Some central notions

Discourse

Coherent piece of text, with length of several sentences/paragraphs

Comprises dialogs *and* monologs

Pragmatics

Issues that reach beyond sentence boundaries

Issues of language use, interpretations consistent with the real world

Several definitions in the literature, some are debatable

Context

Setting/embeddings relevant for the interpretation of utterances

Inference

Makes information entailed by the content of utterances explicit

Some properties of discourse/pragmatics

Differences to syntax/semantics

Structure mapping not such a dominant factor

Compositionality frequently not an adequate principle

Impact of expectations, effects of utterances seriously matter

What makes discourse analysis difficult

Relevant factors of the context hard to grasp

Human inferences are often complex, subtle, and subjective

Detailed world knowledge sometimes indispensible

Human conversation is inherently fallible

Motivations for research on discourse/pragmatics

Discrepancies between human and machine adequate communication

	Machine	Human
Structure	**mostly uniform**	**variations to increase vividness**
Explicitness	**entirely explicit**	**exploiting contextual expectations**
Granularity	**mostly uniform**	**opportunistic, changes possible**

Challenges for discourse processing

Differences between form and content sometimes considerable

Adaptation to human preferences may increase the effectiveness of systems

Balancing between the costs underlying formal models and their impact

Theories about discourse

The formalist approaches

Discourse exhibits internal structure, encapsulate closely related semantic units
Theories used to explain pronominalizations and quantifier scoping effects
Weak on actual contents (precise interrelationship, communicative purpose)
Prominent representative: *Discourse Representation Theory* (DRT)

The functionalist approaches

Discourse segments are defined by communicative purposes
Theories focus on interrelationships between segments (how they fulfil goals)
Complementary to formalist approaches in terms of strenghts and weaknesses
Prominent representative: *Rhetorical Structure Theory* (RST)

A (combined) theory of discourse (Grosz amd Sidner 1986)

Segmentation of the utterances (formalist view)
Structure of the interlocutor intentions (functionalist view)
Attentional state (record of referentially available objects)

Reference

Function

Expression refers to an entity in the discourse

“referring expression” denotes a “referent”

Purposes: identification and information about a referent

Forms of referring expressions

Personal pronouns, proper names

Definite NPs, indefinite NPs, demonstrative NPs, quantified NPs

Challenges in processing referring expressions

Interpretation of pronouns (structural preferences vs. world knowledge)

Generation of human-adequate expressions

Presupposition

Felicity of sentences

"The king of France is wise"

presupposes there is a king of France

Frege's theory

(i) referring phrases and temporal clauses do refer

(ii) sentence and its negations share propositions

(iii) presuppositions must be satisfied for a sentence to be either true or false

A simple view justified by distinction between sense and reference

Challenged by Russell

Presuppositions are defeasible

Relevant for evaluating database queries cooperatively

Presupposition properties

Triggers of presuppositions (selection)

Referential: **"The chacellor decides"**

-> There is a chancellor

Lexical: **"John has opened the window again"**

-> The window was closed, John has opened it before

Syntax-driven: **"Who has eaten the cake"**

-> Someone has eaten the cake

Defeat of presuppositions

Presuppositions that occur in negation, modal contexts, or discourse:

John does not regret that Mary is married. Mary is single.

*** John regrets that Mary is married. Mary is single.**

Conversational implicature

Beyond what is said explicitly

"Can you tell me the time"

"Well, the milkman has come"

Grice's theory of implicature based on general cooperative principle, 4 Maximes

(i) Quality – say what you believe to be true

(ii) Quantity – say exactly as much as required

(iii) Relevance – say only relevant things

(iv) Manner – avoid ambiguity and obscurity, be brief

Implicatures are defeasible

Relevant for (inference-rich) discourse, indirect answers

Conversational implicature - examples

Scalar implicatures

"John has three children" -> (not more than three)

"Some of the candidates passed" -> (not all of them passed)

"I am sometime late" -> (I am not always late)

Special/general implicatures

"I went into a house" -> (not my house)

"Did you see the steak?"

"The dog looks very happy" -> (the dog has eaten the steak)

Explanation

"Why has A been assigned to B"

"Group leaders go to single rooms" -> (A is a group leader, B a single room)

Metaphor

Examples

(1) "Ctrl-z kills the process"

(2) "This boxer is a tank"

One entity stands for another one to which it is related

(1) metaphoric use of verb

(2) transferring essential meanings from physical domain

Metaphoric relation must be transferred

Literal reading preferred, if meaningful

Metaphors are creative

Relevant for processing discourse appropriately

Metonymy

Examples

(1) "The Boston office called"

(2) "The ham sandwich is waiting for his check"

One entity stands for another one to which it is related

(1) purely semantic phenomenon, regularities

(2) pragmatic justification

Metonymic extensions make implicit item explicit

Literal reading preferred, if meaningful

Metonymies are chainable

Relevant for evaluating database queries appropriately

Discourse relations

A example

Jones has lots of experience.
He has been on the board for 10 years.
And he 's refused bribes.
So he's honest.
He would really make a good president.

[Cohen 1987]

Diagnosis

- **Relations between facts/assertions not explicitly expressed**
- **Cue phrases (here: and, so) only contribute to a limited extent – ambiguous!**

Challenges

- **Reconstructing the intended argumentative structure (in analysis)**
- **Presenting arguments in a natural and understandable form (in generation)**

Intentional approach (Grosz and Sidner)

Three dimensions of discourse

Linguistic structure

- **The utterances themselves**
- **Expressions that indicate discourse structure**

  (cue phrases, aspect, tense, intonation, gesture)

Intensional structure

- **Hierarchy of intentions (dominance and precedence)**
- **Purpose/intention held by discourse initiator (assumption: one per discourse)**

Attentional structure

- **Model of objects, properties and relations according to their salience**
- **Participants' focus of attention modeled by focus spaces**

Rhetorical structure theory (Mann and Thompson)

Model of discourse

- **Relations between discourse units (mostly binary relations)**
- **Domain-independent rhetorical structure, compositionally built trees**

  (cue phrases, aspect, tense, intonation, gesture)

Examples of relations

- **Nucleus/satellite: elaboration, condition, purpose, result**
- **Multi-nuclear: contrast, sequence, joint**

Limitations

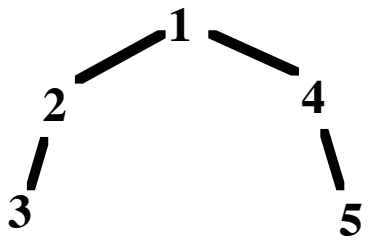
- **Repertoire of relations not determined, singularity of relations problematic**
- **Issues of dialog, overall structure of the discourse**

Generation – presenting discourse relations

Some possible variations

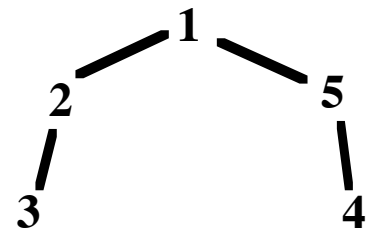
PRE-ORDER

1. Jones would make a good president.
2. He has lots of experience.
3. He has been on the board for 10 years..
4. And he's honest.
5. He's refused bribes.



