NOOJ GRAMMARS FOR ITALIAN TRANSFORMATIONAL ANALYSIS: A BRIEF OUTLINE

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Abstract As known, Transformational Grammar (TG) focuses on bidirectional relationships between sentences sharing the same lexical material, in some cases also the same meaning, but always differing in terms of formal structure and word distribution. We represent such relationships with the symbol "=" (equal to). For instance, we can connect a declarative sentence to its negative and/or passive forms. Similarly, we can connect complex sentences to the respective simple sentences, which make them up, such as sentences with reciprocal verbs and collective subjects, obtained through the coordination of two simple sentences. According to Maurice Gross [1] and Max Silberztein [2,3], examples of possible transformations are those going from declarative sentences to Interrogatives, Pronominalization, Juxtapositions, or other processes producing the so-called Mirror Transformations. In addition, two or more transformations can operate simultaneously on a declarative sentence.

Keywords: NooJ, NooJ Local Grammars, Italian Transformational Analysis, Natural Language Processing, Finite State Automata, Graphs.

GRAMÁTICAS NOOJ PARA EL ANÁLISIS TRANSFORMACIONAL DEL ITALIANO: BREVE RESUMEN

Resumen Como es sabido, la Gramática Transformacional (TG) se centra en relaciones bidireccionales entre oraciones que comparten el mismo material léxico, en algunos casos también el mismo significado, pero siempre difieren en términos de estructura formal y distribución de palabras. Representamos tales relaciones con el símbolo "=" (igual a), usado para conectar, por ejemplo, una oración declarativa con sus formas negativas y/o pasivas, u oraciones complejas con las oraciones simples que las forman, como por ejemplo oraciones con verbos recíprocos y sujetos colectivos obtenidos coordinando dos oraciones simples. Según Maurice Gross [1] y Max Silberztein [2,3], ejemplos de posibles transformaciones son aquellas que van de oraciones declarativas a Interrogativas, Pronominalización, Yuxtaposiciones o las que producen las llamadas Transformaciones Espejo. Además, una o más combinaciones pueden operar simultáneamente en una oración declarativa.

Palabras clave: NooJ, Gramáticas locales de NooJ, Análisis Transformacional del italiano, Procesamiento del Lenguaje Natural, Autómatas de Estado Finito, Gráficos

1. Transformational Grammar and Transformation Typology

As known, according to Maurice Gross [1] and Max Silberztein [2,3], Transformational Grammar (TG) focuses on bidirectional relationships between sentences which share the same lexical material and meaning, but which differ in terms of formal structure and distribution. We represent such relationships with the symbol "=" (equal to) to connect, for example, a declarative sentence to its negative and/or passive forms, as in:

1. James loves Joni = [Passive] Joni is loved by James
2. James loves Joni = [Negation] James dose not love Joni

Transformations also connect complex sentences to the simple sentences forming them, as it is the case of sentences with reciprocal verbs and collective subjects obtained through the coordination of two simple sentences:

3. Joni loves James, James loves Joni =
    a. [Coordination] Joni loves James and James loves Joni =
    b. [Reciprocal] Joni and James love each other

Other examples of possible transformations include from initial declarative sentences to Interrogatives, Pronominalization, Juxtapositions, or those producing the so-called Mirror Transformations:

4. Paul reads today's newspaper = [Interrogative] Is Paul reading today's newspaper?
5. Paul reads today's newspaper = [Pronominalization] He reads today's newspaper = He reads it
6. Paul reads today's newspaper = [N0 Juxtaposition]] It's Paul who reads today's newspaper
7. Paul reads today's newspaper = [N1 Juxtaposition] It is today's newspaper that Paul is reading
8. The garden is swarming with ants = [Mirror] (only with certain verbs) Ants are swarming in the garden

In addition, two or more transformations can operate simultaneously on a declarative sentence:

9. Paul reads today's newspaper = [Interrogative] + [N1 Juxtaposition] Is it today's newspaper that Paul is reading?
10. The garden is swarming with ants = Ants are swarming in the garden [Juxtaposition] + [Mirror] = It is ants that are swarming in the garden = It is the garden that is swarming with ants

As stated in [3], page 288, "An exhaustive formalized description of the transformations of a language would have to contain hundreds of elementary transformations", some of which are visible in the following list:

[Pron0ms] Joe eats an apple = He eats an apple
[Pron0fs] Lea eats an apple = She eats an apple
[Pron0n] The rat eats an apple = It eats an apple
[Pron0Part] Some bread fell = Some fell
[Pron0p] Joe and Lea eat an apple = They eat an apple
[Pron1m] Joe sees Paul = Joe sees him
[Pron1f] Joe sees Lea = Joe sees her
[Pron1n] Joe eats an apple = Joe eats it
[Pron1Part] Joe eats some bread = Joe eats some
[Pron1p] Joe eats two apples = Joe eats them
[Pron2m] Joe gives an apple to Paul = Joe gives him an apple
[Pron2m'] Joe gives an apple to Paul = Joe gives an apple to him
…
[N1Z] Joe eats an apple = Joe eats
[N2Z] Joe gives an apple to someone = Joe gives an apple
…
[PresProg] Joe eats an apple = Joe is eating an apple

[PastProg] Joe eats an apple = Joe was eating an apple
[FutProg] Joe eats an apple = Joe will be eating an apple
[PresPerf] Joe eats an apple = Joe has eaten an apple
[PastPerf] Joe eats an apple = Joe had eaten an apple
[FutPerf] Joe eats an apple = Joe will have eaten an apple
[Preterit] Joe eats an apple = Joe ate an apple
[Future] Joe eats an apple = Joe will eat an apple
[PresCond] Joe eats an apple = Joe would eat an apple
[PastCond] Joe eats an apple = Joe would have eaten an apple
[NearFuture] Joe eats an apple = Joe is going to eat an apple
[NearPast] Joe eats an apple = Joe has just eaten an apple
…
[Passive] Joe eats an apple = An apple is eaten by Joe
[PassiveZ] Joe eats an apple = An apple is eaten
…
[Neg] Joe eats an apple = Joe does not eat an apple
[Neg-no] Joe eats an apple = Joe eats no apple
[Neg-AspCont] Joe eats apples = Joe never eats apples
[Neg-AspStop] Joe eats an apple = Joe no longer eats an apple
…
[Cleft0] Joe eats an apple = It is Joe who eats an apple
[Cleft1] Joe eats an apple = It is an apple that Joe eats
[Cleft2] Joe gives an apple to Lea = It is to Lea that Joe gives an apple
[CleftAdv] Joe ate an apple yesterday = It is yesterday that Joe ate an apple
…
[Intens0] Joe works = Joe works a little
[Intens1] Joe loves Lea = Joe loves Lea very much
[Intens2] Joe loves Lea = Joe loves Lea passionately
…

