INFSCI 2140

Information Storage and Retrieval

Lecture 1: Introduction

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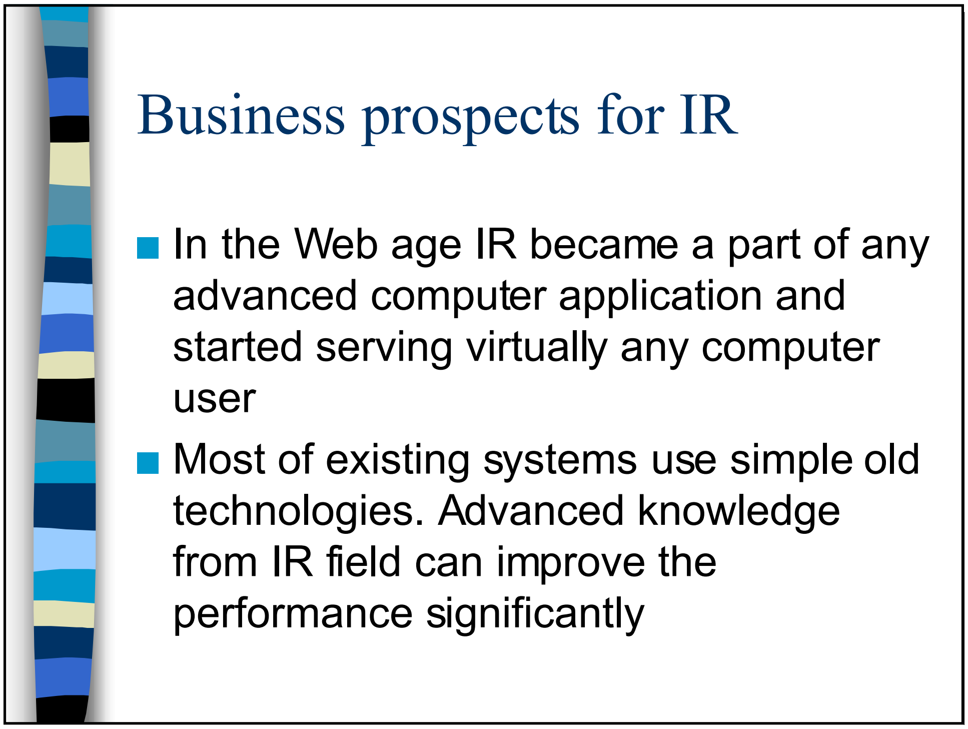
http://www2.sis.pitt.edu/~peterb/2140-051/

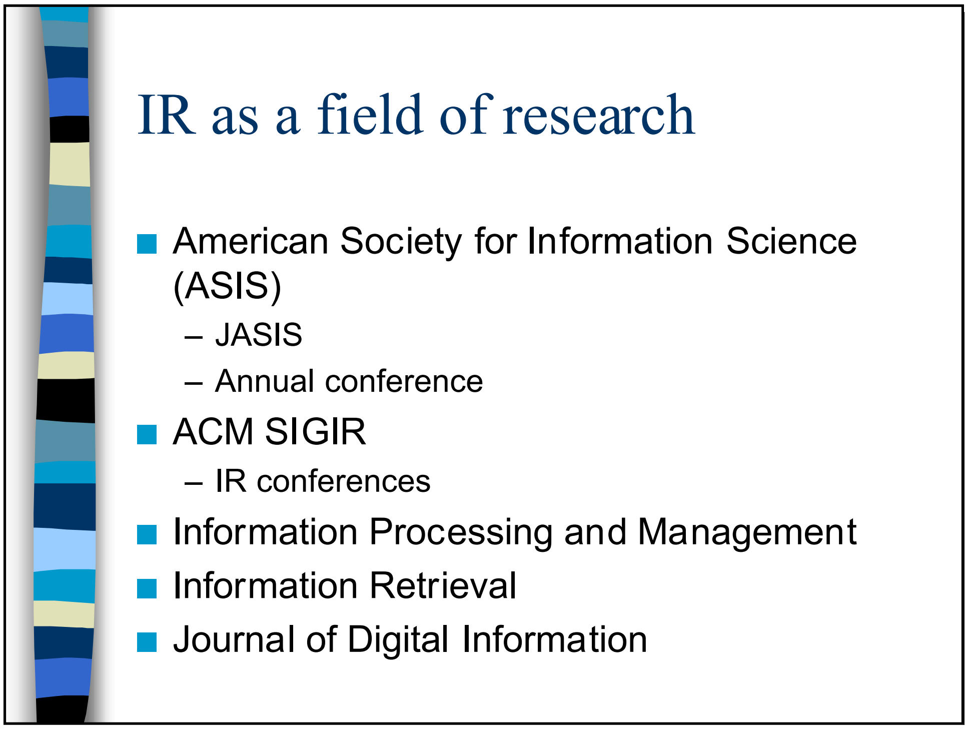
INFSCI 2140 and your program

- Foundation course
- One of the key courses in any LS/IS program
- Information retrieval (IR) is one of the oldest and most developed areas of research in information science
- Hot research area with many crossroads



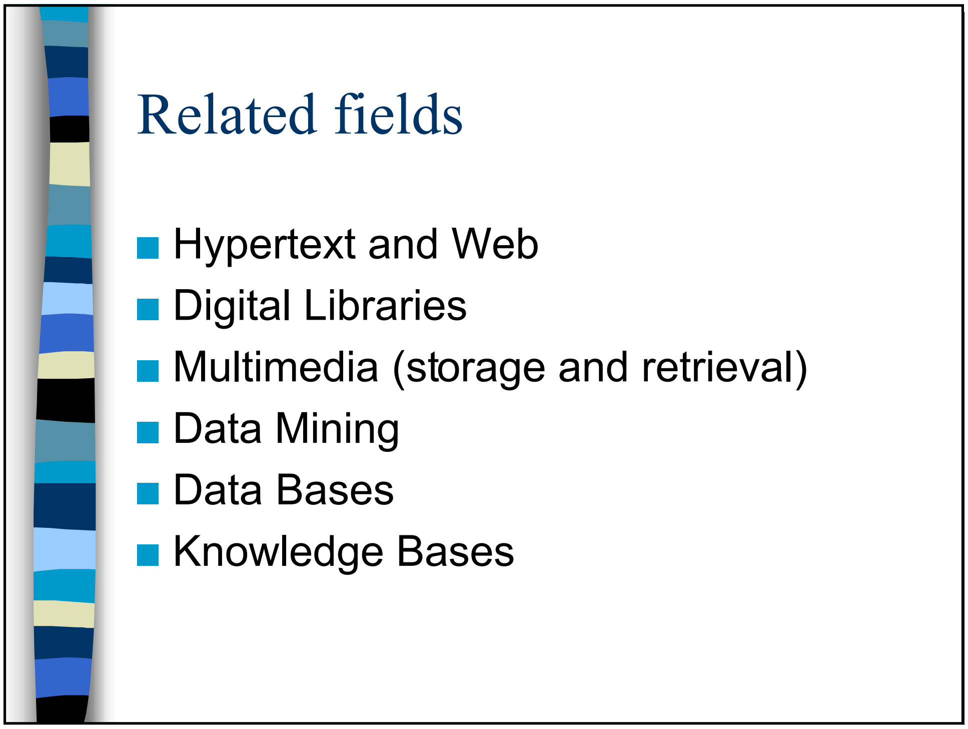
Business prospects for IR

- In the Web age IR became a part of any advanced computer application and started serving virtually any computer user
- Most of existing systems use simple old technologies. Advanced knowledge from IR field can improve the performance significantly



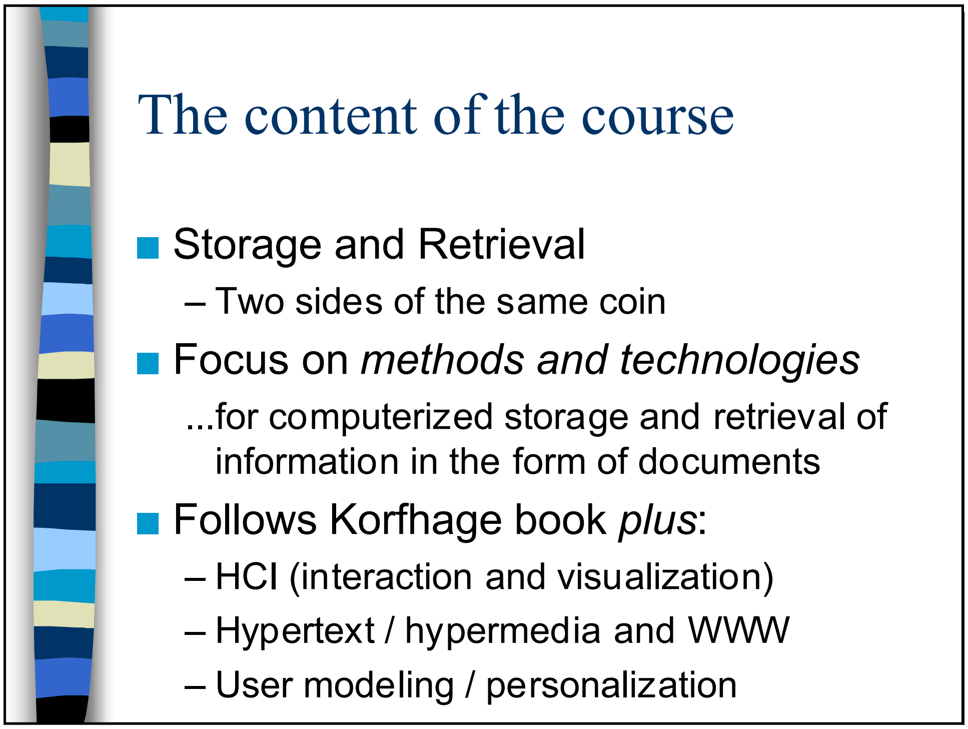
IR as a field of research

- American Society for Information Science (ASIS)
  - – JASIS
  - – Annual conference
- ACM SIGIR
  - – IR conferences
- Information Processing and Management
- Information Retrieval
- Journal of Digital Information



Related fields

- Hypertext and Web
- Digital Libraries
- Multimedia (storage and retrieval)
- Data Mining
- Data Bases
- Knowledge Bases



The content of the course

- Storage and Retrieval
  - Two sides of the same coin
- Focus on *methods and technologies*

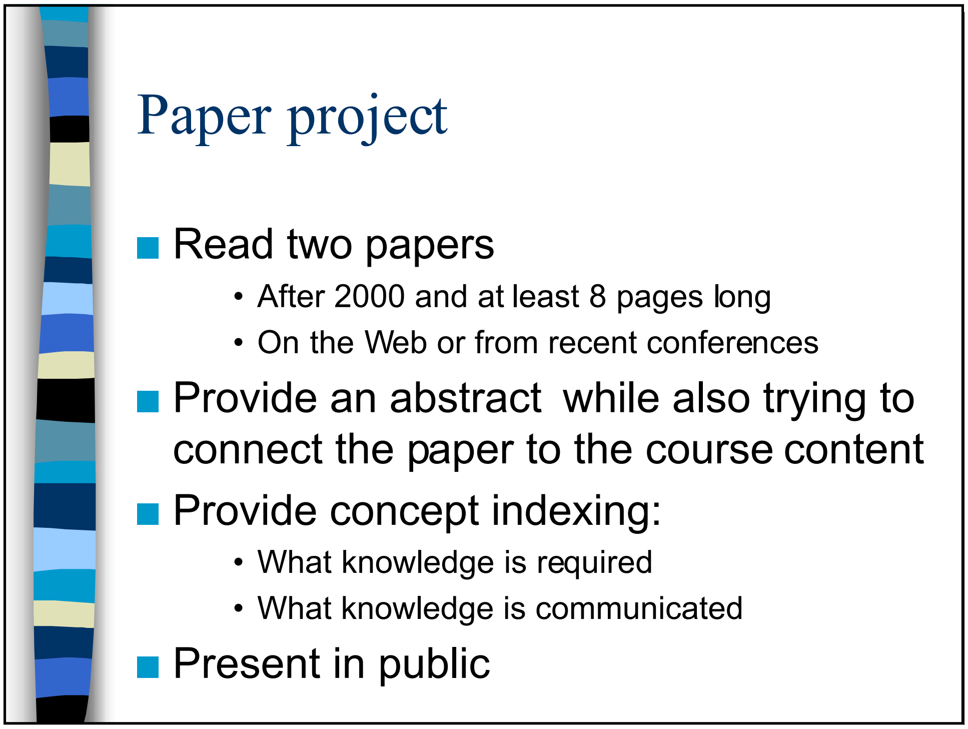
  ...for computerized storage and retrieval of information in the form of documents
- Follows Korfhage book *plus*:
  - HCI (interaction and visualization)
  - Hypertext / hypermedia and WWW
  - User modeling / personalization

Course plan

- Introduction
- Classic Information Retrieval
- Improving Classic Information Retrieval
- What else in IR beyond Classic IR?
- Newest trends
  - User Modeling for IR
  - Web IR

