GENERATING FROM A DISCOURSE MODEL

Rodolfo Delmonte°, Dario Bianchi*, Emanuele Pianta^
°Ca' Garzoni-Moro, San Marco 3417
Università "Ca Foscari"
30124 - VENEZIA
Tel. 39+041-2578464/52/19 - Fax. 39-041-5287683
E-mail: delmont@unive.it –
Website: .http://project.cgm.unive.it
*Dipartimento di Ingegneria dell'Informazione
Universita' degli Studi di Parma
Tel.:+39 0521 905734 Fax:+39 0521 905723
43100 Parma - Italy
E-mail bianchi@ce.unipr.it
^I.R.S.T. - Povo (Trento)
Tel.:+39 0461-314581 E-mail: pianta@itc.it
Website: http://www.itc.it/irst

Abstract
We present a system for text generation which is intended as a back-end for an Intelligent Sentence Extraction system. Generation starts from the Discourse Model (DM) produced by the system for text understanding called GETARUN which produces a full parse and semantic representation of the extracted text. While producing the DM, the system does anaphora resolution, temporal reasoning and builds rethorical strucrtures thus finding or recovering cohesion links between portions of text which might have been lost in the extraction task. Sentence extraction is done in the first language, Italian, but generation can be done in English in case we apply the translation equivalents derived from our bilingual dictionary Italian-English. Provision is made in the generation grammar for language dependent rules, with parametric information for rules belonging to a given language or family of languages – Germanic vx. Romance languages.

1. Introduction
We shall deal with the use of a Discourse Model and other lexical semantic and syntactic specification in a system for text generation called GETA_RUN (GEneration of Text and Reference Understanding), a complete system for text analysis(see references). Seen that the system is able to analyse texts both in English, Italian and German, we assume that a semantic representation can be sufficient to be used as interlingua from any one such languages and to generate texts according to the grammar made available at the end of the pipelined system.
Informally, a DM may be described as the set of entities "naturally evoked" (Webber, 1981) by a discourse, linked together by the relations they participate in. They are called discourse entities, but may also be regarded as discourse referents or cognitive elements. We aim at building text plans at discourse level and then to specify semantic structure sufficient for sentence level generation. Semantic specifications are very much in terms of feature-structure, where on the basis of a set of fixed slots we try to fill a value which is then turned

into some lexical item independently realized by the surface generator. What linguistic information constitutes an adequate input to the tactical component? In order to answer this question we need to decide how much work has to be assigned to the planner. From the subdivision of labour between the two components, we shall be able to ascertain what is left to the grammar itself and the lexicon. The high level system architecture is shown in Table 1.

