Approaches to Mining the Web

Olfa Nasraoui

University of Louisville

Web Mining: Mining *Web Data (3 Types)*

- Structure Mining: extracting info from *topology* of the Web (*links* among pages)
  - Hubs: pages *pointing to* many other pages
  - Authorities: pages *pointed to by* many other pages
  - Communities: pages forming islands
- Usage Mining: extracting info on how *people* visit the above pages, ex: which route through site leads to checkout?
- Content Mining: Extracting useful info from page *content* (text, images, other…etc),
  - used by search engines, agents, recommendation engines to help users find what they are looking for

The Web from the perspective of data mining

- WWW = pages connected by links
- A Web server provides access to the pages on a website
- A Web page may consist of several components/frames
- A *pageview* ⇔ several frames
- From now on, *page* ⇔ 1 *frame*

Idealized Data Representation

- Structure: Directed graph (nodes: pages, edges: links)
- Content: Index:
  - string/word/phrase → page
- Usage: Profile: Each profile summarizes sites, paths, queries, documents read, items purchased, …etc

relatively static/rigid compared to usage

Not static: behavior of users OVER TIME

What can each type of mining do?

- Structure: organize, cluster, rank by authority, …etc
- Content: Information retrieval
- Usage: personalization, Info retrieval
  - Short time frame: single session
  - Long time frame: repeat sessions/repeat visitors (need ID, ex: registered customer)

Type of data	Ideal data	Real life	Applications	Future trends
Content: (Web crawlers collect this data, they *can* have global view)	-Complete -Up-to-date	-Easy to obtain -Public -Unrestricted	Information retrieval	
Structure: (Web crawlers collect this data, they *can* have global view)	-Complete -Up-to-date	-Easy to obtain -Public -Unrestricted	Information retrieval, social networks	
Usage: Web logs + App server logs + databases (external data: product, transaction, etc)	-Complete -Up-to-date	-Hard to obtain -Private -Restricted -Scattered	User profiling, personalization	Information retrieval

Part 1: Mining Structure: *Global* Structure

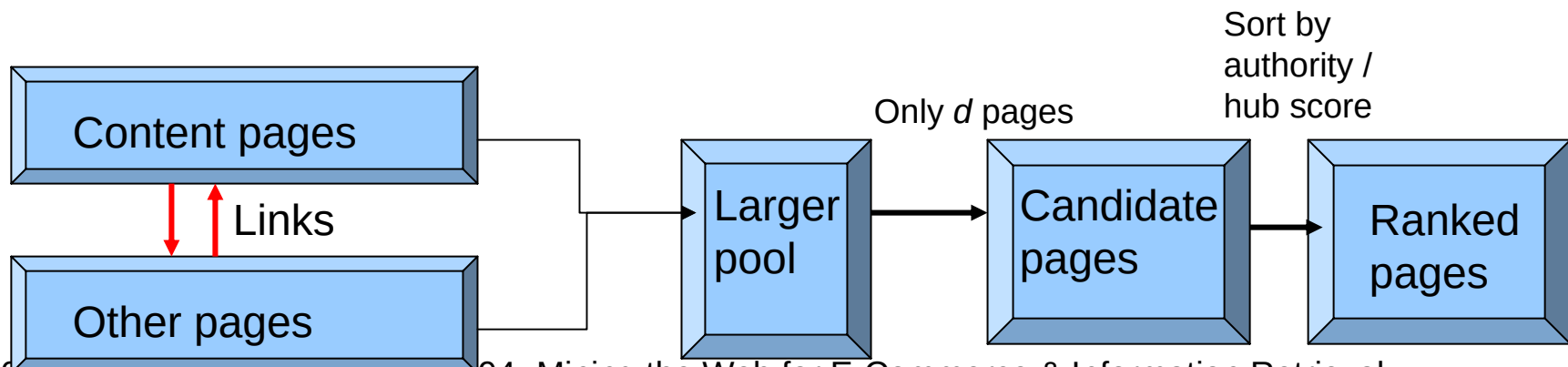
- Links reveal many things:
  - Hubs & authorities ➔ popularity
  - Islands ➔ can help disambiguate synonyms & organize by topic/community
- Web : directed graph
  - Link analysis: branch of DM concerned w/ finding patterns in graphs & networks

Global Structure … continued

- Counting citations: # of citations to an article = main evidence of its usefulness
- The more links leading to a site ➔ the more important it must be
- Yet, an accurate picture of Web links is difficult because the Web is not static.
  - *Static* link: fixed URL
  - *Dynamic* link: not fixed, ex: generated as response to a search/query.

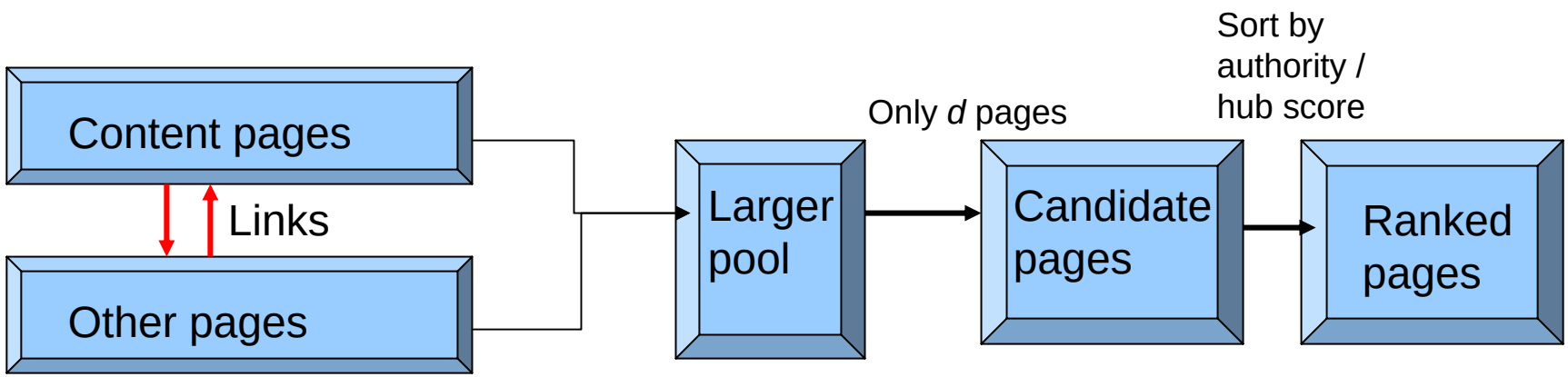
Kleinberg's algorithm: Hubs & Authorities

- Hubs & authorities: measure of usefulness of a page
- Popular sites such as yahoo! Will be ranked higher than *less* popular but *more* authoritative *subject-specific* pages (because of the # links)
- Solution: rank not by total # of links, but # of subject-related links pointing to them
- Essential feature: pages based not only on content (*root set*), but *also* on link analysis: larger pool contains pages w/ in-links/out-links relative to the root set
- Larger pool contains more global structure ➔ can be mined to determine authoritative pages



Kleinberg's Algorithm

- Phase 1: Create root set
- Phase 2: Identify candidate set
- Phase 3: Rank Hubs and authorities



Phase 1: Creating the root set
(Based on *CONTENT* ONLY!)

