Simple, applied text parsing

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Text parsing for use in linguistic or artificial intelligence research can often be ill-suited for use in other lines of investigation in which simple, problem-specific parsing techniques may be used. This paper describes the development of a simple text parser for use in a specific research setting. The resulting parsing programs are compact enough for easy use on most available mini- and microcomputers, while still providing adequate results for some applications such as chunking text into small units for later presentation.

The specific case examined here involves parsing text for use in the Rapid Serial Visual Presentation (RSVP) format. The RSVP format involves the serial presentation of single words or short text segments to a single fixed location on a computer screen. This type of presentation allows for precise control over various aspects of the text presentation, such as presentation duration. Prior work in our laboratory suggested that multiword text units were superior to single-word text units for RSVP presentation up to a point of about 20 character spaces. Beyond that point, little or no useful information is extracted from the text (Rayner, 1978). Furthermore, eye movement studies have shown that eye fixations are longer at points where phrase structure indicates that a heavier processing load should exist (Just & Carpenter, 1980). These results, when taken in combination, suggest that the RSVP format might be improved by providing subjects with text that has been divided into appropriate linguistic units.

In a recent study, Cocklin (1983) compared the readability of text divided into linguistic "idea units" with that of text divided into arbitrary "random" units presented in the RSVP format. The idea units were obtained by having independent raters divide the text into "natural" units. The random units were obtained by having a computer divide the same texts into unconstrained segments of the same average length (i.e., 13 character spaces). Cocklin's subjects were able to use the information preserved in the structured text to improve their comprehension scores as measured by a multiple-choice question answering task.

Cocklin's (1983) study was confounded, however, by the difference in the variability of window sizes in the two conditions, with the structured text being more variable in length. It is possible that the readability of text presented in the random condition benefited from reduced perceptual variability, whereas the readability of text in

the structured condition benefited from linguistic information. Consequently, reduction of window-size variability in the structured-text condition might further have improved comprehension in that condition. Despite this confound of unit variability acting against the linguistic units, Cocklin still obtained results favoring the linguistic units.

The major problem in presenting text as linguistic units in the RSVP condition is not, however, one of unit variability, but one of time. In Cocklin's (1983) study, it was necessary to have four independent raters divide the text into linguistic units. These results were then tabulated, and decisions were made about the final placements of boundaries. After this had been done, the computer text files still required editing so that unit boundaries could be marked for later recognition by the computer. Despite the fact that Cocklin used relatively short passages, each required a great deal of time to be readied for presentation in the RSVP condition. Such a process clearly limits the potential usefulness of RSVP reading by making it clumsy and expensive to prepare text for presentation in the RSVP format. Additionally, due to their periodic nature, text sources such as newspapers and magazines are effectively eliminated from consideration for everyday use in RSVP presentation. It would simply prove to be too clumsy and expensive to prepare these materials for RSVP presentation on a daily, weekly, or monthly basis.

The obvious solution to this problem seemed to be the development of a computerized text parser. Computerized text parsers have been developed in artificial intelligence approaches to natural language comprehension devices (e.g., Winograd, 1972). These differ in their complexity and ability to assign correct syntactic functions to constituents of a sentence. A simple parser would save a great amount of time in preparing texts for RSVP display. Such a parser would need only to divide text into units of near optimal size and structure for RSVP presentation. Since such a parser divides the text into linguistic units only for use by human readers, its linguistic analysis of incoming text would not need to be nearly as extensive as that required by a language comprehension device. Such a system would certainly provide a speed

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advantage over human parsers and could possibly be modified to run on-line so that texts could be parsed during presentation rather than prior to presentation. This would allow computer users the flexibility of selecting the presentation format they prefer for any given text. In addition, the computer could be instructed to use upper and/or lower size restrictions on parsed text to help reduce variability in the length of linguistic units.

The purpose of the research described here was to develop a text-parsing program that would reduce variability in text units presented to subjects and, at the same time, maintain useful linguistic structure.

METHOD

Apparatus

The original version of the parser was written and implemented on a PDP-11/03 minicomputer with 12K of available RAM, using a FORTRAN IV compiler (see Appendix A for a listing). More recently, the parser has been translated to Pascal and implemented on a Sage II minicomputer under the P-System operating system (see Appendix B for a listing).

