Corpus Storage

IB047

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Corpus storage

- enumeration, lexicon
- text, compression
- indexes
- structures
- suffix trees

Corpus model

- corpus consists of attributes and structures
- each one has name (= file prefix)
- each one is independent, they are linked by token numbers
- corpus is sequence of tokens, token numbers from 0 to the size of the corpus (-1)
- standard attribute names: word, tag, lemma, lempos

```
<doc id="S001"
   author="Sha">
<phr type="V">
to     TO
be     VB
</phr>
or     C
<phr type="V">
not    NOT
to     TO
be     VB
</phr>
</doc>
```

Enumeration

- using numbers instead of objects
- example: charsets
- corpus:
  - object: value of attributes on each token, value of structures' attributes
  - words, tags, ...
  - each type has its own sequence of numbers

Lexicon

enumaration of an attribute values

- basic functions:
  - word $\rightarrow$ number
  - number $\rightarrow$ word
- word = character string without any structure
- basic functions:
  - find words matching a regular expression
  - sorting using locales

Lexicon implementation

attr.lex `'\0'` separated strings

attr.lex.idx array of string starts

attr.lex.srt alphabetically sorted string numbers

```
$ od -t a 2bv-2b/word.lex
0000000   t   o nul   b   e nul   o   r nul   n   o   t nul

$ od -td4 2bv-2b/word.lex.idx
0000000           0           3           6           9

$ od -td4 2bv-2b/word.lex.srt
0000000           1           3           2           0
```

Lexicon implementation

Usage

- `lslex` for listing
- `lslex -m` for building `.srt` file
- `lsclex` for listing corpus lexicon (with freqs)

```
$ lslex 2bv-2b/word
0 to
1 be
2 or
3 not

$ lslex 2bv-2b/word|sort -k2
1 be
3 not
2 or
0 to
```

Storage of corpus text

- sequence of positions
- one word ID on each position
- simple storage = array of 32-bit numbers
  used for attributes of structures
- file `attr.text`
- the biggest part of stored data
  $\rightarrow$ compression

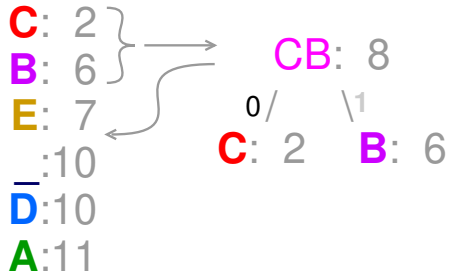
Compression of corpus text

- codes for each number
- different code length
- shorter codes for more frequent words
- Huffman coding
  - optimal code
  - requires code table

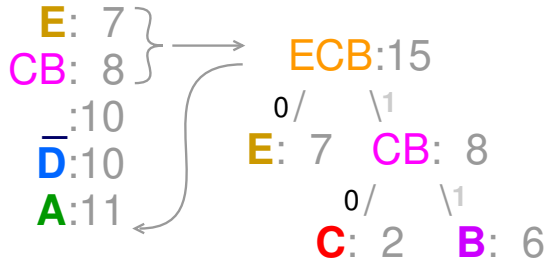
Huffman coding

1. "A_DEAD_DAD_CEDED_A_BAD_BABE_A_BEADED_ABACA_BED"

2.



3.



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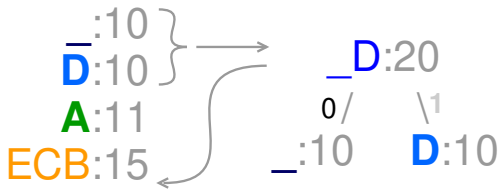

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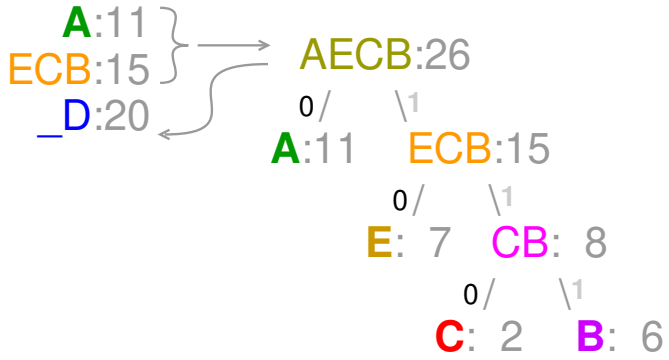

