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AUTOMATIC ANALYSIS OF DUTCH COMPOUND WORDS

BY W.A. VERLOREN VAN THEMAAAT

MATHEMATICAL CENTRE TRACTS 38

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1. THE PURPOSE OF THE ANALYTIC PROGRAM

1.0. INTRODUCTION

This publication is intended as a contribution to the construction of translation programs for computers.

Dutch has a large capacity to form new words by combination of language elements already existing. Some of these language elements are independent words; some are language elements not occurring as independent words, among which the most important are the affixes like *ing* (a suffix to derive nouns from verbs; its sphere of meaning is large; sometimes it corresponds to English *ing* (as gerund ending), sometimes to *-ion*).

Because such compounds are continuously newly formed, not all compounds can be adopted into a lexicon and so for mechanic translation one must be able to determine their structure mechanically.

In linguistics there are several definitions of morphemes, but one which will be accepted by at least some linguists is: morphemes are the smallest elements which one must consider as a unity to be able to construct the words from them and to be able to formulate the construction rules. We adopt a more opportunistic point of view and say: the morphemes are the word constituents whose adoption in the analytic lexicon (the lexicon in which all constituents are looked up) is necessary or useful for a translation program as simple as possible. So the morphemes are not only the constituents truly without constituents, but also the constituents whose meaning cannot be deduced from those of their constituents (e.g., German *Hochzeit* from *hoch* (= high) and *zeit* (= time), but meaning wedlock) or whose compounding rules are too complicated, e.g. that of the compound affix *er* with *er* and *ig*.

In linguistics compounding (formation of a word from two or more independent words) is sometimes distinguished from derivation (formation of a word from one word with dependent morphemes). But since words are also often constructed from words and affixes, in the sequel I shall call all words consisting of more than one morpheme compounds (thus also grammatically inflected forms, as far as obtained by the addition of grammatical affixes to the word stem. Inflectional forms obtained by change of the stem, e.g., the past tense *viel* of *vallen* (English *fall* - *fell*) are con-
sidered as morphemes).

The structure of a compound COMPRIZES its dissection into morphemes, considered as mere strings of letters, but does not COINCIDE with it. Just as one has not described the structure of a sentence completely by its dissection into words, but has also to indicate all intermediate constituents with their grammatical functions, e.g.,

\[
\begin{array}{cccccc}
\text{article} & \text{strong} & \text{mason} & \text{builds} & \text{a} & \text{large} & \text{house} \\
\text{subject} & \text{predicate} & \text{nominal part} & \text{object} \\
\end{array}
\]

so the structure of a compound word is not completely described by its dissection into morphemes, but their intermediate constituents and their grammatical functions must be indicated too (the part of speech of constituents also occurring as words; which indications will be added to each constituent, will be treated in more detail later on). E.g., the word onder-district-s-hoofd has an entirely other meaning and is therefore otherwise translated into English, if onder-district or district-s-hoofd is considered as a constituent (respectively sub-district chief and district vice-chief).

The computer analyses the words occurring in the WORD-LIST with the aid of a LEXICON (the set of the words and morphemes with indications about the way they can occur in compounds) and the ANALYTIC PROGRAM. So the report contains four sections besides this introducing section:

2. The word-list
3. The lexicon
4. The analytic program
5. Results: error-analysis.

The word-list is treated before the lexicon, because the instructions for its punching are simpler.
1.1. THE FORM OF THE OUTPUT AND THE TASKS OF THE ANALYTIC PROGRAM

The analytic program is a program in ALGOL 60.

The complete description of the structure of a compound word \( W \), as given as the result of the analytic program, is a so-called structural tree, indicating the so-called constituents. These constituents have the following properties:

1) \( W \) is the constituent of the 1-st order;
2) A constituent of the \( n \)-th order (\( n > 0 \)) contains at least 1, but at most 3 constituents of the \( n+1 \)-th order, unless all morphemes are constituents of the \( n \)-th order (the limitation, that a constituent has no more than 3 immediate constituents, is not an aprioristic postulate, but is based on specific properties of Dutch; see 4.1.4.);
3) Each constituent of the \( n+1 \)-th order is contained in one and only one constituent of the \( n \)-th order;
4) All constituents of the order \( n+1 \) contained in one constituent of the order \( n \) follow each other immediately.

The order of the constituents of the highest order (the morphemes) is called hoogte (the Dutch word for heighth).

Every constituent is noted on at most 4 lines: on the first line stand its letters, on the second line its indexes, on the third "koppel", if it is united in a pseudo-concatenation with the leading constituent of the next-higher constituent (for the meaning of "pseudo-concatenations" see 4.1.4.), on the line immediately under "koppel" (if present, otherwise under the indexes) "leider", if it is the leading constituent of the next-higher constituent and does not coincide with it.

The indexes of each constituent form a number of 4 or 5 digits. The precise information they convey and the code for its notation will be explained in 3.2. Provisorily I satisfy myself with saying, that these indexes indicate the kind of constituent (word, affix, inflectional morpheme or link), the part of speech of words, and the possible position of the constituent in compounds (at the beginning, in the middle or at the end).

Intuitively the leading constituent of a string of constituents of the same order forming together one next-higher constituent is the constituent of which the other constituents are determiners. So in *huis-deur* (house-
door) *deur* is the leading constituent. In cases in which this semantic criterion does not yield sufficiently clear results, the constituent determining the part of speech of the compound is considered as the leading constituent, e.g. *ing in *wandel-ing* (= *walk* (noun), *wandel* = *walk* (verb); all compounds formed by *ing* are nouns). In 4.1. it will be indicated precisely, which constituents are considered as the leading constituents of the next-higher constituents.

The constituents of the same order stand on the same line and are separated from each other by tabulation(s).

Three or four such lines, together with the following void line, are called a constituent row. Then a structural tree looks as follows:

1) On the upper constituent row stand the morphemes.
2) I suppose the constituent rows hoogte,..., n+1 to be constructed.

Then the constituents of the order n stand under them in a row in the order in which they occur in W. The first letter of each constituent stands perpendicularly under the first letter of the first morpheme belonging to it.

An example of such a structural tree is (under each constituent its English translation or an indication of its function is put - in deviation of the true output of the analytic program -):

<table>
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<tr>
<th>Morphemes</th>
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<tr>
<td><em>reger</em></td>
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<td><em>s</em></td>
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<td><em>leider</em></td>
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<td>22024</td>
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<td>1040</td>
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<td><em>s</em></td>
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So for the calculation of the structural tree we must know:

1) Which are the morphemes;
2) Which constituents can be united to higher constituents;
3) How the indexes of the higher constituents can be calculated from those of the lower ones;
4) How pseudo-concatenations can be recognised;
5) How the leading sub-constituent of a constituent is determined.

1.2. THE DISSECTION INTO MORPHEMES: THE REIFLER CALCULUS

Though the dissection into morphemes is only part of the determination of the structure, it will be treated separately, because it has already been treated by Reifler ([10]).

The word to be analysed is called W and its number of letters, letter. The longest initial segment of a string of letters S is the longest substring of S beginning with the first letter of S which has an equivalent in the lexicon.

Then a simplified version of the Reifler calculus for the dissection of words into morphemes proceeds as follows (actually this is the calculus given by Reifler himself for compounds with more than two constituents, p. 13):

The 1-st, ..., n-th morpheme are determined by complete induction as follows:

1) If W has no longest initial segment the word is declared unanalysable; otherwise the longest initial segment of W is the first morpheme.
2) I suppose the 1-st, ..., n-th morphemes to be determined. If the last letter of the n-th morpheme is the last letter of W, then the morpheme dissection has been completed.

Otherwise, the longest initial segment of T, the segment of W acquired by the subtraction of the 1-st up to the n-th morpheme is the n+1-th mor-
pheme. If T has no longest initial segment, the longest initial segment of
the n-th morpheme after subtraction of the last letter becomes the new n-th
morpheme (in ALGOL 60 value assignments to identifiers can be undone by
later assignments).

This simplified version of the Reifler calculus could be written as
a program fragment in ALGOL 60 (if we neglect many declarations and input
and output procedures, not relevant here). The following identifiers will
be explained:

The ordinal number of the first letter of the k-th morpheme as a let-
ter of W will be called unua [k], the ordinal number of the last letter
of the k-th morpheme lasta [k].

lv(m,n) is the ordinal number of the last letter of the longest
initial segment of the string from the m-th until the n-th letter. If that
string of letters has no longest initial segment, lv(m,n) is put to 0.

The ordinal number of the morpheme being treated is called woord.

SUBJAS is the label immediately after the program fragment for the
dissection into morphemes; this label is preserved for the sake of com-
parison with a fragment of the true analytic program.

unua [1] : = 1; r : = lv(1, letter); woord : = 1;
L: if r = 0 then PUTFEXT \{ unanalysable \} else lasta [1] : = r;
if r = letter then goto SUBJAS else
begin woord : = 2;
lasta [woord] : = r : = lv(q, letter);
F: if r = 0 then goto G else
begin if letter = r then goto SUBJAS else
begin woord : = woord + 1; goto M end
end end;
G: woord : = woord - 1; q : = unua [woord]; r : = lv(q, lasta [woord] - 1);
goto (if woord = 1 then L else F);

SUBJAS:
The characteristic feature of this dissection calculus is, that it takes into account only, WHETHER a certain string of letters can occur as constituent of a word, not IN WHICH POSITION IN THE WORD it can occur. E.g. the dissection ing/reep (ingreep = intervention, operation from in and greep = grasp; reep = roll e.g. of chocolate); ing-ing, -ion) would be un-reproachable according to this dissection calculus, though ing as a suffix can never occur at the beginning of a word. Reifler, indeed, has also gone beyond this primitive stage. For compounds of two constituents his dissection calculus is more refined than the one applied here, since it takes into account the possibility that a compound has the structure LT - X - RT, in which LT, LT - X, X - RT and RT are all possible constituents. He provided some nouns with indexes indicating, that they could not occur as first constituents and rejected the dissection Literat/welt (literary man's primeval world) instead of Literatur/welt (literary world), because Literat cannot occur as the first constituents of a compound. In cases in which this test did not apply, he gave two dissections, e.g. Wacht/raum (guard room) against Wach/raum (day-dream). In my dissection calculus this possibility is ignored, because according to Reifler himself "Such composita, are, however, extremely rare coincidences" ([10] p. 13).

Reifler's dissection method was usable for the limited purpose Reifler put to himself: the dissection of compounds of more nouns. This method is not usable for the far more comprehensive purpose of this study: the analysis of compounds of all possible morphemes: words of all parts of speech, affixes and inflectional morphemes (and links, as we shall see).

In some cases in the analytic program a completed dissection into morphemes is rejected for the impossibility to assign a structure to the word with this dissection into morphemes (see 4.3.), but even apart from that it is easy to see, that the program fragment above does not quite coincide with the fragment 1. 888 - 935 of the analytic program, most nearly analogous to it. Apart from some differences concerning the connection with the rest of the program, the most relevant differences are:

1) The dropping of the hyphens, treams and apostrophs behind morphemes (1. 902 - 903);
2) The examination for each morpheme, whether it can occur at the given
position and the rejection of the dissection into morphemes, if the mor-
pheme cannot occur there (by the statements depending on conditional
clauses containing ind1 and ind2: 1. 892 - 893, 898 - 899, 906 - 907 and
911 - 912) and the statements positie, assigning values to ind1 and ind2.
But the explanation of these statements will be postponed until 4.3.,
because the meaning of ind1, ind2 and positie cannot be explained without
a previous treatment of other properties of the lexicon and the program.
The statements depending on conditional clauses containing ind1 and ind2
serve to exclude morpheme dissections such as *ing/weep* treated in this
section.
2. THE WORD-LIST

The word-list is not allowed to contain a space or NLCR before the first letter.

The words may contain letters of the Latin alphabet, with diacritical signs or not, points, hyphens, apostrophs, but no digits. The letters with diacritical signs are typewritten according to an especial code.

Both in the lexicon and in the word-list we put as many words as possible behind each other on one line, but each word entirely on one line. Two consecutive words in the word-list on the same line are separated by a space. The last word is followed by a space and a closing punching, for which — is elected.

The words in the word-list need not stand in a definite order.
3. THE LEXICON

3.0. THE PURPOSE AND DIVISION OF SECTION 3

The questions section 3 tries to answer are:
1) Into which kinds of constituent are the morphemes and constituents divided;
2) Which morphemes and other constituents have to be adopted into the lexicon;
3) In which form(-s) words with more inflectional forms and other morphemes, which occur in graphemically different forms in compounds, though they must be considered as one morpheme linguistically, have to be adopted, e.g. the suffix *eer* at the end of a word against *er* before a suffix or inflectional morpheme beginning with a vowel (Dutch has added this morpheme to the stem of many verbs borrowed from Romance languages, e.g. *copul-er-er* = French *copuler* = to copulate);
4) Which indications have to be added with each constituent.

Question 1 is answered in section 3.1., question 2 in 3.4. - 3.8. for each kind of constituent, question 3 partially in 3.3. (with respect to modifications determined exclusively by preceding or following letters and sometimes by the kind of constituent of a COCONSTITUENT, but never by the kind of constituent of the constituent itself), partially in 3.4. - 3.8. for each kind of constituent separately, question 4 in 3.2.

3.1. THE CLASSIFICATION OF THE MORPHEMES

The following kinds of constituents are distinguished for the morphemes:

1) WORDS and VIRTUAL WORDS. In 3.4. I shall discuss, which form(s) of inflected words will be adopted.

The so-called virtual words are put on a level with words. "*tuintje* (= little garden, from *tuin* = garden), *tuinier* (gardener), *beplanten* (to plant, from *planten* = to plant), *beplanting* (= planting) are formed with elements not occurring as words: *-tje, -ier, be-, -ing*. They are called PREFIXES and SUFFIXES; the words formed by them are called derivatives." ([11], p. 130).
Certainly all PRODUCTIVE morphemes must occur in the lexicon. Strictly sticking to this definition would yield very strange analyses for many compounds. The strangest consequence is, that some compounds would consist of only affixes without stems.

An example is the word kinder-achtig (= child-ish). Its first constituent kinder does not occur as an independent word. LINGUISTICALLY it must be considered as consisting of a word-morpheme kind (= child) and an inflectional morpheme er, but for our analytic program this dissection would only yield unnecessary complications, i.e. because then in compounds like kind-er-lijk (= child-ish) an inflectional morpheme would be followed by a suffix, what fairly rarely occurs in Dutch and which possibility we have therefore excluded systematically in the analytic program. But it is certainly productive ([5] mentions 280 compounds of kinder). From the definition above it would then follow, that kinder-achtig would consist of two affixes.

A morpheme like kinder is not called an affix, but a VIRTUAL WORD. I define a virtual word as a CONSTITUENT, NOT OCCURRING AS AN INDEPENDENT WORD, BUT ACTING IN THE FORMATION OF COMPOUNDS AS IF IT OCCURRED AS AN INDEPENDENT WORD AND TO WHICH THE MEANING OF AN INDEPENDENT WORD (THE "TRANSLATION") CAN BE ASSIGNED IN SUCH A WAY, THAT THIS MEANING TOGETHER WITH THE MEANINGS OF THE OTHER CONSTITUENTS OCCURRING IN THE COMPOUND YIELDS THE CORRECT MEANING OF THE COMPOUND.

The word with which kinder agrees in meaning is of course kind.

2) AFFIXES are morphemes not occurring with the same meaning as words or virtual words, but yielding a word together with one word or virtual word. E.g. ig in blauw-ig (blu-lish). This does not exclude, that affixes can be HOMONYMOUS with independent words (e.g. in (= in) as a preposition and in as a suffix for female living beings: koning-in = queen from koning = king). In that case the meaning of a compound formed by that affix cannot be derived from the meaning of a homonymous word as an independent word (of course with the aid of the other morphemes occurring in the word).

The affixes are divided into two subspecies: DOMINANT and RECESSIVE ones. An affix A is called DOMINANT, if it imparts a fixed part of speech independent of the part of speech of W to every compound A-W (if A is a
prefix) or \( W-A \) (if \( A \) is a suffix). This part of speech is called the part of speech of the affix itself.

A prefix \( P \) is called RECESSIVE (recessive suffixes do not exist), if every compound \( P-W \) has the same part of speech as \( W \).

These definitions leave us the choice to consider prefixes \( P \) connectible only to words \( W \) of one part of speech \( w \), for which \( P-W \) always has the part of speech \( w \), as dominant or recessive. We consider them as recessive, because this simplifies the analysis and is semantically most acceptable (in other languages such prefixes are mostly translated by determiners to the second constituent, e.g. \( schoon-moeder = \) mother-in-law).

3) INFLECTIONAL MORPHEMES. By this I understand morphemes, which can yield inflectional forms of a word together with words (or virtual words), e.g. \( t \) as the inflectional morpheme of the 3-rd person singular of the present tense of the verb. They have to be distinguished from the INFLECTIONAL FORMS, which are words, e.g. \( loop-t \) (run-a).

The inflectional morphemes cannot be dropped from the lexicon, because inflected compound words do not always occur in the text to be analysed in the form in which they would be mentioned in the lexicon (e.g. a compound noun may occur in the text in plural, while it would be mentioned in its singular form in the lexicon) and must also then be analysable.

4) LINKS, not having a clear own syntactic or semantic function and always standing between two other constituents, e.g. the \( e \) in \( eik-e-blad \) (oak leaf).

3.2. THE FORMAL STRUCTURE OF THE LEXICON AND THE MEANING OF THE SETS OF INDEXES

The lexicon is a series of morphemes (i.e. strings of letters or other writing signs, which can occur in words), each followed by one or more numbers of at most five digits, called SETS OF INDEXES (if the number of digits \( n < 5 \), then the first \( 5-n \) digits are supposed to be 0). The 1-st digit, the 2-nd digit, the number formed by the 3-rd and 4-th digits and the 5-th digit are called, respectively, the 1-st, 2-nd, 3-rd and 4-th index. These sets of indexes give roughly much information: how the morpheme concerned can occur in compounds; its kind of constituent, its part of speech,
its possible position in compounds, etc. A mere string of letters in the lexicon is called a LEXICAL MORPHEME. A lexical morpheme together with one of its (perhaps more) sets of indexes is called a SYNTACTIC MORPHEME. Syntactic morphemes with the same lexical morpheme, but different sets of indexes, are called HOMONYMOUS morphemes (e.g. in as a preposition and in as a suffix for female living beings). A lexical morpheme together with all its sets of indexes is called a COMPLETE MORPHEME.

The lexical morphemes are ordered in the lexicon according to increasing length and alphabetically for equal length. The capitals are supposed to follow the lower-case z in the alphabet.

The point, hyphen, apostroph and the diacritic signs follow:

- cedille (with c) or '  
- Apostroph  
- Hyphen  
- Point

For the determination of the position of a word in an alphabetised lexicon, the diacritic signs are supposed to stand before the letter over or under which they stand.

The lexical morphemes are ordered according to increasing length in order to facilitate the comparison of segments of the words to be analysed with lexical morphemes. Segments are only compared with morphemes of the same length and this comparison is facilitated, if all morphemes of the same length stand together in the lexicon. The conventional position of the capitals behind the lower-case letters is chosen for the sake of adaptation to the representation of the letters in the X8-code (the X8 is the computer at the Mathematical Centre, Amsterdam, on which the analytic program was first executed).

Each set of indexes is written behind the lexical morpheme to which it belongs. Each set of indexes is preceded by a space and followed by a comma. The sets of indexes of one lexical morpheme are ordered according to decreasing frequency of the syntactic morphemes to which they belong.
As we shall see in 4.3., the computer executing the analytic program, having dissected the word into morphemes, first tries to construct a structural tree, in which each lexical morpheme has the first set of indexes standing behind it in the lexicon and only if this turns out to be impossible, it explores consecutively the following sets of indexes (a certain choice among sets of indexes of a lexical morpheme on the base of probabilistic considerations occurs in the analytic program 1. \(443 - 444\) and is explained in 4.2.). The ordering of the sets of indexes according to decreasing frequency promotes the choice of the most probable structural tree.

In order to save paper we put as many complete morphemes as possible on one line, but each complete morpheme entirely on one line. The different complete morphemes are separated from each other by tabulation or transition to a new line. The first complete morpheme has to be preceded by a NLCR on the punch-tape. The lexicon is opened and closed by special punchings; in the analytic program < is elected for the opening and > for the closing.

Homonyms in the usual sense, differing ONLY in their MEANING (e.g. kool as coal and kool as cabbage, both nouns), are not distinguished in the analytic program, but morphemes differing in one of their indexes (e.g. acht as a numeral (eight) and as a noun (attention), ver as an adjective (far) and ver as a prefix (a very wide sphere of meaning, sometimes it corresponds to the English suffix *ify*: *eenvoudig* = simple; *ver-eenvoudig* = simpl-ify)) are distinguished.

The 1-st index indicates the possible position at the beginning of the word, the 2-nd index the possible position at the end of the word.

The 3-rd index indicates the kind of constituent and for affixes moreover the parts of speech with which they can be connected and the order of the parts of speech of decreasing so-called affinity of the affix to the part of speech for affixes connectible with more parts of speech. There are also affinities among parts of speech for words; they will be treated in 4.2.2. In the analytic program the affinities of parts of speech to affixes are represented by array-elements with two indexes. But in their linguistic meaning they are integer functions of two parameters: a part of speech and an affix. Two affixes \(B_1\) and \(B_2\) are called AFFINITY-EQUIVALENT,
if every part of speech has the same affinity to $B_1$ as to $B_2$. The classes of affinity-equivalent affixes are called AFFINITY CLASSES. In the report (not in the analytic program!) if a word or affix $A$ belongs to a part of speech $a$ and an affix $B$ to an affinity class $b$, the affinity of $a$ to $B$ will also be called the affinity of $A$ to $B$, or that of $a$ to $b$. Two other uses of the affinities in the analytic program, and the criteria for the determination of their values, will be treated in 4.2.3. But the affinities serve mainly for the determination of the structure of tripartite compounds $A$-$B$-$C$. If $A$ is a recessive prefix, $B$ a word and $C$ a suffix, $A$ and $B$ together form a constituent, if the affinity of $B$ to $A >$ the affinity of $C$ to $A$ and $B$ and $C$, if the affinity of $B$ to $A <$ the affinity of $C$ to $A$. If $A$ is a dominant prefix, $B$ a word and $C$ a suffix, $A$ and $B$ together form a constituent, if the affinity of $B$ to $A >$ the affinity of $B$ to $C$ and $B$ and $C$ form a constituent, if the affinity of $B$ to $A <$ the affinity of $B$ to $C$. E.g. the prefix *on* (= on) has a greater affinity to adjectives than to nouns, and on the base of that *on*-*gevoel-ig* (*gevoel* = *sentiment*, *ig* = *ing, y, it*) is analysed as *on-*gevoel*ig* (*on*-*sentimental*) and not as *ongevoel-ig*.

The 4-th index indicates the part of speech. By the part of speech of an inflectional morpheme I understand the part of speech of the words with which it can be connected.

The part of speech of a dominant affix has been defined in 3.1. The recessive prefixes get a 4-th index 7.

The links obtain an entirely arbitrary 4-th index, having nothing to do with any part of speech (see 3.8.).

Now follows a table of the meanings of the indexes.

