Cornell University
Computing and Information Science

CS 5150 Software Engineering
Usability and User Interfaces

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Human Computer Interaction

Human Computer Interaction is the academic discipline that studies how people interact with computers.

The Information Science and Communication departments offer a series of courses in Human Computer Interaction and have major research programs in this area.

The Importance of User Interface Design

A computer system is only as good as the interface it provides to its users

- Appropriate functionality, easy navigation, elegant design, and fast response times make a measurable difference to a system's effectiveness
- If a system is hard to use:
  - ⇒ users may fail to find important results, or mis-interpret what they do find
  - ⇒ users may give up in disgust

Good support for users is more than a cosmetic flourish

- **Usability** is more than **user interface design**.
- Developing good user interfaces needs **skill** and **time**.

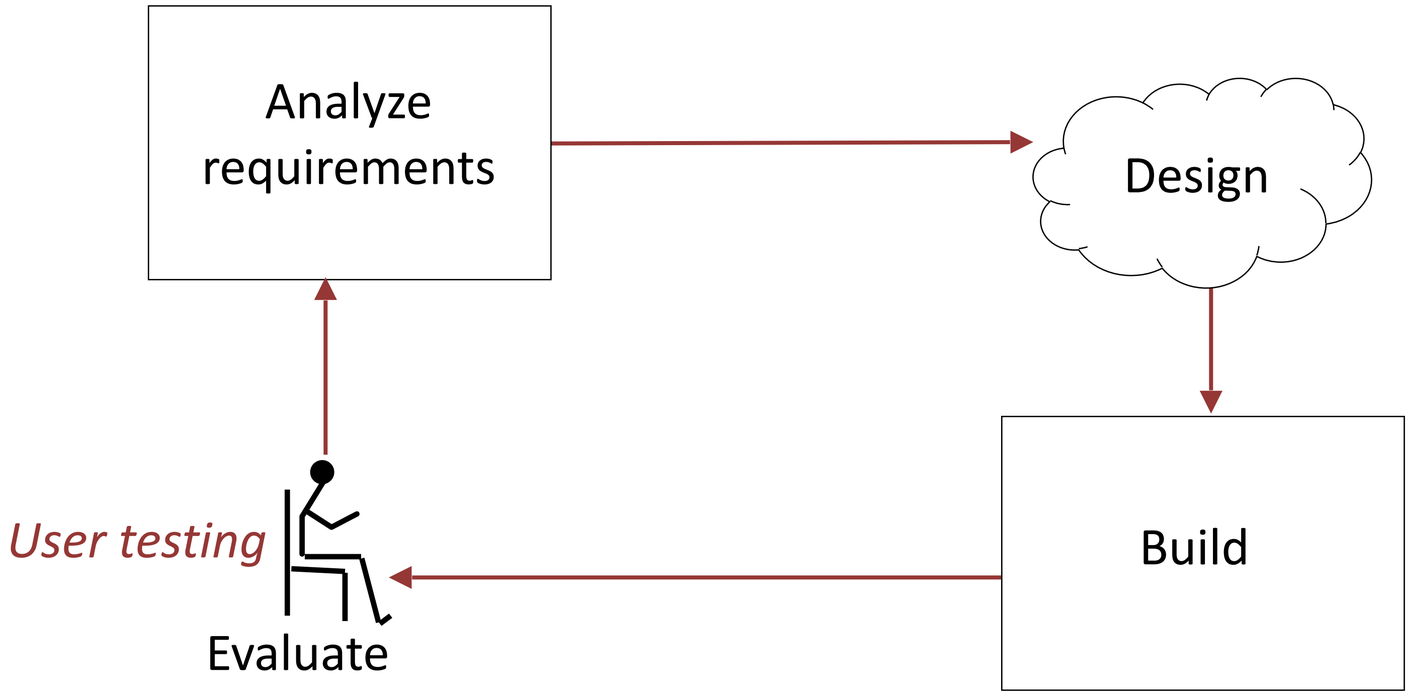
Development Processes for User Interfaces

It is almost impossible to specify an interactive or graphical interface in a textual document.

- **Requirements** benefit from sketches, comparison with existing systems, etc.
- **Designs** should include graphical elements and benefit from a mock-up or other form of prototype.
- User interfaces must be **tested with users**. Expect to change the requirements and design as the result of testing.
- **Schedules** should include user testing and **time to make changes**.

Whatever process you use to develop a software system, the development of the user interface is always iterative.

