Multilingual Information Processing for Digital Libraries

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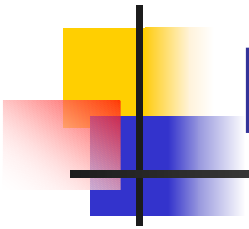
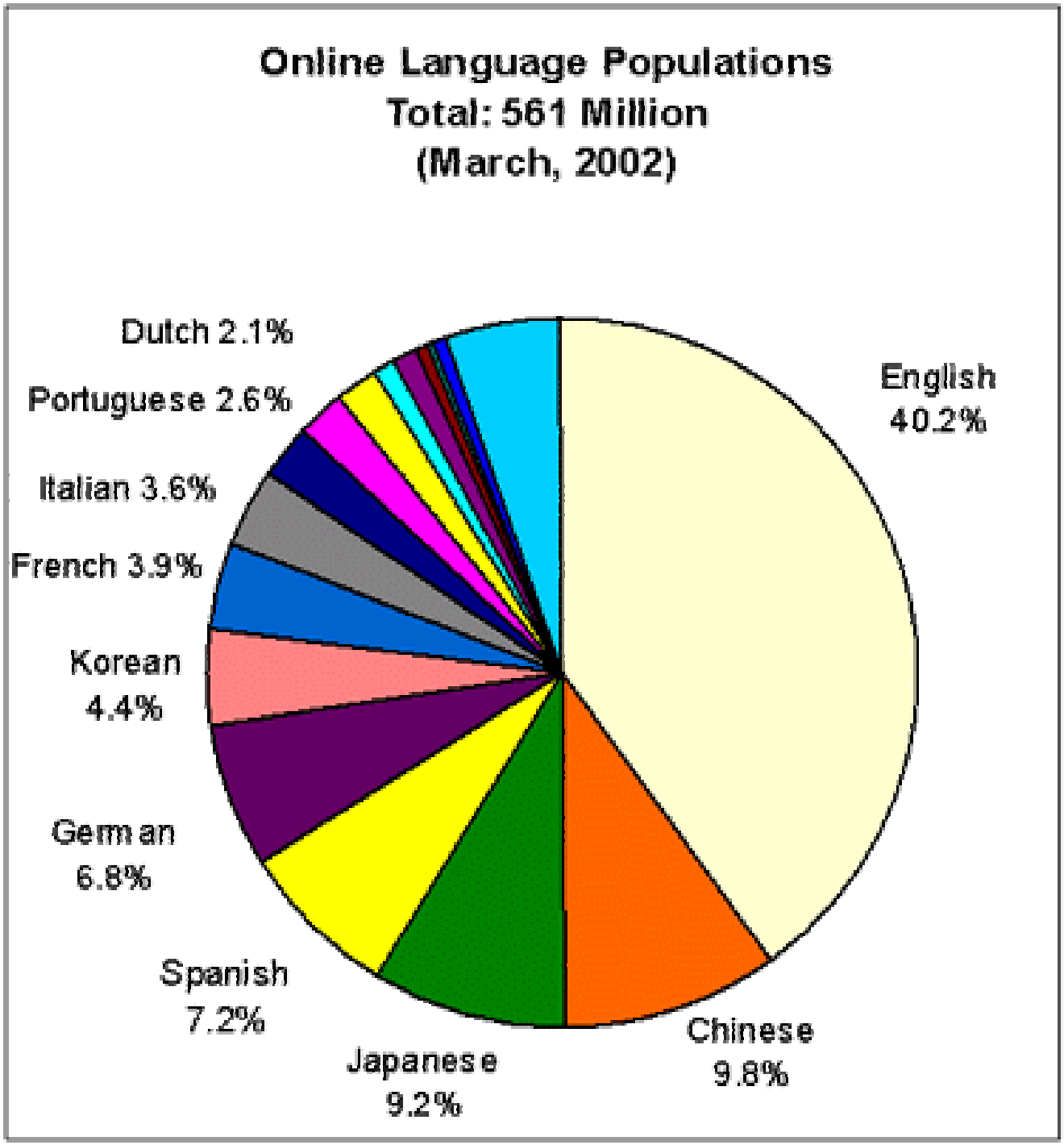