Possible position at the beginning of the word 1-st index

<table>
<thead>
<tr>
<th>Possible position at the beginning of the word</th>
<th>1-st index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can occur at the beginning of the word, but also in other positions</td>
<td>0</td>
</tr>
<tr>
<td>Can only occur at the beginning of the word</td>
<td>1</td>
</tr>
<tr>
<td>Cannot occur at the beginning of the word</td>
<td>2</td>
</tr>
</tbody>
</table>

Possible position at the end of the word 2-nd index

<table>
<thead>
<tr>
<th>Possible position at the end of the word</th>
<th>2-nd index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can occur at the end of the word, but also in other positions</td>
<td>0</td>
</tr>
<tr>
<td>Can only occur at the end of the word</td>
<td>1</td>
</tr>
</tbody>
</table>
**Possible position at the end of the word**  

Cannot occur at the end of the word, but does not impose phonetical restrictions on the following constituent 

Must be followed by a suffix, inflectional morpheme or link beginning with a vowel 

<table>
<thead>
<tr>
<th>Kind of constituent</th>
<th>2-nd index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link</td>
<td>0</td>
</tr>
<tr>
<td>Inflectional morpheme</td>
<td>1</td>
</tr>
<tr>
<td>Word or virtual word</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Affix connectible with (ordered according to decreasing affinity)</th>
<th>3-rd index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noun</td>
<td>3</td>
</tr>
<tr>
<td>Adjective</td>
<td>4</td>
</tr>
<tr>
<td>Cardinal numeral</td>
<td>5</td>
</tr>
<tr>
<td>Verb</td>
<td>6</td>
</tr>
<tr>
<td>Preposition - adverb</td>
<td>7</td>
</tr>
<tr>
<td>Adjective - adverb</td>
<td>8</td>
</tr>
<tr>
<td>Noun - adjective</td>
<td>9</td>
</tr>
<tr>
<td>Adjective - noun</td>
<td>10</td>
</tr>
<tr>
<td>Verb - noun</td>
<td>11</td>
</tr>
<tr>
<td>Noun - adjective - adverb</td>
<td>12</td>
</tr>
<tr>
<td>Noun - adjective - verb - other parts of speech</td>
<td>13</td>
</tr>
<tr>
<td>Noun - verb - adjective - other parts of speech</td>
<td>14</td>
</tr>
<tr>
<td>Adjective - noun - verb - other parts of speech</td>
<td>15</td>
</tr>
<tr>
<td>Verb - noun - adjective - other parts of speech</td>
<td>16</td>
</tr>
<tr>
<td>Verb - adjective - noun - other parts of speech</td>
<td>17</td>
</tr>
<tr>
<td>Adjective - verb - noun - other parts of speech</td>
<td>18</td>
</tr>
<tr>
<td>Noun = verb - adjective - other parts of speech (i.e. equal affinity to nouns and verbs)</td>
<td>19</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part of speech (except for links)</th>
<th>4-th index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noun or substantive pronoun</td>
<td>0</td>
</tr>
<tr>
<td>Adjective or adjunct pronoun</td>
<td>1</td>
</tr>
<tr>
<td>Part of speech (except for links)</td>
<td>4-th index</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Cardinal numeral</td>
<td>2</td>
</tr>
<tr>
<td>Verb</td>
<td>3</td>
</tr>
<tr>
<td>Adverb</td>
<td>4</td>
</tr>
<tr>
<td>Preposition</td>
<td>5</td>
</tr>
<tr>
<td>Conjunction</td>
<td>6</td>
</tr>
<tr>
<td>Recessive prefix</td>
<td>7</td>
</tr>
</tbody>
</table>

By a SUBSTANTIVE pronoun I understand for the determination of the 4-th index a pronoun which can ONLY occur as a substantive pronoun, by an adjunct pronoun a pronoun which can occur both as an adjunct pronoun and as a substantive pronoun, because pronouns only occurring as adjunct pronouns do not exist in Dutch. Compare [1] pp. 87 - 93, the distinction of actual and potential function.

The analytical program does not take account of the possibility of occurrence of articles and interjections in compounds. Pronouns rarely occur in compounds and completely behave like nouns and adjectives. Therefore they are put on a level with them.

Because the purpose of the analytic program is analysis, for each of these indexes it has to be proved, that it is necessary for the analysis at least in some cases.

The 1-st and 2-nd indexes exclude analyses in which a morpheme occurs in a position in which it is not allowed to stand by its indexes.

A 2-nd index 3 occurs with by-forms of morphemes before vowels (see 3.3.2.; e.g. *huis* as a by-form of *huis* (= *house*) occurring in *huis-en* (= *house-s*)). It excludes analyses in which a morpheme with this index is followed by a consonant, e.g. *nav-looi-en* (= to nave-tan) instead of *na-looi-en* (= *catch-ing fleas afterwards*).

The 3-rd index can sometimes help to distinguish homonymous constituents of different kinds of constituent.

The 4-th index sometimes helps to distinguish homonymous constituents, especially affixes and inflectional morphemes, which can be connected only with certain parts of speech. E.g. *drinker* = *drink-er* (English *drinker*), while there are eight homonymous constituents *er*:
1) The adverb er (= there),
2) The prefix er, forming so-called pronominal adverbs: er-mee (= with it), er-tegen (= against it), etc.,
3) The suffix er, occurring i.a. in lop-er (= down-er),
4) The suffix er for the formation of the comparative of adjectives (as in English),
5) The suffix er for the formation of the comparative of adverbs,
6) er as an allomorph of the stem of the verb even (= to honour),
7) er as an allomorph of the noun eer (= honour),
8) er as an allomorph of the suffix eer often added to verbs borrowed from French (adopt-er-en = to adopt).

The syntactic morphemes 4 and 5 are excluded here, because drink is a verbal stem and er as a comparative suffix can only be added to adjectives and adverbs (so because of the 3-rd index of er and the 4-th index of drink). The syntactic morphemes 2, 6, 7 and 8 are excluded by their 2-nd index 2 or 3. This requires that er be followed by other constituents, while in drinker er stands at the end of the word.

Finally, the syntactic morpheme 1 is excluded by the 1-st index 1.

3.3. ALLOMORPHS

3.3.0. INTRODUCTION

In linguistics the notion ALLOMORPH is often taken in a wider sense and all morphs (strings of letters in written language, strings of phonemes in spoken language) expressing the same syntactic or semantic function in connection with different coconstituents (e.g. en en s as plural morphemes in Dutch) are considered as allomorphs. I take the word ALLOMORPH in a more restricted sense and consider as allomorphs only morphemes B_1, ..., B_n alternating according to FIXED RULES on the base of the letters of the preceding constituent A and the following constituent C and sometimes on the base of the kinds of constituent of A and C, but never on the base of the kind of constituent of B_1, ..., B_n themselves (so what Nida calls PHONOLOGICALLY DEFINABLE ALLOMORPHS, [9] p. 14). We ought to speak of GRAPHEMEcALLY definable allomorphs, since we analyse WRITTEN language. The
allomorphs are treated in a separate section, because for morphemes of
different kinds of constituent the choice among allomorphs is often deter-
mined by the same rules.

3.3.1. ALLOMORPHS CONDITIONED BY PRECEDING CONSTITUENTS

In general the superlative is formed by addition of st to the posi-
tive. But if the positive ends by s, only t is added. Therefore we also
adopt t as a superlative ending into the analytic lexicon.

Though there are two homonymous morphemes t, namely the ending t of
the 2-nd and 3-rd person singular of the present tense of the verb and the
affix t of the passive participle (for reasons we shall see we do not con-
sider the participles as inflectional forms, but as derivatives of the
verb, see 3.5.), this solution does not yield ambiguities where they would
not also rise with separate adoption of these superlatives in the analytic
lexicon. If the constituent A preceding t is an adjective, t is a superla-
tive ending; if A is a verbal stem, t is one of the two other morphemes. A
homonymy, because a word may be both a verbal stem and an adjective, is not
eliminated by separate adoption of the superlative (wije-t is the superla-
tive of the adjective wije (= wise) or the 2-nd or 3-rd person singular of
the present tense of the verb wîjsen (= to show)).

Yet the adoption of the superlative ending t in the lexicon necessities a procedure mistest (1. 426 - 430) in the procedure declaration compl
iment to eliminate analyses, in which the superlative ending t would follow an
adjective not ending by s.

The apostroph as a genitive ending is adopted into the lexicon (the
apostroph is considered as a letter in the lexicon).

[14] mentions the following cases of insertion of an apostroph (the
first constituent is called A, the second one B):

1) If A is a noun ending with ñ, ò, ọ or ủ and B is the inflectional
morpheme s, or A is a noun ending with y, having the phonetic value ò and B
is the inflectional morpheme s or the diminutive suffix tje (auto -
auto'tje = auto - little auto),
2) If A ends with an open ọ written with one ọ and B is the plural ending
ọ (aloọ - aloọ's),
3) If A ends with a vowel + h and B is the genitive or plural ending s (fellah - fellah's).
In these cases it is convenient to consider 's and 'tje as allomorphs of s and tje.

3.3.2. ALLOMORPHS CONDITIONED BY FOLLOWING CONSTITUENTS

The treated constituent is called B; its by-form is D. The basic form
of the morpheme B is the one, in which it occurs at the end of the word.
All other forms are called by-forms.

For the determination of the by-form, B must be dissected into B₁, B₂
and B₃, if it ends by a consonant and is no bastard word ending by ief or
ies (e.g. actief = active, precies = precise), in which the j or s is false
(i.e. is changed to v or z before a vowel). B₃ is the final consonant block
of B, i.e. the longest continuous string of only consonants containing the
final consonant of B. j is not considered as a consonant here, because a j
followed only by consonants in the same syllable can only be the second
part of the digraph ij (pronounced approximately as the ei in French
abeille).

B₂ is the last vowel block in B. A RAW VOWEL BLOCK is a string of
writing signs maximal with respect to the properties that
1) Every writing sign is a vowel or j;
2) Every j follows an i;
3) Either only the first writing sign or no writing signs at all has a
trema.

The second condition is theoretically not entirely correct, because
there are also cases, in which i and j occur together and do not form to-
gether the digraph ij (ski-jumper = skj jaoket). But since this case is
difficult to recognise for a computer and has no importance for the deter-
mination of the by-form, I do not take account of it.

The VOWEL BLOCK is obtained from it by dropping the trema on the first
letter, if any.

B₁ is everything in B preceding B₂. The form obtained by juxtaposition
of X and Y is noted as X+Y. Then D = B₁+D₂+D₃, in which D₃ is the final
consonant block and D₂ is the last vowel block in D.

The construction of D proceeds in five stages:
1) The determination of $B_3$,
2) The determination of $B_2$,
3) The construction of $D_3$,
4) The construction of $D_2$,
5) The construction of $D = B_1 + D_2 + D_3$.

I suppose the constructions 1) and 2) to have been completed.

3) There are three cases, in which $D_3$ differs from $B_3$:
31) By the transition of a false $f$ into $v$ (aotief - aotiv-iteit)
32) By the transition of a false $s$ into $z$ (buis - buis-en $\neq$ tube - tube-s).
33) By the duplication of the final consonant ($blok - blok-k-en = block - block-s$).

4) In two cases $D_2$ can differ from $B_2$, namely:
41) By the transition of $aa$, $ee$, $oo$, $uu$ respectively into $a$, $e$, $o$, $u$, if $B$ ends with $xy+xy+yz$, where $xy$ represents $a, e, o$ or $u$ and $yz$ is one consonant ($haar - har-en = hair - hair-s$),
42) By the transition of $iie$ into $il$, if $B$ ends with $iie+xy$, where $xy$ is a consonant ($definiteer - definiteer-en = define - to define$).

A completely mechanical determination of the by-forms is impossible by the completely irregularly inflected words.

But if one has a lexicon indicating

1) The part of speech of each word,
2) The plural of each noun,
3) The 2-nd inflectional form (with added $e$: groen $\neq$ groene $= green$) of each adjective, if it is irregular,
4) The past of each verb,

(the last three requirements are fulfilled e.g. by [13]), it is easy to write a program for the determination of the by-forms of the overwhelming majority of the words.

The by-form of the noun is found by subtraction of $en$, 's or $e$ from the plural; the by-form of the adjective is found by subtraction of $e$ from the 2-nd inflectional form, if it differs from the 1-st inflectional form.

The basic form of the verb is found by subtraction of $de$ or $te$ from the past. The by-form is formed starting from the infinitive I according to the following instructions (the string of letters formed by subtracting
the final string of letters B from the string of letters A is called A - B):

1) I - n is called J. If the last letter of J is not an e, J is the by-form.

2) If the last letter of J is e, J - e is the by-form.

3) In the sequel the last letter of J is e. J - e is called K. If the last letter of K is a consonant, K is the by-form.

4) If the last letter of K is a, e or o, J is the by-form.

5) In the sequel the last letter of J is I. The penultimate letter of K is called vJ. If vJ is a consonant, the by-form is J. If vJ is a vowel, the by-form is K.

Then we explore whether the relation between basic form and by-form belongs to one of the cases just mentioned. In the cases in which this relation does not belong to them, the by-form so found is rejected and afterwards the by-form is determined "by hand", because the mechanical determination of the by-form fails in the case of completely irregular inflection, e.g. komen - kwam (come - came).

It is true, that the by-forms of constituents ending with consonants are often followed in compounds by the link e or by affixes or inflectional morphemes beginning with e. Yet it is not a good solution to adopt D+e and all compounds formed by suffixes beginning with another vowel than e instead of D in the lexicon. For the number of affixes beginning with another vowel than e is very great and even if the number of suffixes with which each stem can be connected would be small, the total number of suffixes involved in compounding is far too large to enable a simple procedure to decide, with which suffixes a certain word-stem can be connected. Moreover there are many compounds not sufficiently usual to be adopted into the lexicon themselves and yet sufficiently conformous to the structure of Dutch to be formed, e.g. *vissig* (= fish-y?).

Six classes of bastard words have besides (or instead of it) another by-form exclusively on the base of their ending (and in one case on the base of their form in the original language), which can be obtained by substitution of the ending. A translation is superfluous, since these words differ very little from the same words in English.
<table>
<thead>
<tr>
<th>Bastard word X (basic form)</th>
<th>Example of X</th>
<th>By-form Y</th>
<th>Example of compound of Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>X = A+eer (X is a verb)</td>
<td>ador-eer</td>
<td>Y = A</td>
<td>ador-atie</td>
</tr>
<tr>
<td>X = A+ie, derived from</td>
<td>natie</td>
<td>Y = A+ion</td>
<td>nation-aal</td>
</tr>
<tr>
<td>a French word on ion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or a Latin word on io</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X = A+teit</td>
<td>qualiteit</td>
<td>Y = A+tat</td>
<td>qualitat-ief</td>
</tr>
<tr>
<td>X = A+air</td>
<td>vulg-air</td>
<td>Y = A+ar</td>
<td>vulg-ar-iteit</td>
</tr>
<tr>
<td>X = A+eel</td>
<td>univers-eel</td>
<td>Y = A+al</td>
<td>univers-al-iteit</td>
</tr>
<tr>
<td>X = A+ie+D₃</td>
<td>reflex-ie-f</td>
<td>Y = A+i+D₃</td>
<td>reflex-iv-iteit</td>
</tr>
</tbody>
</table>

(D₃ differs from D₃ in the same way as on p. 31).

[13] treats only ORTHOGRAPHICAL modifications, i.e. different ORTHOGRAPHY of morphemes with unchanged PRONUNCIATION (except the alternation of f with v and s with z). But for us this limitation is useless, because the computer program treats only WRITTEN words.

Further [14] mentions the following morphographemic modifications in compounding:

1) The transition of ine into ien before the diminutive suffix tje (machine - machientje, machine - little machine),
2) The transition of é and êe into ee before the diminutive suffix tje (logée - logeetje, guest - little guest),
3) The duplication of the final vowel of A, if
31) A is a noun ending with a, o or u, B is the diminutive suffix tje or the suffix (not the inflectional morpheme!) s (Wolvega - Wolvegaas; Wolvega is a Dutch village),
32) A is an adjective ending with a, o or u, B is the superlative ending st or the ending s of the 3-rd inflectional form (oru - oruas; oru = orude; about the 3-rd inflectional form see 3.5.),
33) A is a verbal stem ending with a, o or u, B is the ending t of the 2-nd and 3-rd person singular of the present tense or the ending n of the plural, the affix n of the infinitive, nd of the active participle or d of the passive participle (in the lexicon the verbs are not adopted with their infinitive, but with their stem. In deviation of traditional grammar
the infinitive and the participles are not considered as inflectional forms, but as derivatives: gaa - gaa-ná = go - go-ing).

4) That the diminutive of parachute is parachutje.

5) The transition of ng into nk before elijk and the diminutive suffix je (afhang-en - afhank-elijk, to depend - iepend-ent),

6) The irregular diminutives
   - dejeuner - dejeuenta,
   - diner - dineetta,
   - souper - soupeeta,

7) ([14], pp. LXVIII - LXIX) The compound has a capital, while the first constituent does not have it, or inversely:
   a) Some proper nouns, etymologically compounds, have a capital, while their constituents do not have it (Kalverstraat lit. Calf Street, Koningsplein lit. King's Place),
   b) Compounds with a proper noun as first member which can be considered as common nouns are written with a small letter (aagt-appel lit. Aagt's apple, adamo-appel = Adam's apple,...)
   c) "But one should write with a minuscle all compounds with as first member a person's name indicating the inventor, discoverer etc. of the thing indicated by the whole (dieselmotor = Diesel motor, erlenmeierkolf = Erlenmeier recipient, neutronringen = Newton rings, priemitsverband = Priemits bandage, schakelg'je, vanderaakschroeven = Van der Waals forces)and their shortened forms ( a diesel, an erlenmeier etc.).
   ...
   d) In derivatives like dahlia, darwinisme, flamingant, fuchsia, guillotine, jeremiade the thought of the proper noun notion is so weakened, that the capital is no longer required."
   e) Some titles, which are compounds etymologically, like Hoogheid (= Highness), are written with a capital, while their constituents are not.

8) "Spellings like rij-dier (from rijd-en = to ride and dier = animal), leid-draad (= introduction, from leid-en = to lead and draad = file) must be compared with rij-broek (= riding trousers), lei-boom (= tree trained on trellis-work) etc. (without d between diphthong and consonant)." ([14], pp. XLIII and XLIV).

In the cases 1-6 the morphographemic alternation of a constituent only occurs in compounding with one or two other constituents (the verbs...
mentioned in 33 are also irregular for other reasons). But adoption of a by-form for only one or two compounds does not save memory space in the computer. So in all these cases the compounds mentioned are adopted into the lexicon themselves.

In all sub-cases of case 7 the connection in meaning between the compound and its constituents is so obscure, that adoption of the compound into the lexicon is anyhow inevitable. So we shall not pay further attention to them.

In case 8 the compounds rij-dier and lei-draad are considered as compounds of the virtual words rij and lei for the large number of compounds of rijd and leid without d.

3.4. Words

This section will answer the following questions:

1) Which words has the analytic lexicon to mention?
2) Which inflectional form(s) of inflected words has it to mention?

1) The answer to this question has been given by [10] p. 6.

The words to be adopted are:

a) Non-compound words,
b) Established compounds (i.e. rather usual ones found in many lexica) whose meaning cannot be derived from those of the constituents.

The words not to be adopted are:

a) Improvised compounds (i.e. compounds made by the author of the text to be analysed, which cannot be adopted into a lexicon in principle),
b) Established compounds whose meaning can be derived from those of the constituents.

There are many so-called equiradical words which are homonymous, belong to different parts of speech, but whose meanings are very similar, may sometimes even almost be called synonymous. The clearest example is the stems of many verbs used as nouns indicating the action of that verb. But such words have to be mentioned separately in the lexicon, because in some compounds the word can only be assigned one of the two parts of speech. E.g. in meester-zet (master's move) zet, and consequently also
meestertset, can only be considered as a noun and not as a verb. But this distinction produces linguistic pseudo-problems in many cases. E.g. it is not possible to decide, whether set in set-diuang is a verbal stem or a verbal noun. The meaning can be paraphrased both as "compulsion to move" and as "compulsion to a move". We shall see (4.3.), that on the basis of the order of the sets of indexes in the lexicon one analysis is chosen (in some cases arbitrarily from a linguistic point of view).

In order to make the Reifler calculus applicable (which instructs first to look up the longest constituent at the beginning of each compound, [10] p. 11) I adopt inflectional forms homonymous to the stem of another word themselves into the lexicon (e.g. wagen is a singular noun (= car), the plural of waag (= weighing-house) or the plural form of the verb wagen (= to risk)).

For inflected words for each part of speech it is determined, which is the most frequent ("regular") system of inflectional morphemes, by which the inflectional forms are formed from the stem. Different inflectional morphemes, frequently used for the same function, are each adopted into the lexicon, e.g. en and s as plural morphemes for nouns. But if an inflectional morpheme only occurs with few words, e.g. en as plural morpheme for nouns, it is not adopted into the lexicon, but the inflectional forms formed by them are adopted into the lexicon themselves. In 3.5. it will be indicated exactly, which inflectional morphemes are adopted into the lexicon.

For words, all whose inflectional forms are obtained by compounding these inflectional morphemes with the stem or one of its allomorphs, only the stem and its by-forms are adopted.

For the choice of the form(s) (basic form) in which a regularly inflected word is adopted into the lexicon, the principle is adopted, that the basic form must as much as possible enable one to obtain all inflectional forms, derivatives and compounds by adding morphemes and as little as possible by first subtracting letters and only afterwards adding morphemes.

This principle does not entail changes for most nouns and adjectives (nouns are adopted with their singular form, adjectives with their 1-st declension form (without added final e)), but entails for verbs, that they...
are not adopted with their infinitive, as usual in lexica, but with their 1-st person singular present tense form. For separable compound verbs (compounds of a verb with a preposition or adverb, in which the preposition or adverb can come behind the root-verb in the case of inversion of the sentence, e.g. op-zoek-en = ik zoek een boek op = to look up - I look up a book) the form, in which the 1-st person singular present tense form occurs at the end of a subordinate clause, is adopted. See [2], especially pp. 34-36. An equally detailed description of the syntax of Dutch does not exist as far as I know, but the word order in Dutch is very similar to that in German. Bierwisch takes the subordinate clause order (with the finite verb at the end of the sentence) as the basic order. For this he gives many arguments, but the argument most relevant here, valid also for Dutch, is that subordinate clauses do not separate the parts of a separable compound verb.

Nouns usually have only two inflectional forms: singular and plural. The regular plurals of nouns are formed by addition of en to the stem.

Among the four traditional cases of Dutch the accusative does not differ morphologically from the nominative for any noun.

The genitive, if differing morphologically from the nominative, is adopted into the lexicon with a 3-rd index 

The dative (by a dative I understand only a dative differing morphologically from the nominative) practically only occurs in fixed expressions. For adjectives and verbs things are slightly more intricate. As we shall see in 3.5., in the analytic program the comparative and superlative are not considered as inflectional forms, but as derivatives of the positive. The positive and the comparative have each three inflectional forms, the superlative two. The 2-nd inflectional form of regularly inflected adjectives is formed by suffixing e, the 3-rd inflectional form (not occurring with superlatives) by suffixing s.

The genitives and datives (op heter daad, lit. on hot deed, in flagrant delict, in koelen bloede = in cool blood), only occurring in fixed expressions, are considered as irregularities. Their adoption is still more necessary, because many of these genitives and datives could be confused morphologically with comparatives.
The Dutch verb has two stem forms: the stem and the preteritum stem, because the passive participle is not considered as an inflectional form (see 3.5.).

The preteritum has two inflectional forms, the singular form and the plural form. The preteritum stem is the singular form. The plural is usually formed by adding en or n to the singular. If the plural form of the preteritum is irregular with regard to the singular form, that does not influence the 2-nd index of the stem, but the preteritum stem gets a 2-nd index 1, so e.g.

was 21023
waren 21023

All other inflectional forms (PRESENT STEEM FORMS) are formed from the main stem (in theory an exception would perhaps have to be made for the singular form of the conjunctive of the preteritum, but because it coincides with the indicative of the preteritum in most cases and in the other cases it has a by-form coinciding with the indicative of the preteritum, I shall not pay further attention to it).

By the conjunctive of present I understand the form of the 3-rd person singular of the conjunctive of present, because the other forms coincide with those of the indicative. The inflectional forms for gij (a rather archaic 2-nd person personal pronoun, used both for one person and for more) and the plural form of the imperative (Dutch has an especially plural form of the imperative, but the imperative coinciding with the stem is now most usual also in addressing more persons) are neglected.

The stem of the verb is indicated by st. Then the inflectional forms of the regular verbs have the following forms:

Indicative present singular 1-st person  = st
Indicative present singular 2-nd person  = st+t
Indicative present singular 3-rd person  = st+t
Indicative present plural           = st+en
Indicative preteritum singular   = st+de or st+te
Indicative preteritum plural     = st+den or st+ten
Conjunctive present                 = st+e
Imperative                            = st
The following cardinal numerals are adopted into the lexicon: the numerals from 1 until 20 successively: een, twee, drie, vier, vijf, zes, zeven, acht, negen, tien, elf, twaalf, dertien, veertien, vijftien, zestien, zeventien, achtien, negentien, twintig; dertig (= thirty), veertig (= forty), vijftig (= fifty), zestig (= sixty), zeventig (= seventy), tachtig (= eighty), negentig (= ninety), honderd (= hundred), duizend (= thousand), miljoen (= million), miljard (= thousand million), biljoen (= million times million) (higher numerals like triljoen (= 10^{18}), quadriljoen (= 10^{24}), do occur, but do not belong to common speech, and are mostly replaced by indications by digits in publications, mainly scientific ones, where they would be necessary).