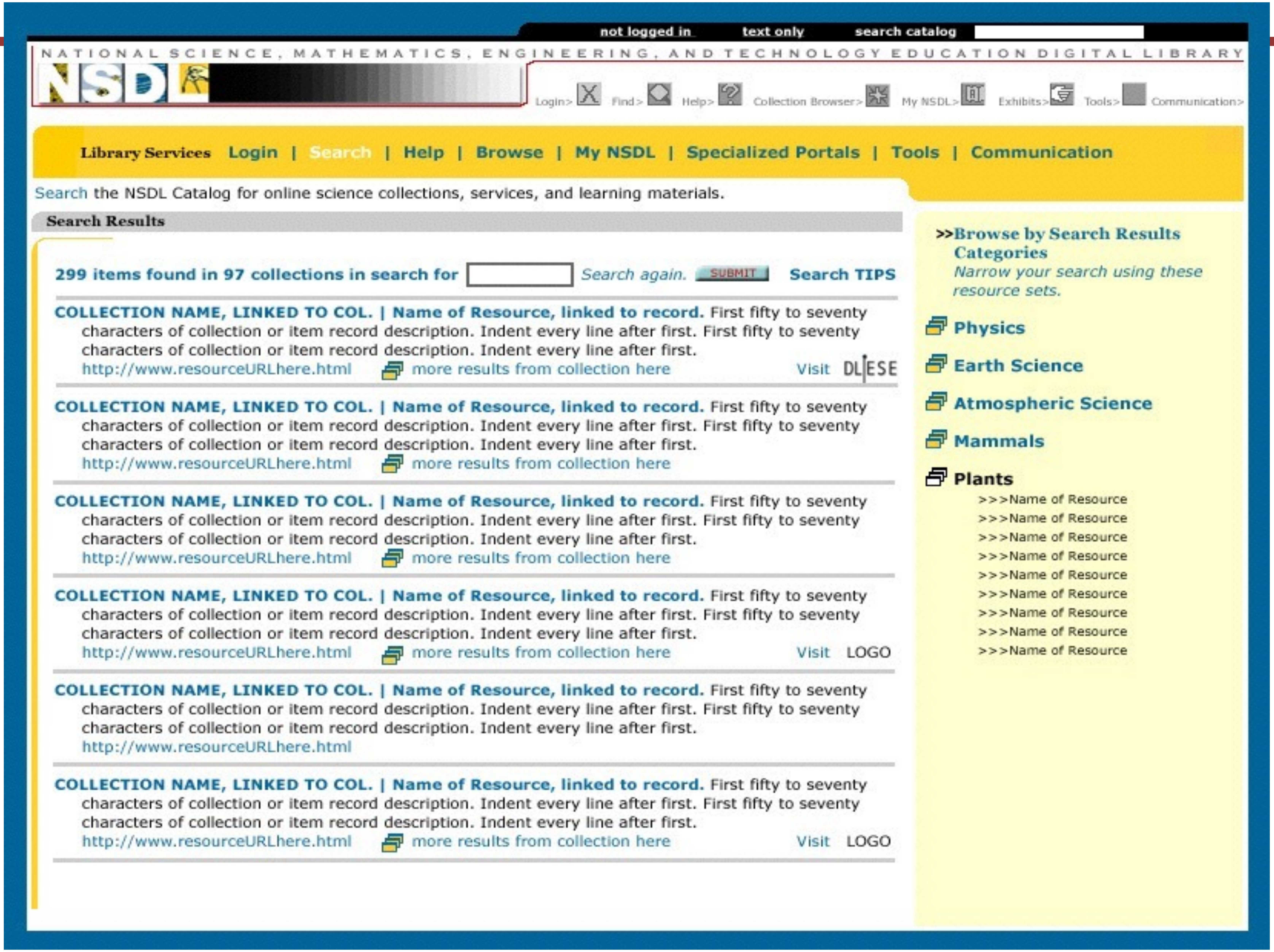
Usability:
The Analyze/Design/Build/Evaluate Loop



Tools for Usability Requirements and Evaluation

	Initial	Mock-up	Prototype	Production
Client's opinions	√	√	√	
Competitive analysis	√			
Expert opinion	√	√	√	
Focus groups	√	√		
Observing users		√	√	√
Measurements			√	√

Tools for Usability Requirements: Mock-up



Tools for Usability Requirements: Focus Group

A focus group is a group interview

- Interviewer
- Potential users
  - Typically 5 to 12
  - Similar characteristics (e.g., same viewpoint)
- Structured set of questions
  - May show mock-ups
  - Group discussions
- Repeated with contrasting user groups

Usability: Accessibility Requirements

Accessibility

Software designers must be prepared for users with poor eyesight, lack of hearing, poor manual dexterity, limited knowledge of English, etc.

Requirements about accessibility (e.g., support for users with disabilities) are most likely to arise in the user interface.

You may have a legal requirement to support people with disabilities.

Example of requirements specification:

The system must comply with Section 508 of the US Rehabilitation Act. See http://www.section508.gov/

Usability: Equipment Requirements

There may also be requirements to support computers with poor performance, limited screen sizes, bad network connections, etc.

Be explicit about the equipment assumptions that you make and how to handle failures. Do user testing with both good and bad equipment.

Example

MacMail has a requirement that operations terminate cleanly if the network connection is lost, but its behavior is erratic if the network connection becomes extremely slow, e.g., it will not quit. (2013)

Design from a System Viewpoint

Usability is more than user interface design

mental model	user interface
	interface functions
	data and metadata
	computer systems and networks

Mental Model

A **mental model** is what a user thinks is true about a system, not necessarily what is actually true.

- A mental model should be similar in structure to the system that is represented.
- A mental model allows a user to predict the results of his/her actions.
- A mental model is simpler than the represented system. It includes only enough information to allow reasonable predictions.

A mental model is also called a **conceptual model**.

Examples of Mental Models

The mental model is the user's internal model of what the system provides:

- The **desk top metaphor** -- files and folders
- The **web search model** -- one vast collection of pages, which are searched on request

User Interface Design

The **user interface** is the appearance on the screen and the actual manipulation by the user

- Fonts, colors, logos, key board controls, menus, buttons
- Mouse control or keyboard control
- Conventions (e.g., "back", "help")

Examples of design choices

- Screen space utilization in Adobe Reader.
- Number of snippets per page in web search.

Principles of User Interface Design

User interface design is partly an art, but there are general principles.

- Consistency -- in appearance, controls, and function.
- Feedback -- what is the computer system doing? Why does the user see certain results?
- Users should be able to interrupt or reverse actions.
- Error handling should be simple and easy to comprehend.
- Skilled users should be offered shortcuts; beginners should have simple, well-defined options.

The user should feel in control.

Interface Functions

The **interface functions** determine the actions that are available to the user:

- Select part of an object
- Search a list or sort the results
- View help information
- Manipulate objects on a screen
- Pan or zoom

There may be alternative **user interface designs** for the same **interface functions**, for example:

- Different versions of the MS Windows desktop have most of the same interface functions, but different user interface designs.
- Applications that run on both Windows and Macintosh computers support a one button mouse (Macintosh) or a two button mouse (Windows).

Data and Metadata

Data and metadata stored by the computer system enable the interface functions and the interface design.

- The desktop metaphor has the concept of associating a file with an application. This requires a file type to be stored with each file:
  -- extension to filename (Windows and Unix)
  -- resource fork (Macintosh)
- Effectiveness of searching depends on the type and quality of data that is indexed (free-text, controlled vocabulary, etc.)

Inexperienced clients sometimes ask for interface functions that require additional data or metadata.