- Preprocess search string:
  - Eliminate stop list words (the, a, for, …etc)
  - Stemming: reduce words to base root (going → go, referral → refer, dogs → dog, … etc)
- Search the Web index consisting of mapping between {words → pages}
- Score each page based on terms it contains (TF.IDF):
  - Term *rarity* in *entire* collection of pages (*IDF*)
  - Term *frequency* within *this page (TF)*
- Sort and select top *n* (typically *n* = 200)
- NOTE: we will discuss TF, IDF when we talk about content mining or text mining

Phase 2: Identifying candidate set (content *enriched w/ structure*)

- Expand root set by including:
  - Pages w/ links *to* each page in root set
  - Pages w/ links *from* each page in root set
- Limit # of pages brought into candidate set by any *single* member of root set to parameter (*d,* typically *d* = 50)
- Typical size of candidate set = 1000 – 5000
- Possible refinement strategies:
  - Filter out any links from within same website/domain as a page in root set (most purely navigational)
  - Diversification: remove bias/redundancy by limiting # of pages from same website brought into candidate set by any *single* member of root set to parameter (*m*)

Phase 3: Ranking Hubs and authorities

- Divide candidate set into hubs & authorities
- Main assumption: hubs & authorities have mutually reinforcing relationship:
  - A strong *hub* links to many authorities
  - A strong *authority* is linked to by many hubs
- HITS algorithm (Hyperlink-Induced Topic Search):
  - For each page *p*, a value a_p in [0,1], measures its *authority*
  - For each page *p*, a value h_p in [0,1], measures its *strength as a hub*

HITS Algorithm (Hyperlink-Induced Topic Search)

- If page is pointed to by many good hubs, we update the value of a_p for the page p, to be the sum of h_q over all pages q that link to p:
- $a_p = \sum h_q$, sum over all q such that $q \rightarrow p$
- If a page points to many good authorities, we increase its hub weight:
- $h_p = \sum a_q$, sum over all q such that $p \rightarrow q$.

HITS Algorithm (Hyperlink-Induced Topic Search)

Initialize a_p and h_p for all pages p in candidate set;

REPEAT {

- $a_p = \sum h_q$, sum over all q such that $q \rightarrow p$;
- Normalize a_p by dividing by sum of squares;
- $h_p = \sum a_q$, sum over all q such that $p \rightarrow q$;
- Normalize h_p by dividing by sum of squares;

} UNTIL Convergence

HITS Algorithm (continued…)

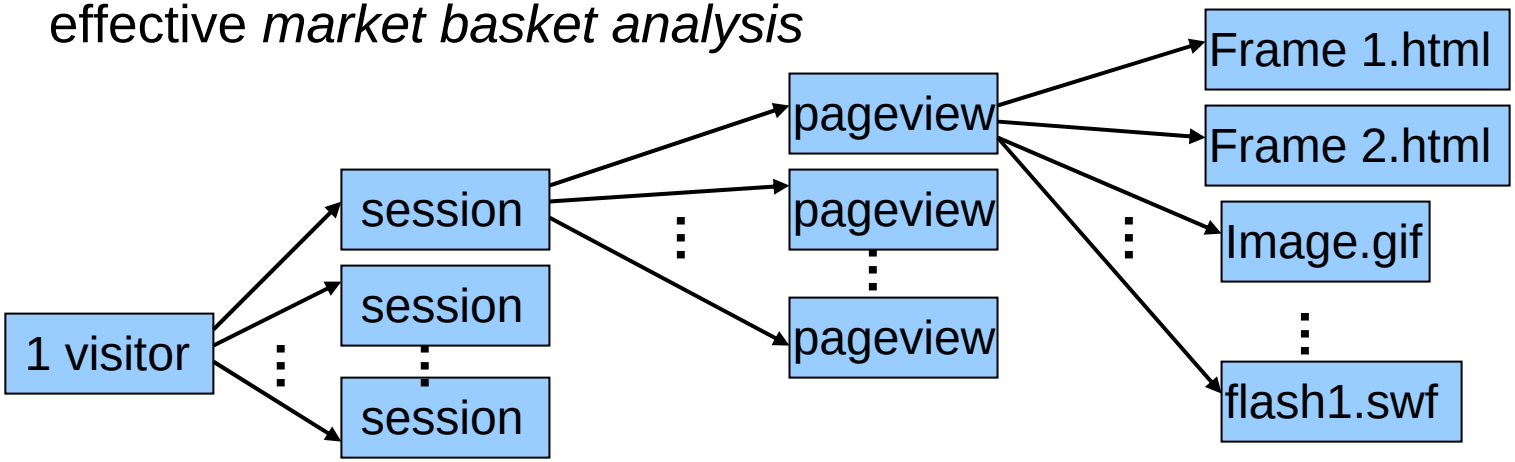
- Systems based on the HITS algorithm:
  - *Google*: achieve better quality search results than those generated by purely content based {term-index} engines such as AltaVista and those based on *directories* created by human ontologists such as Yahoo!
- Difficulties from ignoring textual contexts:
  - Topic Drift: when a hub contain multiple topics to *unrelated* subjects
  - Topic hijacking: when many pages from a single Web site point to the same single *popular* site (even when unrelated to subject of search!)

Local Structure

- *Sticky* vs. *slippery* page on same website
- Stickiness: metric that measures how long visitors stay on same site
- Sticky Pages: should be *Destination* pages: Content! (information, products…etc)
- Slippery pages: opposite of above: exist only to provide links to other pages: *Navigational* Pages
  - In a way checkout pages should not be sticky or this may indicate a problem!
- Local structure of website largely depends on goals

Part 2: Mining Usage Patterns

- Even when main concern is content or structure, usage may be helpful!
- Ex: can measure popularity of a page by # of visitors
- *Clickstream*: lowest level data for web usage mining = series of requests for pages received by web server that hosts a site
- *Hits*: Record of every GIF, JPEG, and HTML file requested by the user's browser
- These hits can be aggregated into *page views*
- Page views can be further aggregated into *sessions*
- Can also link *several* sessions to an identified *visitor* for more effective *market basket analysis*



Different Data Sources

- Web Logs: Low level
  - Tracks individual items (even those that are embedded within a web page like graphics ,…etc) requested by a Web browser
- Application logs: Higher level
  - In e-commerce architecture, page content constructed on the fly by an application server
  - Same URL (in web log) may correspond to different web content (logged on app server)
  - App servers know when customers check in and check out, items placed or removed from shopping cart, …etc

Web Logs

- Web Logs: Low level data
  - Tracks individual items (even those that are embedded within a web page like graphics ,…etc) requested by a Web browser (see next page)
  - Often several servers involved: ad server (banners), web servers (text, images), app. Servers (content calculated on fly, ex: shopping cart data w/ prices …etc)
  - Hence: user clicks on 1 link ➔ turns into multiple hits in website ➔ these hits may be recorded across multiple logs on different servers…

Excerpt from web log file

Format: time stamp, originating IP address, method, requested URL, error status code

17:11:02 141.225.195.29 GET /people/faculty/halford/halford.html 200
17:11:21 141.225.195.29 GET /people/faculty/griffin/griffin.html 200
17:11:25 141.225.160.198 GET /graphics/schematics.jpg 304
17:11:48 141.225.195.29 GET /graphics/griffin.jpg 200
17:11:48 141.225.195.29 GET /people/faculty/nasraoui/nasraoui.html 200
17:11:48 141.225.195.29 GET /people/faculty/nasraoui/frame_content.html 200
17:11:48 141.225.195.29 GET /people/faculty/nasraoui/home1.html 200
17:11:48 141.225.195.29 GET /people/faculty/nasraoui/GRAPHICS/BACKGROUNDS/Horizon.jpg 200
17:11:48 141.225.195.29 GET /people/faculty/nasraoui/GRAPHICS/smallmail.gif 200

