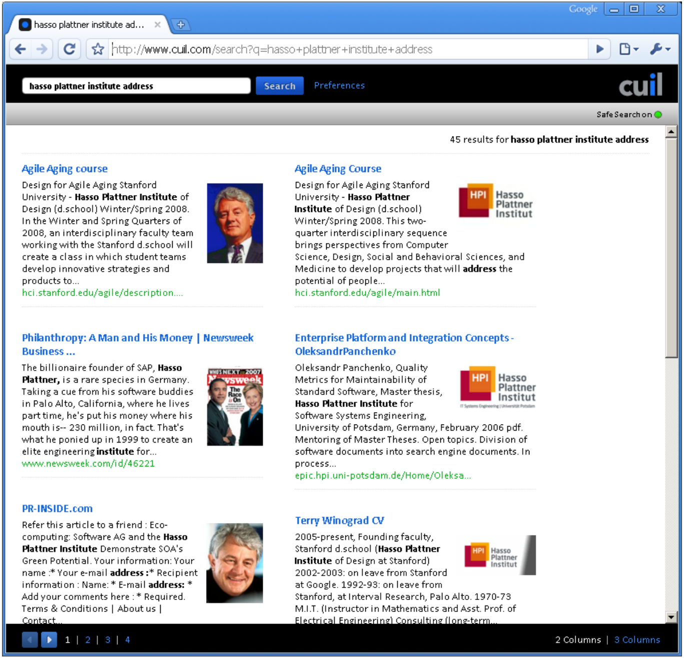
Fast Generation of Result Snippets in Web Search

Felix Geller

January 20, 2009

Agenda

- What are “snippets”?
- How do they fit in?
- Possible difficulties
- Speeding up snippet generation
  - Document compression
  - Document compaction
- Summary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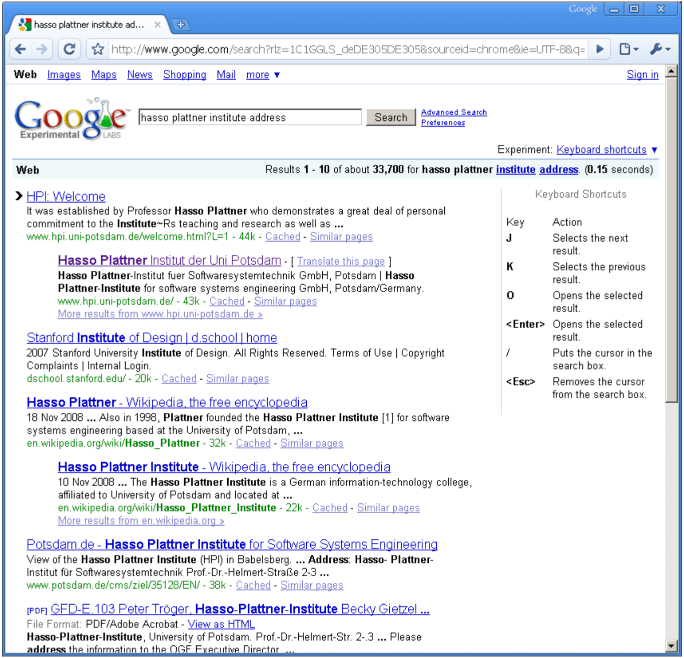
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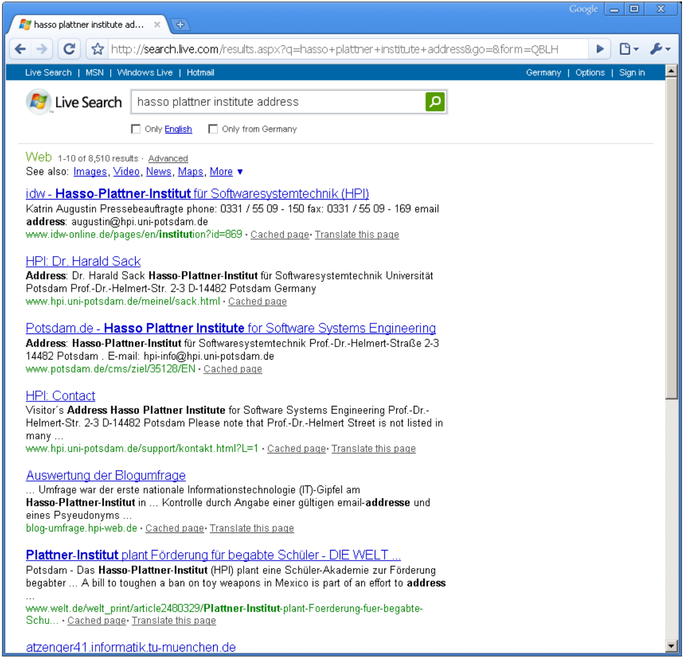
Keyboard Shortcuts