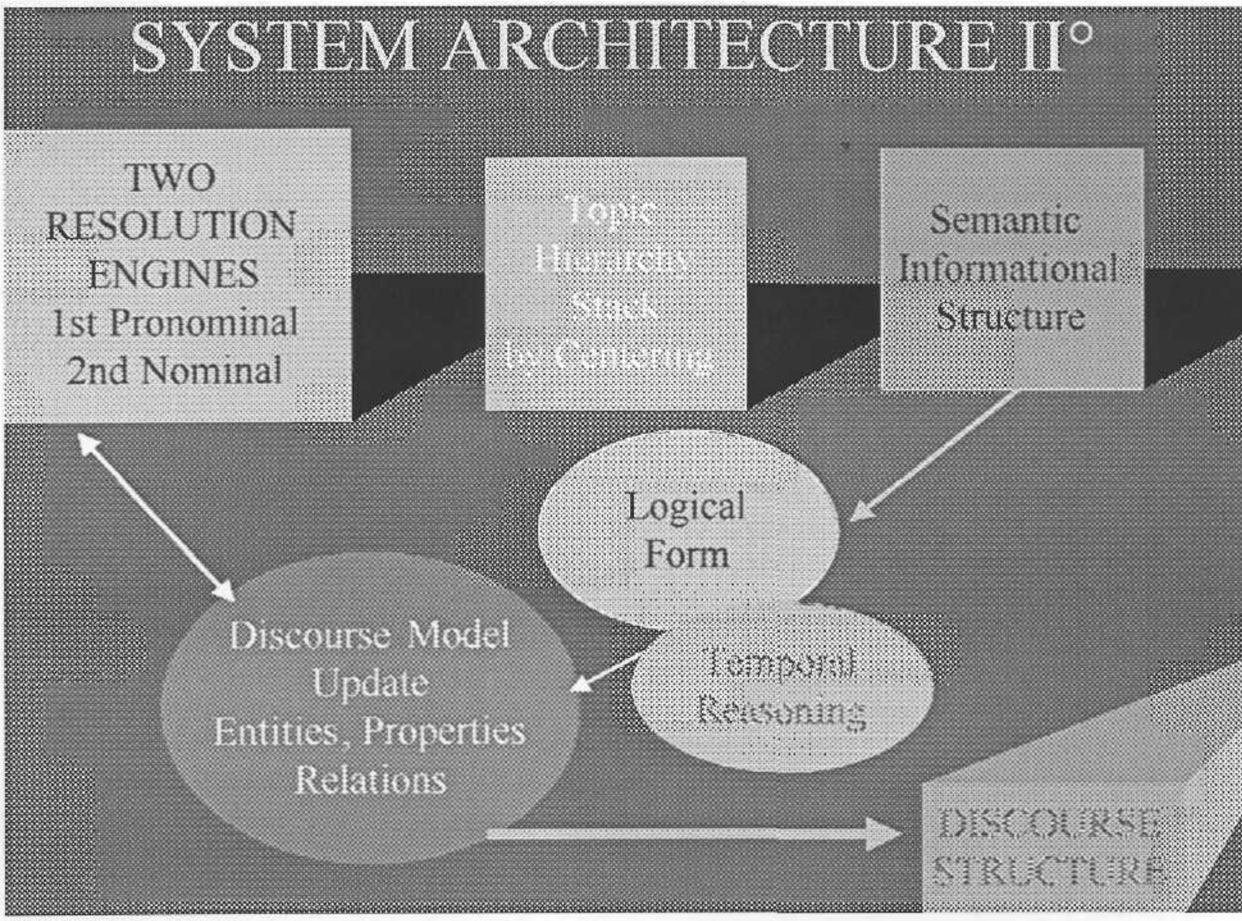

Table 1. Discourse Level Semantic Parser

1.2 Lexical Choice

As a first approximation, we do not want to modify the lexicon used for text analysis in order to introduce a higher quantity of information only if required. Since Italian is a language that requires Gender and Number features in its Agreement to be determined before Lexical Form Selection can adequately take place we would like the Grammar to be able to propagate and solve all problems related to Agreement. The semantics can at times be responsible for the information related to Gender, in particular when the current entity is a person and not a thing. Problems related to Number on the contrary are basically semantic in nature. The entity asserted in the Discourse Model should be individuated either as set, or as individual or else as a generic class entity. In the ontology we also may find locations which again may be assigned the same semantics as entities. This will be shown in the example below.

2. Plan Creation from Rhetorical Relations and Conceptual Representations

There are two main problems we are faced with when thinking of narration/description generator: choice of actual words, and order in which they should occur. In order to select the appropriate lexical predicate, a number of crossing abstract representation should conspire to produce the most adequate result. In particular, we assume that in a plan there are different levels of abstractions involved: the higher level is represented by discourse semantic relations very similar to RST rhetorical relations. We divided up discourse relations into two separate sets, background and foreground relations.

fore_discrels([setting, narration, obligation, inception, result, egression, prohibition, cause, adverse, contrast, purpose]).

back_discrels([evidence, motivation, definition, elaboration, parallel, evaluation, description, permission, hypothesis, condition, circumstance]).

