

COMS W4111 - Introduction to Databases

DBMS Architecture and Implementation: Index (Final), DB Files, Query Processing

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Midcourse Evaluations

Comments and Actions

- Personality:
 - Intimidating: During a dinner conversation,
 - Conversation card: "What one word would most people use to describe you?"
 - Oldest child: "I do not know for me, but for Dad the word is clearly 'dangerous.'"
 - I am cranky and sarcastic.
- Ratings:
 - Summary:
 - Course overall approx. 3.7. Instructor overall approx. 3.8
 - These are approx. 0.4 points lower than normal.
 - Scores normally go up by the end of the semester evaluations.
 - I react to the midterm evaluation and comments.
 - I modify this course every semester and it takes me a little while to fine tune.
- Actions:
 1. I will make the assignment specification more clear. Completing the assignments will be difficult without attending OH/recitations.
 2. Programming versus databases:
 1. This is a 4xxx level computer science course. Course description: "The fundamentals of database design and application development using databases. ... Programming projects are required." "COMS W3137 or W3134 are prereqs."
 2. How do you use databases? You write programs. You do not shout, "Alexa, SELECT * from ..."
 3. You get the basic testing and use of SQL, etc. in the exam questions.
 3. Workload: I will dial it back some.
 4. I need to decide what to do about the step-by-step tutorials for solving the HW and exams. There are pros and cons.

Indexes (Text)

We have discussed two types:

1. B+ Tree
2. Hash

There are several other interesting types and variations on the core type.
One increasingly common type is *inverted text index*.

Seeka TV Demo

seeka.TV AND THE SMALL PRINT

Search 🔍

By Genre By Perspective By Language 🔔 👤

Keyword/term search

Or So the Story Goes

Download on the App Store Download on Apple TV Available on the Channel Store available at amazon appstore GET IT ON Google play

Top Shows

Kate and Joe Just Want to Have SEX Sexy Herpes Pillow Talk Working on It Fem 101 NORTHBOUND Transylvania DEMO

Kate and Joe Just Want to Have Sex Sexy Herpes Pillow Talk Working on It Fem 101 NORTHBOUND Transylvania DEMO

New Episodes and Shows

Sam and Pat are DEPRESSED American Horror Story: Coven Moms Anonymous

Text Search Index

The screenshot shows a search result for the TV show "Sam and Pat Are Depressed". The title is highlighted with a red box. Below it, the genre "Comedy | Women | English | TV-14" is also highlighted. The show's description is enclosed in a large red box: "Roommates Sam and Pat use comedy to navigate the complexities and awkwardness of their individual therapy experiences. Sam frets over how long it takes her to introduce herself to new therapists and whether she's being rude to them, while Pat worries about depressing his therapist and accidentally getting himself put on suicide watch because of poorly-timed nihilistic humor." Below the description are several interactive icons: Trailer, Watch List, Share, Watch Party, and Tip. Two episode thumbnails are shown: "S2 E1: My Therapy Talk Got Cock Blocked" (4:30) and "S2 E2: My Therapist Is Too Attractive" (3:22). Each thumbnail has a play button and a red box highlighting its title and duration. The descriptions for both episodes are also enclosed in red boxes.

- Entities (people, episode, series)
- Have associated text: title, description, genre, ...
- Problem
 - Rapidly find the keywords during text entry.
 - Find associated entities