Text Parsing Program

Both versions of the text parser were created to provide parsed text for later use in other research. Text for these experiments was parsed prior to the experiment by means of the computer text parser. Several criteria were established for the development of the parser. The first of these was that text, regardless of subject matter, had to be parsed into linguistic units that corresponded to Cocklin's (1983) "idea units." Second, the text had to meet a maximum size restriction of no more than 20 character spaces per unit. This restriction was placed on unit length because earlier research had indicated that the eye could perceive and extract useful information from a maximum of about 20 characters per fixation (Rayner, 1978). Additional research has shown that comprehension in the RSVP format tends to decrease for windows averaging more than about 15 characters in length (Cocklin, Ward, Chen, & Juola, 1984). Finally, the parsing program and text up to 9,000 characters in length had to fit within the memory limitations of the computer being used. [Note: This size-limitation restriction did not apply to the Pascal version developed on the Sage II, due to a large amount of available random access memory (RAM)]. Because of possible future use of this program on other machines, the size restrictions were still considered important.

After several possible parsing models were considered, a model similar to one outlined in *Psychology and Language* (Clark & Clark, 1977, pp. 59-61) was adopted. This model was selected because of its compatibility with the criteria outlined above. The parser was based on a limited number of function words: determiners, quantifiers, prepositions, pronouns, auxiliary verbs, relative pronouns, complementizers, subordinating conjunctions,

and coordinating conjunctions (see Appendix C for a listing of function words used).

The original version of the parser was implemented as a three-pass subroutine in FORTRAN IV. Since punctuation is a reliable indicator of linguistic structure in a text, the first pass of the parser simply looked for and marked punctuation boundaries.

The second pass of the parser used a function-word algorithm to mark additional phrase boundaries. The algorithm made use of a conditional variable that was set to false when a non-function word was encountered and to true when a function word was encountered. The parser made a left-to-right, word-by-word scan beginning at a previously defined boundary. The first word in a given text segment was scanned to determine whether or not it was a function word. If it was not, a conditional variable was set to false. If it was, the scan continued until a non-function word was found, and then the conditional variable was set to false. When the conditional variable changed from false to true, the computer was instructed to mark the intervening space as a phrase boundary. This procedure was then repeated until a previously defined boundary was encountered.

The third and final pass of the parser ensured that phrase units did not exceed the size restrictions set for RSVP presentation. This pass of the parser counted the number of characters in each phrase unit of text. When that count exceeded the 20-character maximum, the phrase was divided at a point as near to the center of the unit as possible, without splitting a word. If the center of the phrase unit was the exact middle of a word (e.g., the letter "a" in the word "plant"), the phrase was broken prior to the word.

RESULTS AND DISCUSSION

The resulting parser was flexible enough to parse text on virtually any subject matter. This parser should also be compact enough to be implemented on virtually any of the micro- or minicomputers available today, provided that they have at least 16K of 16-bit RAM or 32K of 8-bit RAM, as well as a higher level computer language, such as FORTRAN or Pascal. It also provided phrases that closely approximated (87% agreement) Cocklin's (1983) idea units, while still resulting in text units that were less variable than those used by Cocklin. (Note: the overall interrater agreement for four raters in Cocklin's study was 90%.) Mean standard deviations were 4.7 and 4.1 characters for Cocklin's idea units and the text-parsing program's units, respectively. A pairwise *t* test of the standard deviations from common materials in the two parsing conditions showed a significant reduction in variability for text units produced by the text-parsing program [$t(47) = 6.52, p = .0001$].

An important result of this work is that it shows that a simple, easily implemented parsing routine can be developed to parse text into linguistic units with a reasonable level of agreement (87%) with human parsers. Since

the parser can easily be modified to run on-line with incoming text from different sources, it is ideally suited for implementation on personal computers with limited memory for RSVP reading of texts via telephone or satellite news and information services. In addition, several personal computer manufacturers are now selling in increasing numbers small, portable computers that have only a few (1 to 5) display lines. Page presentation of text on these computers is quite limited, and RSVP would provide an ideal text-presentation mode for these mini-displays.

