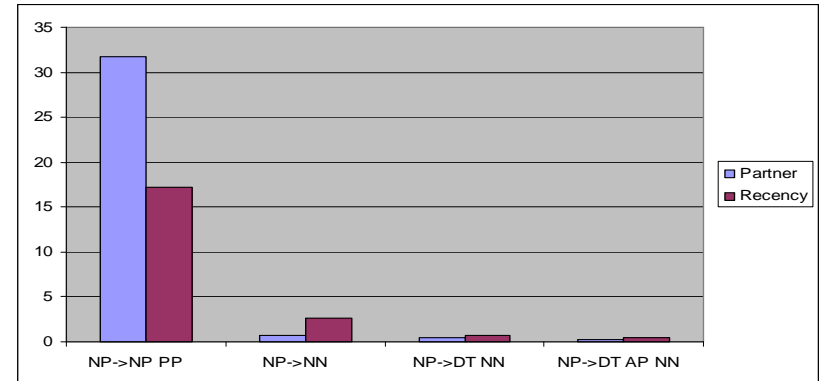# Adaptation Ratio for Selected Syntactic Features
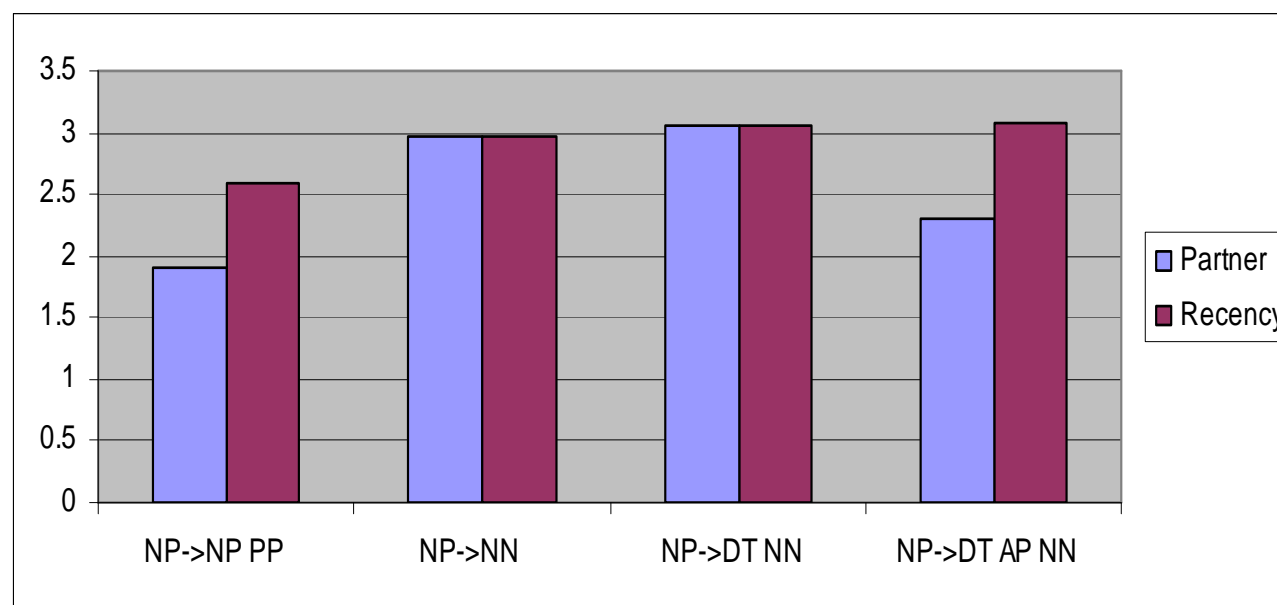
The features examined by Dubey et.al 2006 on Switchboard corpus
Found adaptation between speakers

Adaptation for Selected Syntactic Features

Adaptation Ratio = +adapt / chance	**Distance measure ~ Adaptation strength**

NP->NN PP rule:

adaptation ratio is stronger for recency means that if primed, speaker is more likely to use this rule in the very next conversation

Adaptation Strength is higher for the partner scenario means that the "adapting speaker" in partner-scenario will use this rule with higher frequency than the "adapting speaker" in recency-scenario
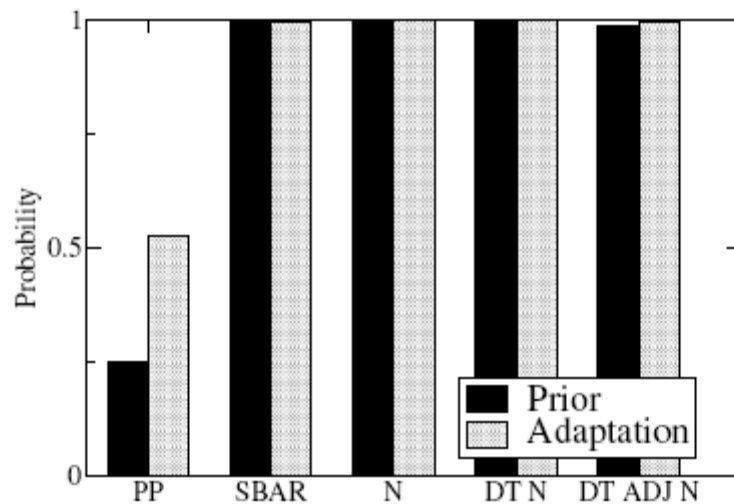
Dubey's Results

