Justsystem-Clairvoyance CLIR Experiments

NTCIR-4 Workshop
Tokyo, Japan

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June 2, 2004

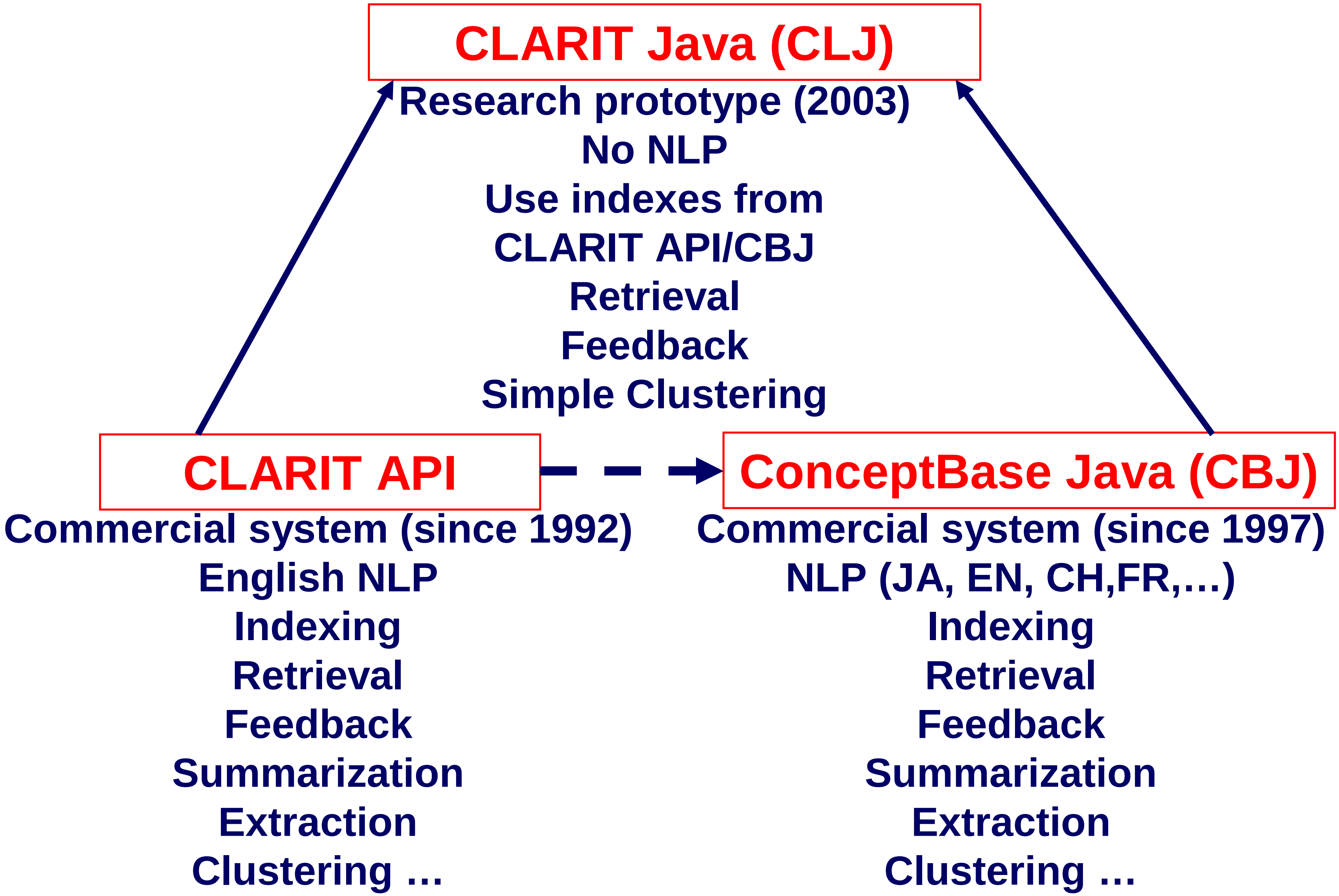
Overview of Participation

- **Clairvoyance (USA) and Justsystem (Japan) collaboration**
- **Single Language IR (SLIR)**
  - Japanese–Japanese
  - Chinese–Chinese
  - English–English
- **Bilingual CLIR (BLIR)**
  - Japanese–English
  - Chinese–English
- **Goal of participation:**
  - Evaluating performance and robustness of commercial-grade CLIR systems for English, Japanese, and Chinese

System Description

- **System framework**
  - Clairvoyance IM APIs (CLARIT)
  - Justsystem ConceptBase Java (CBJ)
- **Functionalities**
  - Natural language processing
  - Ad hoc retrieval
  - Feedback
  - Visualization
  - Cross-language IR
  - Etc.

Systems



CLARIT Java (CLJ)

Research prototype (2003)
No NLP
Use indexes from
CLARIT API/CBJ
Retrieval
Feedback
Simple Clustering