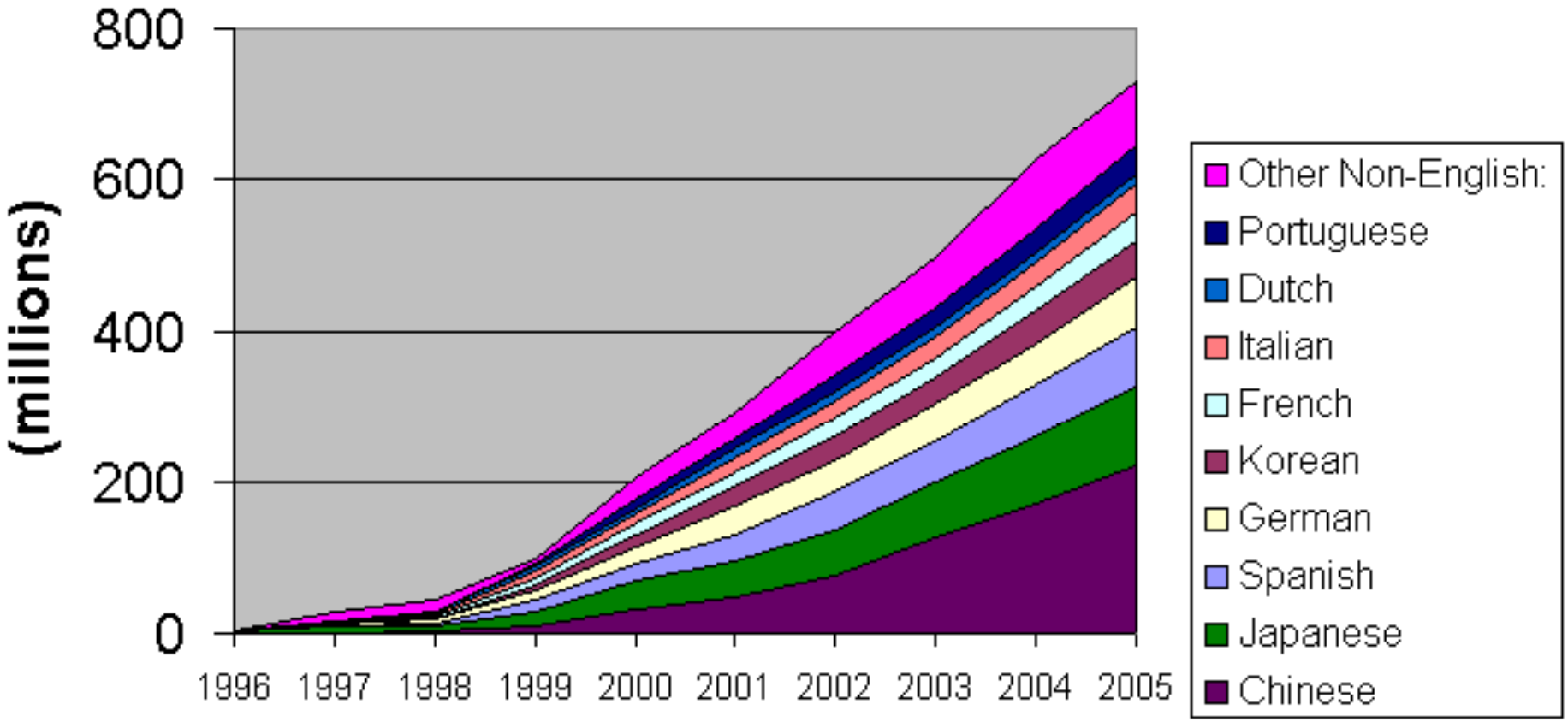
Background

- Increasing popularity of the Internet in various areas in the world
  - Languages used for Web documents are expanded from English to others
- In a digital library (DL), multilingual information processing is essential
  - Even a small library has multilingual materials
  - Accessed from all over the world

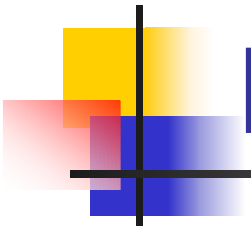


Source:
Global Reach

Evolution of non-English-speaking online population



Source: Global Reach



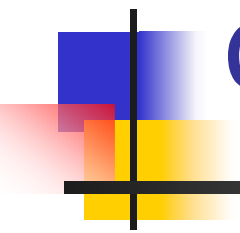
Problems

- Many unsolved problems in order to handle multilingual documents in a DL
- From the user's point of view, fundamental functions for the general use of a DL are: **display**, **input**, and **retrieval**
- From the system's point of view, digital documents often lack information of the **encoding and the language**
  - In web documents, `charset` parameter is not always attached
    - incorrect display on browsers
    - inaccurate indexing on search engines

Proposed solutions

1. **Display and input functions for multilingual text** which does not depend on installed fonts and input methods
2. **Automatic identification of languages and coding systems of Web documents** based on statistics and heuristics
3. **Cross-languages IR technique** which is suitable for documents in diverse domains

