Paragraph 3

word no.	phrase-internal	phrase-final	phrase-initial	sentence-initial	paragraph-initial
42			XXYYYyyy	XXYYYyyy	XXYYYyyy
43	YYY				
44		Xx			
45					
46				XXxxxYy	
47	yy				
48		XYY			
49			YYY		
50		XxYYY			
51					
52				XXxxYyy	
53		xxx			
54					
55			XxYYYy		
56					
57			xYy		
58					
59				XXXYYyyy	
60	XXXYY				
61		xYY			
62		X			
63				Y	
64		xxYYy			
65		yy			
66				X	
67		YYy			
68			Xx		
69			XXYYy		
70	x			x	
71		Xy			
72					

Note:
X = speaker 1, word H tone reset
x = speaker 1, word L tone reset
Y = speaker 2, word H tone reset
y = speaker 2, word L tone reset
X, x, Y,y = single reset (higher F0 value than the preceding tone)
XX, xx, YY, yy = double reset (higher than the preceding single reset value)
XXX, xxx, YYY, yyy = triple reset (higher than the preceding double reset value)

STOCKTEXT – Automatic generation of stockmarket reports

Bengt Sigurd

Introduction

The generation of text by computer is an interesting undertaking which involves all areas of linguistics: semantics, pragmatics, lexicon, morphology, syntax, text linguistics and – if the output is to be speech – also phonology and speech technology. Text generation is an expanding field which has its own workshops and sections at conferences, and there is a reasonable understanding of the main problems of the field (see references). Members of the Swetra group at Lund have some experience of text generation, above all from the project Commentator (Sigurd 1983, Fornell 1983, Sigurd 1984). The new project Stocktext to be introduced in this paper is aimed at both generation and translation of stockmarket texts. It is supported by HSFR/Nutek and is based on experience from both Commentator and Stocktra – a system for automatic translation of stockmarket texts (Sigurd et al. 1992, Sigurd (ed.) 1994).

The following is an excerpt of stockmarket reports as they appear in *Dagens Nyheter* and in *Sydsvenska Dagbladet* (abbreviated):

Stockholmsbörsen fortsatte att stiga under tisdagen. Affärsväldens generalindex steg till 1536,8, en uppgång med 0,3 procent. Omsättningen stannade på 1946 miljoner kronor... Skania blev dagens vinnare med en uppgång på 20 procent... Det totala börsvärdet sjönk 0,6 procent till 1005 miljarder kronor. 47 höjda köpkurser noterades, 95 sänkta och 150 oförändrade.

'The Stockholm stockmarket continued to rise during Tuesday. The *Business World* general index rose to 1536.8, a rise of 0.3 percent. The trade stopped at 1946 million crowns... Skania was the winner of the day with an increase of 20 percent... The total value of the stockmarket fell 0.6 percent to 1005 billion crowns. 47 increased rates were noted, 95 decreased and 150 unchanged.'

Stocktext will take on-line (tables of) share prices for each day as input (via text TV) and the output will be commentaries like those found in the newspapers. The commentaries may be rendered in Swedish or in English using the Stocktra automatic translations modules. As the format of stockmarket comments is very stereotyped, ready-made (canned) phrases can also be used. This paper will present and discuss some of the computational solutions used to generate texts in Stocktext. The program is written in LPA MacPROLOG and runs on Apple computers. As seen from the print-outs of the experimental system, simple computer generated texts sound quite natural and similar to those produced by humans.

Input, calculations, conclusions and guesses

The system's input is information about shares, bonds, rates of interest, currency, etc. from the past few days. The current experimental system is based on information from several successive days and only from a few markets beside Stockholm. It is not difficult to process information of shorter intervals and describe what is happening during the day, even of several stockmarkets. For experimental purposes, the current system contains a very restricted number of shares. The following simplified table indicates the structure and contents of a data base derived from the information from the stockmarket (or text TV).

```
Day   Share    Price  Traded
f(250, Astra A, 231,   60400).
f(250, Aga B,   358,   78200).
f(251, Astra A, 236,   70400).
f(251, Aga B,   353,   88020).
```

The *f* may be read as fact. The days are numbered in the table above, and day 251 is thus the day after day 250, etc. The data base may include the last price paid as well as the price offered by the buyers and demanded by the seller and various other information; but for the present experimental purposes, the table illustrated above is sufficient. It is obvious from the table that Astra A rose, while Aga B fell.