Keyword/Text Search

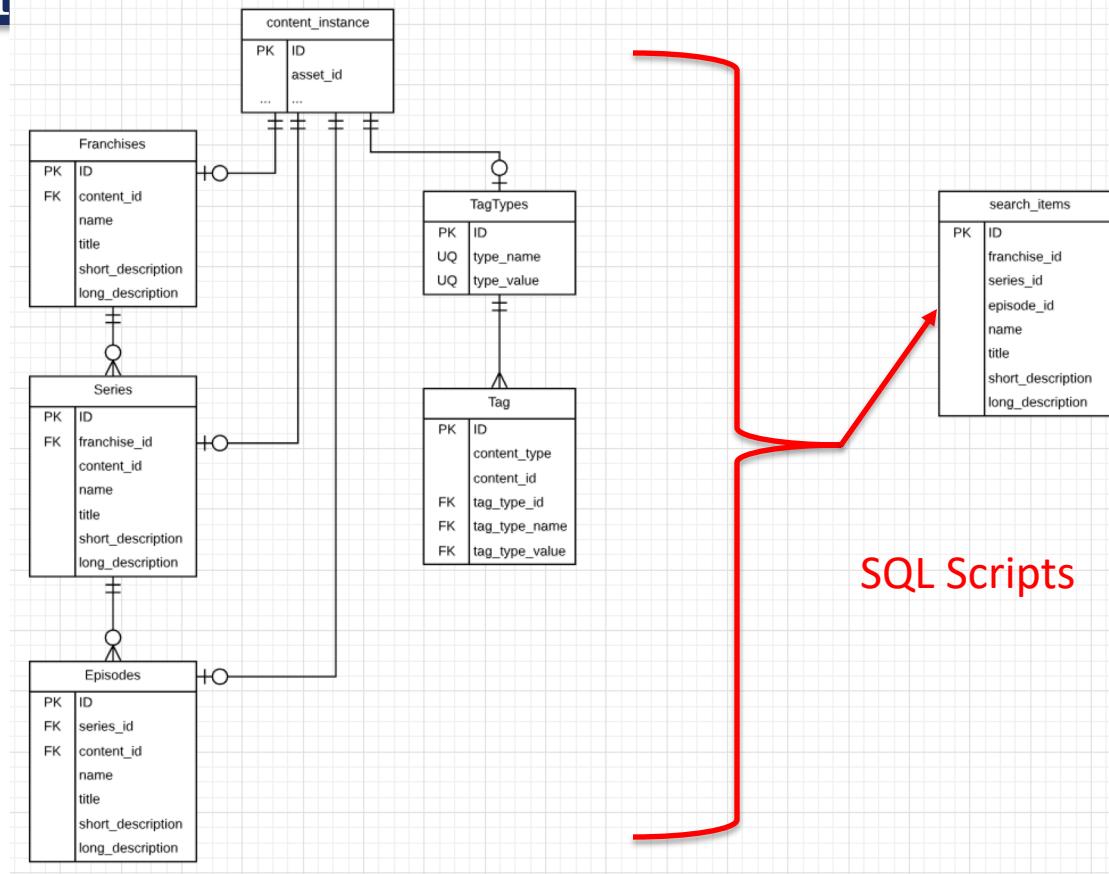
- Keywords/terms.
- Matches
- Series
 - Title
 - Description
 - Cast
 - Genres, Ratings, ...
- Episodes
 - Title
 - Description
 - Cast
 - Genres, Ratings, ...
- People
 - Name
 - Interests
 - Profile

The screenshot shows the seeka.TV website interface. At the top, there is a search bar with the text "Friendly Ferguson". Below the search bar, there are three main sections: "Series", "Episodes", and "People".

- Series:** A thumbnail for the series "Female Friendly" is shown, along with its description: "Female Friendly (Content Rating:TV-MA, Genre:Comedy, Perspective:Women, Theme:Women, Language:English) After wild child Alex gets broken up with and good girl Catherine gets fired, these polar opposite best friends decide to start a female-friendly po...". It also indicates "2 seasons, 9 episodes".
- Episodes:** Two episode thumbnails are listed:
 - "Just a Little Tease": "Having recently decided to start a female friendly porn production company, the girls hold their first company meeting with newcomers Courtney and Sam. Content Rating:TV-MA, Content Descriptor:Adult Content, Content Descriptor:Adult Language"
 - "When I Fall": "A friendly church Bingo match turns into a ferocious competition. Sam shows his true colors. Content Rating:TV-14, Content Descriptor:Adult Content"
- People:** Four profiles are listed, each with a small icon and the name "Donald Ferguson" followed by "Create a tagline". The icons are:
 - A black profile picture.
 - An orange circle with the letters "ee".
 - An orange circle with the letters "ee".
 - An orange circle with the letters "ee".

Seeka TV Search

- Seeka TV Demo
- Operational Data
 - Franchise
 - Series
 - Episode
 - Content_Instance
 - Tags
 - Types, e.g.
 - Genre
 - Rating
 - Values, e.g.
 - Humor
 - PD-13
- SQL scripts merge into a single search table
 - Tags added to description
 - Full text search on title, name, short_description, long_describtion



Seeka TV Demo

- Uses MySQL FULLTEXT index
- Text search in
 - Natural Language Mode
 - On columns
 - name
 - title
 - short_description
 - long_description
- content_id and values returned to UI

Name: catalog_ci_search

Index	Type
PRIMARY	PRIMARY
id_string	INDEX
c_id_string	INDEX
text_search	FULLTEXT

<click to edit>

Index details 'text_search'

