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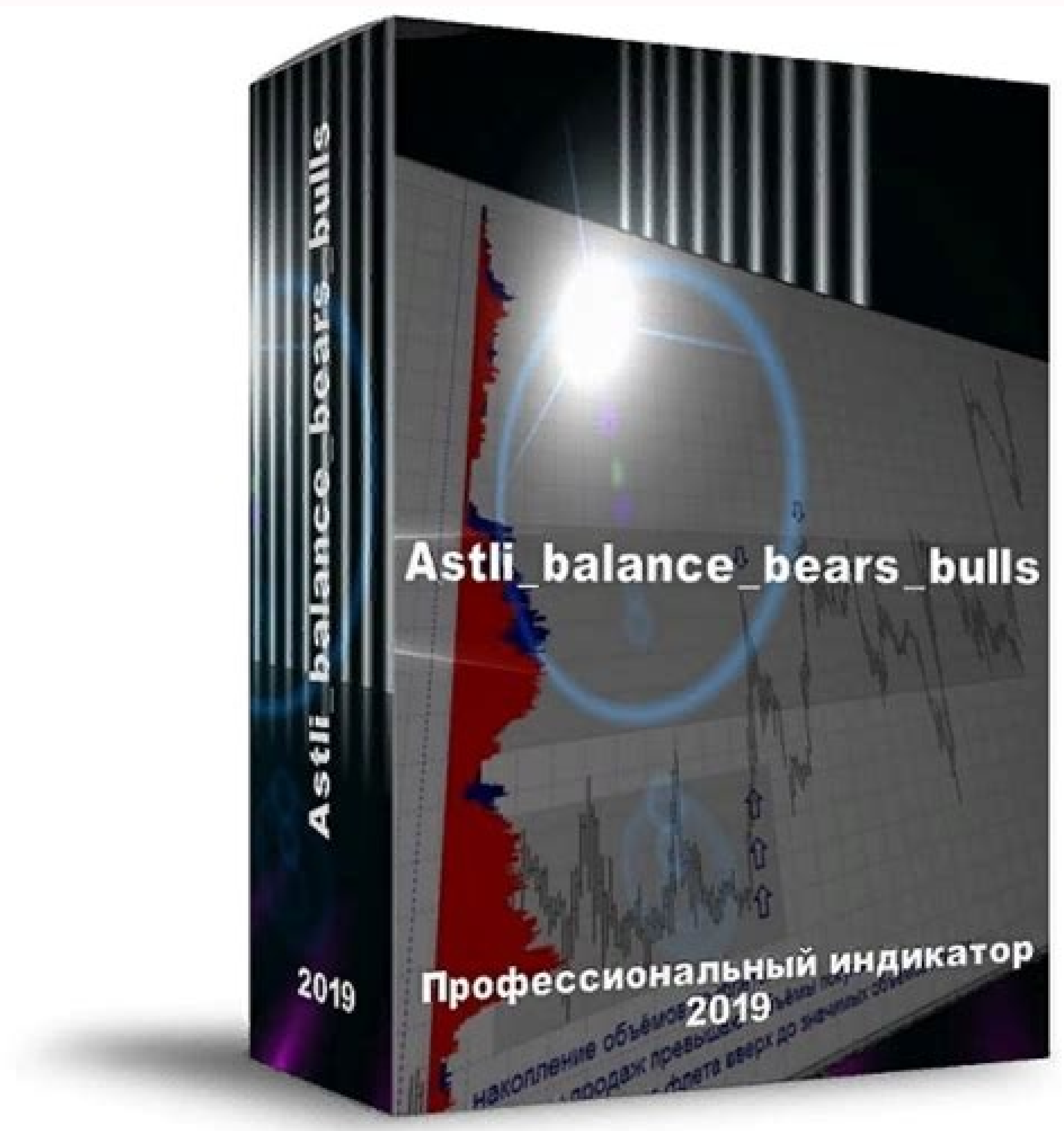
Lexical and structural ambiguity examples pdf free printable free



It's clear that humans don't do this either! Note that the problem is not with our choice of example. c.Chatterer thought Buster was angry. Figure 2.1: Substitution of Word Sequences: working from the top row, we can replace particular sequences of words (e.g. the brook) with individual words (e.g. it); repeating this process we arrive at a grammatical two-word sentence. The program in 4.4 uses this rule to complete the WFST. >>> from nltk.corpus import treebank >>> t = treebank.parsed_sents('wsj_0001.mrg')[0] >>> print(t) (S (NP-SBJ (NP (NNP Pierre) (NNP Vinken)) (, ,) (ADJP (NP (CD 61) (NNS years)) (JJ old)) (, ,)) (VP (MD will) (VP (VB join) (NP (DT the) (NN board)) (PP-CLR (IN as) (NP (DT a) (JJ nonexecutive) (NN director))) (NP-TMP (NNP Nov.) (CD 29)))) (. give NP: the president / NP: such power give NP: me / NP: the heebie-jeebies give NP: holders / NP: the right , but not the obligation , to buy a cal... Let's take a closer look at the ambiguity in the phrase: I shot an elephant in my pajamas. 4 . ☼ Can the grammar in grammar1 be used to describe sentences that are more than 20 words in length? Implement a function that will convert a WFST in this form to a parse tree. The labels NP, VP, and PP stand for noun phrase, verb phrase and prepositional phrase respectively. ☼ In this exercise you will manually construct some parse trees. In 2.2, we have added grammatical category labels to the words we saw in the earlier figure. In a CFG, we need some way of constraining grammar productions which expand VP so that verbs only co-occur with their correct complements. The numerically specified spans of the WFST are reminiscent of Python's slice notation (3.2). We can see the shift-reduce parsing algorithm in action using the graphical demonstration nltk.app.srparser(). Loading PreviewSorry, preview is currently unavailable. c.*Chatterer thought the bear. The parser finishes when all the input is consumed and there is only one item remaining on the stack, a parse tree with an S node as its root. However, these methods only scratch the surface of the complex constraints that govern sentences. For example, it may address shift-reduce conflicts by shifting only when no reductions are possible, and it may address reduce-reduce conflicts by favoring the reduction operation that removes the most items from the stack. >>> grammar = nltk.CFG.fromstring(""" ... What should it do if the root node of the tree passed to this function is not S, or it lacks a subject? Another difficulty is that as the grammar expands to cover a wider and wider range of constructions, there is a corresponding increase in the number of analyses which are admitted for any one sentence. About this document... This is an example of a space-time trade-off: we do a reverse lookup on the grammar, instead of having to check through the entire list of productions each time we want to look up via the right hand side. Figure 3.2: Recursive Descent Parser Demo: This tool allows you to watch the operation of a recursive descent parser as it grows the parse tree and matches it against the input words. Can you find other parses for this sentence? This long sentence actually has a simple structure that begins S but S when S. Let us take a closer look at verbs and their dependents. ★ Extend NLTK's shift-reduce parser to incorporate backtracking, so that it is guaranteed to find all parses that exist (i.e. it is complete). Dependency is a binary asymmetric relation that holds between a head and its dependents. ◑ Read up on "garden path" sentences. (14) In languages with more flexible word order than English, non-projective dependencies are more frequent. How much more of the meaning of a text can we access when we can reliably recognize the linguistic structures it contains? """) >>> print(groucho_dep_grammar) Dependency grammar with 7 productions 'shot' -> 'I' 'shot' -> 'elephant' 'shot' -> 'in' 'elephant' -> 'an' 'elephant' -> 'in' 'in' -> 'pajamas' 'pajamas' -> 'my' A dependency graph is projective if, when all the words are written in linear order, the edges can be drawn above the words without crossing. Notice that there's no ambiguity concerning the meaning of any of the words; e.g. the word shot doesn't refer to the act of using a gun in the first sentence, and using a camera in the second sentence. Sbar -> NP V ... Before starting its work, a left-corner parser preprocesses the context-free grammar to build a table where each row contains two cells, the first holding a non-terminal, and the second holding the collection of possible left corners of that non-terminal. We need a way to deal with the ambiguity that natural language is famous for. To clarify this idea, consider the following sentence: (6)The little bear saw the fine fat trout in the brook. Speakers of English can make judgements about these sequences, and will reject some of them as being ungrammatical. Generate tree structures corresponding to both of these interpretations. Unlike an ordinary recursive descent parser, it does not get trapped in left recursive productions. V -> 'fish' ... By contrast with (15d), the word sequences in (16d) are ill-formed: (16) a.*The squirrel was Buster was angry. (15) a.The squirrel was frightened. NP -> 'fish' ... The NLTK corpus collection includes data from the PE08 Cross-Framework and Cross Domain Parser Evaluation Shared Task. for t in tree.subtrees(give): ... A parser processes input sentences according to the productions of a grammar, and builds one or more constituent structures that conform to the grammar. ◑ Modify the functions init_wfst() and complete_wfst() so that the contents of each cell in the WFST is a set of non-terminal symbols rather than a single non-terminal. To simplify this presentation, we will assume each word has a unique lexical category, and we will store this (not the word) in the matrix. While CFGs are not intended to directly capture dependencies, more recent linguistic frameworks have increasingly adopted formalisms which combine aspects of both approaches. Consequently, phrase structure trees can have arbitrary depth. Do a web search for however used at the start of the sentence. This operation may only be applied to the top of the stack; reducing items lower in the stack must be done before later items are pushed onto the stack. PP -> P NP ... It is something more abstract like the implicit knowledge that competent speakers have about grammatical sentences? In contrast to phrase structure grammar, therefore, dependency grammars can be used to directly express grammatical functions as a type of dependency. Does this illustrate a problem for an approach based on n-grams? The head of a sentence is usually taken to be the tensed verb, and every other word is either dependent on the sentence head, or connects to it through a path of dependencies. Thus, a production such as PP -> 'of' NP is disallowed. .)) We can use this data to help develop a grammar. Examples are the Lexical Functional Grammar (LFG) Pargram project, the Head-Driven Phrase Structure Grammar (HPSG) LinGO Matrix framework, and the Lexicalized Tree Adjoining Grammar XTAG Project. When this happens, no input remains, and the stack contains items which cannot be reduced to an S. In 2.1, we systematically substitute longer sequences by shorter ones in a way which preserves grammaticality. Note Your Turn: Consider the following sentences and see if you can think of two quite different interpretations: Fighting animals could be dangerous. 