Chapter 6.
Language and Communication

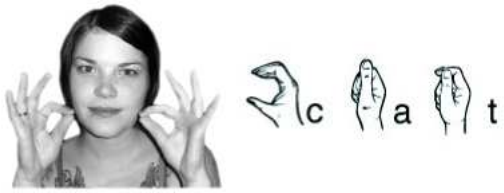

Figure 6.1: Example of American Sign Language for the word “cat” (left). The fingers are drawn away from the upper lip in a way that suggests stroking the whiskers of a cat. Finger spelling for “cat” (right). (check permission)

Formally, languages are systems for creating especially complex and novel representations. Functionally, natural languages facilitate human communication and social interaction (6.5.1) are those in which meanings can be specified unambiguously.

6.1. Natural Language

Natural language is much more ambiguous than formal languages such as computer programming languages. Context and metaphor can completely alter the semantics of a natural language sentence. Indeed, there is ambiguity at many levels. It is unclear in the sentence “The woman saw the man with the binoculars,” exactly who has the binoculars. The context in which these sentences are spoken or used help us to understand these cases. Even when the syntax of a sentence is very simple, the semantics of language may be subtle. Consider the use of metaphor in the sentence “The old man drank in the scenery”; people must possess a very nuanced understanding of language to understand usage such as this. Unlike a formal language, where usage rules are delimited at the outset, natural language is a social artifact (6.4.0); it is active and dynamic. Words can change their meaning over time as prior uses become outdated, and different structures and styles are dropped or adopted. Understanding natural language has as much to do with context, as with learning or memorizing usage rules. Some techniques of natural language processing are described in (10.4.0).

Natural language processing is a frontier of information science. Thus far, only limited progress has been made in creating computers that understand and can interpret natural language. Obviously, the ability to communicate with computers in this way would offer great benefits. However, natural language is used in various forms including text (10.1.0), visual language (11.2.4), and speech (11.3.3), and each modality has its own idiosyncrasies. We will examine topics concerning natural language and its components. Later, we will look at techniques for processing natural language (10.4.0).

Language allows the communication of complex ideas. Utilizing language is a means of interaction. Language games[63]. This should be compared to the mathematical definition of languages.

Symbolic representations versus distributed representations. As we have seen, human language is often a tool for persuasion and it is heavily context dependent.

6.1.1. Characteristics of Natural Language

Not only is natural language ambiguous, it is also often highly redundant. This helps to ensure the transmission of the message, and makes language robust in the face of distortion, such as with accented speakers or noisy environments. It is often easy to guess a missing or garbled word. That is, the semantics are intertwined with context. Coherence of meaning.

6.1.2. Varieties of Natural Language

Human language is amazingly diverse. Beyond the obvious differences between langauges there are differences within languages in jargon and culture The differences among languages create a huge human cost through blocked communication. Not only are there different languages but even for a

given language the are great differences across speakers. Even for a individual speaker, there are differences across social settings.

Human Languages

Differences among Natural Languages There are more than 3000 human languages. Human languages differ from each other in many ways: structures, semantics, alphabets (10.1.1), word segmentation (10.1.5), and word sense (6.2.3); for example. This is apparent in areas related to sensory perception, such as the definition of colors. In Russian, for instance, there is no single word for "blue"; it is necessary to define that color in terms of its being either light blue (*goluboy*) or dark blue (*siniy*). As another example, the English word "fly" exists in approximately 40 different senses when translated into in German in addition to its multiple meanings in English.

Languages also vary in structure. Languages vary in "case order". Grammars versus inflection. The structure of words and of phrases also differ across languages. Typically, English is Subject-Verb-Object (SVO) – John went home. Other languages are different. Object-Subject-Verb (OSV) – Home Yoda went.

Evolution of languages.

There can also substantial differences within what is widely considered to be a single language. Of course there many variants of English and even regional differences with the U.S. (Fig. 6.2) [**?**]. Indeed, there are strong regional differences in language in Tweets. Geographic topic models.

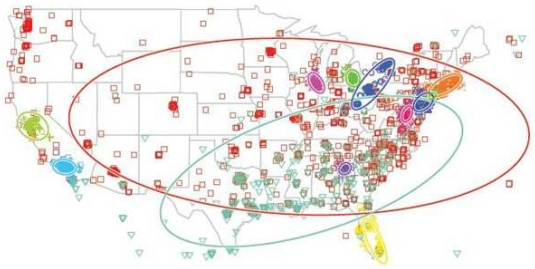

Figure 6.2: Regional differences in Tweets[3]. (check permission).

Cultural Differences and Language While they may seem separate, a people's culture and language are related to one another in complex ways. Culture is inextricably intertwined with language; this important intersection is studied extensively in "sociolinguistics" (6.4.4). Language helps to define and even perpetuate cultural differnces. Linguo-cultural differences may be so pronounced that translation from one language to another is essentially impossible without extensive explanation (6.1.2). For example, many Polynesian cultures have a fundamental different approach to directions than in Western societies. In Japan and Korea, great care must be taken to use the proper honorifics in conversation to express respect for the person with whom one is speaking. Use of language by gender. Use of by young people.

Evolution of Natural Languages Cognitive factors and cultural factors such as assimilation.

Speakers of a language tend to prefer simple statements and expressions. Language adapts to complexity. The "principle of least effort" suggests that common expressions tend to be shortened over time [65]. For instance, nicknames are usually much shorter than full names. This is another example of individuals managing cognitive effort (4.3.3)

Semantic drift as changes in the meanings of words.

Endangered languages (Fig. 6.4).

Modalities of Natural Language

Natural language also crosses sensory modalities. It includes written text, speech (11.3.3) or verbal

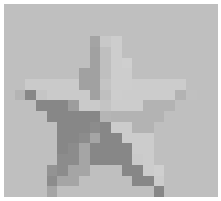

Figure 6.3: Spread of human language.

Figure 6.4: Ishi, The last Yahi Indian and the last native speaker of the Yahi language. (check permission)

communication, and sign language. Moreover, face-to-face communication usually includes gestures (11.4.1) and references to objects in the environment, which are, technically speaking, not part of the language itself, but are nonetheless well understood. Sign language, though seemingly limited, possesses all the subtleties of spoken language. In fact, there are two common forms of sign language: one in which concepts are represented with gestures, and the other in which words are spelled out. Fig. 6.1 shows examples of each: a sign-language gesture (left) and finger spelling (right). Continuum of increasingly complex gestures (11.4.1) and, finally, sign language. Sign language grammars.

6.1.3. Human Cognition and Language

Natural language is a human process and is susceptible to the biases of cognitive processing. Relationship of natural language and cognition. Natural language is integral to being human. Categories and lexical differences [?]. Interplay between language cognition. Categories and lexical semantics. Reading and writing (10.2.0). Human language processing picks first relevant match it finds [?]. Brain science, brain development, and language (-A.12.2). Reading (10.2.0) and writing (sec:writing).

Linguistic relativity (6.4.4). Concept maps (4.4.1) and semantic fields. This implements the notion of compositionality which is a combination of concepts which goes beyond the meaning of the individual components.

How do people learn and produce natural language? Is it simply a function of learning the rules and vocabulary? There is some evidence that language acquisition is rule-based in this way[46]. One supporting example is the over-application of a rule in language use: a child might say *I go-ed to the store* rather than *I went to the store*. Presumably, the child has acquired the rule of adding "-ed" for creating past tense, but has not acquired an understanding of irregular verbs. Cognition (4.3.0). Moreover, the ability of the human brain to develop new representations seems to change across growth Fig. 6.5. The effort to find a universal grammar has largely failed. Language chunking.

Translation. Bilingualism.

Lingua Franca

Common language with pidgin dialects.

Quasi-Natural Constructed Languages

Esperanto.

Figure 6.5: Photos of a child at several points in the first years of life.

Relationship to concept development. Some speculate that humans have a fundamental capability for language. That is, our brains have evolved to produce linguistic ability, and that there are "linguistic universals" common to all people. One of these linguistic universals was a hypothetical "universal grammar," This universal grammar theoretically provides a general template for the acquisition of language, particularly grammar. The particular syntax of any given natural language fits on top of this larger, innate schema. Anecdotal evidence for the innate propensity for language in humans is that it is easier for a child to learn a language than it is for a child to learn to play the piano. Computational language learning entirely from samples of language would provide counter-evidence.

Role of imitation in language learning (5.5.4).

Children learn language remarkably quickly. LSA and Plato's paradox for vocabulary learning[35].

6.2. The Structure of Natural Language

Natural language is highly structured. As we shall see, there are several approaches to describing this structure but by far the most common proposes that there are several levels: Lexicon, Syntax, Semantics, and Pragmatics.

6.2.1. Words: The Natural Language Lexicon

Exactly what constitutes a word is open to debate. The *Oxford English Dictionary* contains approximately 290,000 word entries, but over 615,000 word senses. Should compound words be considered two words, or one? Most estimates put the total number of English words at over 1 million if technical terms are considered. Apart from that, as we will see, specific words are themselves no simple matter. How words are created, how we define them, and how we use them are all questions that we will consider in this section, though it must be noted that answers to these questions may be elusive. One interpretation is that word senses may be implemented as frames as suggested in the FrameNet project (6.2.3).

Stems, morphemes, words. Words are composed of different parts, and those parts, when combined, are what indicate the meaning of the word. "Morphology" is the word structure and the most basic elements of words are called "morphemes". Generally, there are considered to be three morphemes: roots, prefixes, and suffixes. These are the central or main portion of the word, letter combination placed before the root, and letter combination placed after the root, respectively.

Morphology helps to trace the origins of a word or language. Because many words may originate from the same root, finding and identifying the history of that root form facilitates the understanding derivative words. The process of identifying a root is known as "morphological analysis". Whether in written or spoken speech. Lexical semantics (6.2.3).

6.2.2. Phrases, Clauses, and Sentences

Natural Language Syntax, Parts of Speech, and Grammars. Natural language incorporates many types of structure. Probably the most obvious structure is the syntax which is often modeling with grammars. Indeed, this has received the most attention.