The tables of share prices are the basis for a number of calculations, such as the difference between two days in absolute value and percentage, the average rise or fall, the winner and loser of the day, the winning and losing branch, etc. In addition, various indexes such as Dow Jones (industrial average) in New York, Nikkei in Tokyo and Affärsvärldens generalindex (the *Business World* general index) in Stockholm may be derived on the

basis of a certain set of shares related to a certain year, and so on. Furthermore, indexes for specific branches such as industry, banks, medicals are calculated.

The stockmarket comments authored by economy journalists often also include sentences which are based on the relations between the values of certain financial items and certain financial events. It is thus obvious that the commentator assumes that there is an inverse relation between the price of shares and the interest rates, reflected for example in certain bonds. This is obvious from such commentaries as: *The rise of the interest rates caused the fall of the shares* or *The shares fell although the bonds fell*. We may call this the 'share-bond inverse relation'. The realty shares are especially sensitive to the interest rates as houses generally require loans. The value of the Swedish crown is often also related to the development of the shares and the interest rates in the reports. But the relations between the shares, interest rates and the Swedish crown are of course complicated.

The shares generally follow each other and this leads to commentaries such as *Astra A went counter to the general development* (Swedish: ... *gick mot strömmen*). We may call the phenomenon 'the mainstream tendency'.

Similarly, the stockmarkets in different countries often follow each other – if New York falls, Stockholm often falls. If the other European stockmarkets fall, Stockholm is expected to fall. This motivates commentaries such as *The Stockholm stockmarket fell as did the European stockmarkets* or *Stockholm was unchanged although New York rose*. We may call this phenomenon the 'stockmarket contamination phenomenon'. Stockbrokers and economists often refer to psychological effects to explain the phenomena we have been discussing here.

The input to stockmarket commentaries is thus raw data (such as share and bond prices) and calculations based on the raw facts (such as differences and indexes). These are supplemented with a kind of secondary facts, such as conclusions or guesses based on observed relations between different financial items or events (the inverse relations between shares and bonds, the common behaviour of stockmarkets, etc.).

The basic questions of text generation

The basic questions of text generation are:

What to say?
In what order?
How to say it?

The survey of the input presented above answers part of the first question. The commentaries should meet the reader's expectations, and he/she is assumed to require information about the general development, i.e. the development of a general index. He may also be interested in an explanation for the development, making comments about the relation between stocks and bonds appropriate. He may further be interested in relating the Stockholm stockmarket to other stockmarkets.

The reports generally also include information about the winner and loser and about the winning and losing branch. The last part of the reports in *Dagens Nyheter* is very stereotyped. It includes information about the total value of the stockmarket and the number of shares which rose, fell or were unchanged.

Stockmarket reports frequently include information about individual shares and companies, new annual reports, personnel changes, new markets, prospects and sometimes business gossip. This part of the commentaries requires special (inside) knowledge, and we are not planning to include this type of information in the automatically generated stockmarket comments.

In what order to say it?

The order of presentation may vary, but in *Dagens Nyheter* and *Sydsvenska Dagbladet* it is fairly strict. First, the general situation is characterized and usually related to the development of the interest rates, foreign markets and the Swedish crown. The development of the general index is then presented in absolute terms and percentage. Individual shares or branches may be commented on if they show a remarkable development. Then the winner and loser and the winning and losing branches are mentioned. After these standard pieces of information, there may be sections about individual companies or branches, comments on the situation of certain companies, new markets, fusions, personnel changes, etc. At the end, there is a standardized section where the number of winning, losing and unchanged shares is mentioned along with the total value of the stockmarket.

The order used by the author of the stockmarket reports in *Svenska Dagbladet* seems to be less fixed. The opening with a general comment is the same, but other indexes instead of Affärsvärldens index are mentioned, e.g. the OMX-index and VA (*Veckans Affärer*) index. The total trade is for example mentioned early but the winner of the day is mentioned last in one report studied.

