Information Retrieval

Γλώσσες Επερώτησης
Query Languages

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Διάρθρωση Διάλεξης

- **Keyword-based Queries**
  - **Single words Queries**
  - **Context Queries**
    - **Phrasal Queries**
    - **Proximity Queries**
  - **Boolean Queries**
  - **Natural Language Queries**
- **Pattern Matching**
  - **Simple**
  - **Allowing errors (Levenstein distance, LCS longest common subsequence)**
  - **Regular expressions**
- **Structural Queries** *(will be covered in a subsequent lecture)*
- **Query Protocols**

Διάρθρωση Διάλεξης

- Ο τύπος των επερωτήσεων που επιτρέπονται σε ένα σύστημα εξαρτάται από το Μοντέλο Ανάκτησης που χρησιμοποιεί το σύστημα

- Εδώ θα δούμε τι είδους επερωτήσεων μπορεί να έχουμε

Single-Word Queries

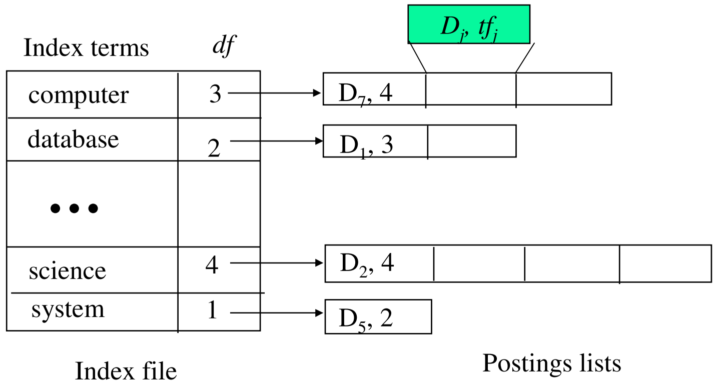
Context-Queries

- Ability to search words in a given context, that is, near other words
- Types of Context Queries
  - Phrasal Queries
  - Proximity Queries

Phrasal Queries

- Retrieve documents with a specific phrase (**ordered** list of contiguous words)
  - “information theory”
  - “to be or not to be”
- May allow intervening stop words and/or stemming.
  - “**buy camera**” matches:
  - “buy a camera”,
  - “buy   a   camera”, (two spaces)
  - “buying the cameras” etc.

(inverted index)



Index terms	df
computer	3
database	2
• • •	
science	4
system	1

Phrasal Retrieval with Inverted Indices

- Must have an inverted index that also stores *positions* of each keyword in a document.
- Retrieve documents and positions for each individual word, intersect documents, and then finally check for ordered contiguity of keyword positions.
- Best to start contiguity check with the least common word in the phrase.
- ***Περισσότερα στην Διάλεξη περί ”Indexing and Searching”***

Επερωτήσεις Εγγύτητας
(Proximity Queries)

- List of words with **specific maximal distance** constraints between terms.
- Example:
  - **"dogs" and "race"** **<u>within 4 words</u>**
- will match
  - "…dogs will begin the race…"
- May also perform stemming and/or not count stop words.
- The order may or may not be important

Proximity Retrieval with Inverted Index

- Use approach similar to phrasal search to find documents in which all keywords are found in a context that satisfies the proximity constraints.
- During binary search for positions of remaining keywords, find closest position of k_i to p and check that it is within maximum allowed distance.
- ***Περισσότερα στην Διάλεξη περί "Indexing and Searching"***

Boolean Queries

- Keywords combined with Boolean operators:
  - OR: (e_1 OR e_2)
  - AND: (e_1 AND e_2)
  - BUT: (e_1 BUT e_2) Satisfy e_1 but **not** e_2
- Negation only allowed using BUT to allow efficient use of inverted index by filtering another efficiently retrievable set.
- Naïve users have trouble with Boolean logic.

Αποτίμηση με χρήση ανεστραμμένων αρχείων

- Primitive keyword: Retrieve containing documents using the inverted index.
- OR: Recursively retrieve e_1 and e_2 and take union of results.
- AND: Recursively retrieve e_1 and e_2 and take intersection of results.
- BUT: Recursively retrieve e_1 and e_2 and take set difference of results.