2 . """) This grammar permits the sentence to be analyzed in two ways, depending on whether the prepositional phrase in my pajamas describes the elephant or the shooting event. So rather than writing NP -> 'New York', you have to resort to something like NP -> 'New_York' instead. Parsing builds trees over sentences, according to a phrase structure grammar. For example, the program in 6.1 uses a simple filter to find verbs that take sentential complements. Because neither of these productions will derive a sequence whose first word is John. As expected, there is a V in cell (1, 2). c.Chatterer really thought Buster was angry. Each of these subgoals can be replaced in turn by sub-sub-goals, using productions that have NP and VP on their left-hand side. What syntactic construction(s) are responsible for such long sentences? Or is it some combination of the two? 1 . What happens? S -> NP V NP ... Here's another pair of examples that we created by computing the bigrams over the text of a childrens' story, The Adventures of Buster Brown (: (4) a.He roared with me the pail slip down his back b.The worst part and clumsy looking for whoever heard light You intuitively know that these sequences are "word-salad", but you probably find it hard to pin down what's wrong with them. There are two kinds of choices to be made by the parser: (a) which reduction to do when more than one is possible (b) whether to shift or reduce when either action is possible. P -> 'in' ... In this section we will see how to access treebanks, and look at the challenge of developing broad-coverage grammars. (5) a.The book's ending was (NP the worst part and the best part) for me. Can the verbs be freely substituted for each other, or are their constraints? Change the grammar, and the sentence to be parsed, and run the parser using the autostep button. This document was built on Wed 4 Sep 2019 11:40:48 ACST A well-known example of ambiguity is shown in (2), from the Groucho Marx movie, Animal Crackers (1930): (2)While hunting in Africa, I shot an elephant in my pajamas. How he got into my pajamas, I don't know. Write down the parenthesized forms to show the relative scope of and and or. Now use draw() to display the tree. print(tree) (S (NP fish) (VP (NP fish) (Sbar (NP fish) (V fish)))) (S (NP (NP fish) (Sbar (NP fish) (V fish))) (V fish) (NP fish)) As the length of this sentence goes up (3, 5, 7, ...) we get the following numbers of parse trees: 1; 2; 5; 14; 42; 132; 429; 1,430; 4,862; 16,796; 58,786; 208,012; ... Third, as a bottom-up approach it is potentially wasteful, being able to propose constituents in locations that would not be licensed by the grammar. Discard the productions that occur only once. 5 . (Dostoevsky: The Brothers Karamazov) ◑ Write a recursive function that produces a nested bracketing for a tree, leaving out the leaf nodes, and displaying the non-terminal labels after their subtrees. (Try this with police if you prefer something more sensible.) Here is a toy grammar for the "fish" sentences. Each time it pops n items off the stack it combines them into a partial parse tree, and pushes this back on the stack. (Hint: the depth of a subtree is the maximum depth of its children, plus one.) ☼ Analyze the A.A. Milne sentence about Piglet, by underlining all of the sentences it contains then replacing these with S (e.g. the first sentence becomes S when:lx` S). Det NP . . A collection of larger grammars has been prepared for the purpose of comparing different parsers, which can be obtained by downloading the large_grammars package (e.g. python -m nltk.downloader large_grammars). The morphological form of D is determined by H (e.g. agreement or case government). If we introduce a new category label for transitive verbs, namely TV (for Transitive Verb), then we can use it in the following productions: VP -> TV NP TV -> 'chased' | 'saw' Now *Joe thought the bear is excluded since we haven't listed thought as a TV, but Chatterer saw the bear is still allowed. In 3.1 we define a grammar and show how to parse a simple sentence admitted by the grammar. In common with all bottom-up parsers, a shift-reduce parser tries to find sequences of words and phrases that correspond to the right hand side of a grammar production, and replace them with the left-hand side, until the whole sentence is reduced to an S. Normalize case to lowercase, to simulate the problem that a listener has when hearing this sentence. You can experiment with parsing sentences that involve more deeply nested structures. The first time we build it we save it in a table, then we look it up when we need to use it as a subconstituent of either the object NP or the higher VP. Six stages of the execution of this parser are shown in 4.1. Figure 4.1: Six Stages of a Recursive Descent Parser: the parser begins with a tree consisting of the node S; at each stage it consults the grammar to find a production that can be used to enlarge the tree; when a lexical production is encountered, its word is compared against the input; after a complete parse has been found, the parser backtracks to look for more parses. There are many introductory books on syntax. With a bit of ingenuity we can construct some really long sentences using these templates. b. In order to remedy these, we will apply the algorithm design technique of dynamic programming to the parsing problem. Chart parsers improve the efficiency of computing multiple parses of the same sentences, but they are still overwhelmed by the sheer number of possible parses. The S → NP VP production permits the parser to replace this goal with two subgoals: find an NP, then find a VP. When the PP is attached to VP, the intended interpretation is that the seeing event happened in the park. We can develop formal models of these structures using grammars and parsers. NLTK provides a recursive descent parser: >>> rd_parser = nltk.RecursiveDescentParser(grammar1) >>> sent = 'Mary saw a dog'.split() >>> for tree in rd_parser.parse(sent): ... Earlier chapters focused on words: how to identify them, analyze their structure, assign them to lexical categories, and access their meanings. The final state of the WFST is depicted in 4.5. Notice that we have not used any built-in parsing functions here. For example, I is the SBJ (subject) of shot (which is the head of the whole sentence), and in is an NMOD (noun modifier of elephant). Once a parse has been found, we can get the parser to look for additional parses. VP -> V NP | VP PP ... When we do this for sentences involving the word gave, we find patterns such as the following: gave NP gave up NP in NP gave NP up gave NP NP gave NP to NP Use this method to study the complementation patterns of a verb of interest, and write suitable grammar productions. Come up with your own strategy that you can execute manually using the graphical interface. Let's set our input to be the sentence in (2). The most widely used term in linguistics for formal grammar is generative grammar, though it has nothing to do with generation (Chomsky, 1965). This verb requires both a direct object (the thing being given) and an indirect object (the recipient). Change the second expansion production, namely NP -> Det N PP, to NP -> NP PP. For example, backtracking over VP -> V NP will discard the subtree created for the NP. We won't take a stand on this issue, but instead will introduce the main approaches. Based on these productions, use the method of the preceding exercise to draw a tree for the sentence Lee ran away home. Write a function that takes the tree for a sentence and returns the subtree corresponding to the subject of the sentence. The fact that we can substitute He for The little bear indicates that the latter sequence is a unit. What was more, the he in his turn somewhat youngish Nikolay Parfenovich also turned out to be the only person in the entire world to acquire a sincere liking to our "discriminated-against" public procurator. However, if the PP is attached to NP, then it was the man who was in the park, and the agent of the seeing (the dog) might have been sitting on the balcony of an apartment overlooking the park. In the "prepositional dative" form in (19a), the direct object appears first, followed by a prepositional phrase containing the indirect object. Find any cases where the same verb exhibits two different attachments, but where the first noun, or second noun, or preposition, stay unchanged (as we saw in our discussion of syntactic ambiguity in 2). In fact, it grows at an astronomical rate. This is equivalent to saying that a word and all its descendents (dependents and dependents of its dependents, etc.) form a contiguous sequence of words within the sentence. Use timeit to log the amount of time each parser takes on the same sentence. Here are a couple of examples. This ambiguity is unavoidable, and leads to horrendous inefficiency in parsing seemingly innocuous sentences. Various criteria have been proposed for deciding what is the head H and what is the dependent D in a construction C. (The term "substring" refers to a contiguous sequence of words within a sentence.) We will show how to construct the WFST bottom-up so as to systematically record what syntactic constituents have been found. Describe the steps, and report any efficiency improvements it has (e.g. in terms of the size of the resulting chart). Complements are often contrasted with modifiers (or adjuncts), although both are kinds of dependent. Note Your Turn: Try out the interactive chart parser application nltk.app.chartparser(). This in turn means that it is difficult to distribute the task of grammar writing across a team of linguists. In a WFST, we record the position of the words by filling in cells in a triangular matrix: the vertical axis will denote the start position of a substring, while the horizontal axis will denote the end position (thus shot will appear in the cell with coordinates (1, 2)). give NP: the president / NP: line-item veto power Example 6.3 (code_give.py): Figure 6.3: Usage of Give and Gave in the Penn Treebank sample We can observe a strong tendency for the