"Moreover, each transformation corresponds to two reverse operations. For example, the [Neg] transformation in fact corresponds to the following two operations":

11. John eats an apple = [Neg] = John does not eat an apple
12. John does not eat an apple = [Neg-inv] John eats an apple

1.1. Verifying the correctness of a transformation

In order to verify the correctness of a transformation, we must:

- analyse the behaviour and syntactic profile (i.e. the predicative qualities) of the predicate;

- Check that a given predicate, after a transformation, produces an acceptable and grammatical sentence (not all predicates allow the same transformations). For example, in Italian, we find specific restrictions with the verb *dare* (to give):

1. *Giovanna dà un libro a Paolo* (Joan gives a book to Paul) =
    a. [N1 Passive] *Un libro è dato a Paolo da Giovanna* (A book is given to Paul by Joan) =
    b. [N2Passive] **Paolo è dato un libro da Giovanna* (Paul is given a book by Joan)

- check that in the transformed sentences the original semantic roles of the complements have not been modified.

As for this last step, it is worth stressing that semantic roles specify whether a complement, in relation to the predicative function expressed in a given sentence, performs the action, or receives it, or even if it is the instrument with which the action is performed. However, it is not possible to formulate a universal list of semantic roles, since their definition depends on the granularity of the syntactic-semantic analysis to perform. Therefore, we give below only the list of the most frequently used semantic roles:

- **Actor**: the entity that tells of an event, but never controls it = **Mary** snores
- **Agent**: the entity who voluntarily carries out an action and who is therefore intentionally an active party of the event = **Mary** eats an apple
- **Beneficiary**: the entity that receives profit or damage from the action = Mary gave **Lucy** a bag; Marie steals **Paul**'s car;
- **Cause**: the entity that causes a process to complete = Because **Clyde** was **hungry**, he ate the cake;
- **Company**: the entity that participates in the activity carried out by the agent or with which he/she establishes a corporate relationship = Maria discussed her thesis **with the professor**;
- **Destination**: place or condition towards which the event is heading, or which constitutes the destination of a movement = Mary goes **on vacation**;
- **Dimension**: the extension in time, space and/or other dimensions = Mary weighs **sixty kilos**;
- **Experiencer**: the entity that experiences a state or undergoes a certain psychological process = **Mary** loves the sea;
- Instrument: The entity (animate or inanimate) that intervenes involuntarily in the achievement of an action (or through that action, if produced) = Marie cut an apple with a **knife**; Marie cheats on Paul with **John**;
- **Location**: location or condition in which the action takes place and/or continues = Mary lives **in town**;
- **Objective**: the state towards which a process or action aims = He took his pills to feel **better**;
- **Origin**: The Place where something comes from = Mary withdraws money **from her account**;
- **Patient**: the entity implied passively in the event achieved by an agent (hence, immediately undergoing its consequences, or falling in a specific condition) = Mary eats an **apple**; Mary beats **Paul**;
- **Recipient**: where the event is addressed (not to be confused with the two previous roles) = I sent **John** the letter. He gave the book to **her**;
- **Result**: The final state that follows the completion of a process = Tabitha phoned 911 right away and she got some **help**;
- **Source** (or Origin): the initial state at the execution of a process; place or condition from which an event originates = The rocket was launched **from Central Command**. She walked away **from him**;
- **Time**: the temporal circumstance of a process = The pitcher struck out nine batters **today**.

However, these definitions in the list tend to be expressly semantic, while our approach here will take into account only the morphosyntactic profiles and behaviours of predicates. Thus, for

example, in the sentence "Marie goes on vacation (Destination)", no physical destination actually occurs. "Vacation" it is not a concrete place, and the expression itself is a fixed sentence, which idiomatically violate the rules of co-occurrence and restriction of selection of the verb "to go", in opposition to sentences as "Marie goes to the countryside".
The previous definitions also lead us to consider certain semantic roles as equivalent or interchangeable, which cannot however happen when it is the morphosyntax of a sentence that govern the semantic roles. For example, the sentence "Mary weighs sixty kilos" (Dimension) does not present any direct complement (*Mary weighs); in it we find only one semantic predicate (Mary), hardly classifiable as either an actor or an agent.
Moreover, according to the definition of simple sentence formulated by Lexicon-Grammar, some of the previous semantic roles are non-essential complements of the sentences in which they occur. Therefore, they can be deleted without altering the meaning of any given sentence, as for the two instrumentals:

2. Mary cuts an apple (E+**with a knife** (ADV));
3. Mary cheats on Paul (E+**with John** (ADV));

and the origin:

4. Marie withdraws money (E+ **from her account** (ADV))

In certain simple phrases, the syntactic subject does not always have the semantic role of agent, as in:

1. Marie (patient) likes Paul (agent);
2. The hill (patient) is covered in snow (agent);
3. The garden (destination + location) is crawling with ants (agent).

2. Some Examples of NooJ Grammars for Italian Transformational Analysis

In the following pages, we will present some Italian NooJ transformational grammars of Italian created based on the syntactic profiles of dative verbs such as *dare* (to give), *regalare* (to donate), *offrire* (to offer), and so on. More precisely, the transformations achieved with the grammars will be:

1. the passivation of a dative declarative sentence;
2. two different pronominalizations (one masculine and one feminine) of the indirect complement of a dative declarative sentence;
3. the extrapositions of the subject and of the direct complement of a dative declarative sentence;
4. the variable distribution of a dative interrogative sentence;
5. as for those dative passive forms that are not acceptable/grammatical, the equivalence between dative-verb sentences and sentences governed by *ricevere* (to receive).

In each figure, we will also show the main structure of each graphs and give, in the debug window, some brief examples of the achievable transformations.