Index Columns	#	Order	Length
<input type="checkbox"/> id		ASC	◊
<input type="checkbox"/> content_instance_id		ASC	◊
<input type="checkbox"/> property_id		ASC	◊
<input type="checkbox"/> franchise_id		ASC	◊
<input type="checkbox"/> series_id		ASC	◊
<input checked="" type="checkbox"/> name	1	ASC	◊
<input checked="" type="checkbox"/> title	2	ASC	◊
<input type="checkbox"/> id_string		ASC	◊
<input type="checkbox"/> c_id_string		ASC	◊
<input type="checkbox"/> p_id_string		ASC	◊
<input type="checkbox"/> f_id_string		ASC	◊
<input type="checkbox"/> s_id_string		ASC	◊
<input type="checkbox"/> f_name		ASC	◊
<input type="checkbox"/> s_name		ASC	◊
<input checked="" type="checkbox"/> short_description	3	ASC	◊
<input checked="" type="checkbox"/> long_description	4	ASC	◊
<input type="checkbox"/> type_id		ASC	◊
<input type="checkbox"/> properties		ASC	◊

```
var sql_prefix = 'select id_string, c_id_string, f_id_string, name, short_description, long_description, f_name, s_name, type_id, resource_type, properties, ' +
  'tag_type_name, tag_value, tag_description, seriescount, episodecount ' +
  ' from search.catalog_ci_search_tag WHERE MATCH (name, title, short_description, long_description, tag_value, tag_description) AGAINST (';
var sql_SUFFIX1 = ' IN NATURAL LANGUAGE MODE) and tag_type_name not in ( ' + "'status'" + ') OR tag_value IN ( ';
var sql_SUFFIX2 = ' );';
var i;
```

Lucene Inverted Index

Inverted Index

We used MySQL because

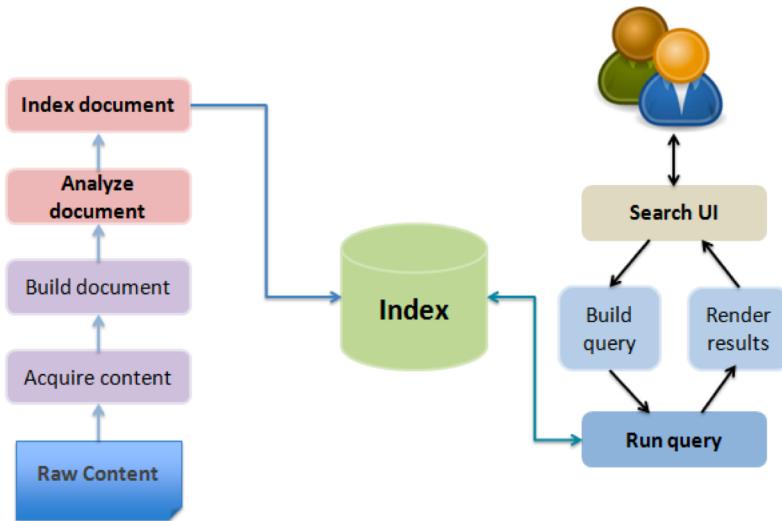
- Small number of “documents.”
- Short documents.
- Already using MySQL for operational data and reporting.

Most systems have a focused, dedicated text ingest and search engine.

- Lucene stores input data in what is known as an inverted index
- In an inverted index each indexed term points to a list of documents that contain the term
- Similar to the index provided at the end of a book
- In this case "inverted" simply means the list of terms point to documents
- It is much faster to find a term in an index, than to scan all the documents



Lucene Flow



Ingestion

- API / Solr XML, JSON, and javabin/SolrJ
- CSV
- Relational databases
- File system
- Web crawl (using Nutch, or others)
- Others - XML feeds (e.g. RSS/Atom), e-mail

Inverted Index Example

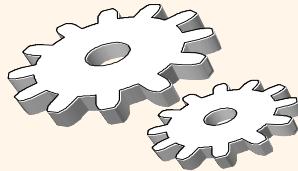
ID	Text
1	Baseball is played during summer months.
2	Summer is the time for picnics here.
3	Months later we found out why.
4	Why is summer so hot here ↑ Sample document data

Dictionary and posting lists →

Term	Freq	Document ids
baseball	1	[1]
during	1	[1]
found	1	[3]
here	2	[2], [4]
hot	1	[4]
is	3	[1], [2], [4]
months	2	[1], [3]
summer	3	[1], [2], [4]
the	1	[2]
why	2	[3], [4]



Database Files



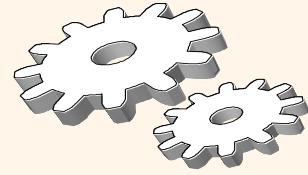
DBMS vs. OS File System

OS does disk space & buffer mgmt: why not let OS manage these tasks?

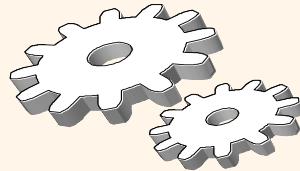
- ❖ Differences in OS support: portability issues
- ❖ Some limitations, e.g., files can't span disks.
- ❖ Buffer management in DBMS requires ability to:
 - pin a page in buffer pool, force a page to disk (important for implementing CC & recovery),
 - adjust *replacement policy*, and pre-fetch pages based on access patterns in typical DB operations.