In addition, we need some criteria to establish the order with which events may take place in the world: this is not to be intended in the sense of domain discourse plans for task oriented dialogues above. Discourse relations are then constrained by logical temporal relations. Temporal logical relations should be semantically adequate. We organized temporal relations into three separate sets labeled as being consistent with or asking for given general discourse relation types:

SET 1
includerel(contains).
includerel(during).
includerel(finished_by).
SET 2
afterrel(after).
SET 3
beforrel(before).
beforrel(started_by).

Since we endorse LFG as our theoretical framework (Bresnan, 2000), and our lexical forms encompass semantic information related to semantic roles, we assume that the correct mapping from lexical forms is achieved by means of semantic roles and aspectual class. C-structure and f-structure representation would be completely lost in our framework once the Discourse Model is being built. The Discourse Model only contains reference to semantic roles and other semantic relations like Poss.

Conceptual Representations(CR) have been introduced by Jackendoff and others, however we refer to Dorr(1993) who introduced a number of augmentation to the original set which we also endorse. Delmonte(1990, 1996) considered CR the link from the semantics to the knowledge of the world needed to represent meaning in a general and uniform manner. In accordance with the principle of meaning decomposition, we assume that concepts denoted by lexical items are made up of primitive concepts which can be expressed by the use of a very limited number of templates. The granularity of the description depends strictly on the (sub)domain and the aim of the task at hand. For instance, abstract concepts like "responsible" or "responsibility" when dealt with in a legal subdomain require a specification of preconditions which is different from what is expected in a generic domain(see Delmonte, Dibattista).

A method for the decomposition of lexical information should represent a principled way to organize a taxonomy of the concepts in a language, categorized by sets of features, which however are tightly interleaved with argument structure and the syntactic nature of each argument.

The content of CR is as follows:

A. a set of primary functions which are, GO, BE, STAY, CAUSE, LET, ORIENT, IDENT and might all be preceded by negation NOT;

B. a fixed finite number of semantic fields distinguishing common areas of meaning in real knowledge of the world, like INFORM, POSSESS, EVAL, SUBJ, HYPER, PERCPT, MANIP, FACTV, MENT_ACT, PROPR, MEASU, POSIT, COERC, ASK, REACT, TOUCH, HOLD, HOLE, DIR, DIVID, UNIT, LET, etc.

C. a small number of directions indicators, FROM, TO, INTO, AGAINST, AT, TOWARD

D. a small number of secondary functions which are REP, TR

E. a finite set of modality operators with scope on the verb meaning and its complements, which include the following:

[*exist, nonexist, major, minor, violnt, difclt, perf*]

Finally, there is a generic evaluative polarity which simply accompanies the concept and encodes the way in which its meaning is perceived in a default manner as having a positive or a negative import: kill, die, destroy are computed as GO(TO[nonexist] X) negative); on the contrary create, be born, heal are computed as GO(TO[esist] X) positive) - they don't appear in this paper. The following is the complete list of the CRs contained in our lexicon:

As to Aspectual Classes we use them to define lexical classes rather than sentence level aspectual class, which as we said above, is the result of the interaction of an extended number of linguistic elements. Lexical aspect is used to individuate the appropriate internal constitu-ency of the event (see also Delmonte, 1997 and above), and also to drive the semantics, which together with the information coming from arguments and adjuncts will be able to trigger the adequate knowledge representation. In particular, as shown in Palmer et al.(1994), we need to process reference to entities and events in the discourse model, in order to know what predicates are asserted to hold over what entities and when. We use the following lexical aspectual classes:

a. achievement; b. achievement irreversible; c. achievement iterable; d. accomplishment; e. accomplishment ingressive; f. activity; g. state; h. state_result

Meaning associated to each semantic class are expanded into conceptual classes by means of aspectual information. For instance, the following class

11 = exten (GO(TO[end] - (GO(TO[exist] finire, creare

is split into the following two meanings:

Funct(exten, achievement irreversible) CAUSE(GO(TO[end] finire "to end"

Funct(exten, accomplishment) CAUSE(GO(TO[exist] creare "to create"

where Funct may assume only those rhetorical or discourse relation labels that constitute a conceptually admissible link. Elaboration or Description are not allowed by Linking Rules. Narration and Egression would be allowed.

