Data Mining and Information Retrieval

Introduction to Web Mining

What is Web Mining?

Discovering useful information from the World-Wide Web and its usage patterns.

Web Mining vs. Data Mining

- Structure (or lack of it)
  - Textual information and linkage structure
- Scale
  - Data generated per day is comparable to largest conventional “data warehouses”
- Speed
  - Often need to react to evolving usage patterns in real-time (e.g., merchandising)

Web Mining topics

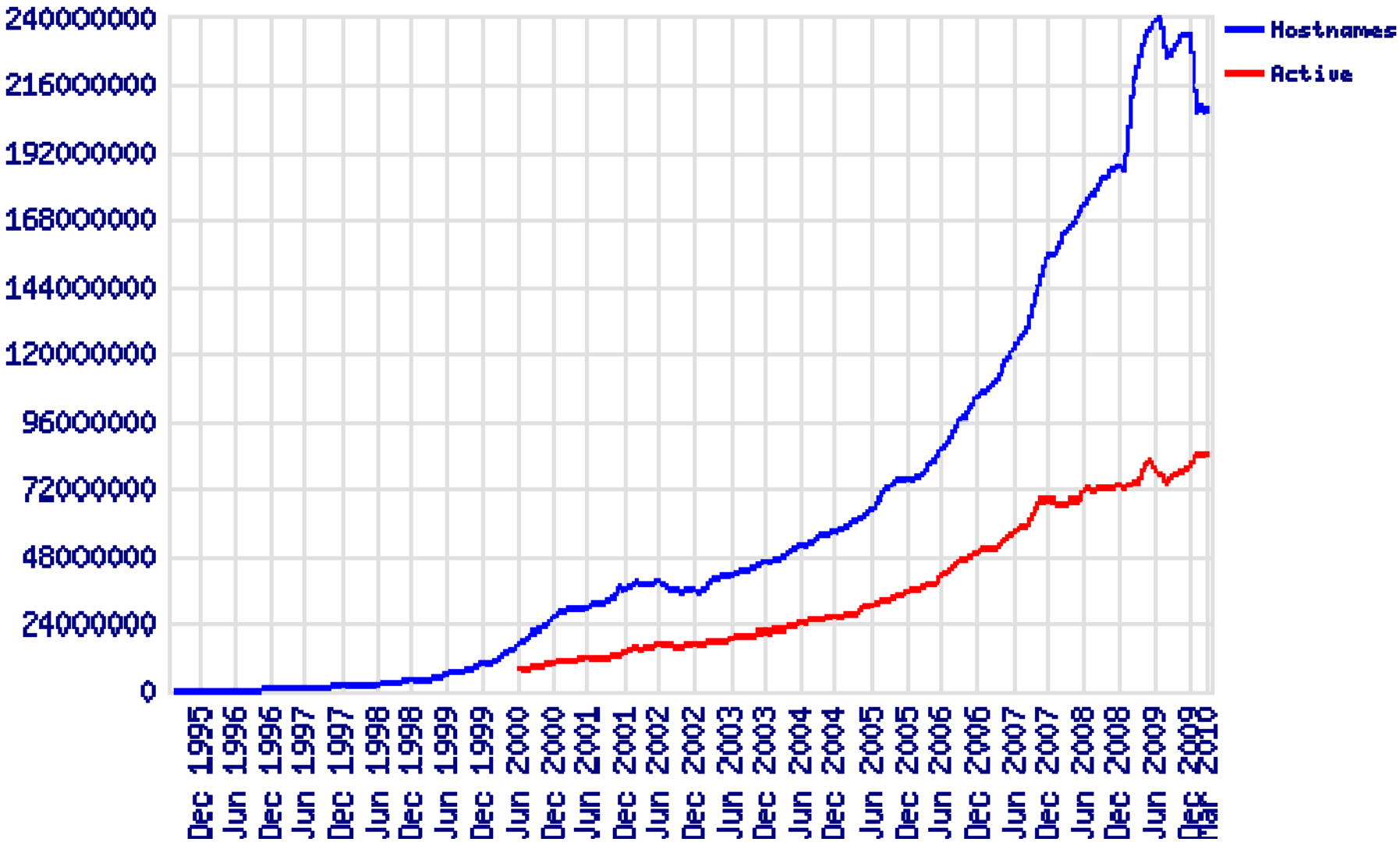
- Web graph analysis
- Power Laws and The Long Tail
- Structured data extraction
- Web advertising
- Systems Issues