Computer Systems and Networks

The **performance**, **reliability** and **predictability** of computer systems and networks is crucial to usability.

Examples

- Instantaneous response time for mouse tracking and echo of key stroke.
- Quality of service for streaming multimedia, e.g., audio has priority over video.
- Response time for transactions, e.g., approve transaction if no reply within five seconds.

Computer Systems and Networks: Requirements

Performance, Reliability, Scalability, Security…

As computer systems improve, users have got more demanding. A response time that is good enough today, may not be good enough five years from now.

Example: Response time

0.1 sec – the user feels that the system is reacting instantaneously

1 sec – the user will notice the delay, but his/her flow of thought stays uninterrupted

10 sec – the limit for keeping the user's attention focused on the dialogue

Computer Systems and Networks: Device-Aware Interfaces

Interfaces must take into account physical constraints of computers and networks:

- How does a desk-top computer differ from a laptop?
- What is special about a smart phone?
- How do you make use of a touch-sensitive screen?
- What works well with a digital camera?

Constraints that the interfaces must allow for:

=> performance of device (e.g., fast or slow graphics)

=> limited form factor (e.g., small display, keyboard)

=> connectivity (e.g., intermittent)

User Interface Design:
Graphical Interfaces with Direct Interaction

Most modern user interfaces are “What you see is what you get”. The user interacts with computer by manipulating objects on screen (e.g., Windows desktop, iPad) using mouse, keyboard, touch screen, icons, menus, etc.

Advantages of graphical interfaces with direct interaction

- Can be intuitive and easy to learn
- Users get immediate feedback
- Requires minimal typing skills
- Straightforward for casual users
- Icons can be language-independent

Disadvantages of graphical interfaces with direct interaction

- Not suitable for some complex interactions
- May be slow for skilled users
- Difficult to build scripts
- Only suitable for human users

Direct Interaction: Design Considerations

Look:

Characteristics of the appearance that convey information

Feel:

Interaction techniques that provide satisfactory experience

Metaphors and mental models:

Conceptual models, metaphors, icons, but there may not be an intuitive model

Navigation rules:

How to move among data, functions, and activities in a large space

Conventions:

Familiar aspects that do not need extra training – good for users, good for designers

e.g., scroll bars, buttons, gestures, help systems, sliders

Interface Design: Menus

- Easy for users to learn and use
- Certain categories of error are avoided
- Enables context-sensitive help

Major difficulty is structure of large choices

- Scrolling menus (e.g., states of USA)
- Hierarchical
- Associated control panels
- Menus plus command line

Users prefer broad and shallow to deep menu systems

Interface Design: Command Line Interfaces

User interacts with computer by typing commands (e.g., Linux shell script)

- Allows complex instructions to be given to computer
- Facilitates formal methods of specification & implementation
- Skilled users can input commands quickly
- Unless very simple, requires learning or training
- Can be adapted for people with disabilities
- Can be multi-lingual
- Suitable for scripting / non-human clients

Help System Design

Help system design is difficult

- Must prototype with mixed users
- Must have many routes to same information
- Categories of help:

  => Overview and general information
  => Specific or context information
  => Tutorials (general)
  => Cook books and wizards
  => Emergency ("I am in trouble ...")

Help systems need experienced designers. Schedule plenty of time for development and user testing.