2.1. Passivation of a Dative Declarative Sentence

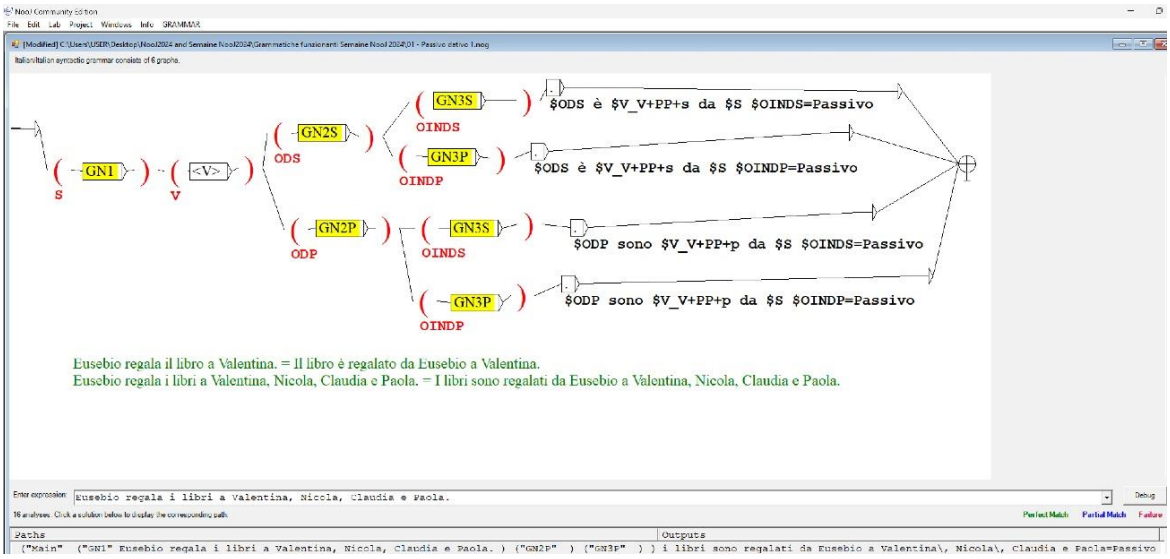

Fig. 1. Passivo dativo 1.nog – Main Structure

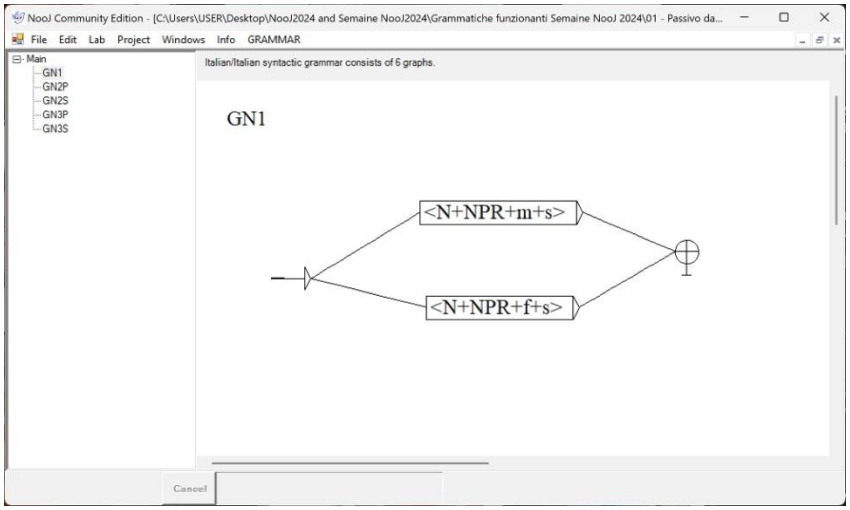

Fig. 2. Passivo dativo 1.nog – GN1

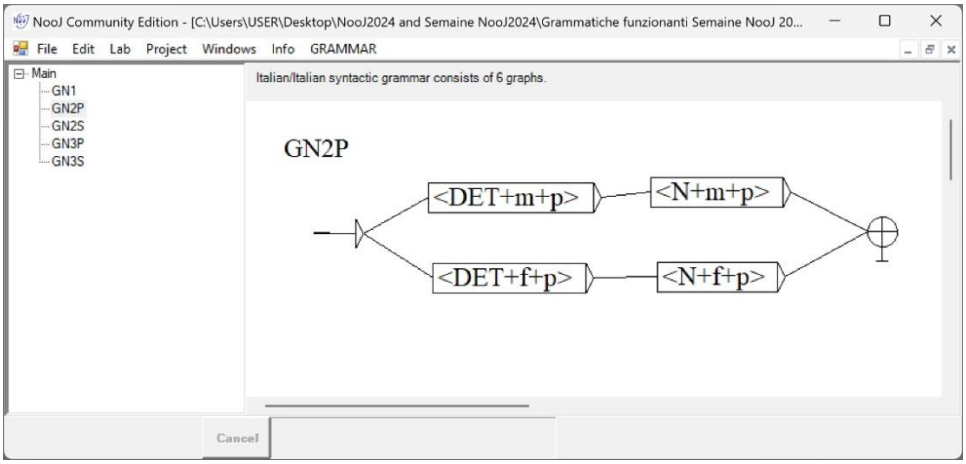

Fig. 3. Passivo dativo 1.nog – GN2P

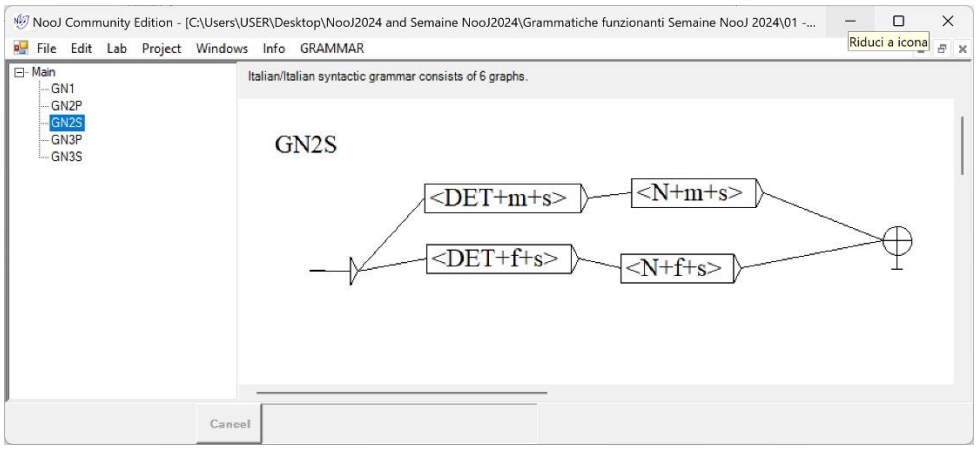

Fig. 4. Passivo dativo 1.nog – GN2S

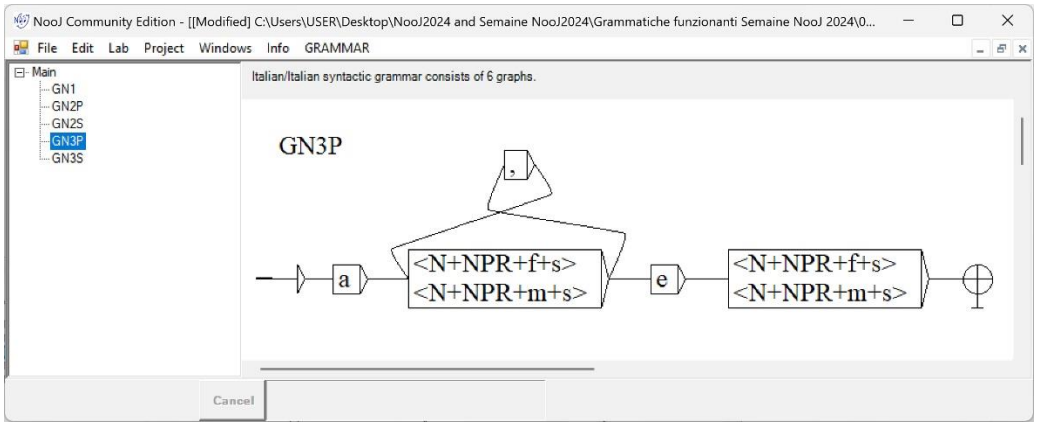

Fig. 5. Passivo dativo 1.nog – GN3P