In theory the by-forms of vijf, zes, elf and twaalf are, respectively, vijf-tig, zes-tig, elf-tig and twaalf-tig, but they are not adopted into the lexicon, because their only compounds are vijf-en, zessen, elven and twaalven (we zijn met one vijven = we are five).

Only the irregularly formed ordinal numerals are adopted: eerste (= first), derde (= third).

In theory the numerals have genitives (ene-sijds = on one hand, ene-keer = of one kind, twee-keer = of two kinds, drie-keer = of three kinds), but they are not used productively in compounds. So these genitives are not mentioned and the compounds formed by them are separately adopted into the lexicon.

Beide (= both) is not considered as a numeral in deviation from [11] (p. 122), because it lacks the only compounding potentiality characteristic for numerals, that of the formation of ordinal numerals.

Only the following pronouns are productive in compounds:

1) The nominatives of the personal pronouns (ik-taal (= I-language) and hij-taal (= he-language), [8] p. 31),
2) zelf (= self),
3) al, alles, alle (= all),
4) aller,
5) niets (= nothing), niemand (= nobody).

So the compounds of all other pronouns are adopted into the lexicon and the words themselves get 1-st and 2-nd indexes 1.
aller, though an independent word in origin (genitive plural of alls),
is especially frequent in compounds of superlatives and so it must rather
be considered as a prefix than as an independent word, moreover because it
often changes the meaning of the superlative from a relative superlative
into an absolute one (de erbarmelijk-este toestand = the most miserable
situation; een aller-erbarmelijk-este toestand = a most miserable situation).
So I adopt aller into the lexicon as aller 2087.

This entails, that all compounds of aller with other adjectives and
adverbs, e.g. aller-heilig-en (= All Saints' Day; this must be rather con­
sidered as a compound of aller with the noun heilige-n, but heilig
(= saint) is an adjective) must be adopted into the lexicon separately.

3.5. INFLECTIONAL MORPHEMES

The inflectional morphemes are treated before the virtual words and
affixes, because they are relatively few and their previous treatment
makes their virtual words and affixes much clearer.

This section starts with a discussion of the definition of inflectional
morphemes, then decides, which forms are considered as inflectional
forms of one word in virtue of this definition, and ends by an enumeration
of the inflectional morphemes.

With regard to the criteria for the distinction of inflection and
derivation, and in connection with that the distinction between affixes
and inflectional morphemes, the authoritative linguists do not quite agree.

[9] gives on p. 99 as a criterion for inflectional forms, that they
do not have the same external distribution as the simplest members of
their class (EXTERNAL DISTRIBUTION CRITERION; from the opposition een
groen huis = (a green house) against de groene boom (= the green tree) it
appears clearly, that groene must be considered as an inflectional form
of groen in virtue of this criterion) and gives moreover as a criterion,
that inflection cannot transform a word into a word of another part of
speech (CRITERION OF PART OF SPEECH).

[3] gives as a criterion on pp. 222-224, that inflection leads to
CLOSURE; after addition of inflectional morphemes either no bound mor-
phemes at all can be added, or only some from a well-defined set of bound
morphemes (morphemes not occurring as independent words) and then the
word-form so formed is closed (CLOSURE CRITERION).

The part of speech criterion and the closure criterion are most re-
levant for our morphological analysis, because the part of speech and the
closedness are relevant for the possibility of combination of a constitu-
cut with other constituents to still longer compounds. Therefore they are
given priority above the external distribution criterion. This has the
following consequences:

1) The grades are considered as derivatives of the positive in virtue
of the closure criterion (ver-slecht-er-ing = deter-tor-er-ation;
slecht = bad; er = comparative suffix, ver = prefix denoting here to be-
come, ing = nominalisation suffix for verbs (~ing or ation)), though they
would be inflectional forms in virtue of the external distribution cri-
teron (a comparative followed by a than-clause cannot be replaced by a
positive).

2) The ordinal numeral is considered as a derivative of the cardinal
numeral in virtue of the part of speech criterion, because the ordinal
numeral quite behaves as an adjective, while the cardinal numeral can act
both as a substance word (with the grammatical function of a noun, e.g.
Drie passeerden de straat = three passed the street) and as a determiner
of a noun.

3) The INFINITIVE and PARTICIPLES are considered as derivatives of the
verb in virtue of both the part of speech and the closure criterion, the
infinitive as a noun, the participles as adjectives.

All passive participles beginning with ge are adopted into the
lexicon, because the Reifler calculus would otherwise produce wrong ana-
lyses far too easily, even in the case of adoption of the prefix ge into
the lexicon. In a test it appeared, that 14 among 45 passive participles
found in two fragments, one newspaper article (Nieuwe Rotterdamse Courant,
21 September 1963) and one fragment from [12], III p. 306, are analysed
erroneously by the Reifler calculus, i.a.

geweigerd (correct analysis: ge-welger-d = refuse-d; gewei = antlers;
ger = gore; d = passive participle suffix); over-gel-ever-d (over = over;
gel = yellow; ever = wild boar; d = passive participle suffix; correct
analysis: *over-ge-lever-d = surrender-ed*; *ger-e-d-ig-eer-d (ger = gore)*; *e* has many different functions; *d* = passive participle suffix; *ig (-y) = suffix forming adjectives with a wide sphere of meaning; *eer = suffix added to verbal stems of Romance origin; d = passive participle suffix; correct analysis: *ge-redigeer-d = redaat-ed*). This is caused by the fact, that because *ge* is such a short morpheme, very many words among those beginning with *ge* have a longer initial segment also occurring in the lexicon.

In virtue of these criteria the following forms are considered as inflectional forms of one word:

1) All forms of indicative, conjunctive and imperative of the verb,
2) Singular and plural of the noun,
3) The cases of the nouns, adjectives, articles and pronouns,
4) The 1-st inflectional form (without *e*), the 2-nd inflectional form (with *e*) and the 3-rd inflectional forms (with *s*) of the adjectives and the analogous inflectional forms of some adjunct pronouns.

The endings *er* for genitive or dative and *en* for dative or accusative are not adopted into the lexicon, because they are used far too sporadically.

From a linguistic point of view it is preferable to consider the final *n* in plural past forms after a past morpheme *de* or *te* as a morpheme: *zij klaag-de-n = they complain-ed* (against *hij klaag-de = he complain-ed*). Yet *den* and *ten* are considered as morphemes, because this simplifies the analysis (the rule, that in Dutch two inflectional morphemes never follow each other, then is without exception).

Then the list of inflectional morphemes is as follows:

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3.6. VIRTUAL WORDS

Among the virtual words there are many "international" ones, like theo-, bio-, -log (=-logist) with an origin in Latin, Greek or the Romance languages. Especially for them one should realise, that they serve for the analysis of Dutch words and are no fragments of e.g. a Greek, Latin or French lexicon. This is relevant for both the form in which they are adopted into the lexicon and their indexes.

As to the form an appeal to the language of origin is already impossible merely because one would not know for a word of Latin or Greek origin, which of the inflectional forms of the word in the language of origin one should take.

Some international words are adopted twice, once as a noun and once as an adjective, e.g. morf (noun) = form and morf (adjective) = with a ... form, since the most frequent type of compound in Dutch is that, in which the preceding constituents are determiners of the last one and so the compound has also the part of speech of the last constituent.

But there are many virtual words of Greek origin, which were nouns in Greek and act as nouns in many compounds, but also occur as last constituents of adjectives. In order to create as few exceptions as possible to the main rule, that the compound has the part of speech of the last constituent, we adopt them into the lexicon not only as virtual nouns, but also as virtual adjectives.

The 1-st, 2-nd and 3-rd indexes do not need further explanation. The 4-th index is determined by the part of speech of the "translation". E.g. the translation of mono- is one, because this gives the correct meaning to the compounds formed by it (mono-the-ism = worship of one god). Therefore the 2-nd index of mono is 2.

Virtual words with any connection in form with their "translation" are in one of the 4 following cases:

1) Formally the translation is a regular inflectional form (financi - financiën = finances, heseen - heseenen = brains), derivative (bruik - gebruik = use, wedue - weduwe = widow) or compound (keret - keretmis = christmas, lief - liefheb = love) of the virtual word;
2) Formally irregular inflectional forms (beender - beender-en = bones, schep - schepen = ships with schip = ship) or compounds (glij = slide (verb) - glij-baan = slide (noun), with glij-en = slide) can be considered as inflectional forms (respectively compounds) of the virtual word;

3) Formally the virtual word is a compound which does not occur alone but does occur as a constituent of still longer compounds: (sterkstroom - sterke stroom = strong current);

4) Formally the virtual word can be considered as a derivative by internal change, analogous to derivatives truly occurring: braak - break-ing = break-ing, name - neem-ing = tak-ing (compare wraak (= revenge as a noun) as a derivative of wreek (= revenge as a verb)).

On the basis of [13] I made a slip system of virtual words. The only virtual words not adopted were:

kolder V [13], VII p. 5114, since it has only four compounds:
kolder-gat = oblong aperture in the ship's deck in which the kolder-stok can be moved going and returning
kolder-stok = kolder-stang = stick moved in the kolder-gat
kolder-schijf = wheel fixed excentrically on an ax converting the rotating movement of an ax into a going and returning one
kolder-gang = kolder-molen = kolder-werk = mill in which the place of the upper grind-stone is occupied by two rollers whose axes, which are the continuation of each other are fixed in the mid to a vertical ax
kolder-steen = cylindrical stone serving as a runner in a kolder-mill

3.7. AFFIXES

By a nominal, adjectival or adverbial affix I mean an affix forming, respectively, nouns, adjectives or adverbs.

The compounds formed by a nominal suffix are nouns and so most of them have plurals. If we call the stem A and the suffix B, the plural of A+B can usually be written A+C, in which C only depends on B and not on A (an exception is e.g. kind-en-tje-s = little children; kind = child, kind-en-en = children, kind-je = child, tje is a diminutive suffix and s a plural end-
ing). C can then very conveniently be called the plural of B. If C is "ir-
oregular" with respect to B (i.e. is not obtained from B by addition of en or s), it must be adopted into the lexicon separately (e.g. heden besides heid; heid is a nominalising suffix added to adjectives, roughly corresponding with English ness).

While some virtual words, like bruk (= use) can occur both at the beginning and the end of a word (bruik-baar = us-able; mis-bruik = ab-use), all affixes are either prefixes or suffixes. It is true, there are HOMONYMOUS affixes, one of which is a prefix and one a suffix, e.g. in as a negative prefix (as in English: in-congruent) and in as a suffix indicating a female being (koning = king, koning-in = queen). But they have so entirely different meanings, that it is clear, that one should speak of homonymous affixes and not of one and the same affix.

Prefixes and suffixes are distinguished by the 1-st index. For prefixes the 1-st index is 0, for suffixes 2. Because it does not occur, that a prefix has an allomorph, whose occurrence depends on preceding constituents, but there are a few suffixes like abl and ation only occurring before following constituents (since they are allomorphs of respectively abel (= able) and atte (= ation)). For such suffixes the 2-nd index is 3.

For affixes the usefulness of the indexes has to be proved separately.

The indexes 3 and 4 help to distinguish homonymous constituents, if two affixes, the latter of which can only be connected to words of a certain part of speech, follow each other. E.g. rek-baar-heid = dilat-able-ity. In general baar can be a noun (with several meanings), an adjective (= bare), a verbal stem (= bear in the sense of bear children) and an adjectival suffix behind verbs corresponding to able, but in this compound it can only be an adjective or an adjectival suffix behind verbs, because the suffix heid can only be connected with adjectives.

The 1-st and 2-nd indexes serve to distinguish homonymous affixes, one of which is a prefix and the other a suffix. So in koning-in (= queen; koning = king) in can only be the suffix in and not the prefix.

Only productive affixes are adopted. Therefore the following affixes are omitted:
de, occurring in lief-de (= love (noun); the virtual noun lief occurs in
ge-lief-d (= love-d) and lief-heb (love as verb) and vreug-de (= joy); 
egge, occurring almost only in diev-egge (= female thief; dief = thief); 
the prefix er before verbs.

All the same the diminutive suffix lijn is not adopted for its small productivity and in order to prevent confusion with the other meaning of lijn (line or linen).

The dominant prefixes have the following sub-types (this sub-division is given, because it will play a role in some later considerations, see 4.2.3.):

1) Preverbal prefixes, prefixes connectible with verbs. They are:

be 2163
ge 2060
ont 2143
ver 2183

*ge* as a formator of nouns from verbs (*ge-bouw* = build-ing) from *bouw* = build), not as morpheme for the formation of passive participles (see 3.5.).

2) Formators of pronominal adverbs. They are connected with prepositions and adverbial by-forms of prepositions, moreover with *heen* (*daar-heen* = thither), and form so-called pronominal adverbs, e.g. *hier-voor* = before this. They are

daar 2074
er 2074
hier 2074
waar 2074

The pronominal adverbs are translated according to the scheme (the translation of X is indicated as Trad(X)):

Trad(A+B) = Trad(B) Subs(A),
in which

Subs (*daar*) = that
Subs (*er*) = it
Subs (*hier*) = this
Subs (*waar*) = what
3) Prefixoids.

If both A and B are true words, their compound $C = A + B$ usually has the part of speech of B. But if A is a dominant prefix, A determines the part of speech of C.

Now, there are some adverbs and prepositions forming verbal compounds together with following nouns or adjectives. So in these compounds the adverb or the preposition determines the part of speech of the compound as a whole and so behaves as a prefix. Hence the name PREFIXOID. I call the compounds formed by them PREFIXOIDAL VERBAL COMPOUNDS.

The prefixoids are noted with 1-st index 3 and 2-nd index 2. The 1-st index indicates, whether they can be connected with nouns or with adjectives.

The prefixoids have to be adopted into the lexicon, since prefixoidal verbal composition is productive. In [4] p. 24 I found om-stam-den = surrounded with stems, the passive participle of a verb om-stam = surround with stems.

Before I shall treat the prefixoids further I have first to define, when a morpheme functions as a word and when as a prefixoid in the case, that B can be both a verb and a noun or adjective. For this I must first know, whether C is a compound of B as a verb or of B as a noun or adjective. I take as a general criterion, that C is considered as a compound of B in that meaning, by which its meaning can be paraphrased in the simplest way. In a non-formalised language this criterion is not entirely exact, but in the case, that the different B's are pure homonymes, it is yet sufficient for a decision.

fris (verb) = melt cast iron in an open furnace and change into malleable iron by removal of carbon

op-fris (transitive) = make fresh (fris = fresh)
op-fris (intransitive) = become fresh

The given definition of op-fris with the aid of the ADJECTIVE fris is simple, while a definition of op-fris with the aid of the VERB fris would be very intricate, even if it were possible.

In many cases this criterion is also sufficient for the distinction of equiradical words. There are also cases, in which a compound has two mean-
ings and is a compound of two words in one case and a prefixoidal compound in the other case, e.g.

\[ \text{om} \quad +\text{hoepel} \rightarrow \text{om-hoepel} \]

<table>
<thead>
<tr>
<th>prefixoid noun</th>
<th>transitive verb</th>
</tr>
</thead>
<tbody>
<tr>
<td>hoop</td>
<td>surround with a hoop</td>
</tr>
<tr>
<td>prefixoidal compound</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{om} \quad +\text{hoepel} \rightarrow \text{om-hoepel} \]

<table>
<thead>
<tr>
<th>preposition</th>
<th>intransitive verb</th>
<th>intransitive verb</th>
</tr>
</thead>
<tbody>
<tr>
<td>around</td>
<td>trundle a hoop</td>
<td>trundle a hoop around something</td>
</tr>
</tbody>
</table>

From these definitions it appears immediately, that \text{om-hoepel} is a compound of the noun \text{hoepel} in the first meaning and a compound of the verb \text{hoepel} in the second meaning.

The prefixoidal compounds of all but eight prepositions and adverbial by-forms of prepositions are few and unproductive. So these compounds are adopted into the lexicon themselves and the prepositions and adverbs only as words, not as prefixoids.

Only eight prepositions and adverbial by-forms of prepositions have a relatively great number of prefixoidal compounds (behind each stands the number of compounds found in \([5]\)), namely \text{af} (=\text{from}, 31), \text{door} (=\text{through}, 6), \text{in} (=\text{in}, 10), \text{om} (=\text{around}, 13), \text{op} (=\text{on}, 26), \text{over} (=\text{over}, 18), \text{toe} (=\text{to}, 5), \text{uit} (=\text{out}, 24). Only \text{toe} is not adopted into the lexicon as a prefixoid, because the relation in meaning between stem and compound is too different for different prefixoidal compounds.

\text{erken-telijk} (=\text{grateful}) and \text{erken-tenis} (=\text{acknowledge}), both derived from the verb \text{erken} =\text{acknowledge}, are irregularly formed and so they are adopted into the lexicon separately.

The 3-rd index contains information about two different things, namely the \text{POSSIBILITIES OF COMBINATION} of the affix with different parts of speech and the affinity of the affix to these parts of speech. The 4-th index and the possibilities of combination are determined on the base of relatively frequent and productive derivation types. It may happen, that a few compounds, in which either the part of speech of the coconstituent or the part of speech of the compound does not agree with the requirements of the
3-rd and 4-th indexes, are formed with the affix. These compounds have to be adopted into the lexicon separately.

E.g. the main function of *heid* is the formation of abstract nouns from adjectives. So *heid* gets a 3-rd index 4 and a 4-th index 0. Then e.g. *mensheid* (= man-kind; *mens* = man) and *alheid* (= universe) have to be adopted into the lexicon separately, also for the semantic irregularity of the first one (*mensheid* has not an abstract meaning, "being a man", but a collective one "the collectivity of all men").

For *ge* the 3-rd index is 6 and the 4-th index is 0. So all verbs formed by *ge* have to be adopted into the lexicon separately, also because no fixed rules for the relation in meaning between the original and the derived verb can be given.

Still more deviating are: *apart-je*, lit. little apart = entre-nous; *tegen-heid*, lit. against-ness = contrast, resistance, repugnancy, antipathy, disaster; *uit-je*, lit. little out = trip.

3.6. LINKS

The meaning of the 1-st, 2-nd and 3-rd indexes has been explained in 3.2.

The 1-st and 2-nd indexes are of course 2 for all links in the meaning in which they have been defined in 3.2.

For analysis of the compound words it is relevant to know, to which kind of constituent and part of speech the constituents, which precede and follow the links, can belong. Unlike for affixes and inflectional morphemes for links the usefulness of the 4-th index for this could be doubted, because the links are so few, that except *en* and *n*, which are allomorphs of each other, there would only be one link for each value of the 4-th index and so the condition "if the 4-th index is 0" could be replaced by "if *A* = e". Yet the 4-th index for links is conserved for three reasons:

1) Because after the dissection into morphemes the structure of the words is constructed exclusively by their indexes (apart from the local procedure "mistest" in the procedure compl in the analytic program l. 426 - 430 and the test, whether a morpheme with a 2-nd index 3 is followed by a vowel, l. 952 - 953) and so the program would become more complicated if one would
deviate from this in this case;

2) Because two sets of indexes are stored in one machine word, so that the omission of the 4-th index would not save memory space;

3) Because in the lexicon punching-tape each index has its array-index by its position in the set of indexes and so the omission of the 4-th index would entail, that the 3-rd index would be considered as the 4-th index.

There are five links (the indexes of each, inclusively the 4-th index- es formally assigned, are indicated)

<table>
<thead>
<tr>
<th>Index</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>22000</td>
</tr>
<tr>
<td>en</td>
<td>22003</td>
</tr>
<tr>
<td>n</td>
<td>22003</td>
</tr>
<tr>
<td>o</td>
<td>22001</td>
</tr>
<tr>
<td>s</td>
<td>22002</td>
</tr>
</tbody>
</table>

$s$ between two nouns or behind a noun and before an adjective (e.g. aanbevel-ing-s-waardig = recommend-able; aanbevel-en = to recommend; aanbevel-ing = recommend-ation; waardig = worthy) is always considered as a link, because it cannot be considered as a genitive ending after historically feminine words (modern colloquial Dutch shows a strong tendency to treat almost all non-neuter inanimate nouns as masculine, but formerly and still in most written language the nouns formed by the suffix ing are feminine; a genitive of de aanbeveling, if any, would have to be der aanbevel- ing and never des aanbeveling-s) and it is then simplest never to consider it as a genitive ending in the middle of a word.

[14] p. LIX: "The intermediate sound $e(n)$ in compounds with as first member a person name not indicating a determined female person, is written $e(n)$.

Examples: helden-daad (= heroic deed, held = hero, daad = deed), her-en-hoed (= gentleman's hat, her = gentleman, hoed = hat), vorst-en-kroon (= princely crown; vorst = prince, kroon = crown), weduwe-n-kap (= widow's cap, weduwe = widow, kap = cap), zieke-n-troost (= consolation of ill people; ziek = ill, troost = consolation), etc."

Adoption of en as a link is necessary, because it could otherwise only be analysed as a plural ending in such compounds, what would not yield the
correct meaning of the compound.

Behind the lexical morpheme *en* in the lexicon 22003 is put before 20010; so between two nouns *en* is always considered as a link, never as an inflectional morpheme.
4. THE ANALYTIC PROGRAM

4.0. INTRODUCTION

In order to be able to construct a program for the determination of the syntactic structure of the compounds, we must know:

1) Which results will be noted and how;
2) Which compounds are POSSIBLE;
3) Which among more structural descriptions of a compound is MOST PROBA- BLE (in order to choose the most probable structural description of a compound, for which more structural descriptions are possible).

The first question has been answered in 1.1. So section 4 consists of 3 subsections:

4.1. The possible compounds.
4.2. The relative probabilities of alternative structural description of compounds.
4.3. The arrangement of the analytic program.

4.1. THE POSSIBLE COMPOUNDS

4.1.0. INTRODUCTION

In section 4.1. I need only treat the relation between the constituents and their immediate sub-constituents, i.e. the constituents standing in the structural tree in the constituent row immediately above them and which are parts of them. The relation between a constituent and its medi- ate sub-constituents need not be treated separately, because all rules for the construction of compound words can be reduced to rules for the con- struction of constituents from their immediate sub-constituents.

The sub-sections of 4.1. are ordered according to increasing number of constituents. I make an exception only for the links, because it depends on an especial convention, whether the next-higher constituent of a link is considered as a compound of two or three constituents.
4.1.1. COMPOUNDS OF ONE CONSTITUENT OR IMMEDIATE DERIVATIVES

A complete description of the structure of compound words must also treat immediate derivation, i.e. the formation from a word of an equiradical word (e.g. the verb and the noun val (= fall)). This way of word-formation is productive too: as it appears from the fact, that the last edition of [5] does mention the noun blunder, but not the verb blunder (as in English), the latter one must have entered Dutch not long ago. So there is also a fair chance of new immediate derivations in the future. But the semantic relation between equiradical words is very irregular. Even apart from some entirely singular cases there are e.g. at least 16 types of semantic relation between equiradical nouns and verbs. So it is practically impossible to establish a mechanical procedure for the determination of the meaning of a new-formed immediate derivative, if that of the basic word is known. Therefore we adopt all sets of indexes assigning different parts of speech to a word separately into the lexicons as much as possible and do not take account of the possibility of the formation of new words equiradical with already existing ones in the analytic program.

4.1.2. COMPOUNDS OF LINKS

By definition a link B follows a constituent A and precedes a constituent C. In order to know the compounding potentialities of B we must know, to which kinds of constituent and parts of speech A and C can belong.

For the synthesis of the meaning it does not matter much, whether we consider A+B, A+B+C or B+C as the next-higher constituent B belongs to. Because it slightly simplifies the analytic program, I consider formally A+B as the next-higher constituent B belongs to. A is the leading constituent of A+B.

A and C cannot be links, since two links following each other do not occur.

C cannot be an inflectional morpheme either, because a word-stem is never connected with an inflectional morpheme with insertion of a link.

A cannot be an inflectional morpheme either. This requires an especial explanation only for the inflectional morpheme e of the 2-nd inflectional
form of the adjective.

One might be inclined to analyse ziekentroost as "ziek-e-n-troost", in which

ziek ("ill") : adjective
e : inflectional morpheme of the 2-nd inflectional form
n : link
troost ("consolation") : noun.