Information Presentation

Simple is often better than fancy

- Text

  precise, unambiguous

  fast to compute and transmit

- Graphical interface

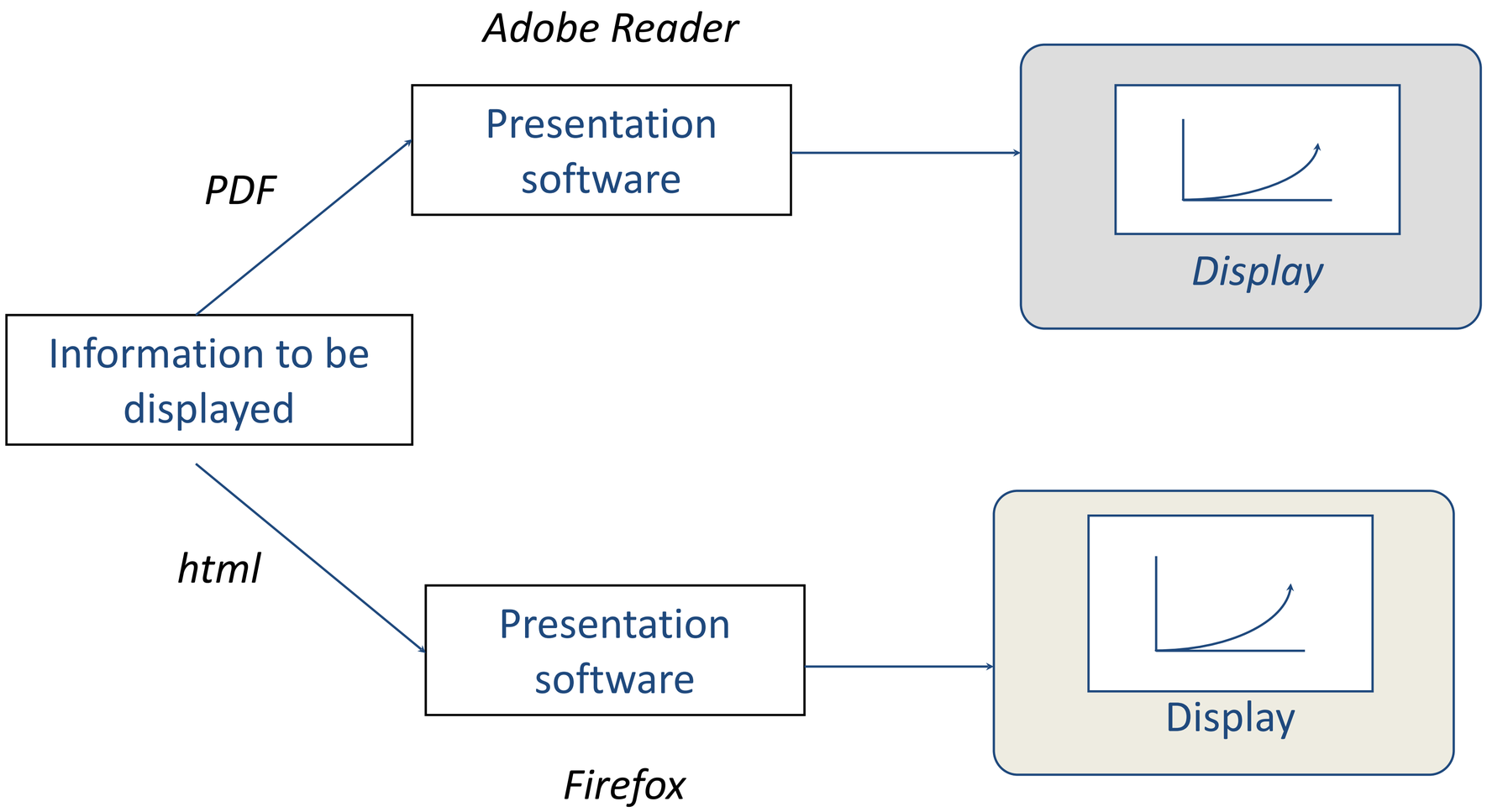
  simple to comprehend / learn,

  but icons can be difficult to recognize

  uses of color

  variations show different cases

Separation of Content from Presentation



Usability: Design Tensions in Networked Systems

Designers wish to control what the user sees, but users wish to configure their own environments.

- Client computers and network connections vary greatly in capacity.
- Client software may run on various operating systems, which may not be the current version.
- Accessibility requires that designers do not take control of parameters such as font size.

Be explicit about the assumptions you make about the user's computer, web browser, etc.

In using style sheets, such as CSS, avoid over-riding user preferences.

System Considerations of User Interface Design

- Personal computer cycles are there to be used
- Any network transfer involves delay
- Shared systems have unpredictable performance
- Data validation often requires access to shared data
- Mobile code poses security risks

Usability and Cost

- User interface development may be a major part of a software development project
- Good usability may be expensive in hardware or special software development
- Costs are multiplied if a user interface has to be used on different computers or migrate to different versions of systems

Design users interfaces that can be built with standard tools:

- Programming environments provide powerful user interface toolkits
- Web browsers provide a general purpose user interface where others maintain the user interface software

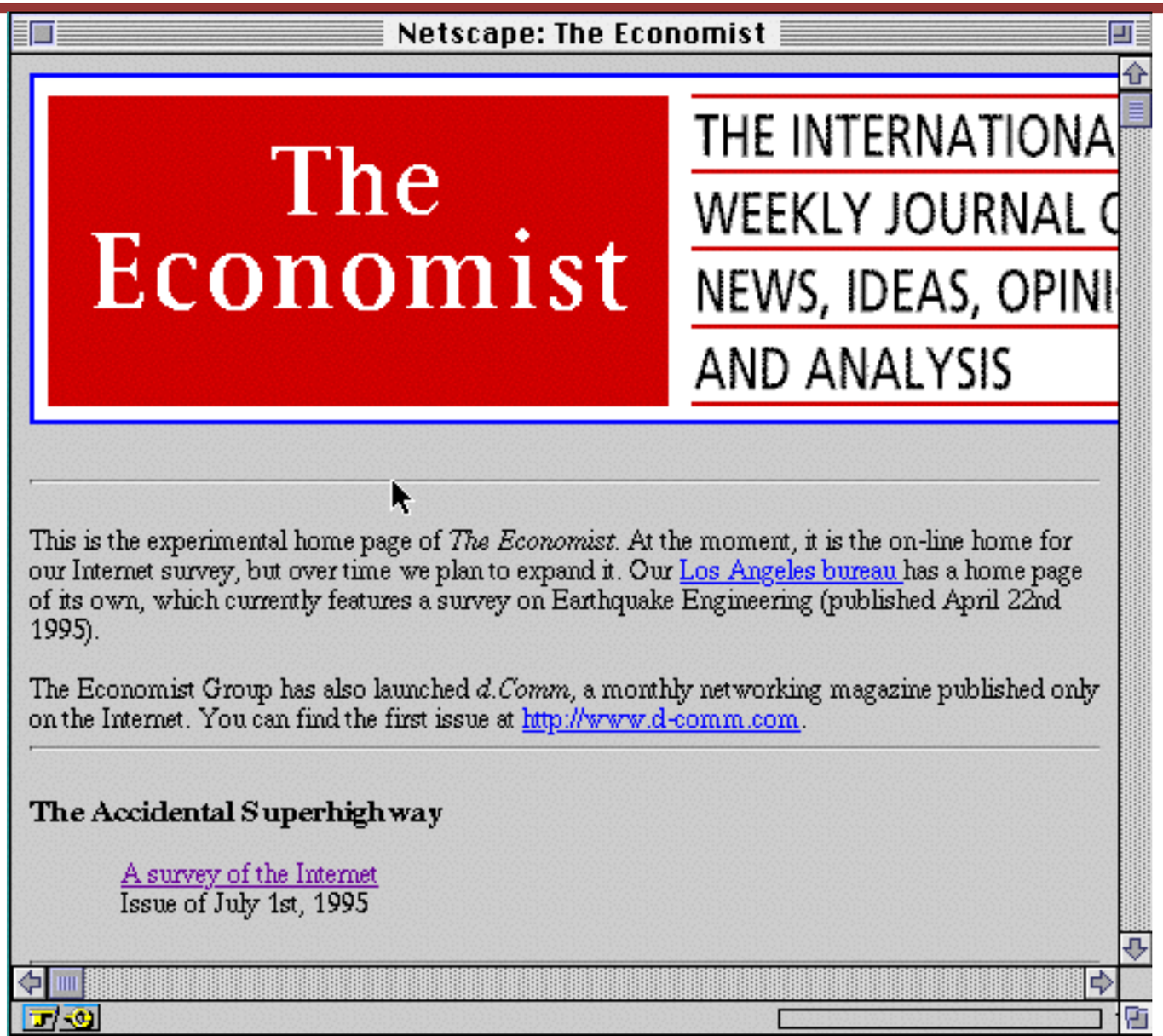
Changes in User Interface Design

Examples of change: 1995 to today

1990

```
SEARCH                          INSPEC Database
-------------------------------------------
Type keywords and press RETURN -- or
enter a command

Default is ADJ: acid free
-------------------------------------------

Set #3:                         acid adj fre
  0 records                     INSPEC Database

Set #4:                         acid adj free
  5 records                     INSPEC Database

Set #5:                         acid and paper
  448 records                   INSPEC Database

Set #6:                         deacidification
  4 records                     INSPEC Database
-------------------------------------------
```