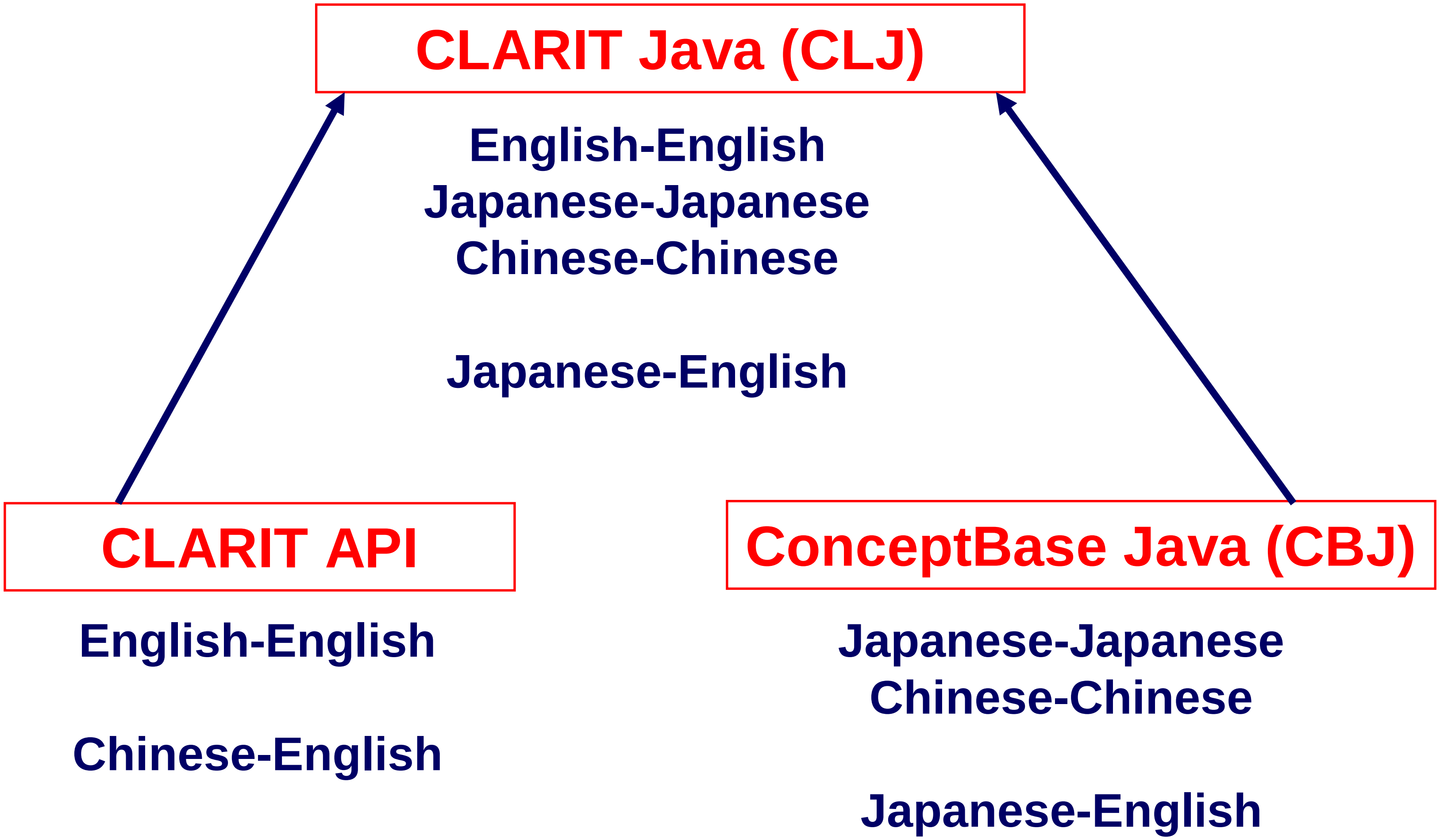
CLARIT API

Commercial system (since 1992)
English NLP
Indexing
Retrieval
Feedback
Summarization
Extraction
Clustering …

ConceptBase Java (CBJ)

Commercial system (since 1997)
NLP (JA, EN, CH,FR,…)
Indexing
Retrieval
Feedback
Summarization
Extraction
Clustering …

Submission Distributions



CLARIT Java (CLJ)

English-English
Japanese-Japanese
Chinese-Chinese

Japanese-English

CLARIT API

English-English

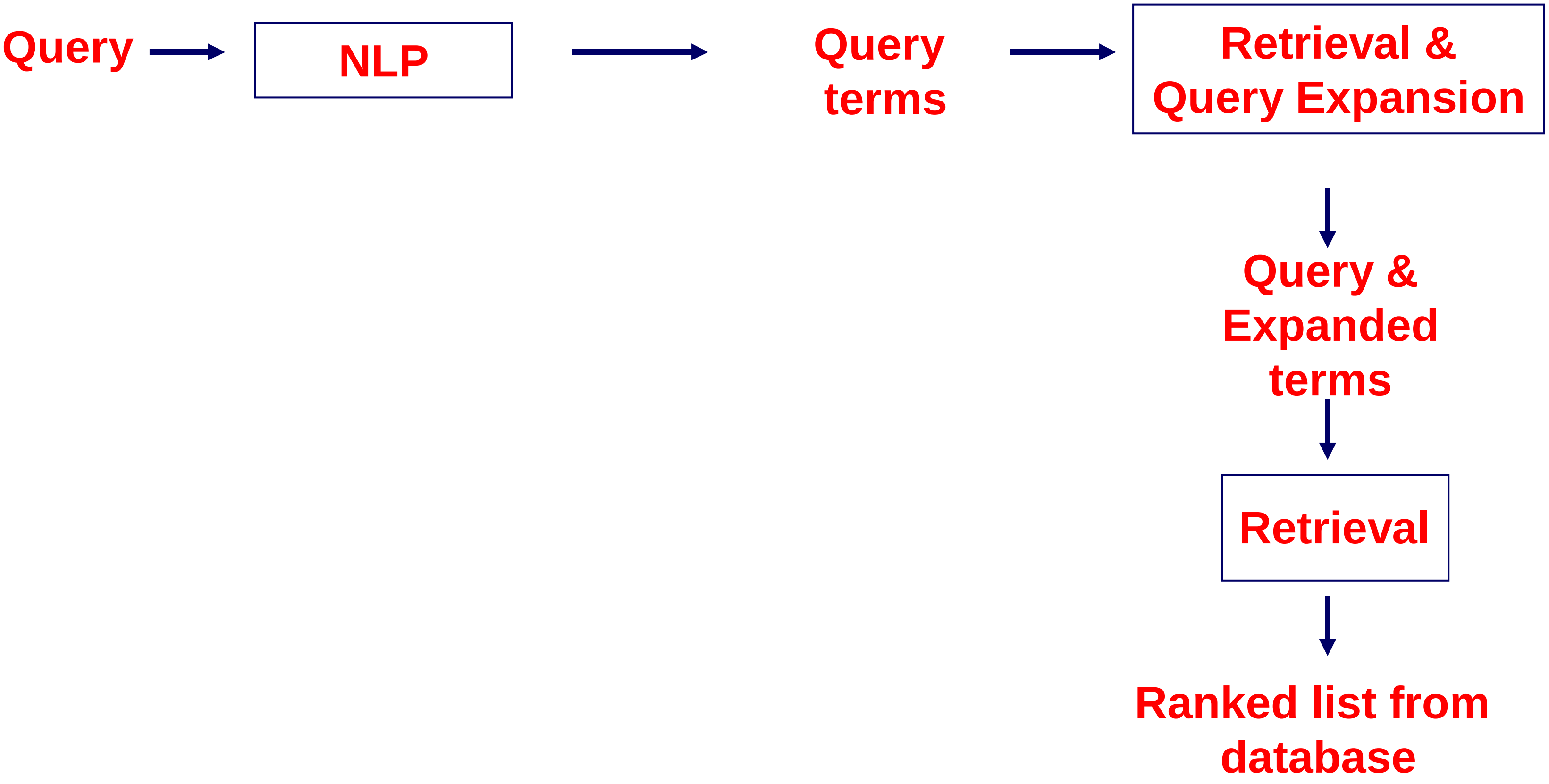
Chinese-English

ConceptBase Java (CBJ)