In particular, we assume that in a plan there are different levels of abstractions involved: overall planning, discourse planning, sentence planning. The higher level is represented by relations very similar to RST rhetorical relations. These in turn specialize into tuples of semantic relations which are subsequently used to recover predicates from the lexicon. These tuples may be represented by a semantic class and an associated aspectual class, as for instance in:

narrative(movement, activity).

background(existence, state).

In addition, we need some criteria to establish the order with which events may take place in the world: this is not to be intended in the sense of domain discourse plans for task oriented dialogues above. The idea we have in mind is based on conceptual classes onto which linking rules may be established so as to disallow unwanted sequences, as for instance in,

LR1: *(GO(TOx ==>GO(TOx)

LR2: *(STAY(ATx ==> STAY(ATx)

LR3: *(BE(ATx ==> BE(ATx)

LR4: *(BE(ATx ==> GO(TOx)

These rules are axioms made up of two sides: the left is a part of a conceptual representation and is the consequent and the right side is the premise; they can be applied at sequences of relations one of which must be the unrealized or yet to be realized relation, represented by the left template.The right side template can be liked to any of the relations already present in the plan. The variable x is linked to the object, location or other semantic type for an argument. In particular, in the case of LR4, if some entity has got to be AT(x), he should GO(TOx) first.

3. Semantic Information in the DM

Generating a text requires the generator to have access to the semantic representation present in the Discourse Model. There are two types of semantic information derived from text analysis: the Discourse Model itself is the list of all facts and entities. The example below is the DM generated from the analysis of the following simple text:

a. Mario ieri corse a casa/Mario yesterday ran home

b.Maria lo aspettava/Maria was waiting for him

c. Lei lo insultò/She insulted him

entities_of_the_world

entity(ind,id3,18,facts([

fact(infon6, inst_of, [ind:id3, class:uomo], 1, univ, univ),

fact(infon7, name, [mario, id3], 1, univ, univ),

fact(id5, correre, [agente:id3, locativo:id4], 1, tes(f4_ta), id2),

fact(id9, aspettare, [actor:id8, tema_nonaff:id3], 1, tes(f4_tb), id2),

fact(id11, insultare, [agente:id8, tema_aff:id3], 1, tes(f4_td), id2)])),

entity(ind,id8,12,facts([

fact(infon30, inst_of, [ind:id8, class:donna], 1, univ, univ),

fact(infon31, name, [maria, id8], 1, univ, univ),

fact(id9, aspettare, [actor:id8, tema_nonaff:id3], 1, tes(f4_tb), id2),

fact(id11, insultare, [agente:id8, tema_aff:id3], 1, tes(f4_td), id2)])),
entity(ind,id4,2,facts([
fact(infon8, has_prop, [ind:id4, main_sloc:id2], 1, id1, id2),
fact(infon9, isa, [ind:id4, class:casa], 1, id1, id2),
fact(infon10, inst_of, [ind:id4, class:cosa], 1, univ, univ),
fact(id5, correre, [agente:id3, locativo:id4], 1, tes(f4_ta), id2)])),
loc (ind,id7,0,facts([
fact(infon28, main_tloc, _, 1, tes(f4_ta), _)])),
loc(ind,id2,0,facts([
fact(infon4, main_sloc, [arg:casa], 1, _, _)])),
loc(ind,id1,0,facts([
fact(infon3, main_tloc, [arg:ieri], 1, _, _)]))

As can be seen, entities of the world are a list of the entities making up the Discourse Model; each entity or location has the following information :

Semantic Type: ind, set, class, ent

Semantic Identifier: constant

Score: numeric value

Facts: list of facts taken from the model in the order in which they occur

Fact: one fact is as usual characterized by an infon index or a semantic identifier, a property which can be a relation of a semantic predicate - a verb or a preposition like linguistic expression -, a list of arguments, a polarity, two indeces for spatiotemporal locations. In turn, the list of arguments may be unary, binary or tertiary and is a term made up of a semantic role and a semantic identifier.

