AI2 Module 2

Tutorial 4

School of Informatics

1. As we saw in Tutorial 3, the sentence

I saw a man in the park with a telescope.

is N-ways ambiguous, in that it can be analysed in N different ways according to the grammar given below.

To see what effect, if any, this kind of ambiguity has on **recognition** using a chart parsing (i.e., on telling whether a string belongs to the language), simulate the CKY chart parsing algorithm given below on the above sentence and the grammar given below. Record your results in the array given on the last page.

Grammar Rules	**Lexicon**
s → np, vp.	tv → [Word], tv(Word).
np → det nom.	tv(saw).
np → pro.	det → [Word], det(Word).
nom → n.	det(the).
nom → nom pp.	det(a).
pp → prep np.	n → [Word], n(Word).
vp → tv np.	n(man).
vp → vp pp.	n(park).
	n(telescope).
	prep → [Word], prep(Word).
	prep(in).
	prep(with).
	pro → [Word], pro(Word).
	pro(i).

Pseudo-code for CKY algorithm

1. for $j := 1$ **to** n **do**
begin
$t(j-1, j) := \{A | A$ is a lexical category for $a_j\}$

2. for $k := j-1$ **down to** 0 **do**
begin
$t(k, j) := \{A |$ where $A \rightarrow B$ for some $B \in t(k, j)$
$\wedge \neg present(A, k, j)\}$

3. for $i := j-2$ **down to** 0 **do**
$t(i, j) := \{A |$ there exists k, $i < k < j$, such that $A \rightarrow B\ C$ for
some $B \in t(i, k)$, $C \in t(k, j)$ $\wedge \neg present(A, i, j)\}$

end end

2. Now consider what happens when the above chart parser is used not just to recognise sentences of the language, but also to associate with each one a syntactic structure or semantic interpretation.

For this, assume that:

- The grammar is altered to explicitly **record** the syntactic structure T and/or the semantic interpretation T that it constructs for each phrase while processing input strings. For example, the first few rules could be altered as follows to build syntactic structure:

  s(s(NP,VP)) → np(NP), vp(VP).
  np(np(Det,Nom)) → det(Det), nom(Nom).
  np(np(Pro)) → pro(Pro).
  nom(nom(N)) → n(N).
  nom(nom(Nom,PP)) → nom(Nom), pp(PP).
  pp(pp(Prep,NP)) → prep(Prep), np(NP).

- The CKY algorithm is changed (see below) to memoize $A(T)$ rather than just A, when there successful rewrite rule for category A, with syntactic or semantic structure T.

With such a grammar and parser, what effect does ambiguity now have on chart parsing?

To help you answer this question, record in the chart the instances of $A(T)$ you get from parsing:

I saw a man in the park with a telescope.

CKY modified to memoize $A(T)$

1. for $j := 1$ **to** n **do**
begin
$t(j-1, j) := \{A(T) | A$ is a lexical category for $a_j\}$

2. for $k := j-1$ **down to** 0 **do**
begin
$t(k, j) := \{A(T) |$ where $A(T) \rightarrow B$ for some $B \in t(k, j)$
$\wedge \neg present(A, k, j)\}$

3. for $i := j-2$ **down to** 0 **do**
$t(i, j) := \{A(T) |$ there exists k, $i < k < j$, such that $A(T) \rightarrow B\,C$ for
some $B \in t(i,k)$, $C \in t(k, j)$ $\wedge \neg present(A, i, j)\}$

end end