Additional data possible: referrer address (the last page where the user was), size of data transferred, protocol (mainly HTTP on a web server), user agent (browser type)

Web Log Data Preparation

- **Step 1: Filtering**: remove all log entries representing requests for graphic files (jpeg, gif, png, …,etc.)
- **Step 2: Despidering**:
  - removing entries generated by requests from spiders/crawlers (ex: used by search engines to index Web pages) and other bots (ex: performance monitoring systems)
  - Some spiders can be recognized by name (in agent field of log entry), also by their access patterns (heuristically)

Web Log Data Preparation... continued

- **Step 3: User identification**: a prerequisite to sessionization:
  - Identify requests made by same user during *single* visit
    - User registration/login (only sure way)
    - Alternatives based on heuristics: Combination of IP Address + Agent field (browser)
  - Identify requests made by same user during *multiple* visits
    - Return visitors are recognized either by registration mechanisms or by cookies
    - Cookies: text strings issued by web server and stored by the browser on client computer. They uniquely identify a user session. In future, Web server requests o see if any of its past cookies is stored on user's computer to recognize user
    - Assumptions: user has "accepted" to store cookie in old session, has not disabled or deleted cookies in new session, and is using same computer + browser

Web Log Data Preparation … continued

- **Step 4: Sessionization**:
  - identifying a series of pageviews as requested by same user during a single visit
  - Heuristics: all requests from same user within a maximal time duration between consecutive requests
  - Same user: recognized
    - by cookie, or
    - by modifying all URLs on currently requested page to include unique session identifier ➔ If user clicks on any link from this page, the web server will be able to track the session by simply parsing the requested URL to extract the user ID
  - Web logs may be insufficient: hard to estimate how long a user was viewing a page

Web Log Data Preparation … continued

- **Step 5: Path completion**: Web logs may be insufficient:
  - caching may hide some requests:
    - Browser keeps a cache of recently visited pages for days. When user requests this page, it is loaded locally without any request to server (unless “reload” page is selected)
    - Caching can also occur at a different level: proxy server (handles requests in an intermediary fashion between the user and the destination server (ex: corporate proxy or Internet Service Provider proxy)
  - Another proxy-caused problem: For different users that connect via the same proxy, IP address of proxy is the one that is logged in the Web log ➔ difficult to distinguish between different users

Web Log Data Preparation … continued

- Path completion: Some solutions:
  - Using referrer info (+ site structure) can approximately reconstruct a session
  - Referrer info can be saved in Web log: records where user was (previous page) just before user requested a local page
- Good News for the caching problem:
  - Dynamic web pages (created using Java Server Pages (JSP) or Microsoft's Active Server Pages (ASP) are not cached because each dynamically created page is unique.

Application logs

- Higher level type of data
  - In e-commerce architecture, page content constructed on the fly by an application server
  - Same URL (in Web log) may correspond to different web content (logged on app. server)
  - Example: request for the price of a product may return different prices depending on the date, promotions, …etc
  - App servers know *when* customers check in and check out, when items are placed or removed from shopping cart, …etc.
  - Will discuss more in next chapter…

Application: Usage Mining to Improve Site Usability

- Very common application of Web usage mining
- Treat user sessions consisting of page requests like market baskets consisting of items purchased
- Analyze data using association rule mining
  - Discovered associations (A => B) may suggest additional links between unconnected pages
  - This makes site easier to navigate, and allows users to find what they need faster…
- Analyze data to group similar sessions into clusters
  - Clusters may correspond to user profiles / modes of usage of the website
  - Knowing user profiles may suggest improvements to web site design and even dynamic website design during same session

Web Usage Mining Tasks: Associations & Sequences

- Treat user sessions consisting of page requests like market baskets consisting of items purchased

- Analyze data using association rule mining
  - Discovered associations (A => B) may suggest additional links between unconnected pages
  - This makes site easier to navigate, and allows users to find what they need faster…
  - Suggest recommendations for associated products based on current basket (cross-sell)

- Sequential pattern discovery: extension of association rules mining that discovers patterns of co-occurrence incorporating the notion of time sequence.
  - Pattern: a Web page or a set of pages accessed immediately after another set of pages.
  - ➔ help to discover users' trends, and make predictions about visit patterns

Web Usage Mining Tasks: Clustering, Collaborative Filtering

- Clustering: Analyze data to group similar sessions into clusters
  - Clusters may correspond to user profiles / modes of usage of the website
  - Knowing user profiles may suggest
    - improvements to web site design
    - dynamic website design during same session
    - Design of several smaller websites or stores

- Collaborative Filtering
  - Recommend products on a site with large # of products
  - Lazy learning: no need for learning, based on examples of past usage
  - Problems: sparse data: many more products/pages than customers/browsers, scaling up to huge # of visitors & # of items or pages

Example: Effect of Recommendation System on a home shopping group

	With traditional methods	**With cross-sell real-time recommendations**
Avg Cross-Sell Value	$19.50	60% higher
Cross Sell Success Rate	9.8%	50% higher

Source: J. Riedl, “Why Does KDD Care About Personalization?”

Mining Web Content

- Task most popularly performed by Web search engines
- Information Retrieval (IR): formal name for task performed by search engine to help users find what they look for.
- Web Content:
  - HTML: Hypertext Markup Language: standard for describing the way document should be **displayed** using tags.
  - XML: eXtensible Markup Language: extensible standard that allows community of users to agree on application-specific set of tags that help in understanding what document info **means**!

Content Mining … continued

- Most current content mining ⇔ Text mining
- Information retrieval:
  - Find what user is looking for
  - But without finding too much else!!!
  - These two conflicting ideas are captured by 2 measures of IR:
    - **Precision**: Of the pages returned, what proportion are correct?
    - **Recall**: Of all the pages that are correct, what proportion are returned?
    - Typically
      - Perfect recall ➔ very low precision
      - Perfect precision ➔ very low recall

Content based Classification

- Classification
  - Very common application of data mining
  - Assign a class label to a data record
- In Web content mining:
  - Assign keywords to a Web page (to predict its topic)
  - Assign a language to a Web page (ex: to restrict search results to a given language)
  - Challenge: Most data mining methods for classification work w/ structured data
    - However free text is unstructured!
    - Traditionally, free text was transformed into structured data (in the form of keyword vectors) via feature (i.e. keyword) extraction

Automatic Classification of Web Documents

- Assign a class label to each document from a set of predefined topic categories
- Based on a set of examples of pre-classified documents
- Example:
  - Use Yahoo!'s taxonomy and its associated documents as training and test sets
  - Derive a Web document classification scheme
  - Use the scheme to classify new Web documents
- Keyword-based document classification methods (mostly using vector space model of documents as a vector of keyword/term frequencies…etc)
- Statistical models (ex: Naïve Bayes: models document classes as word probability distributions)

More Content based Classification Methods

- Genetic Algorithms can be used to evolve classifier of text documents
  - Ex: classify customer comments/e-mails/web blogs as positive or negative?
- Memory based reasoning or K-Nearest neighbors based classification (K-NN):
  - assign keywords to a web page
  - Compare a new page to a set of pre-classified examples
  - The *k* most similar pages are used to classify the new page using weighted voting
  - Confidence in classification: related to degree of similarity to examples…