Discourse Structures are made up of main relation for each clause with its arguments which are characterized by topic hierachy and all relevant information to define discourse relations and structure, as follows (but see previous Chapter):

Utterance-Clause Number: two numeric values

Topic List: list of topics of current clause, which includes a topic type, a semantic identifier, a predicate - the one associated to the topic hierarchy

Shortened Infon: a shortened form of the infon associated to the situation described in the current clause, made up by a relation, the arguments, a polarity and a spatial location

Temporal Relation: a logical relation and its temporal arguments

Discourse Relation: a relation name

Discourse Structure: the structure of discourse at that clause made up of the main node and a structure, a list of nodes attacched to it.

discourse_structures

ds(3-3, [main:id8:maria, secondary:id3:mario], insultare([id8:maria, id3:mario], 1, id2), after, narration, 2-[3]),

ds(2-2, [main:id3:mario, secondary:id8:maria], aspettare([id8:maria, id3:mario], 1, id2), finished_by, elaboration, 1-[1, 2]),

ds(1-1, [expected:id3:mario], *correre*([id3:mario, id4:casa], 1, id2), overlap, narration, 1-[1])]).

4. Tactical Component

It is generally agreed that a suitable input to the realization component must be constituted by some form of semantic representation which may include the actual lexical choice or some abstract conceptual representation of each lexical item for the final realization.
However, there are many differences that can be found between the approaches documented in the literature and ours. In our system, input to the realization has a general argument structure and a number of functional features that are used by the grammar to generate the most adeqauate structural configuration. Top-down semantic, rhetoric and pragmatic decisions are paired with bottom-up lexical requirements imposed by each predicate on the fly, while realizing each lexical item. In particular, argument specification only reflects the order each argument has in canonical predicate argument structure. Syntactic non-canonical realizations, like for instance passive construction, expletive subject insertion, left-dislocation and any other possible grammatically relevant stuctural decision is left to the phrase structure rule component of the grammar. Consider the need to realize one argument as clitic pronoun, as is required in Romance languages: the semantic structure would carry the information that the second argument of the predicate belongs to TOP type, as for instance in the following representation for Mario, which is realized as the clitic pronoun "lo"/him independently by the grammar. The fact that Mario has been assigned the TOP type in the slot reserved for Definitiness does not depend on syntactic but merely on pragmatic and semantic information. Features for the choice of the adequate pronominal form are partially extracted from the lexical entry associated to Mario, which are Person=3, Gender=Masculine, Animacy=Human,

[top, nil, sing, mario] --> lo

In addition, Number is set to singular, and Case is equal to Accusative owing to the fact that the argument is the second. The additional information that "lo" should be anteposed to the verbal predicate is not encoded in the semantic structure but is independently imposed by the phrase structure rules associated to the "transitive verb" syntactic class, and the presence of a TOP argument. On the contrary, by interleaving focus rules with the realization grammar, have the undesirable side-effect of having to check where the Focus argument has been assigned in the case frame slots of the sentence level predicate before entering the correct vp rule. In our grammar, we capture passive structures very simply by means of the feature PASSIVE in slot assigned to VOICE in the input semantic structure. The grammar will look for second argument or third argument according to argument structure and execute a Lexical Redundancy Rule, according to LFG: the argument selected will be set to Subject of the current structural realization and realized first. Then second argument will be passed to VP structure as Adjunct Oblique with the semantic role of Agent. Semantic role will trigger the adequate preposition "by" to be instantiated in front of the NP. Choice of focussed constituent is again present in the linear disposition of arguments: in case Recipient/Beneficiary/Goal should be fronted, it would have been positioned as second argument, for ditransitive verbs only, however. In other words, we perform dative shift in the pragmatic/semantic component before entering the realization phase.

