Reducing Complexity in A Systemic Parser

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Abstract

Parsing with a large systemic grammar brings one face-to-face with the problem of unification with disjunctive descriptions. This paper outlines some techniques which we employed in a systemic parser to reduce the average-case complexity of such unification.

1 Introduction

Systemic grammar has been used in several text generation systems, such as PENMAN (Mann and Matthiessen 1985), PROTEUS (Davey, 1978), SLANG (Patten, 1986), GENESYS (Fawcett and Tucker 1990) and HORACE (Cross, 1991). Systemics has proved useful in generation for several reasons: the orientation of Systemics towards representing language as a system of choices, the strongly semantic nature of the grammar, and the extensive body of systemic work linking discourse patterns and grammatical realisation (e.g., Halliday, 1985; Halliday and Hasan, 1976; Martin, 1992).

Parsing with systemic grammar has not, however, been as successful. To date, there have been six parsing systems using systemic grammar: Winograd (1972), McCord (1977), Cummings and Regina (1985), Kasper (1988a, 1988b, 1989), O’Donoghue (1991a, 1991b) and Bateman et al. (1992). However, each of these systems has been limited in some way, either resorting to a simplified formalism (Winograd, Cummings, McCord), or augmenting the systemic analysis by initial segmentation of the text using another grammar formalism (Kasper: Phrase Structure Grammar; Bateman et al.: Head-driven Phrase Structure Grammar; O’Donoghue: his ‘Vertical Strip Grammar’ (VSG)). There has not so far been a parser that parses using the full systemic formalism, without help from another formalism.

The reasons for this failure relate to those reasons which favour generation. Firstly, the orientation of systemic grammar towards choice means that the grammar is organised into a form full of disjunctions, which leads to complexity problems in parsing. Secondly, the strongly semantic content of systemic grammars (including roles such as Actor, Process and Circumstance in the grammar) leads to a structural richness which adds to the logical complexity of the task.

One result of the work in Systemic generation has been the availability of a large computational generation grammar using the systemic formalism – the Nigel grammar (Matthiessen and Mann, 1985, Matthiessen and Bateman, 1992). As this resource is available, it is desirable to use it for parsing. However, complexity problems have so far made this impossible, except by pre-parsing with another formalism.

In the last few years, we have developed a parser for Systemic grammar, particularly for use with the Nigel grammar. The parser handles the full Systemic formalism, and does not depend on another formalism for segmentation. The parser uses a bottom-up, breadth-first algorithm. A chart is used to handle some of the non-determinism.

This paper focuses on some methods we have used in the parser to reduce the complexity problems associated with using the Nigel grammar. In particular, we focus on the means used to make disjunctive unification more efficient.

Section 2 discusses the problem of disjunctive expansion, and some means of making it more efficient at a general level. Before becoming more specific, the Systemic formalism is introduced (section 3). Section 4 explores one method of avoiding complexity – reducing the size of the disjunctive description by working with sub-descriptions rather than the whole description. Section 5 presents three ways of making expansion, when necessary, more efficient. We conclude the paper with a brief summarisation of our work.

2 Unification with Disjunctive Descriptions

Parsing with a systemic grammar involves much unification of disjunctive descriptions. The usual way to unify such is as follows:

1. Expand out the disjunctive descriptions to Disjunctive Normal Form (DNF) – a form with all
disjunction at the top level of the description – a disjunction of non-disjunctive forms.

2. Unify each term of the first DNF form with each term of the other.

DNF expansion of a description is however an expensive task – the process takes exponential time in the worst case (Kasper and Rounds, 1986). Space is also a problem – DNF expansion is a transformation whereby a disjunctive description is replaced with a set of descriptions each of which contains no disjunction. For a description containing a high level of disjunction, the size of the DNF form can be excessive.

Space has not however been a problem in our processing, but time has. Systemic parsing is very slow. We thus focus on means for speeding up, or avoiding, the unification process.