Size of the Web

- Number of pages
  - Technically, infinite
  - Much duplication (30-40%)
  - Best estimate of "unique" static HTML pages comes from search engine claims
    - Google = 8 billion(?), Yahoo = 20 billion
- Number of web sites
  - Netcraft survey says 206,675,938 sites (March 2010)

(http://news.netcraft.com/archives/web_server_survey.html)

Netcraft Survey



http://news.netcraft.com/archives/web_server_survey.html

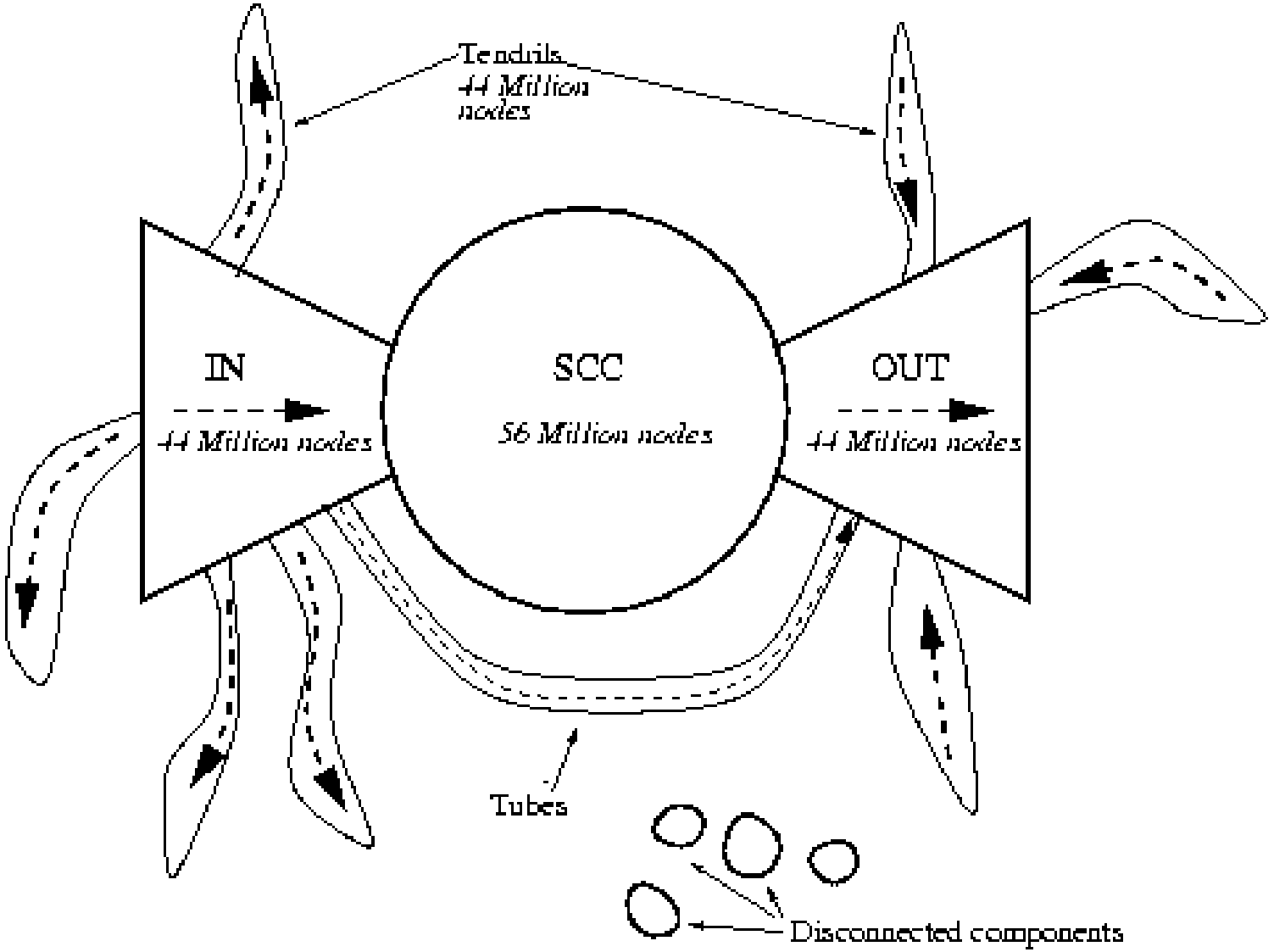
The Web as a Graph

- Pages = nodes, hyperlinks = edges
  - Ignore content
  - Directed graph
- High linkage
  - 8-10 links/page on average