Επερωτήσεις φυσικής γλώσσας (“Natural Language” Queries)

- Full text queries as arbitrary strings.
- Typically just treated as a **bag-of-words** for a vector-space model.
- Typically processed using standard vector-space retrieval methods.

Pattern Matching

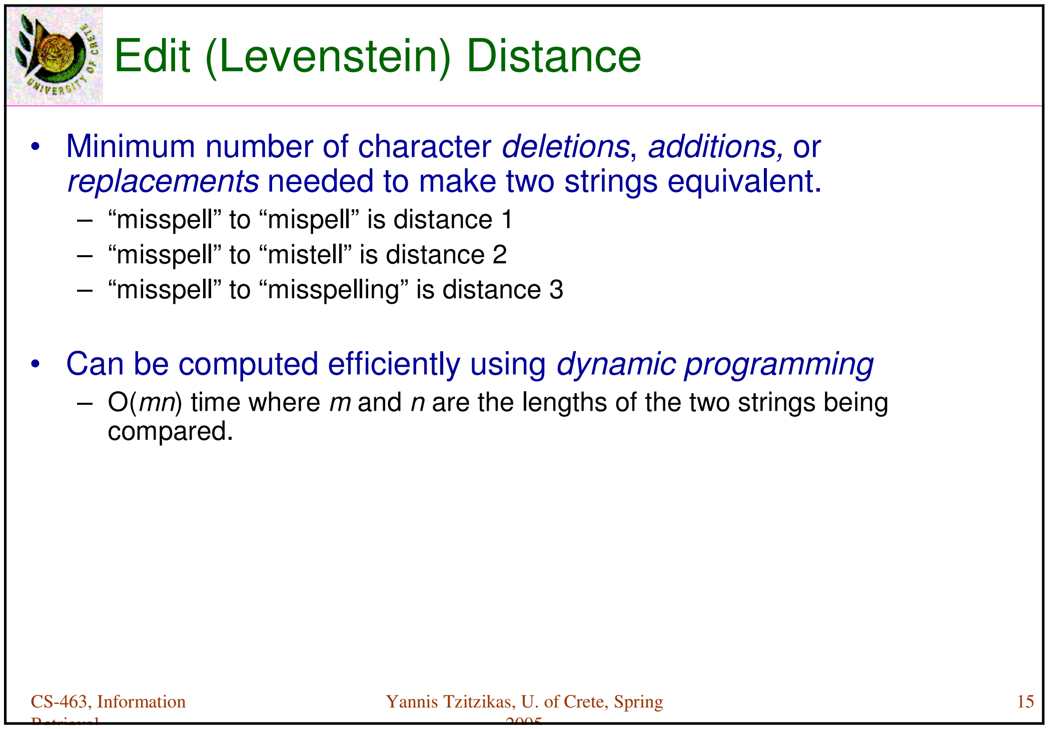
- Allow queries that match strings rather than word tokens.
- Requires more sophisticated data structures and algorithms than inverted indices to retrieve efficiently.

Some types of simple patterns:

- **Prefixes**: Pattern that matches start of word.
  - "anti" matches "antiquity", "antibody", etc.
- **Suffixes**: Pattern that matches end of word:
  - "ix" matches "fix", "matrix", etc.
- **Substrings**: Pattern that matches arbitrary subsequence of characters.
  - "rapt" matches "enrapture", "velociraptor" etc.
- **Ranges**: Pair of strings that matches any word lexicographically (alphabetically) between them.
  - "tin" to "tix" matches "tip", "tire", "title", etc.