MHTML: Display and input functions for multilingual documents

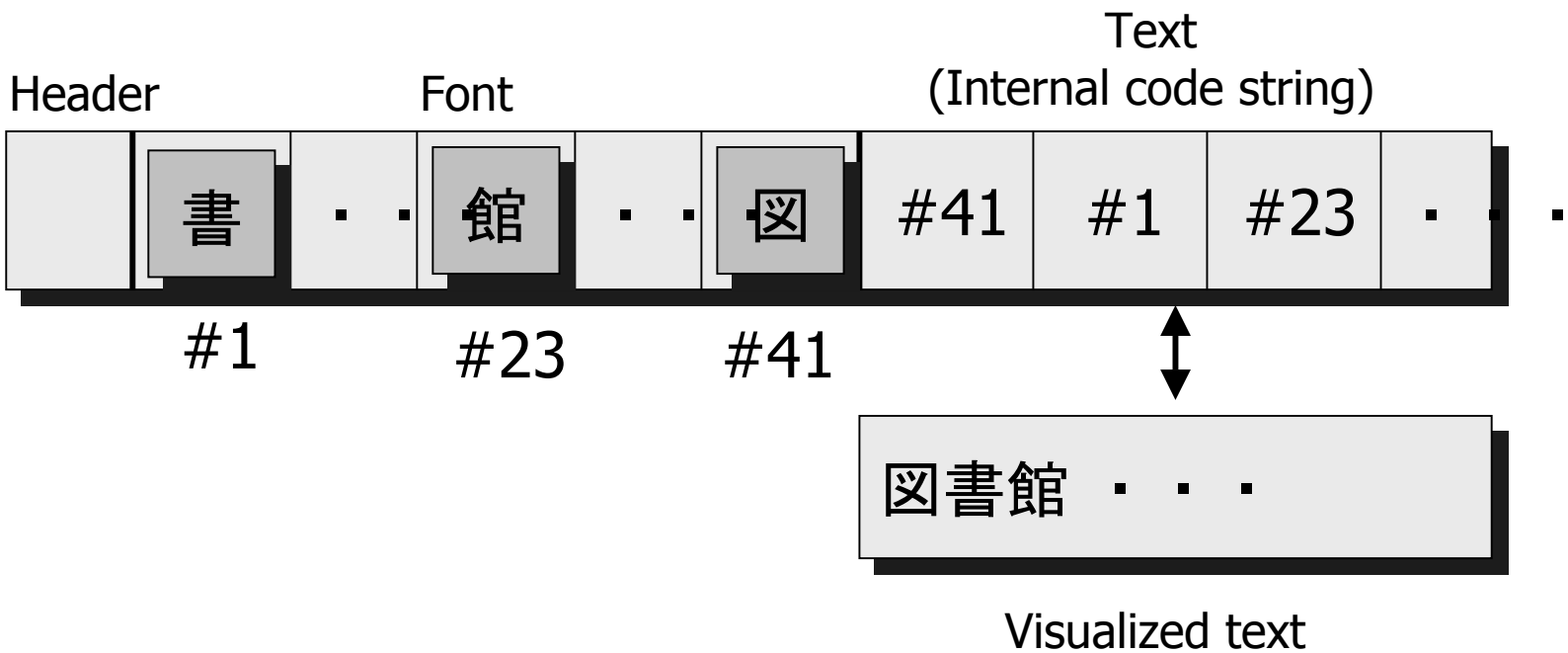


Motivation

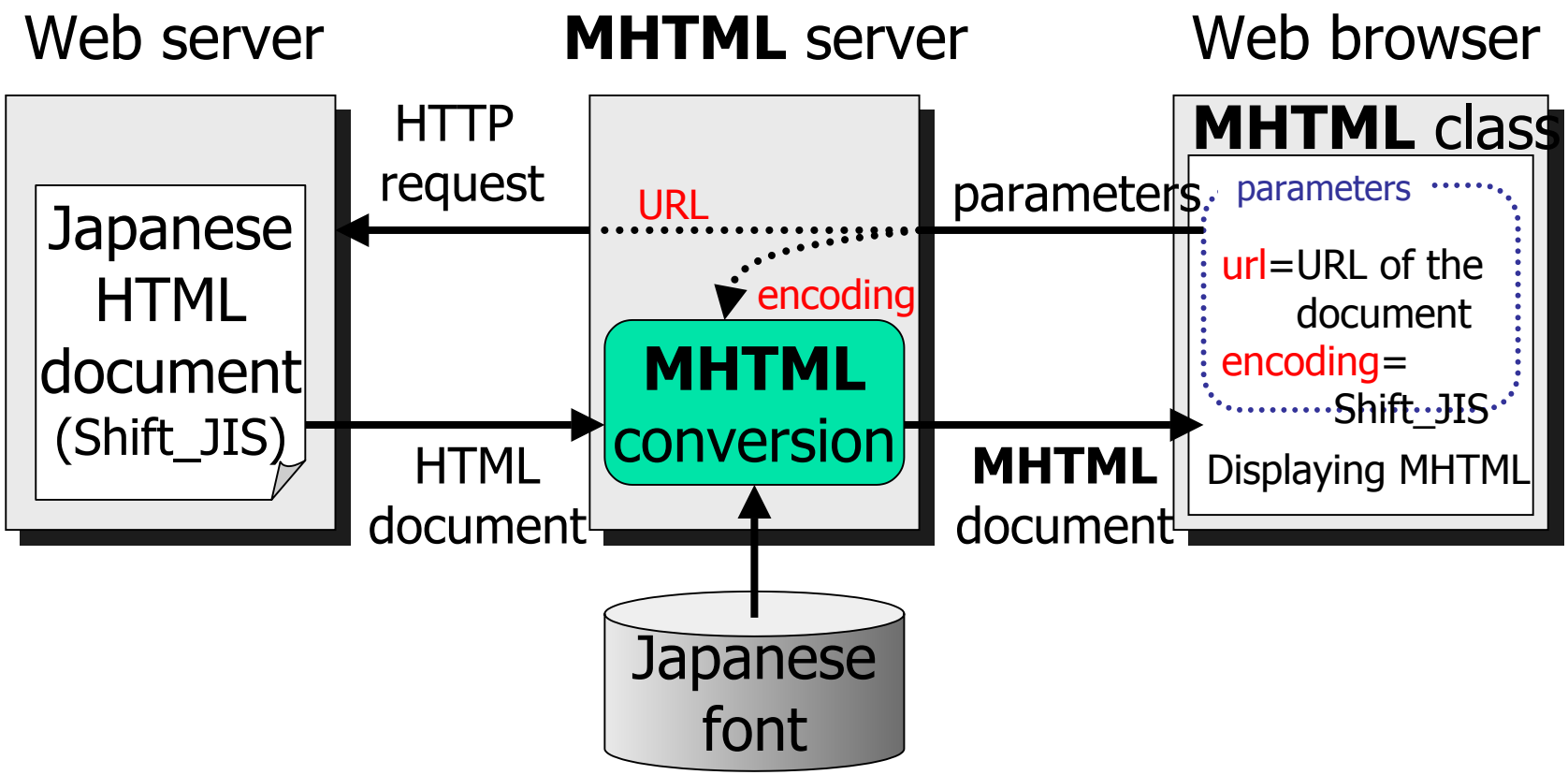
- To enable display/input of foreign language text on an off-the-shelf Web browser
  - Usually, the user have to install fonts or input methods for foreign languages
    - Difficult for novice users
    - Impractical for client PCs in public use

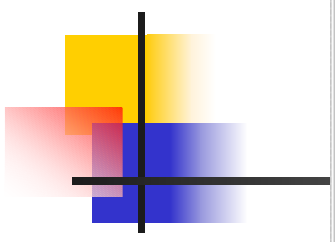
  - A method which does not require installing fonts or input methods on the client
  - **MHTML**: Multilingual-HTML