2.1 Avoiding Expansion

There have been proposals for unification without DNF expansion. Karttunen, for instance, has proposed an algorithm which “uses constraints on disjuncts which must be checked whenever the disjunct is modified” (Kasper, 1987, p81). However, as noted by Kasper (1987, p61), Karttunen’s unification algorithm works only for a limited type of disjunctive description, and not for general disjunction as is needed in the present work.

Kasper has proposed a method of re-representing disjunctive descriptions which in some cases avoids the need for expansion. His approach separates a disjunctive description into two parts – a definite component (which contains no disjunction), and an indefinite component (containing the disjunctive information of the description). A unification process can first check whether the definite components of two descriptions unify, and only proceeds to unify the indefinite components if the definite components unify successfully. The unification of the indefinites is avoided if the unification of the definites fails.

2.2 Delaying disjunctive expansion until necessary

The Kasper-Rounds form also allows us to delay expansion until a later time. When two descriptions are unified, only the definite components need to be checked for compatibility. The result of a Kasper-Rounds unification contains the indefinite descriptions from both descriptions without expansion. At some point in the processing it may be necessary to resolve the indefiniteness, and the disjunctive components are then expanded. However, in many cases, the definite component of the description may become inconsistent before this is necessary, expansion is thus avoided.

2.3 When expansion is necessary, expand efficiently

If DNF-expansion is required, then it should be performed as efficiently as possible. We here discuss some methods to achieve this goal:

1. Reducing the disjunctiveness of the description: By reducing the extent of the description, we reduce the amount of disjunction to be expanded, and thus speed up the expansion process. We use two methods to reduce the size of descriptions:

(a) Extracting descriptions for special-purpose: we segment the grammar description into sub-descriptions for particular purposes. We found that different parsing processes drew upon only subsets of the grammar. Rather than working with the full grammar, sub-descriptions tailored for particular purposes can be compiled-out. These sub-descriptions are less complex to expand than the full description

(b) Register Specific Pruning: parts of the grammar which are not expected to be used in a particular set of target texts are ‘pruned-out’ before processing begins.

2. Expanding Disjunctions Efficiently: a disjunctive description may contain a number of disjunctions. Ordering the expansion of these disjunctions in particular ways can result in improved expansion times:

(a) Multiplying together disjunctions with high likelihood of inconsistency first, thus reducing the number of terms which we continue with.

(b) Spotting inconsistent unifications with minimum of work e.g., checking for inconsistencies between single terms before checking for inconsistencies between combinations of terms.

(c) Using some form of structure sharing in the expansion process: in the expansion process, the same terms may be multiplied together a number of times. A form of structure-sharing, such as a parse chart, can reduce the redundancy in the expansion process.

2.4 Caching and precompilation: avoiding repeating the same expansion.

The parser makes extensive use of caching – when any expansion is calculated which is likely to be used again, the result is stored away for later re-use.
Precompilation has also been a useful technique to improve parsing efficiency. Precompilation is basically a pre-caching of all the values which might be used in the parsing process. By performing most of the DNF expansion of the grammar as a precompilation step, we avoid doing that calculation during the parsing of a sentence.

3 A Systemic Grammar

3.1 Type and Role Logic

Systemic grammar, in distinction to value-attribute grammars, distinguishes type logic (the classes of units) and role logic (the constituency and dependency relations between units). The type logic is expressed in a network, called a system network. The role logic is expressed as a set of constraints on the types of the grammar.

3.2 System Networks

Systemic grammar (e.g., Halliday, 1985, Hudson, 1971, Matthiessen and Mann, 1985) uses an inheritance network to organise grammatical types (or 'feature' in Systemics), and their structural consequences. A Systemic inheritance network is called a system network. A system network is used to organise the co-occurrence potential of grammatical types, showing which types are mutually compatible, and which are incompatible. It consists of a set of systems, which are sets of mutually exclusive types. There is also a covering relation between the types of a system, meaning that if the entry condition of the system is satisfied, then one of the types in the cover must be selected.

