13. Context-Sensitive Grammars

Context-Sensitive Grammars

- Context-sensitive grammars are equivalent to Type 1 Generative Grammars in Chomsky-Schützenberger's hierarchy

- Context-sensitive grammars can be more powerful than regular and context-free grammars.

- They can recognize any context-sensitive language, are very well-adapted to describe distributional and agreement constraints between linguistic units, and can be processed by linear bounded automata.

- Lexical Functional Grammars (LFG) are equivalent to context-sensitive grammars.

Context-Sensitive Grammars

- In NooJ, context-sensitive grammars are context-free grammars + variables and constraints.

- Context-sensitive grammars have two components: the description of sequences and the description of agreement constraints.

Type 1 : Context-Sensitive Grammars

A grammar that recognizes words that contains the same number of "a", "b" and "c"

Type 1 : Context-Sensitive Grammars

A grammar that recognizes words constitued by
a number of "a" that is a power of 2, *e.g.*, 2, 4, 8, 16...
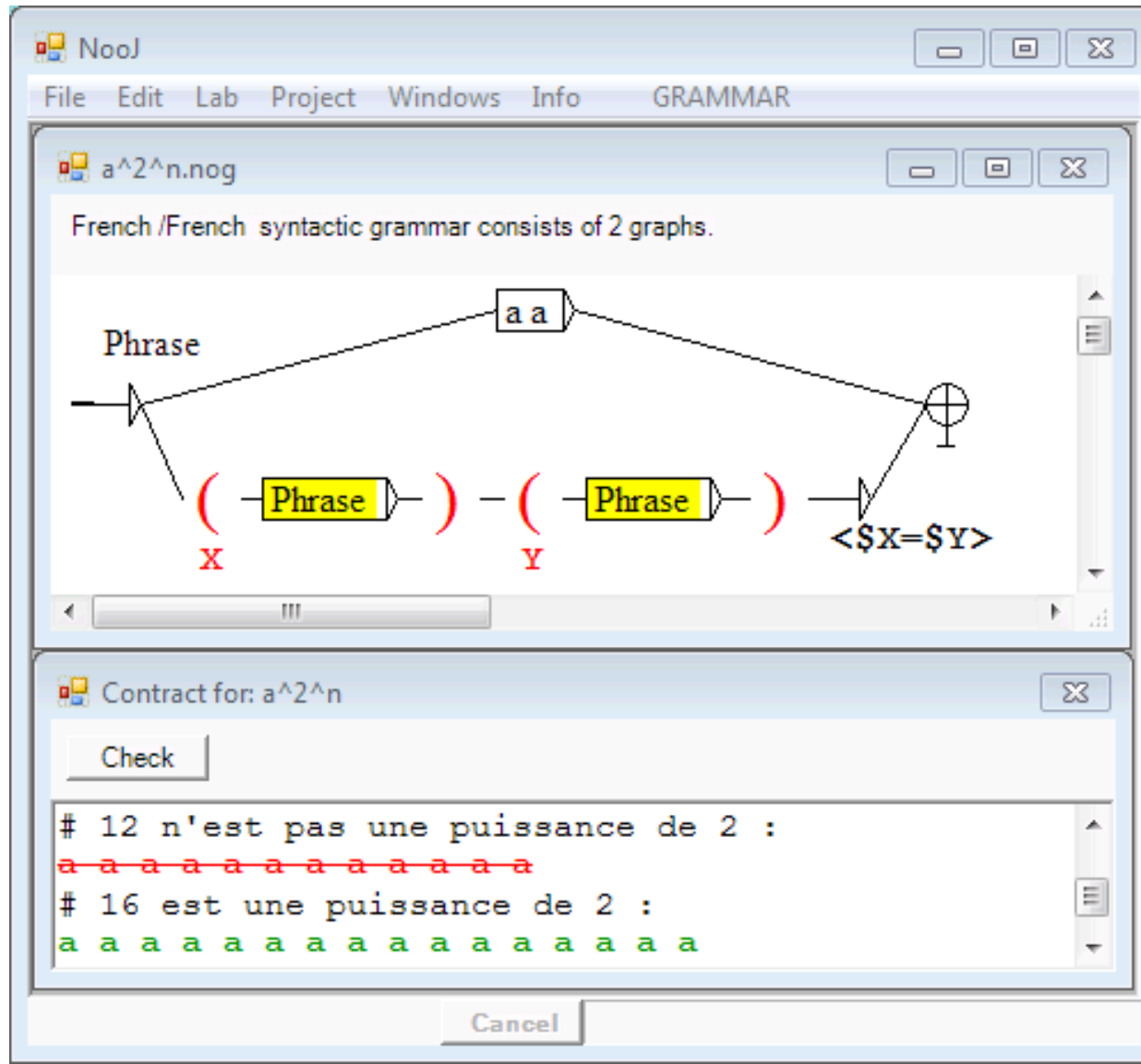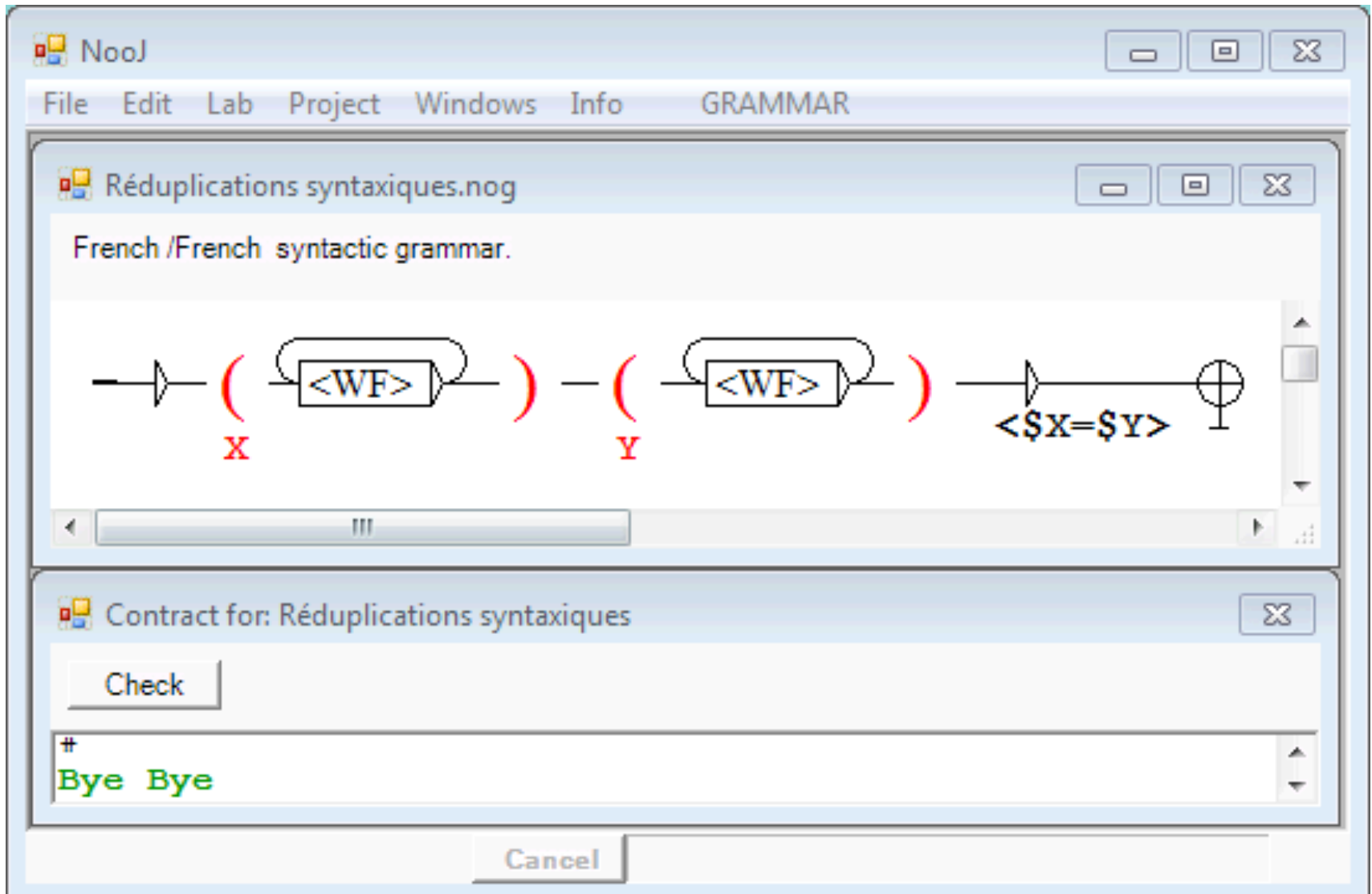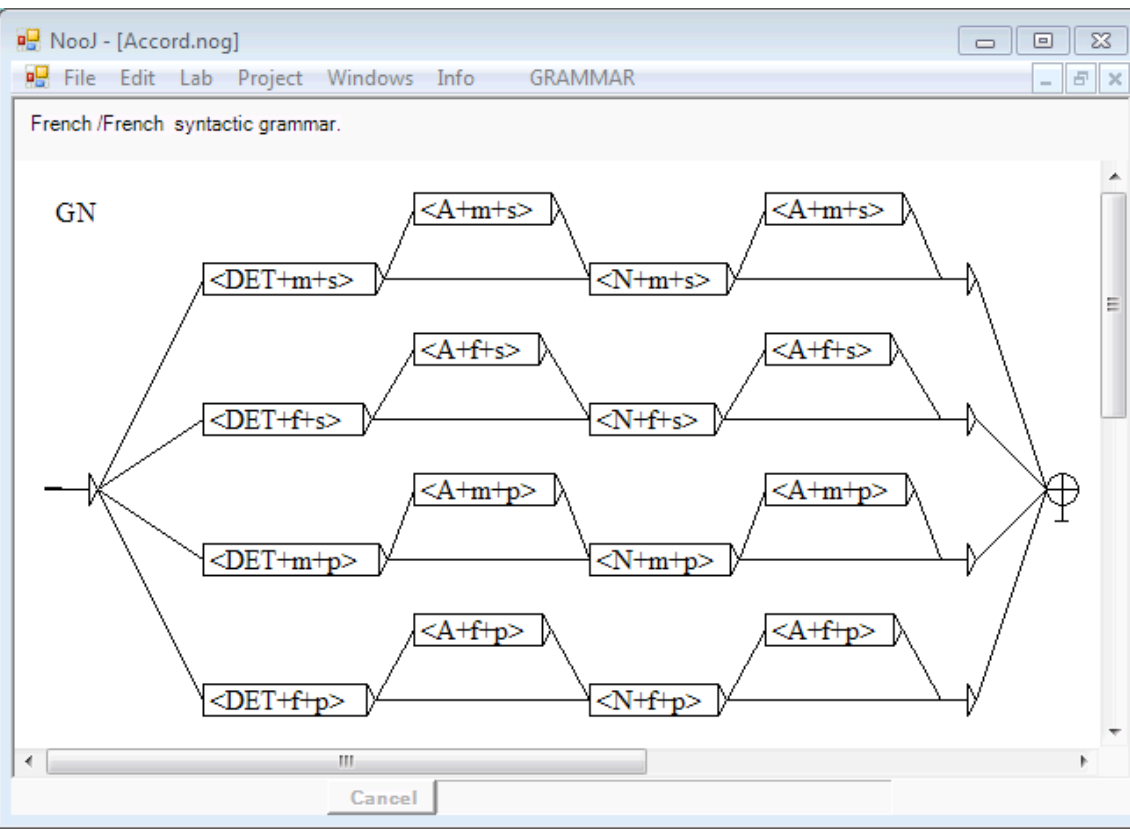
Type 1 : Context-Sensitive Grammars