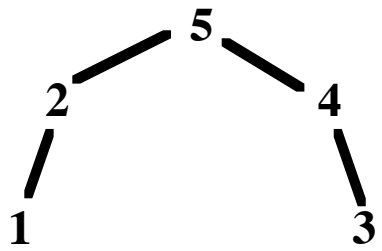
HYBRID

1. Jones would make a good president.
2. He has lots of experience.
3. He has been on the board for 10 years.
4. *And* he 's refused bribes.
5. *So* he's honest.



POST-ORDER

1. Jones has been on the board for 10 years.
2. He has lots of experience.
3. *And* he 's refused bribes.
4. *So* he's honest.
5. He would *really* make a good president.



Methods

- **Ordering and cue-phrase selection, embedded in sentence planning**
  (e.g., [Grote, Stede 1998])
- **Decisions guided by heuristics expressing aspects of linguistic/rhetorical adequacy**
  (e.g., [Scott, de Souza 1992])

Speech acts (Searle)

Simultaneous acts of a speech act

- **Locutionary act – sense and reference of an utterance**
- **Illocutionary act – statement or promise through conventional force of act**
- **Perlocutionary act – effects on the audience**

Categories of speech acts

- **Representatives – entail a commitment of the speaker to the truth of content**
- **Directives – attempt to get the hearer to do something**
- **Commissives – commitment the speaker to some future form of action**
- **Expressives – expresses a psychological state**
- **Declarations – effect changes state of institutional affairs**

Symbolic methods

Processing on surface-near levels

Use of automata, cascaded compositions

Representations

Expressing generalizations, use of inheritance methods (also non-monotonic ones)

Attribute-valuee structures, unification

Reasoning

Rule-based inferencing, planning

Tools

Morphological analysis and generation, syntactic parsing, surface generation

Statistical methods

Development

Data-based methods may be promising where rules are hard to build

Increasingly more areas, dominating in the meantime

Typical areas

Word sense disambiguation, syntactic disambiguation, bi-lingual machine translation

Techniques

Different learning methods are effective in dependency of linguistic data structures

Tendency

Statistical, corpus-based techniques are increasingly overtaking

Reference resolution

Constraints

- **Agreements**
- **Syntactical constraints**
- **Selectional restrictions**

Preferences

- **Recency**
- **Grammatical role**
- **Repeated mention**
- **Paralellism**
- **Verb semantics**

Centering theory (Grosz, Joshi, Weinstein 1995)

Major ingredients

- **each utterance has one backward looking center C_b**
  and an ordered set of forward looking centers C_f
- **proposed C_f ordering Subj < Obj < Other**
  (various other proposals considered in the literature)
- **the most highly ranked item on C_f is the C_p,**
  i.e., the preferred C_b for the next utterance
- **types of center-transitions depending on whether backward looking center is maintained or changed: continuation, retaining, shift**

Centering theory cont'd

Preference rules

If any item is pronominalized, then C_b is pronominalized

Preference for sequences of center continuation, or smooth (gradual) shift

Centering transition types:

	$C_b(U_i) = C_b(U_{i-1})$	$C_b(U_i) \neq C_b(U_{i-1})$
$C_b(U_i) = C_p(U_i)$	Continue	Smooth Shift
$C_b(U_i) \neq C_p(U_i)$	Retain	Rough Shift

$C_b(U_k)$ — backward looking center of utterance U_k
$C_f(U_k)$ — (partially) ordered list of forward looking centers of utterance U_k
$C_p(U_k)$ — highest ranked item on $C_f(U_k)$, the preferred (next) center

Information structure

Theme **- given information, anchoring in the discourse (purpose, topic)**

Rheme **- new information, advances the discourse**

Focus **- emphasis within an utterance**

Expressive means differ across languages

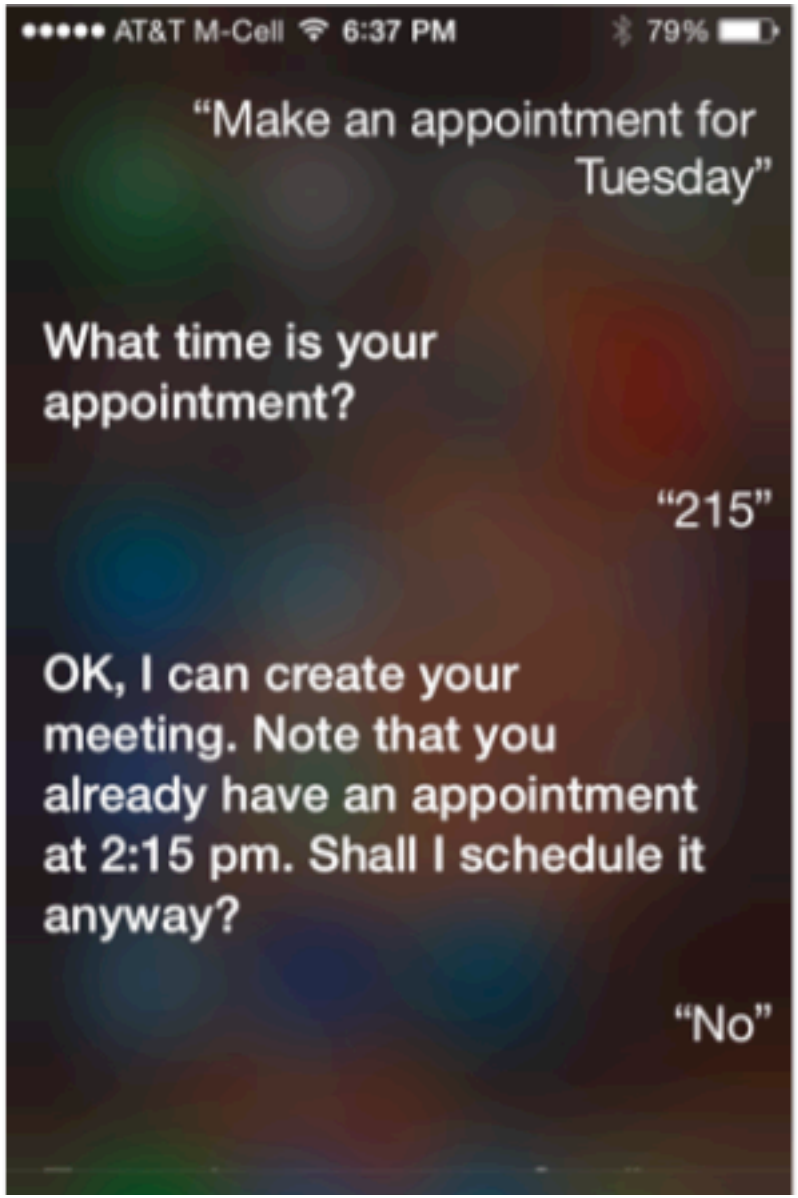
(e.g., word order, syntactic form, intonation)