The order used by the author of the stockmarket comments in *Dagens Nyheter* and *Sydsvenska Dagbladet* may be reflected by calling certain subroutines in order. The command *Börstext(Day)* defined below is used in Stocktext to call a number of subroutines that deliver information which can be printed to make up the text. The information may be delivered as ready-made (canned) text fragments or sentences generated by semantic processes, grammar rules and lexicon. The following is a simplified version of the predicate used to generate the texts showed under *Print-outs* below. The definition reflects the formalism of Prolog.

börstext(Day) :–
    stockcomment(Day,C),print(C),   The Stockholm stockmarket rose on Friday.
    foreigncomment(Day,FC),print(FC), New York fell, however.
    generalindex(Day,G),print(G),   The general index rose to 1567.
    winner(Day,W), print(W),   The winner was ABB A.
    traded(Day,T), print(T).   The trading was lively and shares for 2.8 billion changed hands.

Börstext calls certain subroutines which make calculations, comparisons, etc., and the individual commentaries could be printed as output separately; but for higher textual quality and naturalness, the comments should sometimes be combined into coordinated sentences, and repeated noun phrases should be pronominalized, etc. It is also necessary to insert markers such a *however, too, also*. This is done in the individual sentences in the present system, but could be handled at a higher level when combining sentences in a more sophisticated system.

What to say: subroutines

The question of 'What to say' is answered in the present system by a number of subroutines. They correspond to sections in the stockmarket commentaries some of which are stereotypes. In the structure of the simplified predicate *börstext* presented above, the following subroutines are called: *stockcomment, foreigncomment, generalindex, winner, traded.*

Stockcomment is a subroutine which is supposed to generate a commentary about the general situation: hausse, fall, no change, etc. It may include mentioning the interest rates and the crown as well. The call *foreigncomment* looks at the information about foreign stockmarkets and may deliver a sentence such as *The European stockmarkets fell too*, or

Frankfurt rose, however. Note the interesting small words *too* and *however*, which require comparison between Stockholm and the other stockmarkets.

The Stockholm stockmarket is generally characterized by the *Business World* general index, and the rise or fall of it is also given in percent. The predicate *generalindex* delivers the proper sentence. Predicates such as *winner* and *loser* (and *branchwinner* and *branchloser*) are defined to deliver sentences which generally also specify the percentage. The subroutine *traded* generates sentences such as *Omsättningen var måttlig. Totalt omsattes aktier för X miljoner* 'The trade was moderate. In total, shares for X million changed hands'.

We will not present details of the program here. The order of the subroutines called in the program should ascertain that very important events such as hausse or baisse are mentioned in the beginning of the comments.

How to say it: sentence patterns, pronominalization, conjunctions, text adverbs

In certain experimental programs, the commenting routines may produce ready-made (canned) sentences as output. But in more refined versions, the routines may produce semantic-syntactic representations which can be fed into the modules of Stocktra to be rendered into English, Swedish, Russian, Latvian etc.

The following is the Stocktra semantic-syntactic functional representation of *Affärsväldens generalindex slutade på 0.6 procent* 'The *Business World* General Index closed at 0.6 percent'. This representation, with the functional roles in standard order and standardized word meanings, allows automatic translation between the languages Swedish, English, Russian and Latvian or the generation of sentences in these languages. (For details see Sigurd 1994).

[subj(s(m(def, _1011), m(busigeneralindex, sg), [])), pred(m(m(close, past), [])), obj([]), obj([]), advl([]), advl(s(m(at, _1526), s(0.6, m(percent, _1563), []))), advl([]), advl([]), co(s(m(def, _1011), m(busigeneralindex, sg), []), [.])]

Further text processes may apply to such representations of sentences in order to create coordinations, subordinations, pronominalization, abbreviated (elliptic, telegraphic) sentences or to add conjunctions such as *and, but* or text adverbs such as *however*. Pronominalization may be brought about by the following rule:

```
pron(S1,S2,S3) :-
    S1=[subj(N1),pred(P1),.................],
    S2=[subj(N2),pred(P2),.................], N1=N2,
    np(Agr,N2),np(Agr,m(pron,Agr)),
    S3=[subj(m(pron,Agr)),pred(P2),.........].
```

This rule is supposed to formalize how the identical subject (N1=N2) in the second sentence, S2, is pronominalized taking agreement features into account, by inserting the proper pronoun in place of the subject and returning a new sentence, S3. The process should render examples like: *Astra B rose by 1.2 percent. Astra B reached a new all-time high* into *Astra B rose by 1.2 percent. It reached a new all-time high.*

The program may proceed and build text adding declarative sentences with the subject first (as topic) or use sentences with another topic, e.g. use the adverbial as topic, as demonstrated in *Today the winner was X* as an alternative to *The winner today was X*. Sentence structures may be varied by using random numbers.