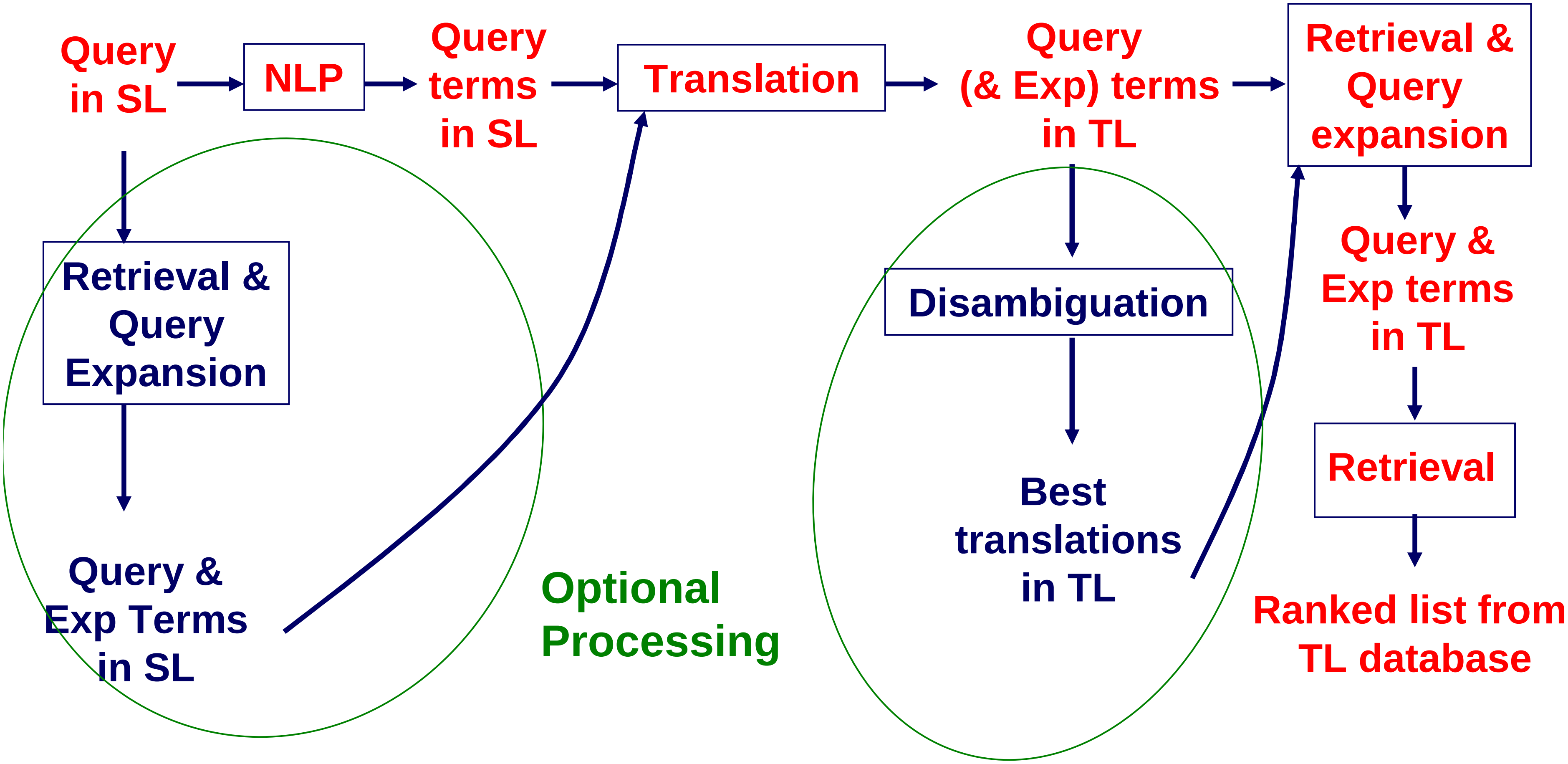
Japanese-Japanese
Chinese-Chinese

Japanese-English

Single-Language IR (SLIR)



Bilingual CLIR (BLIR)



Query in SL

NLP

Query terms in SL

Translation

Query (& Exp) terms in TL

Retrieval & Query expansion

Retrieval & Query Expansion

Query & Exp Terms in SL

Optional Processing

Disambiguation

Best translations in TL

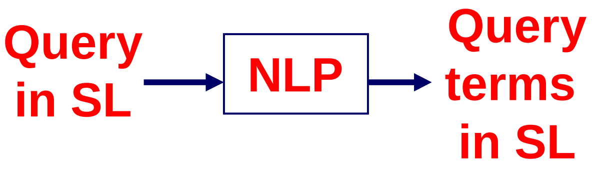
Query & Exp terms in TL

Retrieval

Ranked list from TL database

SL: source language TL: target language

Bilingual CLIR (BLIR)

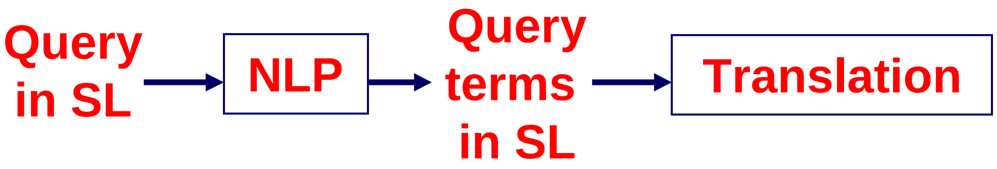


Word segmentation for Chinese/Japanese

- Statistical part of speech tagging
- NLP for phrase identification

SL: source language TL: target language

Bilingual CLIR (BLIR)


Query in SL → NLP → Query terms in SL → Translation

Missing translation

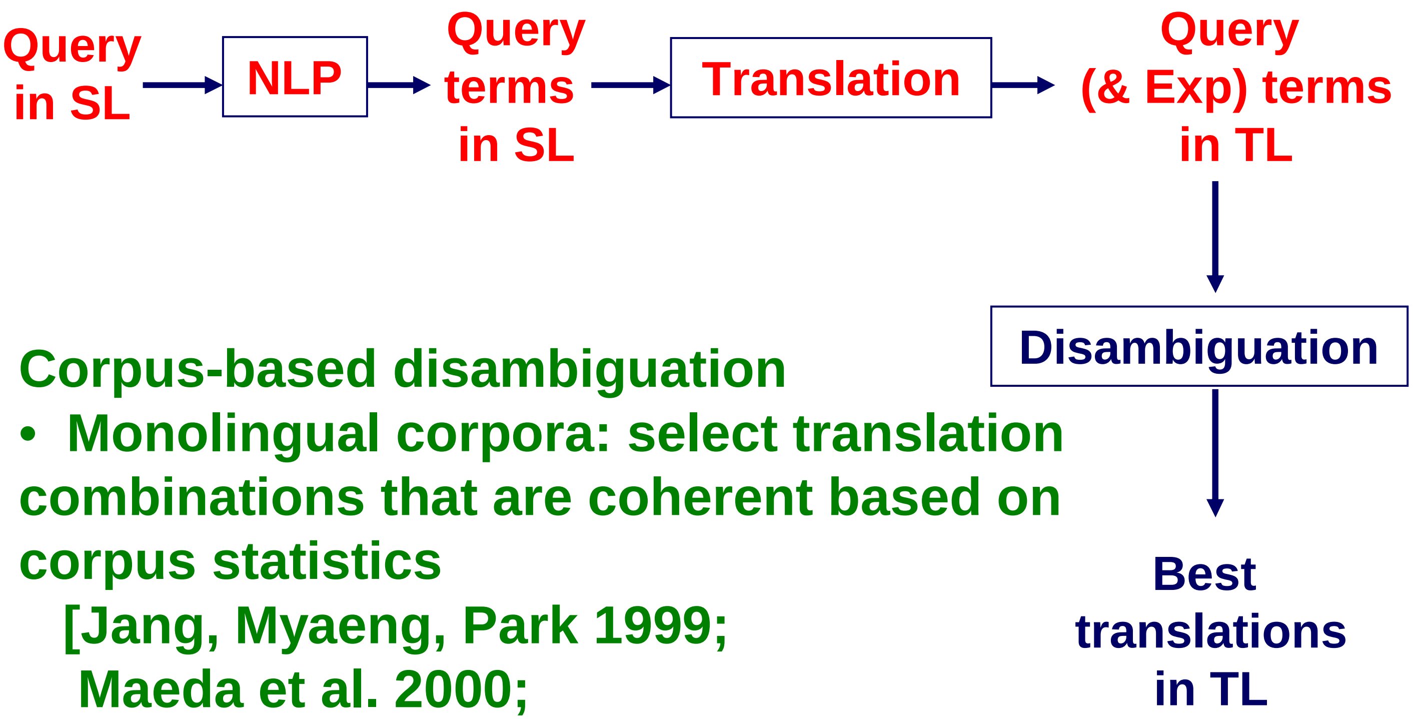
- Proper name translation (transliteration)
- Multi-word terms
- General unknown terms