Parts of Speech

In language, words are combined to form phrases and sentences. Generally, phrases are combination or groups of words that are functionally similar to individual parts of speech — they may identify an object (noun phrase) or an action (verb phrase), or describe an object (adjectival phrase) or an action (adverbial phrase).

Words are typically classified into groups based on the way they are used. This practice of identifying "parts of speech" (e.g., nouns, verbs, etc.) was probably a familiar assignment in grammar school. These parts of speech match grammatical structures. Indeed, we can call them "grammatical categories". Adjectives as modifiers. Predicates. Analytic versus systemic languages.

A sentence combines phrases into higher-level conceptual units; it organizes them into a whole unit that identifies or describe a concept. Through this process, symbols — words — are composed in ways that communicate information (1.1.3). As we have seen, words are complex — meanings and uses vary with time, geography, and context. Designing and information system to understand words and how they are used is a long-term process. Phrases and sentences, however, provide another way of accomplishing this task. Collocations and co-occurrences are statistical measures of what words appear together when communicating certain concepts. In this way, it may be possible to chart the semantics of a particular grouping of words, instead of the semantics of individual words.

Grammars as Models for Natural Language Syntax

Grammars are a logical formalism which describe the sequence in a string, especially in a string of words which form a sentence. We will examine the way grammars are used in constructing formal languages at the end of this chapter (6.5.1). But, of course, grammars are also associated with natural human language. Formal models versus probabilistic models.

While grammars provide an effective formalism, there is a lot of debate about the psychological validity of grammars. One view holds that the grammar of a natural language is based on fixed rules, which maintain its structure and consistency across time. Any deviation from those rules results in an incorrect usage, in a technical sense — the misuse of language for literary or poetic effect is quite common — though it is still, technically, incorrect. The opposing view holds that, in a sense, language is the medium of the people, and its rules are determined by those who use it. In this view, there are general part-of-speech categories that describe how words function within a sentence, but these cannot be conclusively assigned to every word. These are applied to natural language in describing the structure of parts of speech. Phrase-structure grammars. Fig. 6.7. Such a relatively simple grammar can be modeled with a state machine. Indeed, a state machine can be applied as a parser (-A.5.4).

Rewrite Rules		Description
LHS	**RHS**	
S	NP + VP	Sentences (S) are composed of Noun Phrases (NP) and Verb Phrases (VP)
NP	N, D + N	Noun Phrases (NP) can be composed of a Noun (N) or a Determiner (D) (i.e., 'the') and a Noun (N)
VP	V, V + NP	Verb Phrases (VP) can be composed of a Verb (V) or a Verb and a Verb Phrase (VP)

Figure 6.6: Fragment of a phrase-structure grammar. These are recursively expanded as in parse tree shown below.

Figure 6.7: Grammars are closely related to state machines. Here a recursive state machine link shows that one or more adjectives can be repeated before a noun.

String grammars (6.5.2) such as the ones we have been describing thus far often describe the structure of natural language statements. A "constituent grammar" is one that can be understood by breaking

Grammatical Categories	Lexicon
D Determiner	the
N Noun	dog, boy
V Verb	bit

Figure 6.8: Here is a simple lexicon for the example grammar; any real lexicon and grammar would have many more parts.

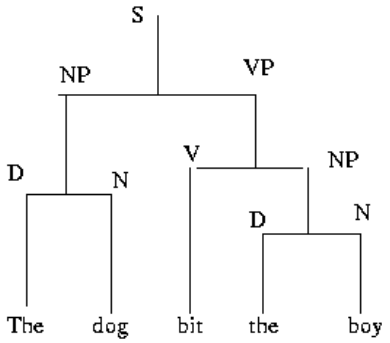

Figure 6.9: Parse tree for "The dog bit the boy". (check permissions)

it down into its constituent parts. The traditional grammar that is taught in most grade schools is an example of a constituent grammar; more specifically, it is a "phrase-structure grammar". In this framework, a sentence (or an entire grammar) can be seen as being composed of ever more discreet units, such as noun phrases and verb phrases at the phrase level, and nouns, verbs, adjectives, etc. at the word level. Simple grammars such as those which approximate state machine are easy to develop but natural language is so complex that they do not handle all cases.

Constituent grammars are generative models of languages; that is, they provide a framework for describing how language could be generated. Natural language grammars are a type of knowledge representation for subjects and predicates. To a large extent, natural languages are well modeled by context-free formal languages.

Grammars and Language Production Grammars and Language Production. Psycholinguistics. From deep structure to surface structure, for instance, there are regular patterns for making a question from a statement. These patterns can be described with "transformational grammars" (Fig. 6.10). This is the basis for the deep structure.

Declarative	Interrogative (Question)
Today is Friday.	Is today Friday?
Jill went to the store.	Did Jill go to the store?

Figure 6.10: Questions are created from declarative sentences with a regular pattern. This change of structure can be accomplished with a "transformation grammar".

Wh-questions and question answering.

Beyond Phrase Structure Grammars Natural language is subtle and there are many aspects of natural language which are not well captured by simple grammars. These include: Agreement and tense as aspect. Language coordination. Stochastic grammars.

6.2.3. Natural Language Semantics

By comparison to formal languages, natural language is ambiguous. One of the hallmarks of natural language is its redundancy. Although the following two sentences have different vocabulary structure, they have approximately the same meaning. Semantics, in this sense, can often be paraphrased — the

same ideas can be expressed in several different ways. Words as distinct lexical units (6.2.3).

The pedestrian was struck by the automobile.
The car hit the person who was walking.

Semantics is the literal definition as derived from the dictionary. rather than the subjective meaning. Rather, subjective meaning is covered as pragmatics (6.3.1).

Lexicography. Semantic analysis of words.

The semantics of natural language differs from formal semantics (6.5.2). The semantics of formal language are specific, and can be defined within that formal system; however, the semantics of natural language are not specific, and may depend on the listener. Meaning can be subjective — ultimately, understanding natural language communication is an act of interpretation on the part of the listener (or reader).

Semantics may be defined by an absolute standard, such as dictionary definitions, but it may also be defined by use.

Lexical Semantics and Definitions

We start with "lexical semantics" which focuses on the meaning of words. In natural languages, as opposed to formal languages. This builds on several issues we have already discussed such as categorization (2.1.1) and semantic networks. there is generally much redundancy at the word level; many words can mean the same thing. This highlights the fact that words themselves (what they sound or look like) are only indirectly related to the concepts they represent. Generally, meaning is not inherent to the word or sound of the word itself, with the obvious exception of onomatopoeic words such as "hiss," or "bang". Meaning is attached to words in an abstract way. Another model for the relationship among words describe the relationships among the words as semantic fields. Semantic relationships (2.1.4).

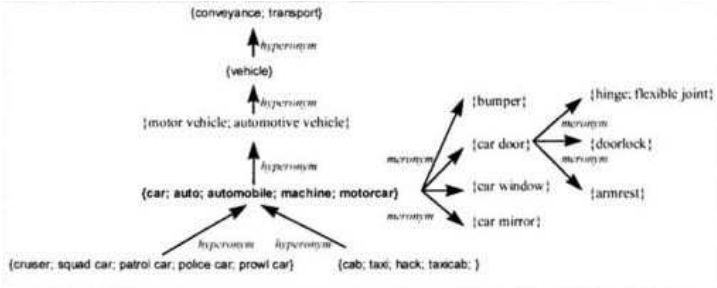

Figure 6.11: Wordnet. (redraw)

Words as signs in the semiotics sense (1.1.4).

Word spaces and search engines.

Definitions

Definitions as declarations versus definitions as reporting actual usage. Ideally, a language would identify each concept with a different word or word sense. A "word sense" is a particular formation or meaning of a word; "fly" vs. "flying," for example, or the different definitions of the word "bank". Following Aristotle, definitions should be based on determining underlying concepts and their attributes. This often works well, but as we noted in (2.1.1) there are other approaches to describing entities than Aristotle's. A single word, however, may be used to describe several different concepts; *Webster's New Collegiate Dictionary* lists 63 different senses for the word "set." Some words even completely change their meaning through time, and in some cases, both senses may continue to be used: "sanction" can mean both to approve and to disapprove. Clearly, it can be difficult to pin down word senses. Indeed, definitions also reflect social usage. Fig. 6.12 contrasts definitions of "music" from two dictionaries. Word senses are often domain specific. Differences of definitions and discourse communities. Moreover, word definitions and usage are fluid. Frames as capturing word senses (6.2.3).

music

1. The art of arranging sounds in time so as to produce a continuous, unified, and evocative composition, as through melody, harmony, rhythm, and timbre.
2. Vocal or instrumental sounds possessing a degree of melody, harmony, and rhythm.
3. a. A musical composition.
   b. The written or printed score for such a composition.
   c. Such scores considered as a group: We keep our music in a stack near the piano.
4. A musical accompaniment.
5. A particular category or kind of music.
6. An aesthetically pleasing or harmonious sound or combination of sounds: the music of the wind.

music

1a: the science or art of incorporating intelligible combinations of tones into a composition having structure and continuity
b: vocal or instrumental sounds having rhythm, melody, or harmony
2: an agreeable sound: EUPHONY
3: punishment for a misdeed
4: a musical accompaniment
5: a musical ensemble
6: the score of a musical composition set down on paper.

Figure 6.12: Entries for "music" from two dictionaries: (upper[1]) and (lower[6]). Why aren't the word definitions and senses exactly the same?

The subtleties of word distinctions suggest the difficulties of creating hierarchical lexical categories such as those in (2.1.2). Organizing natural language for the purposes of computer interaction is further complicated by the evolution of language. Language is not static (Fig. 6.13); the changes in words over time is a problem for controlled vocabularies (2.5.3) such as those used in natural language processing systems.

Language games.

The word *suede* originates in the phrase *Suede gloves*, from the French phrase *gants de Suede*, literally "gloves from Sweden".

Figure 6.13: The meaning of words often evolve from other terms. The word "suede" comes from "Sweden"[21].

We have already seen several techniques for representing semantics such as ontologies (2.2.2). An ontology be used to create a working vocabulary and then build outward, with each new term or usage being labeled to fit into the overall categorization. This is similar to a semantic network in that the meaning of any word is determined by its position relative to other words, but ontologies are usually more limited, seeking to allow communication and understanding based on a predetermined, context-independent vocabulary. Ontology extraction (10.5.3).