Vector Space Model

- **Vector Space Model:** documents represented using *keywords* in text documents.
- Documents are vectors in this *s*-dimensional space.
- Mathematical model: *m*X*s* matrix where each row ⇔ 1 document, each column ⇔ 1 term or keyword

	t_1	t_2	…	t_s
d_1	0	1		0
d_2	0	2		3
…				
d_m	2	0		1

- Entries in matrix: If keyword # *j* occurs *n* times in document #*i*, then the content of [row *i*, col *j*] = *n*

Document Vector

- ***D={d*$_1$*,…,d*$_n$*}*** of documents and ***T={t*$_1$*,….,t*$_s$*}*** of indexing/querying terms.
  - **Vector Space model**: each document is represented as a vector of dimension *s* = the number of terms.

$$d_i =< w_{i1}, w_{i2}, ..., w_{is} >$$

  - ***w*$_{ij}$** is weight of term ***t*$_j$** in ***d*$_i$**.
  - Let ***f*$_{ij}$** = freq of occurrence of term ***t*$_j$** in ***d*$_i$**

$$w_{ij} = f_{ij} * \log[N / N_j]$$

    - *N* = # of documents
    - N_j = # of documents in which term t_j occurs at least once
    - Inverted Document Frequency (*IDF*) = log (N/N_j) measures *rarity* of term
    - ***w*$_{ij}$** typically normalized: divide by Σ ***w*$_{ij}$**, Σ ***w*$_{ij}$** ^{2}, or *max* {***w*$_{ij}$**}.

Similarity

- Assessing similarity between two Web pages
- *Similarity* is inversely related to *distance*
- Euclidean distance is *not* appropriate for text data (huge dimensionality, asymmetrical attributes/words)
- Intuitively, similarity between two pages should depend on the # of words in common compared to total # of words in both pages
- Ex: Cosine similarity = #*common* words /

  (#words in page 1 X #words in page 2)

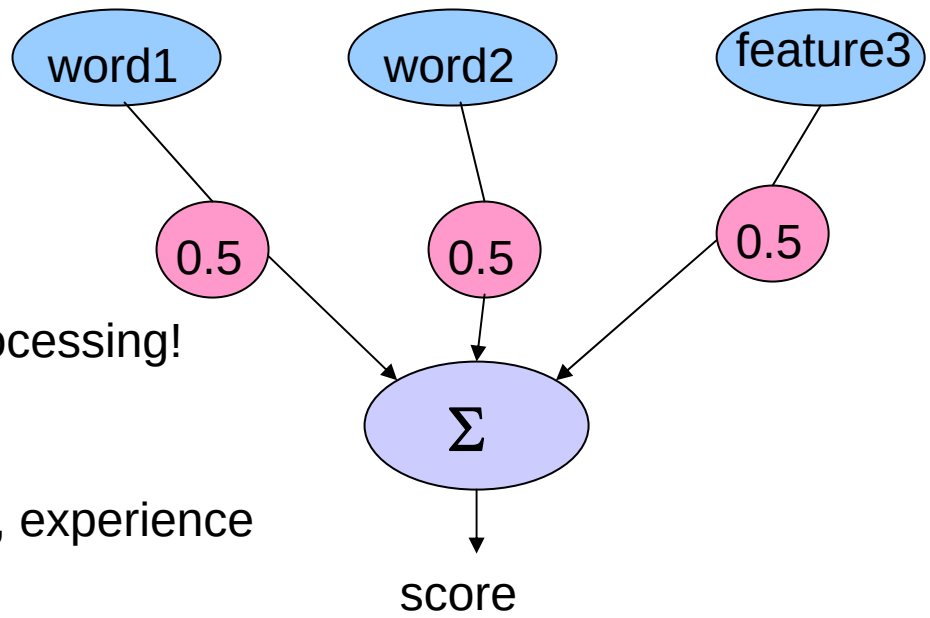
$$SIM(d_i, d_q) = \frac{\sum_{j=1}^{s} w_{ij} * w_{qj}}{\sqrt{\sum_{j=1}^{s} w_{ij}^2} \sqrt{\sum_{j=1}^{s} w_{qj}^2}}$$

Case Study: Classification of Customer Comments as Compliment or Complaint

- Business context: customers comment on quality of service of airline company: e-mails, fill comment forms on website,…etc
- Data: *free text* + other (ex: flight #, service class, date, destination, …etc)
- Preprocessing:
  - Free text → *document vector* + Add *metadata* about comment (size in bytes, # distinct words)
- Data Mining Task: Classification (class 0: compliment, class 1:complaint)

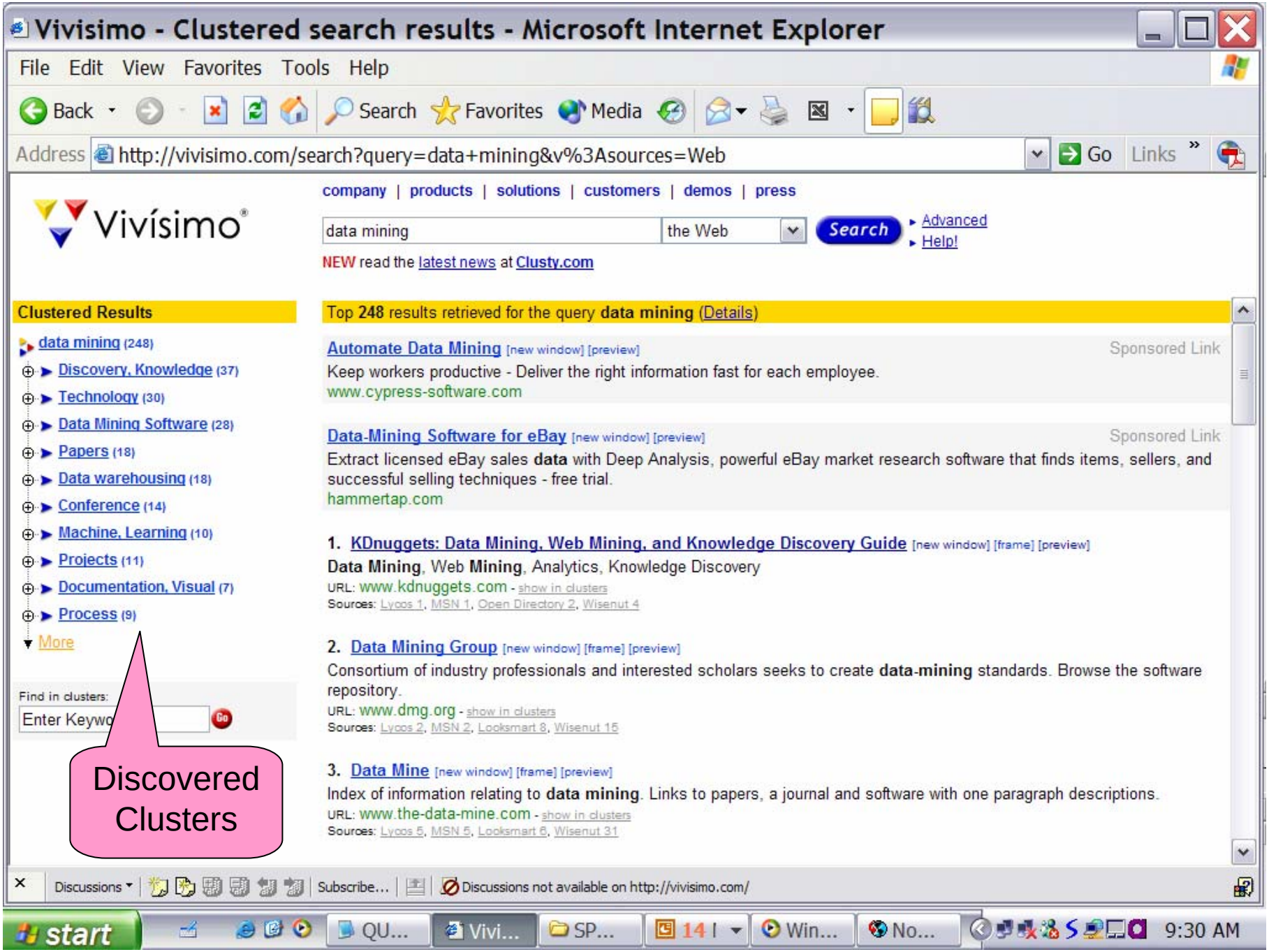
Case Study: Classification of Customer Comments as Compliment or Complaint