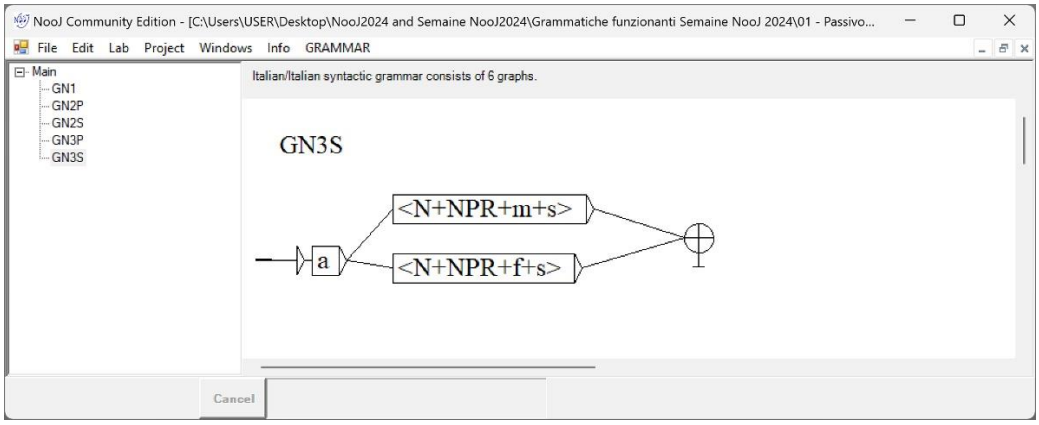

Fig. 6. Passivo dativo 1.nog – GN3S

2.2. Pronominalization of the masculine/feminine indirect complement of a dative declarative sentence

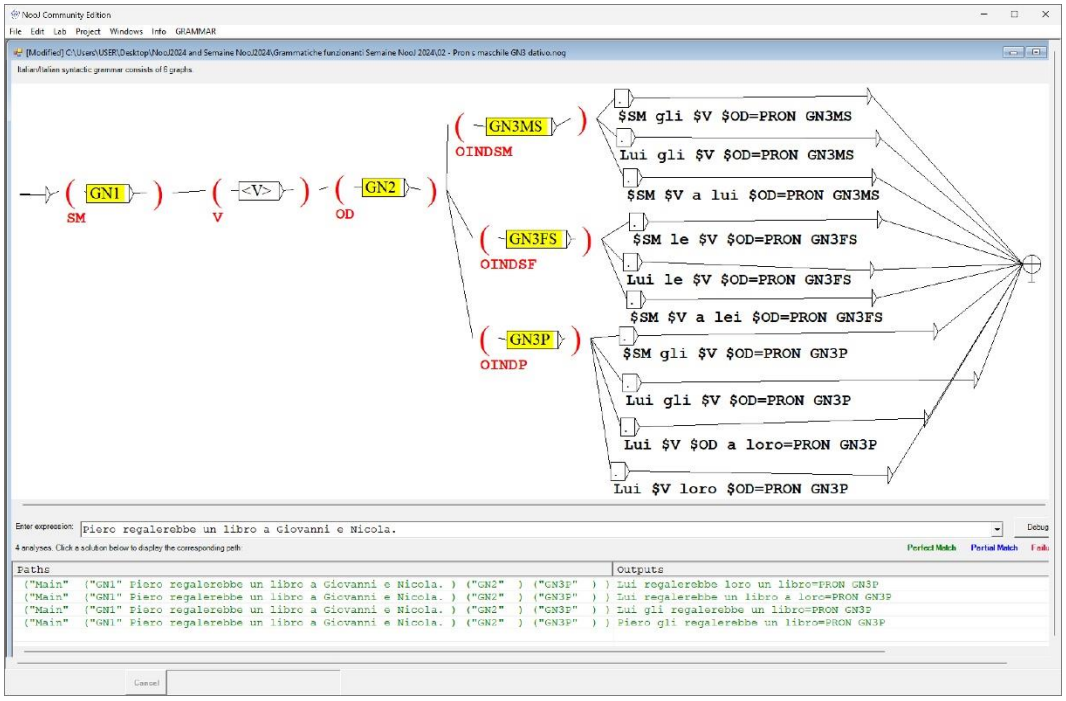

Fig. 7. Pron s maschile GN3 dativo.nog – Main Structure

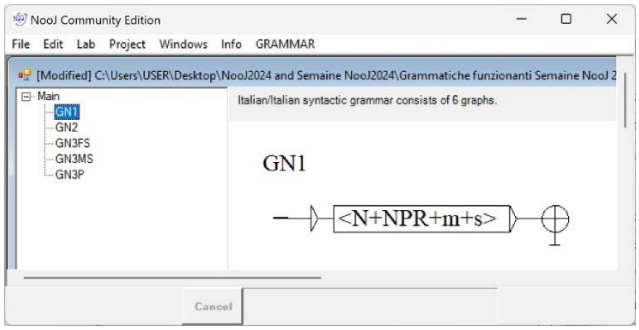

Fig. 8. Pron s maschile GN3 dativo.nog – GN1

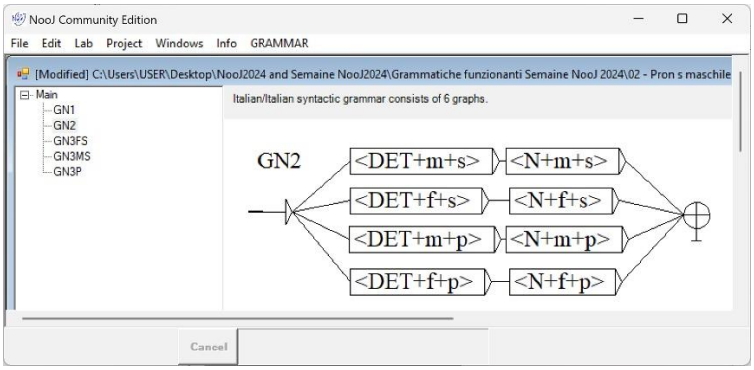

Fig. 9. Pron s maschile GN3 dativo.nog – GN2

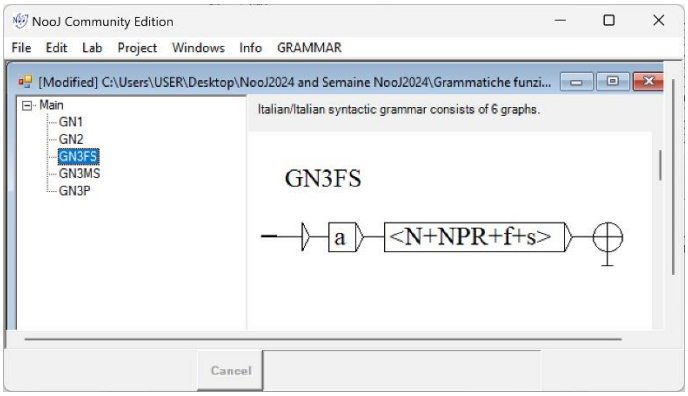