Verbs Verbs link nouns or noun phrases together much the way relationships in ER models link entities. Verb hierarchies establish conceptual dependency between different words (frames). Verb forms and tenses enrich and coordinate conceptual dependencies with ontologies (2.2.2). However, such approaches are often difficult to apply because of the ambiguity of context. Verb type affects syntactic structure (e.g.,[37]). Tense-aspect-mood.

Semantic network (Fig. 6.14).

Denotation and Connotation We may distinguish between "denotation," which is the exact dictionary definition of a word or term, and "connotation," which is the informal meaning it carries. Prescriptive and descriptive definitions.

The discrepancy between literal and intended meaning is often expressed through the use of literary

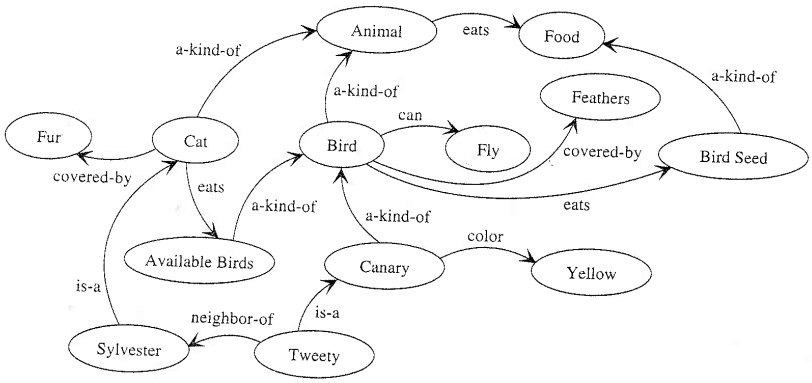

Figure 6.14: Semantic network. (redraw)

devices, such as metaphors. This is when a word or phrase is used to describe something when that word or phrase literally means something else. Metaphors are not meant to be taken literally but to set up a comparison between two things for the purpose of expressing an abstract concept.

Evolving Word Senses and Definitions

The human environment changes. Natural language needs to be malleable. "Ruthless," means to actually be without "ruth," which was a common Middle English word for pity or compassion. That word slowly lost favor and fell out of use; however, "ruthless" remains common today. Languages interact with one another to form new languages, and new words and word senses are constantly coming into being. Some words are introduced from other languages, and are termed cognates; an example would be the word "menu," which was adopted in English from French, where the word means the same. Other words are created. These are termed "neologisms," and frequently arise due to technological or social change. The word "spam" is a good example of a neologism; originally coined as a brand name for a type of canned meat, it now exists as a word in its own right, meaning unsolicited email. The need for a word to describe unsolicited email (or even "email," for that matter) simply did not exist until the 1990s.

Words which have evolved to have multiple meanings are said to have "polysemy," or to be "polysemous". A "chair," which is a piece of furniture, preceded the concept of a "chair" as a person who leads a meeting. The meanings of polysemous words are generally related to one another through abstraction and derivation.

Representing Natural Language Semantics

The meaning is not reflected by parts of speech. Rather, the meaning is defined by the combination of entities. Indeed, a whole other model for representing word meaning is based on words distributed in a space (10.9.2). Using frames of various sorts. Related actions and descriptions.