  - Power-law degree distribution

Structure of Web Graph

- Let's take a closer look at structure
  - Broder et al (2000) studied a crawl of 200M pages and other smaller crawls
  - Bow-tie structure
    - Not a "small world"

Bow-tie Structure



Source: Broder et al, 2000

What can the graph tell us?

- Distinguish “important” pages from unimportant ones
  - Page rank
- Discover communities of related pages
  - Hubs and Authorities
- Detect web spam
  - Trust rank

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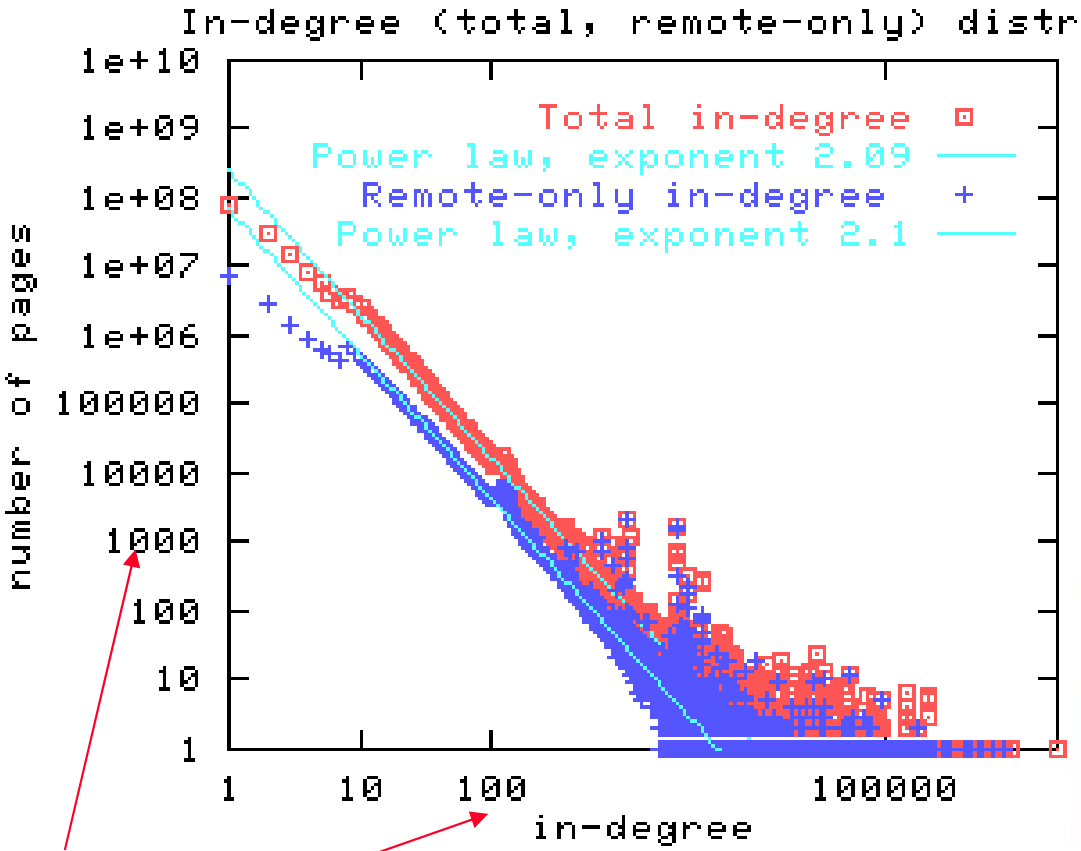
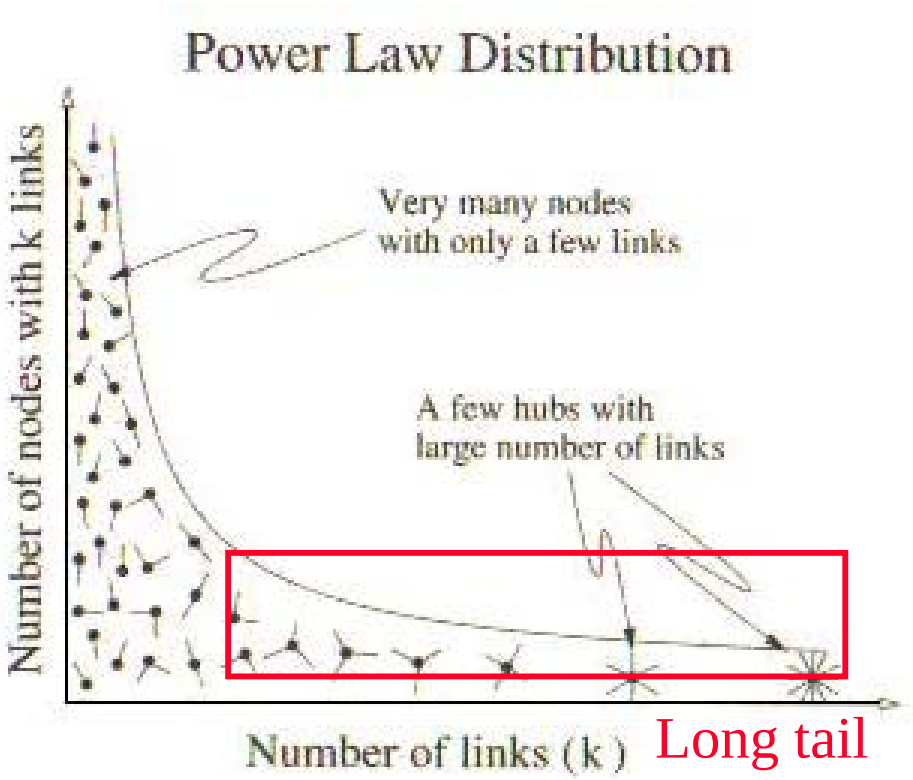
Power-law degree distribution