Fig. 10. Pron s maschile GN3 dativo.nog – GN3FS

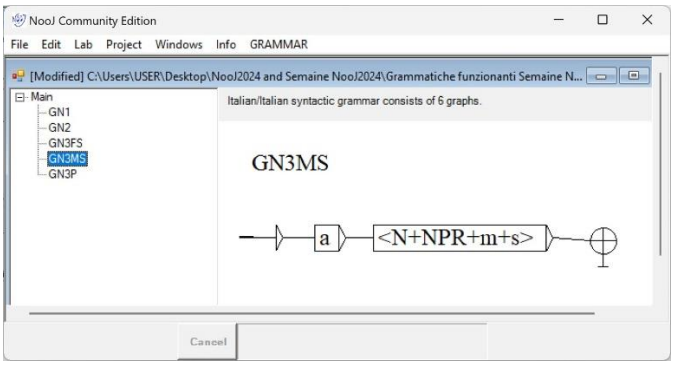

Fig. 11. Pron s maschile GN3 dativo.nog – GN3MS

In this grammar**,** GN3P is the same as in Fig. 5.

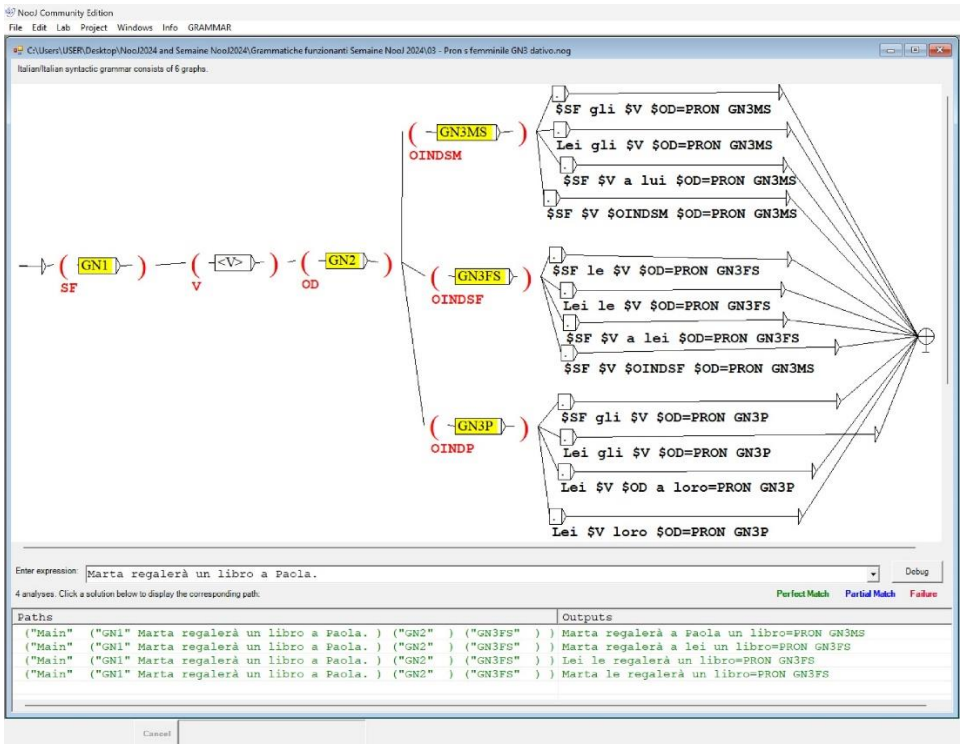

Fig. 12 - Pron s femminile GN3 dativo.nog

In this grammar**,** GN1is the same as in **Fig. 8**; GN2 the same as in **Fig. 9**; GN3FS the same as in **Fig. 10**; GN3MS the same as in **Fig. 11**; GN3P the same as in **Fig. 5**.