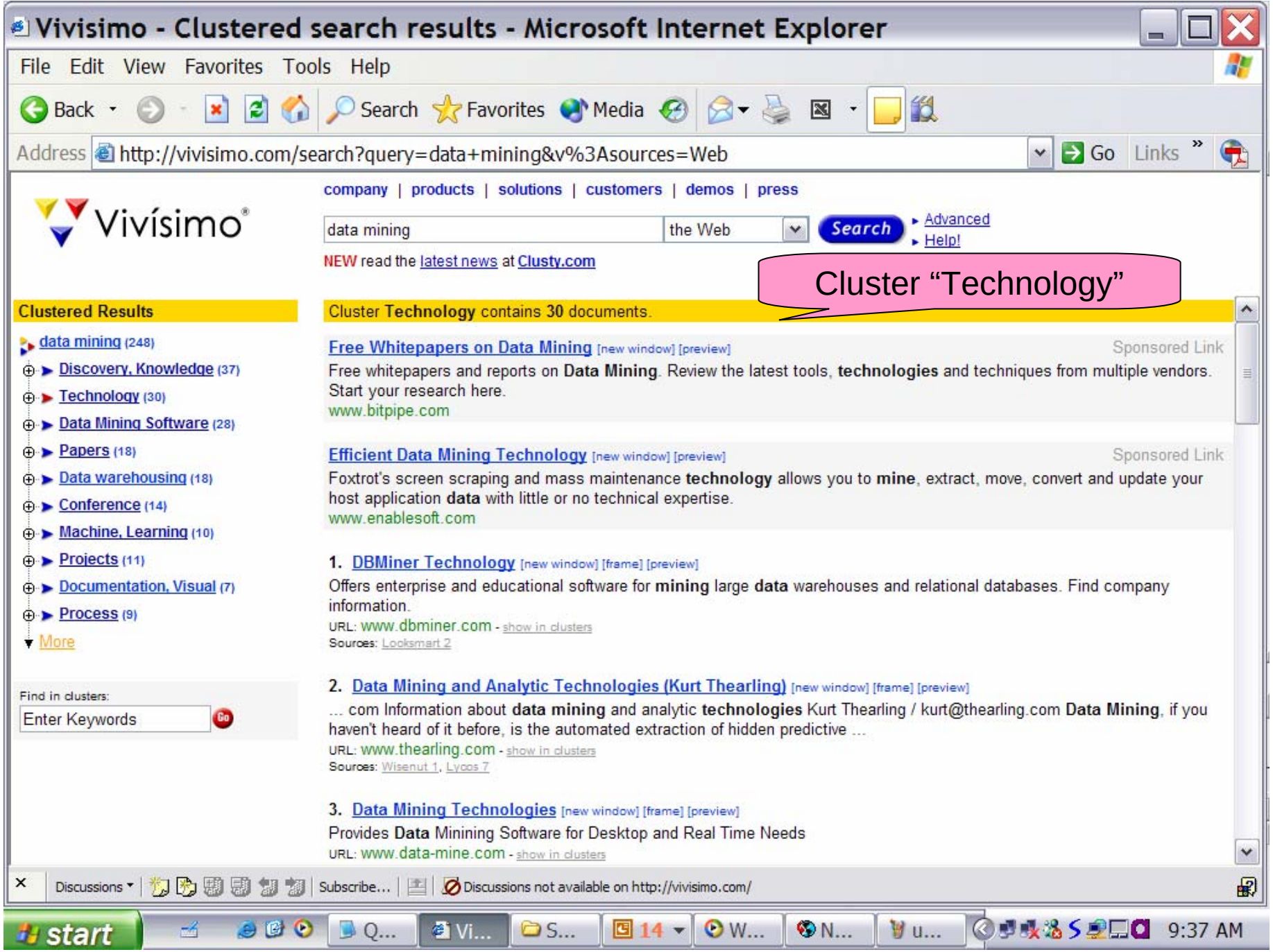
- Data Mining Task: Classification (class 0: compliment, class 1:complaint)
- Genetic Programming is used to evolve prediction tree
- Solutions similar to single layer Neural Net
- Chromosome encodes a solution:
  - each gene = attribute or operation
- Chromosomes compete based on fitness
- 85% classification accuracy
  - Enough to *speed up* complaint processing!
- Important attributes:
  - comment length ➔ complaint
  - Some words: baggage, courteous, experience

