

Natural Language Processing

Midterm Examination

Name: _____

Student ID : _____

Date: April 26, 2018

Time: 14:20-16:20

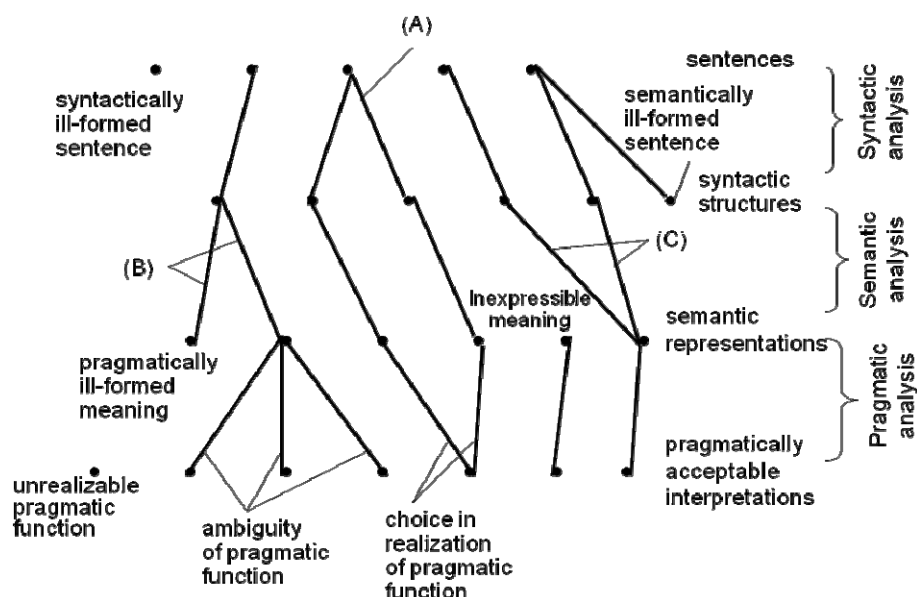
1. Give two issues for evaluating a particular grammar for a language. You should explain for your issues. (10 points)
2. What is part-of speech? Give 5 examples that correspond to 5 different part of speech symbols. (10 points)
3. What is the data structure Chart? Please specify (1) the fundamental rule and (2) the bottom-up rule using Chart. (15 points)
4. Consider the semantic representation of the sentence "Every student majored in a subject." Please reference to the corresponding grammar, and fill in blanks of (A), (B), (C), (D), (E), (F), (G), (H), (I) and (J) in the semantic representation. (10 points)

<p>Rule</p> <p>$S \rightarrow NP VP :$</p> <p style="padding-left: 40px;">$\langle S \text{ sem predicate} \rangle = \langle VP \text{ sem} \rangle$</p> <p style="padding-left: 40px;">$\langle S \text{ sem arg0} \rangle = \langle NP \text{ sem} \rangle.$</p> <p>Rule</p> <p>$VP \rightarrow TV NP :$</p> <p style="padding-left: 40px;">$\langle VP \text{ sem} \rangle = \langle NP \text{ sem} \rangle$</p> <p style="padding-left: 40px;">$\langle NP \text{ hole} \rangle = \langle TV \text{ sem} \rangle$</p> <p style="padding-left: 40px;">$\langle TV \text{ arg0} \rangle = \langle VP \text{ arg0} \rangle$</p> <p style="padding-left: 40px;">$\langle TV \text{ arg1} \rangle = \langle NP \text{ referent} \rangle$</p> <p>Rule</p> <p>$NP \rightarrow Det N:$</p> <p style="padding-left: 40px;">$\langle NP \text{ sem quantifier} \rangle =$</p> <p style="padding-left: 80px;">$\langle Det \text{ sem quantifier} \rangle$</p> <p style="padding-left: 40px;">$\langle NP \text{ sem variable} \rangle = \langle NP \text{ referent} \rangle$</p> <p style="padding-left: 40px;">$\langle NP \text{ sem restriction} \rangle = \langle N \text{ sem} \rangle$</p> <p style="padding-left: 40px;">$\langle NP \text{ sem body} \rangle = \langle NP \text{ hole} \rangle$</p> <p style="padding-left: 40px;">$\langle NP \text{ referent} \rangle = \langle N \text{ referent} \rangle$</p>	<p>Word "majored in":</p> <p style="padding-left: 40px;">$\langle cat \rangle = TV$</p> <p style="padding-left: 40px;">$\langle sem \text{ predicate} \rangle = \text{majored_in}$</p> <p style="padding-left: 40px;">$\langle sem \text{ arg0} \rangle = \langle arg0 \rangle$</p> <p style="padding-left: 40px;">$\langle sem \text{ arg1} \rangle = \langle arg1 \rangle.$</p> <p>Word student:</p> <p style="padding-left: 40px;">$\langle cat \rangle = N$</p> <p style="padding-left: 40px;">$\langle sem \text{ predicate} \rangle = \text{student}$</p> <p style="padding-left: 40px;">$\langle sem \text{ arg0} \rangle = \langle referent \rangle.$</p> <p>Word subject:</p> <p style="padding-left: 40px;">$\langle cat \rangle = N$</p> <p style="padding-left: 40px;">$\langle sem \text{ predicate} \rangle = \text{subject}$</p> <p style="padding-left: 40px;">$\langle sem \text{ arg0} \rangle = \langle referent \rangle.$</p> <p>Word a:</p> <p style="padding-left: 40px;">$\langle cat \rangle = Det$</p> <p style="padding-left: 40px;">$\langle sem \text{ quantifier} \rangle = \text{exists}.$</p> <p>Word every:</p> <p style="padding-left: 40px;">$\langle cat \rangle = Det$</p> <p style="padding-left: 40px;">$\langle sem \text{ quantifier} \rangle = \text{all}.$</p>
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The semantic representation for the sentence: Every student majored in a subject.