2.3. Subject and Direct Object Extrapositions in a Dative Declarative Sentence

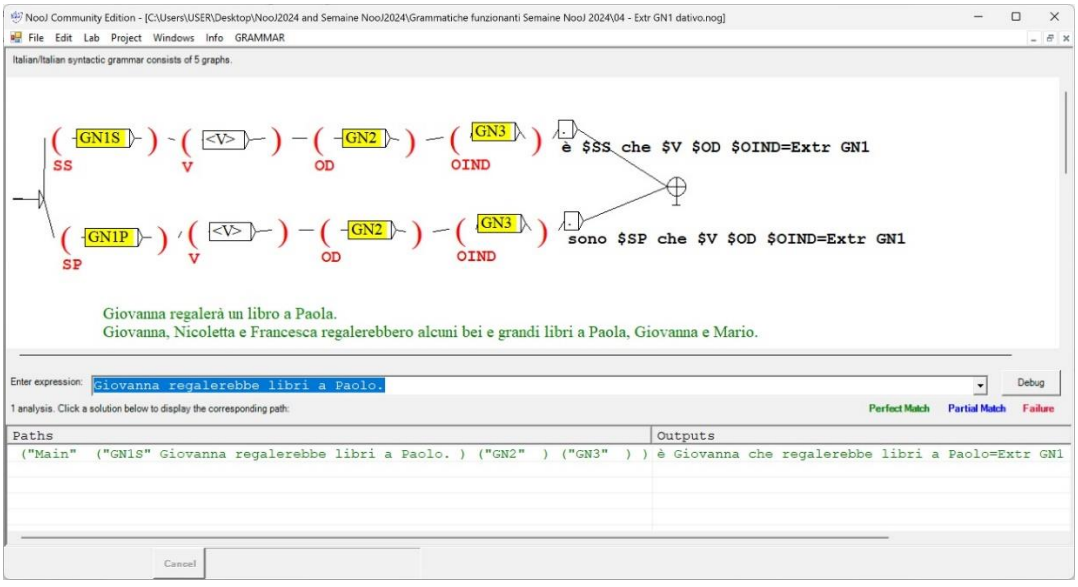

Fig. 13 – Extr GN1 Dativo.nog

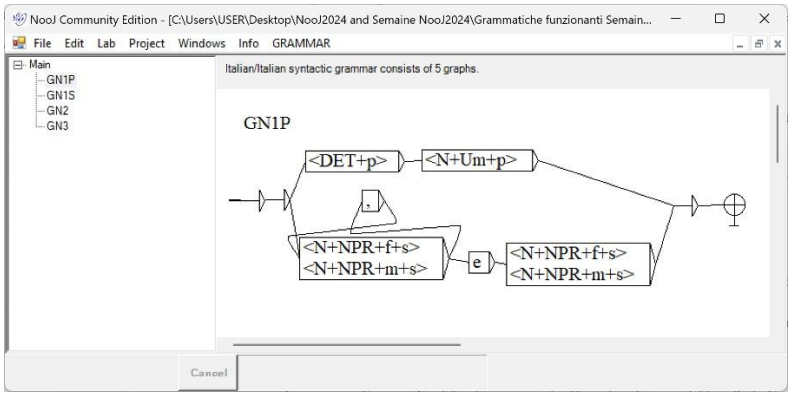

Fig. 14 – Extr GN1 Dativo.nog – GN1P

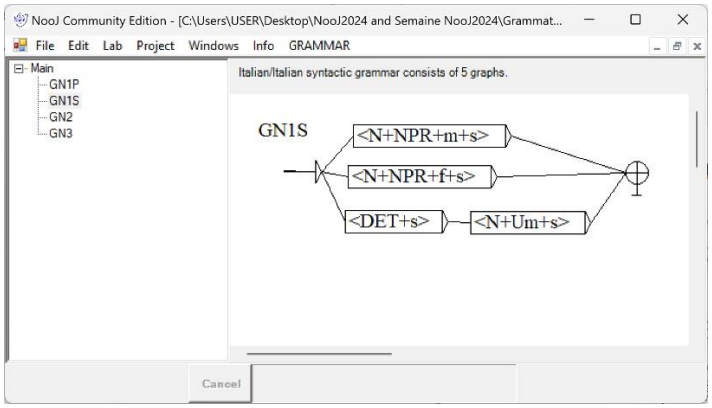

Fig. 15 – Extr GN1 Dativo.nog – GN1S

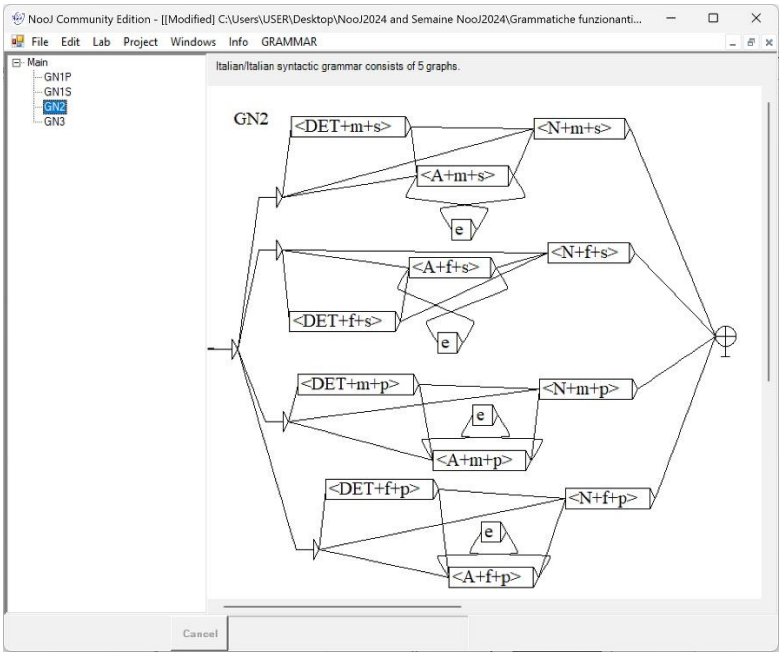

Fig. 16 – Extr GN1 Dativo.nog – GN2

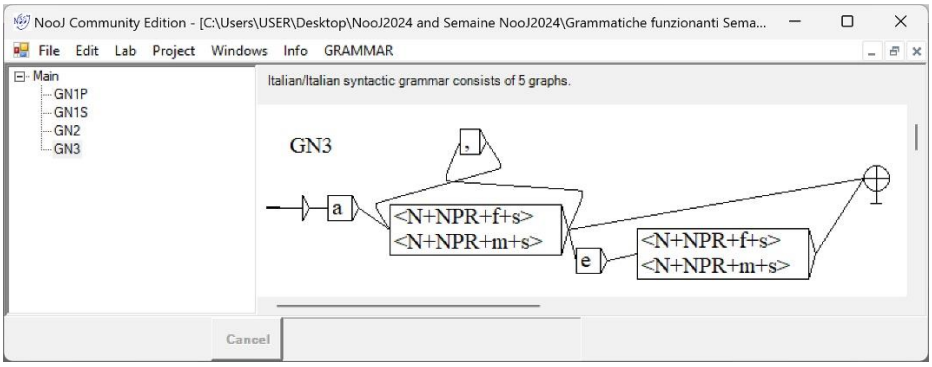