A grammar that recognizes reduplications, *e.g.*, bye bye, chouchou, papa

Context-Sensitive Grammars

- Example of a grammar that describes the agreement in number and in gender in some French noun phrases:

<DET+m+s> (<A+m+s>|<E>) <N+m+s> (<A+m+s>|<E>) |
<DET+f+s> (<A+f+s>|<E>) <N+f+s> (<A+f+s>|<E>) |
<DET+m+p> (<A+m+p>|<E>) <N+m+p> (<A+m+p>|<E>) |
<DET+f+p> (<A+f+p>|<E>) <N+f+p> (<A+f+p>|<E>)

Four quasi-identical terms for French...

But 30 quasi-identical terms for some slavic languages (2 numbers, 3 genders, 5 cases).

Context-Sensitive Grammars

- Example of a Context-Free Grammar that only describes the structure of some French noun phrases:

$$GN = <DET> (<A>|<E>) <N> (<A>|<E>)$$

- We then add agreement constraints for gender and number:

<p align="center"><$THIS$Gender = NGender>
<$THIS$Number = NNumber></p>

- Variable $THIS refers to the current ALU; variable $N refers to the noun.

Context-Sensitive Grammars
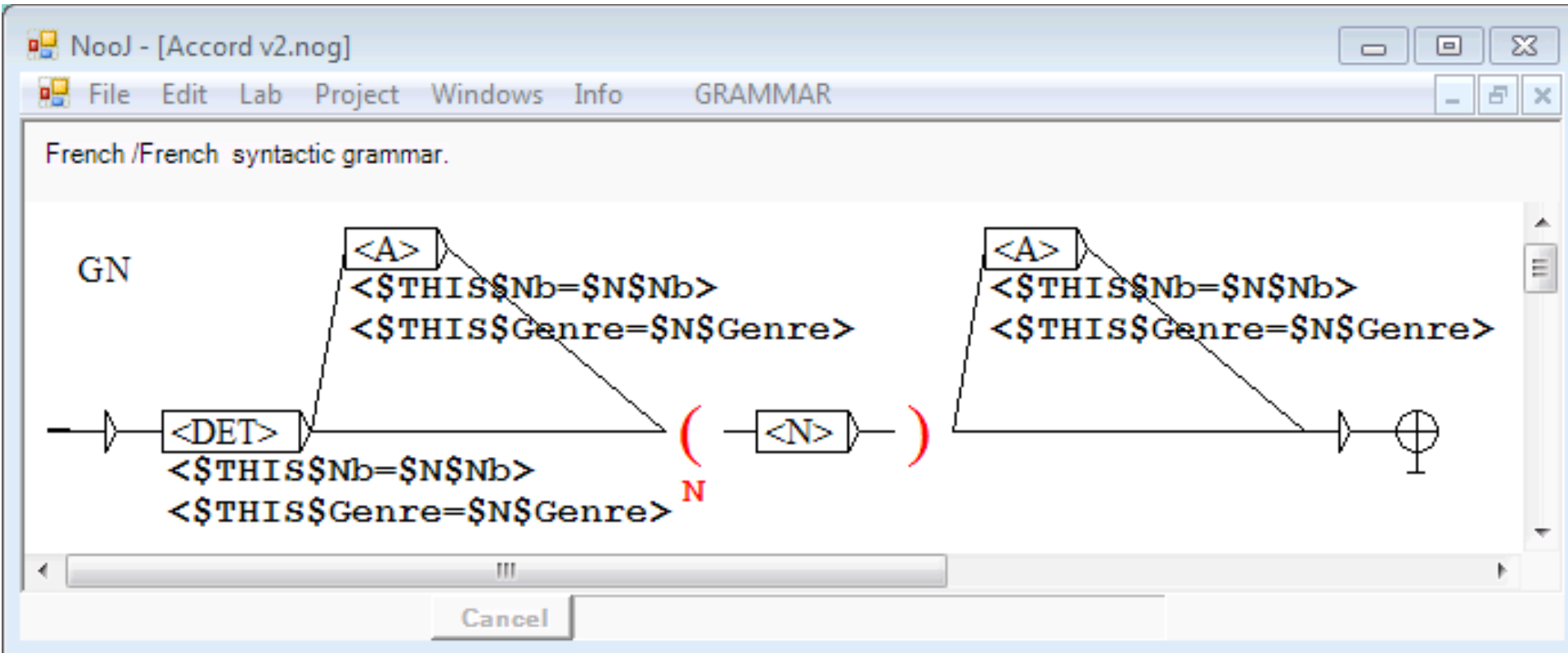

- The noun <N> is stored in variable $N
- Special variable $THIS refers to the current ALU
- Variable NNb refers to the "NB" property of the noun; $THIS$Nb refers to the "NB" property of the current ALU;
- Variable NGenre refers to the "Genre" property of the noun; $THIS$Genre refers to the "Genre" property of the current ALU.