Key	Action
J	Selects the next result.
K	Selects the previous result.
O	Opens the selected result.
<Enter>	Opens the selected result.
/	Puts the cursor in the search box.
<Esc>	Removes the cursor from the search box.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Query-Biased Snippets

> **Snippets** *are short fragments of text extracted from the document content (or its metadata). ... A* **query-biased** *snippet is one selectively extracted on the basis of its relation to the searcher's query.* **[4]**

→ **Quickly** identify relevant documents **without opening** the document as a whole.

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- What are “snippets”?
- **How do they fit in?**
- Possible difficulties
- Speeding up snippet generation
  - Document compression
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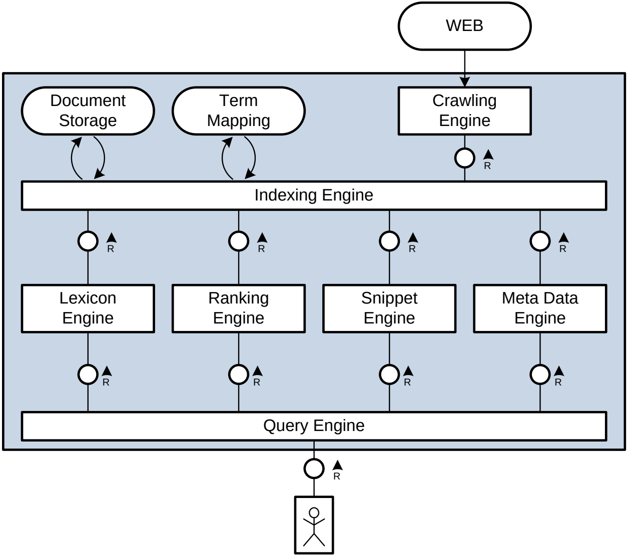
Abstract Search Engine Architecture



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Possible Difficulties

Relevance Query-biased, i.e. non-static summary.

Context "John McCarthy Ph.D. 1951 –
Creator of the **LISP** Programming Language." [5]

Speed
- Storage: "order of ten billion web pages" [4]
- Load: "hundreds of millions of search queries per day" [4]
- Response: File I/O is a major bottleneck

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Speed → Use Caches

[M]ajority of time spent generating a snippet is in locating the document on disk . . . : 64% for whole documents.

*With 1% of documents cached, . . . around 80% of disk seeks are avoided.***[4]**

Disk Cache	Managed by OS, e.g. stores frequently accessed documents
Query Cache	Stores precomputed result pages for popular queries
Document Cache	Stores frequently accessed documents in main memory

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Document Compression: Concepts

- Compressed Token System (CTS)
- Document content is normalized (convert `br`, remove tags)
- Atomic entity: Word
- Entity of interest: Sentence
- Replace words with numbers
- vbyte coding scheme (think UTF-8)
- Words alternate non-words (i.e. punctuation)

Document Compression: Algorithm

1st Pass

- Collect words
- Collect non-words
- Construct model

2nd Pass

- Replace words and non-words
- Escape words which are not encoded

Document Compression: Example

Educators, generals, dieticians, psychologists, and parents program.

Armies, students, and some societies are programmed.

An assault on large problems employs a succession of programs, most of which spring into existence en route.

These programs are rife with issues that appear to be particular to the problem at hand.

To appreciate programming as an intellectual activity in its own right you must turn to computer programming;

you must read and write computer programs -- many of them.

It doesn’t matter much what the programs are about or what applications they serve.

What does matter is how well they perform and how smoothly they fit with other programs in the creation of still greater programs.

Sample taken from [1]

Document Compression: Example

Word Model

Code	Word
0	"with"
1	"you"
2	"how"
3	"are"
4	"in"
5	"computer"
...	...