1995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The Economist Group has also launched *d.Comm*, a monthly networking magazine published only on the Internet. You can find the first issue at http://www.d-comm.com.
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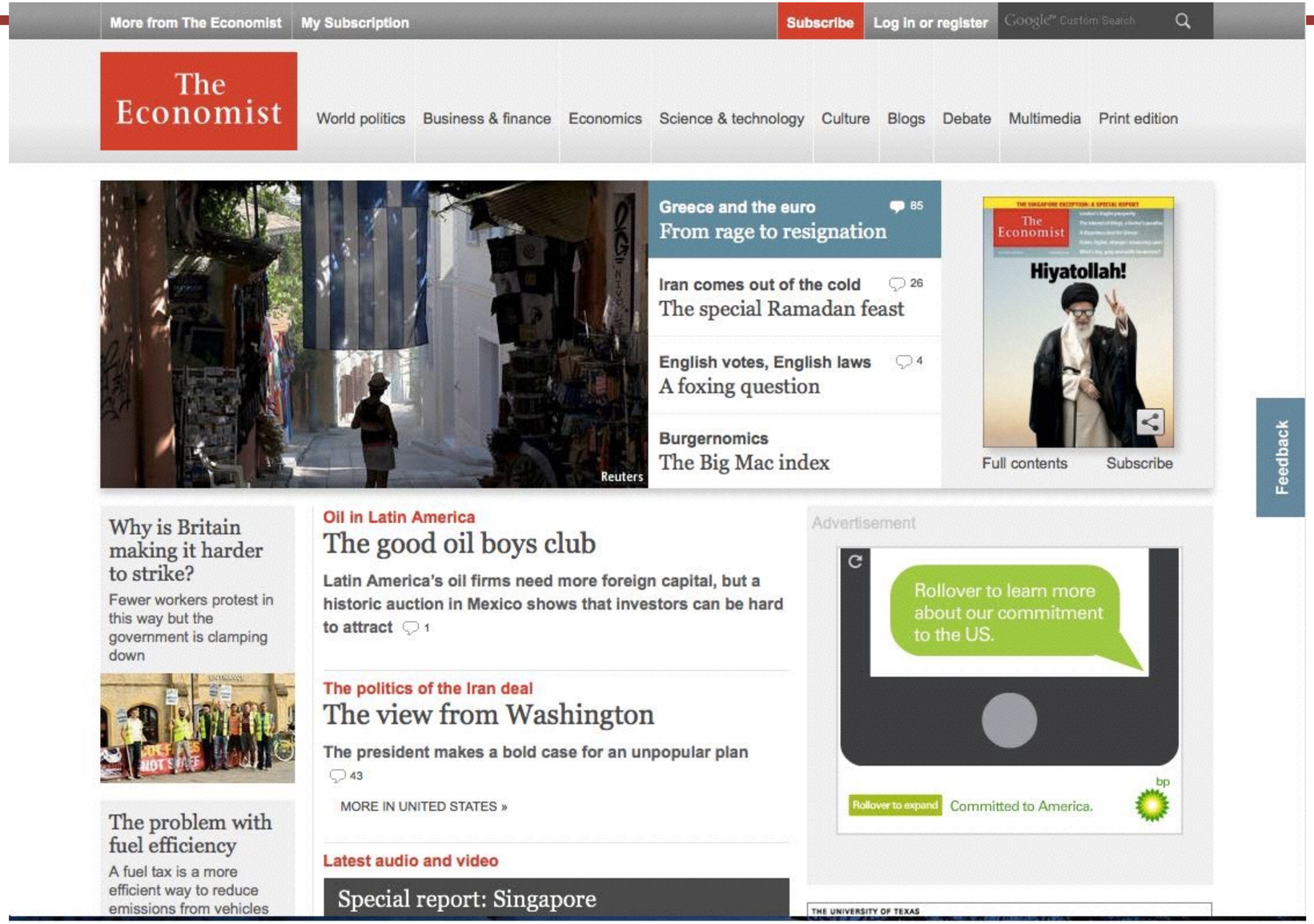
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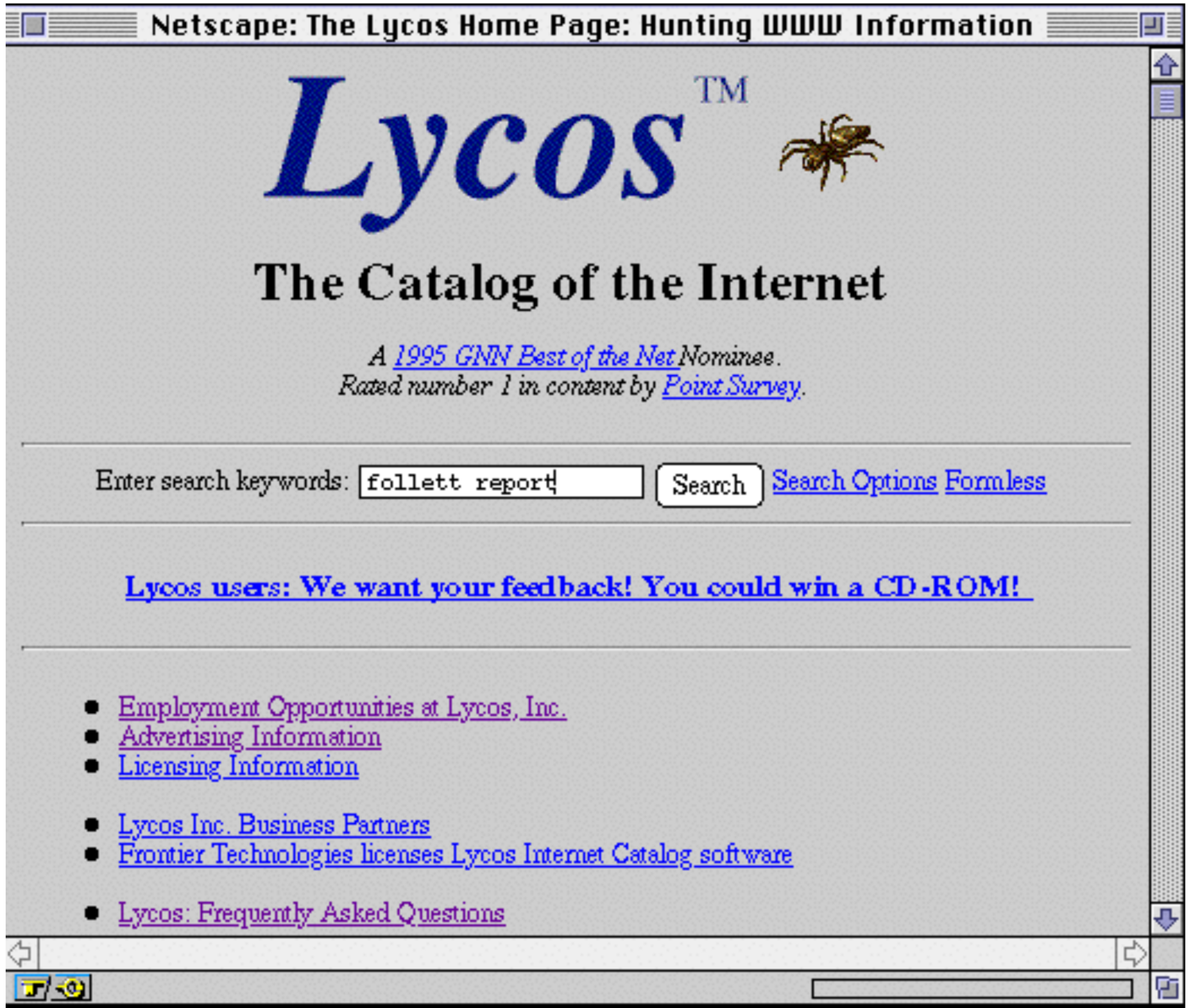
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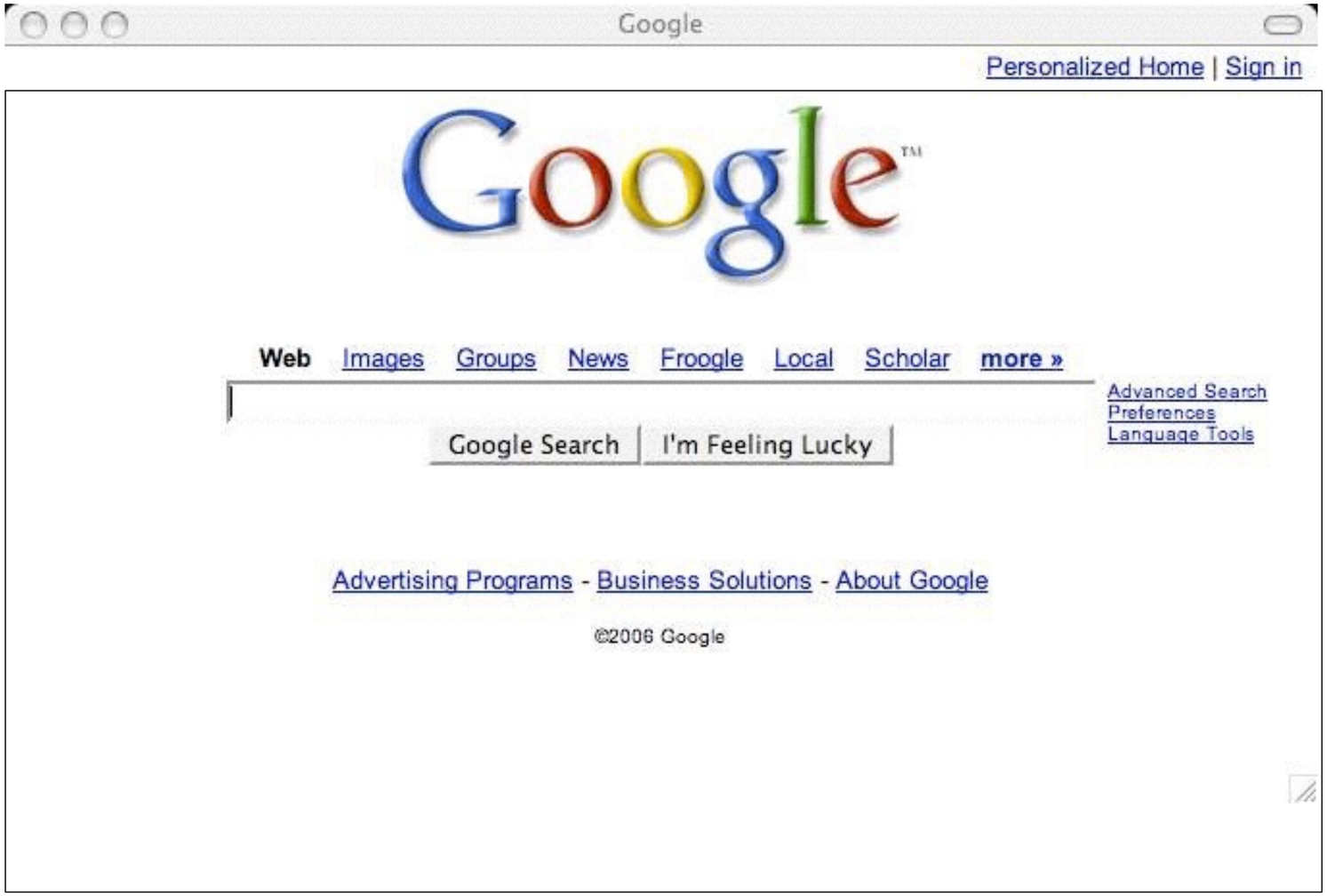