From knowledge representation to knowledge representation languages. Only symbolic representations are considered con in this section. Semantic representations have several useful applications such as summarization and machine translation. A detailed semantic analysis can provide an interlingua (6.2.3). A semantic representation that is language-neutral and can be useful in translation between two or more languages (Fig. 6.15) (10.13.1). Formal knowledge representation languages often employ ontologies (2.2.2). More complex reasoning and logic (-A.7.0). Encapsulating contexts.

```
[ Event GO_Ident([Thing SNOWMAN],
    [Path TO_Ident
     ( Position AT_Ident([Thing SNOWMAN],[Thing PUDDLE],)])],
    [BY <MELT>])]
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Figure 6.15: Possible semantic representation for the sentence "The snowman melted into a puddle"[20].

Case and Semantic Frames Semantic relationships have been important throughout this discussion. Frames are templates of related attributes (6.2.3). Frames can be constructed around verbs. A frame is a group of schemas, or generalized descriptions of an action or event, that form a consistent unit (Fig. 6.16). Frames are used as a means to anchor the potential meaning of language. They provide a context within which to interpret the relationships and can be useful in information extraction (10.5.0). Extends verbs. This is a type of semantic role (2.1.4). Thematic roles.

> An Agent performs a Response_action on a Victim as a punishment for an earlier action, the Injury, that was inflicted on an Injured_party. The Agent need not be identical to the Injured_party but needs to consider the prior action of the Victim a wrong. Importantly, the punishment of the Victim by the Agent is seen as justified by individual or group opinion rather than by law.

Figure 6.16: Frame for the concept of "revenge"[15]. Note the expected Frame Elements: Injury, Agent, Victim, and Response.

Figure 6.17: FrameNet composite frame for a crime scene. Several frames are joined to create an overall scenario. (redraw) (check permission)

Propositions and Semantic Grammars The roles the words play in creating the meaning of the sentence. This may be related to parts of speech but is not necessarily the same. What is "case"? SVO[23]. Sometimes semantic networks will employ "case frames" to help determine context. Case frames are assumptions about common word meaning when used in particular contexts. These seek to disambiguate different possible word meanings by identifying common semantic relationships between words in a given usage. Case grammars are used to facilitate this process. Because the semantics of a particular contextually situated sentence or phrase are often determined by the syntactical relationship between, primarily, the noun and verb phrases, this syntactical relationship can help to determine the semantics of a sentence. Word senses depend largely on context.

Semantic Cohesion

Reasoning about semantic properties helps people understand how statements hold together. The meaning is ultimately defined by a person hearing or reading the language. The relationship of the components is the semantic cohesion. Semantic cohesion develops from an understanding of the relationship among concepts (Fig. 6.18). This cohesion is based on our knowledge of what would be logical in a given context. Attention management in language and conversation.

> Margie was holding tightly to the string of her beautiful new balloon. Suddenly a gust of wind caught it. The wind carried it into a tree. The balloon hit a branch and burst. Margie cried and cried.

> Margie cried and cried. The balloon hit a branch and burst. The wind carried it into a tree. Suddenly a gust of wind caught it. Margie was holding tightly to the string of her beautiful new balloon.

Figure 6.18: The first story is more satisfying because it has semantic coherence and follows our expectations for the logical development of events. (redirect)

Semantic cohesion includes reference which refers to timing, sequence, or indicate cause and effect.

"Anaphora" is the technique of using a word (often a pronoun) to refer to something described earlier. Similarly, a metaphor has a scope of applicability.

These referents are generally based on the unique characteristics of the human experience in the physical world; notions of time, location, mass, movement, and causality are so intuitively used by humans that day-to-day language allows short cuts. This would be confusing to anything not indoctrinated into this system; consider this pronoun reference example, using anaphora: "The table hit the chair and it fell". Most listeners would expect that it was the chair that fell, as it is lighter than a table, but it is also possible to interpret the sentence as saying that the table fell.

This understanding of the physical referents of language help to socially mediate communication and construct a joint understanding of language. This can be termed "groundedness". In situations dealing with non-physical things, people use physical-world referents as metaphors to describe abstract concepts.

Cohesion in text is somewhat subjective. The writer's goal is the management of the listener's attention [29]. Consideration of higher-level units in the text leads us to the possibility of examining the structure of those intentions.

6.2.4. Semantics and Domain Structures

There are many niche applications of language and knowledge of these niches turns out to be crtical in dealing with them.

6.3. Language and Interaction: "Doing things with Language"

Semantics focuses on the literal definitions of terms but natural language goes well beyond the literal meanings. Function rather than structure. Natural language use is very context dependent. This can be viewed as layered interaction which can go beyond natural language. Relationship between language and action and behavior. Semantics and Wikipedia [?]. Linking instances with semantics.

6.3.1. Pragmatics

Pragmatics considers the effects of the social context on the meaning of statements. Thus,y it is essential for communication because the social context and cultural assumptions are often significant factors in determining meaning. Context can often clarify ambiguity.

referential	conveys information about some real phenomenon
expressive	describe feelings of the speaker
conative (instrumental)	attempts to elicit some behavior from the addressee
phatic	builds a relationship between both parties in a conversation
metalingual	self-reference
poetic	focuses on the text independent of reference

Figure 6.19: One taxonomy of pragmatic categories[31].

There are many types of context, such as the context of the communication task being performed, the expected audience, and knowledge that is implicit or shared between the communicators, which may be manifested as assumptions, social conventions or expectations. A sentence may have a literal meaning in one context and an entirely different meaning in another context.

Signs. Semiotics. Indexical signs.

Layers of interaction in education (5.11.4). Communicative practice.

Grounded natural language processing. Reference (Fig. 6.20). Artifacts in computer-mediated communication (5.6.5).

Most conversation has a topical focus that lends it coherence. This focus contributes to attention management[29].

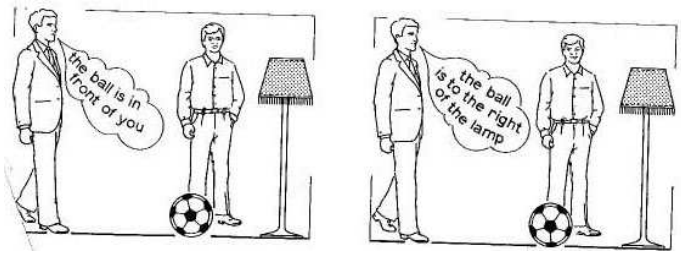


Figure 6.20: Conversations include reference to the physical world. (redraw)(check permission)

Emphasis on the social aspects of language suggests that a focus on social interaction leads readily to a functional analysis of language rather than to a structuralist approach. That is, the focus is on the effect of the language rather than the syntax. Languages have large cultural and political implications. Moreover, language is highly dependent on the task or domain to which is applied. Recognizing the task can help the language understanding.

The context, tone, or history of the speaker may be used to modify the literal meaning of words (11.3.3). Statements such as "It's cold in here" may be intended as a request to close a window. One distinction is between statements that commit a speaker and those that are intended to change the state of the listener (perlocutionary acts).

Speech Acts

We can also try to understand how people "do things" with language[13]. Performatives. Thus, the focus is not on the structure of the language but the functionality. These are speech acts (Fig. 6.21). The approach is based on a model of intentional action.

Earlier, we mapped a negotiation by the transactions and commitments that were made rather than the ways those were expressed (3.4.4). Tutoring dialog may be characterized by speech acts which emphasize the educational purpose behind each statement (5.11.3)(Fig. 6.22). This is for the ideal situation which does not include persuasive speech or gamesmanship. (illocutionary acts)

Speech Act	Explanation	Example
Assertives	To instill a belief	Today is Tuesday. Not Wednesday.
Directive	To get the addressee to do something	Put it over there.
Commissives	To commit to something	I'll fix it after dinner.
Expressives	To express a feeling to somebody	I'm so excited, I could burst!
Declarations	To state a position	I'm in favor of building it!

Figure 6.21: One system speech acts (adapted from[53]).

Speech Acts	Example
Pump priming	Gives some basic data and examples from which a student could generalize.
Splicing	Suggests how to unify ideas that have been expressed separately.
Correct and amplify	Gives corrections and further information.

Figure 6.22: Some speech acts which have been proposed for tutoring dialogs[26].

Multi-sentence speech acts [?]. Macro-speech acts.

6.3.2. Discourse

The term discourse is yet another that is used in a number of different senses. It may refer to any sort of conversational exchange or to a stylized way of speaking or it many simply refer to units of the exchange.

Discourse in science (9.2.3). The author needs to provide context for the reader by managing coherence and attention.

Discourse fulfills social goals as a part of social action. For instance, discourse is essential for tutors (5.11.3). It also helps us better understand "gamesmanship" (5.3.3). However, discourse can often be subjective. To the extent it matches a group's perspectives, it may reflect political opinions.

Discourse as "how things are said". Discourse is often associated with constructing passages that accomplish certain purposes or tasks. Discourse is an interaction sequence which intends a transfer of information. Four types of discourse are commonly identified: Exposition, Description, Argumentation, and Narrative.

Discourse versus genres (6.3.7). Discourse macros. Academic discourse[30]. Moves in discourse shift focus from one level of understanding to the next[17]. Discourse helps disambiguation based on social factors. Discourse types of sentences: declarative, question, imperative, exclamatory.

One example of the style of presentation such as "hedging" – that is allowing for some possibility of error. Discourse management in tutoring and classroom (5.11.3).

Normative ethics[14].

Critical Discourse

How people use language to accomplish their goals. Attitude change. The way people present things when speaking may reveal cultural assumptions and logic. Either explicit or implicit. Passive voice.

Discourse Processes: Elements, Acts, and Moves

Affects processing, understanding, and memory.

Discourse also creates structure of meaning beyond the sentence level. The elements of a discourse are related to the structure of a task (3.5.4). In this sense, the given part of the discourse is based on a task model or user model. For some tasks, the components are clear and the accomplishment of those tasks can be clearly indicated. Discourse elements generally are not useful by themselves. Rather sets of them are needed to complete tasks. There are many ways of classifying discourse. Sets of discourse elements. Functional task analysis.

The transitions within a discourse are called "discourse moves". These are initiated with specific structures. This include discourse pairs such as Topic-Comment, Theme/rheme, and Given-new. It is common in communication to establish a "given" and then to use that as the basis for comparison with a change (Fig. 6.23). This forms the classic "given-new" pairing "Bill went to the store." tells us that somebody we know (Bill) changed to a new state. He went to the store. While given-new is very common, it is not very precise.

Figure 6.23: Before-after pictures are a form of the "given-new" principle. (new picture-K) (check permission)

Automatic Extraction of Discourse Structure. Generating models of what is going on in a discussion.

Discourse macros versus discourse plans.

Discourse Plans

Planning (3.7.2) is a part of a text generation system. Planning as a goal-oriented activity.

Statistical models for speech act detection. For instance, with HMMs.

Discourse and verbs (6.2.3). Verb semantics. Semantic cohesion versus discourse frameworks.

Many of these models are hierarchical. That is, they form discourse tree[47].

When discourse is part of a complex activity intended to have specific effect, it may need to be planned (3.7.2). Determining and filling constraints[41].

Discourse Processing and Comprehension There is a great deal of research about how people understand discourse. That is considered as part of the study of reading (10.2.0). Story understanding as being able to answer questions about a story.

6.3.3. Types of Discourse: Description, Exposition

Here, we use a relatively simple set: Description, Exposition, Explanation, Argumentation, and Narrative.

Scoping communicative acts is a fundamental activity. However, this can get quite complex. For instance, a narrative can be interwoven with an explanation. These can have implications for the design of effective texts. Generally qualitative (4.1.1).

Conveying factual information. Descriptions of information resources (2.4.3).

There are many styles of authoring. From speech generation to design. Language can be styled to express myriad meanings, from the simplest statement to high art. Poetry, for example, combines sounds and sense to give the reader an emotional, aesthetic experience. Other language devices include allusion, alliteration, and rhetoric.