Methods

- Automatic name transliteration
  [Fujii & Ishikawa 2001; Qu, Grefenstette, Evans 2003]
- Corpus-based mining of translations
  pre-translation feedback [Ballesteros & Croft 1996]
  context vectors [Fung & Yee 1997]
- Translation of multi-word terms [Grefenstette 1999]

SL: source language TL: target language

Bilingual CLIR (BLIR)

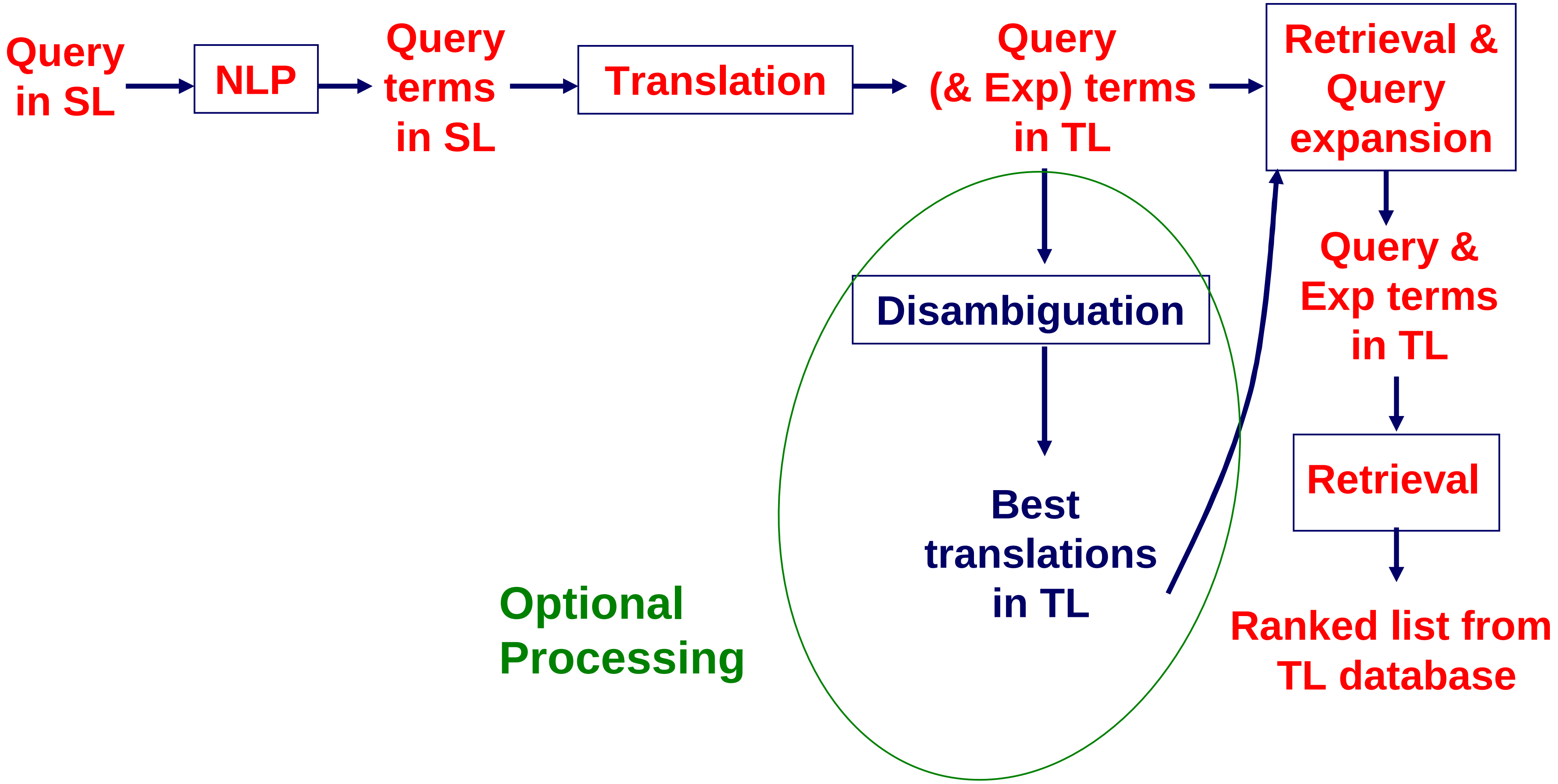


Corpus-based disambiguation

- **Monolingual corpora: select translation combinations that are coherent based on corpus statistics**
  [Jang, Myaeng, Park 1999;
  Maeda et al. 2000;
  Qu, Grefenstette, Evans 2002]
- **Parallel corpora: select translations found in aligned pairs**

SL: source language TL: target language

Bilingual CLIR (BLIR)



Query in SL

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Indexing and Retrieval

- **Indexes based on sub-documents**
- **Vector space model**

“importance coefficient” for phrase down-weighting

$$sim(Q,\ D) = \sum_{t \in Q \cap D} W_Q(t) \cdot W_D(t).$$

term frequency

Inverse document frequency

$$W_Q(t) = C(t) \cdot TF_Q(t) \cdot IDF(t)$$

$$W_D(t) = TF_D(t) \cdot IDF(t)$$

term freq smoothing factor

$$W_D(t) = \frac{(k_1 + 1) \ast TF_D(t)}{k_1[(1 - b) + b \ast (d/\Delta d/ + TF_D(t)}$$

BM25

doc length smoothing factor **doc length** **average doc length**

Query Expansion

Rocchio

$$Rocchio(t) = IDF(t) \bullet \frac{\sum_{D \in DocSet} TF_D(t)}{NumDoc}$$

IDF(t) **= the inverse document frequency of term *t***
NumDoc **= the number of documents in the given set of documents**
TF(t) **= the term frequency score for term *t* in document *D***

Query Expansion

Prob2

$$Prob2(t) = log(R_t + 1) \; x \left(log(\frac{N - R + 2}{N_t - R_t + 1} - 1) - log(\frac{R + 1}{R_t} - 1) \right)$$

N = the number of documents in the target corpus

N$_t$ = the number of documents in the corpus that contain term ***t***

R = the number of documents for feedback that are (presumed to be) relevant to the topic