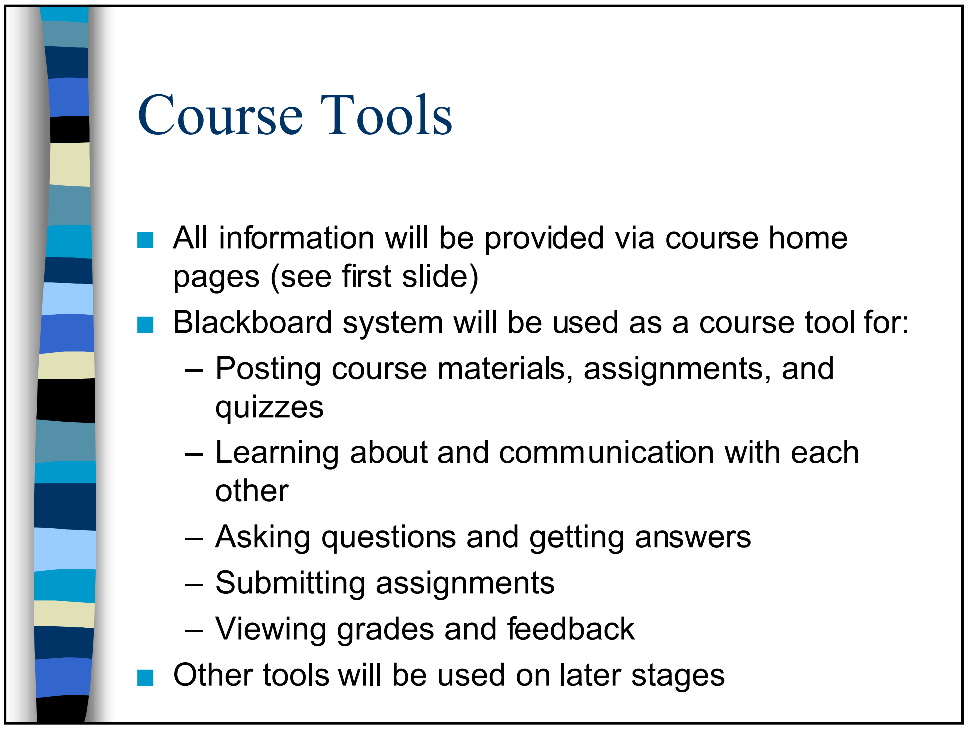
Components of the grade

- Attendance (1 pt per lecture)
- Homework assignments
- Possible Quizzes
- Two Paper projects
- Midterm Exam
- Final group project
  - Will be announced at the next lecture



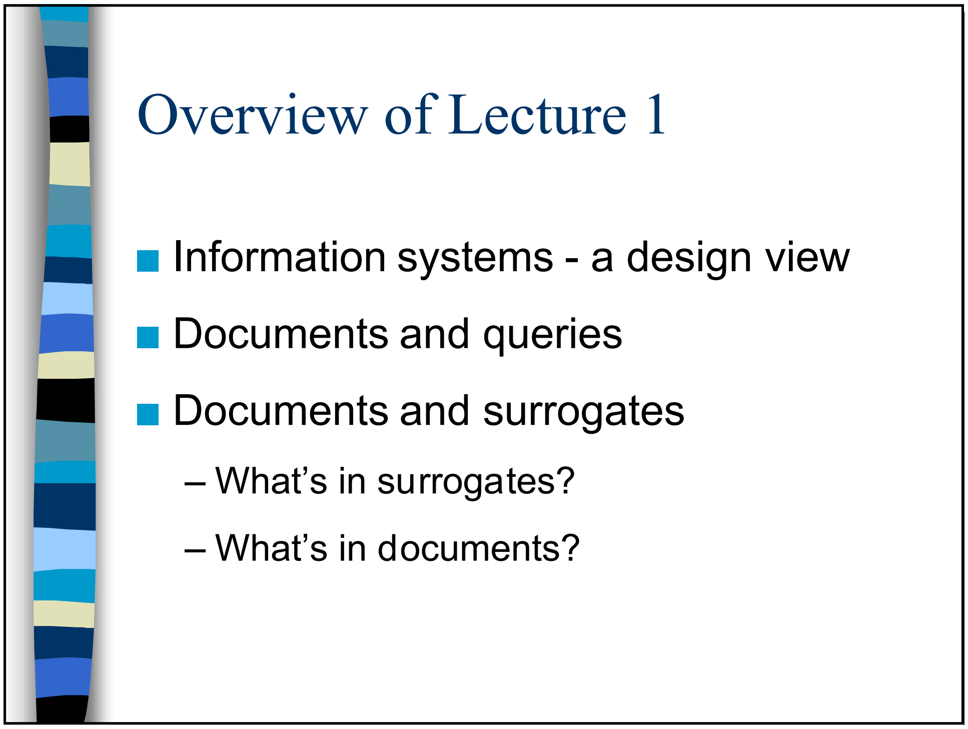
Paper project

- Read two papers
  - After 2000 and at least 8 pages long
  - On the Web or from recent conferences
- Provide an abstract while also trying to connect the paper to the course content
- Provide concept indexing:
  - What knowledge is required
  - What knowledge is communicated
- Present in public



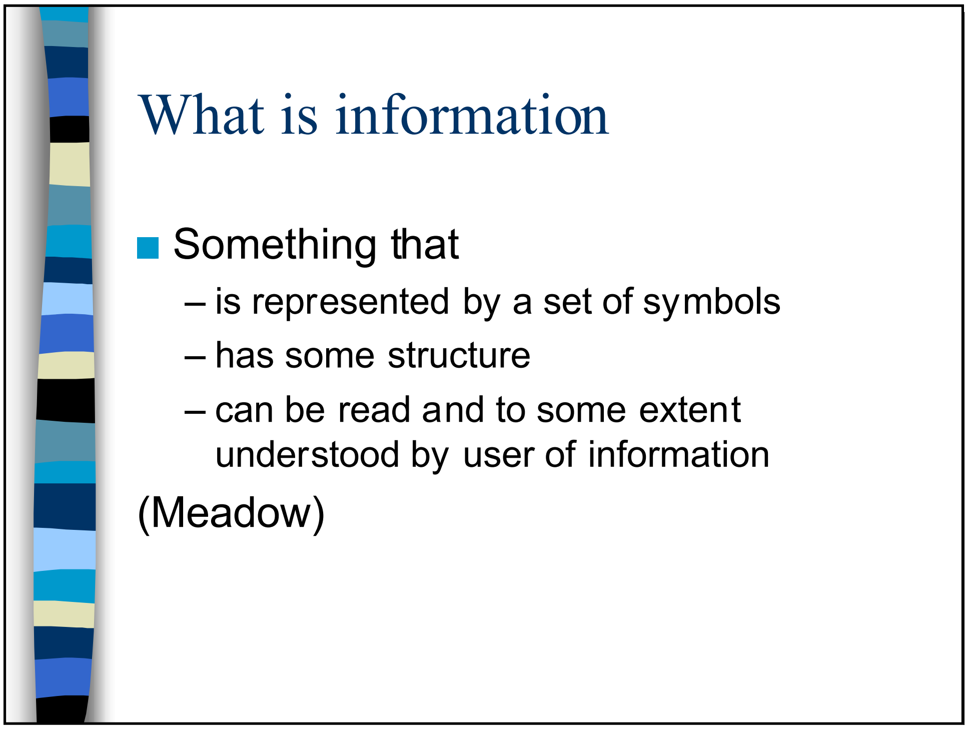
Course Tools

- All information will be provided via course home pages (see first slide)
- Blackboard system will be used as a course tool for:
  - Posting course materials, assignments, and quizzes
  - Learning about and communication with each other
  - Asking questions and getting answers
  - Submitting assignments
  - Viewing grades and feedback
- Other tools will be used on later stages



Overview of Lecture 1

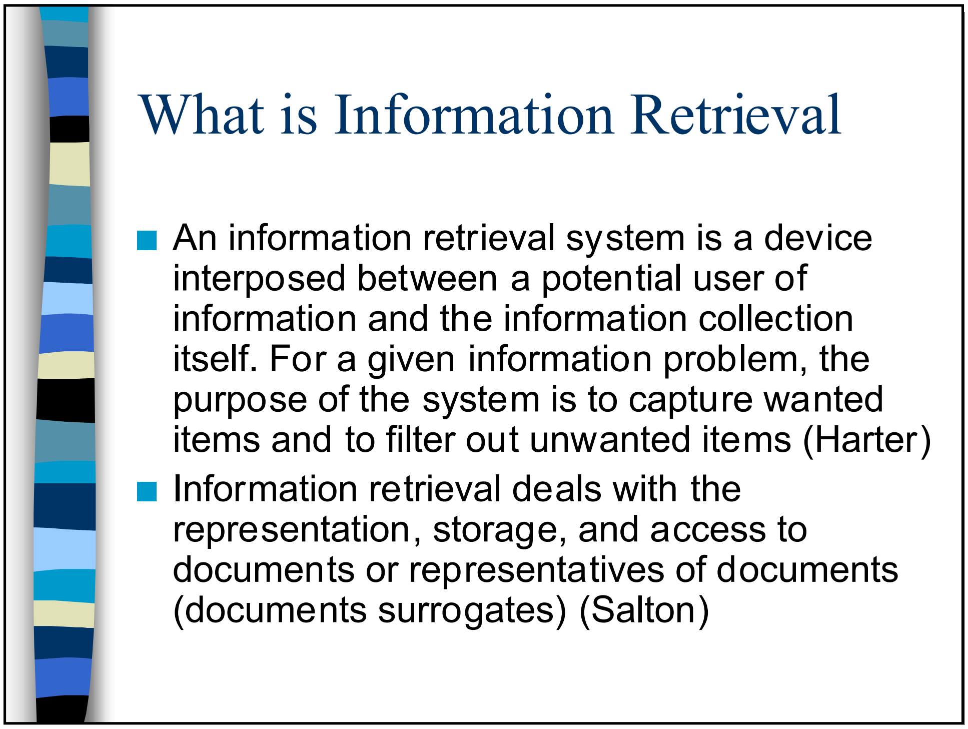
- Information systems - a design view
- Documents and queries
- Documents and surrogates
  - – What’s in surrogates?
  - – What’s in documents?



What is information

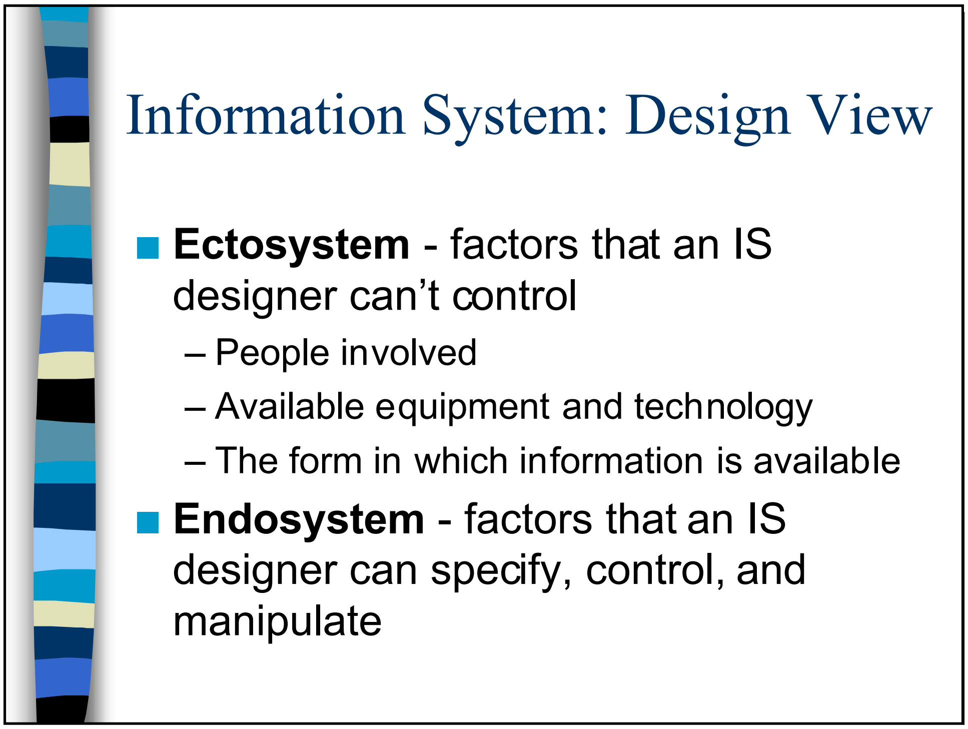
- Something that
  - – is represented by a set of symbols
  - – has some structure
  - – can be read and to some extent understood by user of information

(Meadow)



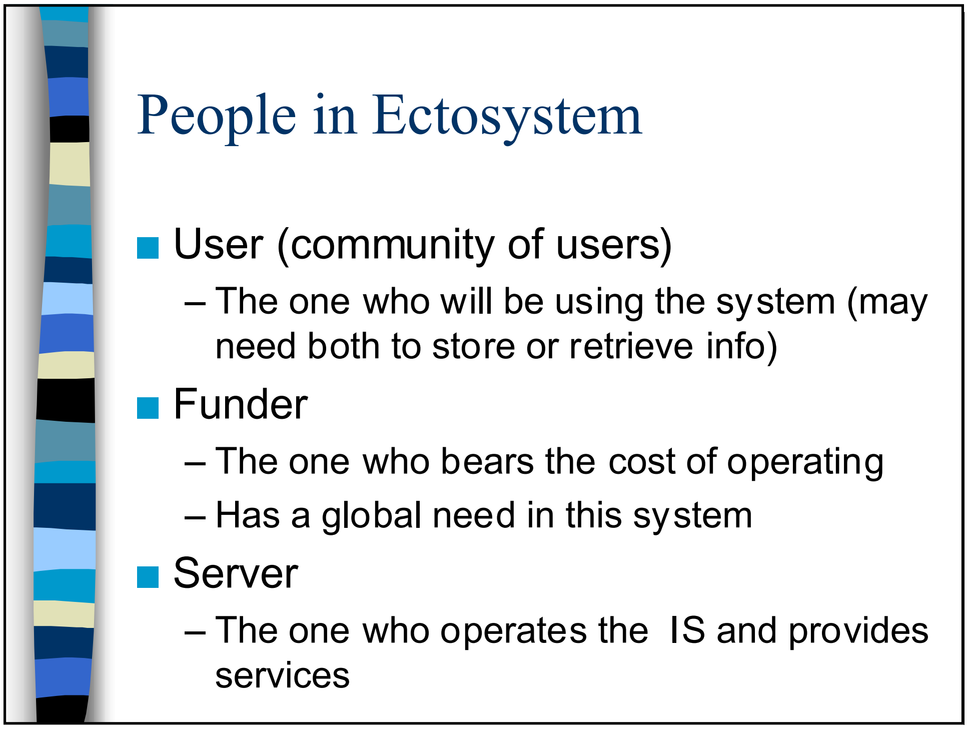
What is Information Retrieval

- An information retrieval system is a device interposed between a potential user of information and the information collection itself. For a given information problem, the purpose of the system is to capture wanted items and to filter out unwanted items (Harter)
- Information retrieval deals with the representation, storage, and access to documents or representatives of documents (documents surrogates) (Salton)