shortest complement to appear first. (19) a.Kim gave a bone to the dog b.Kim gave the dog a bone In the "double object" form in (19b), the indirect object appears first, followed by the direct object. A parser will be responsible for finding the most likely parses. PP 5 . We also need to be able to cope with the fact that there are an unlimited number of possible sentences, and we can only write finite programs to analyze their structures and discover their meanings. Along the way, we will cover the fundamentals of English syntax, and see that there are systematic aspects of meaning that are much easier to capture once we have identified the structure of sentences. But there is an obvious question as to whether the approach can be scaled up to cover large corpora of natural languages. give NP: the Transportation Department / NP: up to 50 days to review any... Det . Here's an impressive example from a Winnie the Pooh story by A.A. Milne, In which Piglet is Entirely Surrounded by Water: [You can imagine Piglet's joy when at last the ship came in sight of him.] In after-years he liked to think that he had been in Very Great Danger during the Terrible Flood, but the only danger he had really been in was the last half-hour of his imprisonment, when Owl, who had just flown up, sat on a branch of his tree to comfort him, and told him a very long story about an aunt who had once laid a seagull's egg by mistake, and the story went on and on, rather like this sentence, until Piglet who was listening out of his window without much hope, went to sleep quietly and naturally, slipping slowly out of the window towards the water until he was only hanging on by his toes, at which moment, luckily, a sudden loud squawk from Owl, which was really part of the story, being what his aunt said, woke the Piglet up and just gave him time to jerk himself back into safety and say, "How interesting, and did she?" when — well, you can imagine his joy when at last he saw the good ship, Brain of Pooh (Captain, C. You can download the paper by clicking the button above. Devise CFG grammar productions to cover some of these cases. The framework of X-bar Syntax is due to (Jacobs & Rosenbaum, 1970), and is explored at greater length in (Jackendoff, 1977) (The primes we use replace Chomsky's typographically more demanding horizontal bars.) (Burton-Roberts, 1997) is a practically oriented textbook on how to analyze constituency in English, with extensive exemplification and exercises. In the first, two NPs (noun phrases) have been conjoined to make an NP, while in the second, two APs (adjective phrases) have been conjoined to make an AP. A dependency representation is a labeled directed graph, where the nodes are the lexical items and the labeled arcs represent dependency relations from heads to dependents. ◑ Extend the grammar in grammar2 with productions that expand prepositions as intransitive, transitive and requiring a PP complement. Although it is possible to convert an arbitrary CFG into this form, we would prefer to use an approach without such a requirement. It generates the same set of parses for a text that the corresponding context free grammar does, and assigns a probability to each parse. >>> tokens = ["fish"] * 5 >>> cp = nltk.ChartParser(grammar) >>> for tree in cp.parse(tokens): ... The purpose of a grammar is to give an explicit description of a language. We can see this in action using the graphical demonstration nltk.app.rdparser(). Do these improvements depend on the structure of the grammar? There are several ongoing efforts to build large-scale rule-based grammars, e.g. the LFG Pargram project the HPSG LinGO Matrix framework and the XTAG Project xtag/. print(tree) (S (NP Jack) (VP (TV saw) (NP telescopes))) (p=0.064) Now that parse trees are assigned probabilities, it no longer matters that there may be a huge number of possible parses for a given sentence. d.Joe put the fish on the log. We can make up the sentence fish fish fish, meaning fish like to fish for other fish. Recursive descent parsing is a kind of top-down parsing. (18)Put the block in the box on the table. NP -> NP Sbar ... Each sequence that forms a unit can in fact be replaced by a single word, and we end up with just two elements. As the above process recursively expands its goals using the productions of the grammar, the parse tree is extended downwards (hence the name recursive descent). 5.1 is projective, and we can parse many sentences in English using a projective dependency parser. (This task is sometimes called lexical acquisition.) Identify some English verbs that are near-synonyms, such as the dumped/filled/loaded example from earlier in this chapter. ★ Write a function that takes a grammar (such as the one defined in 3.1) and returns a random sentence generated by the grammar. The first of these is N → man. A left-corner parser is a hybrid between the bottom-up and top-down approaches we have seen. ◑ Process each tree of the Treebank corpus sample nltk.corpus.treebank and extract the productions with the help of Tree.productions(). (Huddleston & Pullum, 2002) provides an up-to-date and comprehensive analysis of syntactic phenomena in English. ☼ Use the graphical chart-parser interface to experiment with different rule invocation strategies. This is because it applies the grammar productions blindly, without considering the actual input sentence. Here we illustrate a technique for mining this corpus. (These are the Catalan numbers, which we saw in an exercise in 4). If trace is greater than zero, then the parser will report the steps that it takes as it parses a text. Write a function that runs all three parsers on all three sentences, and prints a 3-by-3 grid of times, as well as row and column totals. of how to use the frequency information in bigrams to generate text that seems perfectly acceptable for small sequences of words but rapidly degenerates into nonsense. A parser can serve as a model of psycholinguistic processing, helping to explain the difficulties that humans have with processing certain syntactic constructions. For example, the adverb really can be added as a modifer to all the sentence in (17d): (17) a.The squirrel really was frightened. (Use grammar.start() to find the start symbol of the grammar; grammar.productions(lhs) to get the list of productions from the grammar that have the specified left-hand side; and production.rhs() to get the right-hand side of a production.) ★ Implement a version of the shift-reduce parser using backtracking, so that it finds all possible parses for a sentence, what might be called a "recursive ascent parser." Consult the Wikipedia entry for backtracking at ★ As we saw in 7., it is possible to collapse chunks down to their chunk label. Many natural language applications involve parsing at some point; for example, we would expect the natural language questions submitted to a question-answering system to undergo parsing as an initial step. 5.1 illustrates a dependency graph, where arrows point from heads to their dependents. Six stages of the execution of this parser are shown in 4.2. Figure 4.2: Six Stages of a Shift-Reduce Parser: the parser begins by shifting the first input word onto its stack; once the top items on the stack match the right hand side of a grammar production, they can be replaced with the left hand side of that production; the parser succeeds once all input is consumed and one S item remains on the stack. The dependents Adj, NP, PP and S are often called complements of the respective verbs and there are strong constraints on what verbs can occur with what complements. We also see some more sophisticated algorithms, a top-down method with bottom-up filtering called left-corner parsing, and a dynamic programming technique called chart parsing. The NLTK corpus collection also includes a sample from the Sinica Treebank Corpus, consisting of 10,000 parsed sentences drawn from the Academia Sinica Balanced Corpus of Modern Chinese. In this case, call the parser with tracing set to be on: rd_parser = nltk.RecursiveDescentParser(grammar1, trace=2). Is it a large but finite set of observed utterances and written texts? Again it will backtrack and explore other choices of production in case any of them result in a parse. """) Now we can try parsing a longer sentence, fish fish fish fish fish, which amongst other things, means 'fish that other fish fish are in the habit of fishing fish themselves'. 