R$_t$ = the number of documents that are (presumed to be) relevant to the topic and contain term ***t***

Query Expansion

Term Weighting

$$Q_{new} = k \times Q_{orig} + Q_{exp}$$

- **Term weight options for Q_{exp}**
  - Uniform: $W(t) = 1.0$ for all terms
  - Normalized: $W(t) = W_{prob2}(t) \, / \max W_{prob2}(t)$
  - Scaled: $W(t) = W_{prob2}(t) \, / \, \Sigma \, W_{prob2}(t)$

    applies to Q_{exp} and Q_{orig} (using original weights)
- **Parameters in green are tunable**

Example Prob2 Weights

Topic 5: PRC's economic reform (Ntcir-3) **Uniform**

Prob2 expansion: ndocs = 10, ntrms = 10

k=1, Q_{orig} query weight = 2.0, Q_{exp} expansion term weight = 1.0

			Query Merge Strategy	
	Orig	Prob2	Unif	K Q_{orig} Q_{exp}
prc	1.0	12.66	3.0	←1*2.0 + 1.0 = 3.0
reform	1.0	9.66	3.0	←1*2.0 + 1.0 = 3.0
economic_reform	1.0	8.94	3.0	←1*2.0 + 1.0 = 3.0
economic	1.0	8.55	3.0	←1*2.0 + 1.0 = 3.0
future_status	0.0	7.98	1.0	←1*0.0 + 1.0 = 1.0
political_reform	0.0	7.50	1.0	←1*0.0 + 1.0 = 1.0
political	0.0	6.70	1.0	←1*0.0 + 1.0 = 1.0
accordance	0.0	5.97	1.0	←1*0.0 + 1.0 = 1.0
strait	0.0	5.14	1.0	←1*0.9 + 1.0 = 1.0
continue	0.0	4.64	1.0	←1*0.0 + 1.0 = 1.0

Example Prob2 Weights

Topic 5: PRC's economic reform (Ntcir-3) **Normalized**

Prob2 expansion: ndocs = 10, ntrms = 10

k=0.6, Q_{orig} query weight = 2.0, Q_{exp} expansion term weight = prob2/12.66

			Query Merge Strategy	
	Orig	Prob2	**Scale**	**K Q_{orig} Q_{exp}**
prc	1.0	12.66	**3.00**	**←1*2.0 + 1.00 = 3.00**
reform	1.0	9.66	**2.76**	**←1*2.0 + 0.76 = 2.76**
economic_reform	1.0	8.94	**2.71**	**←1*2.0 + 0.71 = 2.71**
economic	1.0	8.55	**2.68**	**←1*2.0 + 0.68 = 2.68**
future_status	0.0	7.98	**0.63**	**←1*0.0 + 0.63 = 0.63**
political_reform	0.0	7.50	**0.59**	**←1*0.0 + 0.59 = 0.59**
political	0.0	6.70	**0.53**	**←1*0.0 + 0.53 = 0.53**
accordance	0.0	5.97	**0.47**	**←1*0.0 + 0.47 = 0.47**
strait	0.0	5.14	**0.41**	**←1*0.0 + 0.41 = 0.41**
continue	0.0	4.64	**0.37**	**←1*0.0 + 0.37 = 0.37**

Example Prob2 Weights

Topic 5: PRC's economic reform (Ntcir-3) **Scaled**

Prob2 expansion: ndocs = 10, ntrms = 10

k=0.6, Q_{orig} query weight = prob2 / 4
Q_{exp} expansion term weight = prob2 / 77.74

Query Merge Strategy

	Orig	Prob2	Scale	K ↓ Q_{orig} ↓ Q_{exp} ↓
prc	1.0	12.66	0.31	←0.6*0.25 + 0.16 = 0.31
reform	1.0	9.66	0.27	←0.6*0.25 + 0.12 = 0.27
economic_reform	1.0	8.94	0.26	←0.6*0.25 + 0.11 = 0.26
economic	1.0	8.55	0.26	←0.6*0.25 + 0.11 = 0.26
future_status	0.0	7.98	0.10	←0.6*0.00 + 0.10 = 0.10
political_reform	0.0	7.50	0.10	←0.6*0.00 + 0.10 = 0.10
political	0.0	6.70	0.09	←0.6*0.00 + 0.09 = 0.09
accordance	0.0	5.97	0.08	←0.6*0.00 + 0.08 = 0.08
strait	0.0	5.14	0.07	←0.6*0.00 + 0.07 = 0.07
continue	0.0	4.64	0.06	←0.6*0.00 + 0.06 = 0.06
	Sum = 4	Sum = 77.74		

Parameter Calibration

- **Based on NTCIR-3 topics and data collections**
- **Stable performance with parameter variation**

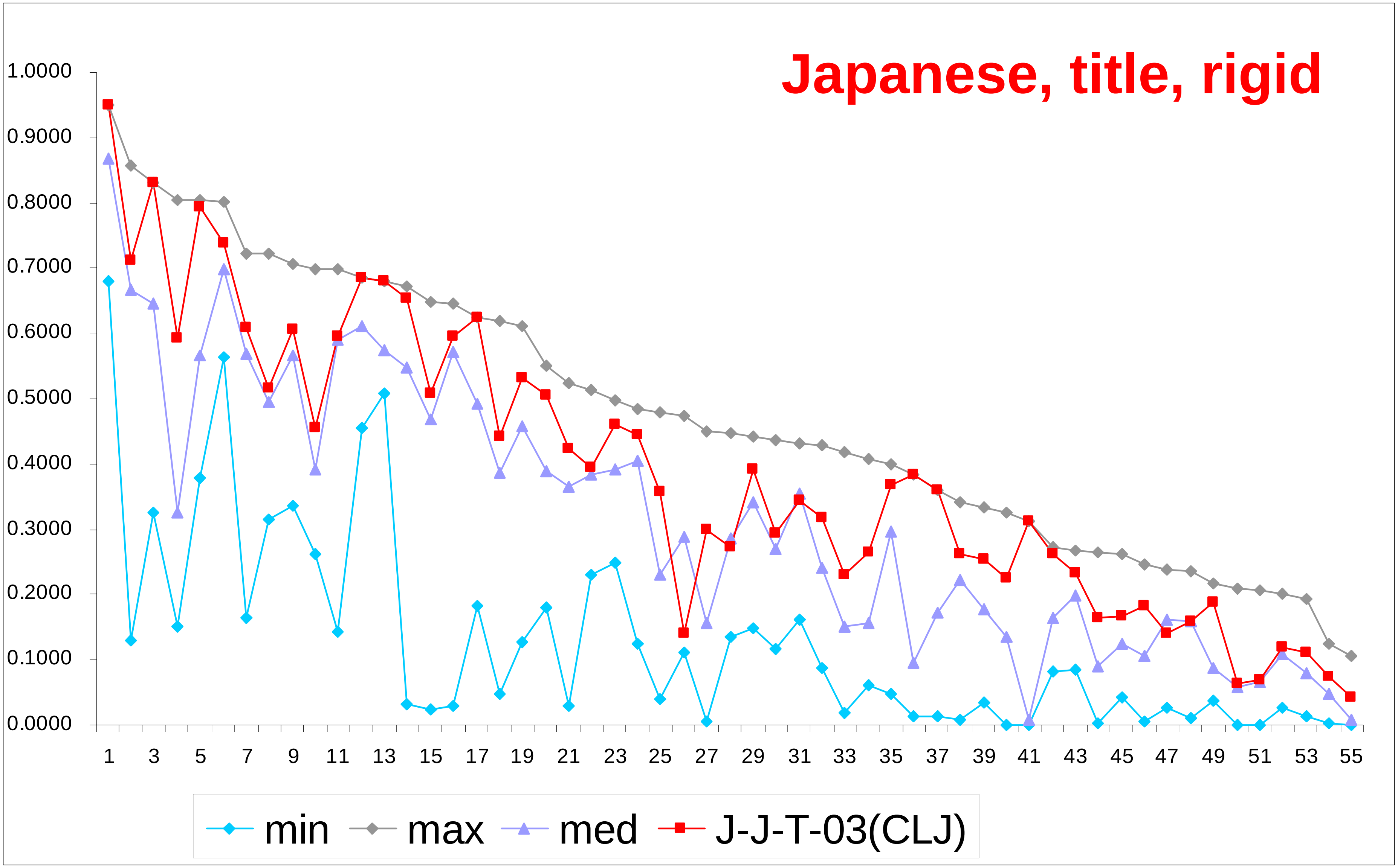
Parameters	Submission	Range
BM25 (k_1, b)	0.311	0.306–0.311
Phrase weight (0.0–1.0)	0.389	0.361–0.389
# docs (5–20) # terms (20–40)	0.389	0.361–0.391
Query weight (0.0–1.0)	0.389	0.366–0.389