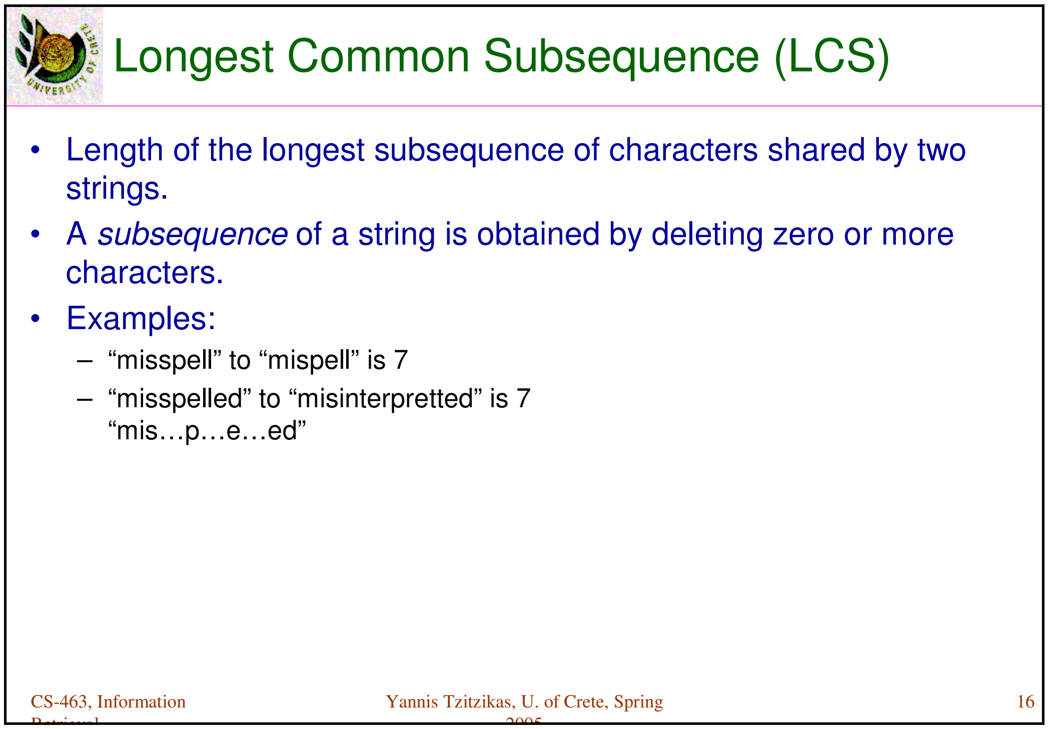
More Complex Patterns: Allowing Errors

- What if query or document contains typos or misspellings?
- Judge similarity of words (or arbitrary strings) using:
  - **Edit distance (Levenstein distance)**
  - **Longest Common Subsequence (LCS)**
- Allow proximity search with bound on string similarity.



Edit (Levenstein) Distance

- Minimum number of character *deletions*, *additions,* or *replacements* needed to make two strings equivalent.
  - “misspell” to “mispell” is distance 1
  - “misspell” to “mistell” is distance 2
  - “misspell” to “misspelling” is distance 3
- Can be computed efficiently using *dynamic programming*
  - O(*mn*) time where *m* and *n* are the lengths of the two strings being compared.



Longest Common Subsequence (LCS)

- Length of the longest subsequence of characters shared by two strings.
- A *subsequence* of a string is obtained by deleting zero or more characters.
- Examples:
  - “misspell” to “mispell” is 7
  - “misspelled” to “misinterpretted” is 7 “mis…p…e…ed”

More complex patterns: Regular Expressions

- Language for composing complex patterns from simpler ones.
  - An individual character is a regex.
  - Union: If e_1 and e_2 are regexes, then (e_1 / e_2) is a regex that matches whatever either e_1 or e_2 matches.
  - Concatenation: If e_1 and e_2 are regexes, then e_1 e_2 is a regex that matches a string that consists of a substring that matches e_1 immediately followed by a substring that matches e_2
  - Repetition (Kleene closure): If e_1 is a regex, then e_1* is a regex that matches a sequence of zero or more strings that match e_1

Regular Expression Examples

- **(u|e)nabl(e|ing)** matches
  - unable
  - unabling
  - enable
  - enabling
- **(un|en)***able matches
  - able
  - unable
  - unenable
  - enununenable

Enhanced Regex's (Perl)

- Special terms for common sets of characters, such as alphabetic or numeric or general “wildcard”.
- Special repetition operator (+) for 1 or more occurrences.
- Special optional operator (?) for 0 or 1 occurrences.
- Special repetition operator for specific range of number of occurrences: {min,max}.
  - A{1,5} One to five A's.
  - A{5,} Five or more A's
  - A{5} Exactly five A's