Figure 1: A partial Systemic network

| Clause: Subject: nominative |
| Actor: human |
| Finite: finiteverb |
| Pred: lexical-verb |

| Declarative: Subject"Finite |
| Yes-no: Finite"Subject |
| Transitive: Object: accusative |
| Actee = [ ] |
| Pred...Object |

| Active: Subject/Actor |
| Object/Actee |
| Finite/Pred |

| Passive: Subject/Actee |
| Object/actor |
| Pass: be-aux |
| AgentM = "by" |
| Finite/Pass |
| Pred: en-verb |
| Pass"Pred |
| AgentM"Object |

| Intransitive: Subject/Actor |
| Finite/Pred |

| Single-subj: Subject: singular |
| Plural-subj: Subject: plural |

Figure 2: Realisation Rules
these roles conflate with two other roles: Actor and Actee. The grammar assumes that both roles are filled by pronouns, which are either [nominative] or [accusative], [singular] or [plural], and [human] (e.g., “I”, “you”, “he”) or [nonhuman] (e.g., “it”, “that”). Only [human] pronouns can fill the Actor role of a clause.

The realisation operators used in the formalism are as follows:

- **Insert** e.g., `Finite = []`: indicates that the function `Finite` must be present in the structure.
- **Conflate** e.g., `Modal/Finite`: indicates that the two functions `Modal` and `Finite` are filled by the same grammatical unit.
- **Order** e.g., `Subject ^ Finite`: indicates the sequencing of functions in the surface structure. In this example, the `Subject` is sequenced directly before the `Finite`. Any number of elements can be sequenced in a single rule.
- **Partition** e.g., `Thing...Event...End`: Another sequence operator, specifies that the appear in this order, but not necessarily immediately adjacent (linear precedence).
- **Preselect** e.g., `Subject: nominal-group`: indicates that the `Subject` element must be filled by a unit of type `nominal-group`.
- **Lexify** e.g., `Deict = “the”`: used to assign lexical items directly to elements of structure. Note that lexify overrides any preselect which may apply to the same element of structure.

### 3.4 Logical Expression of the Grammar

For the purposes of the expansion of this grammar, we re-express it in a logical formalism. Figure 3 shows Logical Form I of this grammar, including the structural constraints embedded in the form. Note that :xor indicates exclusive disjunction.

### 4 Extracting Sub-Grammars for particular Parsing Tasks

Rather than expanding out the whole grammar, it is more efficient to extract out subsets of the grammar, to be used for particular tasks in parsing. In our systemic parser, the description is used for three purposes:

1. **Path Unification**: checking that two type-paths can unify,
2. **Predicting What Comes Next**: seeing which function-bundle(s) can come next in the structure e.g., we have just analysed `Subject/Actor ^ Fin/Mod`, and want to predict what function-bundle can occur next in the structure.
3. **Function-Bundle Assignment**: seeing what function-bundle a given constituent can fill, e.g., we have just parsed a nominal group, and want to see what function-bundle it can be the filler of.

Each of these uses makes only partial use of the grammar description. Thus, rather than expanding out the entire grammar, we can simplify the process by extracting out sub-grammars, one for each of these applications. Since the size of each sub-grammar is smaller, the complexity problem is reduced. This section looks at these three sub-
descriptions in more detail.

4.1 Separating Type Logic from Role Information

It has proved useful to separate the type logic component of the grammar from the role logic. The two logic components have different patterns of use – type logic is used to test whether two partial type-paths can unify. We never try to unify a partial type description with the type grammar as a whole. The type-logic component of the grammar thus does not need to be DNF-expanded.

The role logic, on the other hand, does need to be expanded. We expand the role-logic component to produce a set of non-disjunctive structure rules which can be applied during parsing (sometimes termed ‘chunking’).

These two components of the description have different properties: type logic is acyclic, while role logic is potentially cyclic. Type logic is constrained such that types are always in disjoint coverings (which allows efficient negation), while role logic doesn’t have this constraint.