Exposition lays out the facts of a case. High-level expository styles. Problem-solution. Cause-Effect. Analogy.

Expository content lays out an issue or presents a description of a process or situation. It can also illustrate causal relationships among concepts. Complex texts use elements that enhance their coherence, including time, entailment, implication, and causality.

6.3.4. Types of Discourse: Explanation

Explanations go beyond descriptions to provide context and causation. They describe a model. We have discussed many types of question answering systems in this text, answering those questions often results in providing explanations. An explanation helps a person comprehend a situation or event. Describing content to others. This should emphasize the use of mental models and is similar to tutoring and teaching (5.11.3). Build on the basic elements. We have already discussed many types of explanations such as those used in question answering and tutoring. Another type of super-structure is explanations. The goal is to convey a description of a process as clearly as possible.

There can be several approaches to explanations. Explanations based on theories and causation (4.4.2) and conceptual models (4.4.1). Scientific explanations (9.2.3). History explanations ((sec:historyexplanations)).

Wittgensten and language games.

Adding interactivity to explanation approaches a tutoring system (5.11.3).a Tutoring models with discourse-based explanations [**?**].

Two aspects: what is the explanatory model versus how best to present it.

Explanations and expert systems and case-based reasoning – explaining why a certain decision was reached. Explanations often include appeals to logic but also includes some background. Evaluating explanations[36]. Explanation includes an aspect of presentation of effective conceptual models. Explanations are typically either causes or sub-processes[48].

History attempts to describe and provide explanations for specific events. Fig. 6.24. Science (9.2.2) explanations for general cases.

Explanatory target
Why does a *patient* get *atherosclerosis* with associated symptoms such as chest pain?
Explanatory pattern
The *patient* has inherited various *genes* that encourage the development of risk factors such as hyperlipidemia, hypertension, and diabetes.
The *patient* is subject to various *environmental factors*, such as a high fat diet.
The *genes* and the *environmental factors* interact to produce the disease.

Figure 6.24: Atherosclerosis explanation schema[60].

Explanation is, of course, useful in education where it often in intertwined with the presentation of conceptual models, Models are essential for explanations. of expository writing[32]. Mathematical models such as those in DSS systems are known as influence diagrams. Explaining causes versus identifying actual causes. Explanations are often based on dubious constructs and poor logic. Schemas are similar to frames in providing templates for possible answers (Fig. 6.28).

Explanatory coherence[60].

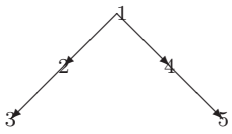
6.3.5. Types of Discourse: Argumentation and Rhetoric

Arguments makes claims and support them with evidence. It's purpose is to persuade; however some of the argumentation systems we describe below simply lay out an argument. We find formal approaches to argumentation in law (8.5.4), history (5.13.0), and science (2.6.2).

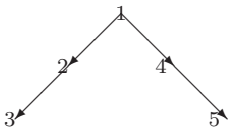
The Structure of Arguments

Issue-based analysis lays out considerations in reaching a decision. It is a type of argumentation system. Claim-support-argument structure (Fig. 6.25)[18]. Argumentation and trustworthiness of information (5.2.3). Design rationale (3.8.7).

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



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



1) The city is a mess.
2) The parks are a mess.
3) The park benches are broken.
4) The grassy areas and parched.
5) Returning to the city problems, the highways are bad too.

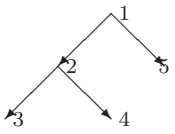


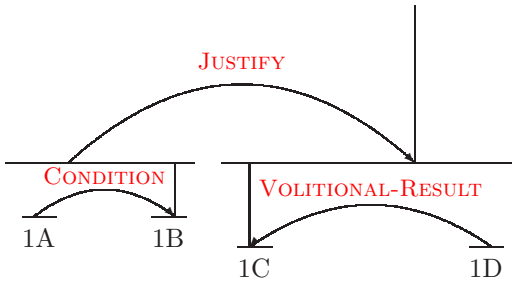
Figure 6.25: A variety of Claim-Support-Argument structures[18]. (different example)(check permission)

Claims and hedging.

Rhetoric and Rhetorical Structure

Rhetoric is sometimes defined as any sort of public speech and sometimes the goal may just be to present information clearly. In a stronger sense, sometimes rhetoric is "persuasive speech," or "effective discourse". One of Aristotle's most famous works was his "Rhetoric" [12] that attempts to instruct people how to be persuasive. For instance, Aristotle emphasized syllogism which is a simple logical device. Teaching effective (persuasive) writing and oratory. Rhetorical devices. Disputation and affect. Procedural rhetoric.

Rhetoric is how a position is presented. Rhetorical structure theory (RST)[40] is probably the best known approach for discourse tagging. Rhetorical Structure Theory (RST) is composed of discourse sets and relationships among them[40] (Fig. 6.26). Nucleus/Satellite. One block of text may "justify" or add "conditions" about another block of text. Genres (6.3.7).



[And if the truck driver's just don't want to stick to the speed limits,]^{1A} [noise and resentments are guaranteed.]^{1B} [It is therefore legitimate to ask for proper roads and speed checks.]^{1C} [And the city officials have signaled to support local citizens.]^{1D} (maz$_{5007e}$)

Figure 6.26: The rhetorical units in a discussion based on an analysis with RST. A specific set of Elements is proposed but also, proposes that thread which connects them follows a specific structure.

Focus on larger elements of the argument. One model's elements include: Claim, warrant, data, backing, rebuttal, qualifier (Fig. 6.27)[61].

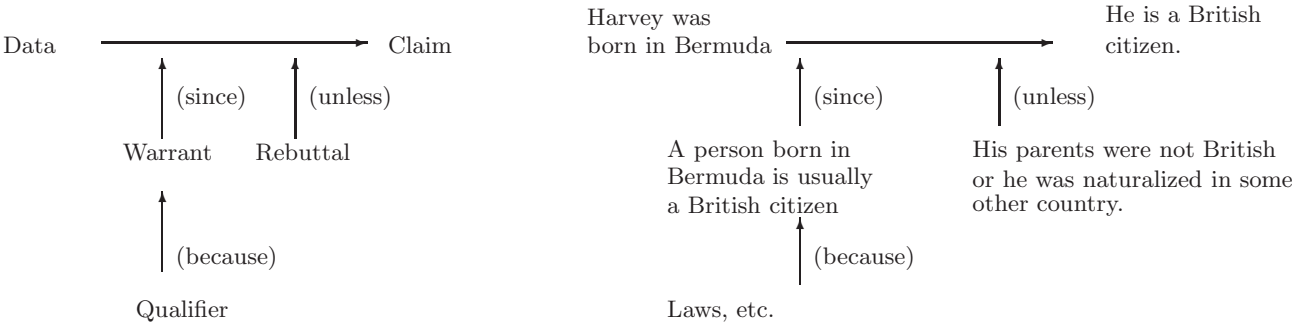


Figure 6.27: The reasoning of an argument can be illustrated graphically. A framework for the components of an argumentation (left) and an example (right) (adapted from[61]).

Science as argumentation (2.6.2). Actual arguments are often more complex than can be handled by Toulmin[42].

Varieties of argumentation systems. Representation of argument elements. Interfaces for browsing the arguments. Overview of most important themes and zoom in. Collabortive and community argumentation. Argumentation systems can be useful for claify arguments and for teaching argumentation.

6.3.6. Types of Discourse: Narrative

Narratives deal with a specific situation rather than general principles. Narratives typically do not emphasize logical explanations but usually emphasize human experience. Typically, a story states a problem or challenge describe how it is resolved. Stories include narrative, plot, and character. Narrative as a trajectory through a story space. Some games. Collaborative story telling. Narrative as revealing cultural gist.

From narrative to drama to cyber-drama. Drama provides a focused context around actions. Theater (11.5.0). Cyber-drama (11.5.3). More theory in (11.5.4). Structure of a story with drama. Character development. Building emotion, affect, and empathy. Yet, in current systems there are restrictions on the possible complexity of the narrative pathways.

The king died. Then the queen died.

The king died. Then the queen died of grief.

Ubiquity of Narratives

We have encountered stories repeatedly as a way that people create coherence of their world. Narratives are similar to explanations but they include additional features such as titles to support emotion and attention management. Having a story understanding the practical constraints can be effective for some management decision making. When there are several possible stories, find the story that is most consistent. There are many ways in which casual models affect perception. Stories and attribution (5.5.2). A strong sense of causality in memory. Episodic memory. Topic-organization content. Narratives and games. However, maintaining the coherence of the narrative in the interactivity can be challenging (4.4.3). Oral histories and cultural heritage.

1. The defendant was speeding and sleepy so the defendant caused the accident.
2. The defendant was speeding and sleepy but another person's car lost its brakes hit him.

Figure 6.28: A narrative based on a plausible causal chain (top) can be persuasive even another statement is more accurate.

Combining events into a larger conceptual whole. Multimedia programming and management of attention.

Narrative as a foundation for cognition (4.3.0). Inferring causation with narrative (6.3.6).

Narrative is the retelling of a sequence of events. Drama (11.5.4). Dimensions of drama from [16] are listed below:

Diachronicity describe the idea that there must be a sense of action taking place over time.
Hermeneutic composability refers to the idea that narratives can be interpreted as a story composed of events.
Canonicity and breach is the principle that stories require the breaking of a normal state of events.
Referentiality is the principle that a story somehow refers to real world states, though this may be tangential.
Genericness means that the story belongs to one or more families of story types.
Normativeness is the idea that narrative depicts norms of behavior.
Context sensitivity and *negotiability* suggest that narrative requires the negotiation of roles between author and text.
Narrative accrual describe the principle that new stories directly follow from older ones.

Narrative Components

We usually enter into a story with expectations that we assume will be fulfilled. A story must reach "closure," that is, the resolution of an initial conflict.

The story has a progression. A dramatic arc describes the evolution of a character across a story. (Fig. 6.29). The arc can also reflect the dramatic tension and presumably, the emotional response of the audience.

Point of view which is also found in video games.

Combining logic and the perception of plausibility. It can often be improved by critical analysis. Combine logic and perception of plausibility. If there is any causal story, people tend to accept it. Stories have many roles in a culture. Myth and canonical structures. Road movie.

Components of narrative. Plot, character, theme. Narrative design. Story planning.

Story episodes.

Systagmatic. Specific time, place, characters.

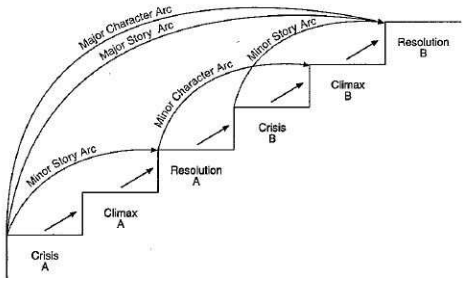


Figure 6.29: Story arc with major and minor characters. (check permission)

Motifs and themes.

Narrative Structure

Many stories follow regular patterns so it seems natural to develop representations. Some aspects of narrative are highly stylized. Indeed, Russian fairy tales (Fig. 6.30) are so stylized[50] that grammars have been proposed describing these. Story lines, story graphs. grammars, and dynamic agents. Agency in narrative[22].

In one village there lived three brothers. The two elder brothers were successful merchants, but the youngest brother was a fool named Emelya who slept on the stove all day long. Once it happened that when he went to the ice-hole for water and he caught a magic pike. The pike asked him to let her go free and promised him to grant any of his wishes. "Just say these magic words: 'By the pike's wish, at my command,' and everything will be done" the pike said. Emelya agreed.

He ordered his water-pails to go home by itself, which they did, much to the surprise of his sisters-in-law. Then he ordered the sledge to go by itself to the nearest forest where his ax felled wood for the fire. The Tsar of the land heard about that wonder and ordered his officer to bring Emelya to the palace. When Emelya came to the Tsar's courtyard he saw the Tsar's daughter and used the pike's magic to make her fall in love with him.

Then the Tsar gave orders to place the princess and Emelya in a barrel and throw them into the sea. But Emelya again used the magic words and the waves rolled the barrel onto the shore of a beautiful island. With the pike's help Emelya "built" a big marble palace. Then the princess asked him to become handsome and smart, and he turned himself into a fine young prince. They started to live peacefully in the palace.

One day the Tsar visited the island and, oh! What a wonder!, he recognized his own daughter and Emelya who was changed into a fine prince. The Tsar wept and asked their forgiveness. They celebrated the family's reunion and lived happily after that.

Figure 6.30: "The Pikes Story" is a Russian fairy tale. Such tales are highly structured and it has been proposed that a grammar could describe the structure. (Translated Richardson). (Check permission).

The fabula is the sequence of behavior in the story world and syujhet.

Markup for narrative[11].

Story grammars. Rewrite rules for narrative [**?**]. Planning and story generation.

Narrative comprehension. Forming mental models.

Stories, Character, and Capturing the Human Experience

Stories have a structure, but they also reveal human experience. Describe such common human experiences as birth, death, and family. Managing affect. Developing empathy (5.5.3)with the characters. A story's closure gives it an emotional satisfaction. The moral of a children's story transmits a lesson as in *Aesop's Fables*. Tracks human life. Social role of narrative. Taxonomies for folktales and folklore. Managing emotional affect (4.6.2). Are the characters believable? Do we develop empathy with them? We need models of the users in order to develop empathy with them. Representing character goals and psychology.

Standard character: Heroes, victims, villains (antagonist), sidekicks[55].

Affect in stories and generating affect. Effective story-telling[5]. Narratives and games (11.7.0).

There are many common patterns of in human lives and , of course, these are reflected in human stories. Universal themes and story templates. Moral. Allusion, Symbolism. Myth. A "failed quest" is one of what is claimed to be 12 basic story forms[4]. An example is the story of the Holy Grail. Stories often follow predictable patterns; one type of story tells of a "failed quest". Plot and character development can also follow patterns. Archetypes.

Figure 6.31: Lancelot and the failed quest for the Holy Grail. (check permission)