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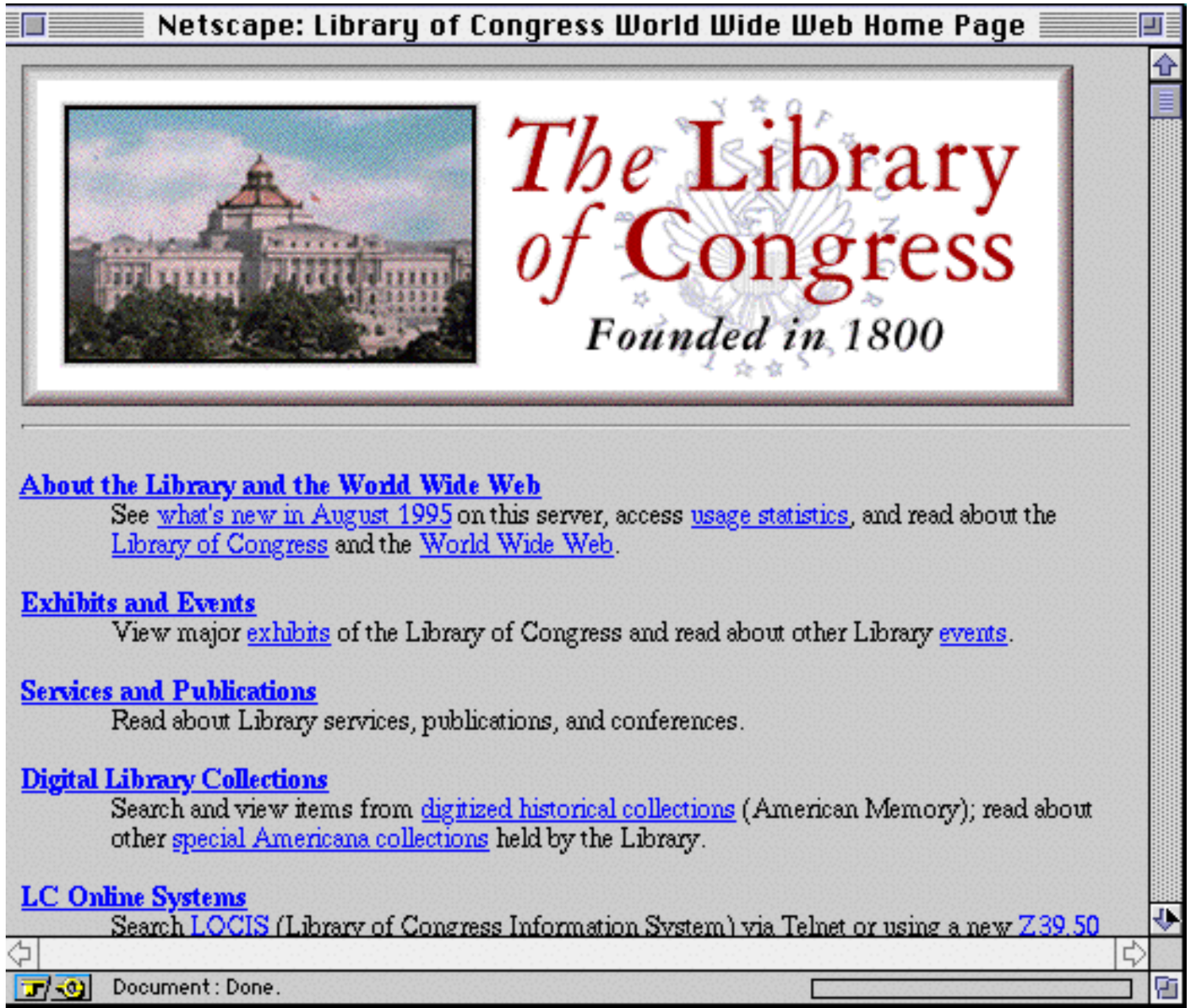
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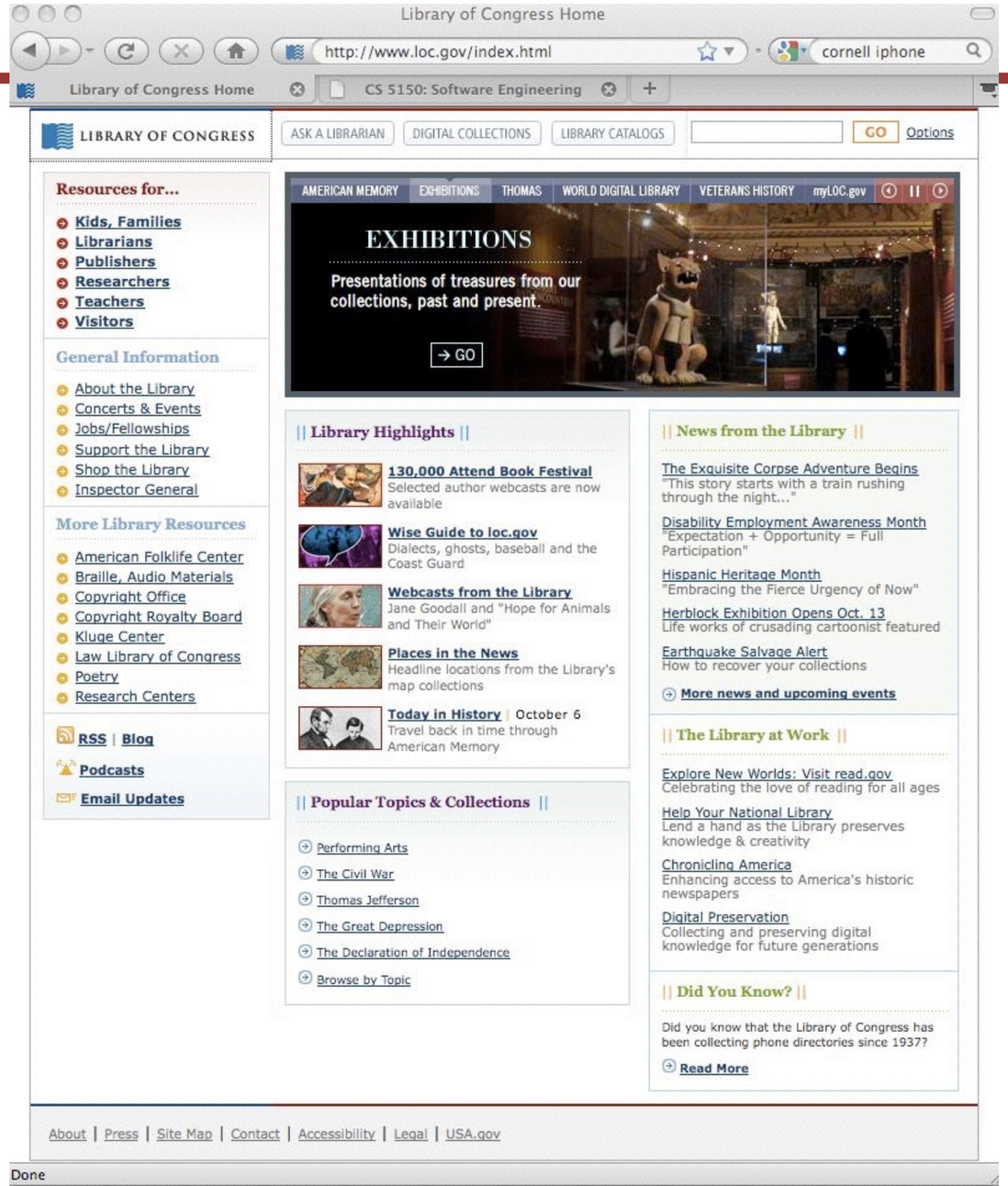