Fig. 17 – Extr GN1 Dativo.nog – GN3

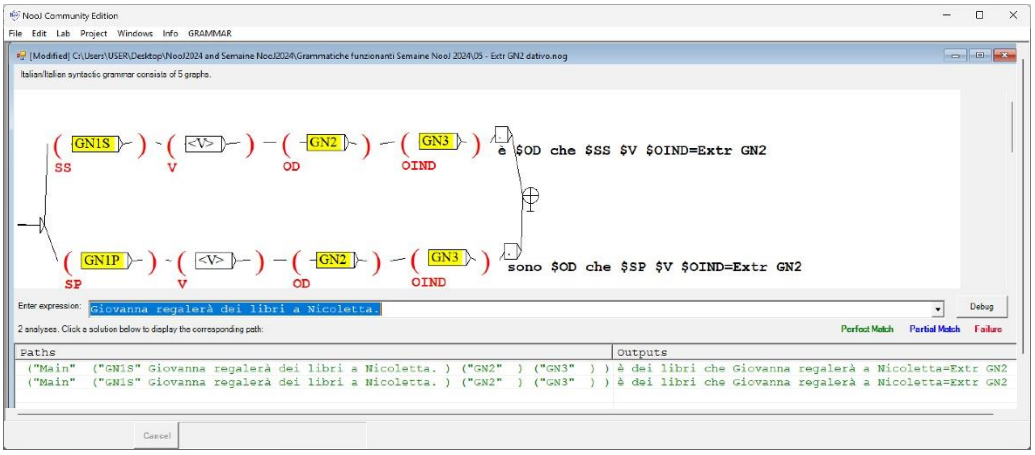

Fig. 18 – Extr GN2 Dativo.nog (the metanodes in the structure are the same as in the figures from 14 to 17)

2.4. Variable Distribution of a Dative Interrogative Sentence

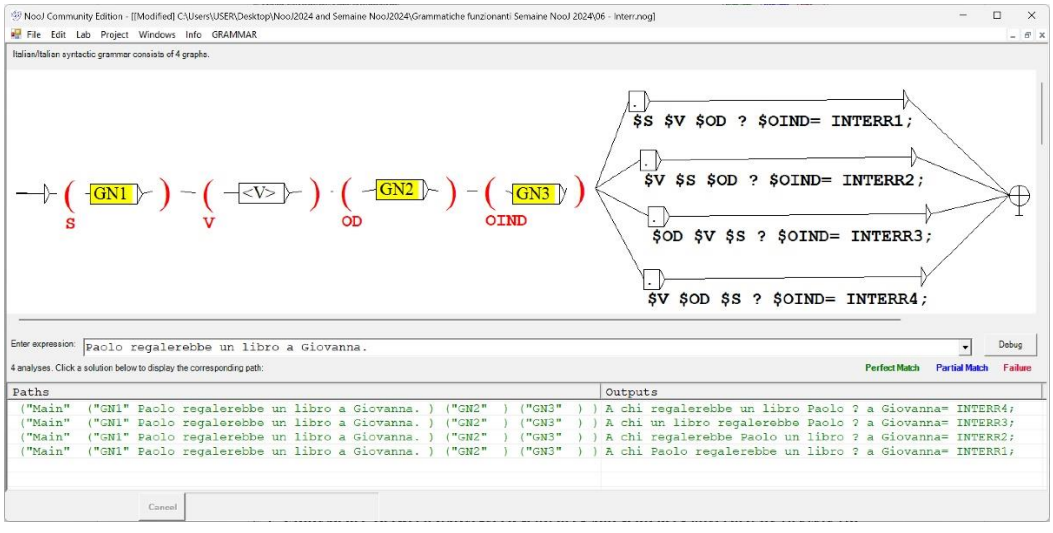

Fig. 19 – Interr.nog

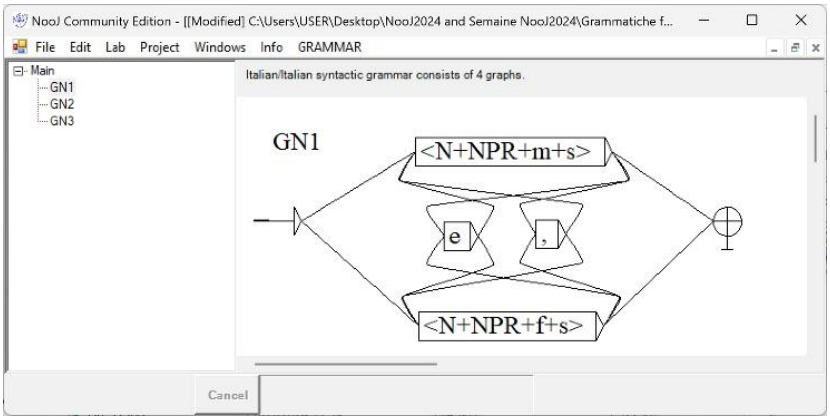

Fig. 20 – Interr.nog – GN1

In this grammar**,** GN1 is the same as in **Fig. 9**.