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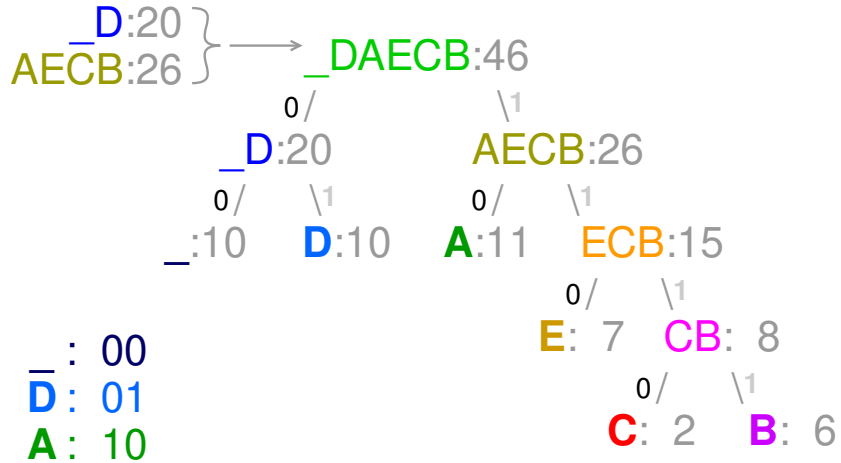


7.

_ : 00
D : 01
A : 10
E : 110
C : 1110
B : 1111

8. "1000011101001000110010011101100111001001000111111001001111101111110
001000111111010011100100101111101110100011111 1001"

Universal codes

non-parametric, prefix-free, universal

N	unary	binary	gamma	delta
0	1	0000	1	1
1	01	0001	01 0	010 0
2	001	0010	01 1	010 1
3	0001	0011	001 00	011 00
4	00001	0100	001 01	011 01
5	000001	0101	001 10	011 10
6	0000001	0110	001 11	011 11
7	00000001	0111	0001 000	00100 000
8	000000001	1000	0001 001	00100 001
9	0000000001	1001	0001 010	00100 010

Compressed text implementation

attr.text delta codes of numbers

attr.text.seg starts of a segments (64 positions) in bits

```
$ od -t x1 word.text
0000000 a3 66 69 6e 44 54 00 00 00 00 00 00 00 00 00 00
0000020 88 80 07 00 00 00 00 00 00 00 00 00 00 00 00 00
0000040 45 4d 01

$ od -t d4 word.text.seg
0000000          256          275
```

Indexes

- store hits for each word
- basic functions:
  - word ID $\rightarrow$ list of positions
  - word ID$\rightarrow$ number of hits

Index implementation

attr.rev lists of positions
delta coding used for position differences

attr.rev.idx array of lists' starts

attr.rev.cnt array of lists' sizes

```
$ od -t x1 word.rev
0000000 a3 66 69 6e 44 52 02 0d 62 00 0a 06

$ od -t d4 word.rev.idx
0000000          7          8         10         11
0000020         12

$ od -t d4 word.rev.cnt
0000000          2          2          1          1
```

Structures

- `struct.rng` – array of (begin,end) pairs
- 32-bit or 64-bit (if TYPE is map64 or file64)
- attributes form a “corpus”

```
<doc id="S001"
   author="Sha">
<phr type="V">
to    TO
be    VB
</phr>
or    C
<phr type="V">
not   NOT
to    TO
be    VB
</phr>
</doc>
```

```
Main corpus
                    doc          phr

to    TO
be    VB
or    C
not   NOT           S001  Sha    V
to    TO                         V
be    VB
```