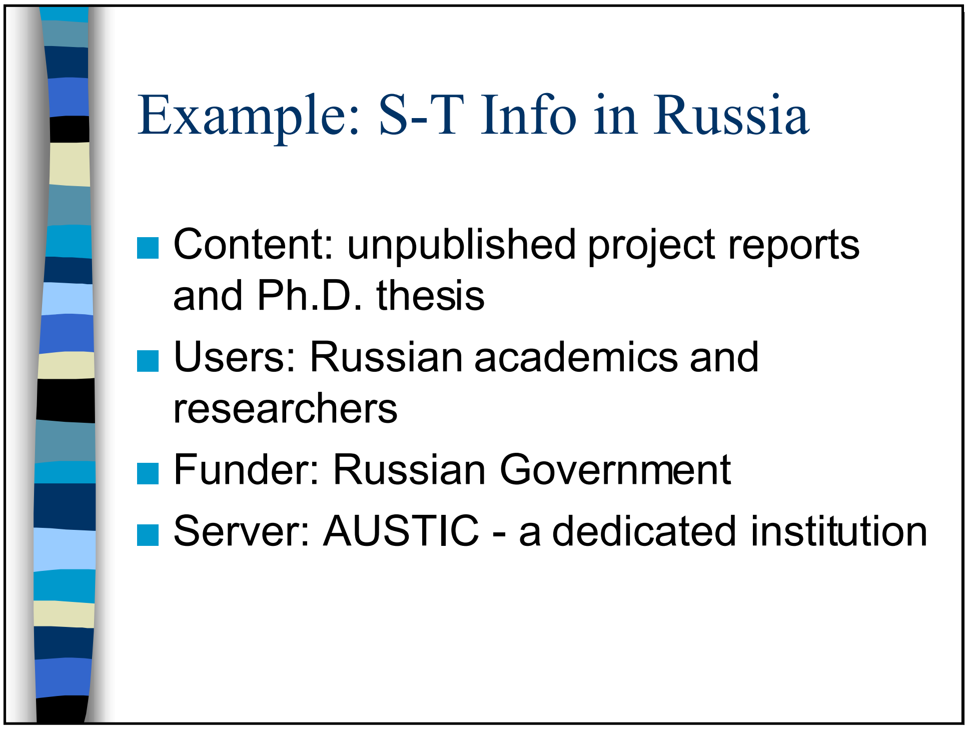
Information System: Design View

- **Ectosystem** - factors that an IS designer can’t control
  - People involved
  - Available equipment and technology
  - The form in which information is available
- **Endosystem** - factors that an IS designer can specify, control, and manipulate



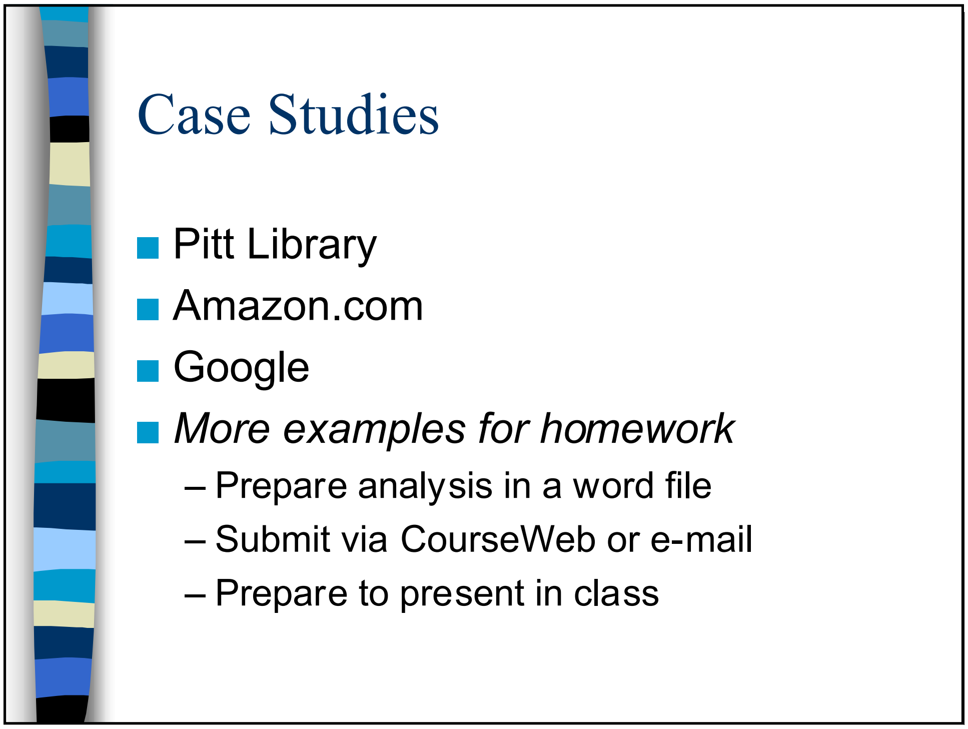
People in Ectosystem

- User (community of users)
  - The one who will be using the system (may need both to store or retrieve info)
- Funder
  - The one who bears the cost of operating
  - Has a global need in this system
- Server
  - The one who operates the IS and provides services



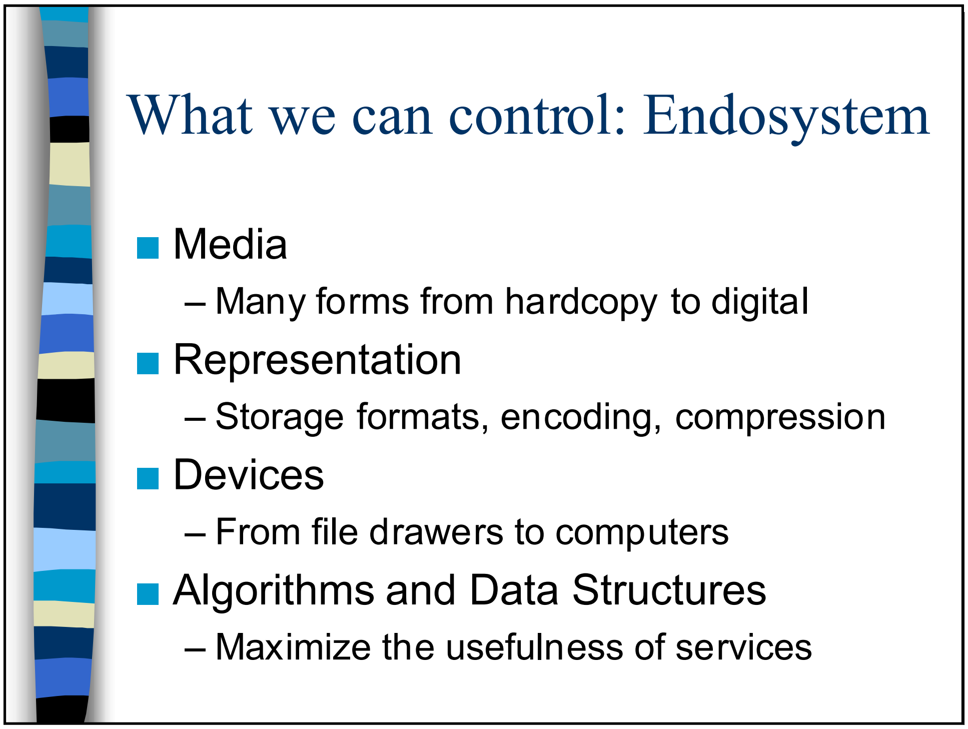
Example: S-T Info in Russia

- Content: unpublished project reports and Ph.D. thesis
- Users: Russian academics and researchers
- Funder: Russian Government
- Server: AUSTIC - a dedicated institution



Case Studies

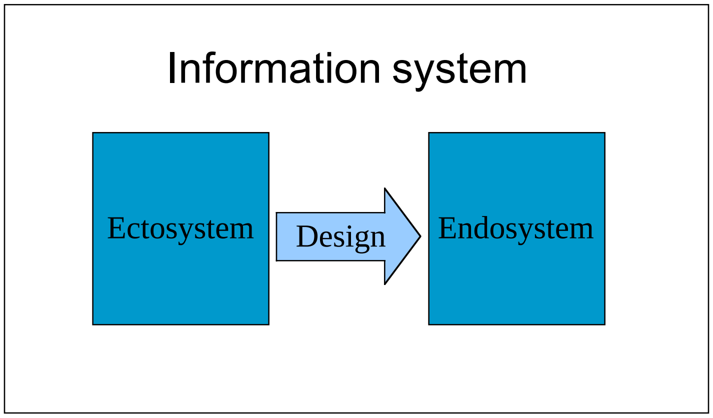
- Pitt Library
- Amazon.com
- Google
- *More examples for homework*
  - Prepare analysis in a word file
  - Submit via CourseWeb or e-mail
  - Prepare to present in class



What we can control: Endosystem

- Media
  - Many forms from hardcopy to digital
- Representation
  - Storage formats, encoding, compression
- Devices
  - From file drawers to computers
- Algorithms and Data Structures
  - Maximize the usefulness of services

Designer’s prospect



Information system

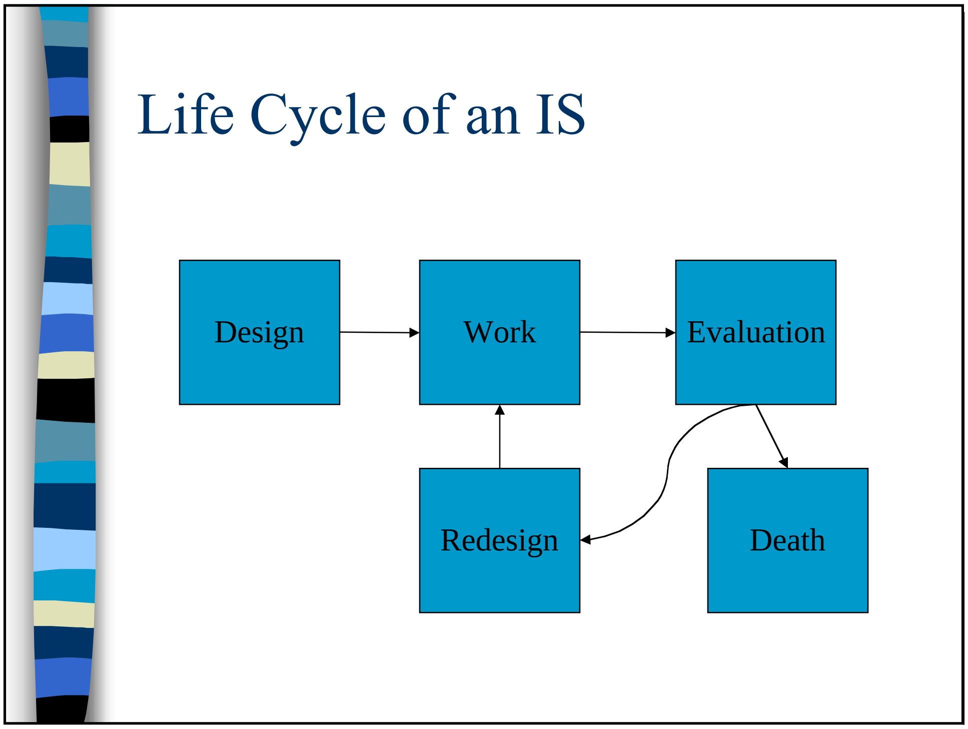
Ectosystem

Design

Endosystem

Performance and evaluation

- User
  - How effective the system is in helping me to satisfy my information needs
- Server
  - How efficient is the system
  - How well the system meets the needs of the user community
- Funder
  - Does the benefits justify costs