4.1 Text Generation in Italian

Generating text in Italian is intrinsically bound to the peculiarities of its surface grammar. Summarizing is a task that requires full discourse structure information which in our case is made available from "GETA_RUN" and feeds directly the planning component. In turn, grammar and lexicon needed for the tactical component is readily available from the DCG parser. However, we do not believe fully reversible grammars in the sense presented by Strzalkowski 1994 are possible or even useful: we take parsing to be a completely different task from generation, especially in languages like Italian. So the DCG used for generation is only a subset and has the only task of instantiating the instructions fed by the higher level Planner into the adequate syntactic ordering satisfying the well defined constrains of completeness, coherence and uniqueness of LFG by means of fully specified lexical forms (see Zajac, 1994).

Italian is a language which allows and in some cases requires the Subject to be generated in postverbal position. Subject inversion is a free process, i.e. it does not obey such constraints as the D(efinitiness) E(effect), and requires no expletive, as is the case with other languages like English, German or French. In fact, Italian is regarded as a language with empty expletives. Choice for auxiliaries is determined on the basis of syntactic category: unaccusatives require "be", while the other categories require "have". However, passive and impersonal constructions also require "be" as auxiliary. In addition, Object NP can be expressed as clitic and be thus obligatorily positioned in front of tensed verb.

Features associated to verbal morphemes, require agreement on the past participle including Gender as well as Number which in case of unaccusatives should agree with the Subject. However, agreement goes with the Object with transitive verbs. In addition, Italian has compound prepositions, i.e. a preposition with article which in turn can undergo epenthesis by the use of the apostrophe. In the latter case, generation of the compound preposition requires gender and number information to be made available beforehand, or else it should be generated afterwards.

As to Functional Features used, input to our Tactical Component is as follows:

Voice: active/passive

Tense: any tense

Mood: any mood including imperative, interrogative etc.

Modality any modality

Main Relation: the main clause relation

Main Relation:Modification

Adverbial Phrase ; Subordinate Clause ; Coordinate Clause ; Prepositional Phrase ; Predicative Adjunct

List of Arguments:

1st Argument: Subject argument - Sentential subject; *2nd Argument*: Object, Oblique, Sentential Object; *3rd Argument*: IndirectObject or Oblique

Argument specifications 1.

Semantic Type:

a. prop (proper name), b. def (definite common noun), c. ndef (indefinite common noun),

d. foc (focussed noun to be fronted by syntactic structures like left dislocation, it- cleft, topicalization, etc.),

e. top (topic noun - to be pronominalized), f. rel (relative pronoun argument),

g.trace(controllee of syntactic or lexical controller), i. pro(empty or lexically unexpressed noun),

Cardinality: : a number/nil; *Number*: : sing(ular)/pl(ural) ; *Head*: : lexical head

Argument specifications *2. Modification*
Adjectival Phrase, Prepositional Phrase, Predicative Adjuncts
We now fully comment on two examples:
Ex.1: Ieri Mario corse a casa / Yesterday Mario ran home
Voice=act,
Tense=past,
Mood=indic,
Modality=assert ,
Main_relation=correre,
Main_relation_modifier=[dtemp,ieri],
List_of_arguments=[
First_argument=[prop, nil, sing, mario],
Second_argument=[meta, casa]
]
Ex.2: Maria che ieri lo cercava lo insultò / Maria who yesterday was looking for him, insulted him
Voice=act,
Tense=past,
Mood=indic,
Modality=assert ,
Main_relation=insultare,
List_of_arguments=[
First_argument=[prop, nil, sing, [maria,
First_argument_modifier=[
Voice=act,
Tense=imperf,
Mood=indic,
Main_relation=cercare,
Main_relation_modifier=[dtemp,ieri],
List_of_arguments=[First_argument=[rel, nil, sing, maria],
Second_argument=[top, nil, sing, mario]
]
Second_argument=[top, nil, sing, mario]]

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