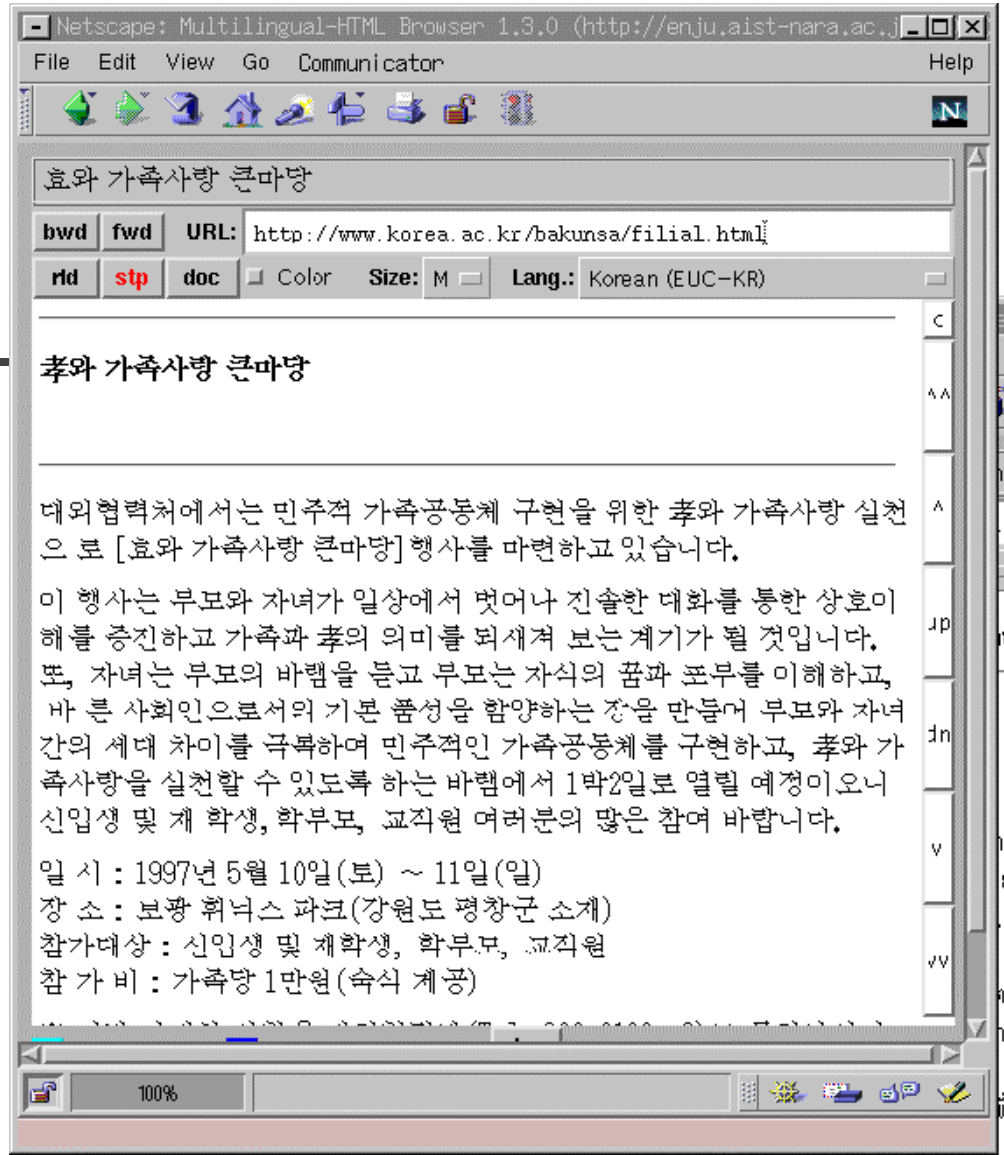
Structure of **MHTML** document

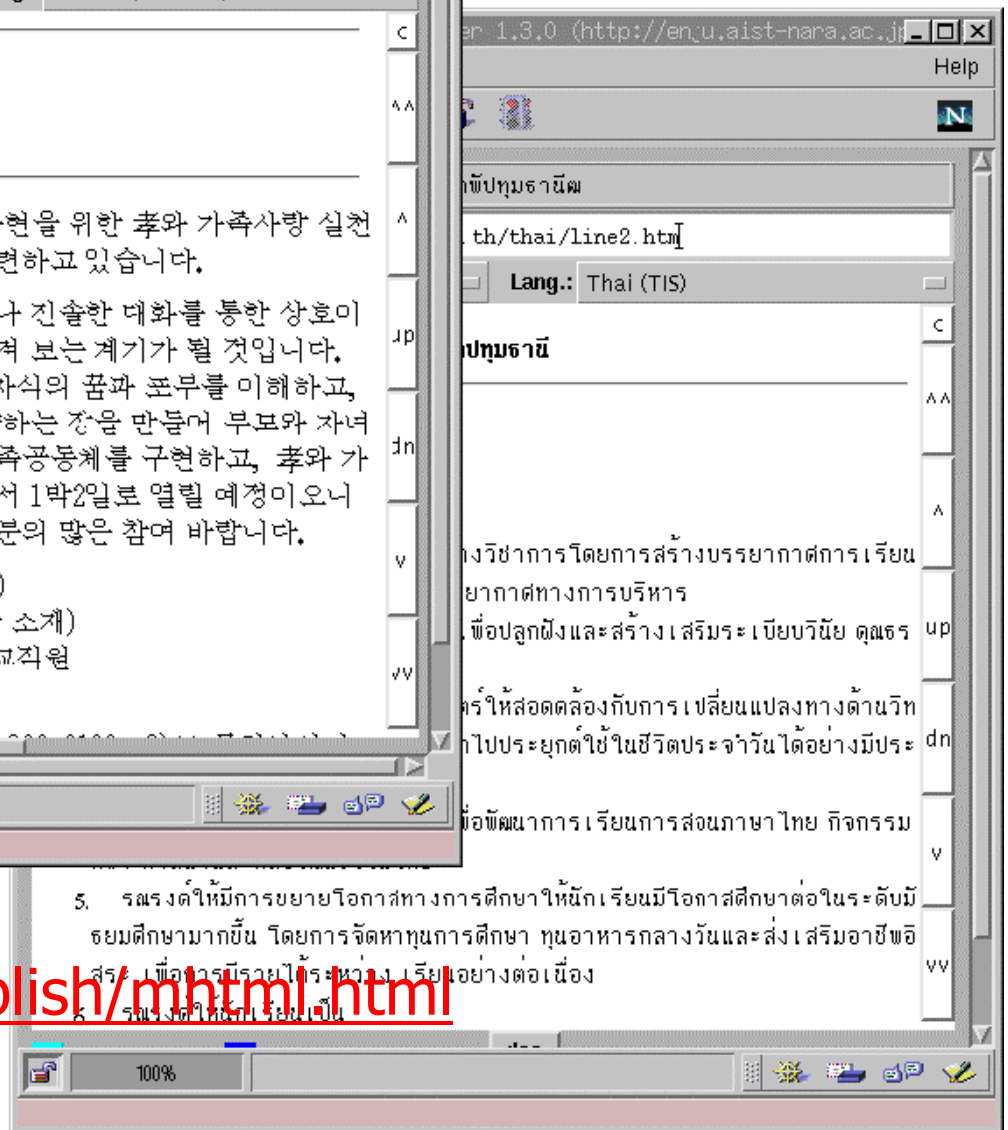


Displaying a document using **MHTML**



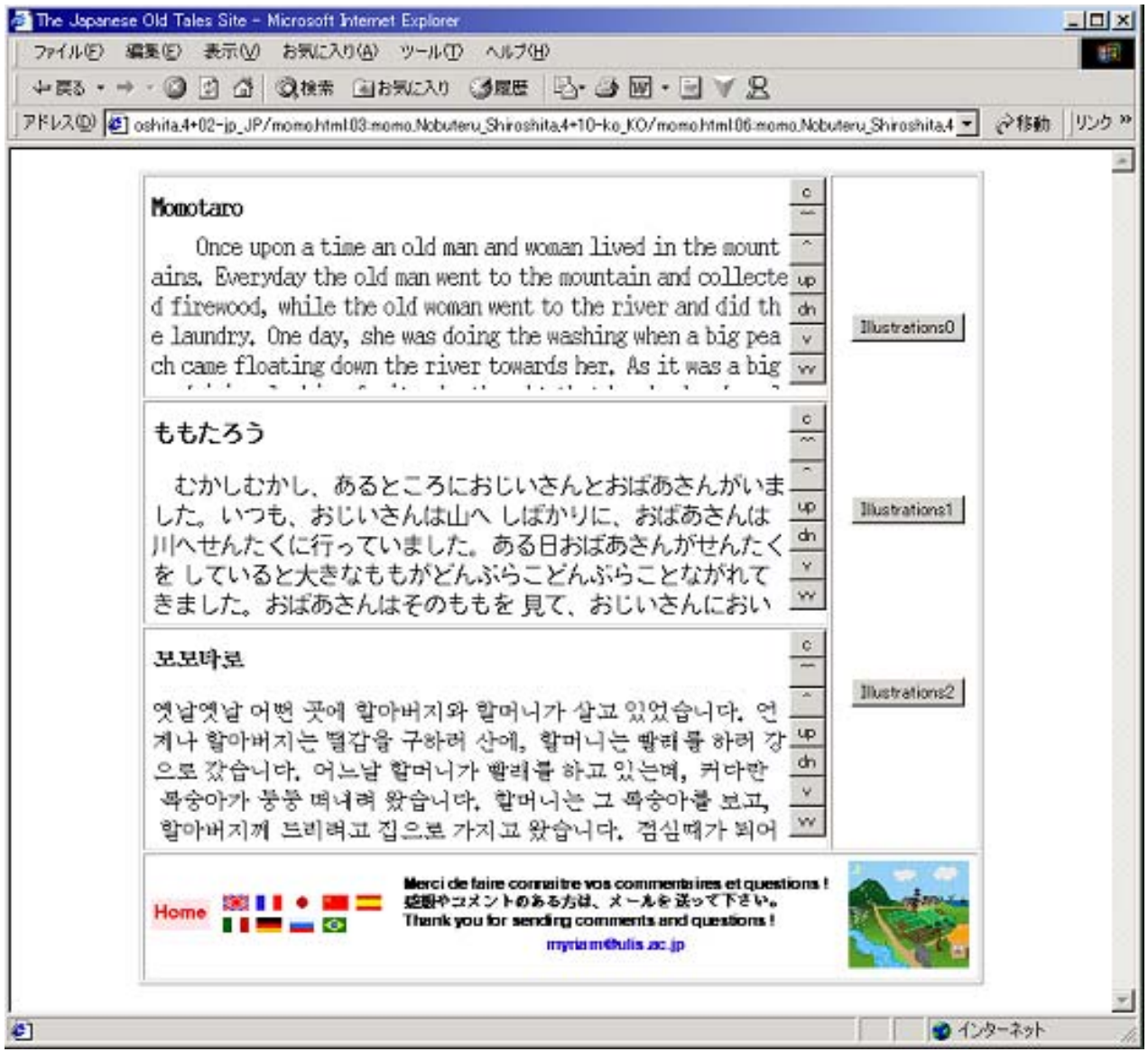




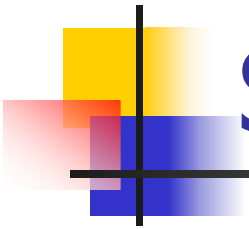


http://mhtml.ulis.ac.jp/
http://www.vt.edu/misc/publish/mhtml.html

Digital library of multilingual old tales



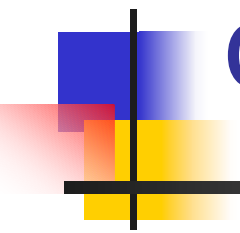
http://www.dl.ulis.ac.jp/oldtales/



Summary

- Multilingual text display/input functions without installing anything
- Simple and efficient
- No need to modify existing HTML documents
- Useful for minor languages