Life Cycle of an IS

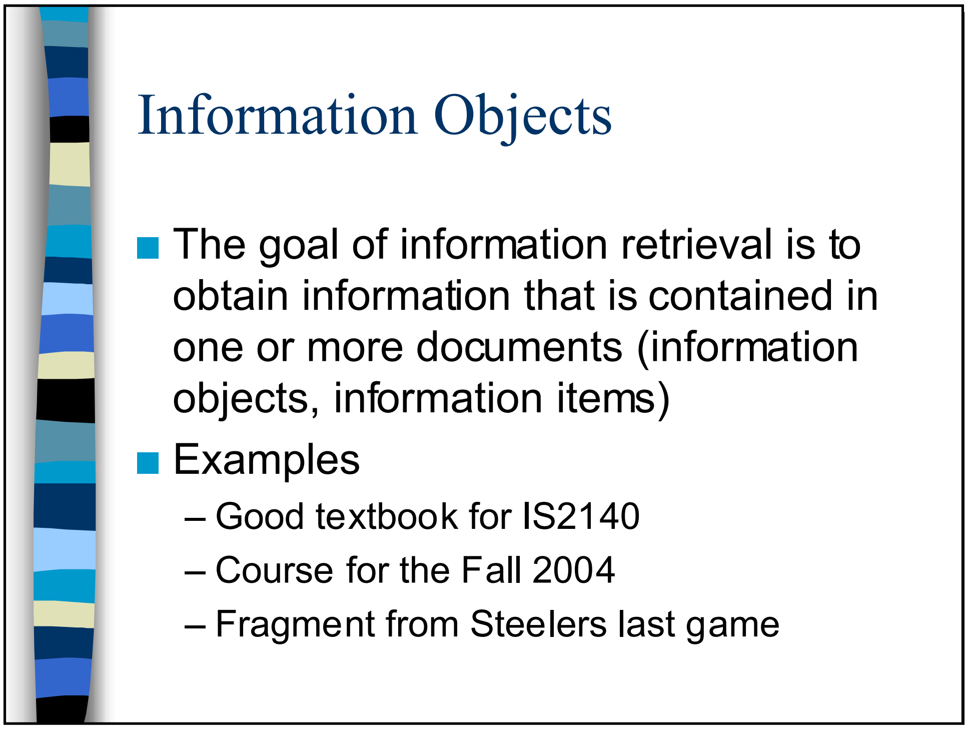
Design

Work

Evaluation

Redesign

Death



Information Objects

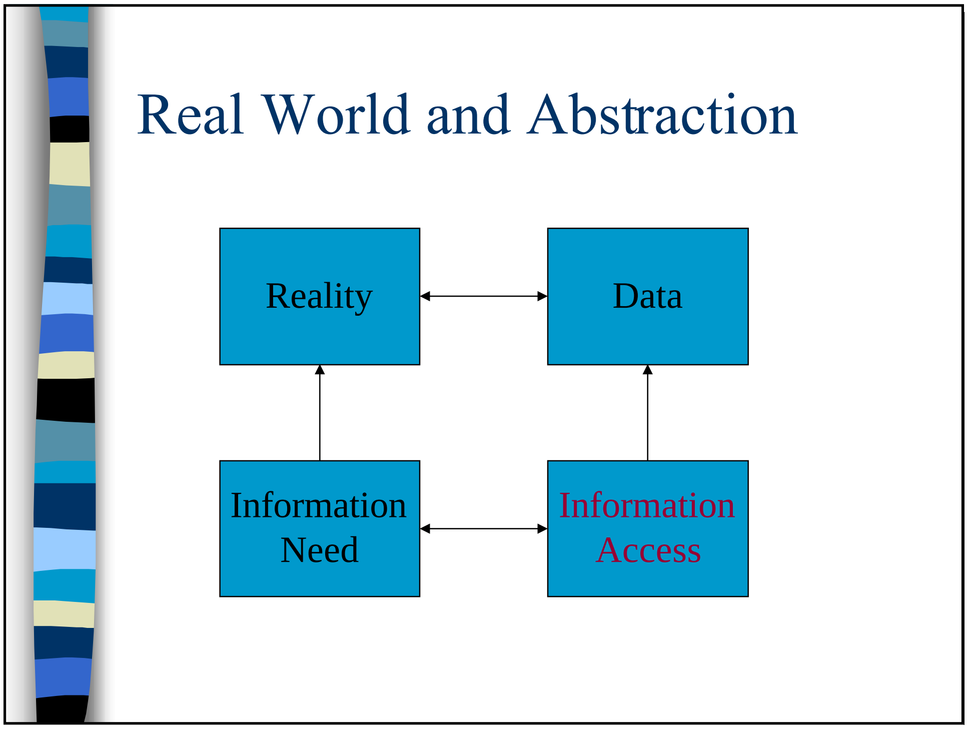
- The goal of information retrieval is to obtain information that is contained in one or more documents (information objects, information items)
- Examples
  - Good textbook for IS2140
  - Course for the Fall 2004
  - Fragment from Steelers last game

Information Need

- What kind of information you need to find - what you have in mind
- Example - Pension in Zurich
  - Relevant web sites will provide the user with necessary information and forms needed to actually make a reservation in a pension in Zurich.

Abstraction: Data

- Real world and its representation
  - Book -> library card -> database record
  - Course -> course syllabus -> Web page
- IS store information about real world as a collection of data abstracted from real world objects
- The amount and kind of stored information influence the search process



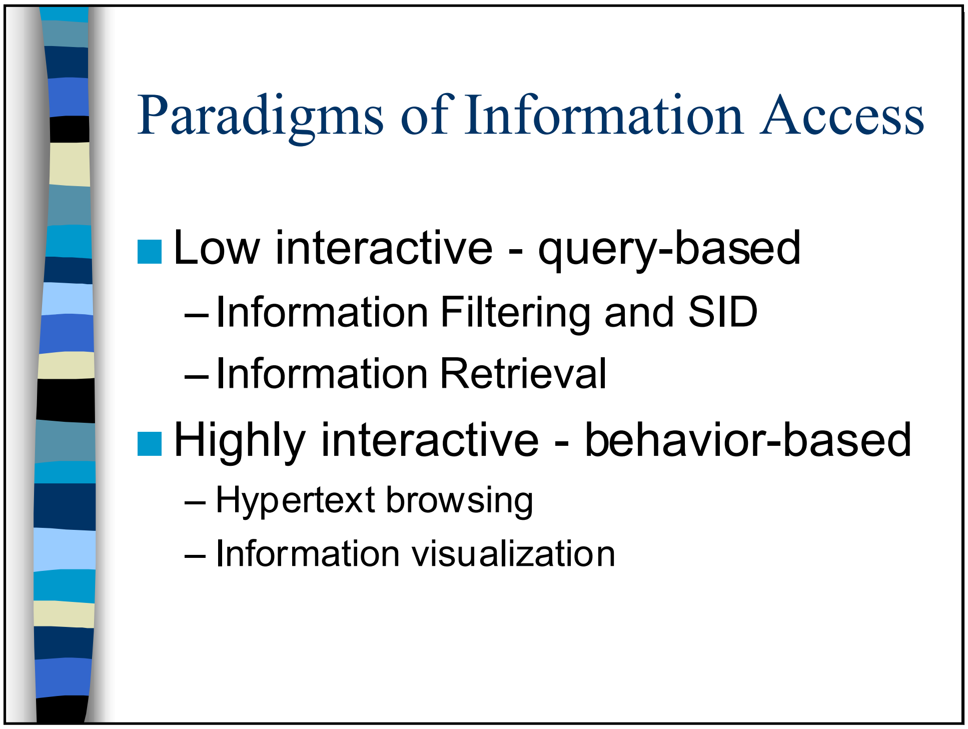
Real World and Abstraction

Reality

Data

Information Need

Information Access



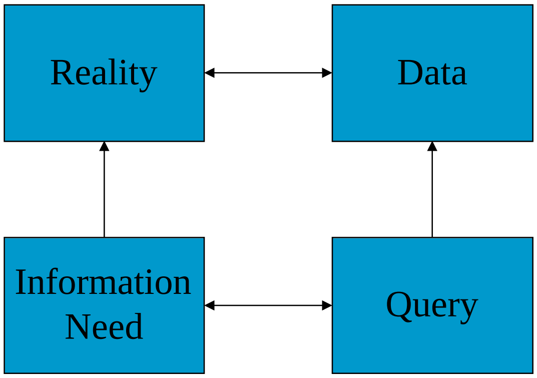
Paradigms of Information Access

- Low interactive - query-based
  - Information Filtering and SID
  - Information Retrieval
- Highly interactive - behavior-based
  - Hypertext browsing
  - Information visualization

Abstraction: Query

- The user has an information need (IN) in her mind. It can be implicit or explicitly verbalized
- The IS can't understand the IN directly. IN has to be abstracted into a form that matches the information system
- This abstraction is *a query*

Real World and Abstraction

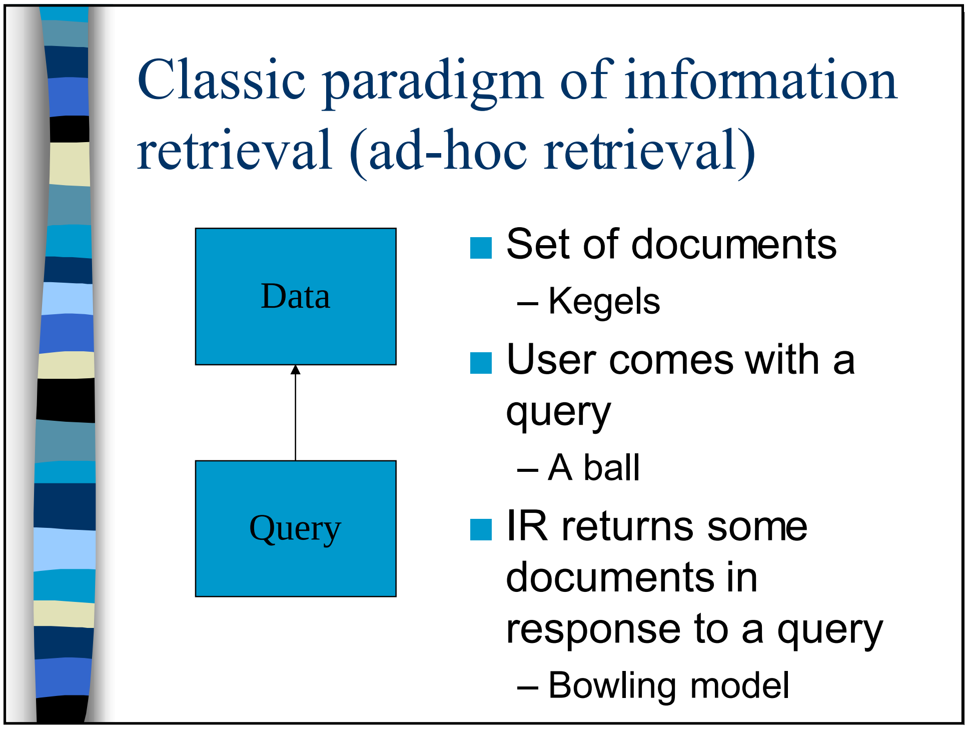


Reality

Data

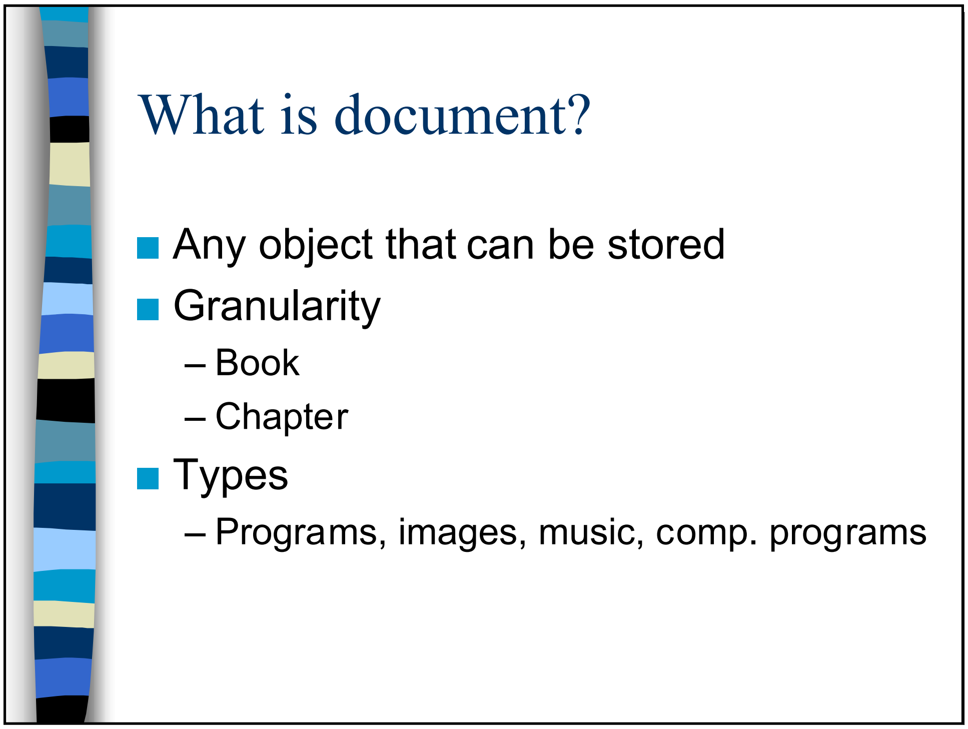
Information Need

Query



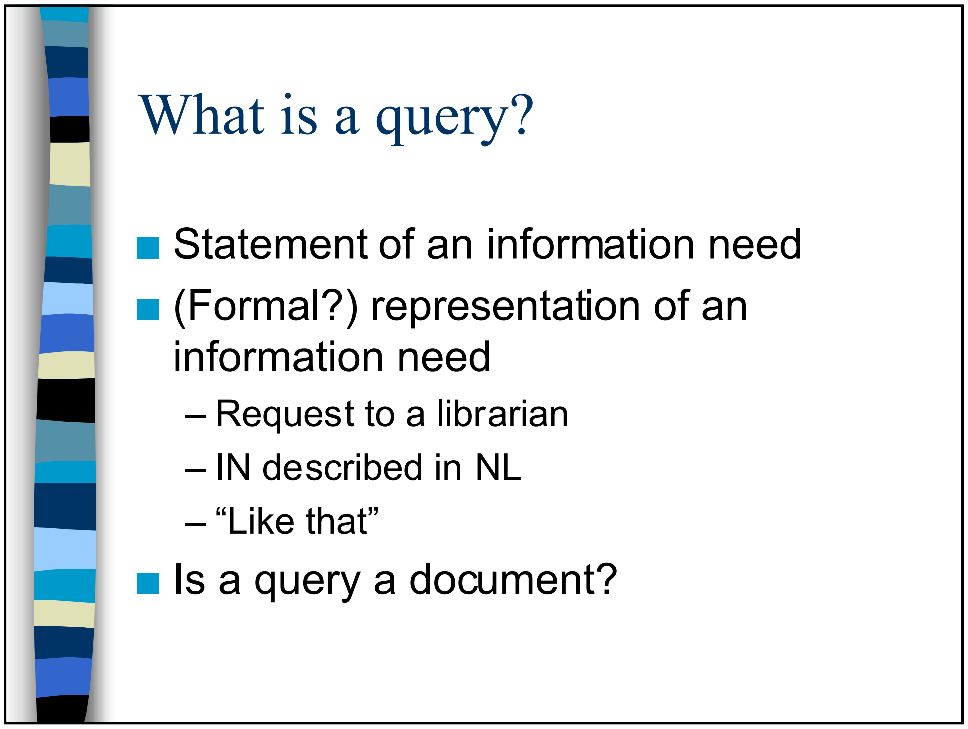
Classic paradigm of information retrieval (ad-hoc retrieval)

- Set of documents
  - Kegels
- User comes with a query
  - A ball
- IR returns some documents in response to a query
  - Bowling model