But the incorrectness of this analysis appears immediately at a periphrasis of the meaning of the compound: consolation to an ill man. So if we should stick to the morpheme dissection "ziek-e-n-troost", we should have to consider e not as an inflectional morpheme, but as an affix. Moreover it would only yield unnecessary complications for the analytic program, if we took account of a morpheme string "e-n" homonymous with the morpheme en, in which n is a link (unnecessary, because links can be neglected for the synthesis of the meaning).

So eventually we obtain the analysis (according to the instructions of 1.1., but with omission of "leider"; for the sake of readability the sets of indexes are replaced by kinds of constituents and parts of speech):

ziek  en  troost
adjective  affix  noun
zieken  troost
noun  noun
ziekentroost
noun

So only words, virtual words and affixes remain for further examination.

A cannot be a prefix, because a prefix is never connected with a wordstem with insertion of a link.

The last morpheme before B can be a suffix, e.g. veiligheid-e-gordel = "security girdle", but in such cases the highest preceding constituent, with which the link can be connected to the next-higher constituent, is not the suffix, but the word formed by the suffix. The structure is
So in the description of A we proceed, as if A were always a word.

If two words A and C are composed with insertion of a link, of course C can begin with a prefix, e.g. aanval-s-ge-vacht = aggressive fighting (aanval = attack), but because the part of speech of C is decisive for the possibility of such compounds and not the character of the prefix with which it begins, we need not take that into account for the requirements to C.

It occurs, however, that B is a suffix, e.g. aanschouw-s-lijk (= plastic from aanschouw, a more sublime word for see).

Now follows the table of the constituents, with which the links can be connected.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>noun, adjective, adverb</td>
<td>s</td>
<td>noun, adjective, verb, nominal suffix, adjectival suffix, adverbial suffix</td>
</tr>
<tr>
<td>noun</td>
<td>s\em</td>
<td>noun, adjective</td>
</tr>
<tr>
<td>noun</td>
<td>n</td>
<td>noun, adjective</td>
</tr>
<tr>
<td>noun, adjective, numeral, verb</td>
<td>\o</td>
<td>noun, adjective, verb</td>
</tr>
<tr>
<td>noun</td>
<td>s</td>
<td>noun, adjective, nominal suffix, adjectival suffix, adverbial suffix</td>
</tr>
</tbody>
</table>

The few compounds, in which s follows an adjunct pronoun (all-s-dag-s = daily) do not influence the analytic program, because adjunct pronouns have the same 2-nd index as adjectives.

Besides in the constructions permitted by this table s occurs: behind an adjective: bloot-s-hoofd-s (= bare-head-ed);
behind an adjunct pronoun: geen-s-zin-s (= by no means; geen = no, zin = sense);
behind a verb: betaal-s-heer (= pay-master);
behind a preposition: achter-s-kind (= grand-nephew, grand-niece; achter = behind, kind = child), voor-s-hand-s (= provisionally; voor = before, hand = hand), but they do not represent productive compounding types.

4.1.3. COMPOUNDS OF TWO CONSTITUENTS

I call the first constituent A, the second one B. These compounds are first classified according to the kinds of constituent of A and B. The virtual words are once again comprised among the words (compare 3.1.).

The compounds of links have been treated in 4.1.2. The only case is: A is a word, B is a link.

A cannot be an inflectional morpheme, because an inflectional morpheme forms a higher constituent only with an immediately preceding constituent and with the list of inflectional morphemes given in 3.5. no Dutch word has two inflectional morphemes following each other.

So only seven cases remain for closer examination:
1) A is a word, B is a word
2) A is a word, B is an affix
3) A is a word, B is an inflectional morpheme
4) A is a word, B is a link
5) A is an affix, B is a word
6) A is an affix, B is an affix
7) A is an affix, B is an inflectional morpheme

Case 7 is eliminated, because though an inflectional morpheme can immediately follow an affix, the highest constituent, with which an inflectional morpheme can be connected to a next-higher constituent is always a word and never an affix.

Case 6 is eliminated. There are a few so-called "compound affixes", like erig. E.g. branderig (= burnt) can only be analysed as brand-erig. The analysis
brand
burn
brander
(= burner)
branderig
(= burnerish?)
is false. But these compound affixes are adopted into the lexicon separately.

So only 5 cases remain and they really occur:

1) word-word: 
   huis-deur = house-door
2) word-affix: 
   drinkbaar = drink-able
3) word-inflectional morpheme: 
   drink-t = drink-s
4) word-link: 
   eik-e (in eik-e-blad = oak's leaf)
5) affix-word: 
   ongeluk = mis-fortune

A+B is called C. The 5 questions of 1.1. (except the 1-st, see 1.2.)
are first treated for the most frequent (so-called normal) types of com-
ounds. For them question 3 can be answered very generally: they are not
pseudo-concatenations.

Now I shall give the instructions for the calculation of the indexes
of C, if the set of indexes of A and the set of indexes of B have been
determined. The choice among the perhaps more sets of indexes of one lexi-
cal morpheme will be treated in 4.2. and 4.3.

The indexes of A, B and C are called respectively:

A[1], ..., A[4],
B[1], ..., B[4],
C[1], ..., C[4].

All constituents of more than 1 morpheme are words or virtual words.
So


For the calculation of C[4] we have only to compute the leading con-
stituent, because according to 1.2. C[4] always coincides with the 4-th in-
dex of the leading constituent. The most frequent cases are (the 5 cases
isolated above with a subdivision of case 5):  

1) A is a word, B is a word, A is a determiner of B. B is the leading constituent. From a merely semantic point of view the COORDINATIVE compounds could be removed from this category, e.g. geneesheer-directeur (physician-director), but C has the part of speech of B in them too.  

2) A is a word, B is an affix. B is the leading constituent.  

3) A is a word, B is an inflectional morpheme. A is the leading constituent.  

4) A is a word, B is a link. A is the leading constituent.  

5) A is a dominant prefix, B is a word. A is the leading constituent.  

6) A is a recessive prefix, B is a word. B is the leading constituent.

An immediate compound belonging to one of these six categories, in which every affix, inflectional morpheme or link follows or precedes a word it may follow or precede according to its indexes is called a NORMAL COMPOUND.

The indexes and the leading constituent of a normal compound can be computed on the base of these instructions.

A virtual word-formation (see the types 4 and 6 of abnormal compounds) is a word-formation F not occurring as such, but which could be used as an intermediate stage in the derivation of a word G from a word E in such a way, that both the derivation of F from E and that of G from F occur according to general derivation patterns in Dutch. The virtual word-formations should not be confused with the virtual words: they are not adopted into the lexicon.

Every compound which is not normal is called abnormal. There are a good deal of abnormal compounds. After subtraction of some entirely isolated word-formations and a far from complete scanning of [5] 9 types of abnormal compounds remained:

1) Pseudo-concatenations, i.e. compounds having at least the part of speech with the grammatical function which the phrase consisting of the constituents would have, if they were written as separate words and whose meaning is sometimes almost the same, as when the constituents would be written as separate words (hand-vol = hand-ful, over-zee = over (the) sea).

2) Adjectival compounds with a nominal last constituent and meaning:
"Having the thing called by the last constituent with its preceding determiners" (acht-kant = eight-side-d, vol-bloed = pure-blood-ed, lit. full-blood);

3) Nominal compounds with nominal last constituent and meaning: "Thing with the thing called by the last constituent with its preceding determiners" (blaas-borstje = blue thrush, bleek-gesicht = pale-faced person);

4) Derivatives of virtual direct derivatives (beeld-end;beeld-end-école = plastic arts; Dutch has a noun beeld = image, statue, but no verb beeld);

5) Compounds of verbal stems with agent-meaning, while the verbal stem itself does not have this meaning (bedil-al = caviller, bedil = cavel, sta-in-de-weg lit. stand-in-the-way = stumbling-block);

6) Direct derivatives of virtual compounds (af-schuw = aversion, schuw (verb) = shun);

7) Compounds, in which the second member determines the first one (seoretarier-generaal = secretary-general);

8) Compounds indicating a thing with the property indicated by the compound, if the compound would be understood as a concatenation (over-al = over-all);

9) Compounds with abnormal insertion of affixes or links (binnen-s-huis = in-door, lit. inside (the) house, voorzien-ing = provision);

The treatment of sta-in-de-weg, binnen-s-huis and voorzien-ing in 4.1.3. may seem strange from a compository point of view, because the words are considered in their relation to more than two constituents. Yet they are treated here, because sta-in-de-weg has a great structural similarity to bedil-al and the two other ones, if the program would take account of them, would have to be considered as mediat forms.

binnen s huis voorzien ing
binnens huis voorzien ing
binnenshuis voorziening

The types 4, 5, 6 and 8 are far too infrequent to be treated. All compounds belonging to these types are adopted into the lexicon separately. The analytic program does not take account of the possibility that new compounds of these types would be formed.
For type 3 only the relation in meaning between the compound and its constituents is abnormal, not the part of speech of the compound.

So only the types 1, 2, 7 and 9 remain for further examination. They are called respectively: pseudo-concatenations, abnormal adjectival compounds, inverse compounds and compounds with abnormal insertions.

I have only found one kind of compounds with abnormal insertions in [5], namely that with the scheme verb-n-postverbal suffix (bezaar-n-baar = pass-able, voorsie-n-ing = provis-ion). These compounds are adopted into the lexicon separately.

One type of the abnormal adjectival compounds has the most representatives, namely the words drie-kant (= tri-angular), vier-kant (lit. four-sided, quare), vijf-kant (penta-gonal), zes-kant (sexta-gonal) and acht-kant (octa-gonal).

As appears from the fact, that the analogous word-formations seven-kant (seven = seven), negen-kant (negen = nine) and tien-kant (tien = ten) are not used, this type is not productive. So the compounds mentioned are adopted into the lexicon separately and the analytic program does not take account of the possibility of the formation of analogous compounds.

Inverse compounds and pseudo-concatenations are always compounds of only words. So in the case, that at least one of A and B is not a word, the compound is always normal.

In inverse compounds the constituents are always separated by a hyphen ([14], p. LXIV). But inversely not all compounds, whose constituents are separated by a hyphen, are inverse.

The inverse compounds, in which neither constituent is a proper noun, e.g. secretaris-generaal (= secretary-general), proces-verbaal (= official report), are adopted into the lexicon themselves. This is possible, because such words are mostly imitations of French words and are not formed new. The few inverse compounds without an analogon in French, such as kwartiermeester-generaal (quartermaster-general), are also adopted in the lexicon.

The only productive type of inverse compounds is that, in which the first constituent is a noun and the second one a proper noun (recognisable by its capital). But [14] also gives a number of types of compounds with hyphens between the constituents, in which the second constituent has a
capital and which are not inverse compounds, namely (p. LXIV):

2) Compounds with *Sint* (*St. = Saint*) as first member: *Sint-Nicolaas, St.-Nikolaas, Sint-Bernhard*, etc.

4) Some geographical names like *Nieuwpoort-Bad* ([14]) also treats this under the head "inverse compounds", but because it is treated otherwise in a translation, if any, than the "true" inverse compounds (as a proper noun it is left unchanged), here we subtract it from the rubric "inverse compounds".

5) In names of married women: *Mevrouw (= Mrs.) A. Jansen-Smit.*

6) In geographical and other names, consisting of a proper noun with an uninflected word added before or behind. *Antwerpen-Oost, Nieuw-Zeeland, Oost-Indonesië (= East Indonesia), Voor-Indië (= Hindostan), Frans-Guyana (= French Guyana), etc.*

7) The compound relies on a coordination still felt as such: *Belgisch-Nederlands (= Belgian-Dutch), Belgisch-Nederlands-Luxemburg (= Belgian-Dutch-Luxemburgian), ...*, station *Naarden-Bussem, Moeder-Maagd (= Mother-Virgin), ...*

8) In a bit unusual compounds, looking constructed, and other formations; further in general to explain the structure of the word or to prevent disguising or strange orthographical images: ..., *niet-Nederlander (= non-Dutchman), ...*; also in compounds whose first member consists of two parts written separately outside the compound, if one wants to stress, that these two parts belong together: ..., *Tweede-Kamersessie (= House of Representatives Session), ...*; further in some words with *pro* and *anti*: *pro-Frans (= pro-French), anti-Duits (= anti-German); ...*

   Remark 3: The orthography officially fixed of town names such as *'s-Gravenhage, 's-Gravenvoeren, 's-Herenldehen* can also be counted to this group".

   The part of C before the first hyphen (this for compounds with more hyphens!) is called A, the part behind the first hyphen B. Then I give the rule:

   C can only be an inverse compound, if A does not begin with a capital and B does, if A is a noun and B occurs in the lexicon either with indexes *B[4] = 0* or not at all.
The condition, that A is not allowed to begin with a capital, excludes the cases 2), 4) and 5). The case 6) is excluded too, because every proper noun begins with a capital.

The town names 's-Gravenhage, 's-Gravenvoeren and 's-Herenwderen of remark 3 are excluded by the condition, that A must be a noun.

The coordinative compounds of case 7 are excluded, if A is not a noun. A noun can only be composed coordinatively with another noun. So our instruction would only wrongly classify a coordinative compound as inverse, if both A and B are nouns and A is written without a capital and B with one, e.g. ingenieur-Nederlander (= engineer-Dutchman). But in this case C[4] is also computed correctly. Only the leading constituent is determined wrongly.

Among the words of case 8 the words with pro and anti are eliminated by the condition, that A must be a noun. The "compounds whose first member consists of two parts written separately outside the compound, if one wants to stress, that these two parts belong together" are noted as A-B+D, in which A is the constituent before the hyphen. So this case would only wrongly classify a word as an inverse compound, if A were a noun and B would begin with a capital. That A and B form one phrase together, is only possible, if B is an apposition of A and so also a noun, more precisely a proper noun (because it is written with a capital), because determining words such as adjectives, articles, pronouns and numerals stand before the noun in Dutch. E.g. koning-Davidster (King David's star) is imaginable. But because such appositions are mostly written with a capital themselves (most people will write e.g. Koning David and not koning David), we need not take account of this either.

Only the use of the hyphen according to the rather vague rule "further in general to explain the structure of the word or to prevent disguising or strange orthographical images" can yield compounds which meet the formal requirements above and are not inverse compounds, e.g. ras-Leemans (pure-blooded Leemans; ras = race). But in that case C[4] is also determined unambiguously.

In an examination of 186 compounds (Nieuwe Rotterdams Courant, 5 July 1963, 16 October 1963 and 17 October 1963; [7]) this procedure appeared to recognise 7 words correctly as inverse compounds, not to recognise 3 in-
verse compounds as such and to classify 3 compounds wrongly as inverse. This number of errors is too great to justify the complications in the analytic program by the incorporation of routines for the recognition of inverse compounds. So the inverse compounds are neglected in the analytic program.

Among the pseudo-concatenations of two constituents there is only one type with a great number of representatives, namely the type preposition + noun + adverb. There are moreover 9 pseudo-concatenations preposition + een + adverb. But for the small number of prepositions all these compounds can be adopted into the lexicon.

Even for bij (= at), which has very many pseudo-concatenations of the main form, in [5] I found 14 pseudo-concatenations of the form preposition + noun + adverb against 124 normal compounds with nouns. So I adopt all established pseudo-concatenations into the lexicon. The analytic program does not take into account the possibility of the formation of new pseudo-concatenations of two elements.

4.1.4. COMPOUNDS OF MORE THAN TWO IMMEDIATE CONSTITUENTS

I call the first constituent of the compounds with three immediate constituents A, the second one B and the third one C. A type of compound is noted as a number of three digits, in which the first digit is A[3], the second one B[3] and the third one C[3]. If A (respectively B, C) is an affix, the 1-st (respectively 2-nd, 3-rd) digit is always posed 3.

None of A, B and C can be a link on the basis of the convention of 4.1.2.

None of A, B and C can be an inflectional morpheme either.
A cannot, because all inflectional morphemes are suffixes.
B cannot be an inflectional morpheme either. The verbal inflectional morphemes never occur in the middle of the word and the morphemes e, en and n behind nouns and adjectives and before other constituents are always considered as links, affixes or words, never as inflectional morphemes (compare 3.8.).

C cannot be an inflectional morpheme either. There are of course plenty of inflectional forms of compounds, but they are so analysed, that either A and B, or B and C form a lower constituent together.
So the compound types possible a priori are: 333, 332, 323, 233, 223, 232, 322, 222.

The compound type 333 does not exist, since if two affixes cannot form a higher constituent together, of course three affixes can do so far less.

But a few representatives of the compound type 332 can be indicated, namely

- on-ge-bloem-d (= unveiled; gebloemd is little usual)
- on-ge-kurk-t (= woork-ed; ge-kurk-t is not mentioned)
- on-ge-schoon-d (= un-purifie-d; a verb schoon does exist)
- ver-on-saad (= exhaust (land) by always sowing the same seed; ver-on-saad (adjective) = corrupted by inexacticity; a verb onsaad does not exist)
- ver-ont-heilig (= profane (verb); ont-heilig also exists)
- ver-ont-reinig (= dirty (verb); ont-reinig is obsolete)
- ver-ont-rust (= disquiet; ont-rust is literary)
- ver-ont-sohuldig (= excuse; ont-sohuldig is obsolete)
- ver-ont-waardig (= make indignant; ontwaardig does not exist)

The meaning of each of these compounds except verontwaardig can also be found by assigning them the following structural tree

- A
- B
- C
- A+B+C

The connection in meaning between verontwaardig and waardig (= worthy) is so opaque, that it has anyhow to be adopted into the lexicon separately. So we do not take account of the possibility of the formation of new immediate compounds of the type 332 and give every compound of the type 332 a structural tree

- A
- B
- C
- A+B+C

Compounds of the type 233 do not exist either. The only compounds which could be considered as such are the compounds with compound affixes,
e.g. *brand-er-ig* (3.1.3.). But in them B and C together are considered as one constituent and then they are compounds of two constituents.

The most numerous among the compounds of the type 323 are those, in which A is the prefix *ge*. They have to be adopted into the lexicon separately, since otherwise they would be analysed wrongly in far too many cases (3.5.). The other ones (*on-god-ist = c-the-ist, ont-sin-d = furious, ver-duivel-d = damned, ver-en-ig = white, ver-enselv-ig = identify*) are so few and moreover partly so idiomatic in meaning, that they are adopted into the lexicon separately.

The same holds for the compounds of the type 322

\(\text{ver-donker-maan = annihilate, lit. make a dark moon, }\)
\(\text{ver-halve-zool = half-sold, lit. make a half sole).}\)

The compounds of the type 232 have only one productive sub-type. In order to understand this sub-type we must anticipate the results of the following.

A productive type of compound with 4 immediate constituents is that of the structure \(A+B+C+D\), in which A is a noun or adjective, B is *be* or *ge*, C is a noun and D is *d* or *t*, e.g. *zwart-ge-lacres-d = black-boot-ed*. If C ends with *d* or *t*, D is dropped and so a compound of the type \(A+be+C\) or \(A+ge+C\) is obtained. Then the entire word is an adjective. But these compounds are too complicated, so that the analytic program does not take account of them.

The number of types of compounds with three immediate constituents of the type 222 and 223 and compounds with more than three immediate constituents is very great, but the analytic program takes account of only one type of pseudo-concatenations, namely the compounds of the form \(A+en+C\), in which A and C have the same part of speech. In that case C is appointed as the leading constituent (e.g. *drie-en-dertig = thirty-three*). The other types have few representatives and are not productive. So the compounds of these types are adopted into the lexicon and the analytic program does not take account of the formation of new compounds of these types. For the reason just explained I do the same for compounds with more than three immediate constituents.
4.2. THE RELATIVE PROBABILITIES OF ALTERNATIVE STRUCTURAL DESCRIPTIONS OF COMPOUNDS

4.2.1. THE SCOPE OF PROBABILISTIC CONSIDERATIONS

As we have seen in 1.1., the structural tree contains the following information:

1) The morphemes;
2) The intermediate constituents;
3) For each constituent:
   3a) The set of indexes;
   3b) (except for the morphemes), whether it is a pseudo-concatenation;
   3c) (except for the morphemes) the leading sub-constituent.

So the analytic program has to accomplish the following tasks:

1) To dissect the words into morphemes;
2) To determine the sets of indexes of the morphemes;
3) To determine the intermediate constituents;
4) To compute the sets of indexes of the higher constituents from those of the lower ones;
5) To determine the leading sub-constituent of all constituents except the morphemes;
6) To determine, which constituents are pseudo-concatenations of their immediate sub-constituents.

The methods for 4, 5 and 6 have been described in 4.1.3. and 4.1.4.

As we have seen in 1.1., probabilistic considerations do not play a part in the dissection into morphemes. After a first dissection into morphemes (analytic program 1. 881 - 934) the computer tries to construct a structural tree and only if this construction appears to be IMPOSSIBLE, it tries another dissection into morphemes.

So probabilistic considerations play a part only in the execution of the tasks 2 and 3.

The first application of probabilistic considerations is the ordering of the sets of indexes of one morpheme in the lexicon according to decreasing frequency (see 3.2.). This amounts to the calculation of the relative
probabilities of different sets of indexes of one lexical morpheme.

All other probabilistic considerations concern the relative probability of the connection of two constituents with given sets of indexes. The only type of compounds with three immediate constituents the analytic program takes account of is the pseudo-concatenation (4.1.4.) and this is recognised without probabilistic considerations. So the relative probability of combinations of three or more constituents is not incorporated into the analytic program.

Problems concerning inflectional morphemes and links are always treated without probabilistic considerations. So the only necessary probability array's are affin[0:6, 0:6] and affix[0:6, 3:19]. affin[a,b] is the probability of a constituent A+B, in which both A and B are words, a the 4-th index of A and b the 4-th index of B. affin[a,b] is called the affinity of the part of speech belonging to the index a to that belonging to the index b. affix[a,b] is the probability of a compound of a word A with a 4-th index a with an affix B with 3-rd index b (B may be both a prefix preceding A and a suffix following A). If F is an affix with 3-rd index b, affix[a,b] is called the affinity of F to the part of speech with 4-th index a.

These "probabilities" do not have exactly the formal properties of the probabilities treated in statistics. Because in the analytic program only the relations <, > and = among them and their being 0 are used, it appeared to be convenient to give them integers as values.

A, B, C and the numerical indications of the types of tripartite compounds have the same meaning as in 4.1.4. If in the tripartite compound A+B+C A+B is an intermediate constituent, we speak of preconnection, if B+C is an intermediate constituent, of postconnection.

The a priori possible types of tripartite compounds of words and affixes are: 222, 223, 232, 322, 233, 323, 332, 333. The type 333 does not occur. For the determination of the intermediate constituent for the types 233 and 332 the array's affin and affix are superfluous, because all compounds of the type 233 have preconnection and all compounds of type 332 postconnection. Compounds of type 232 have preconnection if B is a suffix and postconnection, if B is a prefix.

So the only compound types, for which affin and affix can be used to determine the intermediate constitute, are 222, 223, 322 and 323.
Therefore section 4.2. has two sub-sections besides 4.2.1:

4.2.2. The use of affin and the determination of its elements

4.2.3. The use of affix and the determination of its elements and the third indexes of the affixes.

4.2.2. THE USE OF AFFIN AND THE DETERMINATION OF ITS ELEMENTS

The array affin is used to determine the intermediate constituent in compounds of the types 222 and 223. I call the fourth indexes of A, B and C a, b and c. The subtype of the types 222 and 223, in which the 4-th indexes of A, B and C are respectively a, b and c is noted as $a+b+c$ (for greater readability sometimes as $K+L+M$, in which K, L and M are the parts of speech indicated by a, b and c, e.g. adjective + numeral + numeral). Analogously a type of compound of two words A and B, in which A has the 4-th index a and B the 4-th index b, is noted as $a+b$.

The rule is, that if $\text{affin}[a,b] \geq \text{affin}[a,c]$, the word has preconnection and if $\text{affin}[a,b] < \text{affin}[a,c]$, postconnection.

For the type 223 the array affix is irrelevant for the choice between preconnection and postconnection, because the 4-th index of the constituent with which C is connected (in that case A+B) is also b in the case of preconnection.

This rule entails, that if $b=c$, we always have preconnection. Indeed, all types of compound $a+b+b$ have preconnection in the majority of the cases in the corpus scanned by me (1024 words from different sources) or at most as many cases of preconnection as of postconnection.