The coherence and fidelity of a story can be more important to our beliefs than support from direct evidence[24]. Expectations (4.4.3).

Describing the goals of the characters and the goal conflicts[22].

Interactive Stories: Story Interfaces and Narrative Engines

Beyond books and movies, Computers lend themselves to interactive fiction. Interactive stories. The simplest of these are branching stories and serious games (11.7.3).

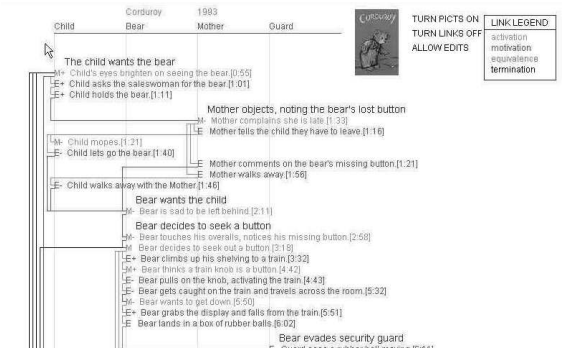


Figure 6.32: A notation for browsing the events which form the plot of a story[11]. (check permission)

Automated story telling. Narratives in games. Planning and narrative. Story re-planning as needed. Believability.

Narrative theory (11.5.4).

Combining Discourse Types

Story interpretation and cultural context[49]. Some types of works are composed entirely one type of discourse. An explanation may be only that. However, some other types of material may interweave several of the types. A news story or a biography have explanation, narrative, and argumentation all mixed together LDM[49] a different approach to discourse units. In other cases, this we see more

structure for organizing content. Simple example: explanation within a story. Trajectory of a discourse. Many types of knowledge are required for understanding language.

6.3.7. Content Genres and Literary Forms

There are trends and styles in information resources. They often reflect technological changes in media presentations or events in society. For a while Western movies were particularly popular and then the interest in that style faded. These emergent patterns often not stable enough to be systematically classified. These are reified as complex objects (7.8.4).

The use of genre can be viewed as social action. They may be relatively stable (e.g., business letters) or ephemeral. They are related to trends in both technology and culture. Genres provide expectations about a resource for the members of a given community.

A literary form is more defined than a genre. XML DTDs as genres (2.3.3). Genre Template.

Genres are found in systems of media. Complex works include books, movies, and songs. Typically, genres are composed of sets of related entities and they often result from a nexus of technology and culture. There are many examples of genres.

Trope.

Media exists in a milieu of technology. Broader units than discourse (6.3.2). Genres can provide expectations about discourse and help build expectations. They can be thought of as a prototype (2.1.3). Genres can are also defined by reference to cultural trends and other works. This latter is known as intertextuality. Genre analysis[58] and genre classification are tricky because genres themselves are often poorly defined and are highly dynamic.

Genre ecologies[56] describe interlocking sets of document and forms in an organization.

Examples of Genres

There are many examples: Graphic novels. Documents as a genre (2.3.1). Music genres. Hip-hop. Genre detection Genres in science writing (9.2.3) are sometimes explicitly defined.

Genres, hypertexts, and interactive video games (11.5.4).

Literary Genres Books are a highly developed and generally very effective genre. Aids for readers and clarity for use. The development of books, printing, printing, libraries, and universities are all inter-twined. Ecologies of genres in organizations. Also, to an extent in businesses and the Web.

Printing and publishing (8.13.4). Print culture (8.13.6).

However, it is a specific style that evolved over time. Novels are a story told in prose.

Figure 6.33: *Kiss of Death*[33] is an example of the 1930s genre known as Film Noir. (redraw) (check permission)

Items from a given genre show shared communicative purpose. Genres are hard to capture. Genres on style, theme, mode. From literary styles to genres. Affected by the culture and technologies. Genre of media forms such as a novel. Content genres such as Film Noir (Fig. 6.33) which was a style of

movie which was popular in the 1940s and 1950s (Fig. 6.33). Building shared expectations about style, symbols, and structures. Emotion, society, content. Social processes and genres. Game types (11.7.0).

Genres in organizational communication. Indeed,[44] argue that communication genres help to define the structure of the organization and may even control members of the organization. Social genres. Genre ecologies[2]. Genres often defines a sub-culture. Genre classification can be tricky because genres are by their nature fuzzy and ephemeral.

6.4. Conversation and Dialog

Language is primarily social. Here, we consider the social component. Conversation is the most direct form of verbal interaction. Social interaction through language.

Modalities (5.6.5). Dialog systems (5.11.3)[27]. As with other types of multi-agent communication, protocols for the interaction. Language is, of course, fundamental to social interaction. Social interaction is highly varied. From simply getting acquainted to communicating shared goals of a group. Communicating the scope of an interaction. Orality and oral traditions (11.3.3). Multimodal social interaction (4.2.4). Gestures (11.4.1). Multi-person conversation and speech analysis (11.3.3).

We may distinguish among different types oral interaction. Debate. Gossip. Genres. Meetings (5.6.3).

Task-based and activity-structured discussions Meetings. Routine activities.

Providing tools for supporting reference in computer-mediated interaction (5.6.2).

6.4.1. Social Interaction through Language

Conversation is social interaction by natural language. It is a model for other kinds of interaction such as, increasingly, the interaction between a person and a computer. Conversation is often instrumental, that is it helps people to accomplish their goals (Fig. 6.34). Development of conversational ability. Types of social coordination (3.5.3).

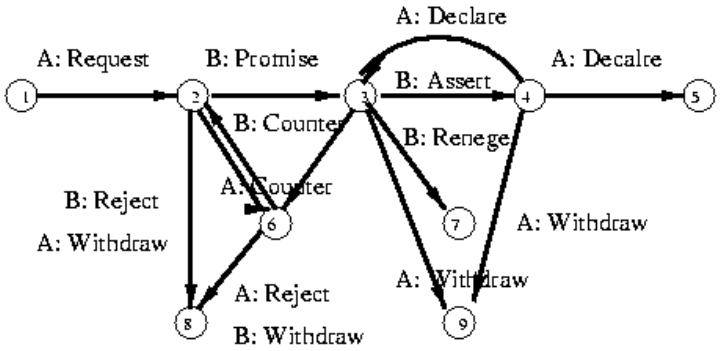


Figure 6.34: Stages of interaction between two people (A and B) during a negotiation (adapted from[62]). (redraw) (check permission)

Conversation and work.

Adjacency-pairs. Question/answer Greeting/Greeting.

Pragmatics is a significant factor in conversation. Indeed, many conversational statements violate syntax but are understood perfectly well because of their context.

Fig. 6.35 during design discussion. Task-oriented discourse.

Chat-room conversation transcript.

While discourse is "public speech", conversation is often an informal discussion between a small number of people. Conversation incorporates linguistics with social interaction. Most conversation is about

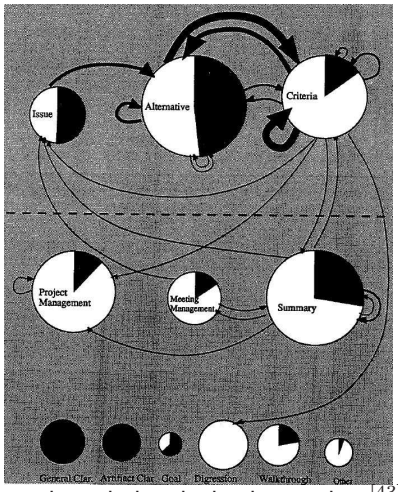


Figure 6.35: Transitions observed discussions during design interaction.[43]. (check permission) (redraw)

narrow topics, is between people who know each other very well, and is heavily context laden. When the participants in a conversation know each other and have a long history, the conversation may appear erratic to an outside observer. Several types of conversational interaction can be identified. Task-oriented interaction versus information interaction (3.4.3). Conversation conveys information and that often creates social bonds (5.2.1).

Rather than focusing on the words which are exchanged, we can also consider conversation?s role in developing affective bonds. Physical aspects of conversation such as gaze and body language. Gestures and facial expression (11.4.1) are an integral part of face-to-face conversation. Social engagement in conversation.

Conversation as developing shard understandings. Conversation and tasks. Conversation for problem solving. Bridging across sessions, illustrates a type of team meta-cognition.

The participants have to identify which object in the environment are being described. Most conversation is oral (11.3.3) and social (1.2.1). Conversation across many different types of social interaction. Dialog management (6.4.2). Recall the basic social interaction model (Fig. 6.36). Judgments about another person in conversation goes beyond judging what the person is saying but also their emotional state.

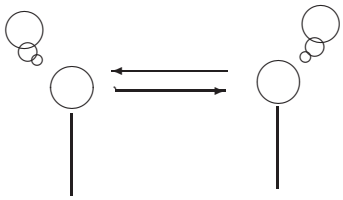


Figure 6.36: User models in conversation; each person tries to determine what is the other person thinking or feeling.

In one view, the meaning of language comes from the extent to which it mediates social action [?]. Conversation does not result in literal transfer of information between people. Repairs negotiating shared meaning.

Subjective sense of the context. Typically, conversation is heavily context laden. There are often abrupt changes in topic when the participants have a long familiarity.

A conversation is language-based interaction between two or more people or organizations. It is generally spoken language (11.3.3) but we can also have asynchronous email conversations. Person-machine

interaction can even be thought of as conversation. Fig. 6.37 shows a fragment of conversation between a consultant and a supervisor at a company help desk. The words within slashes are spoken simultaneously by the two participants. Presumably, this is accompanied with other shared ideas. Face-to-face conversation includes physical interaction and signaling as well. Moreover, there may be subtle clues that participants pick up on[45].

Some electronic text interaction is like oral interaction. Tweeting as a type of conversation. Gossip (6.4.4).

Speaker	Transcript of Conversation
Consultant	... Then escalate it to the benefits. EVA is asking for this information on this (indistinguishable). We show it as having such-and-such. That way /we\
Supervisor	\Okay./ Okay,/I\
Consultant	\can/ tell them... what EVA is looking for.
Supervisor	I can tell the employee it's showing there's not, shouldn't be a problem, so ...
Consultant	... we're trying to fix it.
Supervisor	I'm trying to get a feel for it. Thanks, Nik.

Figure 6.37: Fragment of conversation between a consultant and a supervisor at a company help desk. The words marked by slashes overlap between the users (adapted from[8]).

Following the principle of least effort (6.1.2) and the reduction of cognitive load (4.3.3), the speaker prefers simple messages however, a listener generally prefers unambiguous messages.

Obtaining clarifications and making repairs in a discussion. Conversation often does not proceed in a straight line.

Affect in conversation and social interaction. Social bonding from face-to-face interaction (6.1.2).

Norms for Effective Conversations

We expect a conversation to be cooperative. This is a type of pragmatics. Four norms (5.3.1) or "maxims" of conversation have been proposed[28] as the implicit principles for constructive conversation (Fig. 6.38). If someone asks you for directions, you should answer accurately (quality) and concisely (quantity). There are also the principles an instructor might expect for students answering questions on an examination. Those answers should, of course, be accurate, succinct, relevant, and clear. These are frequently violated. There are many exceptions to these maxims. For instance, "shaggy-dog stories," which never seem to reach a conclusion, violate the principle of "quantity," while deception violates the principle of "quality". We expect statements to show relation. However, the maxims are violated in persuasive speech (4.5.2) and even more so in deceptive speech (5.3.3). Relevance as a cognitive phenomenon. Deception requires inferences about other people with a type of empathy. Multi-person conversations and small group discussions have additional norms (6.4.0).

Norm	Statements should...
Accurate	be genuine and not spurious.
Succinct	give neither more nor less information than is required.
Relevant	be relevant to immediate needs.
Clear	make clear what the contribution is.

Figure 6.38: Proposed norms (maxims) for effective conversation (adapted from[28]). These are frequently ignored.

6.4.2. Conversation Management

Conversation is a social activity so it involves not only natural language but also social skills. Like other types of the social interaction, it needs to be coordinated across participants. Conversations are structured by norms (5.3.1) which provide openings, closings, and turn-taking. Handling restarts, repairs, and silences. Some of these are social skills for smoothly facilitating conversation. These skill

can be supported with a type of scaffolding [**?**]. [52]. Other activities include: Checking, repairs, changing topics.

Opening	"How are you today"?
Closing	"OK, I'll see you around",

Figure 6.39: Openings and closings serve as bookends on a conversation.

Conversation Body

Effective conversation requires that the participants share implicit knowledge about their interaction, as opposed to trying simply to make workable inferences about each other. There should be robust tracking of expectations and a means to allow the participants to back out from misunderstandings and confusion. Structured conversation (10.3.2).

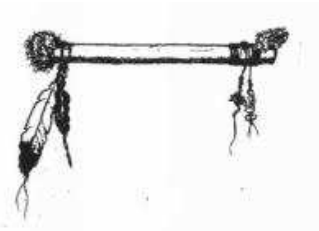


Figure 6.40: The "talking stick" was used by Native Americans to control who was allowed to speak during a council meeting. (redraw-K) (check permission)

Linguistic markers which allow speakers to emphasize what they wish to communicate.

Negotiating meaning in a conversation. Each person makes sure the other person understands. Structured conversations such as threaded chat (10.3.2).

Techniques for conversation analysis[59]: Question-answer pairs. Sequences.

Dialog Goals Some conversations have specific goals. Dialog is tied up with goals for a discourse. Bids for macrogame. A dialog game is composed of three goals: the goal of the initiator, the goal of the recipient, and a joint goal. A information offering game is a specific type of game (Fig. 6.41) [39]. Other types of discourse management games. These are useful approaches for conversational planning (3.7.2).

Goal of initiator	Provide particular information to recipient.
Goal of recipient	To identify and receive the particular information offered.
Joint goal	The responder comes to possess the particular information.

Figure 6.41: Information offering game from the viewpoint of several participants[39].

Initiator	Can I give you directions to help you find something?
Recipient	Yes. How do I get to the Liberty Bell?
Initiator	Go down Arch Street and take a right at 5^{th} Street.