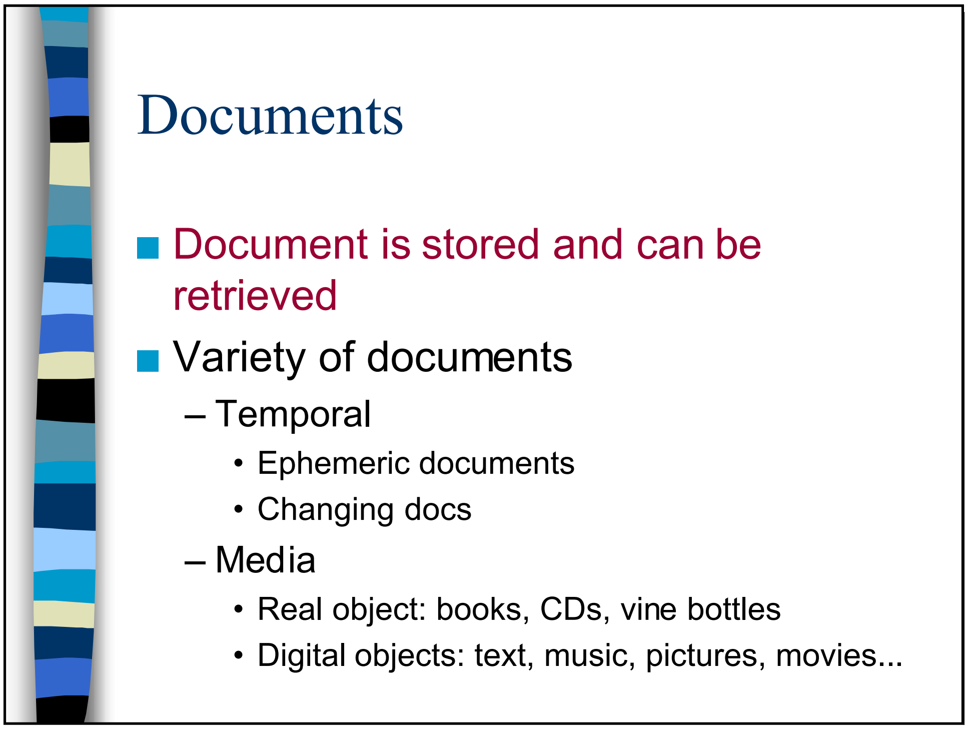
What is document?

- Any object that can be stored
- Granularity
  - Book
  - Chapter
- Types
  - Programs, images, music, comp. programs



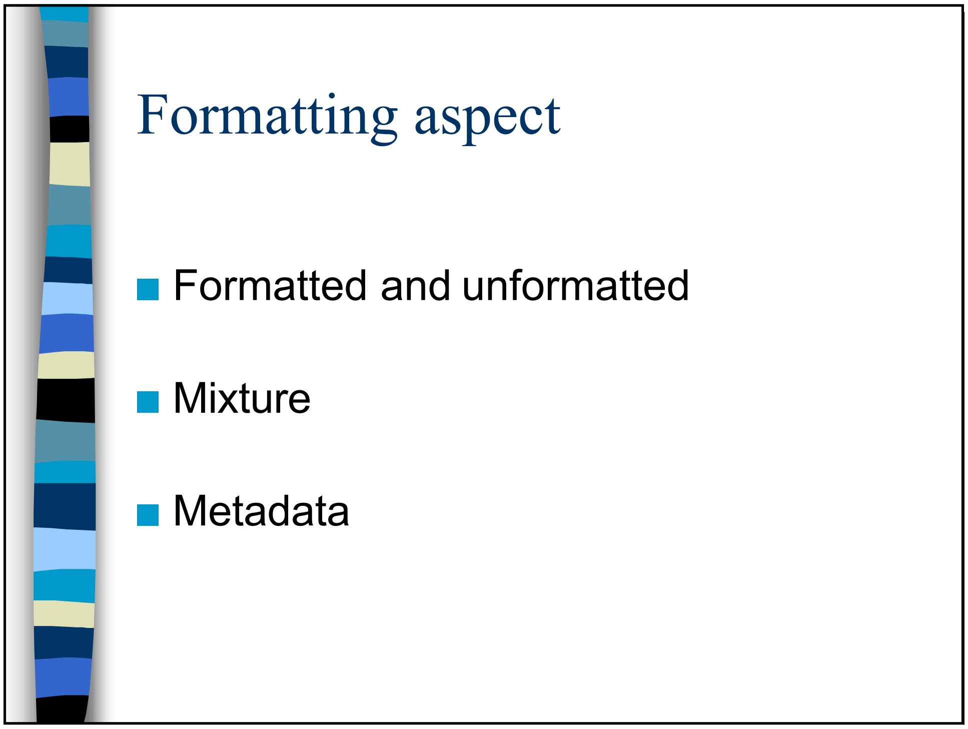
What is a query?

- Statement of an information need
- (Formal?) representation of an information need
  - Request to a librarian
  - IN described in NL
  - “Like that”
- Is a query a document?



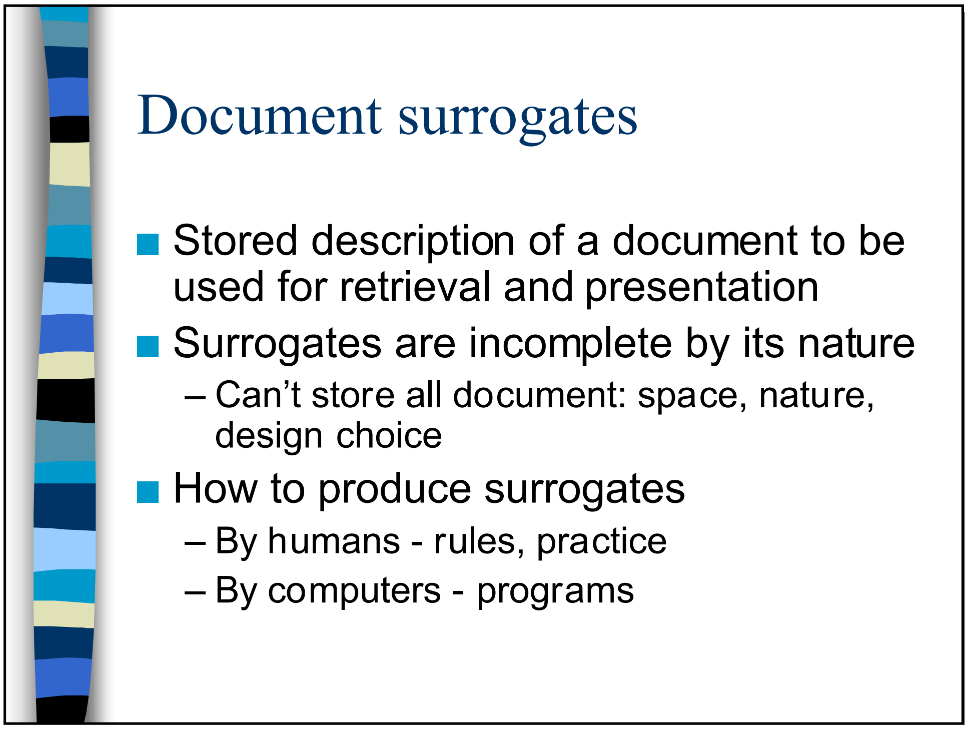
Documents

- Document is stored and can be retrieved
- Variety of documents
  - Temporal
    - Ephemeric documents
    - Changing docs
  - Media
    - Real object: books, CDs, vine bottles
    - Digital objects: text, music, pictures, movies...



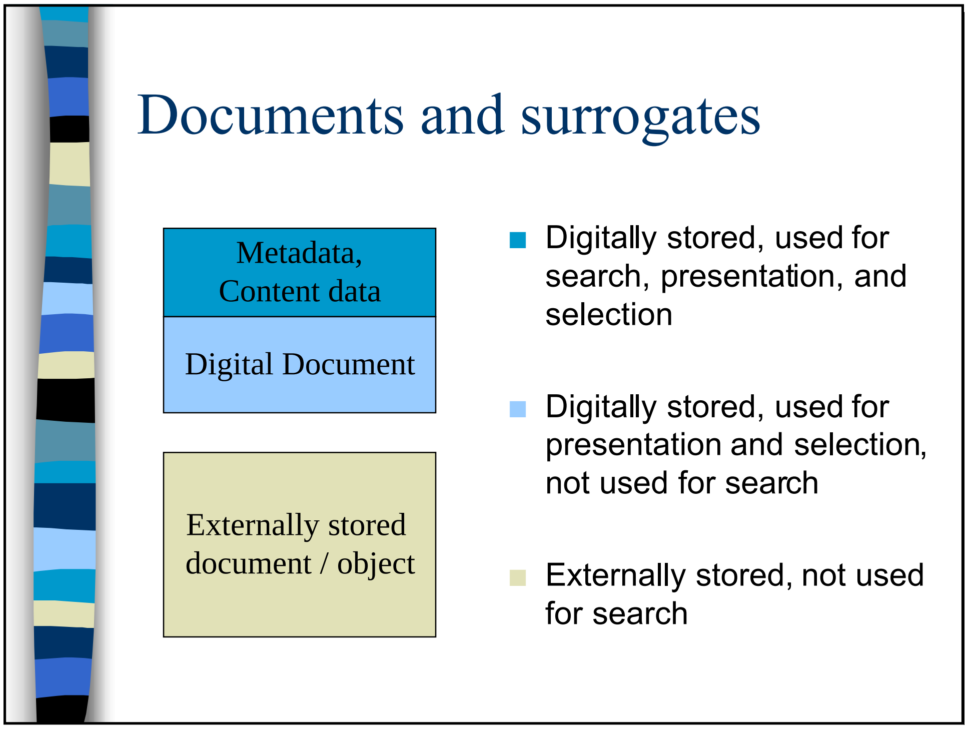
Formatting aspect

- Formatted and unformatted
- Mixture
- Metadata



Document surrogates

- Stored description of a document to be used for retrieval and presentation
- Surrogates are incomplete by its nature
  - Can’t store all document: space, nature, design choice
- How to produce surrogates
  - By humans - rules, practice
  - By computers - programs



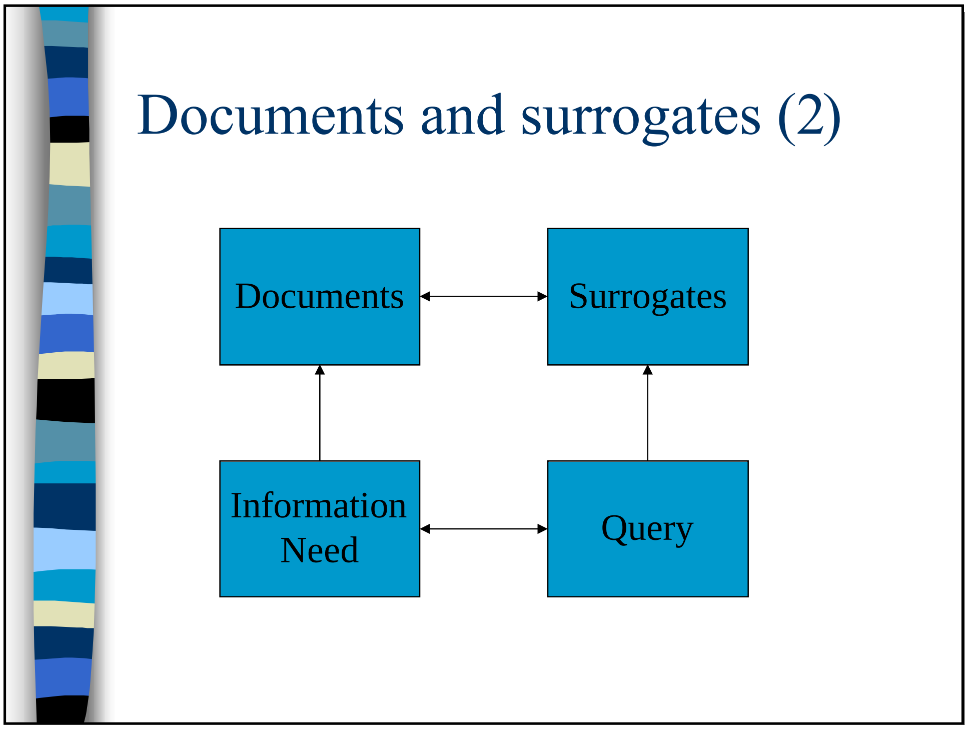
Documents and surrogates

Metadata, Content data

Digital Document

Externally stored document / object

- Digitally stored, used for search, presentation, and selection
- Digitally stored, used for presentation and selection, not used for search
- Externally stored, not used for search



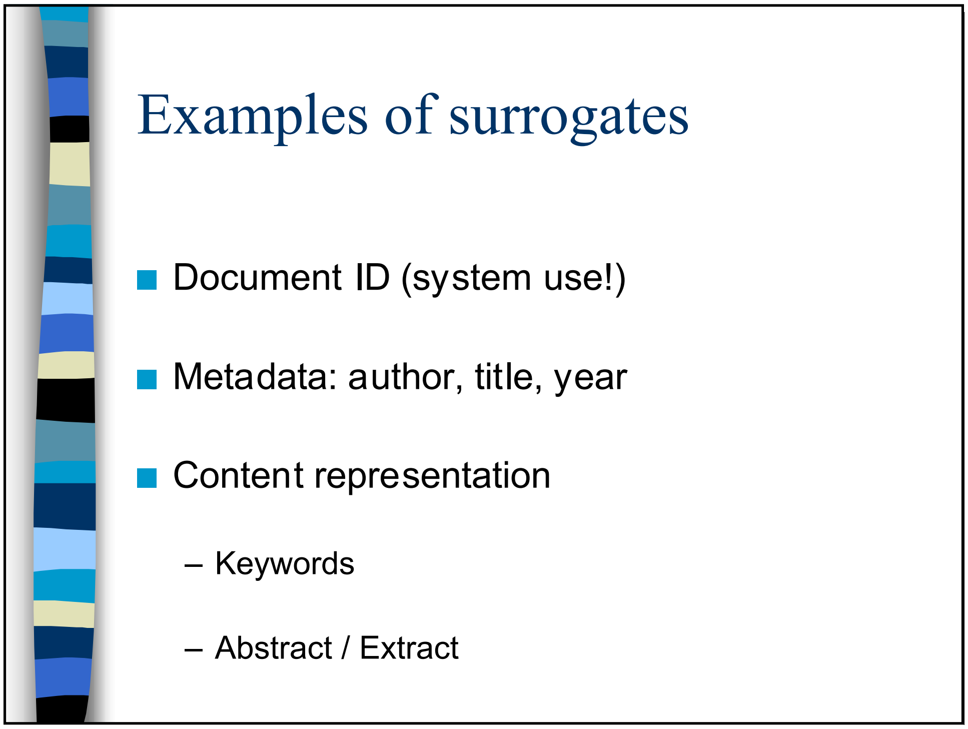
Documents and surrogates (2)