Non-Word Model

Code	Non-word
0	" "
1	"."
2	", "
3	" _ "
4	"""
5	";"

Document Compression: Example

```
|Educators2|generals2|dieticians2|psychologists260|parents0|program1

|Armies2|students260|some0|societies030|programmed1

|An0|assault0|on0|large0|problems0|employs0|a0|succession0140112|most
     0140|which0|spring0|into0|existence0|en0|route1

|These011030|rife000|issues0|that0|appear090|be0|particular090120
     |problem0|at0|hand1

|To0|appreciate0100|as0|an0|intellectual0|activity040|its0|own0|right
     010130|turn09050105

10130|read060|write050113|many0140|them1

|It0|doesn4|t080|much07012011030|about0|or070|applications0150|serve1

|What0|does080|is020|well0150|perform06020|smoothly0150|fit000|other
     011040120|creation0140|still0|greater0111
```

Document Compression: Gain I/II

	WT10G	WT50G	WT100G
No. Docs ($\times 10^6$)	1.7	10.1	18.5
Raw Text	10,522 MB	56,684 MB	102,833 MB
Baseline (*zlib*)	24%	19%	19%
CTS (+1024 MB)	26%	21%	22%

Taken from [4]

Document Compression: Gain II/II

	WT10G	WT50G	WT100G
Baseline	75	157	183
CTS	38	70	77
Reduction in time	49%	56%	58%

Average time (ms) for the final 7000 queries.

Taken from [4]

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Document Compaction: Concepts

- Reduce size of documents
  → Remove sentences which are deemed insignificant
- Reduce query time
  → Order sentences by significance

Document Compaction: Techniques

Natural order First sentence should introduce paragraph!

Significant terms (ST) Score based on term frequency [2]

Query log based (QLt) Score based on past query terms

Query log based (QLu) Same as QLt, but considers only unique terms

Intermezzo: Sentence Ranking

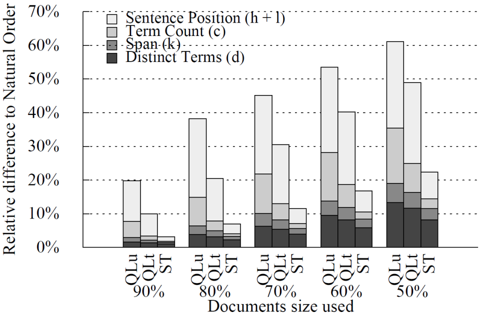
Document is broken into sentences S where $S = [w_1, w_2, ..., w_m]$.
Query Q where $Q = \{q_1, q_2, ..., q_n\}$

h	sentence is a heading
l	sentence is first or second line of document
k	length of longest contiguous run of q_i in S
c	count of $w_j \in Q$
d	c minus repititions

Impact on Sentence Ranking

Impact of omitting 50% of sentences based on ST

h + *l*	approximately 8% change
c	approximately 2% change
k	approximately 3% change
d	approximately 8% change



Taken from [4]

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Summary

- What are “snippets”?
  ⟶ Query-biased text fragments, facilitating the identification of relevant information.
- Possible difficulties
  ⟶ Relevance, Context, Speed.
- Speeding up snippet generation ⟶ Make use of caches.
  - Document compression
    ⟶ Encode words using numbers, make use of dictionary.
  - Document compaction
    ⟶ Reducing document size by 50% has arguably low impact.

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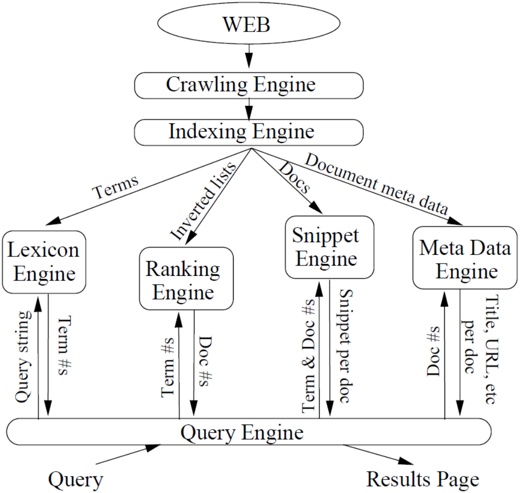

Taken from [4]

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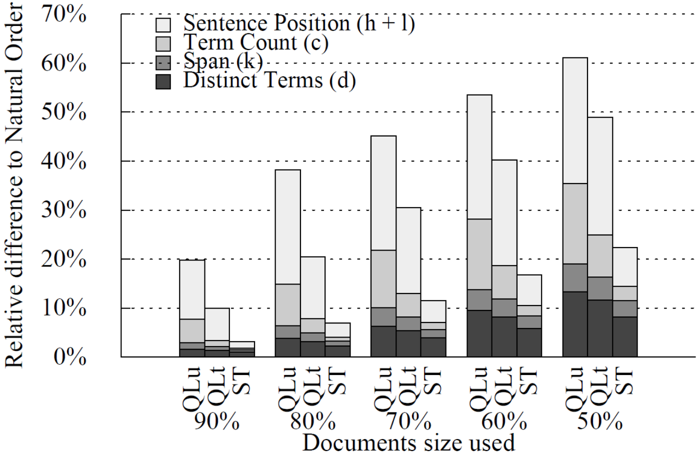