Figure 6.42: Example of an information offering "game"[39].

Group Verbal Interaction

When groups interact at a distance, many of the cues that guide face-to-face interaction are missing. Different methods may have to be established to coordinate such elements as turn-taking and floor control (6.4.2). Back-channels. Toward broader activities such as tutoring, giving directions, negotiation, or teaching a skill.

Conversation Beyond Verbal Interaction

Social interaction beyond words. Non-verbal cues for control on conversation. Eye movements. Attentional gestures. Conversation can also be seen a part of a continuum of communication modalities.

As part of non-linguistic interaction, speakers may use hand movements and other gestures (11.4.1) to emphasize points, and listeners may respond silently with nods, smiles, or other facial expressions. Modalities such as gestures, eye contact, and gaze (5.6.5) can be non-verbal signs of interest. Modalities of interaction in meetings (5.6.3). Coordinating gestures in a conversation (11.4.1).

6.4.3. Sub-Languages and Institutional Dialogs

Language use is also affected by social context. It may be better not to think of natural language as a single entity. There are restricted languages for specific tasks. Languages for special situations or social groups are termed "sub-languages". Institutional dialogs are similar to sub-languages. The discourse is often determined by the roles of the individuals involved. Examples of institutional dialogs between doctor and patient. The dialogs are affected by the relative status of the participants. The relative status is also associated with the beliefs and the information available to the participants. This could be captured with a meeting archiving system (5.6.4) and then used as part of a medical decision support system (9.9.2). Whether intentional or not, jargon acts a barrier to interaction. Jargon.

Inter-generational discourse. Similarly, parents speak in a distinctive way to their children. These may be helpful for the child to learn language. These are known as "care-giver" languages or sometime, "Motherese". For example: "Yes, Mommy will pick baby up". Or, "Would baby like to go night, night".

"Meeting talk".

Figure 6.43: Institutional dialog cartoon.

6.4.4. Synergy of Language with Culture

Language and categories are inter-woven with culture (5.8.2). Language weaves together communities, culture and individuals. Sociolinguistics is concerned with the language and social interaction. Language both unifies and divides groups of people. We noted earlier the importance of language for communities and cultures (5.8.2). Communities of practice develop their own thesauri. One of the ways that communities regulate their membership is via their use of language and they are defined in part by their language. Language needs to be appropriate to the setting or reference group (Fig. 6.44). [64]. Common cultural assumptions allows us to disambiguate language. Kinship relationships (5.1.1).

Dialects to support group identity.

Culture and discourse expectations. For instance, topic-comment vs comment-topic.

Interrelatedness of Concepts and Cultural World View

Language and culture.

QUOTE "Russian speakers, who have more words for light and dark blues, are better able to visually discriminate shades of blue.

"Some indigenous tribes say north, south, east and west, rather than left and right, and as a consequence have great spatial orientation.

"The Piraha, whose language eschews number words in favor of terms like few and many, are not able to keep track of exact quantities.

"In one study, Spanish and Japanese speakers couldn't remember the agents of accidental events as adeptly as English speakers could. Why? In Spanish and Japanese, the agent of causality is dropped:

"The vase broke itself," rather than "John broke the vase." ENDQUOTE

Cultural interpretation. Insults, and cursing. Slang is often a way of marking a social group.

It is not surprising that language reinforces social conventions, as in the use of honorifics to show respect. Social courtesy and politeness. Crudity. "Honorifics" are expressions in language that show respect. In French, "tu" is the singular form of "you," and "vous" the plural. But the two words have another connotation — "vous" is the more formal or respectful mode of address to an individual, while "tu" is more familiar or intimate.

> Most members of the Arizona Tewa speech community regard their language as their unique and self-defining possession. Many older speakers claim that their language cannot be learned by non-Tewas and cite as evidence for this claim the fact that no Hopi, their neighbors for almost 300 years, speaks fluent Tewa. The Tewa help perpetrate this situation by ridiculing any Hopi who attempts to utter even an isolated word or phrase of Arizona Tewa.

Figure 6.44: Language and communities[34].

There are many such examples. Dewey classification and religion. Nonetheless, communities do change definitions and category systems do change across time.

Even gossip has a social function – it helps to elaborate our models of the social world. In other words, it is a type of information exchange. Malicious gossip.

Language is also a clue as to social status. Social chat for understanding the layout of the social world.

Niche use of language in specific domains.

Spread specific information (5.1.0, -A.3.5).

Government control of the language itself. This can be a way to steer culture or even to detach a people from their cultural heritage. German "language reform" by the Nazis.

6.5. Models for Language

6.5.1. Discrete Models for Language Structure

In this chapter, we have focused on natural languages; these are highly dependent on context nonetheless, natural languages all generally share a structure which can be characterized basic formalisms. We end this chapter with a discussion of those formalisms. Transition networks and by grammars provide formalisms which have been widely used to model natural language syntax. These approaches have proven especially useful for formal languages such as computer programming languages. We end this chapter with a discussion of formalisms such as transition networks and grammars which are useful to formal languages. Petri nets (3.10.2). Sequences of words and sequences of phonemes modeled with a state language.

Transition Networks: ATNs and RTNs

Basic transitions networks (TN) are similar to state machines (3.10.1) but they don't cover some essential features of language. They have been extended as Augmented Transition Networks (ATN) which add registers and a stack. Augmented Transition Networks (ATN) variables set at one point in the network and tested in other parts of the network. ATNs are much more general than simple state machines because they hold context. Fig. 6.45 shows a very simple example of how an ATN might be used to manage a game. The states in an ATN might reflect rooms in a dungeon-like game, programmed so that the player would encounter a dragon the second time he or she entered the room. The value "c" is set to 1 in State C, this is the only circumstance under which the dragon will appear in State D. As a model of natural language generation, markers in an ATN could be set to signal a plural subject so the verb could be made to agree with it. Later, we will see how an ATN can be used for parsing (-A.5.4).

Recursion allows statements embedded within other statements. Recursion in language. Recurrent

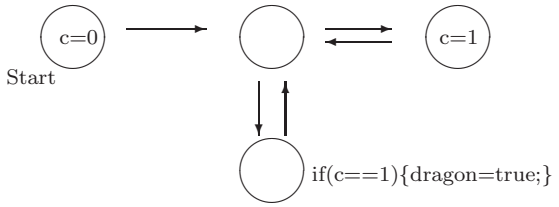


Figure 6.45: A simple Augmented Transition Network (ATN). The Dragon will appear at node D only if node C has been visited and the variable "c" has been set to 1.

Transition Networks (RTNs) are an extension of ATNs which allow ATN networks to be nested one inside of another. These are particularly useful when applying ATNs to natural language processing.

Figure 6.46: An Recursive Transition Network (RTN) for generating a regular expression can recursively embed another RTN. (revise/redraw)

Grammars

Grammars model syntax. State machines and transition networks describe sequences, but a more powerful technique for describing sequences such as those in languages. Specifically, grammars implement recursive productions or re-write rules. These sequences are a sequence of states and could be represented as a state machine, but the grammar allows the repetition of states to be simplified into a more concise statement. While most grammars are deterministic, statistical models can to provide structures similar to grammars (-A.5.5).

Formal grammars are expressed by productions containing symbols on the left-hand side, symbols on the right-hand side, and a right-pointing arrow separating them. When stings are "generated," the components of the equation interact in ways that are dictated by the production rules. In general, the production rules described the ways that non-terminal symbols may be replaced with terminal ones; the end result of the process, in which only terminal symbols remain, is known as a "sentence". All the possible sentences that can be constructed (often an infinite number) constitute that grammar's "language". Any language that is described by a formal grammar is a formal language, and vice versa. Formal grammars are defined by very specific orders of operations and rules for expression, and are practically used only for computer programming, though some are also used as models of natural languages.

Formal grammars can be approached in two ways: one way is to use the rules of the grammar to generate strings of symbols, and the other way is to utilize the rules of the grammar to determine whether or not a given string is consistent with a particular grammar (grammatically correct). While this difference may seem negligible, some grammars are created only for analysis and not for generation. There are two types of formal grammars: "generative grammars" (those that generate symbol strings) and "analytic grammars" (those that analyze symbol strings). The most notable type is Context-Free Grammars (Fig. 6.47).

Rewrite	Expansions
S:	A, AB
A:	x, xy, xyz
B:	y, yz

Figure 6.47: A simple context-free grammar. Using this grammar the strings "x" and "xyzy" are legal while the strings "yx" and "yzx" are not legal.

Parsing Parsing is the identification of grammatical and lexical components of a sequence. A parser is a part of a "compiler" for computer programs. It validates content (often a computer program) to make sure it is syntactically correct [9]. Compilers determine whether the syntax of a computer program is valid, and therefore compatible with the operating system. Parsing can be thought of as a search problem in which the user tries to match the particular case within all possible constructions of the grammar. Natural language parsing in (10.4.2). Rule-based parsing versus parsing as constraint satisfaction (3.7.2). Parsing candidates. Parse trees (-A.5.4).

There are other applications of grammar parsing. Formal grammars form the basis of many types of computer programming languages. Many techniques developed to apply to formal grammars in theory have been able to be applied to computer programs and languages in actuality. There are many possible Document Type Definitions (DTDs) (2.3.3) that an XML document might use; given a document of an unknown source, using a parser-like program it is possible to figure out what DTD generated it [54].

6.5.2. Corpus Linguistics

FrameNet, WordNet. Domain models. Linking to knowledge-bases ((sec:knowledgebase)).

Formal Languages

Formal languages such as programming languages are very different from natural languages. A formal language may be defined as the entire set of complex sequences that can be formed by combining a finite set of symbols (the lexicon) according to rules (i.e., the grammar). A language's "words" make up that language's "lexicon". The two letters are individual symbols that have been combined in a certain way. The particular pattern of symbols and the way in which they are combined would generally be used to convey meaning between two or more entities in a predetermined manner. Even with an alphabet as simple as two symbols, the potential extent of the language can be large. Mathematics (9.7.0) and music (11.3.2) share aspects of natural language.

Theory of language. Expressiveness. Model theory.

Types of programming languages: Procedural, declarative. Rule-based.

Formal Language = Rules & Lexicon

Languages are generative systems — that is, a finite store of base elements can be combined to create an often infinite number of higher-level representations. All of the higher-level representations that can be generated using the base elements are known as a language's "lexicon". In formal languages, the generation of a lexicon is constrained by production rules, while in natural languages these rules are much less controlling, if they exist at all.

Programming languages can specify complex behavior. Formal languages, though, have clearly defined syntax rules. Computer programming languages — an important class of formal languages — have a very rigid operating syntax. Programs will only understand commands if they are syntactically correct. Fig. 6.48 shows the "language" of a particular computer program; if the language were not written correctly, the program would not function. Variables such as "x" form the lexicon. This is a trivial example of a program meaningful programs model the world. The basic elements of a programming language are assignment, loops, conditionals. Parsing to determine syntax errors. In a formal language the meaning of an expression, its semantics, is its behavior. Algorithms (-A.5.0).

Procedural languages. Functional languaes. lambda calculus.

A formal language allows the creation of representations for complex processes. Formal languages can be measured by their "expressiveness," which is the range of meanings they can support. As a simple example, we might ask whether a programming language can support recursion — that is, a program module calls itself repeatedly. Just as there is a difference between the basic syntax of natural language and the elegant use of natural language, programs can also be designed elegantly (7.9.0).