log



Long tail

Source: Broder et al, 2000

Power-laws galore

- Structure
  - In-degrees
  - Out-degrees
  - Number of pages per site
- Usage patterns
  - Number of visitors
  - Popularity
- And much more...

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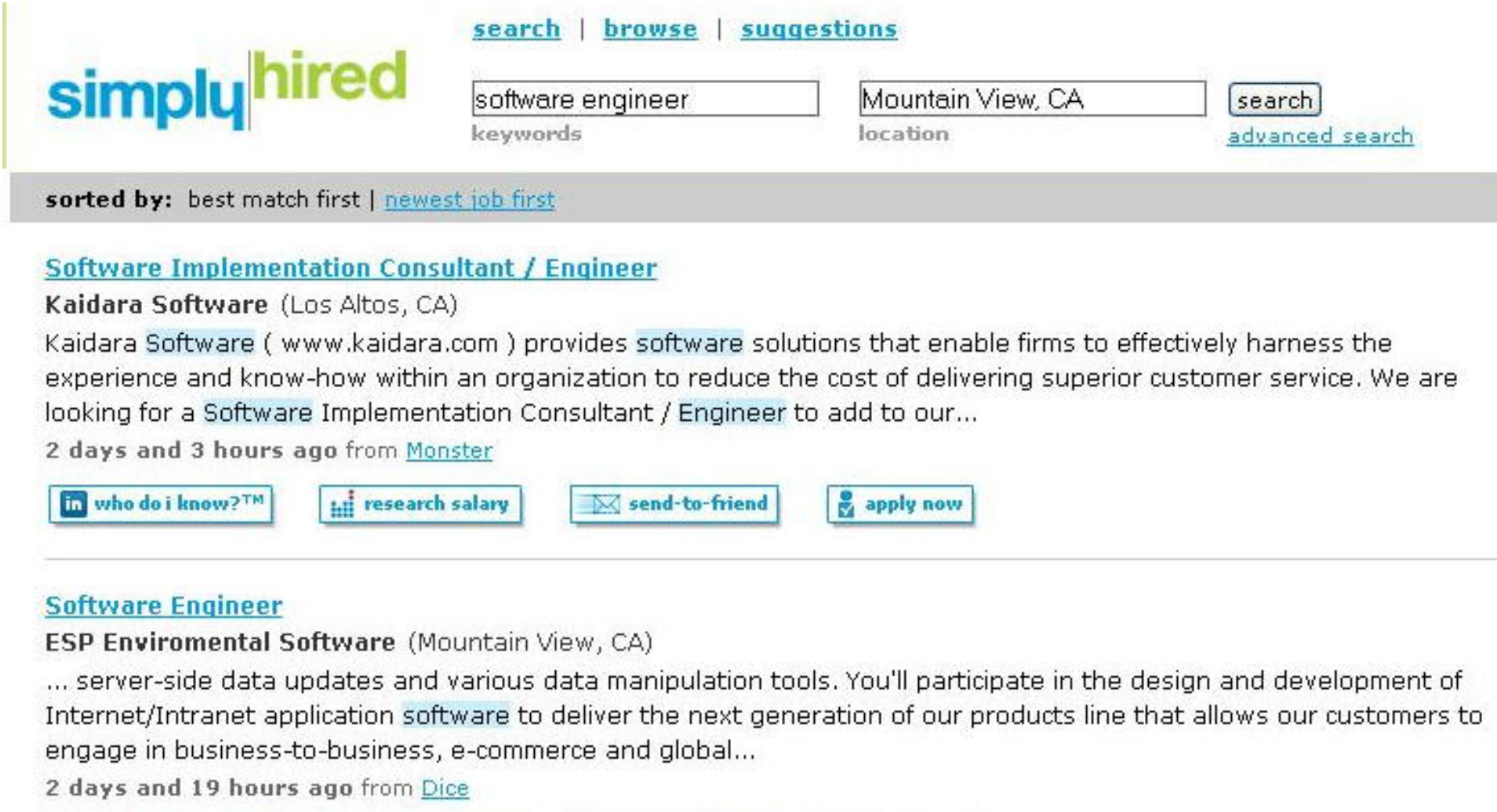
Extracting Structured Data