There are only two types with a majority of postconnections, namely adjective + numeral + numeral and adverb + adjective + adjective. I have only found one example of the type adjective + numeral + numeral in the corpus explored, namely later-negentiende-euws (= in the later nineteenth century). The best solution seemed to me an especial rule, that a numeral is always connected with a numeral to the next-higher constituent, if it stands immediately besides it (the analytic program l. 372 - 373).

I found only one representative of the type adverb + adjective + adjective, occurring twice, namely alleen-saig-makend (= only making beate). I thought I need not attribute value to such a small number.
For the determination of the affinities themselves I took as first criterion, that if the majority of the compounds of the type a+b+c have preconnection, then \(\text{affin}[a,b] \geq \text{affin}[a,c] \{b\cdot c\}\) and if the majority of the compounds of the type a+b+c have postconnection, then \(\text{affin}[a,b] < \text{affin}[a,c]\). It has to be examined, whether this criterion does not produce contradictions.

The application of this criterion only determines the order among elements of affin sharing the first index. So in order to judge, whether this criterion produces contradictions, I have only to compare the statements about different elements of affin with the same first index. This criterion turns out not to produce contradictions. There are only two cases, in which both \(\text{affin}[a,b] \geq \text{affin}[a,c]\) and \(\text{affin}[a,c] \geq \text{affin}[a,b]\) hold. In these cases of course \(\text{affin}[a,b] = \text{affin}[a,c]\). For this reason \(\text{affin}[4,0] = \text{affin}[4,3]\) and \(\text{affin}[5,0] = \text{affin}[5,3]\).

If there is not even one compound of the type a+b in the list of compounds of two constituents, I put \(\text{affin}[a,b] = 0\). \(\text{affin}[0,0]\) and \(\text{affin}[4,4]\) get the value 5 for the great number of compounds of these types.

Further I assign values to \(\text{affin}[a,b]\) for each fixed a according to the following criteria:

1) If there is no c such that \(\text{affin}[a,c] < \text{affin}[a,b]\), then \(\text{affin}[a,b] = 1\).
2) If \(\text{affin}[a,b] \leq \text{affin}[a,c]\) and \(\text{affin}[a,b] \geq \text{affin}[a,c]\), then \(\text{affin}[a,c] = \text{affin}[a,b]\).
3) If \(\text{affin}[a,b] \leq \text{affin}[a,c]\) and on the other hand the tripartite compounds do not give reason to put \(\text{affin}[a,b] \geq \text{affin}[a,c]\) and there is no d such that \(\text{affin}[a,b] \leq \text{affin}[a,d] \leq \text{affin}[a,c]\), then \(\text{affin}[a,c] = \text{affin}[a,b] + 1\).

Here follows a table of the types of tripartite compounds, of which I found at least one representative in the corpus scanned, with their numbers of pre- and postconnections, the inequalities among the elements of affin and eventually the values of the elements of affin on their base. First I scanned 1024 words, which were pure word-compounds. For the types, for which I did not find pure word-compounds, I scanned the compounds, whose third constituents are suffixes, in the Nieuwe Rotterdamse Courant of 23
September 1967 (they were the types $0+3+1$, $1+3+1$, $4+3+1$ and $5+3+1$).

<table>
<thead>
<tr>
<th>Subtype Number of tri-partite connections</th>
<th>Number of pre-partite connections</th>
<th>Number of post-partite connections</th>
<th>Inequalities among the elements of affin</th>
<th>Subtype Number of pre-partite of affin compounds</th>
<th>Number of post-partite of affin compound words</th>
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<td>$0+0+0$</td>
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<td>83</td>
<td>No</td>
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<tr>
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<td>0 $\text{affin}[0,2]=0$</td>
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<td>No</td>
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<td>0 $\text{affin}[0,6]=0$</td>
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<td>No</td>
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<td>Subtype of tri-</td>
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<td>3 immediate con-</td>
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<td></td>
</tr>
</tbody>
</table>
### Inequalities among Subtype Numbers of Compound Elements

<table>
<thead>
<tr>
<th>Subtype</th>
<th>Number of Tripartite Connections</th>
<th>Number of Postconnective Inequalities</th>
<th>Subtype</th>
<th>Number of Bipartite Elements of Affin Compound Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>5+5+3</td>
<td>16</td>
<td>0</td>
<td>affin[5,5] &gt; affin[5,3]</td>
<td>5+6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6+0</td>
<td>affin[6,0] = 0</td>
<td>6+1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6+2</td>
<td>affin[6,2] = 0</td>
<td>6+3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6+4</td>
<td>affin[6,4] = 0</td>
<td>6+5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6+6</td>
<td>affin[6,6] = 1</td>
<td></td>
</tr>
</tbody>
</table>

130 of 1024 words are analysed incorrectly on the basis of these criteria, so 13%.

But if one assumes, that the lexicon contains all words of [5] and all proper nouns occurring in the text, only 691 words remain to be treated (the other ones cease to be compounds with more constituents, because their higher constituents stand in the lexicon), among which 37 are analysed incorrectly, so 5.3%.

### 4.2.3. The Use of Affix and the Determination of Its Elements and the 3-rd Indexes of the Affixes

The determination of the third indexes of the affixes has to be adopted into the topic of this section, because affix[ε, f] is defined as the probability of a compound of a word E with 4-th index ε and an affix F with 3-rd index f, and f itself indicates the order of decreasing affinity of F to the different parts of speech.

Affix is used:

1) To test the POSSIBILITY (not merely the probability) of the connection of E with F. The impossibility of the connection of E with F is indicated
by \text{affix}[^{e,f}] = 0. In order to test the possibility of the connection of E with F the computer just tests, whether \text{affix}[^{e,f}] = 0.

2) To determine the set of indexes of a word-morpheme connected with an affix, if the word-morpheme has more sets of indexes. So \textit{werk-er} (= \textit{work-er}) is analysed as a compound of the \textsc{verb} \textit{werk} and not of the \textsc{noun} \textit{werk}, because \text{affix}[3,11] > \text{affix}[0,11] (the considered set of indexes of \textit{er} is 20110; analytic program 1. 443 - 444). So for this task elements of affix with the same \textsc{second} index are compared. The inventory of all values of the \textsc{third} index of the affixes is made up on the basis of the compounds of \textsc{all} affixes.

3) To choose between preconnection and postconnection for the compound type 322 or 323, in which A is a recessive prefix (analytic program 1. 470 - 471). The rule is: if \text{affix}[C[^4],A[^3]] > \text{affix}[B[^4],A[^3]], then postconnection, else preconnection.

4) To choose between preconnection and postconnection for the compound type 323, in which A is a dominant prefix. The rule is: if \text{affix}[B[^4],C[^3]] > \text{affix}[B[^4],A[^3]], then postconnection, else preconnection (analytic program 1. 540 - 541). An exception has to be made for the case, that \textit{B[^4]} = 3, because the elements of affix cannot be assigned such values, that the correct analysis would then be given in the majority of the cases and no wrong analyses in other cases.

So the elements of affix occur in three kinds of operations except their value-assignments (1. 815 - 830):

1) Examination, whether an element of affix is 0;
2) Determination of the sequential order of two elements of affix with the same \textsc{second} index;
3) Determination of the sequential order of two elements of affix with the same \textsc{first} index.

To fit the elements of affix for the first task is simple: for this we have only to put \text{affix}[k,m] = 0 for all values of \textit{k} and \textit{m}, for which compounds of words with \textsc{fourth} index \textit{k} and affixes with \textsc{third} index \textit{m} are impossible.

Because the \textsc{third} index of \textit{F} itself is defined by the order of decreasing probability of connection of \textit{F} with words of different parts of
speech, only a few extra conventions would be necessary to assign the elements of affix values, by which they could accomplish their second task.

The execution of the third task consists of application of the rule: if affix[B[4],C[3]] > affix[B[4],A[3]], then postconnection, else preconnection.

The optimisation of the results of this rule requires statistic explorations of compounds of the type 323, in which A is a dominant prefix. Because C[3] and A[3] occur in this rule, these explorations require the previous determination of the 3-rd indexes of the affixes.

The determination of the first indexes of the affixes and the elements of affix is executed in four phases:

1) The determination of the 3-rd indexes of the recessive prefixes;
2) The ordering of the parts of speech according to decreasing affinity to F for each dominant affix F. According to the conventions of 3.2. this ordering immediately yields the values of the third indexes for the dominant affixes;
3) The determination of the sequential order of affix[ b, a] and affix[ b, c] for each triple (a, b, c), in which b is the fourth index of a word, a the third index of a dominant prefix and c the third index of a suffix;
4) The computation of the elements of affix on the basis of these facts.

1) For the determination of the third indexes of the recessive prefixes I first determined the number of compounds of each of them with words of different parts of speech (on the basis of an unpublished alphabetic frequency lexicon composed on the base of the corpus of [6]) and determined the sequential order of their affinities to the parts of speech by giving them the greatest affinity to the parts of speech with which most compounds occurred. If possible I tested the results by examining in tripartite compounds, with which parts of speech they are connected. The recessive prefixes connectible to more parts of speech are (their 3-rd index is provisionally set to x):

\[
\begin{align*}
\text{a} &\quad 2\times 7 & \text{ex} &\quad 2\times 7 & \text{mis} &\quad 2\times 7 & \text{oor} &\quad 2\times 7 & \text{van} &\quad 2\times 7 \\
\text{aarts} &\quad 2\times 7 & \text{her} &\quad 2\times 7 & \text{oor} &\quad 2\times 7 & \text{oppar} &\quad 2\times 7 \\
\text{aller} &\quad 2\times 7 & \text{in} &\quad 2\times 7 & \text{on} &\quad 2\times 7 & \text{re} &\quad 2\times 7
\end{align*}
\]
Under the headings "noun - adjective", "noun - verb" and "adjective - verb" the number pairs x-y mean: in the cases, in which the prefix is followed by a noun and adjective (nominal and adjectival suffixes are bracketed with them), the prefix is connected with the noun (or a constituent with the noun as second member) in x cases and with the adjective (or a constituent with the adjective as second member) in y cases (and analogously for the two other headings).

<table>
<thead>
<tr>
<th>Pre-fix</th>
<th>Trans-fixation compounds with</th>
<th>Noun - Noun - Adjective</th>
<th>Order of affinity</th>
<th>3-rd Order of affinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>a</td>
<td>Nouns Adjec-</td>
<td>Adjective-noun</td>
<td>10</td>
</tr>
<tr>
<td>aarts</td>
<td>arche</td>
<td>Adjective-verb tive</td>
<td>Adjunctive-noun</td>
<td>9</td>
</tr>
<tr>
<td>aller</td>
<td>absolute</td>
<td>Verb-noun</td>
<td>Noun-adjunctive</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>superlative</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ex</td>
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<td>her</td>
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<td>in</td>
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<tr>
<td>mis</td>
<td>mis</td>
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<tr>
<td>oer</td>
<td>original</td>
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<td>on</td>
<td>un</td>
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<tr>
<td>oor</td>
<td>original</td>
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<tr>
<td>upper</td>
<td>supreme</td>
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<tr>
<td>re</td>
<td>re</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>wan</td>
<td>bad</td>
<td></td>
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</tr>
</tbody>
</table>

2) I ordered the parts of speech according to decreasing affinity to given dominant affixes by counting the compounds of words of given part of speech and the cases of preference of an affix F for a part of speech a above the part of speech b. If a word E has at least two sets of indexes, one assigning it the part of speech a and one assigning it the part of speech b, and the affix F is connected with E with the part of speech b in a certain compound, it is said, that F prefers b above a in that compound.
For the determination of the part of speech of itself the criterion of 3.7., that the compound is considered as a compound of itself in that meaning, by which its meaning can be paraphrased in the simplest way, is used. For equiradical words, for which the decision may be most difficult, this criterion is specified by the usage of so-called periphrastic schemes. Each affix F connectible to words E of part of speech e has one or more so-called periphrastic schemes, according to which the meaning of the compound can be paraphrased with the aid of the meaning of E. Such a periphrastic scheme must be based on unambiguous cases, e.g. 

\[ \text{ver-A} = \text{become A} (\text{ver-geel} = \text{become yellow}, \text{ver-groen} = \text{become green}). \]

If then there is a periphrastic scheme assigning the compound the correct meaning, if E has the part of speech a, but no such scheme, if E has the part of speech b, E is assigned the part of speech a.

E.g. the prefix ver has for the case, that A is a verb, i.a. the periphrastic scheme ver-A = change by A-ing, e.g. ver-bouw (bouw = build), ver-buig (buig = bend).

For the case, that E is a noun, ver has four periphrastic schemes:

1) A ver-B-t = A becomes B: ver-ambtenaar (ambtenaar = officer), ver-kool (kool = coal);
2) A ver-B-t = A gets into B: ver-armoed (armoed = poverty);
3) A ver-B-t C = A makes C B: ver-afgood (afgood = idol), ver-aZsem (aZsem = wormwood), ver-slaaf (slaaf = slave);
4) A ver-B-t C = A provides C with B: ver-koper (koper = copper), ver-silver (silver = silver).

To the case ver-werk (werk = work, both as a noun and as a verb) the periphrastic scheme ver-A = change by A-ing applied, but none of the four periphrastic schemes with A as a noun. So ver-werk is a compound of werk as a verb.

For this purpose I scanned the Nieuwe Rotterdamse Courant of 24 November 1967. Only for the affixes be 2x3, ig 20x1, tijk 20x1 and ver 2x3 did I stop counting on p. 4, because I had then already counted enough compounds to be able to draw conclusions.

For two parts of speech a and b I assigned an affix F a greater affinity to a than to b, if there were more compounds, in which F prefered a
above b than inversely. If that criterion failed, I gave F the greatest affinity to the part of speech, with which it has most compounds. These criteria turned out not to produce contradictions.

3) In the weekly supplement of the Nieuwe Rotterdamse Courant of 27 April 1968 I counted the compounds of words of given parts of speech with given dominant prefixes, the compounds of words of given parts of speech with suffixes of given 3-rd indexes and the tripartite compounds of type a-b-c, in which A is a dominant prefix with 3-rd index a (if A is a preverbal prefix, a is put equal to A), B a word with 4-th index b and C a suffix with 3-rd index c. For the tripartite compounds of each type I counted moreover the cases of preconnection and postconnection.

If a type of tripartite compounds a-b-c has more cases of preconnection, I put \text{affix}[b,a] > \text{affix}[b,c]$, else \text{affix}[b,a] < \text{affix}[b,c]$. This is in theory the most reliable method. Another method is that, in which each part of speech gets the greatest affinity to the affixes, with which it has the most compounds. But this method yields gross errors. E.g. the corpus contains 3192 compounds of verbs with suffixes with 3-rd index 6 against 478 compounds of verbs with the prefix be 2163, while all compounds of the type be-3-6 have preconnection. So this criterion is only used to determine the order among elements of affix with the same 3-rd index, if that order cannot be determined with tripartite compounds.

If the choice between preconnection and postconnection in the type 323 has to be made only with affix, the inequalities given by the tripartite compounds (the 3-rd indexes of be, ge and ont are provisorily called be, ge and ont; the 3-rd index of ver is immediately called 18, because there is no other affix with 3-rd index 18):
affix[0, 14] > affix[0, be]  affix[3, 6] < affix[3, ge]
affix[0, 11] < affix[0, 18]  affix[3, 14] < affix[3, ge]
affix[0, 14] > affix[0, 18]  affix[3, 16] < affix[3, ge]
affix[0, 16] > affix[0, 18]  affix[3, 19] < affix[3, ge]
affix[0, 19] > affix[0, 18]  affix[3, 6] < affix[3, ont]
affix[3, 19] < affix[3, be]

All these inequalities concern the order of the affinities of the preverbal prefixes and the suffixes. They leave the following gaps:

1) A flat contradiction: the inequalities affix[1, 18] > affix[3, 18], affix[3, 18] > affix[3, 14], affix[3, 14] > affix[1, 14] and affix[1, 14] > affix[1, 18] would hold at the same time;
2) The indeterminedness of the order between the affinities of the preverbal prefixes and the affinities of many suffixes;
3) The indeterminedness of the order of the affinities of the prefixoids and pronominal adverb-formators relative to the affinities of the suffixes.

1 and 2) For the triples (a,b,c), in which a is the 1-st index of a preverbal prefix and b ≠ 3, there are no strong independent reasons to fix the order between affix[b,a] and affix[b,c] (of course the integers affix[b,a] and affix[b,c] always have a sequential order, but this order has little influence on the result of the program). E.g. affix[0,9] and affix[0,10] would have to be smaller than affix[0,be] according to the numbers of the words of the compound types corresponding to them, but exactly for the types be-0-9 and be-0-10 preconnection is impossible, because suffixes with third index 9 or 10 cannot be connected with verbs. Therefore I do not require an especial order among these pairs of elements in the construction of the elements of affix, because a non-optimal analysis in very rare cases
(and the subtypes of tripartite compounds concerned are very rare - that is guaranteed by their absence in the corpus) is not a more serious defect than the assignment of an order to these elements on entirely insufficient grounds.

1) This contradiction is eliminated by dropping all inequalities of the form affix[3,c] > affix[3,d]. Then the instruction of preconnection in all tripartite compounds of the type 323, in which the second constituent is a verb and preconnection is not strictly impossible, is immediately given (analytic program 1. 541: \( \forall (\text{aff} > 0 \land \text{leider} = 3) \)) and not deduced from inequalities among elements of affix. So unique third indexes for be, ge and ont become superfluous.

3) As appears from their low frequency in the corpus (1 compound with om 2033, 2 with over 2033, none with the other ones) the prefixoids are not very productive. So I assign the lowest possible values to affix[0,3], affix[0,9] and affix[1,9].

Pronominal adverbs are very frequent and suffixes forming prepositions or adverbial by-forms of prepositions do not exist (the few derived prepositions, such as niet-tegen-staande (= in spite of, lit. not-against-standing) are adopted into the lexicon). So I assign higher values to affix[4,7] and affix[5,7] than to affix[4,c] and affix[5,c] for any value of c with \( 3 \leq c \leq 19 \) and \( c \neq 7 \). This condition can be reduced to: \( c = 8 \) or \( 12 \leq c \leq 19 \) for adverbs and \( 13 \leq c \leq 19 \) for prepositions, because adverbs and prepositions can only be connected with affixes with these third indexes.

4) The set SI of inequalities which the elements of affix must fulfill is the following one:

1) (in virtue of the definitions of 3.2.; cet = 2, 4 or 5)

\[
\begin{align*}
\text{affix}[0,3] & > 0 & \text{affix}[5,7] & > \text{affix}[4,7] & > 0 \\
\text{affix}[1,4] & > 0 & \text{affix}[1,8] & > \text{affix}[4,8] & > 0 \\
\text{affix}[2,5] & > 0 & \text{affix}[0,9] & > \text{affix}[1,9] & > 0 \\
\text{affix}[3,6] & > 0 & \text{affix}[1,10] & > \text{affix}[0,10] & > 0
\end{align*}
\]
affix[3,11] > affix[0,11] > 0
affix[0,12] > affix[1,12] > affix[4,12] > 0
affix[0,14] > affix[3,14] > affix[1,14] > affix[4,14] > 0
affix[3,16] > affix[0,16] > affix[1,16] > affix[4,16] > 0
affix[1,18] > affix[3,18] > affix[0,18] > affix[4,18] > 0
affix[m, n] = 0 for all combinations of m and n not mentioned in this list.

2) The inequalities given in this section 4.2.3:

affix[0,18] > affix[0,11]  affix[1,14] > affix[1,18]
affix[0,14] > affix[0,18]  affix[1,14] > affix[1,18]
affix[0,16] > affix[0,18]  affix[2,14] > affix[2,18]
affix[0,19] > affix[0,18]  affix[4, 7] > affix[4, 8]
affix[3, 7] > affix[4, c] for 12 ≤ c ≤ 19
affix[5, 7] > affix[5, c] for 13 ≤ c ≤ 19

I determine the elements of affix with value n by complete induction to n as follows.

1) It has been determined, which elements of affix are 0.
2) I suppose all elements of affix < n determined. Then every affix[a,b] which has not yet been assigned a value and for which in every inequality affix[a,b] > K in SI K has been assigned a value < n, gets the value n.

This gives the following values for the elements of affix.

<table>
<thead>
<tr>
<th>2-nd index</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>13</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-st- index</td>
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<td>0</td>
<td>0</td>
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<td>1</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>3</td>
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<td>2</td>
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<td>0</td>
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<td>0</td>
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<td>6</td>
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<td>3</td>
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<tr>
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<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
This table must be read as follows: for each \( m \) and \( n \) the number in the row with pre-index \( m \) and the column with superindex \( n \) is \( \text{affix}[m,n] \).

4.3. THE ARRANGEMENT OF THE ANALYTIC PROGRAM

The analytic program consists of three parts: the first reading of the lexicon (1. 1 - 50), the second reading of the lexicon (1. 51 - 169) and the reading and elaboration of the word-list (1. 170 - 1330).

The information of the lexicon is stored in four integer array's:

- \( \text{DIC}[1:\text{dic}] \), \( \text{wodic}[1:\text{dic}+1] \), \( \text{PAKET}[1:\text{paket}] \) and \( \text{SYNTAX}[1:\text{dic}+1] \) (l. 52 - 53).

\( \text{DIC} \) contains all lexical morphemes of the lexicon, \( \text{wodic}[n] \) is the ordinal number in \( \text{DIC} \) of the element of \( \text{DIC} \), in which the first letters of the \( n \)-th word are stored. The elements of \( \text{PAKET} \) except the last one, if the lexicon contains an odd number of sets of indexes, each contain two sets of indexes following each other. \( \text{SYNTAX}[n] \) is the ordinal number in the series of sets of indexes in the lexicon of the 1-st set of indexes of the \( n \)-th complete morpheme.

\( \text{dicn} \) is the number of complete morphemes in the lexicon. 4 letters following each other of one lexical morpheme (or less at the end of a word, whose number of letters is not a multiple of 4) are stored together in one element of \( \text{DIC} \). \( \text{dicn} \) is the number of elements \( \text{DIC} \) must have in virtue of this. \( \text{paket} \) is the number of elements of \( \text{PAKET} \).

From this it follows, that the lexicon must be read twice: once to determine \( \text{dic} \), \( \text{dicn} \) and \( \text{paket} \) (l. 1 - 50) and once to determine the values of the elements of \( \text{DIC} \), \( \text{wodic} \), \( \text{PAKET} \) and \( \text{SYNTAX} \) (l. 51 - 169).

The integer array's \( \text{alv}[120:127] \) and \( \text{revers}[66:70] \) (l. 20) are used respectively for the compression of the letters in the array \( \text{DIC} \) and the reduction of the modified encodation into the original one.

The array \( \text{alv} \) maps the integers representing ',', '-' and '|' according to the X8-code to the numbers 70, 67 and 66 (so all signs occurring in words are mapped to numbers < 90, so that more letters can be stored in one machine word), \( \text{revers} \) reduces these number representations to the original representations according to the X8-code.

In the analytic program in the second reading of the lexicon two sets
of indexes are stored together in one element of PAKET. This necessitates
the statement-part
\[ \text{REMAINDER}(p,1000)+200\times \text{ind}2+800\times \text{ind}1 \] (l. 156)
in order to "compress" the sets of indexes and a procedure VALIND(k)
(l. 119 - 138) to reobtain the indexes from an element of PAKET for the
analysis of the word to be elaborated (see 4.1.3.). The parameter k is here
the ordinal number of the morpheme being treated in the word to be analysed.
The procedure VALIND uses the auxiliary procedure pakt in its turn, which
makes available the correct set of indexes from two sets stored in one
element of PAKET.

All words of the word-list are read and treated successively and indep-
dently of each other. The information about each word is stored in the
integer array \text{LETTER}[1:45] (l. 24). The representation of the k-th letter
is \text{LETTER}[k].

The word being analysed is called W. The number of morphemes of W is
called woord. The number of letters of W is called letter.

The analysis of W is executed in four stages: the dissection into mor-
phemes (l. 881 - 934), the determination of the so-called dominator of each
morpheme and the determination of the pseudo-concatenations (l. 935 - 1094),
the determination of the intermediate constituents (l. 1095 - 1202) and the
printing or punching of the results (l. 1203 - 1300). The program has two
versions: one in which the output is printed and one in which it is punched.
The second one (with added line numbers) is printed in 6.1.