Documents

Surrogates

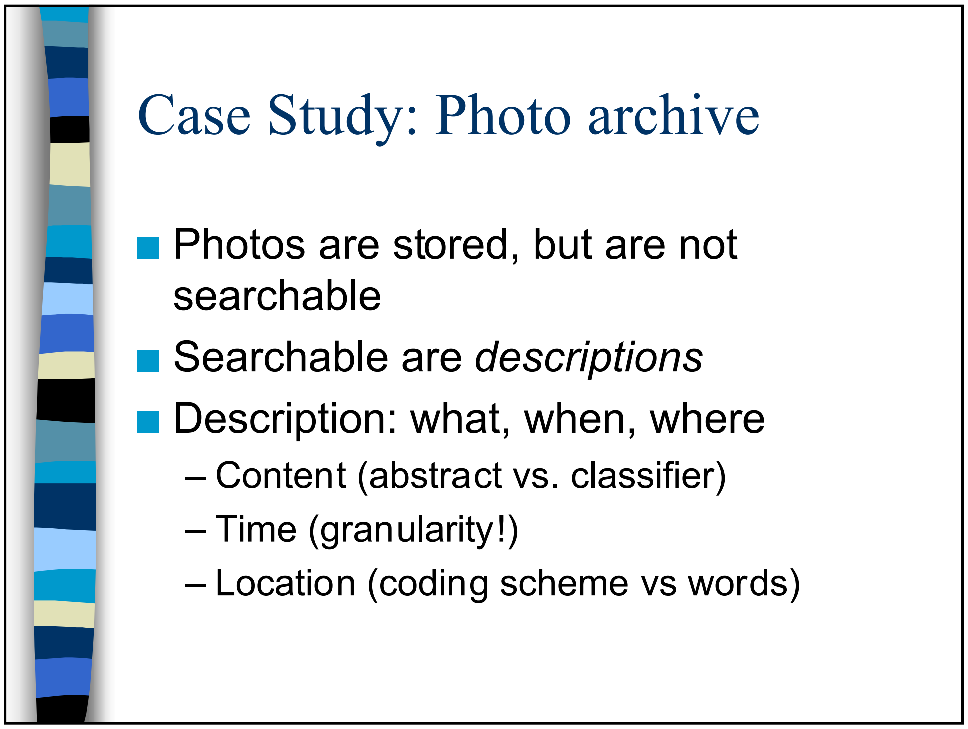
Information Need

Query



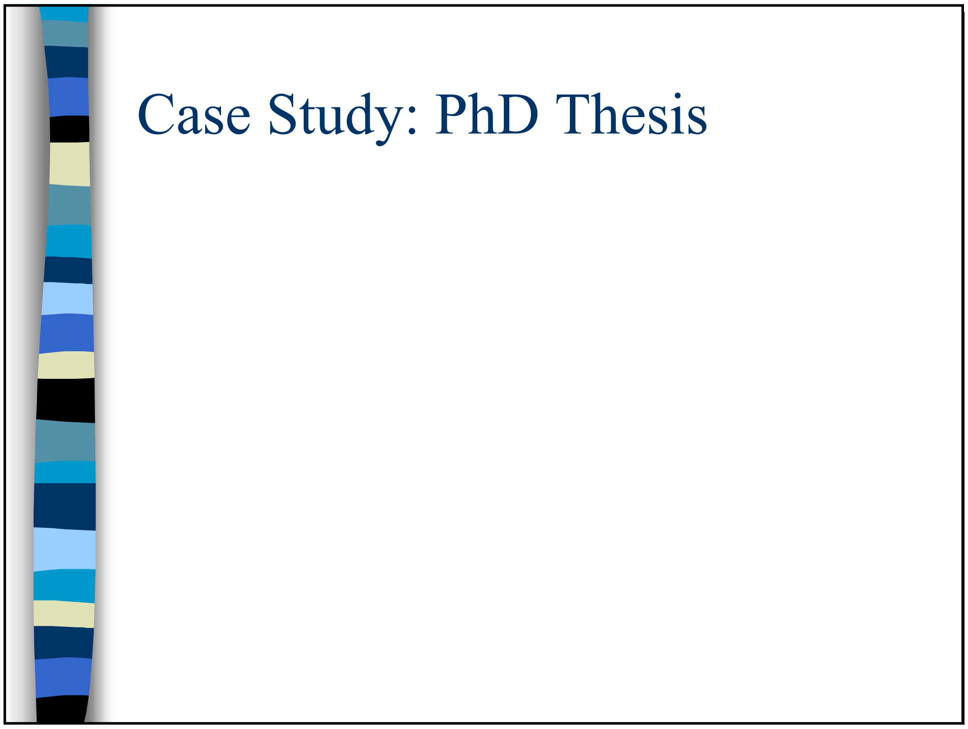
Examples of surrogates

- Document ID (system use!)
- Metadata: author, title, year
- Content representation
  - – Keywords
  - – Abstract / Extract

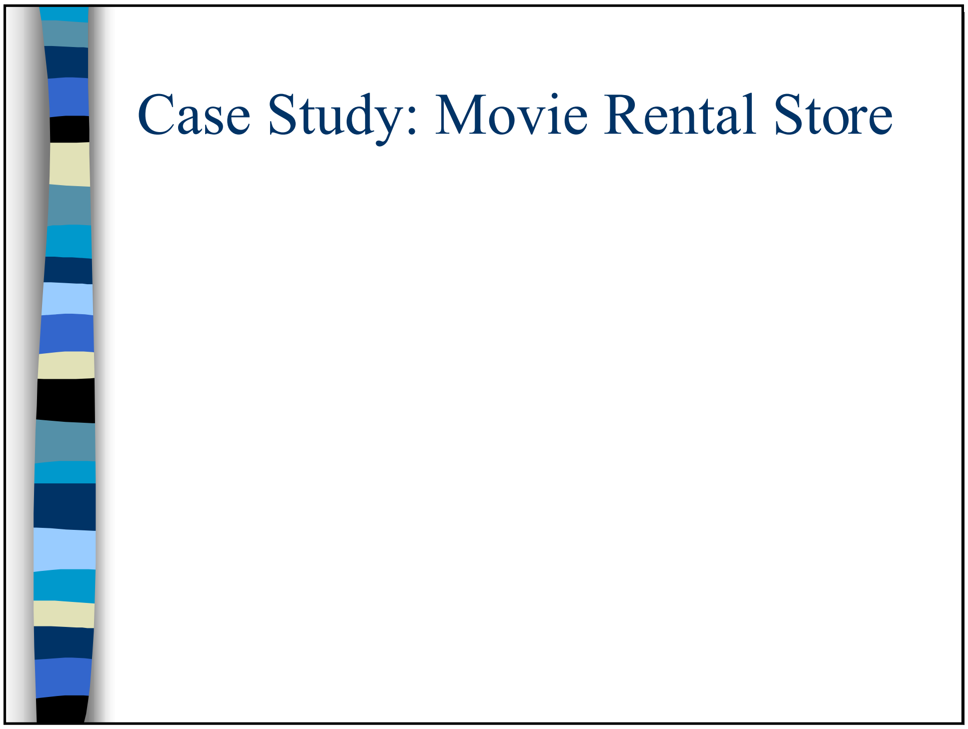


Case Study: Photo archive

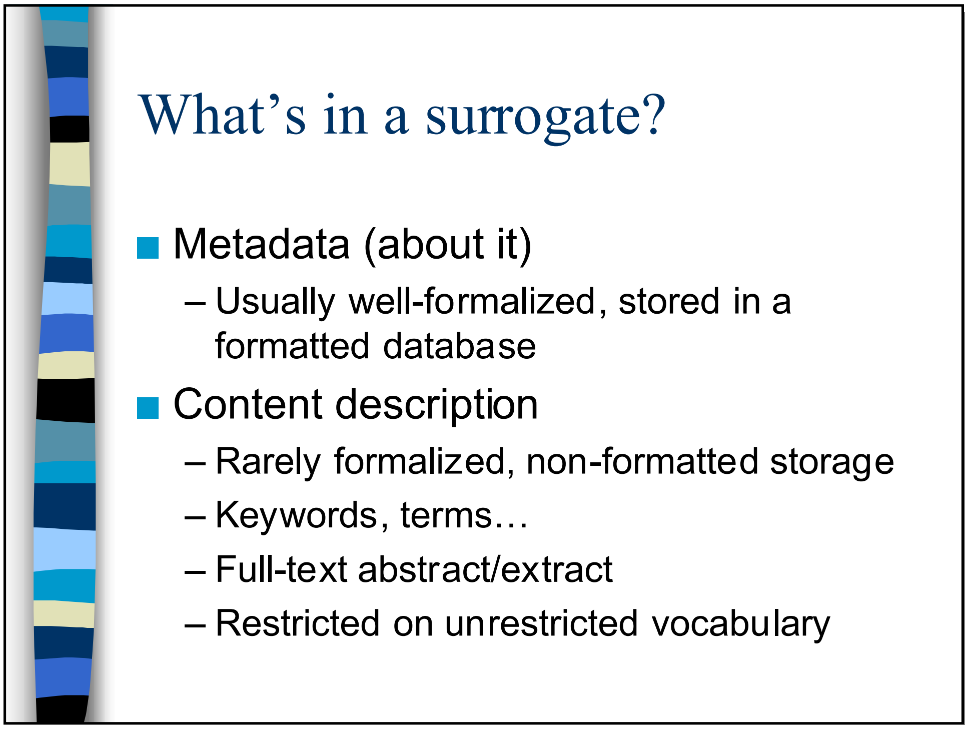
- Photos are stored, but are not searchable
- Searchable are *descriptions*
- Description: what, when, where
  - – Content (abstract vs. classifier)
  - – Time (granularity!)
  - – Location (coding scheme vs words)



Case Study: PhD Thesis

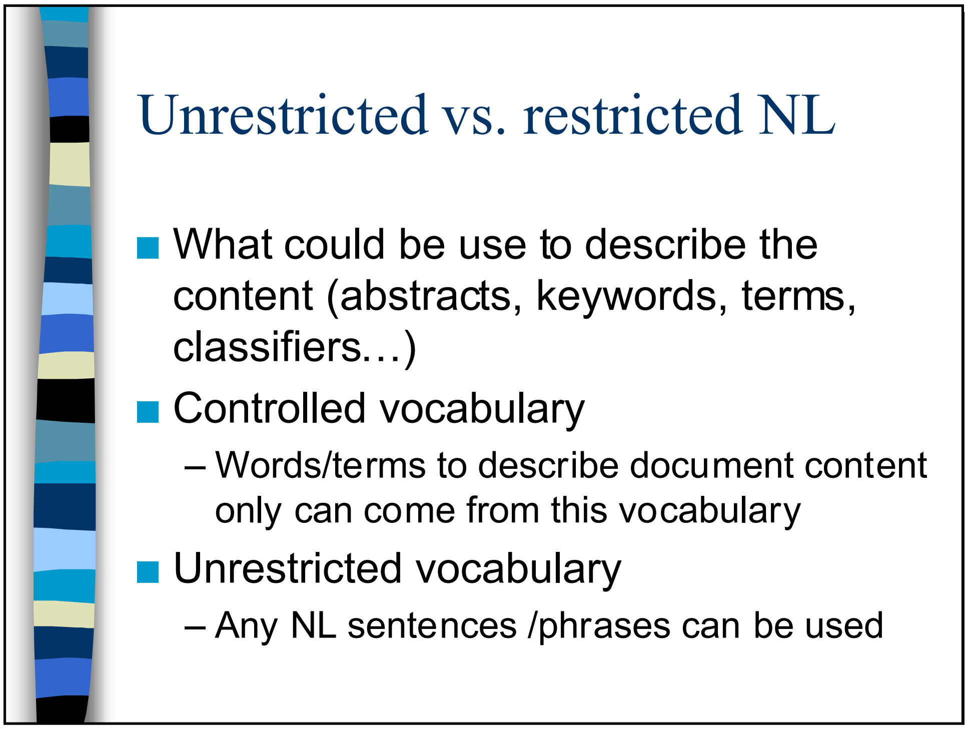


Case Study: Movie Rental Store



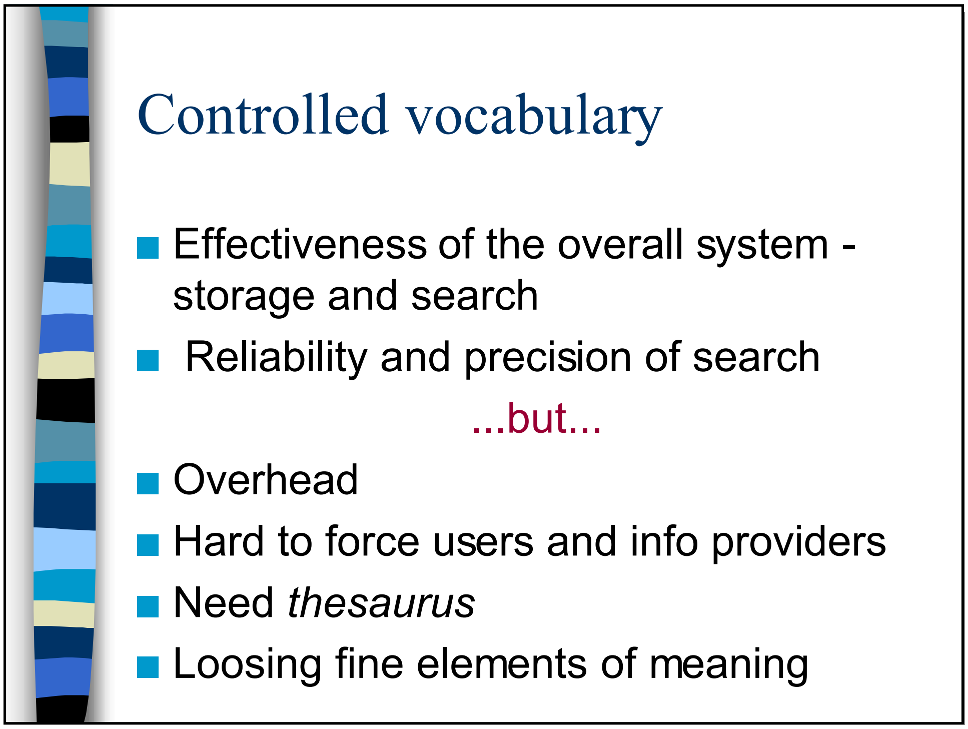
What’s in a surrogate?