```
int x=1;
main(){
    while(x<=4){
        printf(" %d",x);
        x++;
     }
}
```

Figure 6.48: A programming language, such as C, is a formal language. Here is fragment of a very simple C language program which prints the numbers 1 2 3 4 and then ends.

Minimizing errors in synchronization.

Abstraction of processes[7].

Programming languages for a specific task. A programming language should make it easy to express what has to be done in that activity. This is not necessarily a general programming language. Of course, actually programming involves having expectations about the task and the limitations of the computer hardware on which the program runs.

Beyond Discrete Models for Languages
HMMs.

6.5.3. Agent Communication

Formal models for language beyond parsing. This is a formal approach for managing communication. It does not include the emotional and personal interactions that people find so important in social interaction.

Autonomous agents (7.7.8). Alife (-A.10.4). In multi-agent systems (MAS), it should be useful for helping intelligent agents to coordinate (3.5.3). For instance, they need to share commitments and contracts but in a highly controlled framework.

Coordinating agents need to sharing knowledge. Infrastructure needs shared meanings, shared protocols, shared communication infrastructure. Indeed, agents can considered to be defined by their communication [**?**]).

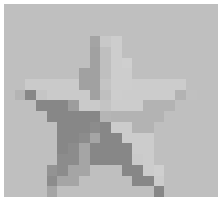


Figure 6.49: Protocol.

Reasoning by Agents
Goal-based model of intention. Practical reasoning often in a business context. Intention as a type of plan. Bounded optimality. BDI [**?**]. BDI and goals versus situated action. Speech acts.

Activity Theory for Agents Activity - Motive
Action - Goal
Operation- Conditions

Exercises

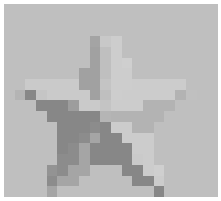


Figure 6.50: Activity theory.

Short Definitions:

Anaphora
Care-giver language
Citation index
Conversation
Dialog
Discourse Model
Floor control
Frames (verb)
Generative model
Genre
Given-new
Grammar
Honorifics
Institutional dialog
Interlingua
Intertextuality
Lexicon
Markers (linguistic)
Mixed-initiative system
Morphology
Narrative
Neologism
Paraphrase
Parsing
Polysemy
Pragmatics
Regular expression
Transition network
Transformational grammar
Semantic field
State machine
Speech act
Turing test
Turn taking

Review Questions:

1. What is the relationship between syntax and grammars? (6.2.2)
2. Give an example of semantic cohesion (6.2.3)
3. Give examples of each type of speech act in Fig. 6.21. (6.3.1)
4. What's the difference between "narrative" and "exposition". (6.3.6)
5. Give an example of the use of each of the "conversational maxims" in Fig. 6.38. (6.4.1)
6. Give two fundamental approaches for representing sequences. (6.4.1, 6.5.1)
7. Evaluate the following regular expressions following Fig. **??** (6.5.1):
   a) Does aXb match a*b
   b) Does aaaab match a*b
   c) Does abccccc match a*b*c
8. Is the statement "PQTUVY" legal in a context-free grammar with the following rewrite rules? (6.1.0, 6.5.1)

LHS	**RHS**
S	AB, CDE
A	J,KL
B	MNO
C	PQ,RS
D	TUV, WX
E	Y, Z

9. Differentiate between formal and natural language grammars. Give examples. (6.2.2), 6.5.1

Short-Essays and Hand-Worked Problems:

1. Is "hot dog" one word or two? Justify your answer. (6.2.1)
2. What are "concepts"? How do they relate to words? (6.2.1)
3. Find a videotape of a conversation (e.g., from a movie) and specify in detail the interaction between the speakers in it. (6.3.1)
4. Use the relationships described in Fig. 2.50 to code a discussion. (6.3.5)

5. Components of narrative. (6.3.6)
6. Describe how grammars are related to XML. (2.3.3, 6.5.1)
7. Specify a simple language, develop a parser for it, generate statements in that language and develop a compiler to validate those statements. (6.5.1)
8. The evaluation of mathematical expressions follows an "order of precedence" which are a type of re-write rule. Make a parse tree for the expression: 1+(2*3). (6.5.1)

Going Beyond:

1. To what extent do languages affect perception of objects is described? (6.1.0)
2. How would you define language. By your definition, do animals "have language"? Do computers "have language"?(6.1.0)
3. Is the use and learning of natural language a human instinct? (6.1.0)
4. Write a part-of-speech tagger. Include a dictionary of terms. (6.2.2)
5. Is it possible to cleanly separate syntax from semantics? (6.2.2)
6. There is a connection between word definitions and the creation of data models. There has been a proposal for creating structured word definition. How feasible is that? (6.2.3).
7. How do we know the definition of a word is accurate? (6.2.3)
8. What are the syntax, semantics, and pragmatics of a book cataloging system? (2.5.1, 6.2.2, 6.2.3, 6.3.1)
9. Explain the difference between "semantic structure' and "rhetorical structure". (6.2.3, 6.3.5)
10. Describe a brief discussion between a patient and a doctor. Develop a system of speech acts for a medical interview. (6.3.1)
11. Quote two examples of the given-new principle in a newspaper. (6.3.2)
12. How is explanation different from description? (6.3.4)
13. How is "conversation" by email different from spoken conversation? (4.2.1, 6.4.0)
14. Compare the S.O.A.P. principles for collection management in a library with Grice's Maxims for conversation (6.4.1, 7.1.2)
15. Observe and describe the difference in language use of school children, teenagers, and adults. (6.4.4)
16. Describe the relationship between discrete grammars and HMMs. (6.2.2, 6.5.1, -A.5.5)

Teaching Notes

Objectives and Skills: This chapter provides a conceptual foundation for understanding different aspects of natural language.

Instructor Strategies: The presentation could focus on either formal languages or natural language, Within natural language teaching could focus on either the structure of function of language.

Related Books

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