NTCIR-4 Max-Med-Min Ranges

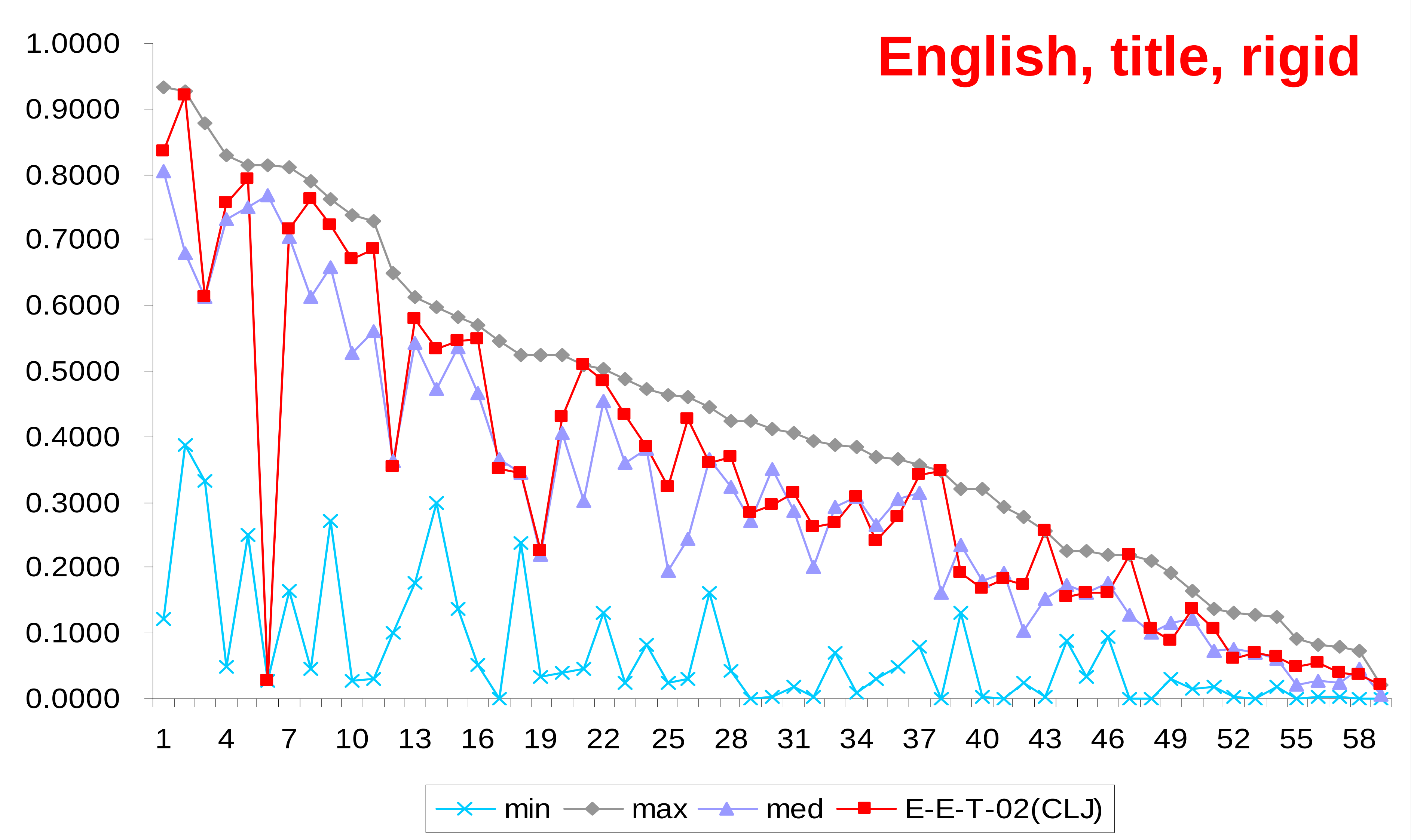
Single-Language IR Results, Rigid, Automatic

subtask	min	max	med	JSC-CC best
E-E-T	0.0802	0.3576	0.3145	0.3412
E-E-D	0.0342	0.3469	0.3026	0.3382
J-J-T	0.1966	0.3890	0.3135	0.3890
J-J-D	0.2130	0.3804	0.3352	0.3747
C-C-T	0.1327	0.3146	0.1881	0.1899
C-C-D	0.1251	0.3255	0.1741	0.1886