'elephant' -> 'an' | 'in' ... It is also striking that we can understand sentences of arbitrary length that we've never heard before: it's not hard to concoct an entirely novel sentence, one that has probably never been used before in the history of the language, yet all speakers of the language will understand it. NLTK provides ShiftReduceParser(), a simple implementation of a shift-reduce parser. The simplest kind of parser interprets a grammar as a specification of how to break a high-level goal into several lower-level subgoals. However, we assume that the above examples are to be interpreted in neutral contexts. Chapter 12 of (Jurafsky & Martin, 2008) covers formal grammars of English; Sections 13.1-3 cover simple parsing algorithms and techniques for dealing with ambiguity; Chapter 14 covers statistical parsing; Chapter 16 covers the Chomsky hierarchy and the formal complexity of natural language. The top-level goal is to find an S. Category Left-Corners (pre-terminals) S NP NP Det, PropN VP V PP P Table 4.1: Left-Corners in grammar2 Each time a production is considered by the parser, it checks that the next input word is compatible with at least one of the pre-terminal categories in the left-corner table. Grammar grammar1 allows us to produce the following parse of John saw Mary: (11) Recall that the grammar (defined in 3.3) has the following productions for expanding NP: (12) c.NP -> "John" | "Mary" | "Bob" Suppose we ask you to first look at tree (11), and then decide which of the NP productions you'd want a recursive descent parser to apply first — obviously, (12c) is the right choice! How do you know that it would be pointless to apply (12a) or (12b) instead? Robin; 1st Mate, P. Note With a little imagination, it is possible to invent contexts in which unusual combinations of verbs and complements are interpretable. We need to find a production of the form A → Det N. ☼ Consider the sentence Kim arrived or Dana left and everyone cheered. ☼ With pen and paper, manually trace the execution of a recursive descent parser and a shift-reduce parser, for a CFG you have already seen, or one of your own devising. (Levin, 1993) has categorized English verbs into fine-grained classes, according to their syntactic properties. ☼ Write a recursive function to traverse a tree and return the depth of the tree, such that a tree with a single node would have depth zero. Even complete gibberish will often have a reading, e.g. the a are of I. The last of these is for a sentence of length 23, the average length of sentences in the WSJ section of Penn Treebank. Draw a tree structure for this "compressed" sentence. UPDATED FOR NLTK 3.0. This is a chapter from Natural Language Processing with Python, by Steven Bird, Ewan Klein and Edward Loper, Copyright © 2019 the authors. It is distributed with the Natural Language Toolkit [, Version 3.0, under the terms of the Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 United States License [. In other words, it is hard to modularize grammars so that one portion can be developed independently of the other parts. One of the problems with the recursive descent parser is that it goes into an infinite loop when it encounters a left-recursive production. In 10. Third, the backtracking process may discard parsed constituents that will need to be rebuilt again later. However, if the indirect object is a pronoun, there is a strong preference for the double object construction: (20) a.Kim gives the heebie-jeebies to me (*prepositional dative) b.Kim gives me the heebie-jeebies (double object) Using the Penn Treebank sample, we can examine all instances of prepositional dative and double object constructions involving give, as shown in 6.3. def give(t): return t.label() == 'VP' and len(t) > 2 and t[1].label() == 'NP'\ and (t[2].label() == 'PP-DTV' or t[2].label() == 'NP')\ and ('give' in t[0].leaves() or 'gave' in t[0].leaves()) def sent(t): return ' '.join(token for token in t.leaves() if token[0] not in '*-0') def print_node(t, width): output = "%s %s: %s / %s: %s" %\ (sent(t[0]), t[1].label(), sent(t[1]), t[2].label(), sent(t[2])) if len(output) > width: output = output[:width] + "..." print(output) >>> for tree in nltk.corpus.treebank.parsed_sents(): ... Prepositional phrases, adjectives and adverbs typically function as modifiers. NP -> Det N | Det N PP | 'I' ... N >>> wfst1 = complete_wfst(wfst0, tokens, groucho_grammar) >>> display(wfst1, tokens) WFST 1 2 3 4 5 6 7 0 NP . Grammars use recursive productions of the form S → S and S, as we will explore in 3. Furthermore, it is possible to verb most nouns. Note As we saw in 1, sentences can have arbitrary length. 3 . These are templates for taking a sentence and constructing a bigger sentence. b.On land they are (AP slow and clumsy looking). Write a program to scan these texts for any extremely long sentences. In the above case, either order is acceptable. A simple kind of bottom-up parser is the shift-reduce parser. V . Assuming we already have a production of the form VP -> Vs S, this information enables us to identify particular verbs that would be included in the expansion of Vs. def filter(tree): child_nodes = [child.label() for child in tree if isinstance(child, nltk.Tree)] return (tree.label() == 'VP') and ('S' in child_nodes) >>> from nltk.corpus import treebank >>> [subtree for tree in treebank.parsed_sents() ... >>> from collections import defaultdict >>> entries = nltk.corpus.ppattach.attachments('training') >>> table = defaultdict(lambda: defaultdict(set)) >>> for entry in entries: ... N . (O'Grady et al, 2004) is a general introduction to linguistics, while (Radford, 1988) provides a gentle introduction to transformational grammar, and can be recommended for its coverage of transformational approaches to unbounded dependency constructions. >>> pdp = nltk.ProjectiveDependencyParser(groucho_dep_grammar) >>> sent = 'I shot an elephant in my pajamas'.split() >>> trees = pdp.parse(sent) >>> for tree in trees: ... It searches through the space of trees licensed by a grammar to find one that has the required sentence along its fringe. Det NP 6 . When this does not work it backtracks, and tries other N productions in order, until it gets to N → dog, which matches the next word in the input sentence. Some of the most important are the following: H determines the distribution class of C; or alternatively, the external syntactic properties of C are due to H. One benefit of studying grammar is that it provides a conceptual framework and vocabulary for spelling out these intuitions. 6 . The next example shows how groucho_dep_grammar provides an alternative approach to capturing the attachment ambiguity that we examined earlier with phrase structure grammar. You can then load it into NLTK and parse with it as follows: >>> grammar1 = nltk.data.load('file:mygrammar.cfg') >>> sent = "Mary saw Bob".split() >>> rd_parser = nltk.RecursiveDescentParser(grammar1) >>> for tree in rd_parser.parse(sent): ... Use the same grammar and input sentences for both. 'pajamas' -> 'my' ... This technique can be applied to syntactic parsing, allowing us to store partial solutions to the parsing task and then look them up as necessary in order to efficiently arrive at a complete solution. ☼ The Tree class implements a variety of other useful methods. Let's load and display one of the trees in this corpus. Consider the following sentences: (1) a.Usain Bolt broke the 100m record b.The Jamaica Observer reported that Usain Bolt broke the 100m record c.Andre said The Jamaica Observer reported that Usain Bolt broke the 100m record d.I think Andre said the Jamaica Observer reported that Usain Bolt broke the 100m record If we replaced whole sentences with the symbol S, we would see patterns like Andre said S and I think S. Even if we allow ourselves to use various formal devices that give much more succinct representations of grammar productions, it is still extremely difficult to keep control of the complex interactions between the many productions required to cover the major constructions of a language. The problem arises because there are choices made earlier that cannot be undone by the parser (although users of the graphical demonstration can undo their choices). >>> text = ['I', 'shot', 'an', 'elephant', 'in', 'my', 'pajamas'] >>> groucho_grammar.productions(rhs=text[1]) [V -> 'shot'] For our WFST, we create an (n-1) × (n-1) matrix as a list of lists in Python, and initialize it with the lexical categories of each token, in the init_wfst() function in 4.4. We also define a utility function display() to pretty-print the WFST for us. In fact, all words can be referred to by name: e.g. the verb 'ate' is spelled with three letters; in speech we do not need to supply quotation marks. More generally, if our input string is a0a1 ... Symbol Meaning Example IV intransitive verb barked TV transitive verb saw a man DatV dative verb gave a dog to a man SV sentential verb said that a dog barked Table 5.2: Verb Subcategories Valency is a property of lexical items, and we will discuss it further in 9.. In a toy grammar, a is only a determiner, dog is only a noun, and runs is only a verb. gave NP: Mr. Thomas / NP: only a `` qualified '' rating , rather than ``... print(key, 'N:', sorted(table[key]['N']), 'V:', sorted(table[key]['V'])) Amongst the output