- Useful for displaying characters that are not defined in standard character set

Automatic identification of coding systems and languages of documents



Target languages and coding systems

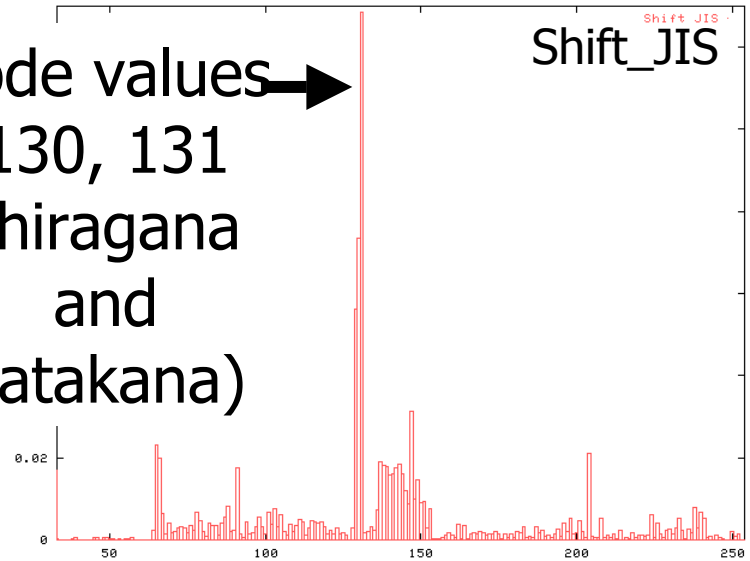
Coding system	Language	Unit	Character range
ISO-2022-JP	Japanese	7	33-126
ISO-2022-CN	Chinese	7	33-126
ISO-2022-KR	Korean	7	33-126
Shift_JIS	Japanese	8	33-252
EUC-JP	Japanese	8	33-126, 142-254
GB2312	Chinese (simplified)	8	33-126, 161-254
Big5	Chinese (traditional)	8	33-126, 161-254
EUC-KR	Korean	8	33-126, 142-254
ISO-8859-1	European languages	8	33-126, 161-254