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Appendix A

Parsing Subroutine—FORTRAN

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C      SUBROUTINE PARSE
C
C      THIS ROUTINE IS DESIGNED TO PARSE TEXT
C      INTO A PHRASE STRUCTURE USING PUNCTUATION
C      AND FUNCTION WORDS. THE PARSER ALSO EXAMINES
C      THE PARSED TEXT AND ADJUSTS THE PHRASES FOR LENGTH
C      SO THAT THEY MAY BE BETTER UTILIZED IN THE RSVP
C      READING FORMAT
C      THIS ROUTINE WAS WRITTEN IN 1983 BY
C      MICHAEL M. GRANAAS FOR USE ON A DEC
C      PDP 11/03 MINI-COMPUTER.
C
C      INPUT TO THIS ROUTINE COME BY WAY OF THE
C      TWO COMMON BLOCKS: WORDS AND TEXT.
C
C      WORDS-
C      WRD- ARRAY CONTAINING THE LIST OF FUNCTION WORDS
C      WHICH WERE READ IN AND STORED IN A TREE STRUCTURE
C      BY ANOTHER SUBROUTINE
C      RT,LT- RIGHT AND LEFT POINTERS FOR THE TREE STRUCTURE
C
C      TEXT-
C      TXT- ARRAY CONTAINING TEXT TO BE PARSED
C      DVEC- ARRAY NOT UTILIZED IN THIS SUBROUTINE
C      TSIZE- INTEGER NUMBER OF CHARACTERS IN TXT
C
C      COMMON/WORDS/ WRD,RT,LT
C      COMMON/TEXT/ TXT,DVEC,TSIZE
C      LOGICAL*1 DVEC(60),TXT(9500),Z,WRD(110,10)
C      BYTE PER,QMARK,EMARK,COM,SEMCOL,STAR
C      BYTE BLANK,APOS,PARN,COL,QT
C      INTEGER FLG,PT,PTT,TSIZE,RT(110),LT(110)
C      INTEGER I,J,CNT,PT,PTT,CNT2,BK,PT2,FLG2,FLG3
C      DATA BLANK/'040'/,APOS/'047'/,QT/'"/
C      DATA PARN/'051'/,COL/'072'/
C      DATA PER/'056'/,QMARK/'077'/,EMARK/'041'/
C      DATA COM/'054'/,SEMCOL/'073'/,STAR/'*'/
C
C      PASS ONE OF THE PARSER FIND AND MARK PUNCTUATION
C      BOUNDRIES WITH A STAR
C      PUNCTUATION OTHER THAN PERIODS AND LEFT PARENS
C      ARE MARKED TO THE IMMEDIATE RIGHT IF A BLANK SPACE
C      IS AVAILABLE, OTHERWISE NO MARK IS MADE.
C      LEFT PARENS ARE MARKED TO THEIR IMMEDIATE LEFT IF A
C      BLANK SPACE IS AVAILABLE. PERIODS ARE MARKED TO
C      THEIR IMMEDIATE RIGHT IF A BLANK SPACE IS AVAILABLE.
C      AND IF NEITHER OF THE TWO CHARACTERS PRECEDING THE