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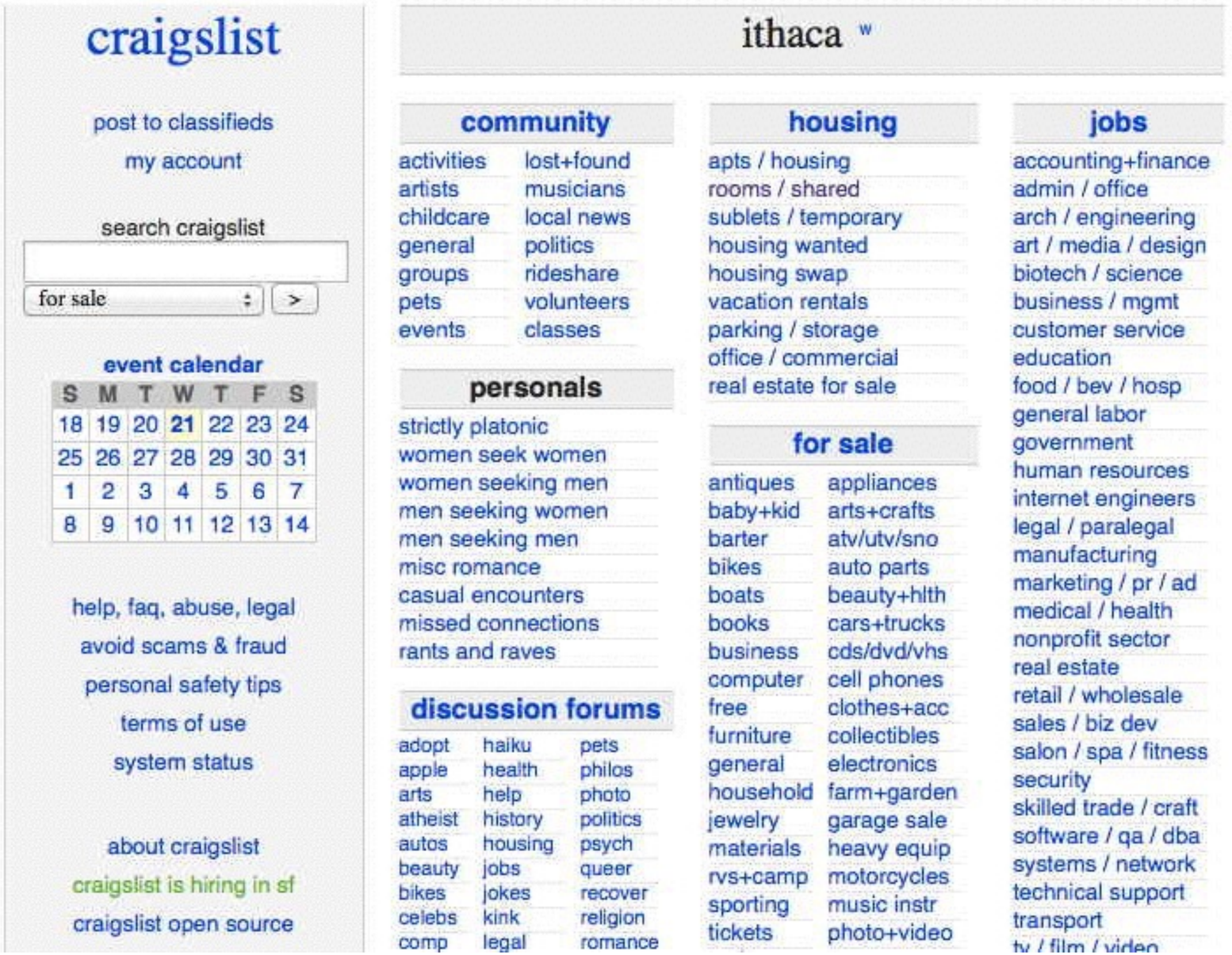

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25	26	27	28	29	30	31
1	2	3	4	5	6	7
8	9	10	11	12	13	14

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