Proposed identification method

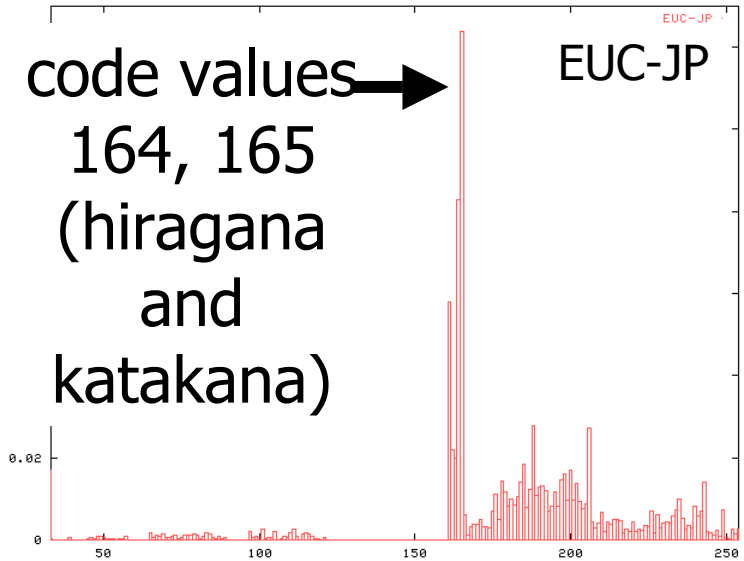
- **7-bit coding systems**
  - can be distinguished from 8-bit codes by checking MSB (Most Significant Bit)
  - Subsets of ISO-2022 can be distinguished by escape sequences
- **8-bit coding systems**
  - identified by analyzing the distributions of character codes

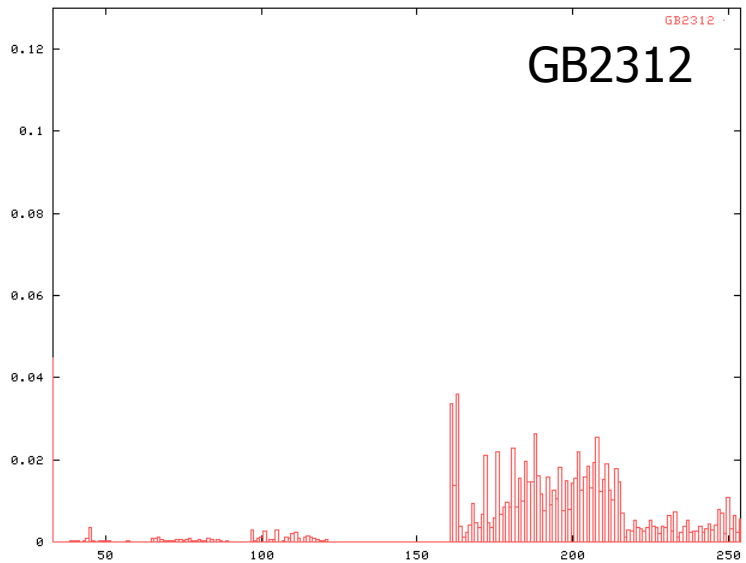
One byte code distributions

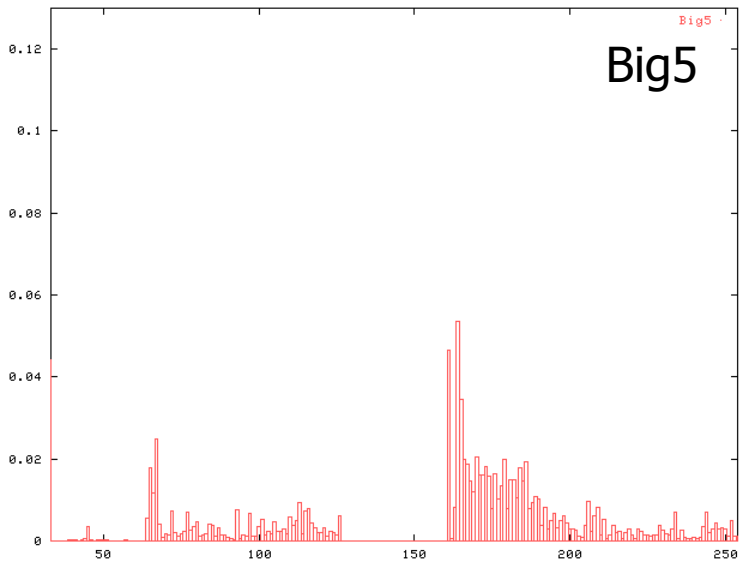
code values 130, 131 (hiragana and katakana)



code values 164, 165 (hiragana and katakana)

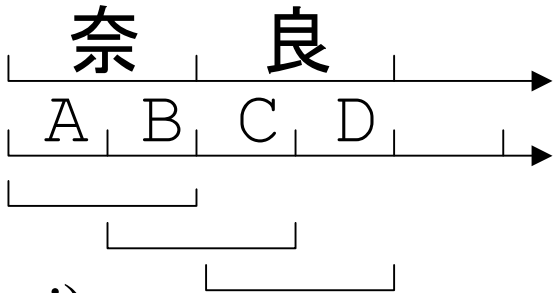






Vector-distance method (consecutive two bytes unit)

