United States Patent [19]

Kucera et al.

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[54] COLLOCATIONAL GRAMMAR SYSTEM

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[52] **U.S. Cl.** **364/419**; 364/900

[58] **Field of Search** ..... 364/419, 900 MS File, 364/200 MS File

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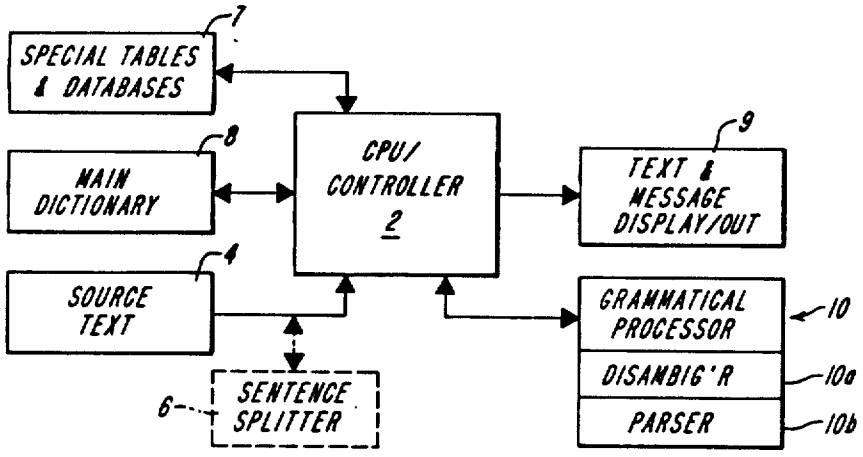
[57] **ABSTRACT**

A system for the grammatical annotation of natural language receives natural language text and annotates each word with a set of tags indicative of its possible grammatical or syntactic uses. An empirical probability of collocation function defined on pairs of tags is iteratively extended to a selected set of tag sequences of increasing length so as to select a most probable tag for each word of a sequence of ambiguously-tagged words. For listed pairs of commonly confused words a substitute calculation reveals erroneous use of the wrong word. For words with tags having abnormally low frequency of occurrence, a stored table of reduced probability factors corrects the calculation. Once the text words have been annotated with their most probable tags, the tagged text is parsed by a parser which successively applies phrasal, predicate and clausal analysis to build higher structures from the disambiguated tag strings. A voice/text translator including such a tag annotator resolves sound or spelling ambiguity of words by their differing tags. A database retrieval system, such as a spelling checker, includes a tag annotator to identify desired data by syntactic features.