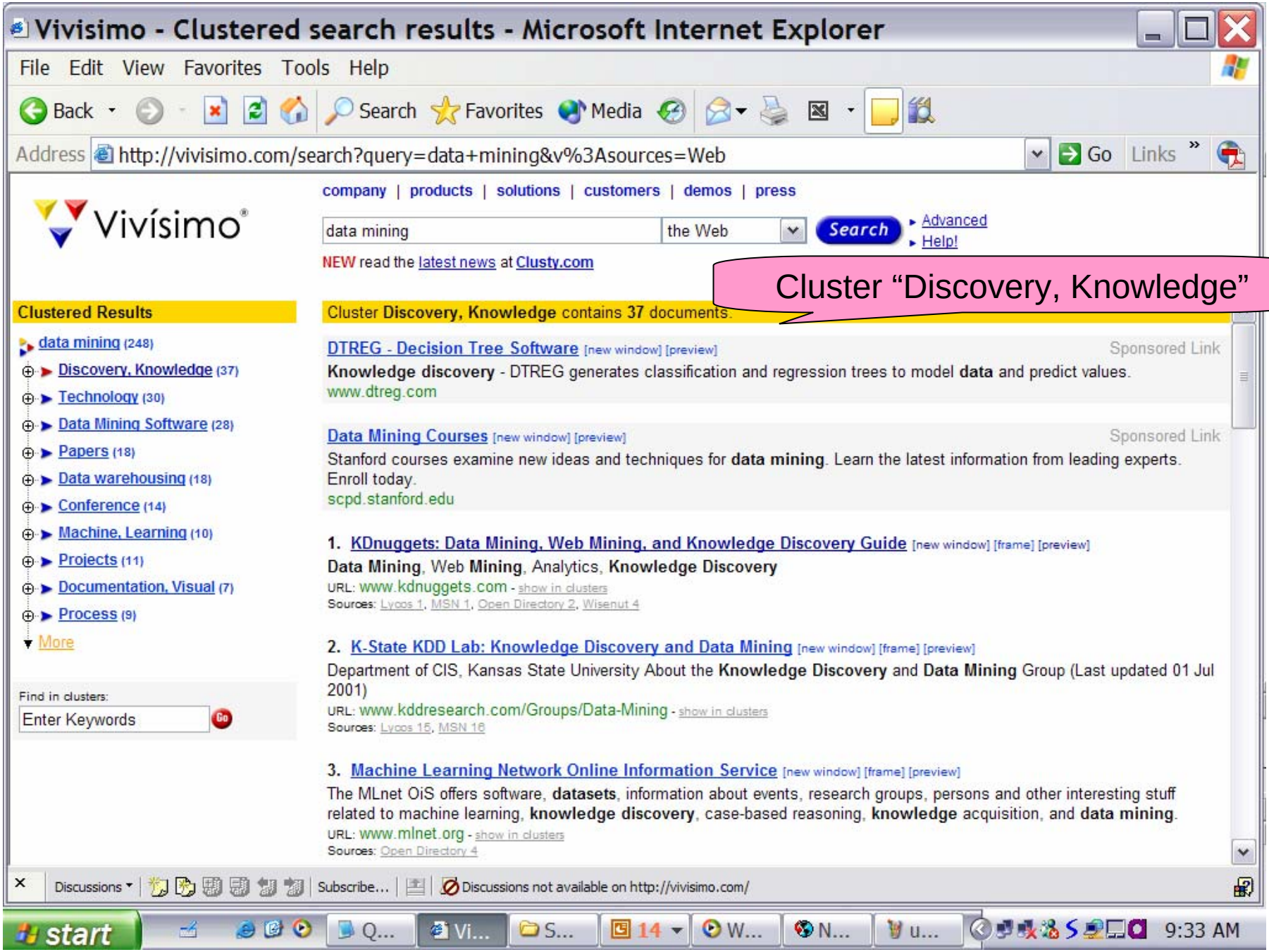


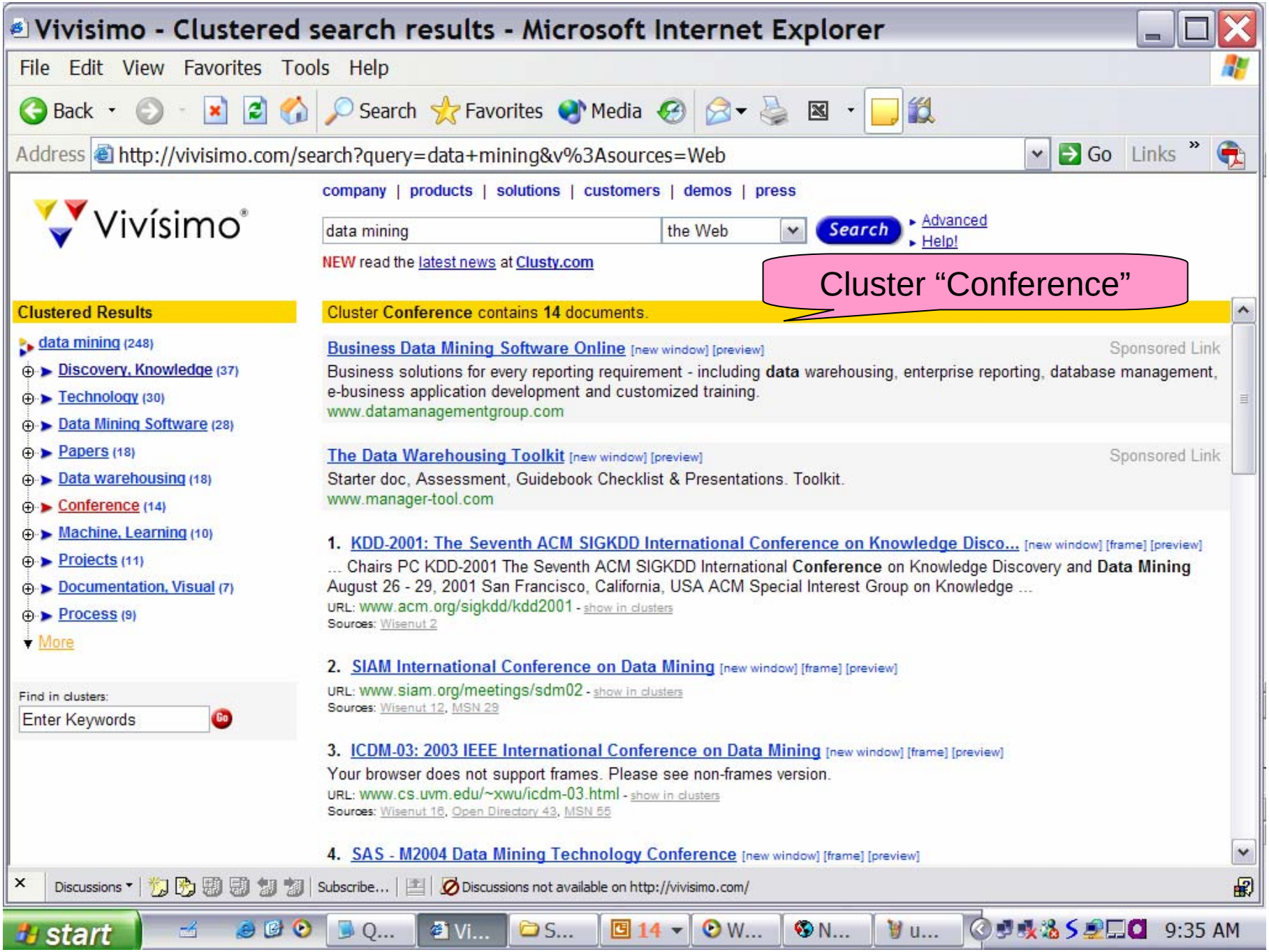
Clustering Web Documents to Support Searching