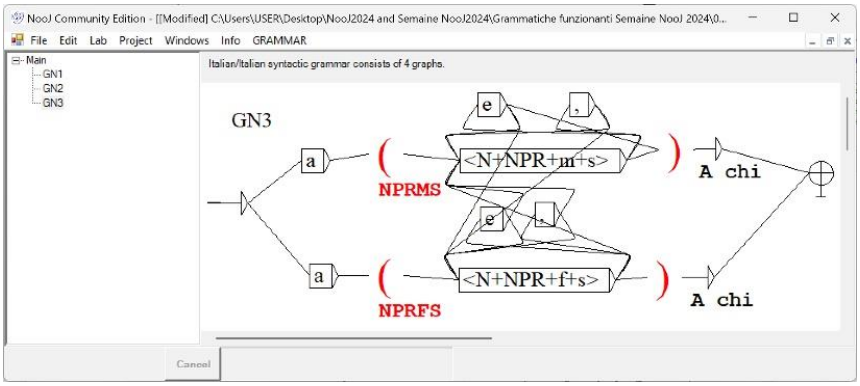

Fig. 21 – Interr.nog – GN3

2.5. Equivalence Between dative-verb sentences and sentences governed by *ricevere* (to receive)

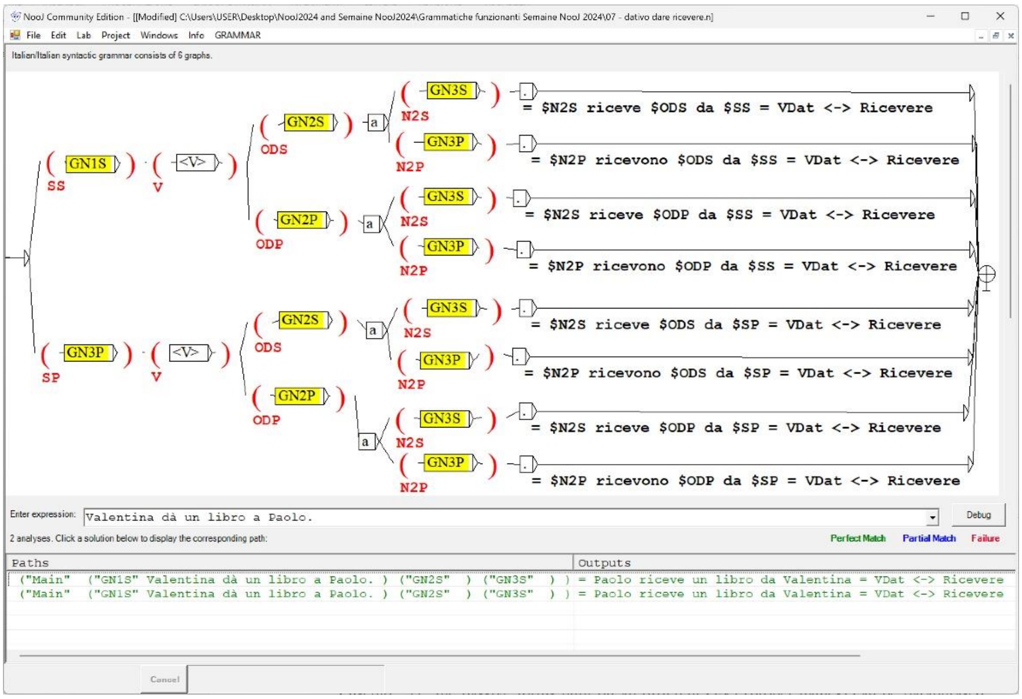

Fig. 22 – Dativo dare ricevere.nog

This grammar can be applied to all Italian dative verbs such as *dare*, *regalare*, *donare*, *portare*, *offrire*, *consegnare*, *distribuire* (to give, to donate, to bring, to offer, to deliver, to distribute etc.). The non-grammatical and non-acceptable passive forms as "*Paolo viene dato (un libro+dei libri) da Eusebio." i.e. the passive forms built on all different GN3 (proper names) can be paraphrased with declarative sentences governed by the verb "ricevere" (to receive).

2.6. Using NooJ Transformation Grammars in Question-Answering Systems

As already stated, NooJ allows the combination of two or more transformations inside grammars. In Fig. 23, we can see an example of a useful question-answering grammar to automate interactions with FAQ sections of web sites, chat or information systems. The questions and resulting answers can be chosen based on the topics covered. It is also possible to provide multiple answers to a single question, delegating the final choice to the user.

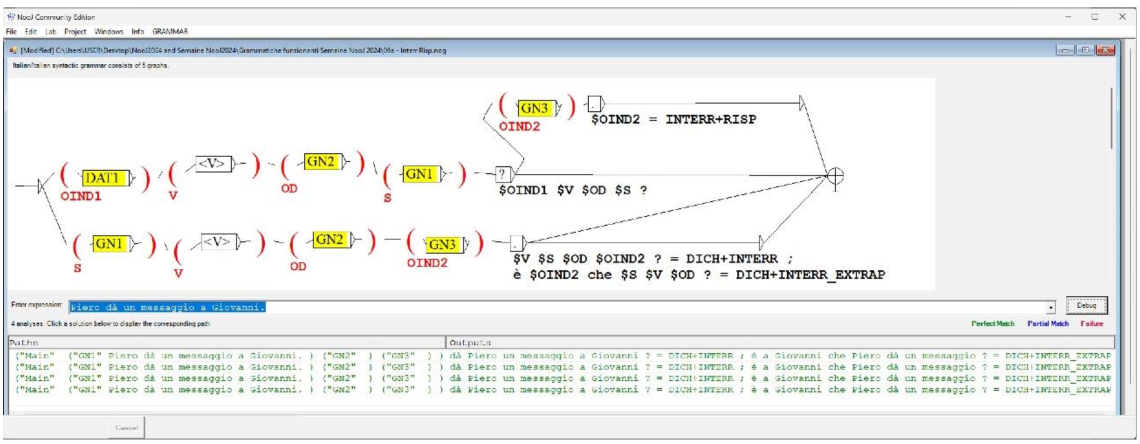

Fig. 23 – Interr risp.nog

3. Conclusions and next steps forward

The transformational analysis of a language and the resulting production of transformed sentences is an operation that cannot be done without a thorough knowledge of either NooJ (the use of variables, above all), or the morphosyntax of our mother tongue.
As regards the syntactic properties shown, we have seen that their formalization does not present particular difficulties other than those relating to the correct and necessary compiling of NooJ variables. However, it is important to underline that the nominal groups shown in the grammars are only simplified examples, and that in common linguistic uses, nominal groups are likely to have much more complex and unpredictable morphosyntactic structures.

Besides, we must not forget a preliminary operation to be carried out, namely the creation of taxonomically exhaustive electronic dictionaries to describe the morphological, syntactic and lexico-semantic properties of all the words in synchronic use of our language. Without such electronic dictionaries, creating NooJ grammars for transformational analysis of any language would be a very difficult task to accomplish. This leads us to reiterate how an efficient achievement of the rule-based NLP routines here described requires numerous human resources, endowed with highly specialized linguistic performance and analysis.

4. References

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[2] Silberztein, M. (2003 -). *The NooJ Manual*. Available for download at: http://www.nooj-association.org

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