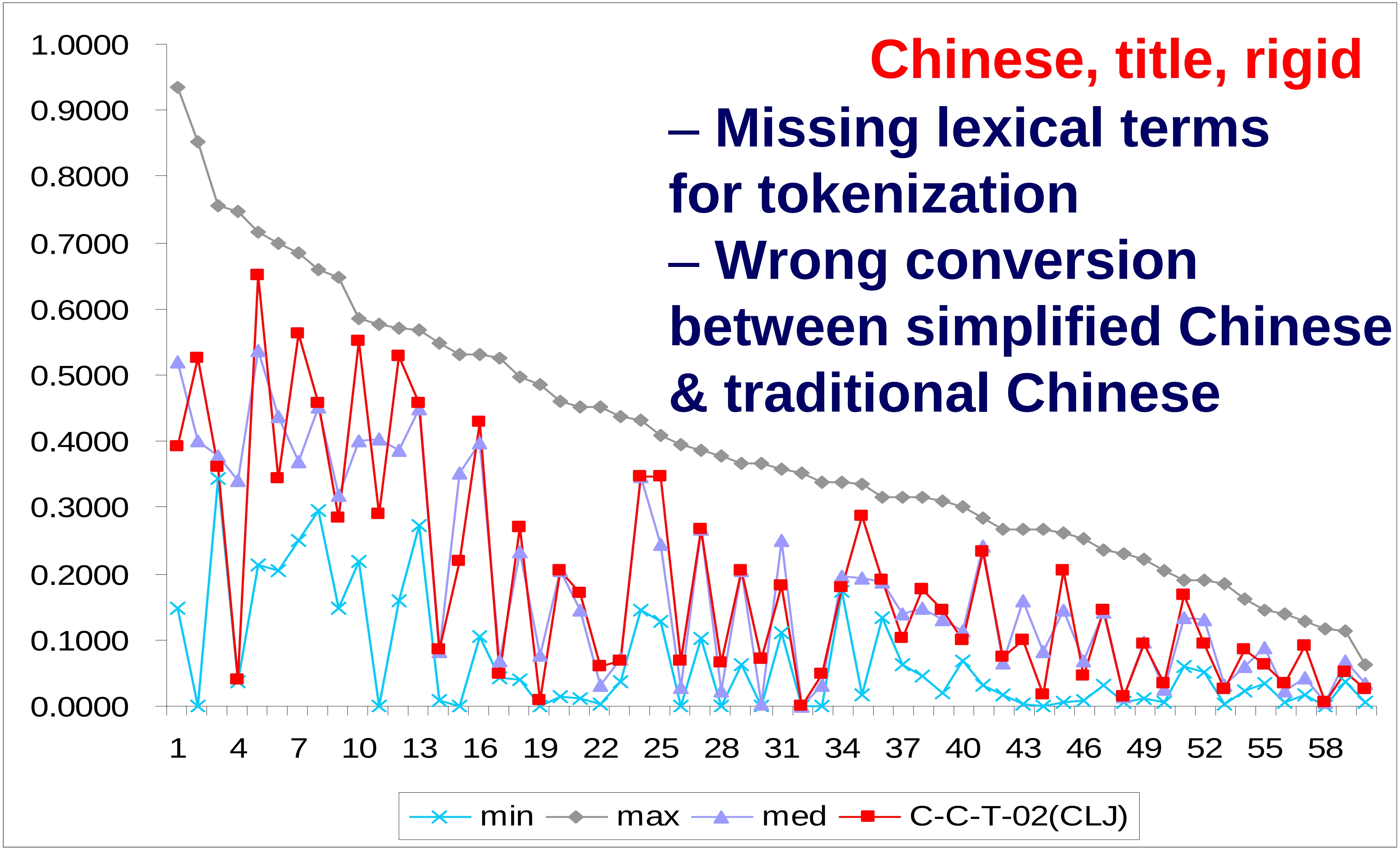
Japanese-Japanese Performance



English-English Performance



Chinese-Chinese Performance



Chinese, title, rigid

– Missing lexical terms for tokenization

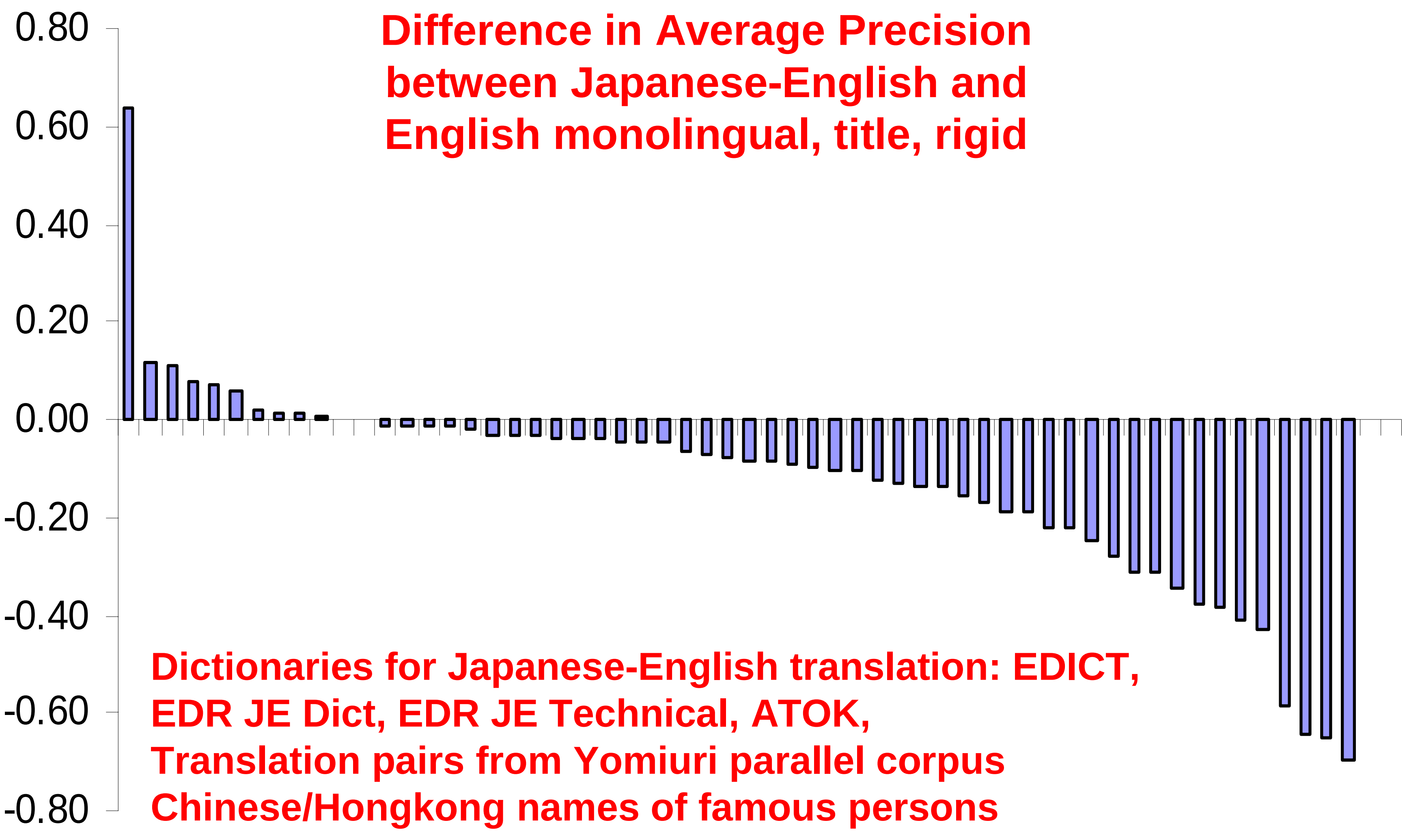
– Wrong conversion between simplified Chinese & traditional Chinese