Files of Records versus DB

Or Why CSVDataTable is not a DB



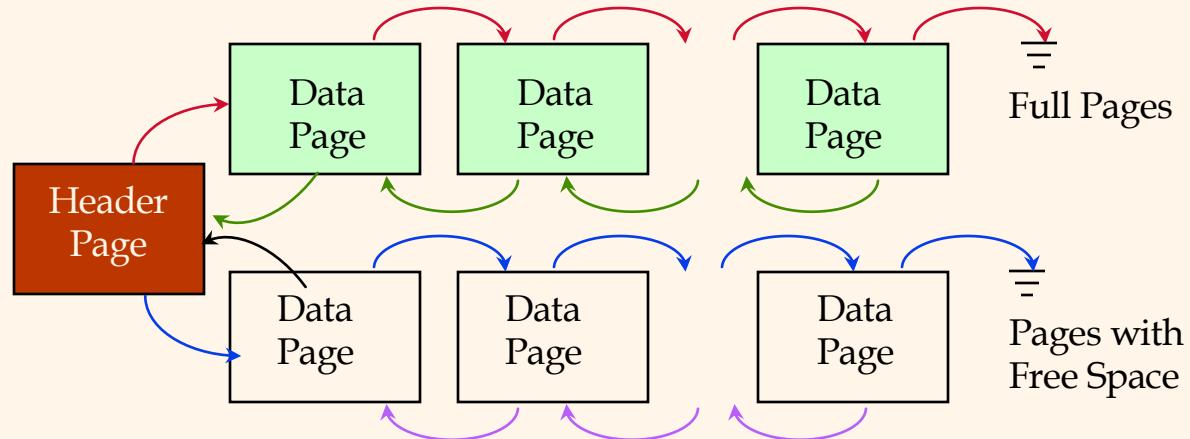
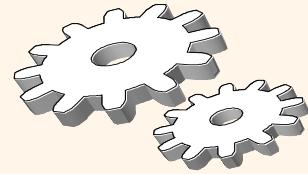
- ❖ Page or block is OK when doing I/O, but higher levels of DBMS operate on *records*, and *files of records*.
- ❖ FILE: A collection of pages, each containing a collection of records. Must support:
 - insert/delete/modify record
 - read a particular record (specified using *record id*)
 - scan all records (possibly with some conditions on the records to be retrieved)



Unordered (Heap) Files

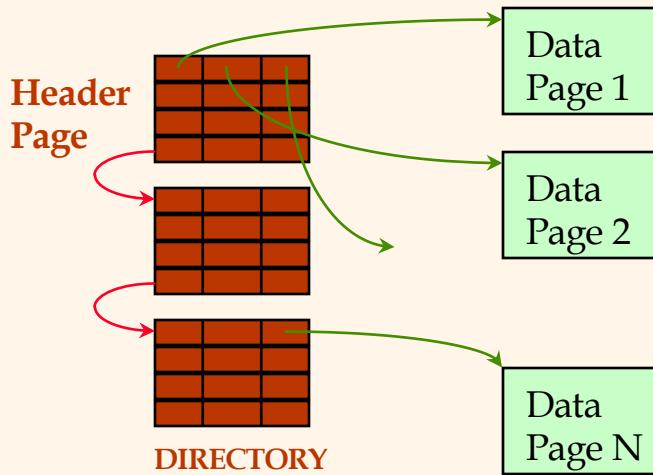
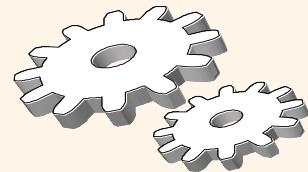
- ❖ Simplest file structure contains records in no particular order.
- ❖ As file grows and shrinks, disk pages are allocated and de-allocated.
- ❖ To support record level operations, we must:
 - keep track of the *pages* in a file
 - keep track of *free space* on pages
 - keep track of the *records* on a page
- ❖ There are many alternatives for keeping track of this.

Heap File Implemented as a List

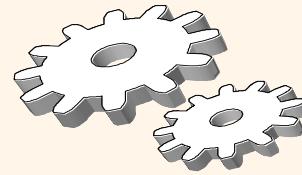


- ❖ The header page id and Heap file name must be stored someplace.
- ❖ Each page contains 2 `pointers' plus data.

Heap File Using a Page Directory



- ❖ The entry for a page can include the number of free bytes on the page.
- ❖ The directory is a collection of pages; linked list implementation is just one alternative.
 - *Much smaller than linked list of all HF pages!*



System Catalogs

- ❖ For each index:
 - structure (e.g., B+ tree) and search key fields
- ❖ For each relation:
 - name, file name, file structure (e.g., Heap file)
 - attribute name and type, for each attribute
 - index name, for each index
 - integrity constraints
- ❖ For each view:
 - view name and definition
- ❖ Plus statistics, authorization, buffer pool size, etc.

☞ *Catalogs are themselves stored as relations!*