Because of these differences in properties and uses, it has proved efficient to treat these two logics separately. Logical Form I of the systemic grammar provided in Figure 3 can be re-represented in the equivalent Logical form II shown in Figure 4, separating out the type and role logic.

4.1.1 Unification of Type Descriptions

The parser uses the type-logic component of this grammar without fully expanding it. Partial expansion, however, is performed, whereby the type-path (the logical-entailment of a system, i.e., the logical expression of types leading back to the root of the network) is pre-compiled for each system. The negation of each type in the system is also pre-compiled, which speeds up unification involving negation of types.

Type-paths are represented in the form proposed by Kasper (1987), and his unification algorithm is used when two type-paths are unified. The main use of the type-logic component is checking the compatibility of two types or type-paths.

Type logic has thus been simplified using three strategies:

1. Separating from Role Logic
2. Using Kasper’s ‘delayed expansion’ technique.
3. Precompiling each system’s logical entailment, and the negation of types.

Because of these methods, unification of type-paths using even quite complex grammars operates quite quickly.

4.2 Function Assignment

Another use made of the grammatical description in parsing is to assign a set of structural roles to a unit. The set of roles a unit fills is called in Systemics the function-bundle of the unit. The systemic formalism allows each unit to be assigned multiple functions. For instance, using the NIGEL grammar, ‘the cat’ in “the cat scratched the woman” would be assigned the function-bundle Subject/Agent/Actor/Theme. The possibility of a unit serving multiple functions is a major source of complexity in systemic parsing.

Assigning function-bundles to a unit is one of the tasks in systemic parsing. For instance, assume we have just parsed a pronoun “he”, assigning it a type-path:

\[ (:\text{and} \text{word:pronoun:nominative:human:singular}) \]

Now, we wish to find what function-bundles the pronoun can serve at a higher level. One result could be:

\[
\begin{array}{c|c|c}
\text{[clause:transitive]} & \text{[pronoun]} \\
\hline
\text{"he"} \Rightarrow \text{Subject/Actor} & \text{[pronoun]} \\
\end{array}
\]

This process draws upon three parts of our grammar:

- Preselection and Lexify rules: used to discover what functions different units can fill.
- Conflation rules: used to discover which functions a unit can serve simultaneously, and thus, which of the preselection and lexify rules can combine.
- The Type Logic: to show which of these preselection, lexify and conflation rules are systematically compatible.

Since we have already set up the type-logic for path unification, we can draw upon that resource as needed. We do not need to include the type-logic in the sub-description for the function-assignment process.

4.2.1 Extracting the relevant description

For the function-assignment process, we do not need all of the role logic description. We can select out only those rules involving preselection, lexify, and conflation. See Logical Form III in Figure 5.
1. Type Logic Component

   (:xor (:and clause
           (:xor declarative yes-no)
           (:xor (:and transitive (:xor active passive))
                 intransitive)
           (:xor single-subject plural-subject))
   (:and word
    (:xor (:and pronoun (:xor nominative accusative)
            (:xor singular plural)
            (:xor human nonhuman))
    (:and verb ... )))

2. Role Logic Component

   (:and (:implies clause (:and Subject: nominative
                            Actor: human
                            Finite: finite-verb
                            Pred: lexical-verb))
        (:implies declarative Subject^Finite)
        (:implies yes-no Finite^Subject)
        (:implies transitive (:and Object: accusative
                                Actee: [ ]
                                Pred...Object))
        (:implies active (:and Subject/Actor
                           Object/Actee
                           Finite/Pred))
        (:implies passive (:and Subject/Actee
                           Object/Actor
                           Pass: be-aux
                           AgentM= "by"
                           Pred: en-verb
                           Finite/Pass
                           Pass^Pred
                           AgentM^Object))
        (:implies intransitive (:and Subject/Actor
                                Fin/Pred))
        (:implies single-subject Subject: singular)
        (:implies plural-subject Subject: plural)))

Figure 4: Logical Form II of the Grammar

4.2.2 Implications Out

We next put this description into a form more suitable for DNF-expansion. Note that implication can be re-expressed using disjunction, conjunction and negation:

   (:implies a b) is-equivalent-to
   (:xor (:and a b) (:not a))

Using this rule, we can re-express the logical form III as Logical Form IV, as shown in Figure 6.