- Takes the connection of consecutive characters into account



$$\cos D'_c = \frac{\sum_i \sum_j freq_c(i,j)\, freq_d(i,j)}{\sqrt{\sum_i \sum_j freq_c(i,j)^2}\sqrt{\sum_i \sum_j freq_d(i,j)^2}}$$

$$(i = 32,65 \ldots 90,97 \ldots 122,128 \ldots 255)$$

Results of the Vector-distance method

Coding system (language)	Correct rate (%)	
	1 byte	2 bytes
Shift_JIS (Japanese)	99.8	100.0
EUC-JP (Japanese)	99.2	100.0
GB2312 (Chinese)	100.0	100.0
Big5 (Chinese)	100.0	100.0
EUC-KR (Korean)	100.0	100.0
ISO-8859-1 (English)	90.9	98.9
ISO-8859-1 (German)	99.4	100.0
ISO-8859-1 (French)	95.1	99.9
ISO-8859-1 (Italian)	98.2	100.0
ISO-8859-1 (Spanish)	90.7	99.9
ISO-8859-1 (Portuguese)	92.8	100.0
ISO-8859-1 (Danish)	69.8	92.6
ISO-8859-1 (Norwegian)	70.1	91.5
ISO-8859-1 (Swedish)	94.9	99.7
Avg.	92.9	98.7

Summary

- Proposed an identification method of coding systems and languages of Web documents
- 98% average correct rate for 12 languages and 10 coding systems
- The method does not require discriminating the boundaries of characters for Asian languages

Query Term Disambiguation for Cross-Language Information Retrieval

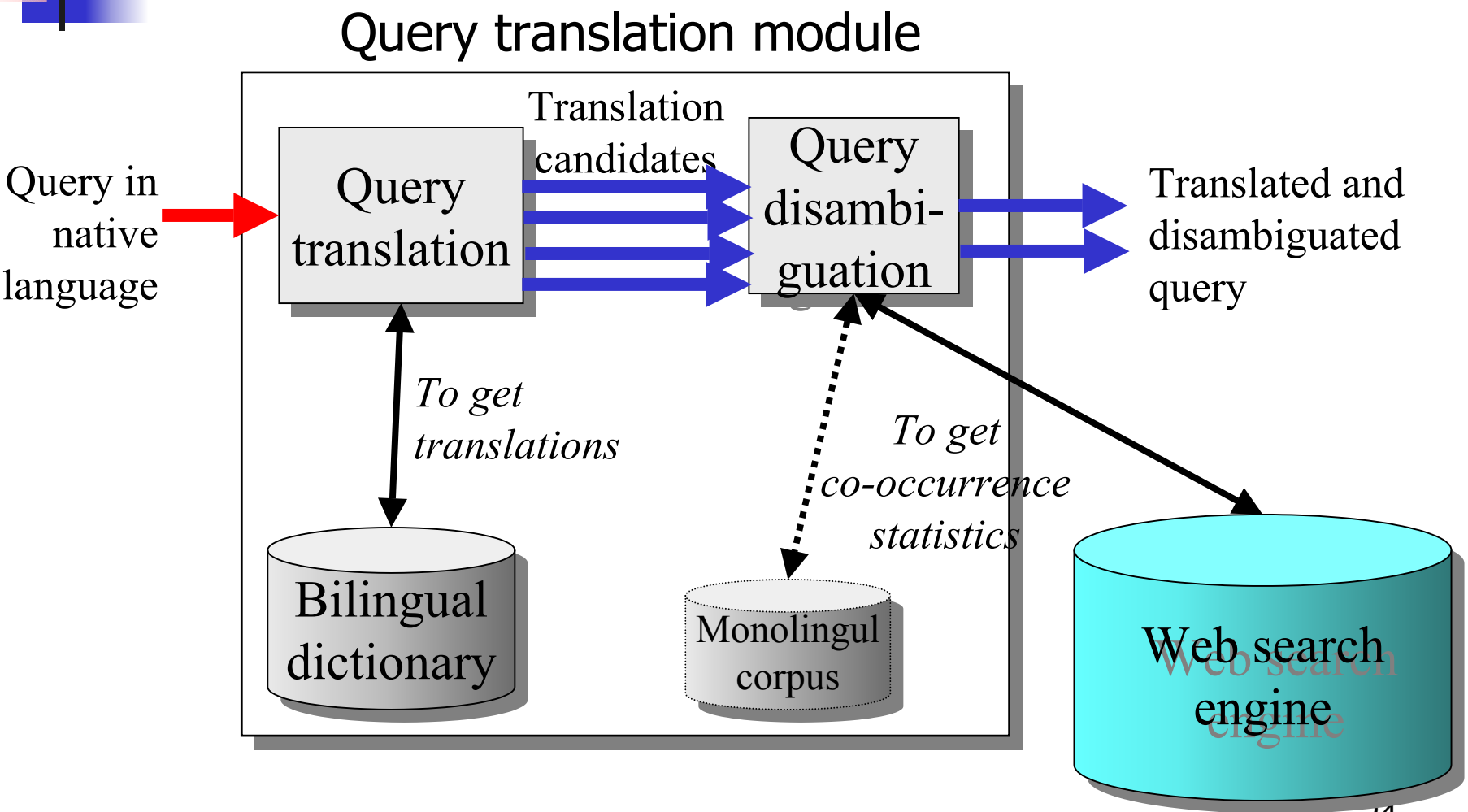
Cross-Language Information Retrieval (CLIR)

- A technique to retrieve documents written in a certain language using a query written in another language
- Who needs CLIR?
  - When users can read several languages
    - Eliminate multiple queries
    - Query in most fluent language
  - Monolingual users can also benefit
    - If translations can be provided
    - Inexpensive Machine Translation software

Approaches to CLIR

- Translation of target collection
  - Has the advantage of utilizing existing MT software
  - Not suitable for multilingual, large-scale, and frequently-updated Web collection
- Translation of user's query
  - Translated queries can simply be fed into existing monolingual search engines
  - Simple dictionary translation introduces ambiguity
    - bank：銀行 (bank to deposit), 堤防 (dike), 土手 (embankment), 川岸(riverside) …