Structure implementation

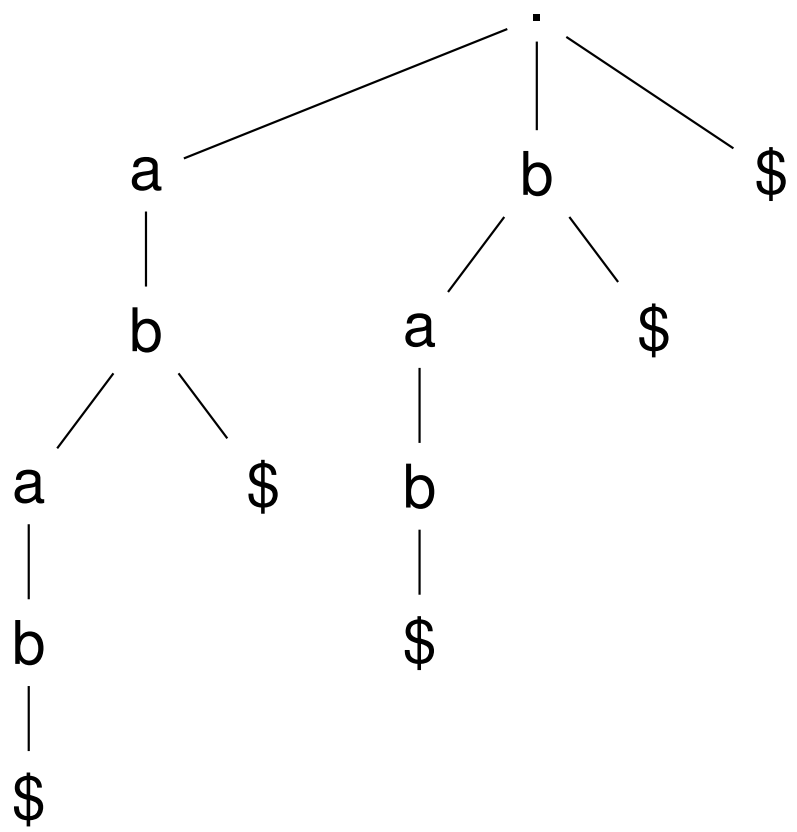
```
$ od -t d4 doc.rng
0000000          0          6

$ od -t d4 phr.rng
0000000          0          2          3          6

$ ls phr.*
phr.rng            phr.type.lex.srt  phr.type.rev.idx
phr.type.lex       phr.type.rev      phr.type.text
phr.type.lex.idx   phr.type.rev.cnt

$ od -t d4 phr.type.text
0000000  1852401315      21577          0          0
0000020            0          0
```

Sufixové stromy

- suffix tree, position tree, subword tree
- pro řetězec znaků
  - všechny podřetězce končící posledním znakem
  - přidáváme speciální symbol ”konec”, aby žádný řetězec nebyl prefixem jiného
  - z podřetězců vytvoříme trie (digitální strom)

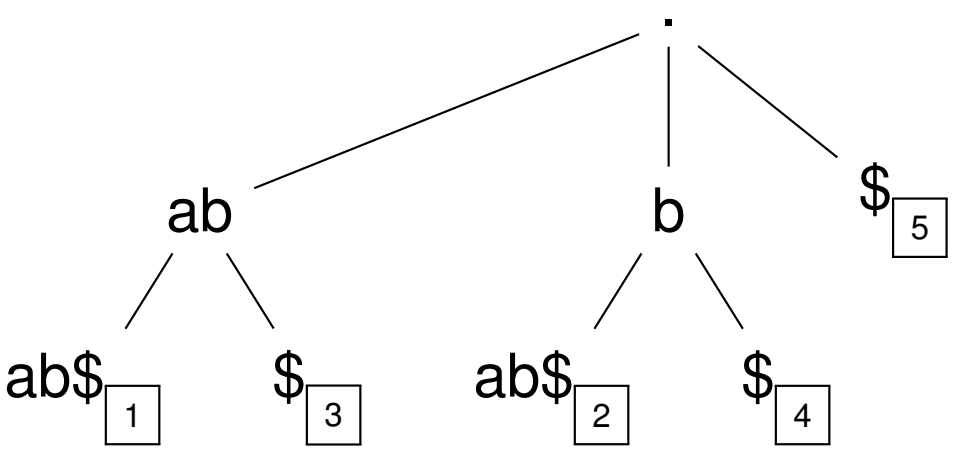
Sufixové stromy - příklad

- řetězec: `abab$`
- podřetězce:
  1. `abab$`
  2. `bab$`
  3. `ab$`
  4. `b$`
  5. `$`