4.2.3 Expansion to DNF

Simple algorithms exist to expand Logical Form IV into DNF (see section 5.1). A small part of the result appears in Logical Form V of the grammar, shown in Figure 7.

The order of worst-case complexity of the expansion to DNF is easily calculated – it is simply two to the power of the number of disjunctions, which is equal to the number of types which have realisation rules of type conflation, insertion, or preselection.

By opting to expand only subsets of the whole grammar, we have reduced the complexity of the description, since the size of n for this sub-description is smaller than for the whole description. However, for a real-sized grammar such as NIGEL, the size of n is still large.

4.2.4 Re-expression in terms of Function Bundles

From the DNF-form of this description, we can extract out partial-descriptions for each function bundle. We now re-express this logical form in terms of the type constraints on each function-bundle, in-
Figure 5: Logical Form III: The Function Assignment Sub-Description

including both the constraint on the type of unit the function-bundle can be part of (the ‘parent-constraint’), and the constraint on the filler of the function-bundle (the ‘filler-constraint’). We show this as a set of triplets, of the form:

( <parent-types> <function-bundle> <child-types> )

1. ( (:and clause transitive active single-subject) Subject/Actor (:and nominative human singular))

2. ( (:and clause transitive active single-subject) Object/Actee (:and accusative))

3. ( (:and clause transitive active plural-subject) Subject/Actor (:and nominative human plural))

4. ( (:and clause transitive active plural-subject) Object/Actee (:and accusative))

Figure 6: Logical Form IV: The Function Assignment

Figure 7: Logical Form V: The Function Assignment Sub-Description in DNF

(:xor (:and clause transitive active single-subject) Subject/Actor (:and nominative human singular))

Object/Actee: accusative

Finite/Pred: (:and verb finite-verb lexical-verb))

(:and clause transitive active plural-subject) Subject/Actor: (:and nominative human plural))

Object/Actee: accusative

Finite/Pred: (:and verb finite-verb lexical-verb))

etc...
5. ( (:and clause transitive
active singular-subject
Finite/Pred
(:and verb finite-verb lexical-verb))

This representation can now be used to assign function-bundles. A unit can take on a function-bundle if it can unify with the filler-constraint on the function-bundle.

For the instance we started with, "he", with types: (:and pronoun nominative human singular), only one triplet would unify. We could thus posit structure for our unit:

```
[clause:transitive:active:single-subject]
```

Note that we have also gained information about the types of the parent-unit of which the unit is a constituent.

4.2.5 Reducing the number of Rules

Note that there is another simplification we can make to the triplet list. We can take all triplets with identical function bundle and child-type specification, and join them. The parent-types slot is replaced with the disjunction of the two parent-type slots. Thus, elements 2 and 4 above become a single item. This process reduces the number of rules to apply:

2,4. ( (:and clause transitive active)
Object/Actee
accusative)))

4.3 Predicting What Comes Next

Another process we use in parsing involves the prediction of what function-bundles can come next in a partially completed structure. With a systemic grammar, this process requires:

- Ordering and Partition rules: to see which function can come next.
- Conflation rules: to see which functions can conflate with the function predicted to come next.
- The type logic: to show which of these ordering, partition and conflation rules are systemically compatible.

The processing of this sub-description, and any others, is exactly the same as for function-assignment.

1. Extract from the role logic description the relevant realisation rules;
2. Replace implications with disjunction and negation;
3. Expand out the grammar;
4. Index the rules in a form useful for the processing.

4.4 Register Restriction

Another means of reducing the overall complexity of the descriptions involves eliminating from the grammar parts which are unlikely to be utilised in the target texts. In systemic terms, we apply register restrictions to the grammar.