The ordinal number of the first letter of the k-th morpheme as a letter
of W is called unua[k]; the ordinal number of the last letter of the k-th
morpheme lasta[k] (l. 23).

The dissection into morphemes uses two procedures: \text{Meq}(m,n)
(l. 200 - 243) and \text{lv}(m,n) (l. 246 - 293).

The ordinal number of the equivalent of the k-th morpheme of W in the
lexicon is called \text{WOORD}[k] (l. 20; if the k-th morpheme has no equivalent
in the lexicon, \text{WOORD}[k] is put 0). The procedure for the determination of
the equivalent of the string from the m-th to the n-th letter is called
\text{Meq}(m,n) (\text{Meq} does not need a parameter k, because the index of the element
of \text{WOORD} being determined is always woord).

\text{lv}(m,n) is the ordinal number of the last letter of the longest ini-
tial segment of the string from the m-th to the n-th letter with an equivalent in the lexicon. If that string of letters does not have such an initial segment, \( lv(m,n) \) is put to 0.

The Reifler calculus and the deviation from that in the analytic program has largely been treated in 1.2. Only two deviations of this fragment from the Reifler calculus could not be explained there: the statements depending on conditional clauses containing \( \text{ind1} \) and \( \text{ind2} \) and the statements positie. \( \text{ind1} \) and \( \text{ind2} \) are parameters of each lexical morpheme provisionally found in \( W \) (the program is such, that \( \text{ind1}'s \) and \( \text{ind2}'s \) of different lexical morphemes need never to be considered at the same time; \( \text{ind1} \) and \( \text{ind2} \) themselves do not occur in the sets of indexes of the lexical morphemes, but can be calculated from them by the procedure positie, l. 296 – 308). The meaning of \( \text{ind1} \) and \( \text{ind2} \) is as follows (they occur in quite another sense on l. 154 – 157):

<table>
<thead>
<tr>
<th>Occurrence of the morpheme as first morpheme</th>
<th>( \text{ind1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can occur as the first morpheme of a word, but also in other positions</td>
<td>0</td>
</tr>
<tr>
<td>Can only occur as the first morpheme of a word</td>
<td>1</td>
</tr>
<tr>
<td>Cannot occur as the first morpheme of a word</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Occurrence of the morpheme as last morpheme</th>
<th>( \text{ind2} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can occur as the last morpheme of a word, but also in other positions</td>
<td>0</td>
</tr>
<tr>
<td>Can only occur as the last morpheme of a word</td>
<td>1</td>
</tr>
<tr>
<td>Cannot occur as the last morpheme of a word, but may be followed both by vowels and consonants</td>
<td>2</td>
</tr>
<tr>
<td>Can only occur followed by a vowel</td>
<td>3</td>
</tr>
</tbody>
</table>

A morpheme is rejected as first morpheme, if its \( \text{ind1}=2 \); as last morpheme, if its \( \text{ind2}>1 \); in all other positions, if its \( \text{ind1}=1 \) or \( \text{ind2}=1 \).

At first view the definitions of \( \text{ind1} \) and \( \text{ind2} \) are very similar to those of \( \text{INDEX}[k,1] \) and \( \text{INDEX}[k,2] \) in 3.2. The difference between \( \text{INDEX}[k,1] \) and \( \text{INDEX}[k,2] \) on one hand, \( \text{ind1} \) and \( \text{ind2} \) on the other hand is,
that \text{INDEX}[k,1] \text{ and } \text{INDEX}[k,2] \text{ are properties of SYNTACTIC morphemes, but }
\text{ind1 and ind2 properties of COMPLETE morphemes. E.g. that INDEX}[k,2] = 2, 
means, that the lexical morpheme A cannot occur as the last morpheme of W
WITH THE SET OF INDEXES BEING CONSIDERED AT THAT MOMENT; that ind2 = 2 
means, that A cannot occur as the last morpeme of W WITH ANY OF ITS (PER- 
HAPS MORE) SETS OF INDEXES. E.g. for in 2107 INDEX[k,2] = 2; but for in
ind2 = 0, because the lexical morpheme \text{ in } can occur as the last morpheme of 
W WITH ANOTHER set of indexes (e.g. in 20030).

Because the word-list is read only once, unua, lasta, \text{WOORD}, \text{MORFEEM}, 
\text{LETTER and INDEX must have fixed upper bounds. They are chosen such, that
for the overwhelming majority of the words occurring in practice the index-
es of their elements fall inside the array-bounds. }

In the determination of the dominator the array subj[1:12] (l. 23) is
used. subj[k] = m means: the dominator of the k-th morpheme is the m-th
morpheme. subj[k] = 0 means: the k-th morpheme has no dominator.

The determination of subj uses six auxiliary procedures: structur(k,m) 
(l. 356 - 416), compl(n,k,m) (l. 419 - 703), maxaffin(p,r) (l. 706 - 732),
macrostructur(k,m) (l. 735 - 806), close (l. 311 - 317) and transform 
(change) (l. 331 - 353).

Formally the dominators fulfil the following conditions:

1) The word has exactly one morpheme without a dominator; each other mor-
pheme has exactly one dominator. 

2) There is no series of morphemes \(a_1, \ldots, a_n\) such that for \(2 \leq k \leq n, \)
\(a_k\) is always the dominator of \(a_{k-1}\) and \(a_1 = a_n\).

3) Every set of morphemes which always contains b, if it contains a mor-
pheme a and a is the dominator of b, is a continuous series of morphemes.

Starting from the complete structural tree one finds the LEADING MOR-
PHHEME of a constituent \(C = C_0\) as follows:

We construct the series of constituents \(C_0, \ldots, C_n\) by complete induc-
tion as follows:

If \(C_n\) is a morpheme, it is the leading morpheme of C and the construc-
tion is completed; if \(C_n\) is not a morpheme, the leading immediate sub-con-
stituent of \(C_n\) is \(C_{n+1}\) (this construction serves to explain the linguistic
meaning of the term LEADING MORPHEME; since it presupposes the construction
of the structural tree, it is nowhere executed in the analytic program).

If A is the largest constituent whose leading morpheme is a, B is the next-higher constituent of A and b the leading morpheme of B, then b is called the DOMINATOR of a.

\text{structur}(k,m) \text{ determines the structure of the series of the } k \text{-th up to the } m \text{-th morpheme, if they are all words (according to 3.2. this means: if } \text{INDEX}[p,3] = 2 \text{ for } k \leq p \leq m). \text{ The } m \text{-th morpheme is the leading morpheme of this series. So for the other morphemes the dominator is determined and whether the next-higher constituent, whose leading morpheme it is, is a normal compound or a pseudo-concatenation.}

According to 4.1.3. and 4.1.4. the program takes only account of two possible relations between mere word-compounds and their immediate constituents:

1) Normal compounds of the form \( A+B \), in which B is the leading constituent;
2) Pseudo-concatenations of the form \( A+\text{en}+C \), in which C is the leading constituent (at least, in the analytic program it is considered as such; from a mere linguistic point of view A and C are equivalent members of a coordination).

\text{en} \text{ is recognised by its } \text{INDEX}[k,3] = 6 \text{ (except in one place of the procedure } \text{compl (the local procedure mistest, l. 426 - 430) and the test, whether a morpheme with a 2-nd index 3 is followed by a vowel, the structure is only determined with the aid of the indexes of the morphemes, not their letters; only in the punching of the results (l. 1203 - 1330) are the letters used again).}

In compounds without \( \text{en} \) the dominator of each morpheme is determined with the aid of the affinities of \text{INDEX}[p,4] (the values of the elements of affin are assigned on l. 831 - 839). If W does not contain \( \text{en}'s \), in the execution of structur\( (k,m) \) initially the \( k+1 \)-th morpheme is indicated as the dominator of the \( k \)-th morpheme and then all morphemes are scanned and each time, when

\[ \text{affin}[\text{INDEX}[k,h],\text{INDEX}[r,h]] > \text{affin}[\text{INDEX}[k,h],\text{INDEX}[s,h]] \]

(\( s \) is the ordinal number of the morpheme last indicated as the dominator of the \( k \)-th morpheme), then the \( r \)-th morpheme is indicated as the dominator of
the k-th morpheme. Then the following morphemes are treated in the same way as the k-th one.

If the r-th morpheme is en, all morphemes from the r+1-th one up to the m-th one are scanned and the first one with the same part of speech as the r-1-th morpheme, the s-th morpheme of W, is indicated as the dominator of both the r-1-st and the r-th morpheme. Then the compound of the constituents with as leading morphemes, respectively, the r-1-th, the r-th and the s-th morpheme is a pseudo-concatenation. If such a morpheme is not found, the analysis is continued for other values of the sets of indexes or if all sets of indexes of all morphemes have been tried, another dissection into morphemes is tried and if that turns out to be impossible, the word is declared unanalysable.

normaal[k] (normaal[1:12] (1. 25) is a boolean array) means: the next-higher constituent of the constituent whose leading morpheme is the k-th morpheme, is a normal compound. Normal compounds are far more frequent than pseudo-concatenations. So for each combination of sets of indexes all elements normaal[1], ..., normaal[woord] are put true (1. 959) and in other places in the procedures structur, compl and macrostructur an element of normaal is put false, if the constituent with the morpheme concerned as leading morpheme appears to be connected with its co-constituents to the next-higher constituent in a pseudo-concatenation, but nowhere explicitly true.

compl(n,k,m) analyses the structure of the k-th up to the m-th morpheme. n is the ordinal number of the BLOCK to which the k-th up to the m-th morpheme belong (the meaning of the blocks will be explained on p. 78); compl(n,k,m) also determines lblok[n], the leading morpheme of the series.

compl is only applied to morpheme sequences consisting of at most three sub-sequences following each other: an initial segment, consisting only of prefixes, a central segment, consisting only of words and a final segment, consisting only of suffixes and links. The initial segment and the final segment may also miss.

The procedure compl has the local switch IkIm (1. 424) and four local procedures: P27op (1. 464 - 477), terugschuif (1. 480 - 487), mistest (1. 426 - 430) and optimum (1. 433 - 450).
The morpheme sequence to which \texttt{compl} is applied can be in four cases:

1) It has an initial segment and a final segment;
2) It has an initial segment, but no final segment;
3) It has a final segment, but no initial segment;
4) It has neither an initial segment, nor a final segment.

The elements of \texttt{IkIm} are successively followed by the instructions for these four cases.

The ordinal number of the last morphemes of the initial segment is called \texttt{lpref}, the ordinal number of the first morpheme of the final segment is called \texttt{bsuff}.

In the case \texttt{Ik2Im2} two subcases are distinguished. In the first subcase

\[\text{INDEX[bsuff,3]} > 2^{\text{affix[INDEX[bsuff-1,4], INDEX[lpref,3]]}} = 0.\]

In that case first the structure of the central segment is determined by the procedure structur (so every element of the central segment, except the last one, is assigned a morpheme of the central segment as dominator).

Then the structure of the series is further constructed concentrically with the aid of the labels open, openeind, openbegin and gesloten. At each moment I call the maximal sequence of morphemes in the sequence, all of which, except the leading morpheme and recessive prefixes, have been assigned a dominator, the EXPLORED FIELD. I call the ordinal number of the first morpheme of the explored field begin, that of the last morpheme of the explored field eind and that of the leading morpheme of the explored field leider. The explored field is continuously extended so, that either the longest preceding continuous sequence of recessive prefixes is added (by the procedure terugschuif), or the last morpheme before the explored field or the first morpheme behind it is assigned as the dominator of the leading morpheme, or the leading morpheme is assigned as the dominator of the first morpheme behind the explored field. At each moment of the elaboration four cases are possible:

1) \(k = \text{begin}, \; \text{eind} = m\) ("gesloten");
2) \(k = \text{begin}, \; \text{eind} < m\) ("openeind");
3) \(k < \text{begin}, \; \text{eind} = m\) ("openbegin");
4) \(k < \text{begin}, \; \text{eind} < m\) ("open").
The four labels mentioned are followed by the instructions for these four cases.

The execution of the program fragments \(Ik2Im2\) and \(Ik2Im3\) is completed by the execution of the procedures optimum and \(P27op\); the execution of \(Ik3Im2\) by the execution of optimum.

The procedure optimum changes the set of indexes of the last morpheme of the central segment, if in this way that gets a greater affinity to its dominator. The procedure \(P27op\) assigns dominators to the recessive prefixes.

A more detailed description of procedure \(compl\) would only be a useless paraphrase of the concerned program fragment.

A block is a continuous sequence of morphemes maximal with respect to the property to contain no more than one continuous sequence of prefixes at the beginning and one continuous sequence of suffixes, inflectional morphemes and links at the end. macrostruct assigns the dominators to the leading morphemes of the block (except the last one, which has no dominator). If the dominator of the leading morpheme of the \(p\)-th block is a morpheme of the \(r\)-th block and the \(r\)-th block begins with a prefix, then this dominator is ALWAYS the leading morpheme of the \(r\)-th block. If the dominator of the leading morpheme of the \(p\)-th block is a morpheme of the \(r\)-th block and the \(r\)-th block does not begin with a prefix, then this possible dominator is determined with the procedure \(maxaffin(p,r)\). The procedure macrostruct for the determination of the relation among the leaders of the blocks is very analogous to the procedure structur for the determination of the relation among a sequence of word-morphemes following each other.

By the ordinal number of a set of indexes I mean its ordinal number in the series of all sets of indexes in the lexicon. Then \(inf[p]\) (1. 22) is the ordinal number of the first set of indexes of the \(p\)-th morpheme of the word being analysed. \(sup[p]\) (1. 22) is the ordinal number of the last set of indexes of the \(p\)-th morpheme of the word being analysed. \(tract[p]\) is the ordinal number of the set of indexes assigned to the \(p\)-th morpheme at that moment. \(finit\) is the ordinal number of the last morpheme, for which \(tract[p]\) has not yet become equal to \(sup[p]\).

Close modifies \(finit\), if that has become necessary by modifications in \(tract\). transform modifies the elements of \(tract\), when the case, that \(tract\)
has a certain value, has been elaborated completely.

Four non-local switches are used: SIND, INDAF, SCHAK and Prenpo
(l. 171 - 174). SIND is used on l. 968, SCHAK on l. 1003, INDAF on
l. 970 - 974 and Prenpo on l. 1144 - 1168.

The elements of SIND are followed by the instructions for the cases,
in which the morpheme being treated is, respectively, a link, an inflec-
tional morpheme or a word.

The elements of SCHAK are followed by the instructions for the cases
in which a link is followed, respectively, by a link, an inflectional mor-
pheme or a word.

The elements of INDAF are followed by the instructions for the cases,
in which the morpheme behind a certain prefix is, respectively, a link, an
inflectional morpheme or a word.

The middle part of the program for the analysis of words consists it-
self of two parts: the division of the morpheme sequence into blocks
(l. 935 - 1059) and the definitive determination of the elements of subj
(l. 1060 - 1094).

The fragment of l. 935 - 1059 determines the elements of the integer
array’s eblok[0:12], thblok and lblok[1:12] (l. 22 - 23). The number of
blocks in the word is called blokn. blokn is only determined in this pro-
gram fragment. Therefore eblok and lblok have to be declared with a fixed
upper bound. But values are only assigned to the elements of eblok and
lblok with index ≤ blokn.

bblok(p) (l. 141) is the ordinal number of the first morpheme of the
p-th block as a morpheme of W.

eblok[p] is the ordinal number of the last morpheme of the p-th block
as a morpheme of W (eblok[0], which would be undefined according to this
definition, is formally assigned the value 0 (l. 876); note, that this
statement is executed before the analysis of the words). This serves to
simplify some calculations.

lblok[p] is the ordinal number of the leading morpheme of the p-th
block. Note, that the value assignment to lblok is provisory. It can be un-
done on l. 1063 - 1094.

blok[p] is the ordinal number of the block to which the p-th morpheme
belongs.
morpheme in the range behind OMK immediately dominated by OMK and endom.

The program fragment 1. 1095 - 1262 computes the constituents of W. FIN gets the value 2, if the word is unanalysable, 3, if the word is analysable.

The program fragment 1. 1095 - 1202 uses the procedure dom(A,B,m) (1. 92 - 99) and eind(n,k) (1. 76 - 77) and computes the elements of the array's lengte, begin, leider, diepte and naasthoger and the integer hoogte. As for the array's LETTER, WORD, etc., values are often not assigned to all their elements. lengte[n] is the number of constituents of the n-th order. begin[m,n] is the ordinal number of the 1-st morpheme of the n-th constituent of the m-th order (formally begin[hoogte, lengte[m]+1] is put to word + 1 for the determination of eind(n,lengte[m]). leider[m,n] is the ordinal number of the leading morpheme of the n-th constituent of the m-th order. naasthoger[n,m] is the ordinal number of the 1-st morpheme of the constituent of the m-th order, which is the leading constituent of the m-th constituent of the n+1-th order. Formally naasthoger[n, lengte[n+1]+1] is put to word + 1. hoogte is the maximum of the orders of the morphemes as constituents. diepte[k] is the order as constituent of the greatest constituent, whose leading morpheme is the k-th morpheme.

In the determination of diepte and leider the switch Prenpo is used. The leading morphemes of the immediate subconstituents of a constituent with the OMK-th morpheme as leading morpheme always have the OMK-th morpheme as dominator and stand in the range between the leading morphemes of the two adjacent constituents of the same constituent as the constituent dominated by the OMK-th morpheme. The candidates for the function of leading morpheme of an immediate subconstituent are predom, the 1-st morpheme in the range before OMK immediately dominated by OMK, postdom, the last morpheme in the range behind OMK immediately dominated by OMK and endom,
the conjunction immediately dominated by OKX (each of these three is put 0, if the morpheme concerned is absent). The elements of Prenpo have the form Pkmn, in which k, m and n are each 0 if and only if predom, endom and post-dom are, respectively, 0.

eind(m,n) is the ordinal number of the last morpheme of the n-th constituent of the m-th order.

In the punching of the results the procedures PUCAS(m) (l. 66 - 73) and notind(n,k) (l. 80 - 89) are used.

PUCAS serves to punch the elements of LETTER in the form of the letters, from which they have originally been obtained. Its parameter m is the ordinal number of the morpheme being treated (each time an entire morpheme is punched at the same time).

notind(n,k) computes (and punches!) the set of indexes of the k-th constituent of the n-th order.

dom(A,B,m) (l. 92 - 99) means: diepte[8] ≤ m and there is a chain C₀, ..., Cn such that A = C₀, B = Cn and for every k with 1 ≤ k ≤ n Ck+1 = subj[Ck].

The program fragment from 1. 1203 - 1330 becomes very complicated by the necessity to put the first letter of each constituent perpendicularly under the first letter of its leading morpheme. This makes an integer array kolon (l. 23) necessary. kolon[k] - 1 is the distance in tabulations between the first letter of the k-th morpheme and the beginning of the line. mod8 is the distance in carriage places between the letter just printed and the last tabulation. In this program fragment the sets of indexes of the constituents are also computed and punched (by the execution of notind).
5. RESULTS: ERROR ANALYSIS

I executed this program with as word-list the first 197 compounds with more than 2 morphemes in "De Groene Amsterdammer" of 12 November 1966.

The lexicon contained all lexical morphemes which should occur in a complete lexicon of Dutch according to the instructions of 3. and which, considered as mere strings of letters, occurred in at least one of the words in the word-list. Each was followed by all the sets of indexes which should follow it in the complete lexicon. So the lexicon had e.g. to contain the word *mes (= tit)* because of *stadsbouwmeester (= urban architect)* in the word list, though it is not a morpheme of *stadsbouwmeester*. This composition of the lexicon was necessary to control, in how far the analytic program itself could find the correct morpheme analysis instead of being forced to it by a restricted lexicon.

The lexicon, the word-list, the analytic program and the results are given in appendix 6.

Only 4 errors occurred, namely:

- *post/academi/aal (= post-academi-al)*, in which post was considered as a noun;
- *af/beeld/en (= map (verb)), in which beeld was considered as a noun;*
- *winkel/bedrijv/ig/heid = shop-busy-ness*, in which *winkelbedrijv (= shop enterprise)* was considered as a constituent;
- *tussen/verkiez/ing (= by-election)*, in which *tussenverkiez* was considered as a constituent.

The first two errors are a consequence of the fact, that the noun *post* is more frequent than the virtual preposition, respectively the noun *beeld* more frequent than the verb.

The erroneous analysis of *winkel/bedrijv/ig/heid* is caused by the general instruction of preconnection of tripartite compounds, whose last two constituents have the same part of speech, what is justified by statistical considerations (see 4.2.2.), that of *tussen/verkiez/ing* by the equal affinity of prepositions to verbs and to nouns.

So all errors could only be avoided by modifications in the analytic program, which would either be completely AD HOC, or cause far more errors in other cases. An error procentage of 2% seems reasonable to me.
6. APPENDICES

6.1. THE ANALYTIC PROGRAM
begin comment : Integrated program for the dissection into morphemes and the construction of structural trees by Dr. W.A. Verloren van Themaet, R1436. This program has been executed on the computer X8 of the Mathematical Centre and combines the functions of the programs R1079 and R1173. The words to be treated by this program are allowed to contain capital and lower-case letters of the Latin alphabet, also with special signs, hyphens, apostrophes and full stops. The program contains two number-tapes. The first one is the lexicon, the second one the word-list. The word-list contains the words to be analysed. The lexicon is noted according to the instructions of section 2 of the report. The output is a structural tree of words according to the model described in section 1.1. of the report.

integer k, m, n, p, q, r, s, dic, dian, maxl, symbol, RETURN, mod4, KOLON, paket, woord, blokn, hoogte, ind3, tractk, letter, FIN, AP, EC, plaats, indn, indp, ind1, ind2, ebl, lem, leml, aff1, u, v, finit, FASE, P, Q, R, u1, OMK, predom, postdom, endom, regel;

boolean lex, SCHOON, CHANGE, NORMAAL, NASCHAK;