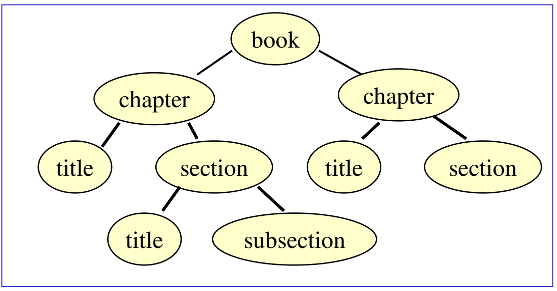
Perl Regex's

- Character classes:
  - \w (word char) Any alpha-numeric (not: \W)
  - \d (digit char) Any digit (not: \D)
  - \s (space char) Any whitespace (not: \S)
  - . (wildcard) Anything
- Anchor points:
  - \b (boundary) Word boundary
  - ^ Beginning of string
  - $ End of string
- Examples
  - U.S. phone number with optional area code:
    - `/\b(\(\d{3}\)\s?)?\d{3}-\d{4}\b/`
  - Email address:
    - `/\b\S+@\S+(\.com|\.edu|\.gov|\.org|\.net)\b/`

Note: Packages available to support Perl regex's in Java

Δομικές Επερωτήσεις (Structural Queries)

- Εδώ τα έγγραφα έχουν **δομή** που μπορεί να αξιοποιηθεί κατά την ανάκτηση
- Η δομή μπορεί να είναι:
  - Ένα προκαθορισμένο σύνολο πεδίων
    - title, author, abstract, etc.
  - Δομή Hypertext
  - Μια ιεραρχική δομή
    - Book, Chapter, Section, etc.



- ***Θα τις μελετήσουμε αναλυτικά σε μια άλλη διάλεξη***

Query Protocols

- They are not intended for final users
- They are query languages that are used automatically by software applications to query text databases
- Some of them are proposed as standard for querying CD-ROMs or as intermediate languages to query library systems

Some Query Protocols (I):

- Z39.50
  - 1995 standard ANSI, NISO
  - bibliographical information
- WAIS (Wide Area Information Service)
  - used before the Web
- Dienst Protocol
- For CD-ROMS
  - CCL (Common Command Language)
    - 19 commands. Based on Z39.50
  - CD-RDx (Compact Disk Read only Data Exchange)
  - SFQL (Structured Full-text Query Language)

SFQL

- **SFQL** (Structured Full-text Query Language)
  - Relational database query language SQL enhanced with “full text” search.
  - Παράδειγμα:

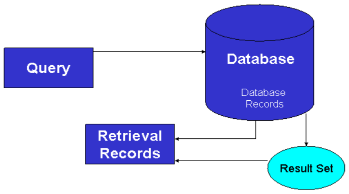
```
Select abstract
from journal.papers
where   author contains “Teller” and
        title contains “nuclear fusion” and
        date < 1/1/1950
```

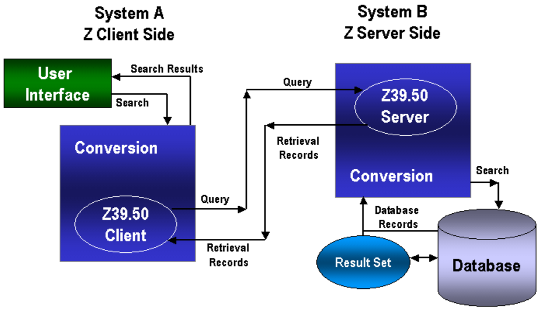
- Supports Boolean operators, thesaurus, proximity operations, wild cards, repetitions.