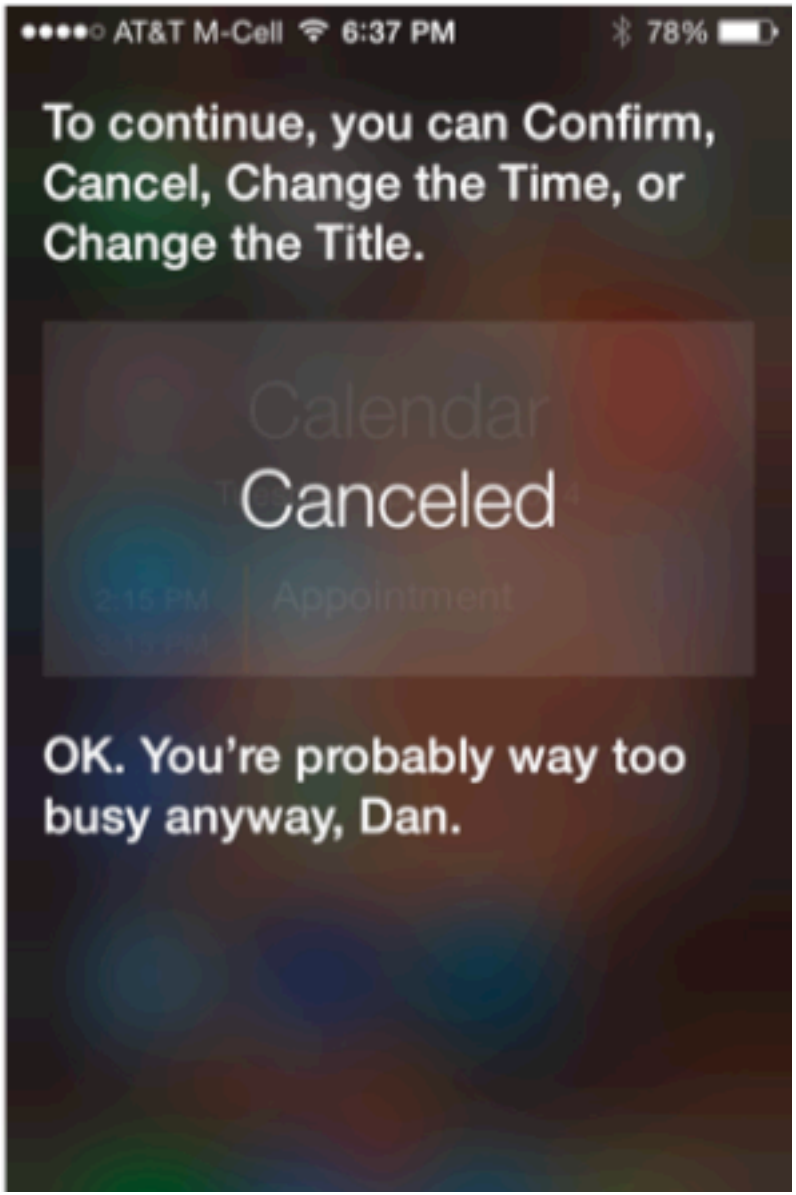
A famous example

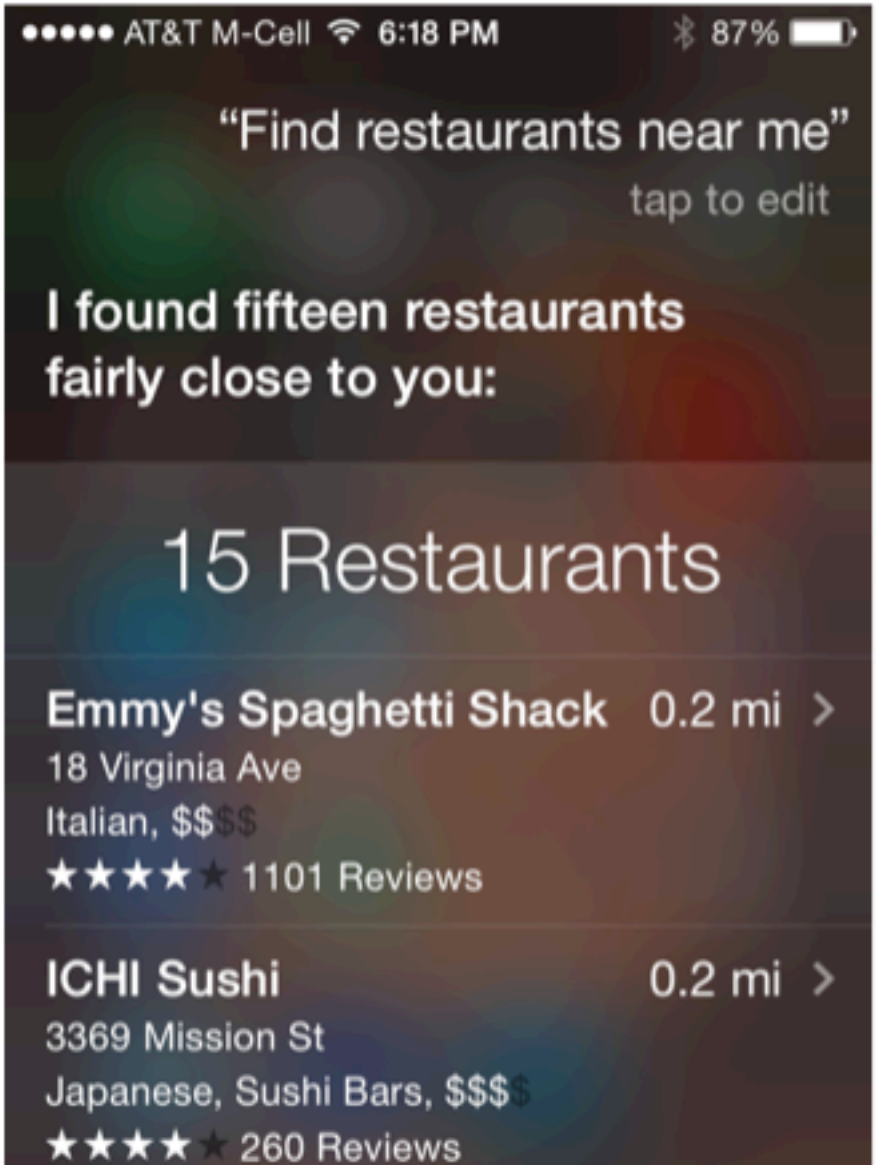
The good news is that Czechs made revolution,