NTCIR-4 Max-Med-Min Ranges

Bilingual CLIR Results, Rigid, Automatic

subtask	min	max	med	JSC-CC best
C-E-T	0.0389	0.2380	0.1860	0.1660
C-E-D	0.0412	0.2238	0.1819	0.1575
J-E-T	0.0189	0.3407	0.2131	0.2131
J-E-D	0.0075	0.3340	0.2427	0.2620

Japanese–English Performance



Difference in Average Precision between Japanese-English and English monolingual, title, rigid

Dictionaries for Japanese-English translation: EDICT, EDR JE Dict, EDR JE Technical, ATOK, Translation pairs from Yomiuri parallel corpus Chinese/Hongkong names of famous persons

Japanese–English: Error Analysis

- **Missing translations of proper nouns**

  Topic 10: 胡錦涛(Hu JinTao)

  Topic 22: 起亜(Kia)

- **Missing multi-word terms because of stop words**

  Topic 20: 西暦2000年問題(Y2K problem)

  ⇒ 西暦(A.D.), 2000 (問題 is a stop word)

- **Improper low distribution translations**

  Topic 37: 対応(correspondence)

  ⇒ "対応" has many translations and they contain improper and low distribution word, such as "pentagon".

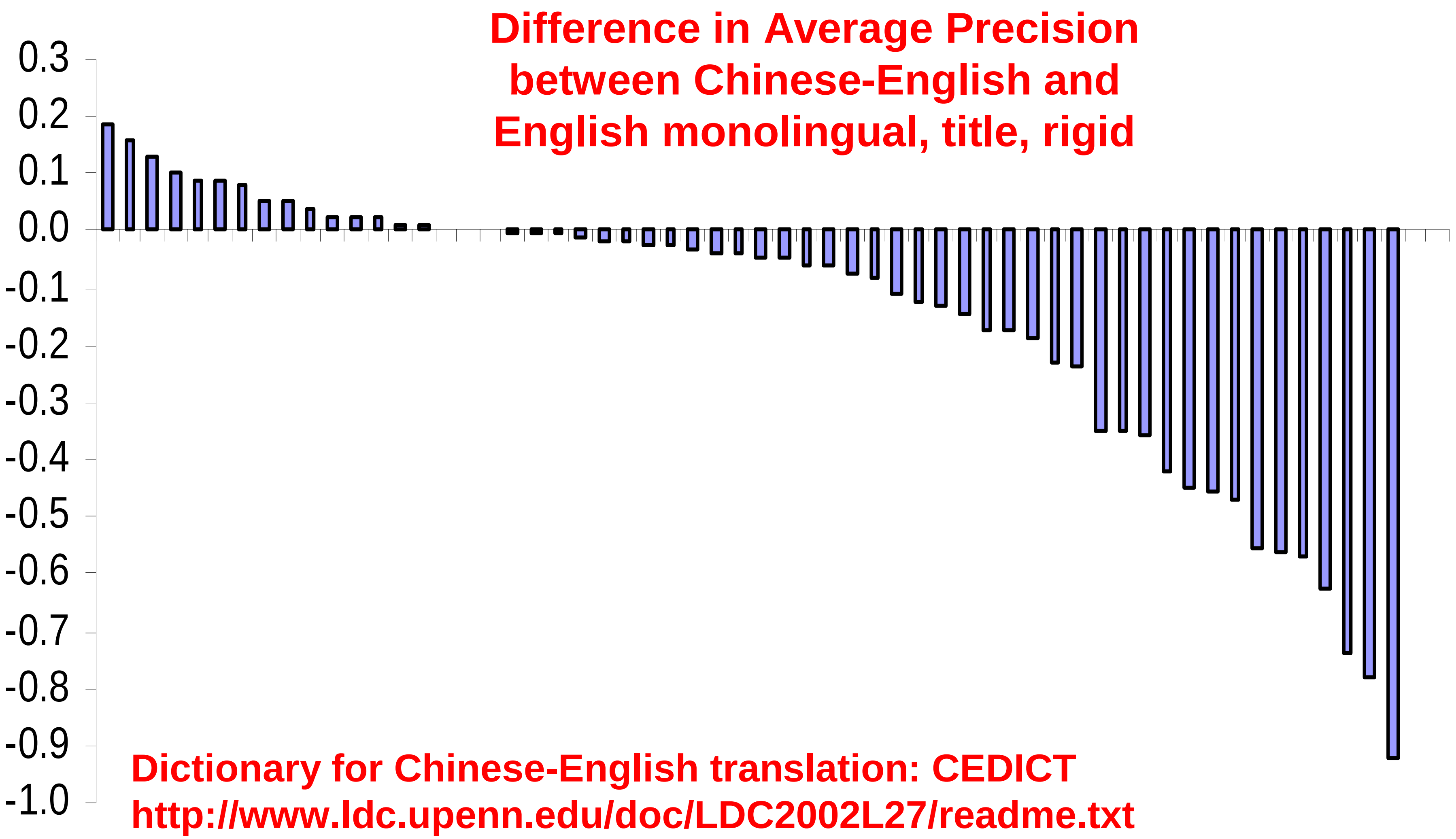
- **Using only noun phrases in retrieval**

  Topic 43: デリバティブ(derivative)

  ⇒ "derivative" is parsed as an adjective, so it isn't used in retrieval.

- **Insufficient tuning of weighting and scoring algorithms. The higher the number of expansion terms, the more influential they become.**

Chinese–English Performance



Difference in Average Precision between Chinese-English and English monolingual, title, rigid

Dictionary for Chinese-English translation: CEDICT
http://www.ldc.upenn.edu/doc/LDC2002L27/readme.txt

Chinese–English: Error Analysis

- **Improper segmentation of words**

  Topic 43: 衍生性商品 (derivative)

  ⇒ 衍生 (derivative) 性 (sex) 商品 (commodity)

- **Improper segmentation of names**

  Topic 2: 约翰走路 (Jonnie Walker)

  ⇒ 约 (partake) 翰 (pen)走 (walk) 路 (path)

  Topic 4: 佛罗伦斯·葛瑞菲丝．乔纳，花蝴蝶 (Florence Griffith Joyner, FloJo)

  ⇒ 佛 (buddha) 罗 (surname) 伦 (human relationship) 葛 (coarse grass linen) 瑞 (auspicious) 菲 (Philipines) 丝 (silk) 乔 (tall) 纳 (pay) 花 (blossom) 蝴蝶 (butterfly)

  Topic 8: 威而钢 (Viagra) → 威 (power) 钢 (steel)

  Topic 10: 胡锦涛 (Hu Jintao) → 胡 (beard) 锦 (bright) 涛 (big wave)

  Topic 12: 黑 泽明 (Akira Kurosawa) → 黑 (black) 泽 (beneficence) 明 (bright)

- **Absence of disambiguation causes unbalanced translations**

Summary

- Our systems have demonstrated stable and good performance for English and Japanese monolingual IR.
- Chinese word segmentation and lexicon coverage need improvement for better performance.
- Missing translation of proper names and terminology is still a big problem in CLIR.
- Our ongoing work focuses on automatic name translation and transliteration
  (Qu, Grefenstette, Evans 2003;
  Qu & Grefenstette 2004)

The End