Integer array alv[120:127], revers[66:70], blok, WOORD[1:12], INDEX[1:12],7,7, begin[1:7,1:15], leieder[1:7,0:15], stanzahtog[2:7,1:15], tract, inf, sup, thblok, ublok, subj, kolon, una, lasta[1:15], diepte, ebl[0:15], LETTER[1:45], prod[0:8,1:4], affin[0:6,0:6], affix[0:6,3:19];

boolean array norma.a1[1:12], voorschak[0:6,0:3], naschak[0:3,0:6], suffix[0:3,0:4];

integer procedure nexttape;

begin integer heptad;
heptad:= RESYM;
nexttape:= if heptad < 120 V heptad > 127 then heptad else
alv[heptad]
end;

alv[126]:= 70; alv[127]:= 67; alv[120]:= 66; revers[70]:= 126;
revers[67]:= 127; revers[66]:= 120; dic:= dian:= paket:= 0;
mod4:= 3; SCHOON:= true;
BEGIN: symbol:= nexttape;
goto if symbol = 72 then COUNT else BEGIN;
COUNT: symbol:= nexttape; if symbol < 76 then
begin if symbol = 118 v symbol = 119 v symbol = 135 then
begin dian:= dian + 1; mod4:= 3 end
else if symbol = 93 then
begin symbol:= read; if SCHOON then paket:= paket + 1;
SCHOON:= ~SCHOON
end
else if mod4 = 3 then
begin dian:= dian + 1; mod4:= 0 end
else mod4:= mod4 + 1; goto COUNT
end;
51  comment Leg de eerste band opnieuw in de bandlezer;
52  begin integer array DIC[1:dic], wodic, SYNTAX[1:dic + 1],
53    PAKET[1:paaket];
54
56  procedure PUCAS(m); integer m;
57    begin integer p, q, s;
58      s := Instma[m];
59      for q := una[m] step 1 until s do
60        begin p := LETTER[q];
61          if p < 66 \ p > 70 then PUSYM(p) else PUSYM(revers[p])
62        end;
63
66  integer procedure eind(n, k); integer n, k;
67    eind := begin[n,k + 1] - 1;
68
80  procedure notind(n, k); integer n, k;
81    begin integer nk, IND1, IND2, IND3, IND4;
82      if begin(n,k) = eind(n, k) then
83        begin nk := begin[n,k]; IND3 := INDEX[nk,3]; IND4 := INDEX[nk,4]
84          end
85      else
86        begin IND3 := 2; IND4 := INDEX[leider[n,k],4] end;
87      IND1 := INDEX[begin[n,k],1]; IND2 := INDEX(eind(n,k),2);
88      ABSFIXP(5, 0, 10000 × IND1 + 1000 × IND2 + 10 × IND3 + IND4)
89    end;
92  boolean procedure dom(A, B, m); value A, B, m; integer A, B, m;
93    begin integer C;
94      C := A;
95      if diepte[C] < m then
96        begin Dom := if B = 3 then true else false end
97      else
98        begin C := subj[C]; goto D end
99      end;
102  integer procedure len(n); integer n;
103    begin integer REST;
104      REST := DIC[wodic[n + 1] - 1];
105      len := (if REST < 8100 then (if REST < 90 then 1 else 2)
106        else if REST < 729000 then 3 else 4) + (wodic[n + 1] -
107          wodic[n] - 1) × 4
108    end;
111  integer procedure pekt;
112    begin Integer PAK0;
procedure VALIND(k); value k; integer k;
begin integer m, PAK;
integer array PAK[1:3];
PAK[1]:= PAK[1]: 800; PAK[2]:= PAK[2]: 200;
PAK[3]:= PAK[3]: 10; INDEX[k,1]:= PAK[1];
INDEX[k,2]:= PAK[2] - 4 * PAK[1];
INDEX[k,3]:= PAK[3] - 20 * PAK[2];
end;

integer procedure bblok(k); integer k; bblok := eblock[k - 1] + 1;
k := m := n := 0; mod4 := 3; wodic[dict + 1] := dict + 1;
SYNTAX[dict + 1] := 2 * packet + (if SCHOOON then 1 else 0);
SCHOOON := true;
SKIP: symbol := nexttape;
goto if symbol = 72 then ASSIGN else SKIP;
ASSIGN: symbol := nexttape; if symbol = 76 then
begin if SCHOOON then PAKET[n] := PAKET[n] X 4000 end
else
begin if symbol = 118 V symbol = 119 V symbol = 135 then
begin lex := true; m := m + 1; wodic[m] := k + 1; mod4 := 3 end
else if symbol = 93 then
begin if SCHOOON then n := n + 1; p := read; ind1 := p : 10000;
ind2 := p : 10000 - 10 * ind1;
PAKET[n] := REMAINDER(p, 1000) + 200 * ind2 + 800 * ind1 +
(if SCHOOON then 0 else PAKET[n] X 4000); if lex then
begin SYNTAX[m] := 2 * n - (if SCHOOON then 1 else 0);
lex := false
end;
SCHOOON := 1SCHOON
eend; eblock := eblock[k - 1] + 1;
end if mod4 = 3 then
begin Mod4 := 0; k := k + 1; DIC[k] := symbol end
else
begin mod4 := mod4 + 1; DIC[k] := DIC[k] X 90 + symbol end;
goto ASSIGN
end;
maxl := len(dict);
begin integer array ewl[0:maxl], bwl[1:maxl];
switch SIND := IND0, IND1, IND2;
switch INDAF := AFF0, AFF1, AFF2;
switch Prevent := P100, P101, P110, P111, P000, P001;
switch SINK := U0, U1, U2;
integer procedure soort(n); value n; integer n;
begin integer p;
p:= LETTER[n];
soort:= if p < 10 then 2 else if p = 66 ∨ p = 65 then 3
else if p = 88 then 4 else 1;
end;

boolean procedure sl(m, n); integer m, n;
sl:= (if m = 1 then true else soort(m - 1) = 3) ∧ (if n = letter then true else soort(n + 1) = 3);

procedure Meq(m, n); integer m, n;
begin integer p, q, r, F, G, R, s, AD, snee, rest, divid,
last, u, MEQ, morfeem;
morfeem:= n + 1 - m;
if morfeem > maxl then MEQ:= 0 else if bw[l[morfeem] = 0
then MEQ:= 0 else
begin divid:= morfeem : 4; last:= divid × 4;
rest:= morfeem - last; snee:= divid + sign(rest);
begin integer array SNEE[1:snee];
integer procedure SEQ(p); integer p;
begin integer q;
q:= 1; s:= wodic[p];
P:= AD:= sign(SNEE[q] - DIC[s + q - 1]);
if AD ≠ 0 then SEQ:= AD else if q = snee then
SEQ:= 0 else
begin q:= q + 1; goto F end
end;
for q:= 1 step 1 until divid do
begin u:= 4 × q + m - 1;
SNEE[q]:= LETTER[u + 3] × 729000 + LETTER[u + 2]
× 8100 + LETTER[u + 1] × 90 + LETTER[u]
end;
if rest ≠ 0 then
begin SNEE[snee]:= 0;
for q:= last + 1 step 1 until morfeem do
SNEE[snee]:= 90 ∧ (morseem - q) × LETTER[m + q -
1] + SNEE[snee]
end;
p:= bw[l[morfeem]]; r:= ew[l[morfeem]]; P:= SEQ(p);
R:= SEQ(r);
G:= if r < p + 1 then MEQ:= if P = 0 then p else if
k = 0 then r else 0 else
begin q:= (p + r) : 2; q:= SEQ(q);
if Q = 0 then MEQ:= q else if Q = - 1 then
begin r:= q; goto G end
else
begin p:= q; goto G end
end

procedure lv(m, n); value m, n; integer m, n;
if n < m then lv:= 0 else
begin integer q, t, v-; w, vms, wms, wo;
switch vms:= vms0, vms1, vms2, vms3, vms4, vms5, vms6, vms7, vms8;
procedure goback; if m = v then lv:= 0 else
begin v:= v - 1; goto k end;
q:= m + max1 - 1; v:= n;
k: t:= m; vms:= soort(m);
w: if t = n then
begin if vms = 4 then goto vms4 end;
begin t:= t + 1; vms:= prod[vms, soort(t)]; goto w end;
wo:= letter[n];
if wo > 66 \ wo < 75 then ms:= 0 else goto ms[vms[vms + 1]]; vms0 ms:= 0; goto end;
vms1: ms:= 1; goto end;
vms3: ms:= if m = n then 3 else 0; goto end;
vms4: ms:= 0; goto end;
vms2:
vms5: ms:= if (if m = 1 then true else letter[m - 1] = 65) \ (if n = letter then true else letter[n + 1] = 65)
then 2 else 0; goto end;
vms6: ms:= if soort(m) = 3 \ soort(n) = 3 then 0 else 1;
goto end;
vms7: ms:= if mal(m, n) \ soort(n) = 4 then 0 else 2;
goto end;
vms8: ms:= if mal(m, n) \ letter[m] = 88 then 0 else 2;
end:
if woord[woord] = 0 then goback else lv:= v
begin if v > q then goback else
begin meq(m, v);
end:
end;
procedure positie;
begin integer meq, synt1, synt2, test1, test2;
meq:= woord[woord]; trak: synt2:= syntax[meq + 1] - 1;
if \( p = 0 \) then \( trakte := synt2 := synt2 - 1; \)
\[
\begin{align*}
\text{for } & trakte := synt2 - 1 \text{ step } -1 \text{ until } synt1 \text{ do} \\
\text{begin } & \text{VALIND(woord); test1 := INDEX[woord,1];} \\
\text{test2 := INDEX[woord,2]; if test1 + ind1 then ind1 := 0;} \\
\text{if } & \text{test2 \times ind2 = 6 then ind2 := 2 else if test2 \times ind2} \\
\text{then ind2 := 0.} \\
\end{align*}
\]

procedure close; if finit \(<\) woord then
\[
\begin{align*}
\text{begin } & \text{if } \text{tract[fini]} = \text{sup[fini]} \text{ then} \\
\text{begin } & \text{init := init + 1; if init \# woord + 1 then} \\
\text{if } & \text{inf[fini]} = \text{sup[fini]} \text{ then goto A} \\
\text{end.} \\
\end{align*}
\]

procedure transform(change); value change; integer change;
\[
\begin{align*}
\text{begin } & \text{FIN := FIN + 2; goto if } \text{FIN = 2 then G else BOOMBOUW} \\
\text{end.} \\
\end{align*}
\]

procedure structur(k, m); value k, m; integer k, m;
\[
\begin{align*}
\text{begin } & \text{integer } p, q, r, s, adj;} \\
\text{if } & k > m \text{ then goto END;} \\
\text{begin } & \text{boolean array klaar[k:m];}
\end{align*}
\]
for p := k step 1 until m do klaar[p] := false; p := k;
q := m;
if p < m then
begin integer r, indp, afp, pl, indr;
boolean INDP;
p1 := INDEX[p + 1, k]; indp := INDEX[p, k];
subj[p] := p + 1; afp := affin[indp, pl];
INDP := indp = 1 \lor indp = 2;
for r := p + 1 step 1 until q do
begin indp := INDEX[r, k];
if indp = 0 \land r < m \land INDP then
begin for s := p step 1 until r - 1 do
begin if INDEX[s, k] = T \lor INDEX[s, k] = 2 then
adj := s
end;
subj[adj] := r
end
end
else if indp + 6 then
begin if affin[indp, indr] > afp then
begin subj[p] := r; afp := affin[indp, indr]
end
else
begin normal[r - 1] := normal[r] := false;
s := r + 1; NORMAAL := false;
if s > m then goto END
if INDEX[s, k] = INDEX[r - 1, k] then
begin subj[r - 1] := subj[r] := s;
structur(r + 1, s); p := s; goto G
end
else if s = m then CHANGE := false else
begin s := s + 1; goto H end
end
END:
90

procedure compl(n, k, m); value n, k, m; integer n, k, m;
begin integer d, ACHTER, bauft, lpref, radik, ind1, lpref2,
begin, eind, leider, kern, aff, bsuff1, leider2, eind2,
test, test1, d2, p27;
integer array P27[1:5];

procedure mistest;
begintract\[\tau\]= tract\[\tau\];
--nr LEI'TER\[\tau\]
lasta\[\tau\]- 1 } +
IPakt = 1+6
I\!E:rrER\[unua\[\tau\]\]=29 then transform(\tau)
end;

procedure optimum;
beginnerger aff2, lpref2, subkern;
  subkern:= subj\[kern\]; if subkern = 0 then goto Y;
  lpref2:= INDEX\[subkern,3]\;
  aff:= affix[INDEX\[kern,4\],lpref2];
  tractk:= tract\[kern\];
  X: if tractk \# sup\[kern\] then
  begin tractk:= tractk + 1; VALIND(kern);
  if INDEX\[kern,3\] \# 2 then goto X else
  begin aff2:= affix[INDEX\[kern,4\],lpref2];
  if aff2 = aff then
  begin aff:= aff2; tract[kern]:= tractk end;
  goto X
  end
  end
  Y:
  if subj\[begin\]= 0 then
  begin CHANGE:= false; goto END end
  goto END
  end;

procedure P27op;
begin for d:= p27 step - 1 until 1 do
  begin begin:= P27[d]; indl:= INDEX\[begin,3\]; aff:= 0;
  eInd:= begin + 1;
  if INDEX\[eind,4\] = 7 then eind:= subj\[eind\];
  if INDEX\[eind,4\] = 7 then subj\[begin\]:= eind;
  lpref:= affix[eind2,indl]; if lpref \> aff then
  begin subj\[begin\]:= eind; aff:= lpref end
  end
  goto END
  end;

procedure terugschuif;
begin if \!d\!\!:= begin - 1; if INDEX\[d,4\] = 7 then
begin begin:= d;
goto if begin = k then (if m = eind then gesloten
else openeind) else J
end

begin CHANGE:= true; P27:= 0; if k = m then
begin b1lok[in]:= m; goto END end;
If k > m then goto END;
for d:= k step 1 until m do
begin subj[d]:= 0 end;
lpref:= k;
if INDEX[lpref,3] > 2 then
begin if INDEX[lpref,4] = 7 then
begin p27:= p27 + 1; P27[P27]:= 1pref end;
lpref:= 1pref + 1; goto F
end
else lpref:= 1pref - 1; bsuff:= m;
G: if INDEX[bsuff,3] = 2 then bsuff:= bsuff + 1 else
begin bsuff:= bsuff - 1; goto G end;
kern:= bsuff - 1;
goto (ksign(2 - INDEX[k,3]) * 2 - sign(INDEX[m,3] - 2)
* sign(INDEX[m,3] - 2) + 1);
lpref2:= INDEX[bsuff,3];
leider2:= INDEX[bsuff - 1,4];
if bsuff1 > 2 \wedge affix[leider2,bsuff1] \neq 0 then goto H
else if bsuff1 = 0 then
begin if voorschak[leider2,INDEX[bsuff,4]] \wedge
affix[leider2,INDEX[lpref,3]] \neq 0 then
begin for d:= k step 1 until m do
begin subj[d]:= 0 end;
begin:= lpref + 1; leider:= eind:= bsuff - 1;
structur(begin, eind);
open: terugschuif; leider2:= INDEX[leider,4];
test:= eind + 1; eind2:= INDEX[test,4];
lpref2:= INDEX[test,3];
if lpref2 > 2 then ACHTER:= affix[leider2,lpref2]
else if voorschak[leider2,eind2] then
begin if test = m then
begin subj[m]:= leider; goto openbegin end
else if suffix[eind2,INDEX[eind + 2,4]] = 0 then
begin subj[test]:= leider; eind:= test; goto open end
end
else ACHTER:= 0
end;
d[begin - 1; aff:= affix[leider2,INDEX[d,3]]];
if ACHTER + aff = 0 then transform(d) else if aff
> ACHTER \lor (aff > 0 \wedge leider2 = 3) then
begin begin:= d; subj[leider]:= begin;
leider:= begin; if begin \neq k then goto open
end
end
else
begin mistest; eind:= test; subj[leider]:= eind;
leider:= eind;
goto if m = eind then openbegin else open end;
openeind: test:= eind + 1; eind2:= INDEX[test,4];
leider2:= INDEX[leider,4]; lpref2:= INDEX[test,3];
if lpref2 > 2 then
begin if affix[leider2,lpref2] = 0 then
transform(eind) else
begin mistest; eind:= test; subj[leider]:= eind;
leider:= eind;
goto if m = eind then gesloten else openeind
end
end
else if voorschak[leider2,eind2] then
begin if test = m then
begin subj[m]:= lblok[n]:= leider; P27op end
else if suffix[eind2,INDEX[eind + 2,4]] then
begin subj[test]:= leider; eind:= test;
goto openeind
end
else transform(eind)
end;
openbegin: terugschuif;
if affix[INDEX[leider,4],INDEX[begin - 1,3]] = 0
then transform(m) else
begin begin:= begin - 1; subj[leider]:= begin;
leider:= begin; if begin + k then goto openbegin
end;
gesloten: lblok[n]:= leider; optimum; P27op
end
else
begin compl(n, k, bsuff - 1); leider:= lblok[n]; d:= bsuff;
if CHANGE then
begin CHANGE:= true; goto H end;
L: leider2:= INDEX[leider,4]; d2:= INDEX[d,4];
lpref2:= INDEX[d,3]; if lpref2 > 2 then
begin aff:= affix[leider2,lpref2];
if aff = 0 then goto H else
begin subj[leider]:= d; if d = m then
begin lblok[n]:= m; optimum; P27op end
else
begin leider:= d; d:= d + 1; goto L end
end
end
else if voorschak[leider2,d2] then
begin if d = m then
begin subj[m]:= lblok[n]:= leider; optimum; P27op
end
else if suffix[d2,INDEX[d + 1,4]] then
begin subj[d]:= leider; d:= d + 1; goto L end

if d < lpref then
begin if INDEX[d,4] < 7 then
begin subj[d + 1]:= d end;
d:= d + 1; goto B end;  
radik:= lpref + 1; indl:= INDEX[1pref,4];
C: aff:= affix[INDEX[radik,4],INDEX[1pref,3]];  
if aff + 0 then
begin if indl < 7 then
begin subj[radik]:= lpref; 1pref2:= INDEX[1pref,3] end end;
else if radik = m then
begin block[n]:= m; CHANGE:= false; goto END end

begin radik:= radik + 1; goto C end;
structur(lpref + 1, radik); 1pref2:= d:= radik + 1;
D: if d = m + 1 then
begin if lpref2 < m then 1pref2:= m;
structur(lpref2 + 1, m); structur(lpref + 1, 1pref2);
if indl < 7 then
begin subj[1pref2]:= 1pref end;
if 1pref2 < m then
begin subj[1pref]:= m end;
for p:= k step 1 until m do
begin if subj[p] = 0 \ INDEX[p,4] < 7 then
begin block[n]:= p; optimum; P2top end end;
end end;
else

begin if affin[indl,INDEX[d,4]] >
affin[indl,INDEX[1pref,4]] then 1pref2:= d; d:= d + 1;
goto D end;

end;

begin lblock[n]:= m; goto END;

link3m2:= bsuff:= INDEX[bsuff,3]; radik:= kern;
if bsuff1 = 0 then
begin lpref2:= INDEX[bsuff,4];
if voorschaak[INDEX[radik,4],lpref2] \ 
suffix[lpref2,INDEX[bsuff + 1,4]] then
begin subj[bsuff]:= radik; bsuff:= bsuff + 1;
goto link3m2
end;
end;

aff:= affix[INDEX[radik,4],bsuff]; if aff = 0 then
begin if tract[radik] + sup[radik] then transform(radik)
670     else transform(bsuff)
671             end
672     else
673             begin test:= bsuff; mistest; subj[radik]:= bsuff;
674                 tleider:= bsuff; lpref2:= INDEX[test,3]
675                     end;
676             test1:= bsuff;
677             for test:= bsuff + 1 step 1 until m do
678                 begin
679                     if INDEX[test,3] = 0 then
680                         begin subj[test]:= test - 1 end
681                     else
682                         begin if affix[INDEX[test1,4],INDEX[test,3]] ≠ 0 then
683                             begin mistest; subj[test1]:= test end
684                             else if tract[test1] ≠ sup[test1] then
685                                 transform(test1) else transform(test); test1:= test
686                     end
687                     end;
688             end;
689             end;
690             indp:= INDEX[bsuff,4];
691             for test:= bsuff - 2 step - 1 until k do
692                 begin
693                     aff:= affin[INDEX[test,4],indp] =
694                     affin[INDEX[test,4],INDEX[radik,4]]; afp1:=
695                     if aff > 0 ∨ (aff = 0 ∧ affin[INDEX[test,4],indp] >
696                     affin[INDEX[test,4],INDEX[test + 1,4]]) then radik:=
697                     test
698                 end;
699             subj[radik]:= bsuff; structur(radik + 1, bsuff - 1);
700             struct(k, radik - 1); if radik > bblock(n) then
701                 begin subj[radik - 1]:= r if affin[INDEX[radik -
702                     1,4],INDEX[radik,4]] ≥ affin[INDEX[radik -
703                     1,4],INDEX[bsuff,4]] then radik else bsuff
704                     end;
705             end;
706             lblock[n]:= m; optimum;
707             END:
708             end;

709     integer procedure maxaffin(p, r); value p, r; integer p, r;
710     begin integer indp, q, MAX;
711     indp:= INDEX[lblock[p],4]; indr:= INDEX[lblock[r],4];
712     if INDEX[bblock(r),3] > 2 then
713     begin MAX:= lblock[r]; afp1:= affin[indp,INDEX[MAX,4]]; MAXaffin:= MAX
714     end
715     else
716     begin MAX:= bblock(r); afp1:= affin[indp,INDEX[MAX,4]]; afp:=
717     for q:= bblock(r) + 1 step 1 until thbblock[r] do
718     begin if affin[indp,INDEX[q,4]] > afp then
719         begin MAX:= q; afp:= affin[indp,INDEX[q,4]] end
720     end;
721     MAXaffin:= MAX
722     end
723     end
procedure macrostructur(k, m); value k, m; integer k, m;
begin if k < m then goto END;
begin integer p, q, r, s, adj, MAX;
boolean array klaar[k:m];
for p:= k step 1 until m do klaar[p] := false; p:= k;
q:= m;
0: if p < m then
begin integer r;
reg[p]:= p + 1; subj[lblok[p]]:= maxaffin(p, p + 1);
afp:= afp1;
for r:= p + 1 step 1 until q do
begin
indr := INDEX[lblok[r],4];
end
if indr = 0 then for s:= p step 1 until r - 1 do
begin if INDEX[lblok[s],4] = 1 then
adj:= s;
subj[lblok[adj]]:= lblok[r]; reg[adj] := r
end
if indr = 6 then
begin if INDEX[lblok[r],3] > 2 then
begin if affin[indp,indr] > afp then
begin reg[p]:= r; subj[lblok[p]] := lblok[r];
afp:= affin[indp,indr]
end
end
end
end
begin MAX:= maxaffin(p, r);
if affin[indp,INDEX[MAX,4]] > afp then
begin reg[p]:= r; subj[lblok[p]] := MAX;
afp:= afp1
end
end
begin normal[lblok[r - 1]] := normal[lblok[r]] := false; s:= r + 1; NORMAL:= false;
if s > m then goto END;
H: if INDEX[lblok[s],4] = INDEX[lblok[r - 1],4]
then
begin reg[r - 1]:= reg[r]:= s;
subj[lblok[r - 1]] := subj[lblok[r]] := s;
microstructur(r + 1, s); p:= s; goto G
end
else if s = m then CHANGE:= false else
begin s:= s + 1; goto H end
end
end
end
klaar[reg[p]] := klaar[p] := true;
microstructur(p + 1, reg[p]); p:= reg[p];
if p = m then goto END else
begin q := p + 1;
if klaar(q) then r := q else if q = m then r :=
0
else
begin q := q + 1; goto A end
end

q := if r = 0 then m else r; goto G

for k := 0 step 1 until 8 do
begin
for m := 1 step 1 until 4 do prod[k,m] := 0 end;
prod[1,1] := 1; prod[2,2] := 2;
prod[1,4] := prod[7,1]; prod[7,4] := 7;
end;

for k := 0 step 1 until 6 do
begin
for m := 3 step 1 until 19 do affix[k,m] := 0 end;
affix[0,10] := affix[0,11] := affix[4,2] := 1;
end;

for k := 2, 4, 5 do
begin
for m := 13 step 1 until 19 do affix[k,m] := 1 end;
affix[0,18] := affix[1,19] := 2;
affix[3,19] := 3;
affix[3,18] := 6; affix[0,14] := 7;
end;

for k := 0 step 1 until 6 do
begin
for m := 0 step 1 until 6 do affin[k,m] := 0 end;
affin[6,6] := 1;
affin[0,1] := affin[1,0] := affin[1,1] := affin[3,0] :=
end;

for k := 0 step 1 until 6 do
begin
for m := 0 step 1 until 3 do voorschak[k,m] := false end;
voorschak[0,0] := voorschak[1,0] := voorschak[3,0] :=
voorschak[4,0] := voorschak[0,1] := voorschak[1,1] :=
voorschak[2,1] := voorschak[3,1] := voorschak[0,2] :=
voorschak[5,2] := voorschak[0,3] := true;
end;

for m := 0 step 1 until 3 do
begin
for n := 0 step 1 until 6 do naschak[m,n] := false end;
neschak[0,0]:= neschak[0,1]:= neschak[0,3]:= neschak[1,0]:= neschak[1,1]:= neschak[1,3]:= neschak[2,0]:= neschak[2,1]:= neschak[3,0]:= neschak[3,1]:= true;
for m:= 0 step 1 until 3 do
    begin for n:= 0 step 1 until 4 do suffix[m,n]:= false end;
for m:= 0, 2 do
    begin for n:= 0, 3, 4 do suffix[m,n]:= true end;
for m:= 0 step 1 until dicn do
    begin
        q:= 
        r:= len(p); s:= r - 1; if q != r then
            begin for m:= q + 1 step 1 until s do bwl[m]:= ewl[m]:= 0; 
                bwl[r]:= p; ewl[q]:= p - 1
            end;
    end;
for k:= 1 step 1 until 8 do
    begin
        leider[k,0]:= 0; begin[k,1]:= 1 end;
for k:= 1 step 1 until 15 do begin[7,k]:= leider[7,k]:= k;
len[1]:= begin[1,1]:= k;To[letter]:= 
letter:= FIN:= 0; woord:= 1;
AB: symbol:= nexttape;
if symbol = 76 then EXIT else if symbol = 93 V symbol = 118 
V symbol = 119 V symbol = 135 then RETURN:= if RETURN = 0 
then 1 else 3 else 
begin letter:= letter + 1; LETTER[letter]:= symbol; goto AB 
end;
begin r:= 1v(1, letter); woord:= 1;
L: if r = 0 then
begin FIN:= 2; lasta[1]:= letter; goto BOOMBOUW end
else lasta[1]:= r; positie:= if r = letter then 
begin if ind2 < 2 V indl < 2 then
begin woord := 1; goto SUBJAS end
else begin r:= 1v(1, letter - 1); goto L end
end;
begin if indl > 1 then
begin r:= 1v(1, r - 1); goto L end
else woord:= 2;
M: EC:= lasta[woord - 1] + 1; AP:= LETTER(EC);
q:= unusal[woord]:= EC + (if AP = 65 V AP = 66 V AP = 70 
then 1 else 0); lasta[woord]:= r:= 1v(q, letter);
F: if r = 0 then goto G else
begin positie:= if letter = r then 
begin if ind2 > 1 then 
begin r:= 1v(q, letter - 1); goto F end 
else goto SUBJAS 
end
else
begin if ind2 = 1 V ind1 = 1 then
begin r:= lv(q, r - 1); goto F end
else
begin lasta[woord] := r; woord:= woord + 1; goto M
end
end
end

end

G; FIN:= 0; woord:= woord - 1; q:= unua[woord];
if woord = 1 then
begin r:= lv(1, lasta[woord] - 1); goto L end
else
begin r:= lv(q, lasta[woord] - 1); goto F end;
i
SUBJAS: lasta[woord]:= letter; finit:= 1;
for m:= 1 step 1 until woord do sub[m]:= 0;
for k:= 1 step 1 until woord do
begin inf[m]:= SYNT.AX[wort]; sup[k]:= SYNT.woord; ao
end;
end;
fin:= 0;
form:= 1 step 1 until woord do
subj[m]:= O;
for k:= 1 step 1 until woord do
begin
tract[k]:= inf[k];
end;
Close;
in:
for u:= k step 1 until woord do
begin
if pakt = 0 then sup[k]:= tract[k] - 1
end;
end;
end;
end;
end;