17 Claims, 13 Drawing Sheets



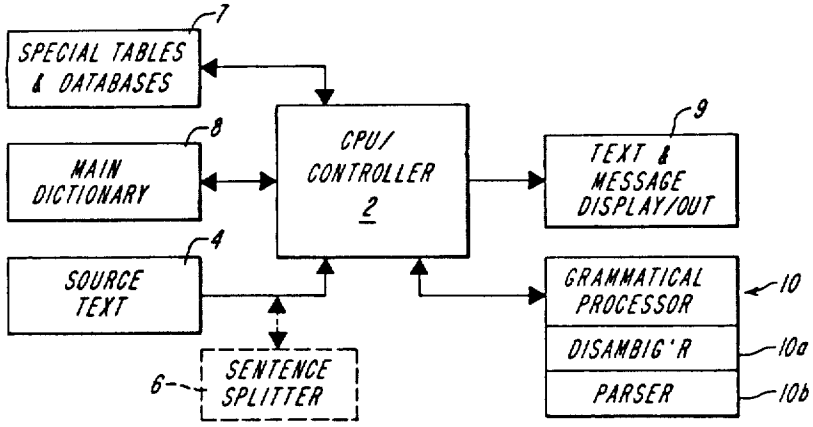


FIG. 1

.	SENTENCE CLOSER (PUNCTUATION TAG)	01
(	OPEN PARENTHESIS (PUNCTUATION TAG)	02
*	"NOT" (ADVERBIAL TAG)	03
)	CLOSE PARENTHESIS (PUNCTUATION TAG)	04
;	SEMI-COLON (PUNCTUATION TAG)	05
-	DASH (PUNCTUATION TAG)	06
,	COMMA (PUNCTUATION TAG)	07
:	COLON (PUNCTUATION TAG)	08
ABL	PRE-QUALIFIER (PRE-NOMINAL TAG)	09
ABN	PRE-QUANTIFIER (PRE-NOMINAL TAG)	10
ABX	PRE-QUANTIFIER/DOUBLE CONJUNCTION (PRE-NOMINAL TAG)	11
AP	POST-DETERMINER (PRE-NOMINAL TAG)	12
AT	ARTICLE (PRE-NOMINAL TAG)	13
BED	"WERE" (VERBAL TAG) <F>	14
BEDZ	"WAS" (VERBAL TAG) <F>	15
BEG	"BEING" (VERBAL TAG) <N>	16
BEI	"BE"-BASE FORM (VERBAL TAG) <N>	17
BEM	"AM" (VERBAL TAG) <F>	18
BEN	"BEEN" (VERBAL TAG) <N>	19
BER	"ARE" (VERBAL TAG) <F>	20
BEZ	"IS" (VERBAL TAG) <F>	21
CC	COORDINATING CONJUNCTION (SENTENTIAL TAG)	22
CD	CARDINAL NUMBER (PRE-NOMINAL TAG)	23
CS	SUBORDINATING CONJUNCTION (SENTENTIAL TAG)	24
DOD	"DID" (VERBAL TAG) <F>	25
DOG	"DOING" (VERBAL TAG) <N>	26
DOI	"DO"-BASE FORM (VERBAL TAG) <N>	27
DON	"DONE" (VERBAL TAG) <N>	28
DOP	"DO" (VERBAL TAG) <N>	29
DOZ	"DOES" (VERBAL TAG) <F>	30
DT	SINGULAR DETERMINER (PRE-NOMINAL TAG)	31
DTI	SINGULAR/PLURAL DETERMINER (PRE-NOMINAL TAG)	32
DTS	PLURAL DETERMINER (PRE-NOMINAL TAG)	33
DTX	DETERMINER/DOUBLE CONJUNCTION (PRE-NOMINAL TAG)	34
EX	EXTISTENTIAL "THERE" (NOMINAL TAG) <P>	35
HVD	"HAD"; PAST TENSE (VERBAL TAG) <F>	36
HVG	"HAVING" (VERBAL TAG) <N>	37
HVI	"HAVE"-BASE FORM (VERBAL TAG) <N>	38
HVN	"HAD"; PAST PARTICIPLE (VERBAL TAG) <N>	39
HVP	"HAVE" (VERBAL TAG) <N>	40
HVZ	"HAS" (VERBAL TAG) <F>	41
IN	PREPOSITION (SENTENTIAL TAG)	42
JJ	ADJECTIVE (PRE-NOMINAL TAG)	43
JJR	COMPARATIVE ADJECTIVE (PRE-NOMINAL TAG)	44
JJS	SUPERLATIVE ADJECTIVE (PRE-NOMINAL TAG)	45
JJT	SEMANTIC SUPERLATIVE (PRE-NOMINAL TAG)	46
MD	MODAL AUXILARY (VERBAL TAG) <F>	47

FIG. 2
(01 THRU 47)