For example, in a domain of computer manuals, the description of interrogative structures is not likely to be drawn upon. By eliminating this sub-description, we reduce the degree of disjunction in the whole description, and thus speed up the parsing of the forms which do appear in the text.

The method of deriving the register-restrictions was as follows:

1. We parsed by hand a chapter of the computer manuals we were attempting to parse, building up a register-profile of our target texts.
2. An automatic procedure then extracted out all the grammatical types which occur in these sentences.
3. The process used this information to discover the types not occurring in the sample.
4. The process then eliminated these types and their realisations from the description.

We were thus left with a restricted grammar which was capable of parsing the sentences in the sample, and also parsing many which were not in the sample (under the assumption that the grammatical forms in the sample were representative of the forms found in the manual as a whole). We reduced the size of the grammar by approximately 60% using this method.

4.5 Summary

By extracting out sub-descriptions from the full description, we reduce the complexity of the description-to-be-expanded.

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4 Note that some of the forms we restrict through register restriction may actually appear in any one text, although quite rarely. We are trading off between speed for the majority of sentences, and ability to parse all sentences in a text.

5 The hand-parsing is really computer-assisted, – a tool was developed to traverse the system network for each sentence (and each constituent of the sentence) asking the human which feature was appropriate for the target string. This process guaranteed that the human-analysis conformed to the computer grammar.
5.1.2 Tree Organisation of Expansion

The disjunctive description above can easily be represented in the form below:

\[
\text{(:and (xor A B) (xor C D) (xor E F))}
\]

The process here involves expanding out the first two disjunctions, eliminating inconsistent results, and then expanding the result out with the next disjunction. The incremental expansion is illustrated in Figure 8.

This method is more efficient than the full expansion method, since:

- Some terms, such as a\&c, a\&d etc. are unified only once. However note that terms e and f are still involved in multiple products.
- The failure of a combination of terms early in the unification process eliminates a large number of expansions by the end of the process.

5.1.3 Binary Organisation of Expansion

A third approach aims at maximising the degree of ‘sharing’ unifications in the expansion. The disjunctions in the description are split into pairs, and unified. The results of these unifications are then unified in the same pair-wise manner. This expansion for a conjunction of four disjunctions is shown in Figure 9.

The advantage of this approach is that we are maximising the amount of structure-sharing in the unification.
| N  | Full   | Tree   | Binary |
|----|--------|--------|--------|
| 11 | 20480  | 4092   | 2364   |
| 12 | 45056  | 8188   | 4424   |
| 13 | 98304  | 16380  | 8448   |
| 14 | 212992 | 32764  | 16780  |
| 15 | 458752 | 65532  | 33236  |
| 16 | 983040 | 131068 | 66144  |
| 17 | 2097152| 262140 | 133528 |
| 18 | 4456448| 524284 | 266660 |
| 19 | 9437184| 1048572| 526956 |
| 20 | 19922944| 2097148| 1053304|

Table 1: Worst-case comparison

5.1.4 Comparison of Expansion Approaches

We compared the number of unifications which take place using each of these methods for various numbers of disjunctions (all disjunctions having two disjuncts).

One can see from Table 1 that the worst-case score for the full expansion method is far worse than the other methods. It is not a practical method.

Comparing the worst-case for the ‘tree’ and the ‘binary’ expansion method, we see that the binary method clearly comes out better, by around 50%.

We also did a simulation to check an average case score, since the worst-case score doesn’t take into account that many later unifications are avoided when early unification proves inconsistent. We found that while the binary method still seems superior, in some instances the tree method requires fewer unifications. More work is needed here.

5.2 Ordering Incompatible Disjunctions

First

When using either the Tree or Binary expansion methods, fewer unifications will be required if we place the disjunctions with the greatest chance of inconsistency first. In a sense, we are pruning inconsistent branches of the expansion tree ‘at the root’.

In the systemic parser, several heuristics have been used to group disjunctions which are most likely to produce the fewest cross-products, and perform these first.