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C      PERIOD ARE CAPITALIZED.
C
C      DO 5,I=1,TSIZE
C      Z=TEXT(I)
C      IF (Z.GE.'101') GOTO 5
C      IF (Z.EQ.PER.AND.TXT(I-1).LT.'133.AND.TXT(I-1).GT.'100') GOTO 5
C      IF (Z.EQ.PER.AND.TXT(I-2).LT.'133.AND.TXT(I-2).GT.'100') GOTO 5
C      IF (Z.EQ.PER.OR.Z.EQ.QMARK.OR.Z.EQ.EMARK) GOTO 7
C      IF (Z.EQ.COM.OR.Z.EQ.SEMCOL.OR.Z.EQ.PARN.OR.Z.EQ.COL) GOTO 7
C      IF (Z.EQ.QT.AND.TXT(I-1).EQ.BLANK) TXT(I-1)=STAR
C      IF (Z.EQ.QT.AND.TXT(I+1).EQ.BLANK) TXT(I+1)=STAR
C      GOTO 5
C      I=I+1
C      IF (TXT(I).NE.BLANK) GOTO 5
C      TXT(I)=STAR
C      CONTINUE
C
C      NOW WE START THE FUNCTION WORD SEARCH.
C      WHEN WE FIND A NON-FUNCTION WORD FOLLOWED BY
C      A FUNCTION WORD WE PARSE BETWEEN THEM
C
C      FLG2=0
C      FLG=0
C      FT=1
C      BK=1
C      GOTO 13
C      FLG=1
C      IF (FLG2.EQ.0) GOTO 13
C      TXT(FT)=TXT(FT)-'40'
C      FLG2=0
C      CNT=0
C      FT=BK
C      IF (TXT(FT).EQ.STAR) FLG=0
C      Z=TEXT(FT)
C      IF (Z.GE.'101') GOTO 14
C      IF (Z.LE.'071.AND.Z.GE.'060') GOTO 14
C      BK=BK+1
C      GOTO 13
C      PT2=1
C      CNT=CNT+1
C      BK=BK+1
C      IF (BK.GE.TSIZE) GOTO 302
C      Z=TEXT(BK)
C      IF (Z.LT.'101.AND.Z.NE.APOS) GOTO 25
C      GOTO 15
C
C      25      IF (CNT.GE.11) GOTO 12
C      IF (TXT(PT).GE.'141') GOTO 30
C      FLG2=1
C      TXT(FT)=TXT(FT)+'040'
C
C      PT=FT
C      J=1
C      CNT=1
C      31      IF (CNT.EQ.12) GOTO 300
C      IF (TXT(PT).NE.WRD(PT2,J)) GOTO 110
C      PT=PT+1
C      IF (PT.EQ.BK.AND.WRD(PT2,J+1).LT.'141') GOTO 300
C      J=J+1
C      CNT=CNT+1
C      GOTO 31
C
C      110      IF (TXT(PT).LT.WRD(PT2,J)) GOTO 115
C      PT2=RT(PT2)
C      IF (PT2.EQ.0) GOTO 12
C      GOTO 30
C
C      115      PT2=LT(PT2)
C      IF (PT2.EQ.0) GOTO 12
C      GOTO 30
C
C      300      IF (FLG.EQ.0) GOTO 303
C      309      IF (TXT(PT-1).EQ.BLANK.OR.TXT(PT-1).EQ.STAR) GOTO 310
C      FT=FT-1
C      GOTO 309
C      310      TXT(FT-1)=STAR
C      FLG=0
C      303      IF (FLG2.EQ.0) GOTO 301
C      TXT(FT)=TXT(FT)-'040'
C      FLG2=0
C      GOTO 13
C
C      THE THIRD AND FINAL PASS OF THE PARSER CHECKS
C      THE PREVIOUSLY PARSED TEXT FOR UNIT SIZE.
C      ANY UNIT LARGER THAN 20 CHARACTERS IN LENGTH IS

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C      PARSED AS NEAR THE MIDDLE AS POSSIBLE WITH OUT
C      SPLITTING UP A WORD
C
302      FT=2
      PT=3
      CNT=1
305      IF (TXT(PT).EQ.STAR) GOTO 350
      PT=PT+1
      CNT=CNT+1
      IF (PT.GE.TSIZE) GOTO 999
      GOTO 305

C
C
350      IF (CNT.GT.20) GOTO 355
351      FT=PT+1
352      IF (TXT(FT).NE.BLANK) GOTO 353
      FT=FT+1
      GOTO 352
353      PT=FT+1
      CNT=1
      GOTO 305

C
C
355      BK=CNT/2
      FLG=FT+BK
      FLG2=FLG
356      IF (TXT(FLG).NE."040") GOTO 360
      TXT(FLG)=STAR
      PT=FT+1
      CNT=1
      GOTO 305
360      IF (TXT(FLG2).NE."040") GOTO 365
      TXT(FLG2)=STAR
      PT=FT+1
      CNT=1
      GOTO 305
365      FLG=FLG-1
      FLG2=FLG2+1
      IF (FLG.LT.FT.AND.FLG2.GE.PT) GOTO 351
      GOTO 356