A morphological context-sensitive grammar

A grammar that recognizes wordforms that start with "re", "de" or "dis"
The constraint <$Verb=:V> checks that the following letters constitute a valid verb.
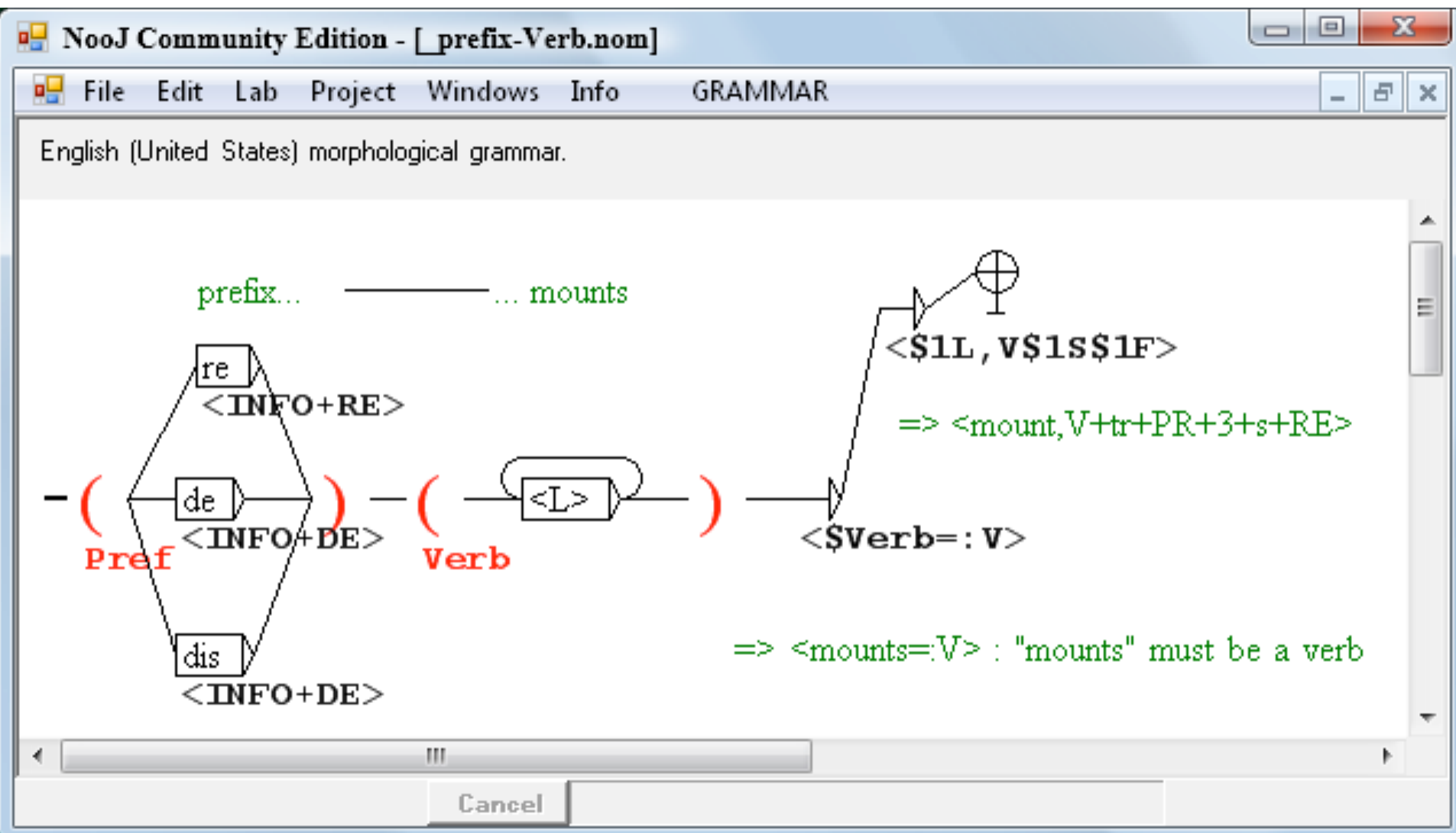
There are three types of constraints

- The operator "=" tests that the two sides are identical strings, *e.g.*:

<$X=$Y> tests that ALU $X is identical to ALU $Y

<NNb="plural"> tests that ALU $N number is "plural"

<DETNb=NNb> tests that ALUs $DET and $N agree in number

- Matching:

<$X=:N> tests that $X is a noun (<N>)

<$Y=:have> tests that $Y is a form of have (<have>)

<$V=:V+Trans+F+3+s> test that $V is a transitive verb conjugated in the Present, third person, singular (<V+Trans+F+3+s>)

- Existence:

<$NE> tests that variable $NE has a non-empty value, *i.e.*, the corresponding ALU occurs in the matching sequence.

CONGRATULATIONS

You know how to construct context-sensitive grammars to describe phrase structures and agreements between their components