http://www.simplyhired.com

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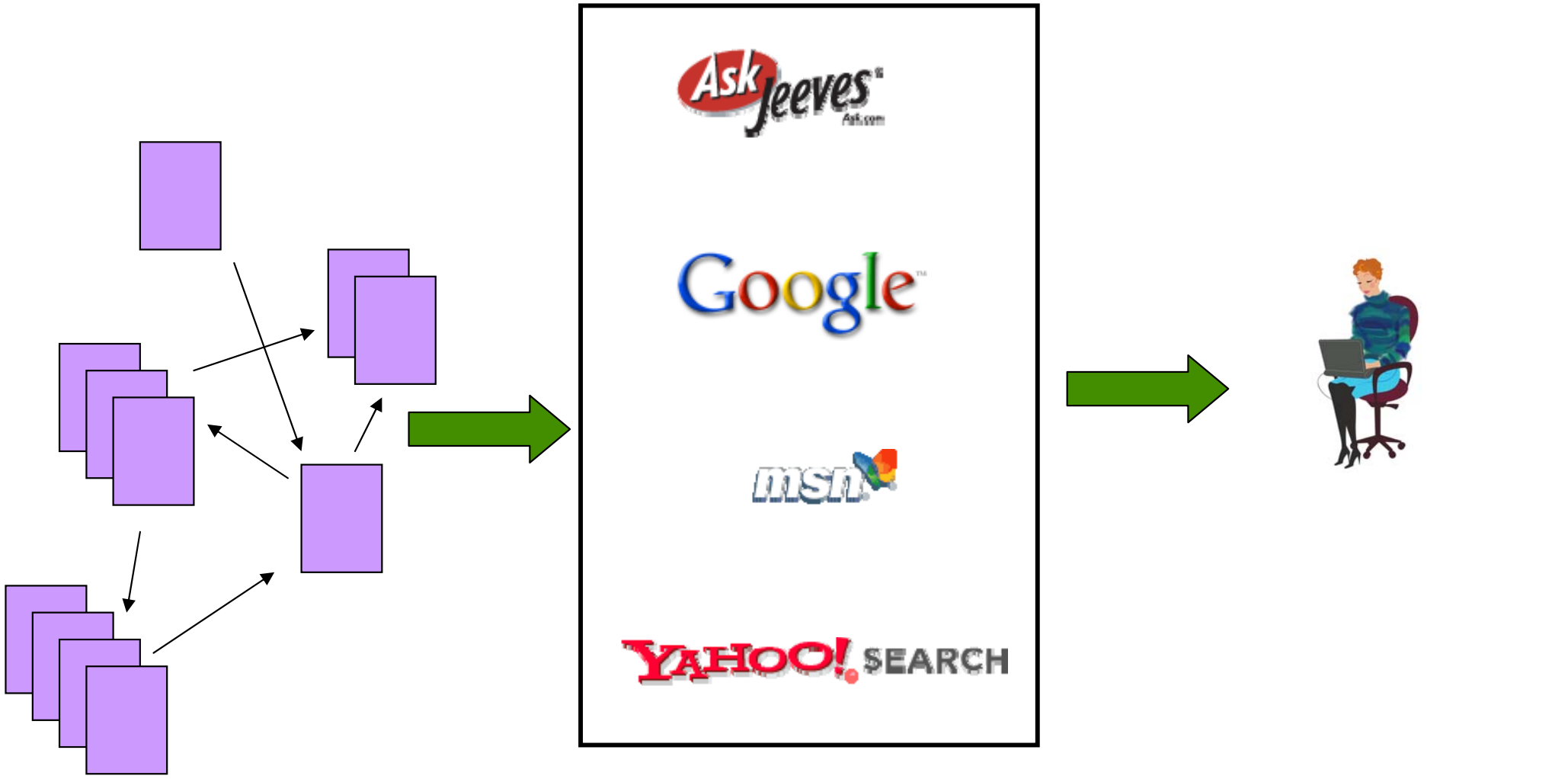
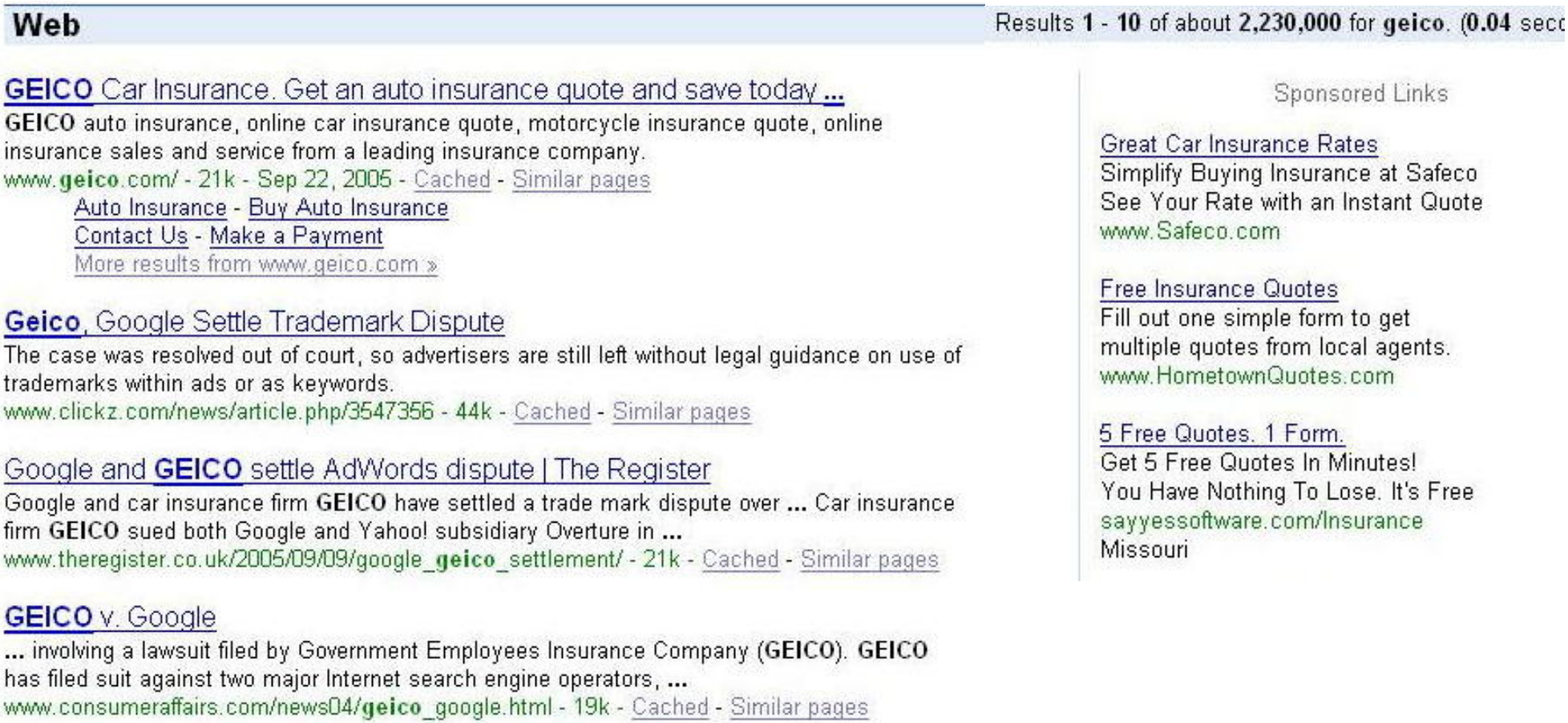
Searching the Web