sem : quantifier : (A) _____
 variable : (B) _____
 restriction : arg0 : (C) _____
 predicate : student
 body : quantifier : (D) _____
 variable : (E) _____
 restriction : arg0 : (F) _____
 predicate : (G) _____
 body : arg0 : (H) _____
 arg1 : (I) _____
 predicate : (J) _____

5. Consider the following figure. It shows three layers of analysis, including syntactic analysis, semantic analysis and pragmatic analysis. A dot (·) indicates a sentence, a syntactic structure, a semantic representation, or a pragmatically acceptable interpretation depending on the layer of analysis. Some cases have been explained in this figure, and some cases are still left open for your answers. Please fill in (A), (B), and (C). Your answers should include the terminology to describe the linguistic phenomenon and an example for each case. (15 points)



6. If we have the following grammar, show the parsing tree of “MediCenter employed nurses” using (1) bottom-up parsing and (2) top-down parsing. (20 points)

Rule {simple sentence formation}

$S \rightarrow NP VP$.

Rule {transitive verb}

$VP \rightarrow V NP$.

Rule {intransitive verb}

$VP \rightarrow V$.

Word Dr Chan:

$\langle \text{cat} \rangle = NP$.

Word nurses:

$\langle \text{cat} \rangle = NP$.

Word MediCenter:

$\langle \text{cat} \rangle = NP$.

Word patients:

$\langle \text{cat} \rangle = NP$.

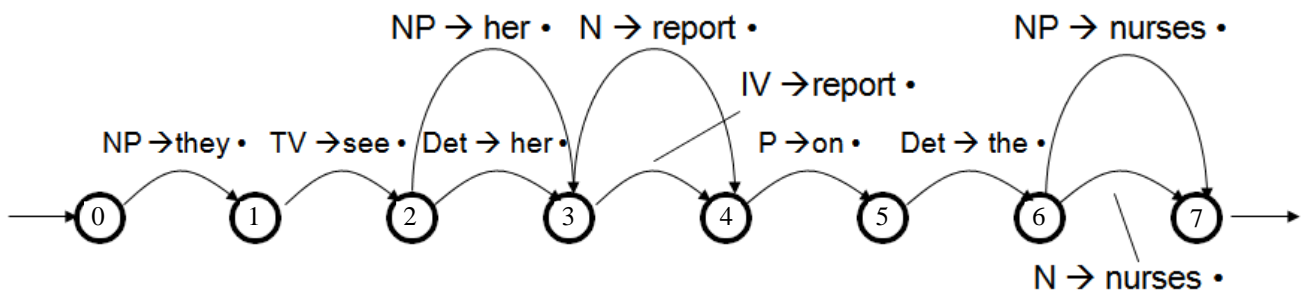
Word died:

$\langle \text{cat} \rangle = V$.

Word employed:

$\langle \text{cat} \rangle = V$.

7. What is the top-down strategy in rule invocation for chart data structure? Suppose we have the following chart and the grammar rules. Please draw the new charts when adopting the top-down strategy step by step. For simplification, please only add the new edges to the first node (node 0). You don't need to apply to the other 7 nodes. (20 points)



Grammar rules:

Rule {simple sentence formation}

$S \rightarrow NP VP$

Rule {intransitive verb}

$VP \rightarrow IV$

Rule {intransitive verb plus PP complement}

$VP \rightarrow IV PP$

Rule {transitive verb}

$VP \rightarrow TV NP$

Rule {transitive verb plus PP complement}

$VP \rightarrow TV NP PP$

Rule {transitive verb plus VP complement}

$VP \rightarrow TV NP VP$

Rule {simple noun phrase}

$NP \rightarrow Det N$

Rule {noun phrase with PP complement}

NP \rightarrow Det N PP

Rule {simple prepositional phrase}

PP \rightarrow P NP

8. In question-answering applications, users ask questions with natural language statements, and a system answers the questions based on a database. Suppose you are given the web as the supporting database in your question-answering system. Please propose such a natural language understanding system. (5 points, bonus)