- Metadata (about it)
  - Usually well-formalized, stored in a formatted database
- Content description
  - Rarely formalized, non-formatted storage
  - Keywords, terms…
  - Full-text abstract/extract
  - Restricted on unrestricted vocabulary



Unrestricted vs. restricted NL

- What could be use to describe the content (abstracts, keywords, terms, classifiers…)
- Controlled vocabulary
  - Words/terms to describe document content only can come from this vocabulary
- Unrestricted vocabulary
  - Any NL sentences /phrases can be used

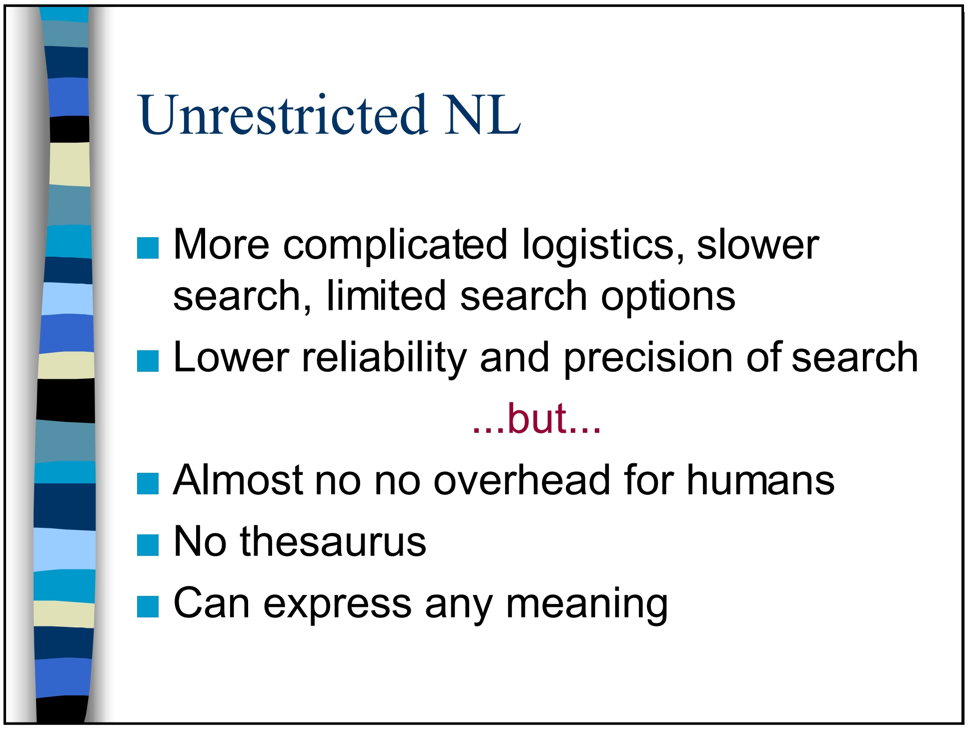


Controlled vocabulary

- Effectiveness of the overall system - storage and search
- Reliability and precision of search

...but...

- Overhead
- Hard to force users and info providers
- Need *thesaurus*
- Loosing fine elements of meaning

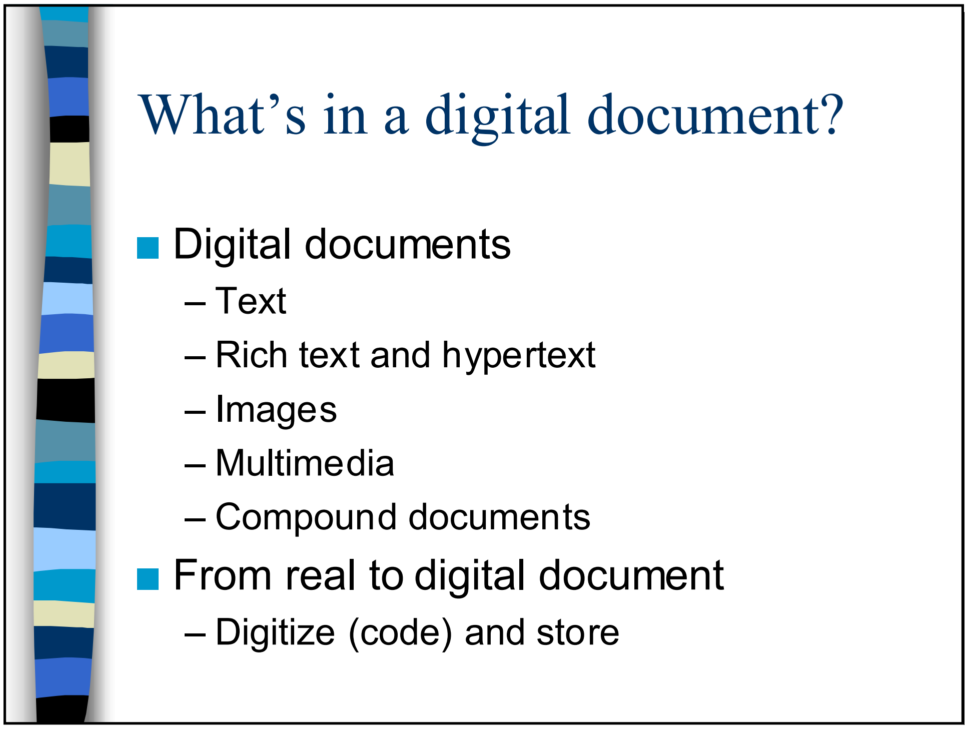


Unrestricted NL

- More complicated logistics, slower search, limited search options
- Lower reliability and precision of search

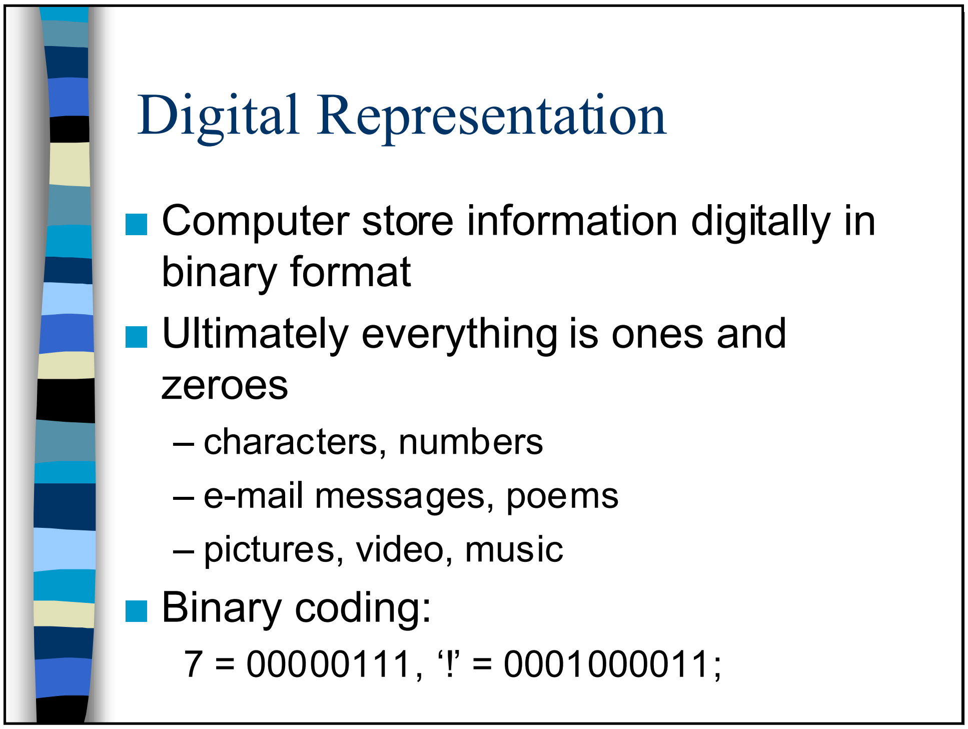
...but...

- Almost no no overhead for humans
- No thesaurus
- Can express any meaning



What’s in a digital document?

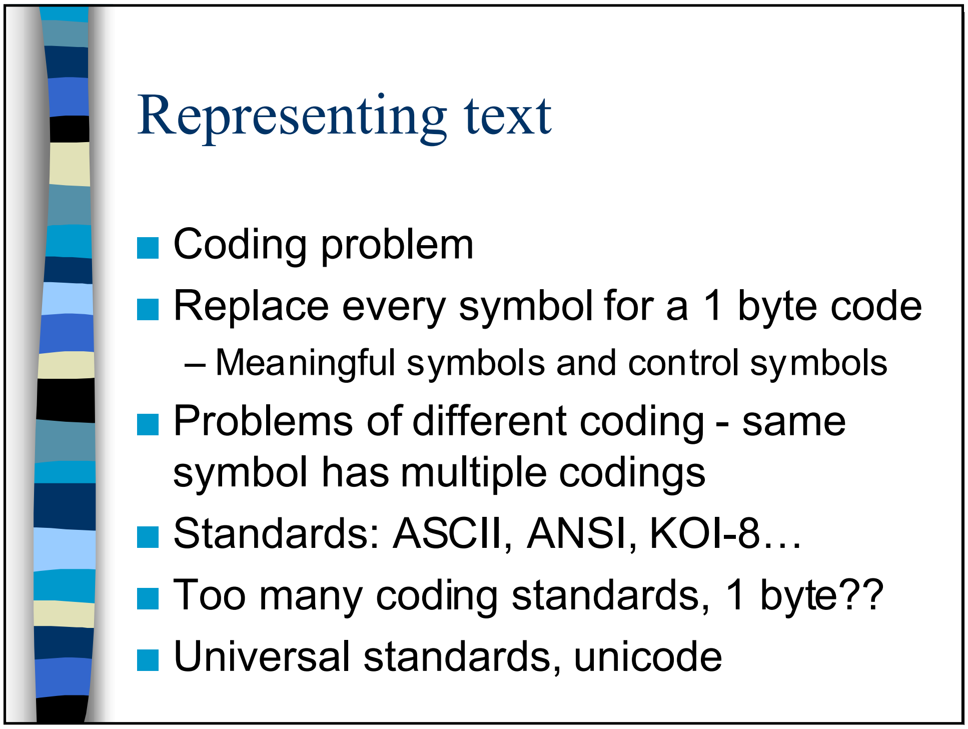
- Digital documents
  - – Text
  - – Rich text and hypertext
  - – Images
  - – Multimedia
  - – Compound documents
- From real to digital document
  - – Digitize (code) and store



Digital Representation

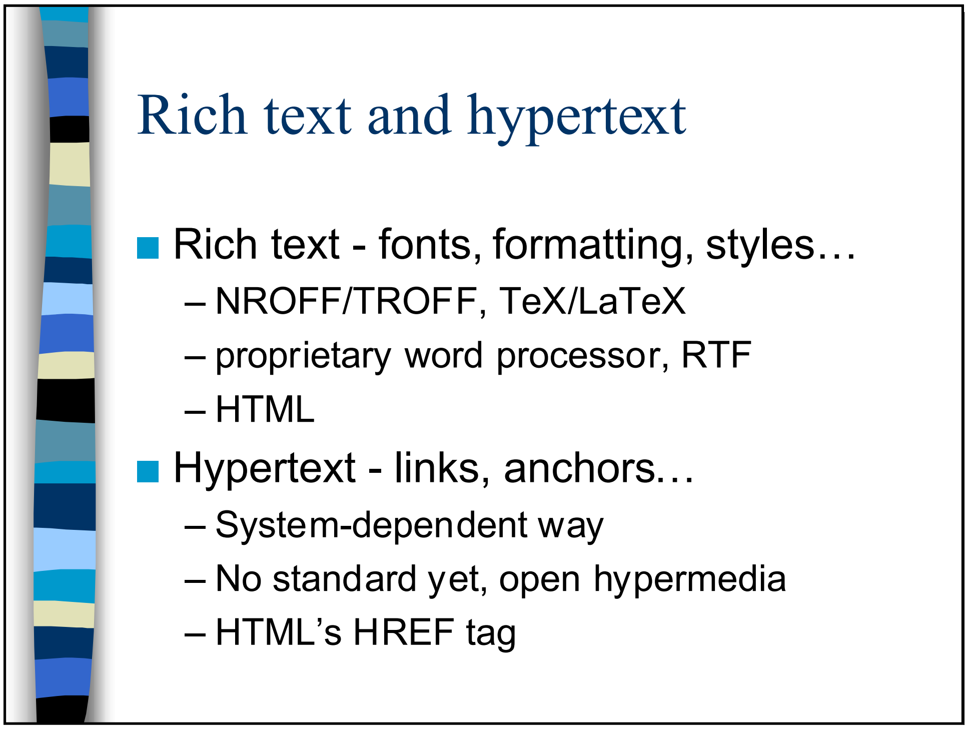
- Computer store information digitally in binary format
- Ultimately everything is ones and zeroes
  - – characters, numbers
  - – e-mail messages, poems
  - – pictures, video, music
- Binary coding:

  7 = 00000111, ‘!’ = 0001000011;



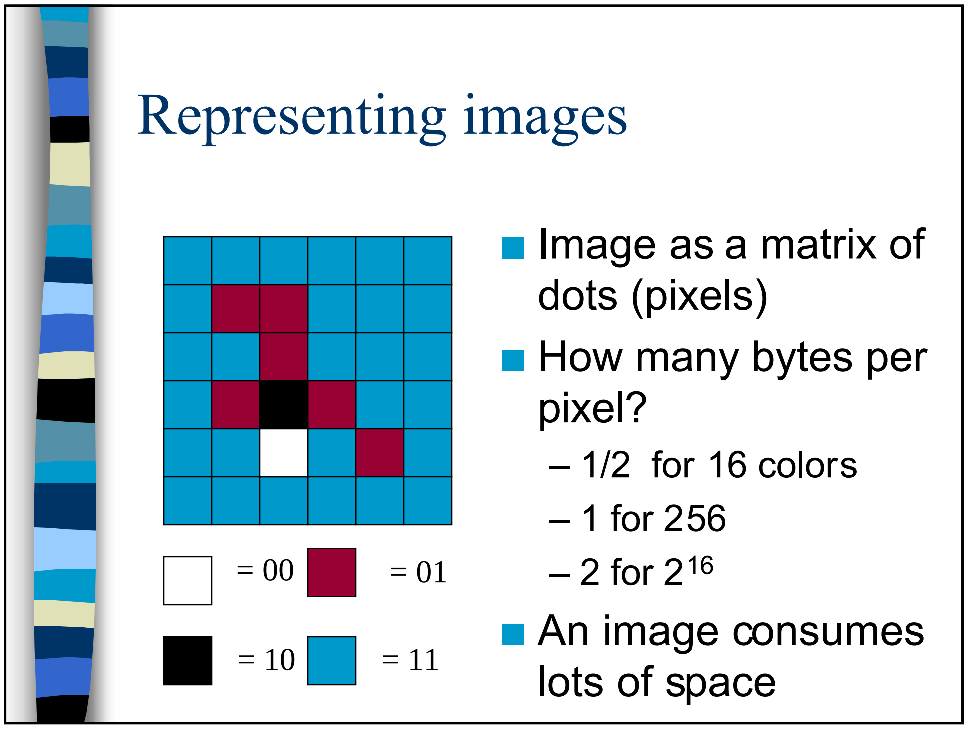
Representing text

- Coding problem
- Replace every symbol for a 1 byte code
  - Meaningful symbols and control symbols
- Problems of different coding - same symbol has multiple codings
- Standards: ASCII, ANSI, KOI-8…
- Too many coding standards, 1 byte??
- Universal standards, unicode



Rich text and hypertext

- Rich text - fonts, formatting, styles…
  - NROFF/TROFF, TeX/LaTeX
  - proprietary word processor, RTF
  - HTML
- Hypertext - links, anchors…
  - System-dependent way
  - No standard yet, open hypermedia
  - HTML’s HREF tag



Representing images

🟦	🟦	🟦	🟦	🟦	🟦
🟦	🟥	🟥	🟦	🟦	🟦
🟦	🟦	🟥	🟦	🟦	🟦
🟦	🟥	⬛	🟥	🟦	🟦
🟦	🟦	⬜	🟦	🟥	🟦
🟦	🟦	🟦	🟦	🟦	🟦

⬜ = 00 🟥 = 01

⬛ = 10 🟦 = 11

- Image as a matrix of dots (pixels)
- How many bytes per pixel?
  - – 1/2 for 16 colors
  - – 1 for 256
  - – 2 for 2^{16}
- An image consumes lots of space

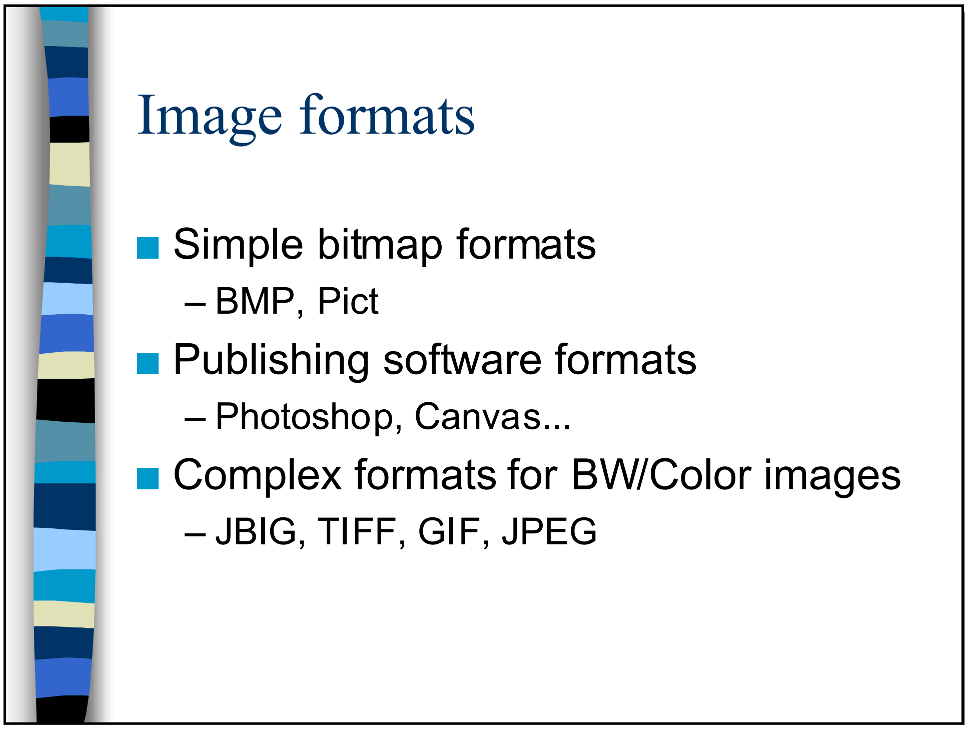
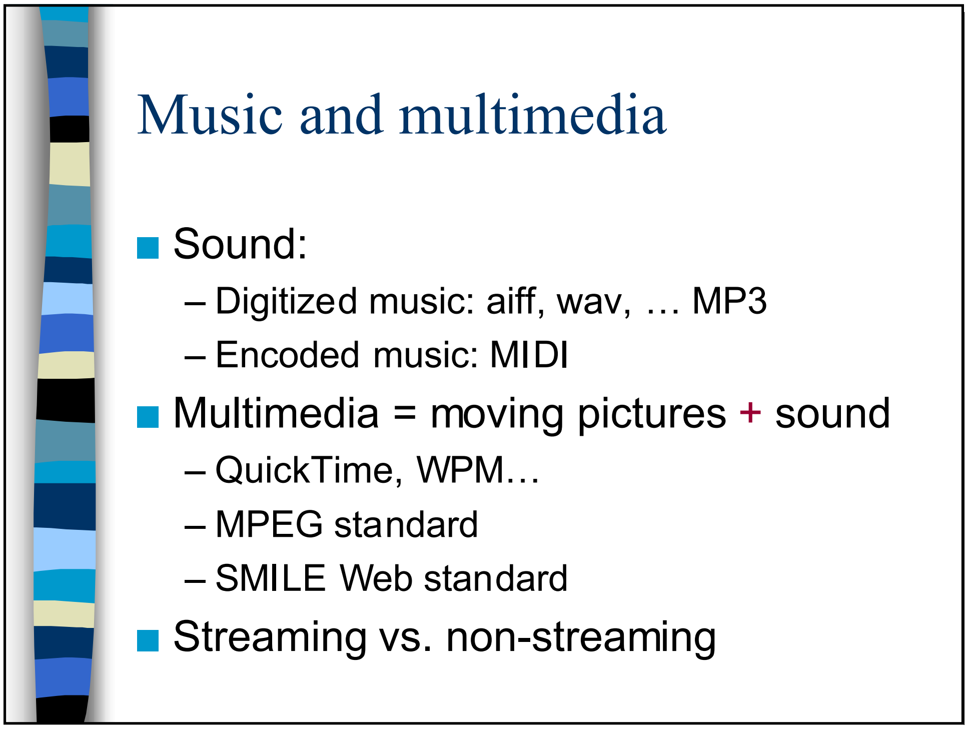


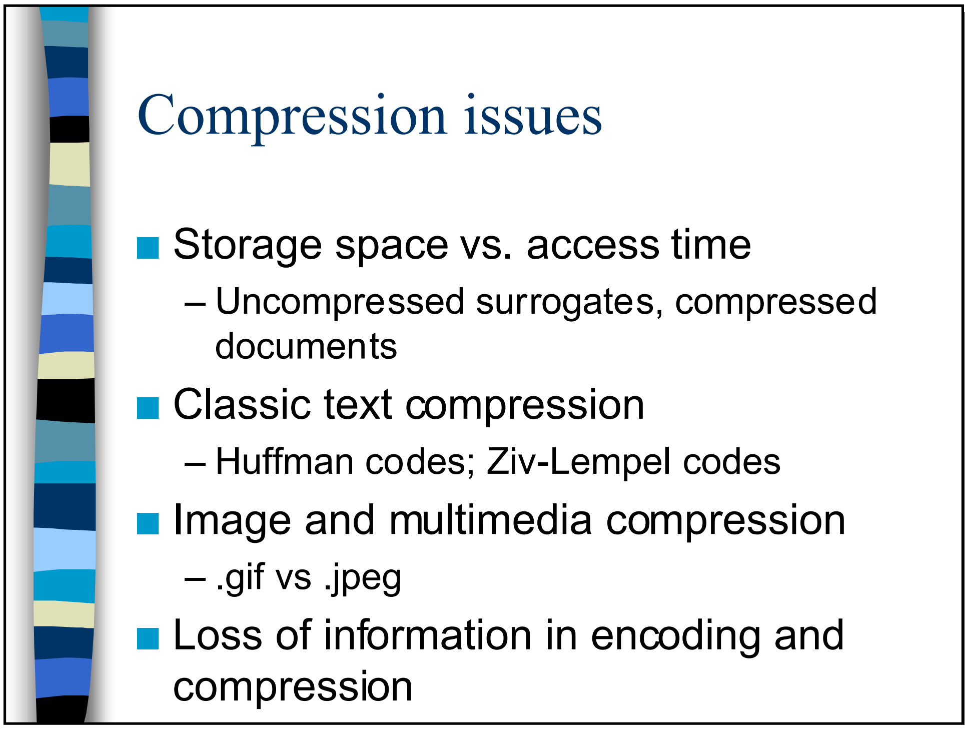
Image formats

- Simple bitmap formats
  - – BMP, Pict
- Publishing software formats
  - – Photoshop, Canvas...
- Complex formats for BW/Color images
  - – JBIG, TIFF, GIF, JPEG



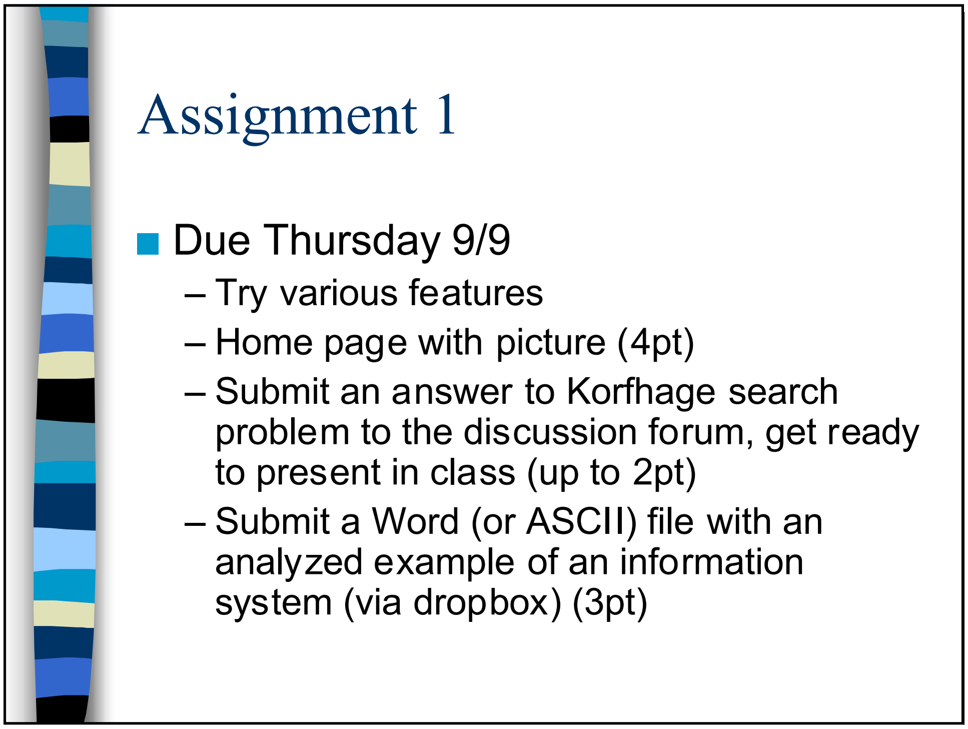
Music and multimedia

- Sound:
  - – Digitized music: aiff, wav, … MP3
  - – Encoded music: MIDI
- Multimedia = moving pictures + sound
  - – QuickTime, WPM…
  - – MPEG standard
  - – SMILE Web standard
- Streaming vs. non-streaming



Compression issues

- Storage space vs. access time
  - – Uncompressed surrogates, compressed documents
- Classic text compression
  - – Huffman codes; Ziv-Lempel codes
- Image and multimedia compression
  - – .gif vs .jpeg
- Loss of information in encoding and compression



Assignment 1

- Due Thursday 9/9
  - – Try various features
  - – Home page with picture (4pt)
  - – Submit an answer to Korfhage search problem to the discussion forum, get ready to present in class (up to 2pt)
  - – Submit a Word (or ASCII) file with an analyzed example of an information system (via dropbox) (3pt)