K: for u:= k step 1 until woord do
begin tract[k]:= tract[u]:= thr[u]; VALIND(u) end;
close;
end;

PP: if INDEX[1,1] = 2 then transform(1);
if INDEX[woord,2] > 1 then transform(woord); k:= 1;
for u:= 1 step 1 until woord - 1 do
begin if INDEX[u,2] = 1 then transform(u) else if INDEX[u,2] = 3 then
begin aff1:= LETTER[unua[u + 1]];
if (aff1 = 10 V aff1 = 14 V aff1 = 18 V aff1 = 24 V
aff1 = 30 V aff1 = 34) \ INDEX[u + 1,1] = 2 \ INDEX[u
+ 1,3] = 2 then else transform(u)
end
end;
for u:= 2 step 1 until woord do
begin if INDEX[u,1] = 1 then Transform(u) end;
for u:= 1 step 1 until woord do normaal[u]:= true;
MALM:= true; aff1:= 0;
M4: ebil:= eblok[k]; aff1:= aff1 + 1; FASE:= 0;
if k = 1 then goto QO else if eblok[k -1] = woord then
begin blok:= k -1; goto S end
else
QQ: end
begin
K: lem:= INDEX[aff1,3];
go to if lem > 2 then IND3 else SIND[lem + 1]
end;

AFFO:

AFF1:= transform(p);
AFF3: if INDEX[p,1] = 2 then transform(p) else

begin eblock[k] := p; p := p + 1; goto LL end;

AFF2: aff1 := p; goto K;

IND0: compl(k, bblock[k], thblock[k]);

if (bblock[k] == eblock[k] ∧ INDEX[eblock[k],3] + 2) ∨ aff1 = word then transform(aff1) else if

voor(err, INDEX[lblock[k],4], INDEX[aff1,4]) then

begin if traint[aff1 - 1] = sup[aff1 - 1] then transform(aff1)

else transform(aff1 - 1)

end

else

begin subj[aff1] := lblock[k]; eblock[k] := aff1; u := aff1 + 1;

u1 := INDEX[u,3] + 1; if u1 > 3 then

begin if INDEX[u,1] = 2 then

begin if suffix(INDEX[aff1,4], INDEX[u,4]) then

begin aff1 := u; goto IND3 end

else transform(u)

end

else goto MW

end

else goto SCHAK[u1]

end;

U0:

U1: transform(aff1);

U2: k := k + 1; goto MW;

IND1: if aff1 > ebl then

begin compl(k, bblock[k], thblock[k]);

begin subj[aff1] := lblock[k]; eblock[k] := aff1;

if FASE < i then

begin FASE := FASE + 2 end

else transform(aff1); if aff1 = word then

begin aff1 := aff1 + 1;

if INDEX[aff1,3] = 1 then transform(aff1) else

goto K

end

else

else transform(aff1);

end

else transform(aff1); goto RR;

IND3: if INDEX[lblock,1] + 2 then

begin if aff1 + 1 then k := k + 1; lblock[k] := aff1;

p := aff1 + 1; FASE := 1;

LL: if p > word then transform(word) else

begin indp := INDEX[p,3] + 1;

goto if indp > 3 then AFF3 else INDAF[indp]

end

else

else if aff1 ≠ ebl then

begin if FASE > 3 then transform(aff1) else

begin FASE := 3 end;

end

else if aff1 < word then
begin aff1 := aff1 + 1; goto K end
end;
goto RR;  
if FASE > 1 then
begin eblock[k]:= aff1 - 1; if aff1 > 1 then k:= k + 1;
  thblock[k]:= eblock[k]; lblock[k]:= aff1;
  if aff1 = woord then
    begin aff1 := aff1 + 1; goto K end
end;

---nID2:
if FASE > 1 then
begin eblock[k]:= aff1 - 1;
  if aff1 > 1 then
    k := k + 1;
  enbok[k]:= eblok[k];
  eblok[k]:= a.ffl T;
  if a.ff1 = woord then
    begin
      a.ff1:= a.ff1+1;
      goto K
    end
  else
    begin
      eblock[k]:= eblok[k];
      FASE:= FASE + 2;
    end
end;

RR: if eblock[k] < woord then
begin k:= k + 1; goto MM end
else blokn:= k;
for m:= 1 step 1 until blokn do
begin compl(m, bblock[m], thblock[m]);
if CHANGE then transform(thblock[m]);
if thblock[m] < eblok[m] then
begin subj[eblok[m]]:= lblock[m] end;
if INDEX[eblok[m],3] = 0 then
begin NASCHAK:= true;
  For k:= m + 1 step 1 until blokn do
    begin compl(k, bblock[k], thblock[k]);
      if CHANGE then transform(thblock[k]);
    end
  if NASCHAK then transform(thblock[blokn])
end;
if CHANGE then
begin k:= eblock[m];
if k = woord + 1 then transform(woord) else
if tract[k] = sup[k] then
  begin k:= k + 1; goto B end
else
  begin tract[k]:= tract[k]:= tract[k] + 1; VALIND(k);
    if finit = woord + 1 then
      begin FIN:= FIN + 2; goto BOXBOUW end;
      close; k:= k + 1; goto N end
end;

FIN:= 1; macrostructur(1, blokn);
for k:= 1 step 1 until blokn do
begin for mi:= bblock[k] step 1 until eblock[k] do blok[m]:= k end;
BOXBOUW: if FIN = 2 then
begin lasta[1]:= letter; if regel > 52 then
begin for k:= regel + 1 step 1 until 71 do PUNLCR;
regel:= 5
end;
PUNLCR; PUNLCR; PUNLCR; regel:= regel + 3; PUTEXT("niet onleesbaar");
PUCAS(1); PUTEXT("niet onleesbaar");
end
else if FIN ≠ 0 then
begin hoogte:= 1;
for k:= 1 step 1 until woord do
begin if subj[k] ≠ 0 then
begin leider[1,1]:= k; diepte[k]:= 1 end
else diepte[k]:= 20
end;
end;
lem:= 1; begin[1,2]:= woord + 1;
SS: if lem < woord then
begin leider[hoogte,lem + 1]:= woord + 1;
hoogte:= hoogte + 1; lem:= 0;
for n:= 1 step 1 until lem do
begin CM:= leider[hoogte - 1,n];
predom:= endom:= postdom:= 0;
for k:= leider[hoogte - 1,n] + 1 step 1 until CM - 1 do
begin if subj[k] = CM then goto POSTDOM end;
if normal[k] then goto POSTDOM else
begin for k:= predom + 1 step 1 until CM - 1 do
begin if subj[k] = CM ∧ normal[k] then
begin endom:= k; goto POSTDOM end
end
end
end;
POSTDOM: for k:= CM + 1 step 1 until leider[hoogte - 1,n + 1] - 1 do
begin if subj[k] = CM then postdom:= k end;
goto for: predom:= sign(premto) × 4 + sign(endom) × 2 + sign(postdom) + 5;
P101: if blok[predom] = blok[CMK] ∧
(INDEX[postdom,3] > 2 ∧ INDEX[CMK,3] > 2) then
goto P001;
P001: lem1:= lem1 + 2;
leider[hoogte,lem1 - 1]:= predom;
leider[hoogte,lem1]:= CMK; diepte[predom]:= hoogte;
goto verhoog;
P117: if blok[predom] = blok[CMK] ∧
(INDEX[postdom,3] > 2 ∧ INDEX[CMK,3] > 2) then
goto P001;
P116: lem1:= lem1 + 3;
leider[hoogte,lem1 - 2]:= predom;
leider[hoogte,lem1 - 1]:= endom;
leider[hoogte,lem1]:= CMK;
diepte[predom]:= diepte[endon]:= hoogte;
goto verhoog;
POO: lem1:= lem1 + 2;
leider[hoogte,lem1 - 1]:= CMK;
leider[hoogte,lem1]:= postdom;
diepte[postdom]:= hoogte; goto verhoog;
POO: lem1:= lem1 + 1; leider[hoogte,lem1]:= CMK;
verhoog:
end;
begin[hoogte,lem1 + 1]:= leider[hoogte,lem1 + 1]:= 
woord + 1; lem:= lengte[hoogte]:= lem1; goto SS
end;
for m:= 2 step 1 until hoogte do
begin for n:= 2 step 1 until lengte[m] do

if R = P + 1 then

begin Q:= (P + R) ; 2;

if dom(Q, leider[m,n - 1], m) then P:= Q else

R:= Q; goto TT

end
end
end;
for m:= 2 step 1 until hoogte - 1 do
begin
k:= 1;
for n:= 1 step 1 until lengte[n] do

begin if diepte[leider[m,n]] < m then

begin naasthoger[m,k]:= begin[m,n]; k:= k + 1 end

end;
naastrhoger[m,k]:= woord + 1
end;
end;
BLANK XXII: if regel + 4 x hoogte > 58 then
begin for k:= regel + 1 step 1 until TT do PUNLCR;
regel:= 5
end;
PUNLCR; PUNLCR; PUNLCR; regel:= regel + 3;
for k:= 1 step 1 until woord + 1 do
begin for m:= begin[hoogte,k] step 1 until end[hoogte, k] do
begin PUCAS(m);
symbol:= lasta[end[hoogte,k]] -
unu[begin[hoogte,k]] + 1;
kolon[k + 1]:= kolon[k] + symbol ; 8 + (if
REMAINDER(symbol, 8) = 7 then 2 else 1)
end;
PUNIM(118)
end;
for m:= begin[hoogte,woord] step 1 until end[hoogte,
woord] do PUCAS(m); PUNLCR; regel:= regel + 1;
begin
if kolon[m - 1] + 2 step 1 until kolon[m] do
PUSYM(118); notind(hoogte, m)
end;
end
if NORMAAL then
begin PUNLCR; regel := regel + 1;
if normaal[1] then PUTEXT(\normaal) else PUTEXT(\koppel);
for m := 2 step 1 until woord do
begin symbol := kolon[m] - kolon[m - 1] - (if normaal[m - 1] then 1 else 0);
for ki := 1 step 1 until symbol do PUSYM(118);
if normaal[m] then PUTEXT(\normaal) else PUTEXT(\koppel);
end
end
FUNLCR; regel := regel + 1;
for k := 2 step 1 until kolon[leider[hoogte - 1,1]] do
PUSYM(118); if begin[hoogte - 1,2] # 2 then PUTEXT(\leider);
for m := 2 step 1 until lengte[hoogte - 1] do
begin for ki := kolon[leider[hoogte - 1,m - 1]] + 1 step 1
until kolon[leider[hoogte - 1,m]] do PUSYM(118);
if begin[hoogte - 1,m] # eind[hoogte - 1, m] then
PUTEXT(\leider);
end
end
for n := hoogte - 1 step 1 until 2 do
begin FUNLCR; FUNLCR; regel := regel + 2;
for k := 1 step 1 until lengte[n] - 1 do
begin indn := begin[n,k]; plants := eind[n, k];
KOLON := kolon[indn];
for m := indn step 1 until plants do PUCAS(m);
symbol := last[plants] - uns[indn] + 1;
KOLON := KOLON + symbol : 8 + (if REMAINDER(symbol, 8) = 7 then 1 else 0);
for m := KOLON + 1 step 1 until kolon[begin[n,k + 1]]
do PUSYM(118)
end;
end
for m := begin[n,lengte[n]] step 1 until eind[n, lengte[n]] do PUCAS(m); FUNLCR; regel := regel + 1;
notind(n, 1); KOLON := 3;
for k := 2 step 1 until lengte[n] do
begin if KOLON > kolon[begin[n,k]] then PUSYM(93) else
for E := KOLON step 1 until kolon[begin[n,k]] do
PUSYM(118); notind(n, k);
KOLON := kolon[begin[n,k]] + 2
end;
BLANK XXIII: if NORMAAL then
begin FUNLCR; regel := regel + 1;
if normaal[leider[n,1]] then PUTEXT(formaal); else PUTEXT(koppel); for m:= 1 step 1 until lengte[n,1] do
  begin
    symbol:= kolon[begin[n,m]] - kolon[begin[n,m - 1]] - (if normaal[leider[n, m - 1]] then 1 else 0); for k:= 1 step 1 until symbol do PUSYM(118); if normaal[leider[n,m]] then PUTEXT(formaal); else PUTEXT(koppel); end;
end;

end;
PUNLCR; regel:= regel + 1;
for k:= 2 step 1 until kolon[naasthoger[n,1]] do
PUSYM(118);
if begin[n,2] # begin[n - 1,2] then PUTEXT(kleider);
p:= q:= 1;
for k:= 2 step 1 until eind(n - 1, 1) do
  begin
    if k = begin[n, p + 1] then p:= q:= p + 1 end;
  for m:= 2 step 1 until lengte[n - 1] do
    begin
      for k:= kolon[naasthoger[n, m - 1]] + 1 step 1 until kolon[naasthoger[n, m]] do PUSYM(118);
p:= q:= p + 1;
    for k:= begin[n - 1, m] step 1 until eind(n - 1, m) do
      begin
        if k = begin[n, p + 1] then p:= p + 1 end;
      if p # q then PUTEXT(kleider); end;
end;
PUNLCR; PUNLCR; regel:= regel + 1;
for m:= 1 step 1 until woord do RUSAC(m); PUNLCR;
regel:= regel + 1; notind(1, 1)
end;
if RETURN = 1 V RETURN = 3 then goto LEES
end;
end.
end.
6.2. The word-list
(this precedes the lexicon, because the lexicon is adapted to the word-list, 5.)

postchecks abonnementsoverwaarden nationale gezondheidszorg
vooropstellen Nederlandse gezondheidszorg waaromheen
gesondheidsstoestand ziekenfondswegen wesenverzorging loonexplosies
vijfdagse ingrijpende landelijke huisartsenvereniging
angstaanjagend ziekenfondsen uitoefenen gezondheidszorg
Nederlanders artsstatus beëindiging omzetting verminderen
artsenberoep ziekenfondsen vergaande ziekenfondsen ziekenfondsen
gesondheidszorg bijverschijnselen gezondheidsstoestand
ziekenfondsen ziekenfondsen gezondheidszorg uiteindelijk
nationalisering beoefenaar werktijden uitoefening postacademicaal
onvermijdelijk overgangsverschijnselen internationaal langlopende
ontwapening meningsvorming ontwapening internationale
ontwapening halfjaarlijks loonverhogingen produktiviteit
werkgevers verplichtingen meerjarige loonovereenkomsten
vakbonden Westduitse afbeelden bedenken bedreigd kantonrechter
ontwapent rechtsvervolging provinciale veroordeeld onverbindend
strijdigheid mensenrechten plaatselijke provinciale verordeningen
navloeden mensenrechten ineenstorting bouwonderneming opblazen
regeringsteun gemeenschapshanden beleidsdaden werknemers
Amsterdamse misleidend Amsterdamse belangenspel Amsterdamse
Amsterdamse binnenstadsbeleid misgrepen goedvinden
Amsterdamse vertegenwoordiger architectuurmedewerker
opdrachtgever loonslaven opdrachtgever grachtenhuizen
regentenpaleis Amsterdamse stadsregenten Amsterdammers
koopmansstad bouwkunstige regentenarchitectuur bouwkundigen
monumentale koopliedenregenten grachtenhuizen culturele
bedillerijen dagelijkse culturele vreemdelingen landgenoten
culturele beursnoteringen stedebouwkundige welstandscommissies
Nederlandse stadsruimte ruilvoorwaarden ongevoelig vakbladen
zesenzeventig woonruimte winkelbedrijvigheid stede bouwers
bouwkunstige internationale winkelhuizen bestuursbeslissingen
stadsbouwmeester beleidsbeslissingen verwerkelijking
oorlogsvoorbereiding regeringsverantwoordelijkheid taakstelling
verkiezingen bekrachtigen veelzeggende verantwoordingsplicht
partijraadsvergadering Amsterdamse houdbaarheid
confessionalisme kiezelenstenen regentenmaatregel
vertegenwoordigers verwezenlijking vakbondspecialisten
besprekingen zwaargewichten overschatting invoering
aantrekkingskracht meningsverschillen opvolgingsvaten
regeringsleider vooruitstrevende doorslaggevende
verkiezingscampagne verkiezingen beinvloeden
presidentsverkiezingen verzorgingsstaat gelijkberechtigden
verkiezingscampagne bestrijders volksvertegenwoordigers
presidentsverkiezingen verkiezingen gouverneurszetels
verschuivingen verkiezingen verschuivingen tussenverkiezing
toomaangevende veranderingen belastingverhogingen verhoging
consultatiebureau buitenechtelijk onvermijdelijk verkiezingen
verkiezingen geloofsbriefen melkbedrijven voetklachten
sokkenfabrikanten voetartsen partijstromingen schoolgaande
diplomatenkinderen ziekenfondspatient ziekenfondspremie
6.3. The lexicon

<
\[ a 1097, 2030, \ d 20061, \ e 22000, 20011, 21013, 20040, \]
\[ n 22003, 21010, 21013, 21030, 21033, 20060, 20040, 20031, \ o 22001, \]
\[ r 20041, 20054, 20120, 22123, \]
\[ s 22002, 21010, 21011, 21031, 20141, 21154, \ t 21013, 20041, \]
\[ u 11020, \]
\[ ad 23110, \ af 24, 2033, \ ak 3020, \ al 23031, 24, 3020, \]
\[ an 23030, \ ap 3020, \ ar 23031, 23110, 3020, 20, \]
\[ as 20, \ at 23110, \ au 11024, \ az 3023, 3020, \ be 2163, \]
\[ co 2034, \ de 21013, 20061, 11021, \ eb 20, 23, \ eg 20, 23, \]
\[ el 20, \ el 23031, 20063, 20, \]
\[ en 22003, 21010, 21013, 21030, 21033, 20040, 20031, 20060, 26, \]
\[ ep 3020, \]
\[ er 20060, 20030, 20041, 20054, 3074, 11024, 23123, 3023, 3020, \]
\[ es 20030, 20, \ et 3023, \ ex 2025, 2097, \ ga 23, \ ge 2060, \]
\[ ha 11024, \ ho 11024, \ ie 20140, \ ig 20141, \]
\[ hj 20030, \ in 25, 20030, 21017, 23, \ is 23093, 20023, \]
\[ it 23090, \ iv 23061, \ iz 23093, \ ja 11024, \]
\[ je 20030, 20, \ ka 20, \ ke 20030, \ la 20, \ ma 20, \]
\[ me 11020, \ na 25, \ nd 20061, \ nu 24, \ of 1026, \]
\[ og 3020, 3023, \ om 25, 2083, \ on 2107, \ op 25, \]
\[ or 20060, 3020, \ os 23031, 20, \ pa 20, \ po 20, \]
\[ ra 20, 11023, \ re 20041, 2117, \ st 20041, 20054, \]
man 20, 3020, 3023,  mat 3020, 23, 21, 20, mee 24, 20, 
mel 3020,  men 3023, 11020,  mer 3020, 3023, 
mij 11020,  min 21, 23, 20,  mis 2107, 23, 21, 20,  mon 3022, 
mar 23030, 3021, 20,  nat 21,  nav 3020,  nee 11024, 
nem 3023,  not 3020, 3023,  oef 11024,  oer 3097, 
oma 20,  ons 11020, 20,  ont 2143,  ooi 20, 
oor 20, 2097,  oud 21,  pal 3020, 21,  par 3020, 3023, 
pat 20,  pel 23, 20,  pen 20, 23, 3020,  pre 2025, 
pro 2025,  ree 20,  rei 20, 23,  rek 23, 20,  rel 20, 23, 
rem 23, 20,  ren 23, 20,  rep 3020, 23,  rev 3023,  rij 20, 23, 
roe 20,  rom 3020,  rov 3023, 3020,  rui 20, 23, 
sar 23,  sel 2060,  sla 23, 20,  sok 20,  sta 23, 
sul 20,  tal 20, 3020, 3023,  tan 3023,  tat 23040, 
tel 23, 20, 3023,  ten 21013, 3020,  ter 3023, 3020, 25, 
tij 20,  tin 20,  toe 24,  tom 3023, 3020, 20, 
tor 20,  tri 2022,  tur 23060, 3023,  uil 20, 
ut 25, 23,  uur 20, 20160,  vak 20,  vee 20, 
ven 3020, 20,  ver 2183, 21, 3020,  vet 20, 21,  vin 20, 
vit 23,  vlo 20,  vol 21,  vor 3020, 
wel 24, 20,  wer 3023, 3020,  win 23,  zeg 23, 20, 
zef 3020,  zen 20,  zes 22,  zet 23, 20, 
zev 3023, 3020,  zie 23,  zin 20, 23,  zon 20, 23, 3020, 
aard 20, 23,  acht 22, 23, 20,  adem 20, 23,  ader 20, 
akst 20,  arch 20020, 3023,  arts 20,  atie 20060, 
baar 20061, 23, 20, 21,  bede 20,  best 21,  beur 23,
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<td>tell</td>
<td>3023, 3020</td>
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<tr>
<td>toon</td>
<td>20, 23, trek 23, 20, trom 20, tuur 20060, 23</td>
</tr>
<tr>
<td>uwer</td>
<td>20, veel 21, 23, verg 23, vers 21, 20</td>
</tr>
</tbody>
</table>
bedill 3023, belang 20, beleid 20, bereid 21, 23,
beroep 20, 23, beslis 23, binnen 25, buiten 25, 20, bureau 20,
consul 20, cultur 3020, dracht 20, gelijk 21, 20, 23,
geloof 23, 20, gemeen 21, gering 21, gevoel 20, 23, gezond 21,
gracht 20, grepen 1023, 20, intern 21, kanton 20,
kiezel 20, kinder 2020, 23, klacht 20, kracht 20,
kundig 21, lied 20, mening 20, mental 3021,
minder 21, 23, missie 20, nation 3020, oorlog 20, 3023,
opvolg 23, paleis 20, partij 20, plaats 20, 23,
plicht 20, premie 20, regent 1023, 20, schatt 3023, 3020,
schijn 23, 20, schill 3020, 3023, school 20, 1023,
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tering 20, tussen 25, vreemd 21, waarde 20, 21,
winkel 20, 23, wonder 20,
academi 3020, bedrijv 3020, 3023, besliss 3023, besprek 3023,
bestuur 23, 20, consult 20, 3023, diploma 20,
genoten 20, 1023, gewicht 20, invloed 20, meester 20,
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INDEX OF TECHNICAL TERMS AND SYMBOLS

This list contains only the technical terms introduced or deviantly defined by me, with the page of definition behind it to facilitate the re-finding of the definition for the reader, together with some identifiers in the analytic program, used in a more or less constant meaning. These latter ones are followed by declarations between brackets.

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