NN	SINGULAR COMMON NOUN - BASE FORM (NOMINAL TAG) <N>	48
NN$	POSSESSIVE SINGULAR COMMON NOUN (PRE-NOMINAL TAG)	49
NNS	PLURAL COMMON NOUN (NOMINAL TAG) <N>	50
NNS$	POSSESSIVE PLURAL COMMON NOUN(PRE-NOMINAL TAG)	51
NNX	NON-POSSESSIVE COMMON NOUN - BASE FORM (NOMINAL TAG) <N>	52
NP	SINGULAR PROPER NOUN - BASE FORM (NOMINAL TAG) <N>	53
NP$	POSSESSIVE SINGULAR PROPER NOUN (PRE-NOMINAL TAG)	54
NPS	PLURAL PROPER NOUN (NOMINAL TAG) <N>	55
NPS$	POSSESSIVE PLURAL PROPER NOUN (PRE-NOMINAL TAG)	56
NR	SINGULAR ADVERBIAL NOUN - BASE FORM (NOMINAL TAG) <P>	57
NR$	POSSESSIVE SINGULAR ADVERBIAL NOUN (PRE-NOMINAL TAG)	58
NRS	PLURAL ADVERBIAL NOUN (NOMINAL TAG) <P>	59
NRS$	POSSESSIVE PLURAL ADVERBIAL NOUN (PRE-NOMINAL TAG)	60
OD	ORDINAL NUMBER (PRE-NOMINAL TAG)	61
PN	NOMINAL PRONOUN (NOMINAL TAG) <P>	62
PN$	POSSESSIVE NOMINAL PRONOUN (PRE-NOMINAL TAG)	63
PP$	POSSESSIVE PRONOUN (PRE-NOMINAL TAG)	64
PP$$	SECOND POSSESSIVE PRONOUN (NOMINAL TAG) <P>	65
PPL	SINGULAR REFLEXIVE PRONOUN (NOMINAL TAG) <P>	66
PPLS	PLURAL REFLEXIVE PRONOUN (NOMINAL TAG) <P>	67
PPO	OBJECTIVE PERSONAL PRONOUN (NOMINAL TAG) <P>	68
PPS	THIRD PERSON NOMINATIVE PERSONAL PRONOUN(NOMINAL TAG <P>	69
PPSS	NON-THIRD PERSON NOMINATIVE PERSONAL PRONOUN (NOMINAL TAG) <P>	70
PPX	NON-POSSESSIVE PERSONAL PRONOUN (NOMINAL TAG) <P>	71
QL	QUALIFIER (PRE-NOMINAL TAG)	72
QLP	POST-QUALIFIER (PRE-NOMINAL TAG)	73
RB	ADVERB (ADVERBIAL TAG)	74
RBR	COMPARATIVE ADVERB (ADVERBIAL TAG)	75
RBT	SUPERLATIVE ADVERB (ADVERBIAL TAG)	76
RN	NOMINAL ADVERB (ADVERBIAL TAG)	77
RP	ADVERB/PARTICLE (ADVERBIAL TAG)	78
TO	INFINITIVAL "TO" (VERBAL TAG) <(IN)>	79
UH	EXCLAMATION (SENTENTIAL TAG)	80
VBD	VERB PAST TENSE FORM (VERBAL TAG) <F>	81
VBG	VERB PRESENT PARTICIPLE (VERBAL TAG) <N>	82
VBI	VERB INFINITIVE - BASE FORM (VERBAL TAG) <N>	83
VBN	VERB PAST PARTICIPLE (VERBAL TAG) <N>	84
VBP	VERB NON-THIRD PERSON SINGULAR, PRESENT TENSE (VERBAL TAG) <N>	85
VBZ	VERB THIRD-PERSON SINGULAR, PRESENT TENSE (VERBAL TAG) <F>	86
WDT	WH-DETERMINER (PRE-NOMINAL TAG)	87
WP$	PERSONAL WH-PRONOUN (PRE-NOMINAL TAG)	88
WPO	OBJECTIVE WH-PRONOUN (NOMINAL TAG) <P>	89
WPS	NOMINATIVE WH-PRONOUN (NOMINAL TAG) <P>	90
WQL	WH-QUALIFIER (PRE-NOMINAL TAG)	91
WRB	WH-ADVERB (ADVERBIAL TAG)	92
XX	-PARSER INTERNAL - NO TAG ASSIGNED-	93
ZZZZ	END-OF-FILE MARKER	94

FIG. 2
(48 THRU 94)

EXAMPLES OF "NORMAL" MAIN DICTIONARY RECORDS

/1	/26	/30	/34	/80
.			.	
!			.	
a			AT	
aback			RB	
abandonment	NI			
abase		VI		
abasement	NI			
abashed			JJ	
as			CS IN QL RB	
back	NI	VI	JJ RB	
backing	NI			

FIG. 3A

EXAMPLES OF "EXCEPTION" MAIN DICTIONARY RECORDS

/1	/26	/30	/34	/80
adieu	NIs		(NN: adieus/adieux)	$
adieus	N4p		(NNS: adieu)	$
adieux	N4p		(NNS: adieu)	$
am			BEM (xref: be)	$
are			BER (xref: be)	$
arise			(VBI-1: arose/arisen)	$
arisen			(VBN: arise)	$
arose			(VBD: arise)	$
ate			(VBD: eat)	$
awake			JJ RB (VBI-1: awoke/awoken)	$
awoke			(VBD: awake)	$
awoken			(VBN: awake)	$
bacilli			(NNS: bacillus)	$
bacillus			(NN: bacilli)	$
bade			(VBX: bid)	$
base			(NN: bases)	$
bases			(NNS: base/basis)	$
basis			(NN: bases)	$
be			BEI (xref: is)	$
bear			(VBI-1: bore/borne)	$

FIG. 3B

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