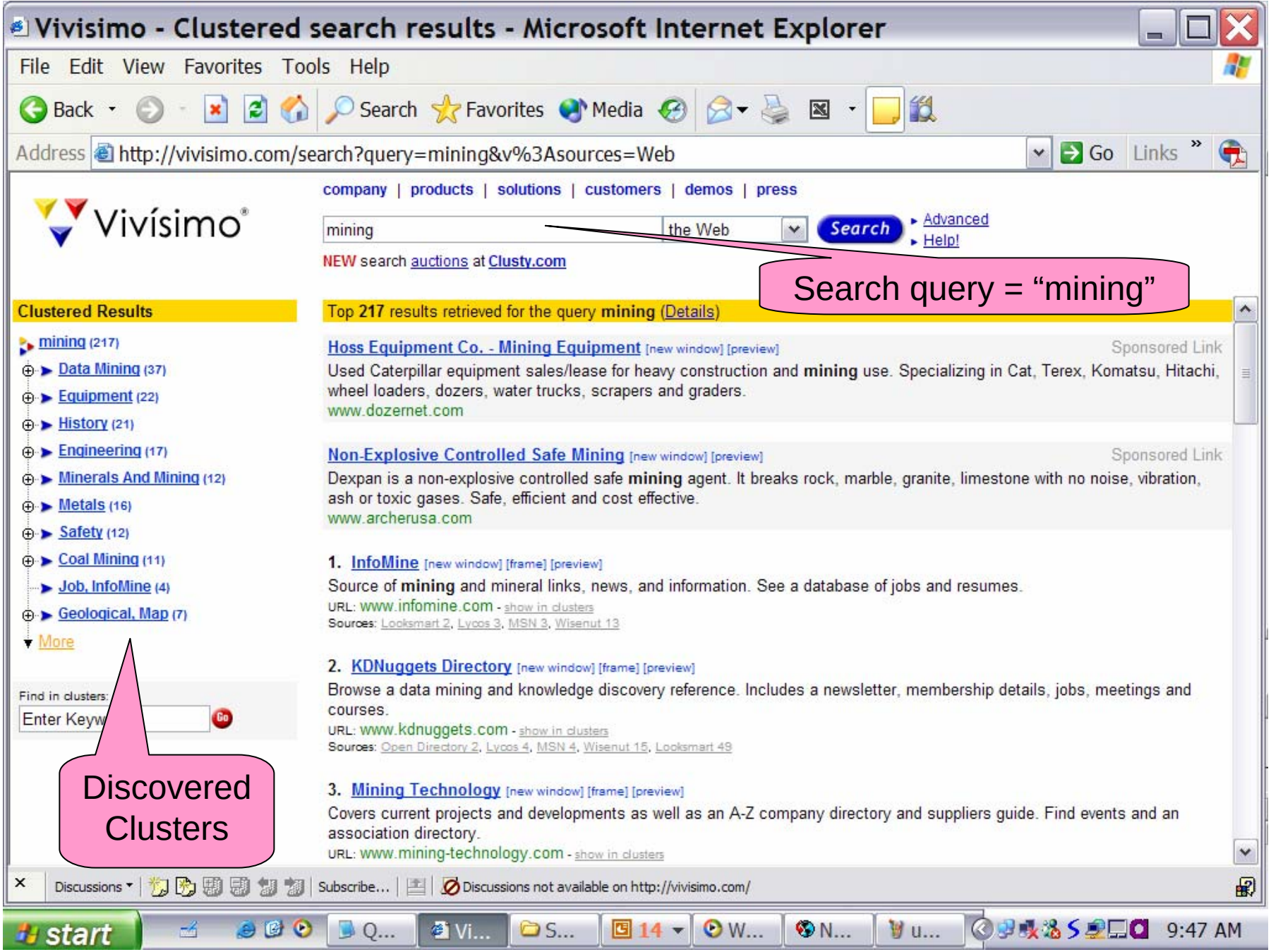
- Search engine can help users find what they need by clustering search results into folders and sub-folders.
- *Northern Light* organizes the Web into custom search folders
  - Folders are labeled by humans (hence semi-automatic)
  - Accessible only by registration / subscription
  - Newest version: Enterprise Search Engine (to be used inside a business ➔ Knowledge Management)
- Example: *Vivissimo* clusters search results on the fly…without any labeling (see next slide…)
- Difference is in the use of a *concept hierarchy*!
- Most extreme use of such a hierarchy: *yahoo!* (entirely manual)


Vivisimo - Clustered search results - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://vivisimo.com/search?query=data+mining&v%3Asources=Web
Go Links
Vivísimo
company | products | solutions | customers | demos | press
data mining
the Web
Search
Advanced
Help!
NEW read the latest news at Clusty.com
Clustered Results
data mining (248)
Discovery, Knowledge (37)
Technology (30)
Data Mining Software (28)
Papers (18)
Data warehousing (18)
Conference (14)
Machine, Learning (10)
Projects (11)
Documentation, Visual (7)
Process (9)
More
Find in clusters:
Enter Keywo
Go
Discovered Clusters
Top 248 results retrieved for the query data mining (Details)
Automate Data Mining [new window] [preview]
Sponsored Link
Keep workers productive - Deliver the right information fast for each employee.
www.cypress-software.com
Data-Mining Software for eBay [new window] [preview]
Sponsored Link
Extract licensed eBay sales data with Deep Analysis, powerful eBay market research software that finds items, sellers, and successful selling techniques - free trial.
hammertap.com
1. KDnuggets: Data Mining, Web Mining, and Knowledge Discovery Guide [new window] [frame] [preview]
Data Mining, Web Mining, Analytics, Knowledge Discovery
URL: www.kdnuggets.com - show in clusters
Sources: Lycos 1, MSN 1, Open Directory 2, Wisenut 4
2. Data Mining Group [new window] [frame] [preview]
Consortium of industry professionals and interested scholars seeks to create data-mining standards. Browse the software repository.
URL: www.dmg.org - show in clusters
Sources: Lycos 2, MSN 2, Looksmart 8, Wisenut 15
3. Data Mine [new window] [frame] [preview]
Index of information relating to data mining. Links to papers, a journal and software with one paragraph descriptions.
URL: www.the-data-mine.com - show in clusters
Sources: Lycos 5, MSN 5, Looksmart 6, Wisenut 31
Discussions
Subscribe...
Discussions not available on http://vivisimo.com/
start
QU...
Vivi...
SP...
14 I
Win...
No...
9:30 AM

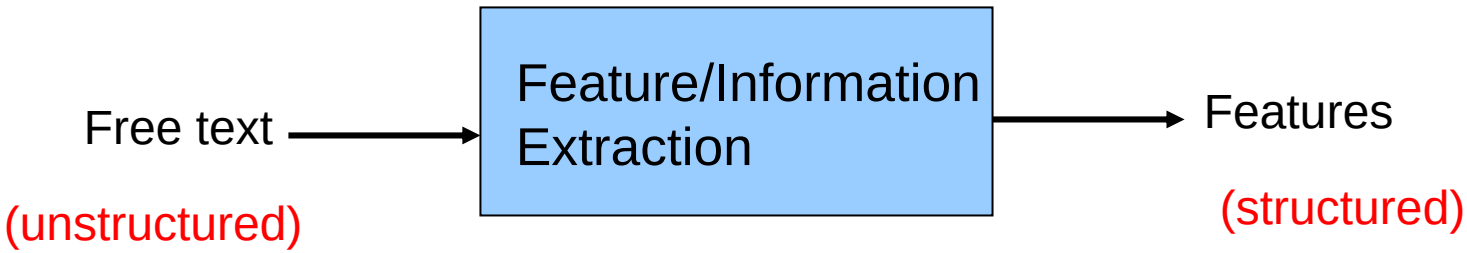

Vivisimo - Clustered search results - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://vivisimo.com/search?query=data+mining&v%3Asources=Web
Go Links
company | products | solutions | customers | demos | press
Vivísimo
data mining
the Web
Search
Advanced
Help!
NEW read the latest news at Clusty.com
Cluster "Technology"
Clustered Results
data mining (248)
Discovery, Knowledge (37)
Technology (30)
Data Mining Software (28)
Papers (18)
Data warehousing (18)
Conference (14)
Machine, Learning (10)
Projects (11)
Documentation, Visual (7)
Process (9)
More
Find in clusters:
Enter Keywords
Cluster Technology contains 30 documents.
Free Whitepapers on Data Mining [new window] [preview]
Sponsored Link
Free whitepapers and reports on Data Mining. Review the latest tools, technologies and techniques from multiple vendors. Start your research here.
www.bitpipe.com
Efficient Data Mining Technology [new window] [preview]
Sponsored Link
Foxtrot's screen scraping and mass maintenance technology allows you to mine, extract, move, convert and update your host application data with little or no technical expertise.
www.enablesoft.com
1. DBMiner Technology [new window] [frame] [preview]
Offers enterprise and educational software for mining large data warehouses and relational databases. Find company information.
URL: www.dbminer.com - show in clusters
Sources: Locksmart 2
2. Data Mining and Analytic Technologies (Kurt Thearling) [new window] [frame] [preview]
... com Information about data mining and analytic technologies Kurt Thearling / kurt@thearling.com Data Mining, if you haven't heard of it before, is the automated extraction of hidden predictive ...
URL: www.thearling.com - show in clusters
Sources: Wisenut 1, Lycos 7
3. Data Mining Technologies [new window] [frame] [preview]
Provides Data Minining Software for Desktop and Real Time Needs
URL: www.data-mine.com - show in clusters
Discussions
Subscribe...
Discussions not available on http://vivisimo.com/
start
9:37 AM