Taken from [4]

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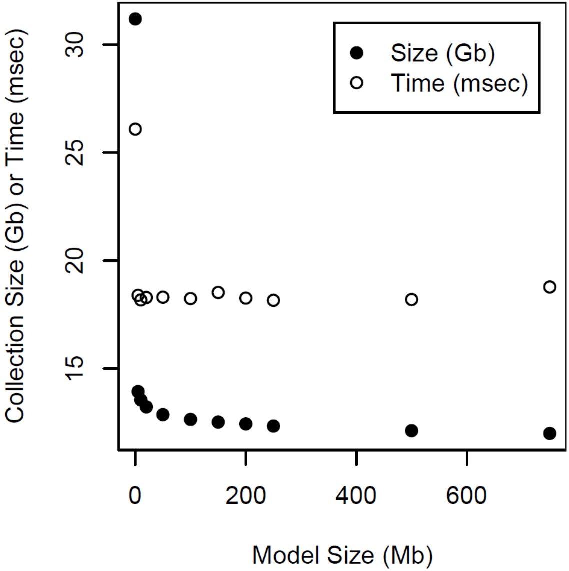

Taken from [4]

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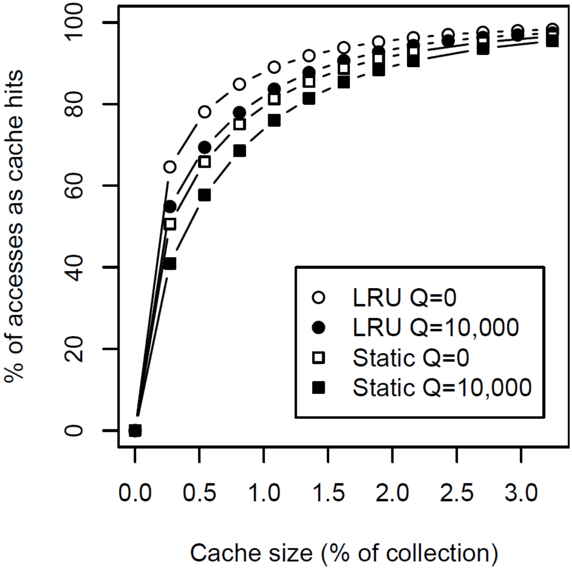

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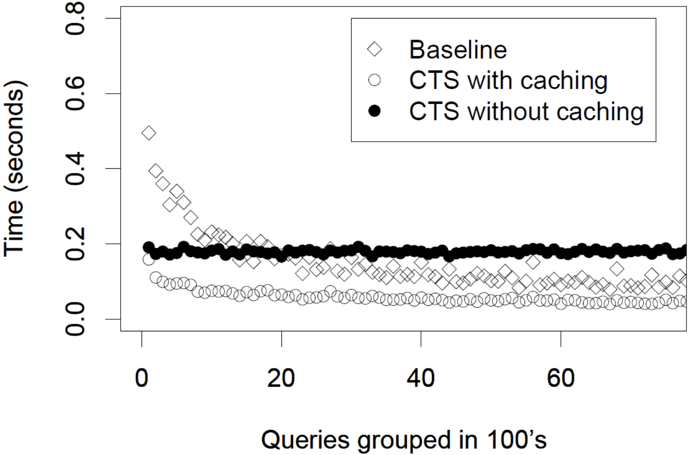

Taken from [4]

Backup Slide

Let $f_{d,t}$ be the frequency of term t in document d, then term t is determined to be significant if:

$$f_{d,t} \leq \begin{cases} 7 - 0.1 \times (25 - s_d), & \text{if } s_d < 25 \\ 7, & \text{if } 25 \leq s_d \leq 40 \\ 7 + 0.1 \times (s_d - 40), & \text{otherwise} \end{cases}$$

where s_d is the number of sentences in document d.

A *bracketed section* is defined as a group of terms where the leftmost and rightmost terms are significant terms, and no significant terms in the bracketed section are divided by more than four non-significant terms.

The *score for a bracketed section* is the square of the number of significant words falling in the section, divided by the total number of words in the entire sentence.

The *score for a sentence* is the maximum of all scores for the bracketed sections of the sentence.

Quoted from [4], technique based on [2], [3].