Some Query Protocols (II)

- **SRW (Search and Retrieve Web Service)**
  - **Extension of Z39.50 using Web Technologies**
  - **Queries in CQL**
- **…**

Z39.50



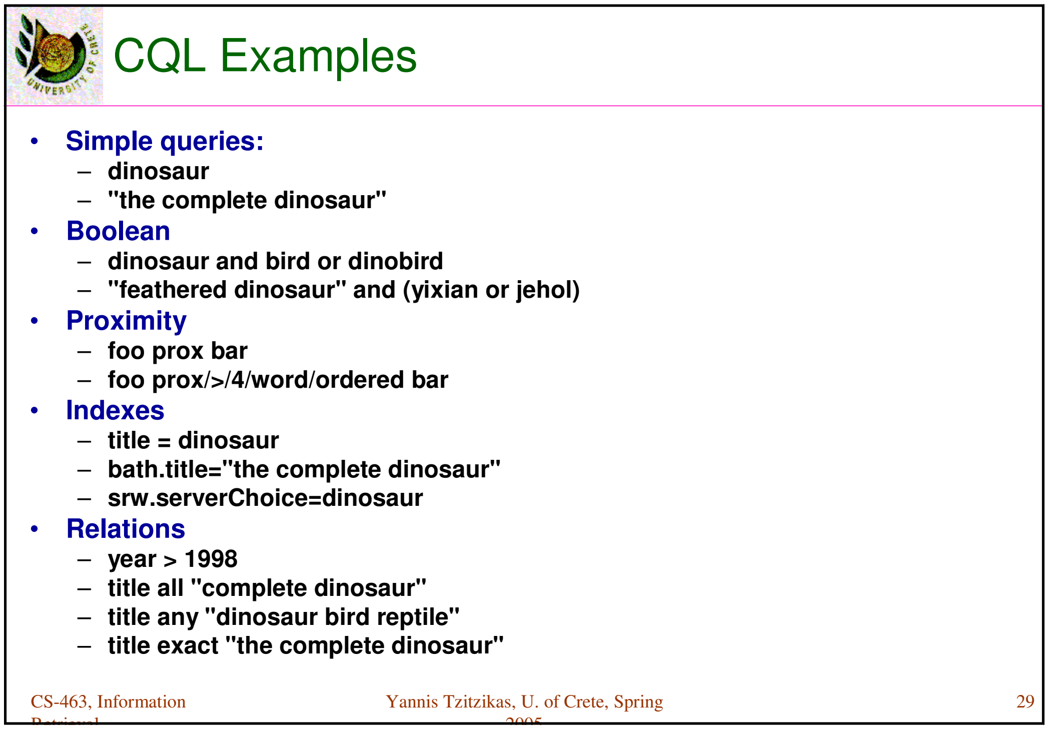


CQL (Common Query Language)

- A formal language for representing queries to information retrieval systems
- Human-readable
- Search clause
  - Always includes a term
    - simple terms consist of one or more words
  - May include index name
    - To limit search to a particular field/element
    - Index name includes base name and may include prefix
      - title, subject
      - dc.title, dc.subject
    - Several index sets have been defined (called Context Sets in SRW)
      - dc
      - bath
      - srw
    - Context set defines the available indexes for a particular application

CQL (Common Query Language) (II)

- Relation
  - <, >, <=, >=, =, <>
  - exact used for string matching
  - all when term is list of words to indicate all words must be found
  - any when term is list of words to indicate any words must be found
- Boolean operators: and, or, not
- Proximity (prox operator)
  - relation (<, >, <=, >=, =, <>)
  - distance (integer)
  - unit (word, sentence, paragraph, element)
  - ordering (ordered or unordered)
- Masking rules and special characters
  - single asterisk (*) to mask zero or more characters
  - single question mark (?) to mask a single character
  - carat/hat (^) to indicate anchoring, left or right



CQL Examples

- **Simple queries:**
  - dinosaur
  - "the complete dinosaur"
- **Boolean**
  - dinosaur and bird or dinobird
  - "feathered dinosaur" and (yixian or jehol)
- **Proximity**
  - foo prox bar
  - foo prox/>/4/word/ordered bar
- **Indexes**
  - title = dinosaur
  - bath.title="the complete dinosaur"
  - srw.serverChoice=dinosaur
- **Relations**
  - year > 1998
  - title all "complete dinosaur"
  - title any "dinosaur bird reptile"
  - title exact "the complete dinosaur"