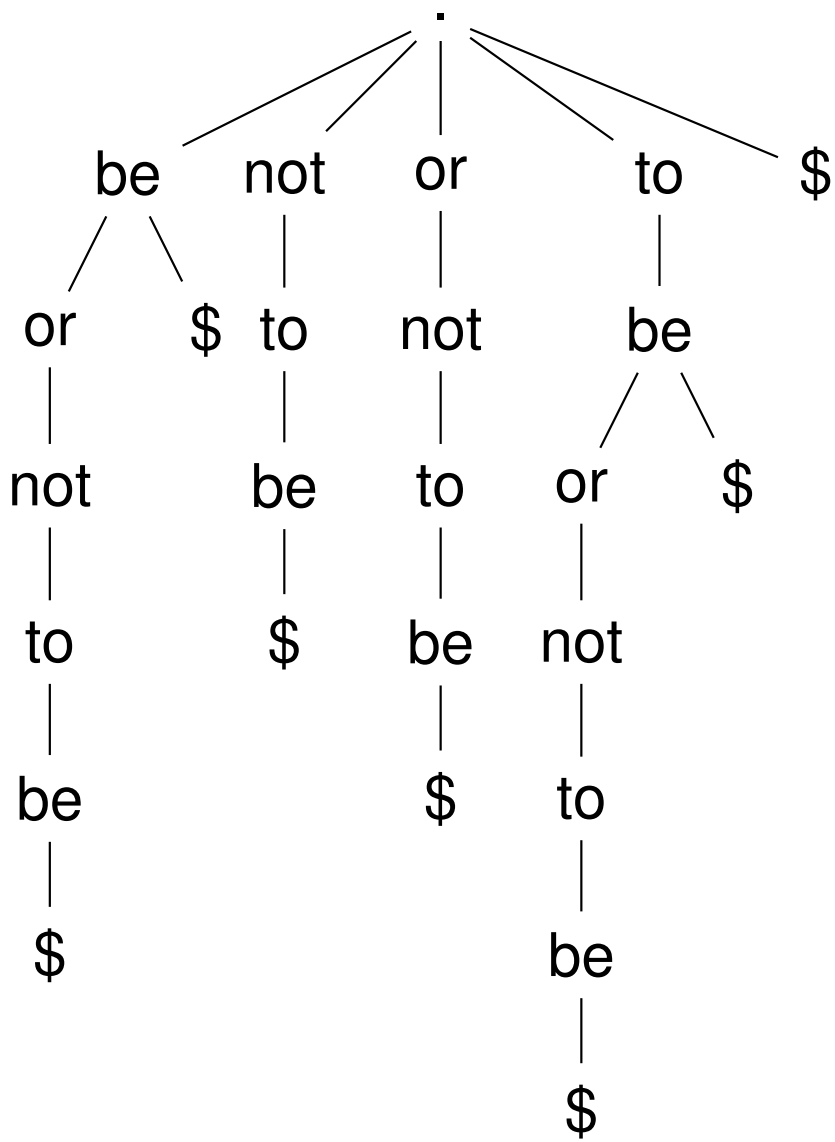
Sufixové stromy - vlastnosti

- řetězec délky N
  - N listů
  - v kompaktním trie max. 2*N uzlů
- listy ohodnoceny pozicí
- vnitřní uzly ohodnoceny velikostí podstromu



Sufixové stromy pro korpus

- znaky $\rightarrow$ slova
- řetězec $\rightarrow$ text korpusu
- funkce
  - strom (seznam) pozic pro každé slovo i posloupnost slov
  - upořádání pozic je lexikografické



Sufixová pole

- suffix array, PAT array
- optimální uložení sufixových stromů
- uložení pozic v listech suf. stromu podle pevného uspořádání hran
- stejné funkce jako suf. stromy

abab$:

1	3	2	4	5

to be or not to be $:

1	5	3	2	0	4	6