One possible method for utilising this phenomenon is:

1. Separate the disjunctions into sub-sets which maximise likelihood of incompatibility between rules inside the sub-expressions.
2. Expand out the disjunctions inside each sub-set. The results of each sub-set are cached so they need only be expanded once.
3. Expand out the results of (2) against each other.

5.3 Avoiding Expansion of Incompatible Terms

Sometimes, it is possible to tell without full unification that a set of rules will not unify with another set. For instance, assume a larger grammar than the one we have been using, a grammar which includes clauses, nominal-groups\(^6\), prepositional phrases, adverbial phrases and words. These categories are all types in the system network, just like any other types.

Since these types won’t unify with each other, we can also know that types which inherit from one of these basic types will not unify with the the sub-types of another basic type. We thus do not need to try to unify descriptions which differ in their basic type. If we split any disjunctive description into sub-components for each basic type, we know a priori that there is no unification between these sub-components.

Before trying any of the expansion techniques outlined in this paper, the whole grammar is segmented into sub-descriptions, one for each of these basic types. The complexity of the expansion of each of these sub-grammars is less than for the grammar as a whole.

Other principles can be used to locate sets of rules which will not unify. These can be applied also.

6 Conclusion

While the techniques outlined here have been applied in ways particular to a systemic grammar, and for a particular implementation, there are principles behind the re-representations which are general to all implementations:

1. Avoid DNF-expansion where possible, as in Kasper’s unification algorithm.
2. Delay expansion to a later time – information gained later may show the description to be inconsistent in the definite component.
3. When expansion is necessary,
   (a) Try to extract out sub-descriptions which can be used, rather than expanding the entire grammar.
   (b) Expand out first disjunctions which are most likely to conflict, since this will reduce the total number of terms which will need to be multiplied.
   (c) Avoid expanding terms that can be known to be incompatible.

As a result of the application of these techniques (and others not here mentioned), we have been able

\[^6\text{Systemics prefers the term ‘nominal-group’ over the equivalent term ‘noun-phrase’}.\]
to implement a parsing system which parses using a large systemic grammar.

1. We start with the Nigel grammar, as used in the Penman Generation System, slightly modified for parsing purposes.

2. This grammar is then reduced by applying register-restrictions, leaving a less complex grammar, but a grammar which still handles the bulk of the phenomena in the target texts.

3. Sub-descriptions of the grammar tailored for particular processes are then extracted, and expanded out as a precompile step, producing a set of ‘chunks’ which can be used in parsing. This expansion takes approximately 2 minutes using Sun Common Lisp on a Sun Sparc II.

4. The ‘chunked’ grammar is then used to parse sentences. On the above-mentioned platform, parsing a sentence like “A user-password is a character string consisting of a maximum of eight alpha-numeric characters.” took 35 seconds to parse.\footnote{Note that when the parser is given a less complex systemic grammar, the parsing time is under two seconds for this sentence.} This parser is slow, compared to most non-systemic parsers, but is far faster than the parser would be without the methods outlined here.

Future work will attempt to reduce this parsing time. Four directions are being followed:

- Streamlining the unification process.
- Moving more processing to the pre-compilation stage.
- Reducing the complexity of the description without reducing its coverage.
- Incorporating heuristics to resolve ambiguities without full expansion.

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Bibliography

Bateman, John – Martin Emele – Stefan Momma, (1992) “The nondirectional representation of Systemic Functional Grammars and Semantics as Typed Feature Structures” in Proceedings of COLING-92, Volume III, Nantes, France, 916-920.

Benson, J. – W. Greaves (eds.) (1985) Systemic Perspectives on Discourse, Volume 1. Norwood: Ablex.

Cross, Marilyn (1991) Choice in Text: A Systemic-Functional Approach to Computer Modelling of Variant Text Production, Ph.D. thesis submitted June 1991, Macquarie University.

Cummings, Michael – Al Regina (1985) “A PROLOG parser-generator for Systemic analysis of Old English Nominal Groups”, in Benson and Greaves, 1985.