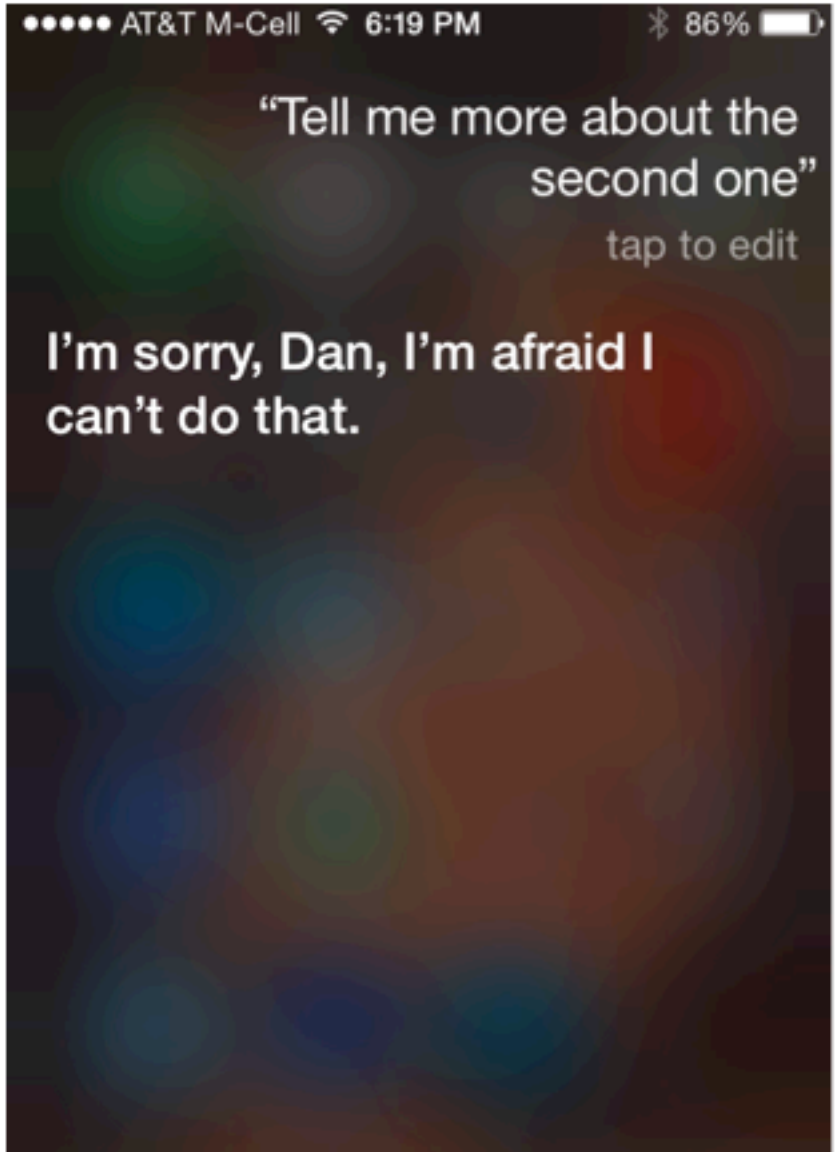
the bad news is that revolution is made by Czechs