C
999      CONTINUE
      RETURN
      END

```

Appendix B

Parsing Program—Pascal

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{**** this program is designed to parse text into a
a phrase like structure using punctuation and
function words. The parser also examines the
parsed text and adjusts the units for length
so that they may be better utilized in the RSVP
reading format ****}

{**** This version of the text parser was written in
1984 by Michael M. Granaas for use on a Sage II
mini-computer. ****}

var
  ch : char;
  chin, wrds, temp, pl, pf : integer;
  wrd, data, prnt, outpt : text;
  words : array [1..115, 1..12] of char;
  text : array [1..3000] of char; {this could be expanded to any size
                                   within bounds of available memory
                                   to meet requirements of larger text
                                   files}

  fnt, cap, flg, stp, i, j, k : integer;
  mid, mid1, mid2, numchar, numparse : integer;
  avchr, avwrds : real;
begin
  chin := 0;
  k := 1;

  {**** this current version requires editing the name
of each new input/output file. Minor modifications
would allow for prompting of the user thus eliminating
the need for continued editing and recompiling ****}

  reset (data, 'exp2:s1');
  rewrite(outpt, 'exp2:ps01.text');
  rewrite(prnt, 'PRINTER:');
  numparse:=0;

  for i:= 1 to 3000 do
    text[i]:=' ';

  for i:= 1 to 115 do
    for j:=1 to 12 do
      begin
        words[i, j]:=' '
      end;

  while not EOF(data) do
    begin
      while not EOLN(data) do
        begin
          read (data, ch);
          text[k] := ch;
          k := k+1;
        end;
        if EOLN(data) then
          begin

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    read (data,ch);
end;
end;
close(data);
chin :=k-1;
while not (text[chin] in ['#']) do begin
    chin := chin-1;
    writeln (chin);
end;

{**** read in function word list ****}

reset (wrd,'expl:words.text');
k:=1;
j:=1;
while not EOF(wrd) do begin
    While not EOLN(wrd) do begin
        read (wrd,ch);
        words[j,k] := ch;
        k:=k+1;
    end;
    if EOLN(wrd) then
        begin
            read(wrd,ch);
            words[j,k]:='*';
            k:=1;
            j:=j+1;
        end;
    end;
close(wrd);

{**** so ends our input of the function word list ****}
{**** now we begin the actual parsing by marking appropriate
punctuation boundaries ****}

wrds :=j-1;
i:=0;
k:=0;
while not (k=1) do
    begin
        i:=i+1;
        if text[i]='*' then i:=i+1;
        if text[i] in ['!','(',')','(',')','(',')','?'] then
            begin
                if text[i+1] = ' ' then text[i+1]:='*';
            end;
        if text[i] = '.' then
            begin
                if not (text[i-1] in ['A'..'Z']) then
                    begin
                        if not (text[i-2] in ['A'..'Z']) then
                            begin
                                if text[i+1]=' ' then text[i+1]:='*';
                                end;
                            end;
                        end;
                    end;
                if text[i] = '' then
                    begin
                        if text[i-1]=' ' then text[i-1]:='*';
                        if text[i+1]=' ' then text[i+1]:='*';
                    end;
                if text[i]='*' then
                    begin
                        k:=1;
                        text[i+1]:='*';
                    end;
            end;

        {**** we now begin the second pass of the parser which performs a
        function word search--whenever a non-function word is followed
        by a function word a parse is made between them ****}

        fnt:=1;
        cap:=0;
        flg:=0;
        sto:=0;
        pf:=1;
        while not (text[pf] in ['A'..'Z','a'..'z']) do
            pf:=pf+1;

        repeat
            ol:=pf;
        until
            while (text[ol+1] in ['A'..'Z','a'..'z']) do
                ol:=ol+1;
    end;