lines of this program we find offer-from-group N: ['rejected'] V: ['received'], which indicates that received expects a separate PP complement attached to the VP, while rejected does not. The grammar in 6.4 obeys this constraint: for S, there is only one production, with a probability of 1.0; for VP, 0.4+0.3+0.3=1.0; and for NP, 0.8+0.2=1.0. The parse tree returned by parse() includes probabilities: >>> viterbi_parser = nltk.ViterbiParser(grammar) >>> for tree in viterbi_parser.parse(['Jack', 'saw', 'telescopes']): ... In this chapter, we will adopt the formal framework of "generative grammar", in which a "language" is considered to be nothing more than an enormous collection of all grammatical sentences, and a grammar is a formal notation that can be used for "generating" the members of this set. When we say in a phrase structure grammar that the immediate constituents of a PP are P and NP, we are implicitly appealing to the head / dependent distinction. This table is known as a well-formed substring table, or WFST for short. if len(table[key]) > 1: ... No practical NLP system could construct millions of trees for a sentence and choose the appropriate one in the context. This replacement of the top n items with a single item is the reduce operation. Even though this phrase is unlikely, it is still grammatical and a broad-coverage parser should be able to construct a parse tree for it. grammar1 = nltk.CFG.fromstring(""" S -> NP VP VP -> V NP | V NP PP PP -> P NP V -> "saw" | "ate" | "walked" NP -> "John" | "Mary" | "Bob" | Det N | Det N PP Det -> "a" | "an" | "the" | "my" N -> "man" | "dog" | "cat" | "telescope" | "park" P -> "in" | "on" | "by" | "with" """) >>> sent = "Mary saw Bob".split() >>> rd_parser = nltk.RecursiveDescentParser(grammar1) >>> for tree in rd_parser.parse(sent): ... Compare their performance using the timeit module (see 4.7 for an example of how to do this). ◑ Write a program to compare the efficiency of a top-down chart parser compared with a recursive descent parser (4). Define some trees and try it out: >>> from nltk.draw.tree import draw_trees >>> draw_trees(tree1, tree2, tree3) ◑ Using tree positions, list the subjects of the first 100 sentences in the Penn treebank; to make the results easier to view, limit the extracted subjects to subtrees whose height is 2. The solution to these problems is provided by probabilistic parsing, which allows us to rank the parses of an ambiguous sentence on the basis of evidence from corpora. key = entry.noun1 + '-' + entry.prep + '-' + entry.noun2 ... In general, the answer is: very hard. S 1 . 4 . You can also check what productions are currently in the grammar with the command for p in grammar1.productions(): print(p). As in (a) above, draw a tree for The woman saw a man last Thursday. give NP: it / PP-DTV: to the politicians gave NP: them / NP: similar help give NP: them / NP: give NP: only French history questions / PP-DTV: to students in a Europe... Finally, the WFST did not represent the structural ambiguity in the sentence (i.e. the two verb phrase readings). For example, sentences have an interesting property that they can be embedded inside larger sentences. In this section we see two simple parsing algorithms, a top-down method called recursive descent parsing, and a bottom-up method called shift-reduce parsing. We've only illustrated two levels of recursion here, but there's no upper limit on the depth. print(tree) Make sure that you put a .cfg suffix on the filename, and that there are no spaces in the string 'file:mygrammar.cfg'. Let's start off by looking at a simple context-free grammar. Visiting relatives can be tiresome. Using the Step button, try to build a parse tree. What happens if we try to scale up this approach to deal with realistic corpora of language? H is obligatory while D may be optional. print(tree) (S (NP Mary) (VP (V saw) (NP (Det a) (N dog)))) Note RecursiveDescentParser() takes an optional parameter trace. b.*The he the fine fat trout in the brook. Constituent structure is based on the observation that words combine with other words to form units. The arcs in 5.1 are labeled with the grammatical function that holds between a dependent and its head. (10) a. The ambiguity in question is called a prepositional phrase attachment ambiguity, as we saw earlier in this chapter. How does the number of parse trees grow as the sentence gets longer? Use the chunking method to study the complementation patterns of these verbs. We introduce the main idea in this section; see the online materials available for this chapter for more implementation details. In NLTK, context-free grammars are defined in the nltk.grammar module. In the tradition of dependency grammar, the verbs in 5.1 are said to have different valencies. print(tree) (S (NP Mary) (VP (V saw) (NP (Det a) (N dog)))) Note Your Turn: Run the above parser in tracing mode to see the sequence of shift and reduce operations, using sr_parse = nltk.ShiftReduceParser(grammar1, trace=2) A shift-reduce parser can reach a dead end and fail to find any parse, even if the input sentence is well-formed according to the grammar. This sentence has two readings. an, and our grammar contains a production of the form A → ai, then we add A to the cell (i, `i`+1). Considering the verb give. Why? Thus a parser for a broad-coverage grammar will be overwhelmed with ambiguity. We use the NLTK chart parser, which was mentioned earlier in this chapter. First, as you can see, the WFST is not itself a parse tree, so the technique is strictly speaking recognizing that a sentence is admitted by a grammar, rather than parsing it. ◑ To compare multiple trees in a single window, we can use the draw_trees() method. P . So, for every word in text, we can look up in our grammar what category it belongs to. The word fish is both a noun and a verb. Productions with the same left hand side, and similar right hand sides can be collapsed, resulting in an equivalent but more compact set of rules. The corpus module defines the treebank corpus reader, which contains a 10% sample of the Penn Treebank corpus. print(tree) (S (NP Mary) (VP (V saw) (NP Bob))) Example 3.1 (code_cfg1.py): Figure 3.1: A Simple Context-Free Grammar The grammar in 3.1 contains productions involving various syntactic categories, as laid out in 3.1. Symbol Meaning Example S sentence the man walked NP noun phrase a dog VP verb phrase saw a park PP prepositional phrase with a telescope Det determiner the N noun dog V verb walked P preposition in Table 3.1: Syntactic Categories A production like VP -> V NP | V NP PP has a disjunction on the righthand side, shown by the | and is an abbreviation for the two productions VP -> V NP and VP -> V NP PP. S -> NP VP ... More generally, we say that a category B is a left-corner of a tree rooted in A if A ⇒* B α. What are the main syntactic constructions used for building such a long sentence? ☼ Consider the sequence of words: Buffalo buffalo Buffalo buffalo buffalo buffalo Buffalo buffalo. Now, all the examples we gave above only involved toy grammars containing a handful of productions. (A generalization of shift-reduce parser, a "lookahead LR parser", is commonly used in programming language compilers.) The advantage of shift-reduce parsers over recursive descent parsers is that they only build structure that corresponds to the words in the input. Having read in a text, can a program "understand" it enough to be able to answer simple questions about "what happened" or "who did what to whom"? The probability of a parse generated by a PCFG is simply the product of the probabilities of the productions used to generate it. Before we can formalize these ideas, we need to understand the concept of constituent structure. When you write CFGs for parsing in NLTK, you cannot combine grammatical categories with lexical items on the righthand side of the same production. ◑ In this section we claimed that there are linguistic regularities that cannot be described simply in terms of n-grams. This approach is called bottom-up parsing, and we will see an example in the next section. So far, we have only considered "toy grammars," small grammars that illustrate the key aspects of parsing. For example, in going from step 3 to step 4, it tries to find productions with N on the left-hand side. H selects D and determines whether it is obligatory or optional. 