Stockmarket texts often include sentences such as *Astra B steg med 4 kronor, en ökning med 1 procent* 'Astra A rose 4 crowns, an increase of 1 percent'. The phrase *en ökning med 1 procent* 'an increase of 1 percent' may be regarded as an abbreviated relative clause i.e. 'which is an increase of 1 percent'. Such a sentence may be represented by the same f-representation but marked as abbreviated or telegraphic.

How to say it: which words to choose

One basic problem of text generation is how to find patterns in the development of shares, interest rates, etc. and how to find words that encode these patterns. The words available in natural languages reflect the cognitive experience of human beings. Only certain patterns can be put into words. Special calculations are needed to discern movement patterns, which are verbalized by words such as those in the following table. It is often a question of setting limits in the quantitive world corresponding to the discrete categories of the natural languages. Tentative definitions are suggested after the words in the table. The term *diff* denotes the difference between the prices of shares, etc. given in percent. The first line thus states that a difference between +0.1 and +0.3 may be called a small rise.

small rise	$+0.3 > \text{diff} > +0.1$
rise	$+1.5 > \text{diff} > +0.3$
hausse	$\text{diff} > +1.5$
small fall	$-0.1 > \text{diff} > -0.3$
fall	$-0.3 > \text{diff} > -1.5$
baisse	$\text{diff} < -1.5$
unchanged	$+0.1 > \text{diff} > -0.1$

Various technical words are used in order to characterize the stockmarket. Some words have entered the standard language, e.g. *all-time high*. The following are some Swedish words used in the comments on the general situation: *stark* 'strong', *fast* 'firm', *hävdad* 'maintained', *oregelbunden* 'irregular, mixed', *orolig* 'uneasy', *nervös* 'nervous', *avvaktande* 'resting, subdued', *håglös* 'indifferent', *vikande* 'receding', *svag* 'weak'. How should these terms be defined in numerical terms along a scale? *Sydsvenska Dagbladet* shows a picture above the stockmarket commentaries of a semi-circle resembling a barometer. Along the periphery, the following words are ordered: *baisse, svag, vikande, oregelbunden, hävdad, fast, hausse*. There are, however, no figures along the periphery.

Some words characterize long term changes (between more than two days), e.g. *fluctuations, continued fluctuation, unstable, continued rise, continued fall*. In order to find correlates of such words, more extensive calculations are necessary. We give some examples of what is needed below. V0 is today's value, V1 the value the day before and V2 the value the day before V1.

continued rise		$V0>V1>V2$
long rise		$V0>V1>V2>V3$
fluctuation	(a)	$V0>V1<V2>V3$
	(b)	$V0<V1>V2<V3$

One of the problems involved is the length of the perspective, i.e. the number of days to consider. Another problem is the size of the change to be considered: how great must a change be in order to be taken into account?

The problem of relating words to reality is also demonstrated when the size of the trading is to be characterized in one word. Words typically used to characterize the Swedish stockmarket are: *stor/livlig handel* 'lively trading', *måttlig handel* 'moderate trading', *liten handel* 'small/little trading'. The use of the evaluating words has to be related to some figure, i.e. what is to be regarded as normal. For the Stockholm stockmarket, ca

2.5 billion seems to be regarded as normal, and one may therefore use the words according to the following table:

trade < 2.3	*liten, svag handel*	'small, little trading'
2.7 > trade > 2.3	*måttlig handel*	'moderate trading'
trade > 2.7	*stor, livlig handel*	'lively trading'

There are some synonyms in the stock domain which may be used to give stylistic variation. The terms *stockmarket* and *stock exchange* can thus often be used interchangeably. Instead of the *New York stock exchange* one may say *Wall Street*. Beside saying that a share, etc. *fell* one may use the stronger verbs *plunged, tumbled* (as in *The Swedish crown tumbled against German mark*). The term *decline* may be used as a synonym of *fall*, which has a stronger variant in *free fall*. The terms *wallow, rally, shore up* and *profit-taking* have their special use in stockmarket commentaries. In the commentaries *losers take a beating* and *some fare worst* by the *turbulence* or *turmoil*. There is a certain amount of stockmarket jargon or slang. For example, the *Dow* is e.g. used for *the Dow Jones industrial average index* and *blue chips* for the safest assets on the New York stockmarket. The preposition in phrases like *on Monday* is often left out.