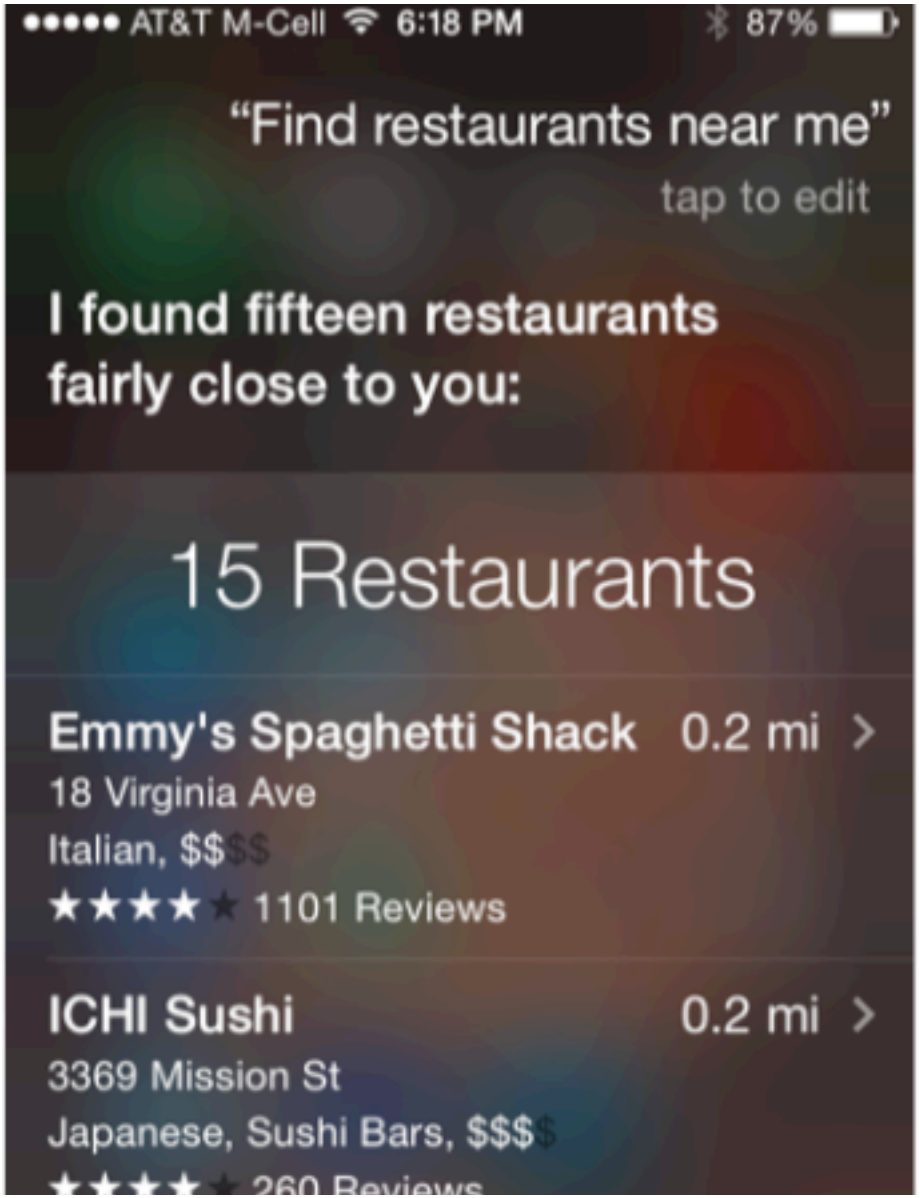
Dialog systems


AT&T M-Cell 6:37 PM 79%
"Make an appointment for Tuesday"
What time is your appointment?
"215"
OK, I can create your meeting. Note that you already have an appointment at 2:15 pm. Shall I schedule it anyway?
"No"


AT&T M-Cell 6:37 PM 78%
To continue, you can Confirm, Cancel, Change the Time, or Change the Title.
Calendar
Canceled
2:15 PM
Appointment
OK. You're probably way too busy anyway, Dan.

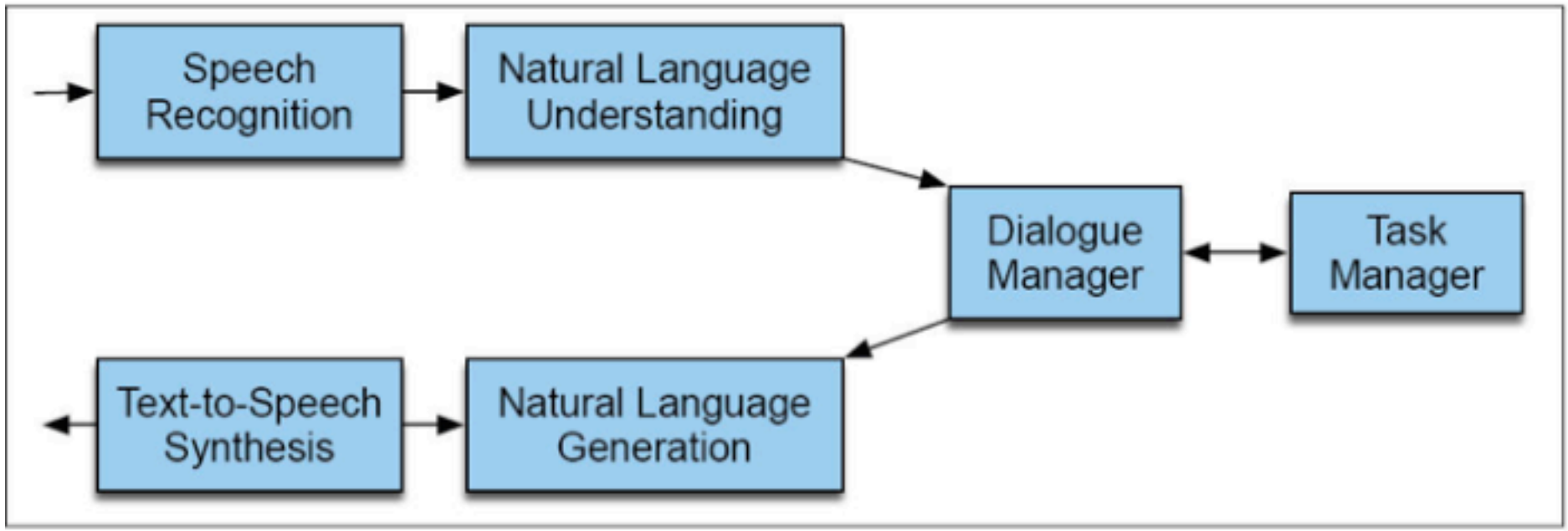

AT&T M-Cell 6:18 PM 87%
"Find restaurants near me"
tap to edit
I found fifteen restaurants fairly close to you:
15 Restaurants
Emmy's Spaghetti Shack 0.2 mi
18 Virginia Ave
Italian, $$$$
1101 Reviews
ICHI Sushi 0.2 mi
3369 Mission St
Japanese, Sushi Bars, $$$$
260 Reviews


AT&T M-Cell 6:19 PM 86%
"Tell me more about the second one"
tap to edit
I'm sorry, Dan, I'm afraid I can't do that.


AT&T M-Cell 6:18 PM 87%
"Find restaurants near me"
tap to edit
I found fifteen restaurants fairly close to you:
15 Restaurants
Emmy's Spaghetti Shack 0.2 mi
18 Virginia Ave
Italian, $$$$
1101 Reviews
ICHI Sushi 0.2 mi
3369 Mission St
Japanese, Sushi Bars, $$$$
260 Reviews


AT&T M-Cell 6:19 PM 86%
"Are any of them Italian"
tap to edit
My web search turned this up:
Web Search
Are any of them Italian
any - Dizionario inglese-italiano WordReference
www.wordreference.com
English-Italian Dictionary | any ... of any sort adj (of an unspecified variety) di qualsiasi
Italian language - Wikipedia, the free

Dialogue System Architecture



ARCHITECTURES FOR DIALOG MANAGEMENT

Finite state

Reliable in general, but inflexible
Compiled versions resulting from more abstract models useful

Frame-based

Domain-specific target structure
Requires processing component to interpret state of the frame

Information state

Theoretically motivated model
Based on force of speech acts, central notion discourse obligations
No generally agreed vocabulary
Theretical elaborations for selected discourse phenomena/situations
Used in some experimental systems (GODIS)