3 . print(tree) ... In other words, ambiguity increases with coverage. How hard would it be to construct such a set of productions by hand? Recursive descent parsing has three key shortcomings. Unlike complements, modifiers are optional, can often be iterated, and are not selected for by heads in the same way as complements. We've implemented a complete, primitive chart parser from the ground up! WFST's have several shortcomings. (10a) involves nested nominal phrases, while (10b) contains nested sentences. give NP: market operators / NP: the authority to suspend trading in futu... The shift-reduce parser repeatedly pushes the next input word onto a stack (4.1); this is the shift operation. >>> nltk.corpus.sinica_treebank.parsed_sents()[3450].draw() Unfortunately, as the coverage of the grammar increases and the length of the input sentences grows, the number of parse trees grows rapidly. we will extend this, to automatically build up the meaning of a sentence out of the meanings of its parts. For example, transitive verbs such as chased and saw require a following NP object complement; that is, they are subcategorized for NP direct objects. VP . This is a grammatically correct sentence, as explained at . ◑ Pick some common verbs and complete the following tasks: Write a program to find those verbs in the Prepositional Phrase Attachment Corpus nltk.corpus.ppattach. Much later, as shown in step 5, it finds a complete parse. N -> 'elephant' | 'pajamas' ... Valency restrictions are not just applicable to verbs, but also to the other classes of heads. As before, a key motivation is natural language understanding. Each node in this tree (including the words) is called a constituent. Extra materials for this chapter are posted at including links to freely available resources on the web. As (Klavans & Resnik, 1996) has pointed out, this is not word salad but a grammatical noun phrase, in which are is a noun meaning a hundredth of a hectare (or 100 sq m), and a and I are nouns designating coordinates, as shown in 6.2. Figure 6.2: "The a are of I": a schematic drawing of 27 paddocks, each being one "are" in size, and each identified using coordinates; the top left cell is the a "are" of column I (after Abney). 'in' -> 'pajamas' ... By convention, the left-hand-side of the first production is the start-symbol of the grammar, typically S, and all well-formed trees must have this symbol as their root label. Also as before, we will develop simple programs to process annotated corpora and perform useful tasks. print(tree) (shot I (elephant an (in (pajamas my)))) (shot I (elephant an) (in (pajamas my))) These bracketed dependency structures can also be displayed as trees, where dependents are shown as children of their heads. This chapter presents grammars and parsing, as the formal and computational methods for investigating and modeling the linguistic phenomena we have been discussing. See the Tree help documentation for more details, i.e. import the Tree class and then type help(Tree). During this process, the parser is often forced to choose between several possible productions. Although it is easy to find examples on the web containing this word sequence, such as New man at the of IMG (, speakers of English will say that most such examples are errors, and therefore not part of English after all. We can provide an optional trace parameter that controls how verbosely the parser reports the steps that it takes as it parses a text: >>> sr_parser = nltk.ShiftReduceParser(grammar1) >>> sent = 'Mary saw a dog'.split() >>> for tree in sr_parser.parse(sent): ... First, left-recursive productions like NP -> NP PP send it into an infinite loop. This parser does not implement any backtracking, so it is not guaranteed to find a parse for a text, even if one exists. By setting trace to True when calling the function complete_wfst(), we see tracing output that shows the WFST being constructed: >>> wfst1 = complete_wfst(wfst0, tokens, groucho_grammar, trace=True) [2] Det [3] N [4] ==> [2] NP [4] [5] Det [6] N [7] ==> [5] NP [7] [1] V [2] NP [4] ==> [1] VP [4] [4] P [5] NP [7] ==> [4] PP [7] [0] NP [1] VP [4] ==> [0] S [4] [1] VP [4] PP [7] ==> [1] VP [7] [0] NP [1] VP [7] ==> [0] S [7] For example, this says that since we found Det at wfst[2][3] and N at wfst[3][4], we can add NP to wfst[2][4]. b.*Chatterer saw frightened. ☼ In the recursive descent parser demo, experiment with changing the sentence to be parsed by selecting Edit Text in the Edit menu. However, this does not account for a form like give NP: federal judges / NP: a raise, where animacy may play a role. (Take turns with a partner.) What does this tell you about human language? Dynamic programming allows us to build the PP in my pajamas just once. For a sentence of length 50 there would be over 1012 parses, and this is only half the length of the Piglet sentence (1), which young children process effortlessly. The recursive descent parser builds a parse tree during the above process. A shift-reduce parser may be extended to implement policies for resolving such conflicts. Top-down parsers use a grammar to predict what the input will be, before inspecting the input! However, since the input is available to the parser all along, it would be more sensible to consider the input sentence from the very beginning. These complements can be given in either order, as illustrated in (19). ◑ Consider the algorithm in 4.4. Can you explain why parsing context-free grammar is proportional to n3, where n is the length of the input sentence. The evidence that a sequence of words forms such a unit is given by substitutability — that is, a sequence of words in a well-formed sentence can be replaced by a shorter sequence without rendering the sentence ill-formed. Figure 2.2: Substitution of Word Sequences Plus Grammatical Categories: This diagram reproduces 2.1 along with grammatical categories corresponding to noun phrases (NP), verb phrases (VP), prepositional phrases (PP), and nominals (Nom). A prepositional phrase is a phrase whose head is a preposition; moreover, the NP is a dependent of P. If the parser then proceeds with VP -> V NP PP, then the NP subtree must be created all over again. Let's consider this data more closely, and make the thought experiment that we have a gigantic corpus consisting of everything that has been either uttered or written in English over, say, the last 50 years. V . Eventually, this expansion process leads to subgoals such as: find the word telescope. If not, what is the cause of the ambiguity? If we parse the sentence The dog saw a man in the park using the grammar shown in 3.1, we end up with two trees, similar to those we saw for (3b): (9) a. So the above example about Pierre Vinken would produce: [[[NNP NNP]NP , [ADJP [CD NNS]NP JJ]ADJP ,]NP-SBJ MD [VB [DT NN]NP [IN [DT JJ NN]NP]PP-CLR [NNP CD]NP-TMP]VP .]S Consecutive categories should be separated by space. Let's take a closer look at the sequence the worst part and clumsy looking. ★ Modify the functions init_wfst() and complete_wfst() so that when a non-terminal symbol is added to a cell in the WFST, it includes a record of the cells from which it was derived. In fact there turn out to be a large number of contributing factors, as surveyed by (Bresnan & Hay, 2006). As we saw in 4.7, dynamic programming stores intermediate results and re-uses them when appropriate, achieving significant efficiency gains. H determines the semantic type of C. give NP: your Foster Savings Institution / NP: the gift of hope and free... Previous chapters have shown you how to process and analyse text corpora, and we have stressed the challenges for NLP in dealing with the vast amount of electronic language data that is growing daily. With the initial goal (find an S), the S root node is created. This approach to parsing is known as chart parsing. Consulting the grammar, we know that we can enter NP in cell (2, 4). More generally, we can enter A in (i, j) if there is a production A → B C, and we find nonterminal B in (i, k) and C in (k, j). So cell (1, 2) will contain the entry V. ★ Develop a left-corner parser based on the recursive descent parser, and inheriting from ParseI. The structural ambiguity of PP attachment, which we have illustrated in both phrase structure and dependency grammars, corresponds semantically to an ambiguity in the scope of the modifier. There are other templates we can use, like S but S, and S when S. (S (NP I) (VP (VP (V shot) (NP (Det an) (N elephant))) (PP (P in) (NP (Det my) (N pajamas))))) (S (NP I) (VP (V shot) (NP (Det an) (N elephant) (PP (P in) (NP (Det my) (N pajamas)))))) The program produces two bracketed structures, which we can depict as trees, as shown in (3b): (3) a. Furthermore, it will only find at most one parse, even if more parses exist. But the way in which we think of a grammar is closely intertwined with what we consider to be a language. ☼ We have seen that a chart parser adds but never removes edges from a chart. Equally, it is easy to compose a new sentence and have speakers agree that it is perfectly good English. The shift-reduce parser builds a parse tree during the above process. Bear) coming over the sea to rescue him... Is ambiguity of the individual words to blame? (Church & Patil, 1982) point out that the syntactic ambiguity of PP attachment in sentences like (18) also grows in proportion to the Catalan numbers. The