Ads vs. search results



Web Results **1** - **10** of about **2,230,000** for **geico**. (**0.04** secc

GEICO Car Insurance. Get an auto insurance quote and save today ...
GEICO auto insurance, online car insurance quote, motorcycle insurance quote, online insurance sales and service from a leading insurance company.
www.**geico**.com/ - 21k - Sep 22, 2005 - Cached - Similar pages
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Contact Us - Make a Payment
More results from www.geico.com »

Geico, Google Settle Trademark Dispute
The case was resolved out of court, so advertisers are still left without legal guidance on use of trademarks within ads or as keywords.
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Google and **GEICO** settle AdWords dispute | The Register
Google and car insurance firm **GEICO** have settled a trade mark dispute over ... Car insurance firm **GEICO** sued both Google and Yahoo! subsidiary Overture in ...
www.theregister.co.uk/2005/09/09/google_**geico**_settlement/ - 21k - Cached - Similar pages

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... involving a lawsuit filed by Government Employees Insurance Company (**GEICO**). **GEICO** has filed suit against two major Internet search engine operators, ...
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Simplify Buying Insurance at Safeco
See Your Rate with an Instant Quote
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Free Insurance Quotes
Fill out one simple form to get multiple quotes from local agents.
www.HometownQuotes.com

5 Free Quotes. 1 Form.
Get 5 Free Quotes In Minutes!
You Have Nothing To Lose. It's Free
sayyessoftware.com/Insurance
Missouri

Ads vs. search results

- Search advertising is the revenue model
  - Multi-billion-dollar industry
  - Advertisers pay for clicks on their ads
- Interesting problems
  - What ads to show for a search?
  - If I'm an advertiser, which search terms should I bid on and how much to bid?