Conclusions, problems and perspectives

As can be seen from the sample texts shown below, it is quite possible to generate simple texts on the basis of the available indata. Running time is no problem at present but may be if more data and processing is included. The texts have to be restricted to certain fields, and speculations about things like the effect of the war in X or the banking problems in Y cannot be included unless the database and routines are very much expanded.

There should be many applications of a text generating system such as the one presented here. A computer system which can produce commentaries of this type on the development of the prices of shares, etc. over time may also be useful for other tasks, such as generating verbal commentaries on changes in temperature, voltage, capacity, storage, sales, etc. Systems which generate weather forecasts have been developed already (Kittredge et al. 1986, Sigurd et al. 1992, Kerpedjiev 1992). Written reports have an advantage over instruments, tables and diagrams in that text can sum up the basic facts, patterns and developments in a compact manner. Listening to spoken commentaries can be more convenient than reading in certain situations.

Print-outs of sample texts generated by Stocktext

For convenience, all numbers are given with decimal points instead of decimal commas which are normally used in Swedish. The command *ebörstext1(Day)* generates a text in English for a certain day.

:– börstext1(249)

Hausse på stockholmsbörsen på fredagen. Börsen i Franfurt föll däremot. Affärsvärldens generalindex blev 1666.5, en uppgång med 4.6 procent. Kronan försvagades. Vinnare blev Atlas Copco A. Atlas Copco A steg med 7 kronor, en uppgång med 8.1 procent. Förlorare blev Asea A. Asea A sjönk 10 kronor, en nedgång med 1.9 procent. Branschvinnare var verkstäder. Förlorande bransch blev industri. 8 höjda köpkurser noterades, 0 sänkta och 0 oförändrade. Det totala börsvärdet steg 4 procent till 1811450000 kronor. Omsättningen var hög, totalt omsattes aktier för 3177925 kronor.

:– ebörstext1(249)

Hausse at the Stockholm stockmarket on Monday. Franfurt fell however. The *Business World* General Index was 1666.5, a rise of 4.6 percent. The Swedish crown was weakened. Today the winner was Atlas Copco A. Atlas Copco A rose by 7 crowns, a rise of 8.1 percent. The loser was Asea A. Asea A fell by 10 crowns, a fall of 1.9 percent. The best branch was workshops. The losing branch was industry. 8 higher rates were noted, 0 lower and 0 unchanged. The total value of the stockmarket rose 4 percent to 1811450000 crowns. The trade was lively; in total, shares for 3177925 crowns changed hands.

:– börstext1(250)

Stockholmsbörsen fortsatte uppåt under tisdagen. Börsen i Franfurt steg också. Affärsvärldens generalindex blev 1609.3, en uppgång med 1 procent. Den svenska kronan var oförändrad. Vinnare blev Aga A. Aga A steg med 2 kronor, en uppgång med 2.9 procent. Förlorare blev Asea A. Asea A sjönk 1 kronor, en nedgång med 0.1 procent. Branschvinnare var industri. Förlorande bransch blev verkstäder. 7 höjda köpkurser noterades, 1 sänkta och 0 oförändrade. Det totala börsvärdet steg 0.4 procent till 1820300000 kronor. Omsättningen var måttlig, totalt omsattes aktier för 2869658 kronor.

:– ebörstext1(250)

The Stockholm stockmarket continued upwards on Tuesday. Frankfurt rose too. The *Business World* General Index was 1609.3, a rise of 1 percent. The Swedish crown was unchanged. Today the winner was Aga A. Aga A rose by 2 crowns, a rise of 2.9 percent. The loser was Asea A. Asea A fell by 1 crowns, a fall of 0.1 percent. The best branch was industry. The losing

branch was workshops. 7 higher rates were noted, 1 lower and 0 unchanged. The total value of the stockmarket rose 0.4 percent to 1820300000 crowns. The trade was moderate; in total, shares for 2869658 crowns changed hands.