Vivisimo - Clustered search results - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://vivisimo.com/search?query=data+mining&v%3Asources=Web
Go Links
company | products | solutions | customers | demos | press
Vivísimo
data mining
the Web
Search
Advanced
Help!
NEW read the latest news at Clusty.com
Cluster "Discovery, Knowledge"
Clustered Results
data mining (248)
Discovery, Knowledge (37)
Technology (30)
Data Mining Software (28)
Papers (18)
Data warehousing (18)
Conference (14)
Machine, Learning (10)
Projects (11)
Documentation, Visual (7)
Process (9)
More
Find in clusters:
Enter Keywords
Cluster Discovery, Knowledge contains 37 documents.
DTREG - Decision Tree Software [new window] [preview]
Sponsored Link
Knowledge discovery - DTREG generates classification and regression trees to model data and predict values.
www.dtreg.com
Data Mining Courses [new window] [preview]
Sponsored Link
Stanford courses examine new ideas and techniques for data mining. Learn the latest information from leading experts. Enroll today.
scpd.stanford.edu
1. KDnuggets: Data Mining, Web Mining, and Knowledge Discovery Guide [new window] [frame] [preview]
Data Mining, Web Mining, Analytics, Knowledge Discovery
URL: www.kdnuggets.com - show in clusters
Sources: Lycos 1, MSN 1, Open Directory 2, Wisenut 4
2. K-State KDD Lab: Knowledge Discovery and Data Mining [new window] [frame] [preview]
Department of CIS, Kansas State University About the Knowledge Discovery and Data Mining Group (Last updated 01 Jul 2001)
URL: www.kddresearch.com/Groups/Data-Mining - show in clusters
Sources: Lycos 15, MSN 16
3. Machine Learning Network Online Information Service [new window] [frame] [preview]
The MLnet OiS offers software, datasets, information about events, research groups, persons and other interesting stuff related to machine learning, knowledge discovery, case-based reasoning, knowledge acquisition, and data mining.
URL: www.mlnet.org - show in clusters
Sources: Open Directory 4
Discussions
Subscribe...
Discussions not available on http://vivisimo.com/
start
9:33 AM


Vivisimo - Clustered search results - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://vivisimo.com/search?query=data+mining&v%3Asources=Web
Go Links
company | products | solutions | customers | demos | press
Vivísimo
data mining
the Web
Search
Advanced
Help!
NEW read the latest news at Clusty.com
Cluster "Conference"
Clustered Results
data mining (248)
Discovery, Knowledge (37)
Technology (30)
Data Mining Software (28)
Papers (18)
Data warehousing (18)
Conference (14)
Machine, Learning (10)
Projects (11)
Documentation, Visual (7)
Process (9)
More
Find in clusters:
Enter Keywords
Cluster Conference contains 14 documents.
Business Data Mining Software Online [new window] [preview]
Sponsored Link
Business solutions for every reporting requirement - including data warehousing, enterprise reporting, database management, e-business application development and customized training.
www.datamanagementgroup.com
The Data Warehousing Toolkit [new window] [preview]
Sponsored Link
Starter doc, Assessment, Guidebook Checklist & Presentations. Toolkit.
www.manager-tool.com
1. KDD-2001: The Seventh ACM SIGKDD International Conference on Knowledge Disco... [new window] [frame] [preview]
... Chairs PC KDD-2001 The Seventh ACM SIGKDD International Conference on Knowledge Discovery and Data Mining August 26 - 29, 2001 San Francisco, California, USA ACM Special Interest Group on Knowledge ...
URL: www.acm.org/sigkdd/kdd2001 - show in clusters
Sources: Wisenut 2
2. SIAM International Conference on Data Mining [new window] [frame] [preview]
URL: www.siam.org/meetings/sdm02 - show in clusters
Sources: Wisenut 12, MSN 29
3. ICDM-03: 2003 IEEE International Conference on Data Mining [new window] [frame] [preview]
Your browser does not support frames. Please see non-frames version.
URL: www.cs.uvm.edu/~xwu/icdm-03.html - show in clusters
Sources: Wisenut 16, Open Directory 43, MSN 55
4. SAS - M2004 Data Mining Technology Conference [new window] [frame] [preview]
Discussions
Subscribe...
Discussions not available on http://vivisimo.com/
start
9:35 AM


Vivisimo - Clustered search results - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://vivisimo.com/search?query=mining&v%3Asources=Web
Go Links
company | products | solutions | customers | demos | press
Vivísimo
mining
the Web
Search
Advanced
Help!
NEW search auctions at Clusty.com
Search query = "mining"
Clustered Results
Top 217 results retrieved for the query mining (Details)
mining (217)
Data Mining (37)
Equipment (22)
History (21)
Engineering (17)
Minerals And Mining (12)
Metals (16)
Safety (12)
Coal Mining (11)
Job, InfoMine (4)
Geological, Map (7)
More
Find in clusters:
Enter Keyw
Go
Discovered Clusters
Hoss Equipment Co. - Mining Equipment [new window] [preview]
Sponsored Link
Used Caterpillar equipment sales/lease for heavy construction and mining use. Specializing in Cat, Terex, Komatsu, Hitachi, wheel loaders, dozers, water trucks, scrapers and graders.
www.dozernet.com
Non-Explosive Controlled Safe Mining [new window] [preview]
Sponsored Link
Dexpan is a non-explosive controlled safe mining agent. It breaks rock, marble, granite, limestone with no noise, vibration, ash or toxic gases. Safe, efficient and cost effective.
www.archerusa.com
1. InfoMine [new window] [frame] [preview]
Source of mining and mineral links, news, and information. See a database of jobs and resumes.
URL: www.infomine.com - show in clusters
Sources: Looksmart 2, Lycos 3, MSN 3, Wisenut 13
2. KDNuggets Directory [new window] [frame] [preview]
Browse a data mining and knowledge discovery reference. Includes a newsletter, membership details, jobs, meetings and courses.
URL: www.kdnuggets.com - show in clusters
Sources: Open Directory 2, Lycos 4, MSN 4, Wisenut 15, Looksmart 49
3. Mining Technology [new window] [frame] [preview]
Covers current projects and developments as well as an A-Z company directory and suppliers guide. Find events and an association directory.
URL: www.mining-technology.com - show in clusters
Discussions Subscribe... Discussions not available on http://vivisimo.com/
start
9:47 AM

Extracting Information from Free Text



- Feature/Information extraction: important to extract specific data, ex: price, product attributes, vendors, …etc
- Useful in e-commerce: comparison shopping
- This has been made easier by recent structuring of content using XML tags

Summary of Approaches for Mining the Web

- Structure Mining:
  - analyzing links between pages
  - *Global* vs. *local* structure
    - Global structure ➔ identify *hubs*, *authorities*
    - Local structure ➔ understand site's intended purpose, detect design problems
  - Typically based on graph analysis
  - HITS algorithm
  - App: search engines (for global structure)
- Usage Mining:
  - Analyzing user behavior *over time*
  - Build user *profiles* of *anonymous* visitors
  - Data mining tasks: association rule discovery, clustering
  - App: personalization, marketing, etc
- Content Mining
  - Extract info from web pages
  - Data mining tasks: clustering, classification
  - App: search engines