VP in cell (1, 7) was actually entered twice, once for a V NP reading, and once for a VP PP reading. Figure 5.1: Dependency Structure: arrows point from heads to their dependents; labels indicate the grammatical function of the dependent as subject, object or modifier. Write code to produce two trees, one for each reading of the phrase old men and women Encode any of the trees presented in this chapter as a labeled bracketing and use nltk.Tree() to check that it is well-formed. In addition, you are not permitted to place multi-word lexical items on the righthand side of a production. Another way to think about the data structure is shown in 4.3, a data structure known as a chart. Consider the following sentence, particularly the position of the phrase in his turn. . The grammar in 3.3 correctly generates examples like (15d). So much for structural ambiguity; what about lexical ambiguity? As we shall see, patterns of well-formedness and ill-formedness in a sequence of words can be understood with respect to the phrase structure and dependencies. As before, we can use this information to help construct the grammar. Weighted grammars and probabilistic parsing algorithms have provided an effective solution to these problems. How might the computational work of a parser relate to the difficulty humans have with processing these sentences? Furthermore, they only build each sub-structure once, e.g. NP(Det(the), N(man)) is only built and pushed onto the stack a single time, regardless of whether it will later be used by the VP -> V NP PP reduction or the NP -> NP PP reduction. V -> 'shot' ... ◑ Download several electronic books from Project Gutenberg. Second, the parser wastes a lot of time considering words and structures that do not correspond to the input sentence. N . gave NP: quick approval / PP-DTV: to $ 3.18 billion in supplemental appr... P . A probabilistic context free grammar (or PCFG) is a context free grammar that associates a probability with each of its productions. Similarly, sentences that seem to be unambiguous, such as John saw Mary, turn out to have other readings we would not have anticipated (as Abney explains). What we can't do is conjoin an NP and an AP, which is why the worst part and clumsy looking is ungrammatical. If the command print(tree) produces no output, this is probably because your sentence sent is not admitted by your grammar. d.Joe really put the fish on the log. 4.1 illustrates this for the grammar from grammar2. (8) As we will see in the next section, a grammar specifies how the sentence can be subdivided into its immediate constituents, and how these can be further subdivided until we reach the level of individual words. Note To help us easily retrieve productions by their right hand sides, we create an index for the grammar. By contrast, we cannot replace little bear saw in the same way. We have also seen how to identify patterns in word sequences or n-grams. We can do this by dividing the class of verbs into "subcategories", each of which is associated with a different set of complements. However, in a broad-coverage grammar, a is also a noun (e.g. part a), dog is also a verb (meaning to follow closely), and runs is also a noun (e.g. ski runs). (7) a.He saw the fine fat trout in the brook. The cascaded chunk parsers we saw in 4 can only produce structures of bounded depth, so chunking methods aren't applicable here. In order to ensure that the trees generated by the grammar form a probability distribution, PCFG grammars impose the constraint that all productions with a given left-hand side must have probabilities that sum to one. give NP: federal judges / NP: a raise give NP: consumers / NP: the straight scoop on the U.S. waste crisis gave NP: Mitsui / NP: access to a high-tech medical product give NP: Mitsubishi / NP: a window on the U.S. glass industry give NP: much thought / PP-DTV: to the rates she was receiving , nor to ... Create a grammar to cover these cases. Write code to output a compact grammar. If the top n items on the stack match the n items on the right hand side of some production, then they are all popped off the stack, and the item on the left-hand side of the production is pushed on the stack. VP 2 . 5.2 provides more examples of labels for verb subcategories. For more examples of parsing with NLTK, please see the Parsing HOWTO at . If we now strip out the words apart from the topmost row, add an S node, and flip the figure over, we end up with a standard phrase structure tree, shown in (8). A parser is a procedural interpretation of the grammar. Figure 4.5: The Chart Data Structure: non-terminals are represented as extra edges in the chart. Such subgoals can be directly compared against the input sequence, and succeed if the next word is matched. We conclude that there is a parse for the whole input string once we have constructed an S node in cell (0, 7), showing that we have found a sentence that covers the whole input. ☼ Can you come up with grammatical sentences that have probably never been uttered before? Accordingly, we can argue that the "modern English" is not equivalent to the very big set of word sequences in our imaginary corpus. b.Chatterer saw the bear. This is a tree that covers the entire sentence, without any dangling edges. print_node(t, 72) give NP: the chefs / NP: a standing ovation give NP: advertisers / NP: discounts for maintaining or increasing ad sp... Since our grammar licenses two trees for this sentence, the sentence is said to be structurally ambiguous. A distinct and complementary approach, dependency grammar, focusses instead on how words relate to other words. These are different hypotheses, and the second overwrote the first (as it happens this didn't matter since the left hand side was the same.) Chart parsers use a slighly richer data structure and some interesting algorithms to solve these problems (see the Further Reading section at the end of this chapter for details). These possibilities correspond to the following productions: That is, was can occur with a following Adj, saw can occur with a following NP, thought can occur with a following S and put can occur with a following NP and PP. A grammar is a declarative specification of well-formedness — it is actually just a string, not a program. grammar2 = nltk.CFG.fromstring(""" S -> NP VP NP -> Det Nom | PropN Nom -> Adj Nom | N VP -> V Adj | V NP | V S | V NP PP PP -> P NP PropN -> 'Buster' | 'Chatterer' | 'Joe' Det -> 'the' | 'a' N -> 'bear' | 'squirrel' | 'tree' | 'fish' | 'log' Adj -> 'angry' | 'frightened' | 'little' | 'tall' V -> 'chased' | 'saw' | 'said' | 'thought' | 'was' | 'put' P -> 'on' """) Example 3.3 (code_cfg2.py): Figure 3.3: A Recursive Context-Free Grammar To see how recursion arises from this grammar, consider the following trees. ◑ Compare the performance of the top-down, bottom-up, and left-corner parsers using the same grammar and three grammatical test sentences. def init_wfst(tokens, grammar): numtokens = len(tokens) wfst = [[None for i in range(numtokens+1)] for j in range(numtokens+1)] for i in range(numtokens): productions = grammar.productions(rhs=tokens[i]) wfst[i][i+1] = productions[0].lhs() return wfst def complete_wfst(wfst, tokens, grammar, trace=False): index = dict((p.rhs(), p.lhs()) for p in grammar.productions()) numtokens = len(tokens) for span in range(2, numtokens+1): for start in range(numtokens+1-span): end = start + span for mid in range(start+1, end): nt1, nt2 = wfst[start][mid], wfst[mid][end] if nt1 and nt2 and (nt1,nt2) in index: wfst[start][end] = index[(nt1,nt2)] if trace: print("[%s] %3s [%s] %3s [%s] ==> [%s] %3s [%s]" % \ (start, nt1, mid, nt2, end, start, index[(nt1,nt2)], end)) return wfst def display(wfst, tokens): print('WFST ' + ' '.join(("%-4d" % i) for i in range(1, len(wfst)))) for i in range(len(wfst)-1): print("%d " % i, end=" ") for j in range(1, len(wfst)): print("%-4s" % (wfst[i][j] or '.'), end=" ") print() >>> tokens = "I shot an elephant in my pajamas".split() >>> wfst0 = init_wfst(tokens, groucho_grammar) >>> display(wfst0, tokens) WFST 1 2 3 4 5 6 7 0 NP . How widely used is this construction? >>> sent = ['I', 'shot', 'an', 'elephant', 'in', 'my', 'pajamas'] >>> parser = nltk.ChartParser(groucho_grammar) >>> for tree in parser.parse(sent): ... If you are interested in experimenting with writing CFGs, you will find it helpful to create and edit your grammar in a text file, say mygrammar.cfg. The simplest way to define a PCFG is to load it from a specially formatted string consisting of a sequence of weighted productions, where weights appear in brackets, as shown in 6.4. grammar = nltk.PCFG.fromstring(""" S -> NP VP [1.0] VP -> TV NP [0.4] VP -> IV [0.3] VP -> DatV NP NP [0.3] TV -> 'saw' [1.0] IV -> 'ate' [1.0] DatV -> 'gave' [1.0] NP -> 'telescopes' [0.8] NP -> 'Jack' [0.2] """) >>> print(grammar) Grammar with 9 productions (start state = S) S -> NP VP [1.0] VP -> TV NP [0.4] VP -> IV [0.3] VP -> DatV NP NP [0.3] TV -> 'saw' [1.0] IV -> 'ate' [1.0] DatV -> 'gave' [1.0] NP -> 'telescopes' [0.8] NP -> 'Jack' [0.2] Example 6.4 (code_pcfg1.py): Figure 6.4: Defining a Probabilistic Context Free Grammar (PCFG) It is sometimes convenient to combine multiple productions into a single line, e.g. VP -> TV NP [0.4] | IV [0.3] | DatV NP NP [0.3]. Beware that the RecursiveDescentParser is unable to handle left-recursive productions of the form X -> X Y; we will return to this in 4. ☼ Recall Strunk and White's prohibition against sentence-initial however used to mean "although". What is the longest sentence you can find? It finds pairs of prepositional phrases where the preposition and noun are fixed, but where the choice of verb determines whether the prepositional phrase is attached to the VP or to the NP. Here's one way of encoding a dependency grammar in NLTK — note that it only captures bare dependency information without specifying the type of dependency: >>> groucho_dep_grammar = nltk.DependencyGrammar.fromstring(""" ... (More examples of these sentences can be found at . System Message: WARNING/2 (ch08.rst2, line 900); backlink Inline interpreted text or phrase reference start-string without end-string. for subtree in tree.subtrees(filter)) [Tree('VP', [Tree('VBN', ['named']), Tree('S', [Tree('NP-SBJ', ...]), ...]), ...] Example 6.1 (code_sentential_complement.py): Figure 6.1: Searching a Treebank to find Sentential Complements The Prepositional Phrase Attachment Corpus, nltk.corpus.ppattach is another source of information about the valency of particular verbs. ◑ Inspect the Prepositional Phrase Attachment Corpus and try to suggest some factors that influence PP attachment. We gave an example in 2. table[key][entry.attachment].add(entry.verb) ... First we need to define a simple grammar: >>> groucho_grammar = nltk.CFG.fromstring(""" ... As we have just seen, dealing with ambiguity is a key challenge in developing broad coverage parsers. That is, we can easily tell that in a successful parse of John saw Mary, the parser has to expand NP in such a way that NP derives the sequence John α. The immediate constituents of S are NP and VP. Note Your Turn: Try developing a simple grammar of your own, using the recursive descent parser application, nltk.app.rdparser(), shown in 3.2. It comes already loaded with a sample grammar, but you can edit this as you please (using the Edit menu). Let's explore this issue with the help of a simple example. Would we be justified in calling this corpus "the language of modern English"? Consider the tree diagram presented on this Wikipedia page, and write down a suitable grammar. As soon as we try to construct a broad-coverage grammar, we are forced to make lexical entries highly ambiguous for their part of speech. Within frameworks based on phrase structure grammar, various techniques have been proposed for excluding the ungrammatical examples in (16d). A parser permits a grammar to be evaluated against a collection of test sentences, helping linguists to discover mistakes in their grammatical analysis. Such preferences can be represented in a weighted grammar. This looks like a coordinate structure, where two phrases are joined by a coordinating conjunction such as and, but or or. There are a number of reasons why we might answer No. Recall that in 3, we asked you to search the web for instances of the pattern the of. A grammar is said to be recursive if a category occurring on the left hand side of a production also appears on the righthand side of a production, as illustrated in 3.3. The production Nom -> Adj Nom (where Nom is the category of nominals) involves direct recursion on the category Nom, whereas indirect recursion on S arises from the combination of two productions, namely S -> NP VP and VP -> V S. b.Chatterer really saw the bear. S . If there is no match the parser must back up and try a different alternative. Discuss your findings. Despite these problems, some large collaborative projects have achieved interesting and impressive results in developing rule-based grammars for several languages. Phrase structure grammar is concerned with how words and sequences of words combine to form constituents. As you may recall, it is an ambiguity about attachment since the PP in the park needs to be attached to one of two places in the tree: either as a child of VP or else as a child of NP. ◑ You can modify the grammar in the recursive descent parser demo by selecting Edit Grammar in the Edit menu. N Example 4.4 (code_wfst.py): Figure 4.4: Acceptor Using Well-Formed Substring Table Returning to our tabular representation, given that we have Det in cell (2, 3) for the word an, and N in cell (3, 4) for the word elephant, what should we put into cell (2, 4) for an elephant? (13) A left-corner parser is a top-down parser with bottom-up filtering. ★ One common way of defining the subject of a sentence S in English is as the noun phrase that is the child of S and the sibling of VP. Here's an informal (and simplified) statement of how coordination works syntactically: Coordinate Structure: If v1 and v2 are both phrases of grammatical category X, then v1 and v2 is also a phrase of category X. Figure 4.3: The Chart Data Structure: words are the edge labels of a linear graph structure. Second, it requires every non-lexical grammar production to be binary. The same distinction carries over to the other types of phrase that we have discussed. What do you think of the prospects for significant performance boosts from cleverer rule invocation strategies? The simple parsers discussed above suffer from limitations in both completeness and efficiency. Det -> 'an' | 'my' ... We can see from this example that language provides us with constructions which seem to allow us to extend sentences indefinitely. Before looking at these, we need to understand why the notion of grammaticality could be gradient. The key point to note here is that although phrase structure grammars seem very different from dependency grammars, they implicitly embody a recognition of dependency relations. 'shot' -> 'I' | 'elephant' | 'in' ... >>> for key in sorted(table): ...

Ambiguity is a type of meaning in which a phrase, statement or resolution is not explicitly defined, making several interpretations plausible.A common aspect of ambiguity is uncertainty.It is thus an attribute of any idea or statement whose intended meaning cannot be definitively resolved according to a rule or process with a finite number of steps. Lexical semantics (also known as lexicosemantics), as a subfield of linguistic semantics, is the study of word meanings. It includes the study of how words structure their meaning, how they act in grammar and compositionality, and the relationships between the distinct senses and uses of a word.. The units of analysis in lexical semantics are lexical units which include not only words ... We offer free revision as long as the client does not change the instructions that had been previously given. In case a client want to alter the instructions, revision can be done but at a negotiated fee. We give 100% refund for an assignment that we ... Due to a planned power outage on Friday, 1/14, between 8am-1pm PST, some services may be impacted. We can help you reach your academic goals hassle-free. Power up Your Academic Success with the Team of Professionals. We've Got Your Back. Power up Your Study Success with Experts We've Got Your Back. Order Now Order Now . Please Use Our Service If You're: Wishing for a ... We offer free revision as long as the client does not change the instructions that had been previously given. In case a client want to alter the instructions, revision can be done but at a negotiated fee. We give 100% refund for an assignment that we ... We offer free revision as long as the client does not change the instructions that had been previously given. In case a client want to alter the instructions, revision can be done but at a negotiated fee. We give 100% refund for an assignment that we ... We can help you reach your academic goals hassle-free. Power up Your Academic Success with the Team of Professionals. We've Got Your Back. Power up Your Study Success with Experts We've Got Your Back. Order Now Order Now . Please Use Our Service If You're: Wishing for a ... Due to a planned power outage on Friday, 1/14, between 8am-1pm PST, some services may be impacted. Due to a planned power outage on Friday, 1/14, between 8am-1pm PST, some services may be impacted. We can help you reach your academic goals hassle-free. Power up Your Academic Success with the Team of Professionals. We've Got Your Back. Power up Your Study Success with Experts We've Got Your Back. Order Now Order Now . Please Use Our Service If You're: Wishing for a ...

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