Davey, Anthony (1978) Discourse Production: a computer model of some aspects of a speaker, Edinburgh: Edinburgh University Press. Published version of Ph.D. dissertation, University of Edinburgh, 1974.

Fawcett, Robin P. – Gordon H. Tucker (1990) “Demonstration of GENESYS: a very large semantically based Systemic Functional Grammar”. In Proceedings of the 13th Int. Conf. on Computational Linguistics (COLING ’90).

Halliday, M. A. K. (1985) Introduction to Functional Grammar, London: Edward Arnold.

Halliday, M. A. K. – R. Hasan (1985) Cohesion in English, London: Longman.

Hudson, R.A. (1971) English Complex Sentences, North-Holland.

Kasper, Robert (1986) “Systemic Grammar and Functional Unification Grammar” In Benson, J. and Greaves, W., Selected Papers from the 12th International Systemics Workshop, Norwood, N.J: Ablex.

Kasper, Robert (1987a) Feature Structures: A logical Theory with Application to Language Analysis, PH.D. dissertation, University of Michigan

Kasper, Robert (1987b) “A Unification Method for Disjunctive Feature Descriptions” in Proceedings of the 25th Annual Meeting of the Association for Computational Linguistics, held July 6-9, 1987 Stanford, California.

Kasper, Robert (1988a) “An Experimental Parser for Systemic Grammars”, Proceedings of the 12th Int. Conf. on Computational Linguistics, Budapest: Association for Computational Linguistics.

Kasper, Robert (1988b) “Parsing with Systemic Grammar”, Mimeo.

Kasper, Robert (1989) “Unification and Classifi-
cation: An Experiment in Information-Based Parsing.” In Proceedings of the International Workshop on Parsing Technologies, pages 1-7, CMU, Pittsburgh.

Kasper, Robert (1990) “Performing Integrated Syntactic and Semantic Parsing Using Classification” paper presented at Darpa Workshop on Speech and NL Processing, Pittsburgh, June 1990.

Kay, Martin (1979) “Functional Grammar” in Proceedings of the Fourth Annual Meeting of the Berkeley Linguistics Society.

Kay, Martin (1985) “Parsing In Functional Unification Grammar” in Dowty D., L. Karttunen, and A. Zwicky, (Eds): Natural Language Parsing, Cambridge University Press, Cambridge, England.

Mann, W. C. and C. I. M. Matthiessen (1985) “Demonstration of the Nigel Text Generation Computer Program”. in Benson and Greaves, 1985

Martin, James (1992) English Text: System and Structure, Amsterdam: Benjamins.

Matthiessen, C. I. M. and W. C. Mann (1985) “NIGEL: a Systemic Grammar for Text Generation” in Benson and Greaves, 1985

Matthiessen, C. I. M. and J. Bateman (1992) Text Generation and Systemic Functional Linguistics: Experiences from English and Japanese. London: Pinter Publishers.

McCord, Michael (1977) Procedural Systemic Grammars in Int. J. Man-Machine Studies, 9, 255-286, London: Academic Press.

Mellish, Chris (1988) “Implementing Systemic Classification by Unification”, Computational Linguistics, Vol. 14, Number 1, Winter 1988.

O’Donoghue, Tim F. (1991a) “The Vertical Strip Parser: A lazy approach to parsing” Research Report 91.15, School of Computer Studies, University of Leeds, Leeds, UK.

O’Donoghue, Tim F. (1991b) “A Semantic Interpreter for Systemic Grammars” in Proceedings of the ACL Workshop on Reversible Grammars, University of California at Berkeley, June 1991.

Patten, Terry and Graeme Ritchie (1986) “A formal model of Systemic Grammar”, paper presented at 3rd International Workshop on Language Generation, Nijmegen, August 19-23, 1986.

Patten, Terry (1986) Interpreting Systemic Grammar as A Computational Representation: A Problem Solving Approach to Text Generation, Ph. D. dissertation, University of Edinburgh.

Winograd, Terry (1972). Understanding Natural Language. New York: Academic Press.