```

```

if (text[pf] in ['A'..'Z']) then
  begin
    cap:=1;
    text[pf]:= chr(ord(text[pf])+32)
  end;

flg :=0;

for i:= 1 to wrds
do begin
  j:=1;
  if text[pf] < words [i,j] then i:=wrds;

  if text[pf] = words[i,j] then
    begin
      temp:=pf+1;
      j:=j+1;

      while ((temp=ol) and not (words[i,j] in ['*']))
      do begin

        if text[temp] = words[i,j] then
          begin
            temp:=temp+1;
            j:=j+1
          end
        else
          begin
            temp:=pl+1;
          end
        end;

        if (temp=pl+1) and (words[i,j]='*') then
          begin
            flg:=1;
            i:=wrds
          end
        end {if}
      end;{for}

      if (flg=1) and (fnt=0) then
        begin
          fnt:=1;
          if text[pf-1]=' ' then text[pf-1]:='*';
          flg:=0
        end
      else if (flg=1) and (fnt=1) then
        flg:=0
      else if (flg=0) and (fnt=1) then
        fnt:=0;

      if cap=1 then
        begin
          cap:=0;
          text[pf]:= chr(ord(text[pf])-32);
        end;

      pf:=pl+1;
      while not (text[pf] in ['A'..'Z','a'..'z']) do
        begin
          if text[pf]='*' then fnt:=1;
          if text[pf]='*' then stp:=5;
          pf:=pf+1
        end
      until stp > 1;

{**** end function word search ****}
{**** we now begin the final pass of the parser, which checks the
length of the units, and adjusts them so that they are no
greater than 20 characters in length ****}

pf:=1;
sto:=0;
flg:=0;

while not (text[pf] in ['A'..'Z']) do
  pf:=pf+1;

pl:=pf+1;

while not (text[pl] in ['*']) do
  pl:=pl+1;

mid:=4;

```

```

repeat
  numchar:=pl-pf;

  if numchar<=20 then flg:=3;
  if numchar>20 then mid:=(numchar div 2)+pf;

  if (text[mid]=' ') and (flg<1) then
    begin
      text[mid]:='*';
      flg:=2;
    end;

  mid1:=mid-1;
  mid2:=mid+1;

while (flg<1) do
  begin

    if text[mid1]=' ' then
      begin
        text[mid1]:='*';
        flg:=2;
      end
    else if text[mid2]=' ' then
      begin
        text[mid2]:='*';
        flg:=2;
      end;
    mid1:=mid1-1;
    mid2:=mid2+1;
  end; {while}

  if flg=3 then pf:=pl+1;
  flg:=0;

  while not (text[pf] in ['A'..'Z','a'..'z']) do
    begin
      if text[pf]='*' then sto:=5;
      pf:=pf+1;
    end;

  pl:=pf+1;
  while not (text[pl] in ['*']) do
    begin
      if text[pl]='*' then sto:=3;
      pl:=pl+1;
    end;

  until (sto<1);

{**** we now end the size adjustment pass of the parser ****}
{**** final part of program outputs the text in an appropriate
      format for later use ****}

for i:= 1 to chin do
  if text[i]='*' then numparse:=numparse+1;

  writeln('there are ',numparse,' windows in this text');

  pl:=78;
  while not (text[pl] in [' ','*']) do
    begin
      pl:=pl-1;
    end;

  for j := 1 to pl
    do begin
      write(outot,text[j]);
    end;

  pf:=pl+1;
  k:=0;

  while (k<1) do
    begin
      writeln(outot);
      pl := pf+78;

      if pl>= chin then
        begin
          pl := chin;
          k:=7;
        end;
      while not (text[pl] in [' ','*'])
        do begin
          pl:=pl-1;
        end;

```

```
for i := pf to pl
do begin
  write(output, text[i]);
end;

pf := pl+1;
end;
writeln(output);
writeln(output, 'EOF');
close(output, lock);
end.
```

Appendix C
Function Words

a	can	nor	what
about	concerning	of	whatever
above	could	off	when
across	dare	on	where
after	despite	once	which
against	do	onto	whichever
all	during	or	while
although	except	ought	who
amid	following	our	whoever
amidst	for	over	whom
amoung	from	past	whose
an	had	regarding	why
and	have	shall	will
are	he	she	with
around	how	should	within
as	I	since	without
at	if	so	would
be	in	than	yet
because	including	that	you
before	into	the	under
behind	is	though	underneath
below	it	through	unless
beneath	like	till	until
besides	may	to	upon
between	might	toward	versus
beyond	must	was	via
but	near	we	
by	need	were	