:– börstext1(251)

Stockholmsbörsen vände neråt på onsdagen och räntorna gick uppåt. De europeiska börserna föll också. Affärsvärldens generalindex blev 1583, en nedgång med 0.5 procent. Den svenska kronan var oförändrad. Vinnare blev Astra B. Astra B steg med 0.5 kronor, en uppgång med 0.2 procent. Förlorare blev Aga A. Aga A sjönk 1.5 kronor, en nedgång med 2.1 procent. Branschvinnare var läkemedel. Förlorande bransch blev industri. 2 höjda köpkurser noterades, 5 sänkta och 1 oförändrade. Det totala börsvärdet blev praktiskt taget oförändrat nämligen 1816650000 kronor. Omsättningen var måttlig, totalt omsattes aktier för 2524214 kronor.

:– ebörstext1(251)

The Stockholm stock exchange turned downwards on Wednesday, and the interest rates rose. The European stockmarkets fell too. The *Business World* General Index was 1583, a fall of 0.5 percent. The Swedish crown was unchanged. Today the winner was Astra B. Astra B rose by 0.5 crowns, an increase of 0.2 percent. The loser was Aga A. Aga A fell by 1.5 crowns, a fall of 2.1 percent. The best branch was medicals. The losing branch was industry. 2 higher rates were noted, 5 lower and 1 unchanged. The total value of the market was almost unchanged, 1816650000 crowns. The trade was moderate; in total shares for 2524214 crowns changed hands.

:– börstext1(252)

Stockholmsbörsen var nästan oförändrad under torsdagen. Frankfurt föll däremot. Affärsvärldens generalindex blev 1591.6. Den svenska kronan var oförändrad. Vinnare blev Atlas Copco A. Atlas Copco A steg med 1 kronor, en uppgång med 1 procent. Förlorare blev Astra B. Astra B sjönk 1.5 kronor, en nedgång med 0.7 procent. Branschvinnare var verkstäder. Förlorande bransch blev läkemedel. 2 höjda köpkurser noterades, 5 sänkta och 1 oförändrade. Det totala börsvärdet blev praktiskt taget oförändrat nämligen 1814800000 kronor. Omsättningen var måttlig, totalt omsattes aktier för 2804036 kronor.

:– ebörstext1(252)

The Stockholm stockmarket was almost unchanged during Thursday. Frankfurt fell however. The *Business World* General Index was 1591.6. The Swedish crown was unchanged. Today the winner was Atlas Copco A. Atlas Copco A rose by 1 crowns, a rise of 1 percent. The loser was Astra B. Astra B fell by 1.5 crowns, a fall of 0.7 percent. The best branch was workshops. The losing branch was medicals. 2 higher rates were noted, 5

lower and 1 unchanged. The total value of the stocks was almost unchanged, 1814800000 crowns. The trade was moderate; in total shares for 2804036 crowns changed hands.

:– börstext1(253)

Stockholmsbörsen var nästan oförändrad under fredagen. Frankfurt steg däremot. Affärsvärldens generalindex blev 1593.3. Kronan stärktes. Vinnare blev Atlas Copco B. Atlas Copco B steg med 2 kronor, en uppgång med 2.1 procent. Förlorare blev Aga B. Aga B sjönk 1.5 kronor, en nedgång med 2.1 procent. Branschvinnare var verkstäder. Förlorande bransch blev industri. 4 höjda köpkurser noterades, 4 sänkta och 0 oförändrade. Det totala börsvärdet steg 0.2 procent till 1818450000 kronor. Omsättningen var hög, totalt omsattes aktier för 3291033 kronor.

:– ebörstext1(253)

The Stockholm stockmarket was almost unchanged during Friday. Frankfurt rose however. The *Business World* General Index was 1593.3. The Swedish crown was strengthened. Today the winner was Atlas Copco B. Atlas Copco B rose by 2 crowns, a rise of 2.1 percent. The loser was Aga B. Aga B fell by 1.5 crowns, a fall of 2.1 percent. The best branch was workshops. The losing branch was industry. 4 higher rates were noted, 4 lower and 0 unchanged. The total value of the stockmarket rose 0.2 percent to 1818450000 crowns. The trade was lively; in total shares for 3291033 crowns changed hands.

Acknowledgement

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