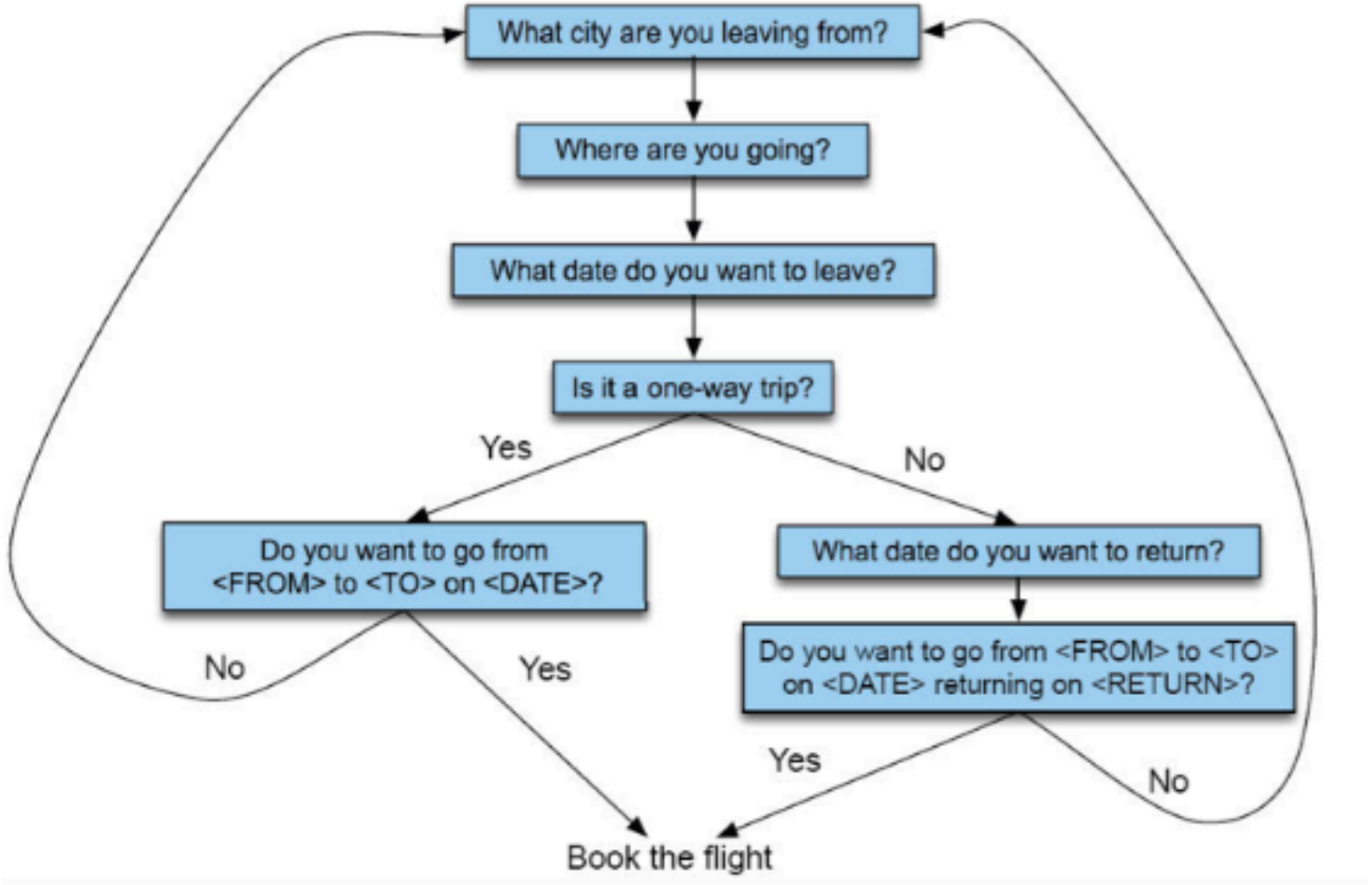
A SIMPLE EXAMPLE

Airline travel system

Asking required about

- **Departure city**
- **Destination city**
- **Time**
- **Single- or round trip**

Finite State Dialog Manager



ASSESSMENT OF THE FINITE STATE APPROACH

Conceptually

Completely controls the dialog, asking a series of questions

Ignores or misunderstands anything that is not a direct answer

Technically

Easy to build

Expectations usable by speech recognition and language analysis

Usability

Only for very simple tasks

Very tedious, ineffective dialogs

FRAME-BASED DIALOG MANAGEMENT

Dialog control extensions

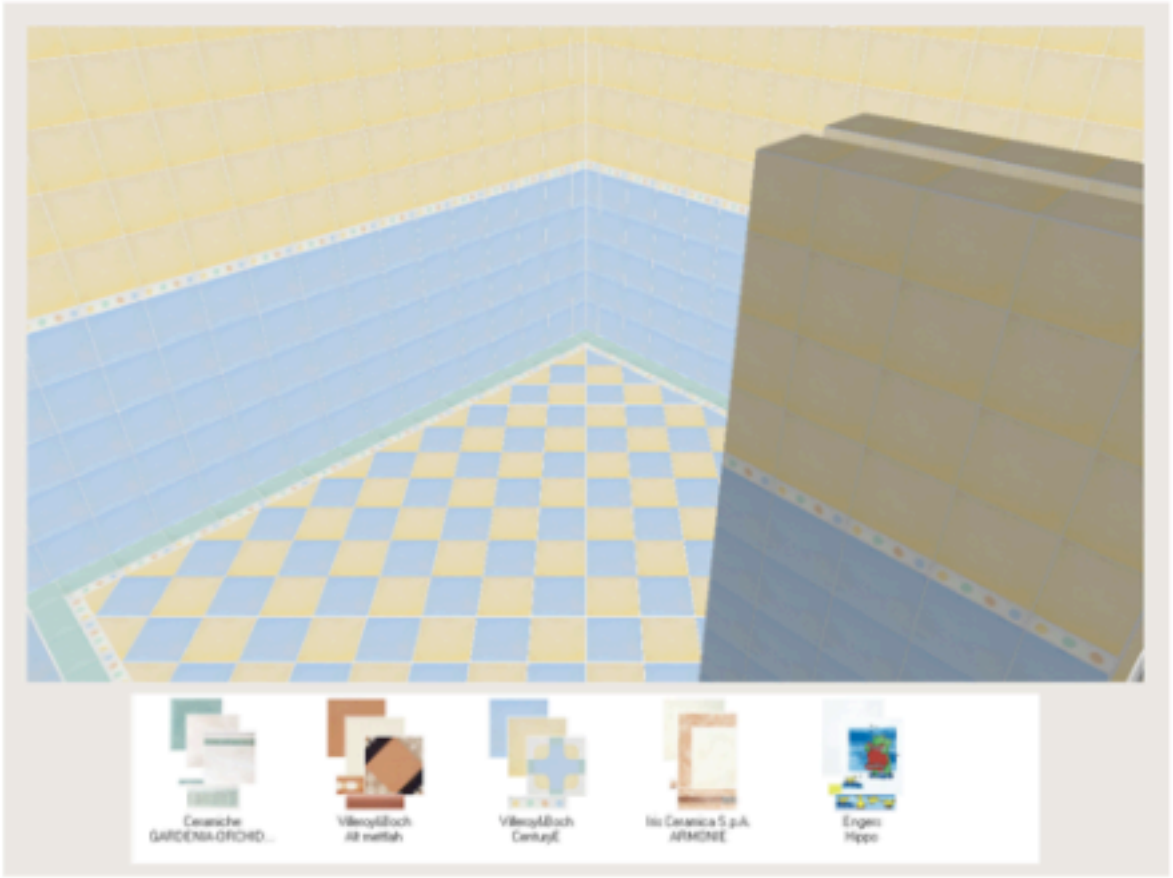
- **Answering several questions at once possible**
- **Specifying**