Flow of query translation

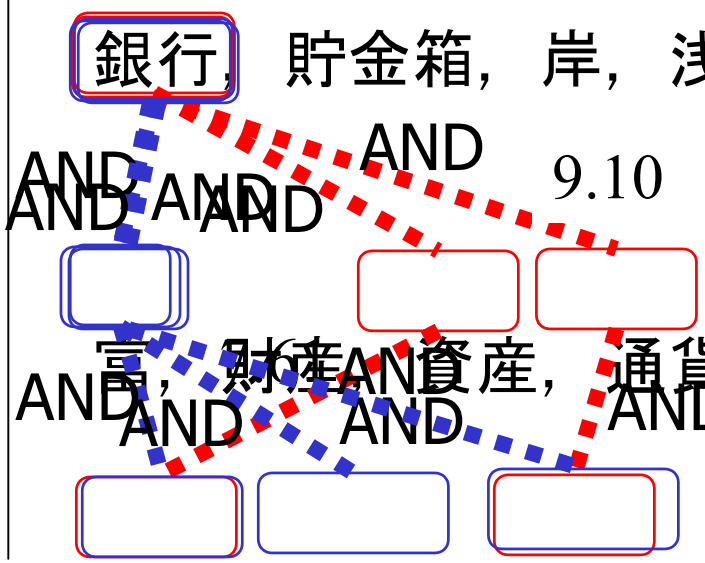


Mutual Information

w1	w2	$COT_{MI}(w1, w2)$
database	multimedia	3.37
database	transaction	2.41
database	relational	2.01
database	chair	-2.96
database	soul	-3.43
database	iron	-4.62

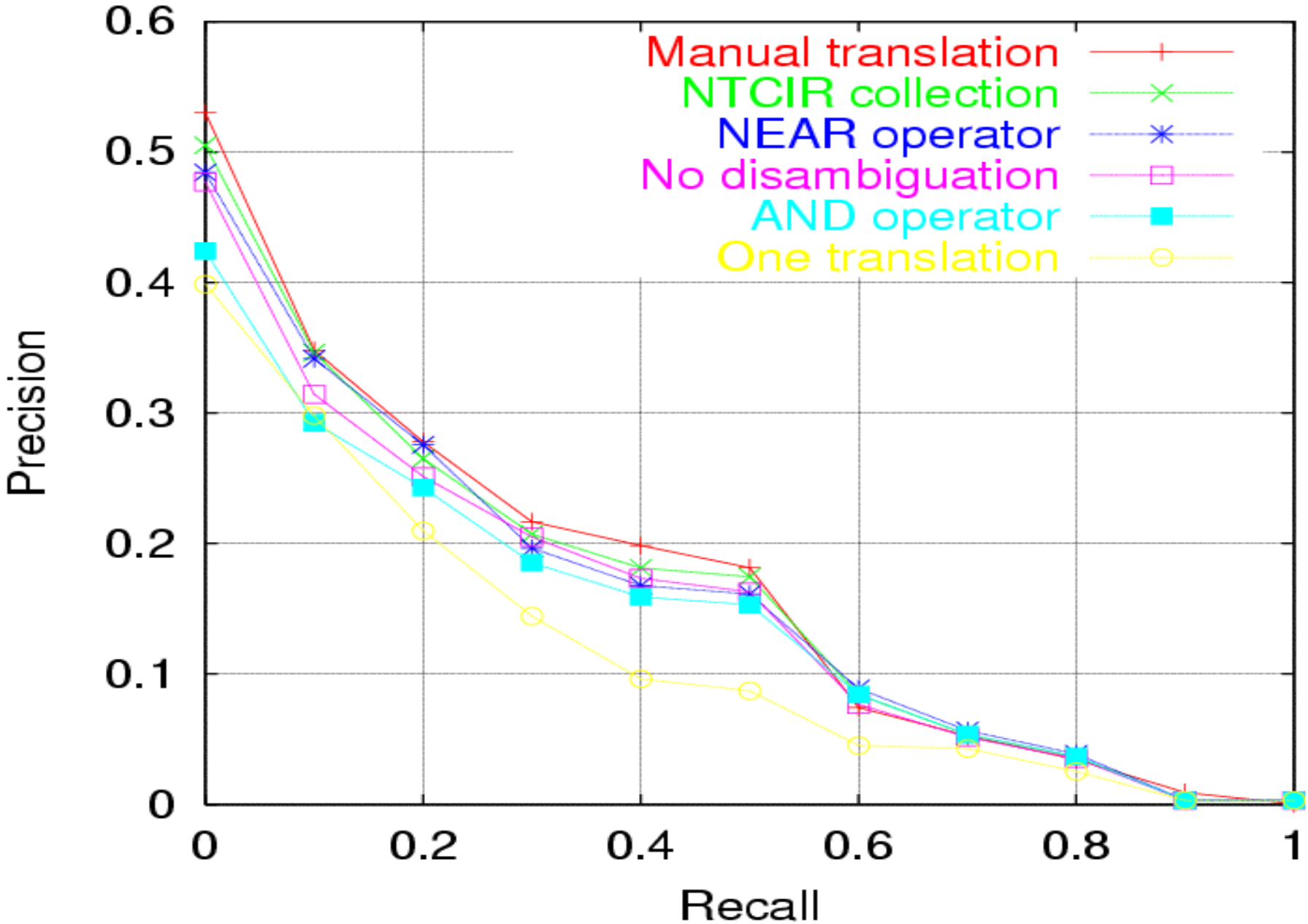
Disambiguation using Mutual Information

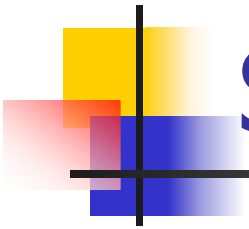
Query	Translation candidates
Bank	銀行，貯金箱，岸，浅瀬，土手，堤防．．．
Money	金，財産，資産，通貨．．．
Trade	商売，同業者，貿易，交換，道．．．



Query： （銀行 AND 通貨 AND 貿易） OR （銀行 AND 資産 AND 商売）

Experiment (MI:n words COT)





Summary

- CLIR method for DL documents in diverse domains
  - utilizing a Web search engine as a corpus
- Effective for very short queries
- Can easily be extended to other languages

Conclusions

- Proposed some solutions to the problem of multilingual information processing for DL
  - **Display**, **input**, and **retrieval**