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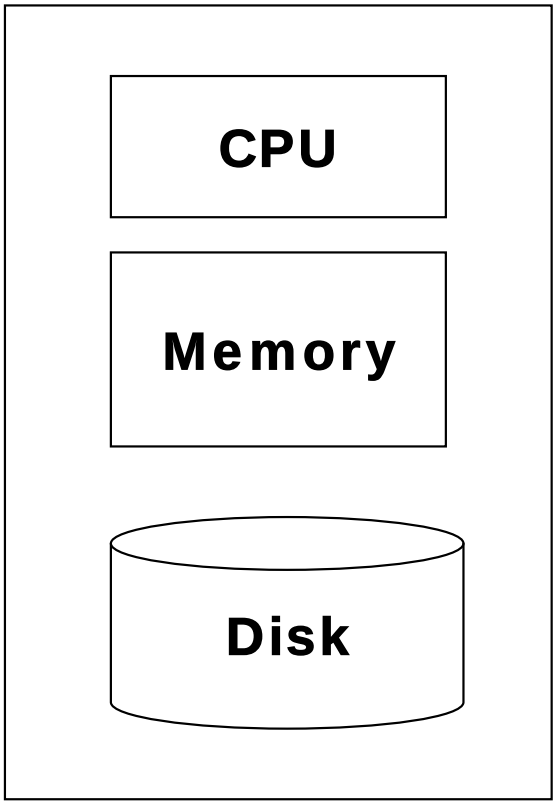
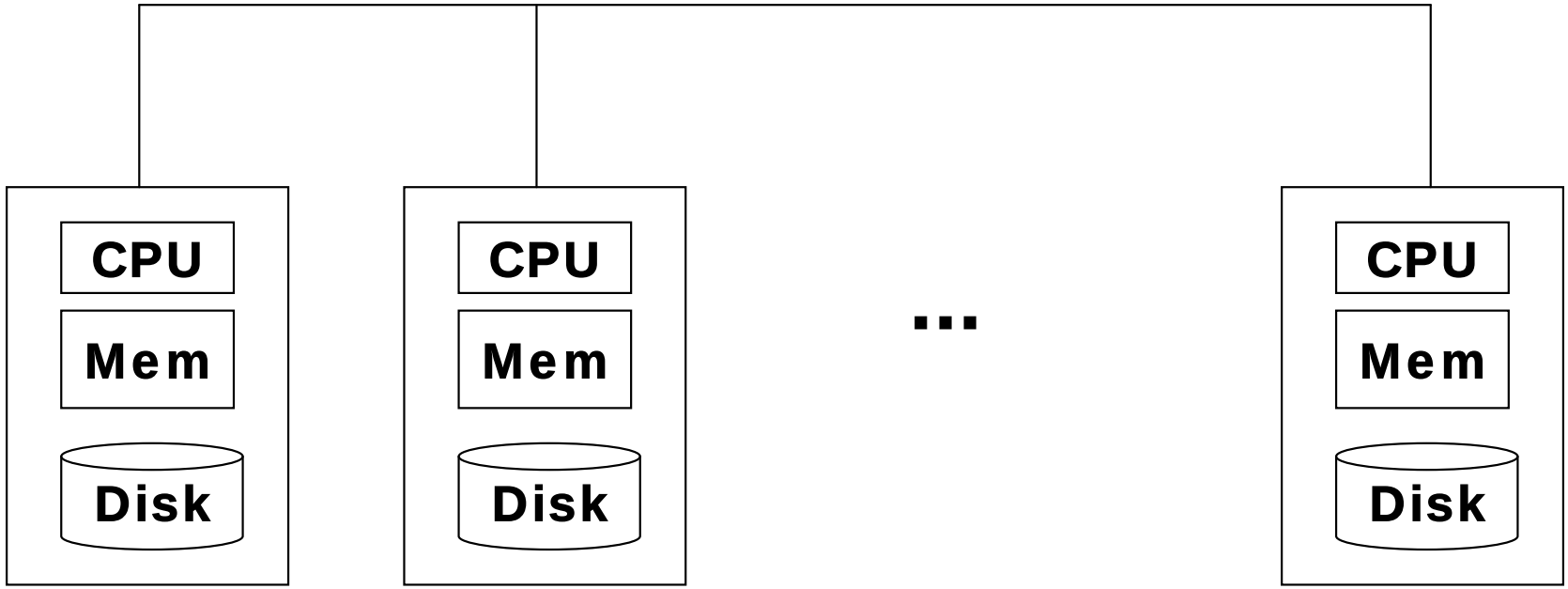
Systems architecture



Machine Learning, Statistics

“Classical” Data Mining

Very Large-Scale Data Mining



Cluster of commodity nodes

Systems Issues

- Web data sets can be very large
  - Tens to hundreds of terabytes
- Cannot mine on a single server!
  - Need large farms of servers
- How to organize hardware/software to mine multi-terabye data sets