Conceptual extensions

- **Multiple frames, e.g.,**
  - **flights, hotels, rental cars**
  - **multiple-leg flights, general information about airlie policy**

Additional problems

- **Scope of specifications may sometimes be a concern/problematic**
- **Recgnition of implicit topic shifts challenging**



(a) Bathroom-design application

(b) Talking head

Figure 1: Components of the COMIC interface

User	Tell me about this design *[click on Alt Mettlach]*
COMIC	*[Look at screen]*
	THIS DESIGN is in the CLASSIC style. *[circle tiles]*
	As you can see, the colours are DARK RED and OFF WHITE. *[point at tiles]*
	The tiles are from the ALT METTLACH collection by VILLEROY AND BOCH. *[point at design name]*

Figure 2: Sample COMIC input and output

HANDLING DISJUNCTIVE INPUTS (White 2006)

Motivation

Language planning components produce sets of reasonable expressions

- **Paraphrases with no preferences among them**
- **Alternatives within context widely interchangable**
- **Surface realizer may decide**

Representation alternatives

Underspecified expressions

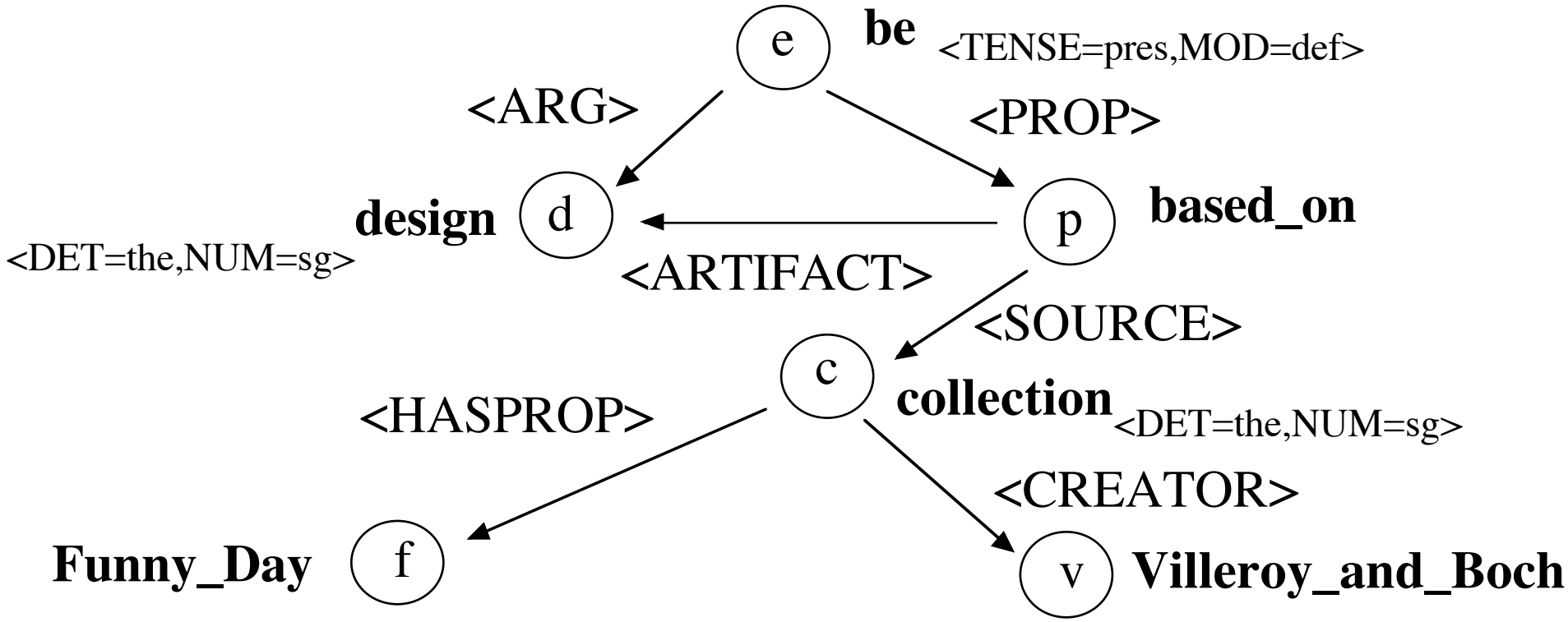
Explicit disjunctions (the alternative used here)

Functionality

Generate most alternatives in parallel (overlapping substructures)