Figure 8: Adaptation within documents in the Brown corpus (all items exhibit weak yet statistically significant positive adaptation)
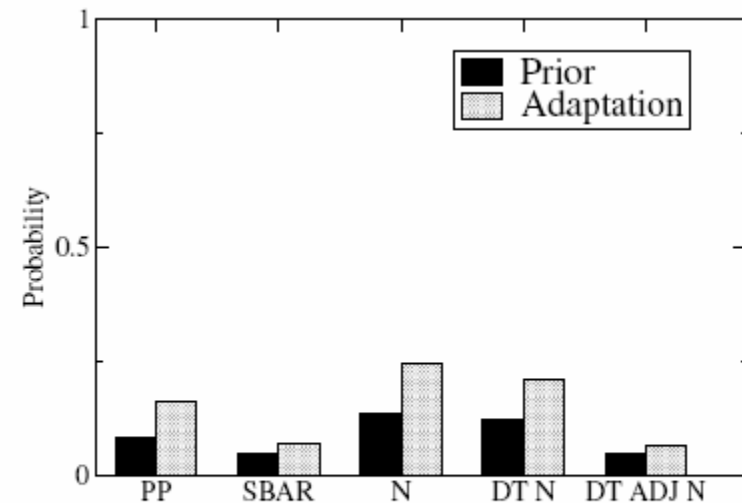
Figure 10: Adaptation between speakers in the Switchboard corpus

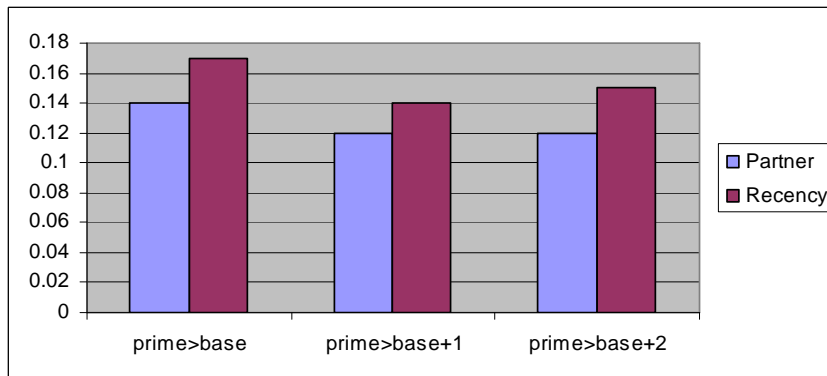**Prior** $\quad P_{\text{prior}}(w) = \dfrac{f_{w_{p,t}} + f_{w_{\bar{p},t}}}{N}$

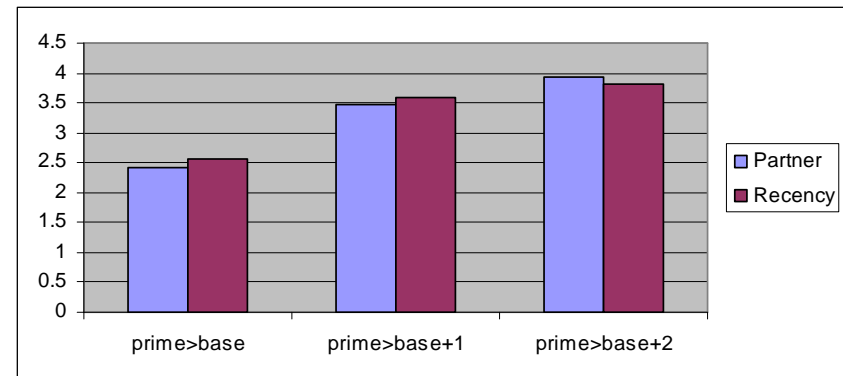**Positive Adaptation** $\quad P_{+}(w) = \dfrac{f_{w_{p,t}}}{f_{w_{p,t}} + f_{w_{p,\bar{t}}}}$

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Effect of Frequency in the Prime

Compute adaptation ratio for all features
Consider the feature to be "Adapted" if Adaptation Ratio >1

% of features adapted   Adaptation Strength

Frequency of the feature in prime
does not affect the chance of adaptation
But affects the strength of adaptation

Conclusions

- Identified types of features affecting adaptation, difficult to cluster them
- Found evidence for partner and for recency adaptation between dialogs
- Adaptation ratio is stronger in the recency scenario
- Adaptation ratio and adaptation strength are not always proportional

Implications

Evidence for partner adaptation suggests benefits of

- Tuning parsing models (rule and vocabulary probabilities) of a dialog system to a particular user

- Sharing information between parsing and language generation modules

Future Work

- We are open to suggestions for other measures that would help differentiate between recency and partner adaptation.

Future Work

- Do the analysis with low-frequency words only
- Consider adaptation of the 'taker'
- Measure within-dialog adaptation
- Consider a setup with no interleaving dialog for partner scenario:
  - 1) A->B, 2) B->A   partner
  - 1) A->B, 2) B->C   recency
- Take into account whether the conversation partners know each other.
- Take into account the eye gaze condition

Questions?

Svetlana Stoyancheva svetastenchikova@gmail.com

Thank you