Decide on the basis of corpus frequencies of surface expressions

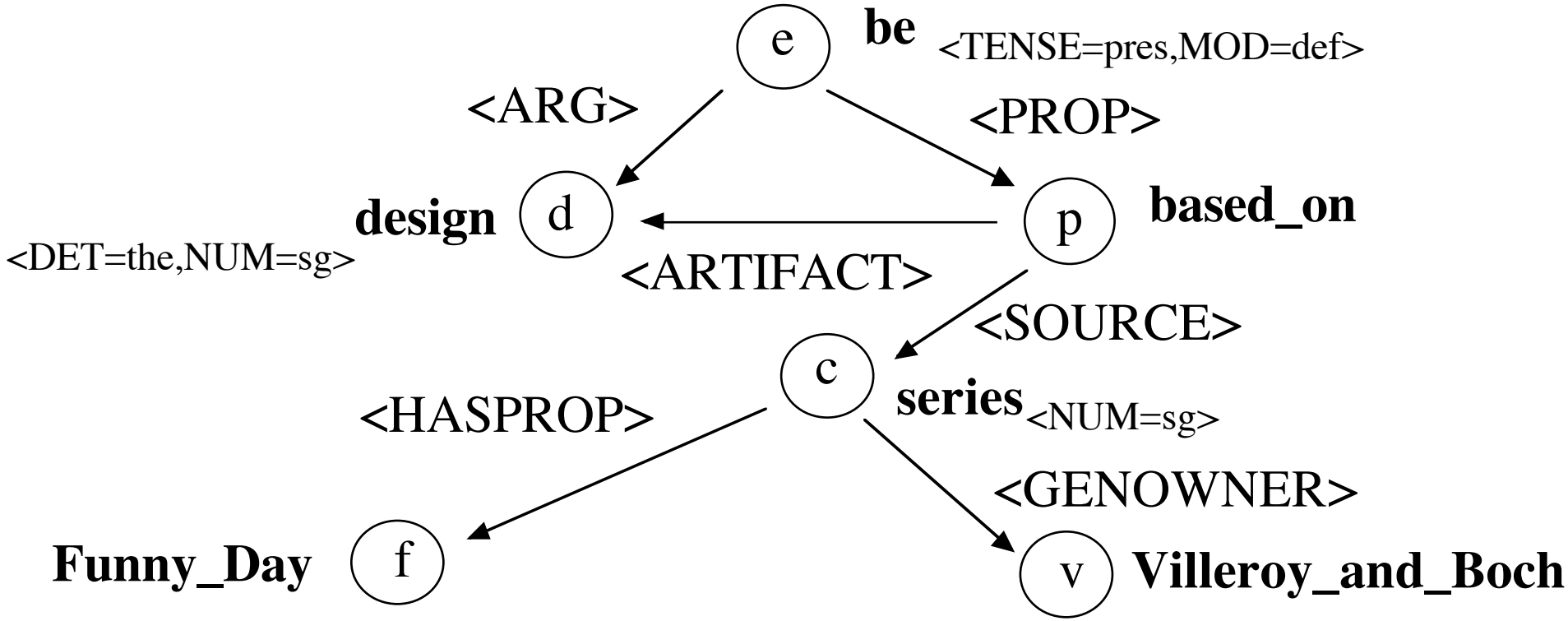
EXAMPLE REPRESENTATION (1)



Semantic dependency graph for

"The design is based on the Funny Day collection by Villeroy and Boch"

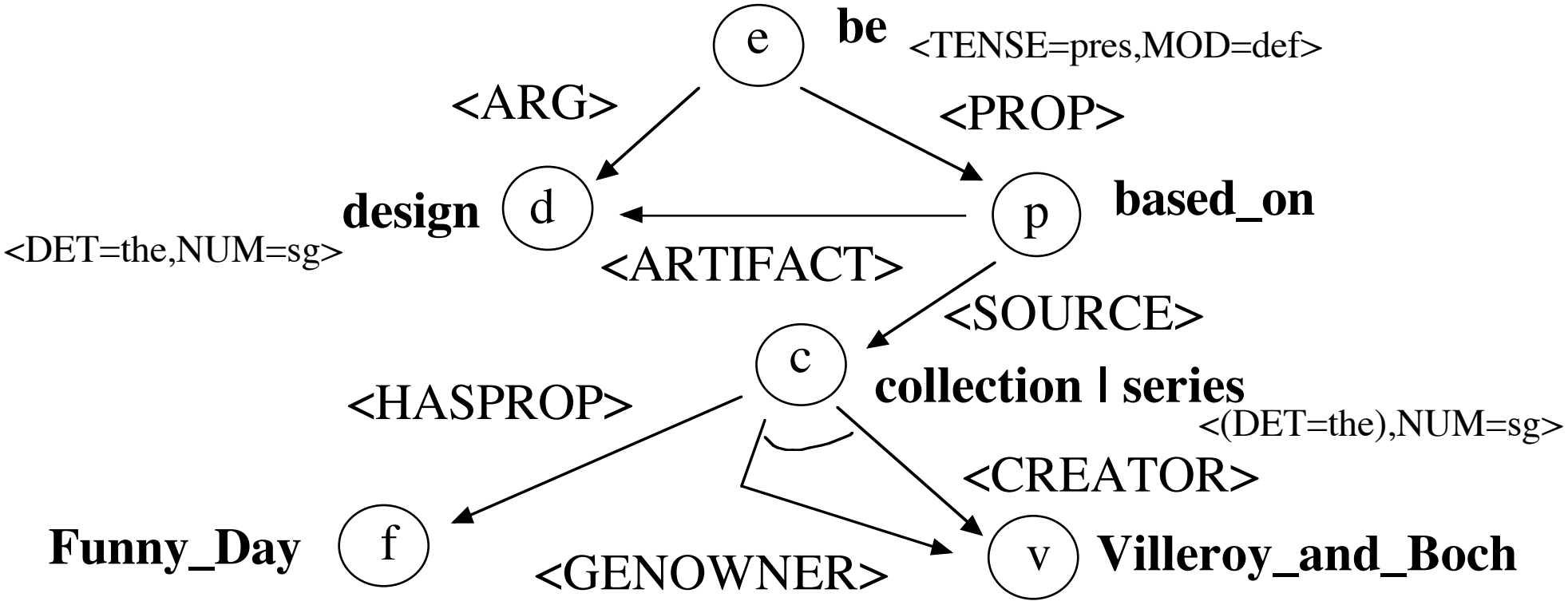
EXAMPLE REPRESENTATION (2)



Semantic dependency graph for

"The design is based on Villeroy and Boch's Funny Day series"

EXAMPLE REPRESENTATION (3)



Disjunctive Semantic dependency graph covering

"The design is based on (the Funny Day (collection | series)

by Villeroy and Boch | Villeroy and Boch's Funny Day (collection | series))"

THE PROCEDURE (SKETCH)

Flattening

Preprocessing step - array of elementary predications, alternations and options

Through tree traversal with incrementally building alternative groups

Edges

Edges associated with bit vectors to record coverage of alternatives

Lexical instantiation

Returns non-overlapping matches with coverage indicating bit vectors

Derivation

Edges may be introduced as alternatives

Edge combination involves a coverage check

Unpacking

Realizations recursively unpacked, filtering duplications

SOME SYSTEM FEATURES

Dialog management

- **High-level, modality-independent specifications (input and output)**
- **Simple stack architecture with a control structure**
- **Topics and are pushed onto and popped off of the stack as the dialog proceeds**

Natural language generation

- **Opportunistic processing**
- **Delaying decisions, producing compact intermediate representations**
- **Decisions about alternatives at the very end, whenever possible**