CJK Searching and Discovery: Recent Developments and Future Directions

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Introduction

- Summon is a multilingual search engine which supports language-specific search features (*native search features*) for 17 languages including Chinese, Japanese and Korean (CJK)
- Summon clients can access content in multiple languages; native search features are applied according to language of record

Challenges with CJK Searching and Discovery

- Lack of word boundary marks
  - Word boundaries are not marked with white spaces in Chinese and Japanese. In Korean, white spaces often mark larger syntactic units than words. (e.g., noun + postposition)
  - Examples:
    - Chinese: 科学首先指**对应**于自然**领**域的知**识**，**经扩**展、引用至社会、思**维**等**领**域，如社会学。
    - Japanese: 科学という語は文脈に応じて多様な意味をもつが、おおむね以下のような意味で用いられている。
    - Korean: 과학은 사물의 구조·성질·법칙 등을 관찰 가능한 방법으로 얻어진 체계적·이론적인 지식의 체계를 말한다.

Challenges with CJK Searching and Discovery (cont'd)

- Character variations – Same words can be spelled using different characters
  - Traditional vs. simplified Chinese characters
    - 科学 ("science" simplified) vs. 科學 ("science" traditional)
  - Chinese vs. Japanese variations
    - 經 (Chinese traditional) vs. 经 (Chinese simplified) vs. 経 (Japanese)
  - Other character variations
    - 研 (U+7814) vs. 研 (U+784F)
    - 拼 (U+62FC) vs. 拚 (U+62DA)
    - 郎 (U+90DE) vs. 郎 (U+90CE)

Challenges with CJK Searching and Discovery (cont'd)

- Other writing variations (spelling of foreign loan words, synonyms, etc.)
  - Japanese: コンピューター vs. コンピュータ ("computer")
  - Japanese: ヴァージニア vs. バージニア ("Virginia")
  - Chinese: 公交车 ("bus" – Mainland China) vs. 巴士 ("bus" – Singapore, Taiwan, Hong Kong, Macau)
- Use of mixed scripts and alternate scripts
  - Japanese mixed scripts: Kanji(漢字) + Katakana(カタカナ) + Hiragana(ひらがな)
  - Korean mixed scripts: Hanja(漢字) + Hangul(한글)
  - Romanization: Pinyin (Chinese), Romaji (Japanese)

Technology Advances in Recent (Past 10-15) Years

- Improved Unicode support by operating systems and web browsers
  - No/little need to deal with character encoding issues
- Availability of powerful open source search platforms, such as Solr and Elastic Search
  - Allows adding our own new features and improvements as plugins
- Advances in Natural Language Processing (NLP) research and availability of open source software
  - Chinese Word Segmentation
  - Japanese and Korean Morphological Analysis
  - And more

Multilingual Search Engine and Relevance

- Relevance: "*how well a retrieved document or set of documents meets the information need of the user.* "
- (Within-language) relevance
  - Improve discoverability (*recall*) of items
  - Maintain high *precision*, especially among top ranked results
- Across-language relevance
  - Example: searching for "心理学" could match Chinese, Japanese or Korean documents -> we need to ensure results from languages other than user's primary language do not dominate top results

CJK Word Segmentation and Morphological Analysis

- Chinese:
  - Example: 梵文基础读本 -> 梵文 (“Sanskrit”) + 基础 (“basic”) + 读本 (“reader”)
- Japanese:
  - Example: サクラを歌った -> サクラ (noun: “Sakura”) + を (postposition) + 歌う (verb: “sing”)
- Korean:
  - Example: 시애틀에서 -> 시애틀 (“Seattle”) + 에서 (“from”)

- Alternate approach
  - Tokenize every character (unigram tokenization)
  - Example: 梵文基础读本 ->梵+文+基+础+读
  - Better for *recall*, but not for *precision*
  - In Summon, we use this to complement word segmentation for certain important fields such as Title

CJK Phrase Matching vs Non-phrase Matching

- Example: q= 梵文**读**本 (梵文 “Sanskrit” + **读**本 “reader”)
  - Option 1: return only exact phrase matches to “梵文**读**本”
  - Option 2: return matches to both “梵文**读**本” and non-phrase matches such as “梵文基**础读**本” (梵文 “Sanskrit” + 基础 “basic” + **读**本 “reader”)
  - Option 3: same as Option 2, but boost relevance ranking/scores of exact phrase matches over non-phrase matches => *best approach*

CJK Character Normalization

- Chinese traditional vs. simplified characters
  - By normalizing characters at index time and query time, we can make them *cross-searchable*
  - Example:
    - Chinese: 科學 (“science” traditional) -> 科学 (simplified)
    - Chinese: 經濟 (“economy” traditional) -> 经济 (simplified)

- Other character variations:
  - Examples:
    - Japanese: 经济 (Chinese simplified) -> 経済 (Japanese)
    - Japanese: 横濱 (Japanese archaic) -> 横浜 (Japanese modern)
    - Japanese: ｱｲｳｴｵ (half-width) -> ア イ ウ エ オ (full-width)

Searching by Alternate Scripts of CJK

- Use of a morphological analyzer or dictionary-base converter allows supporting searching by alternate scripts
- Chinese: searching for Hanzi using Pinyin
  - Example: q=beijing daxue (“Peking University” Pinyin) => matches “北京大学” (“Peking University” Hanzi)
- Japanese: searching for Kanji or Katakana using Hiragana
  - Example: q=けいざいがく (“economics” Hiragana) => matches “経済学” (“economics” Kanji)
- Korean: searching for Hanja using Hangul
  - Example: q=해외 (”overseas” Hangul) => matches “海外” (”overseas” Hanja)

Verbatim Match Boosting for Better Precision

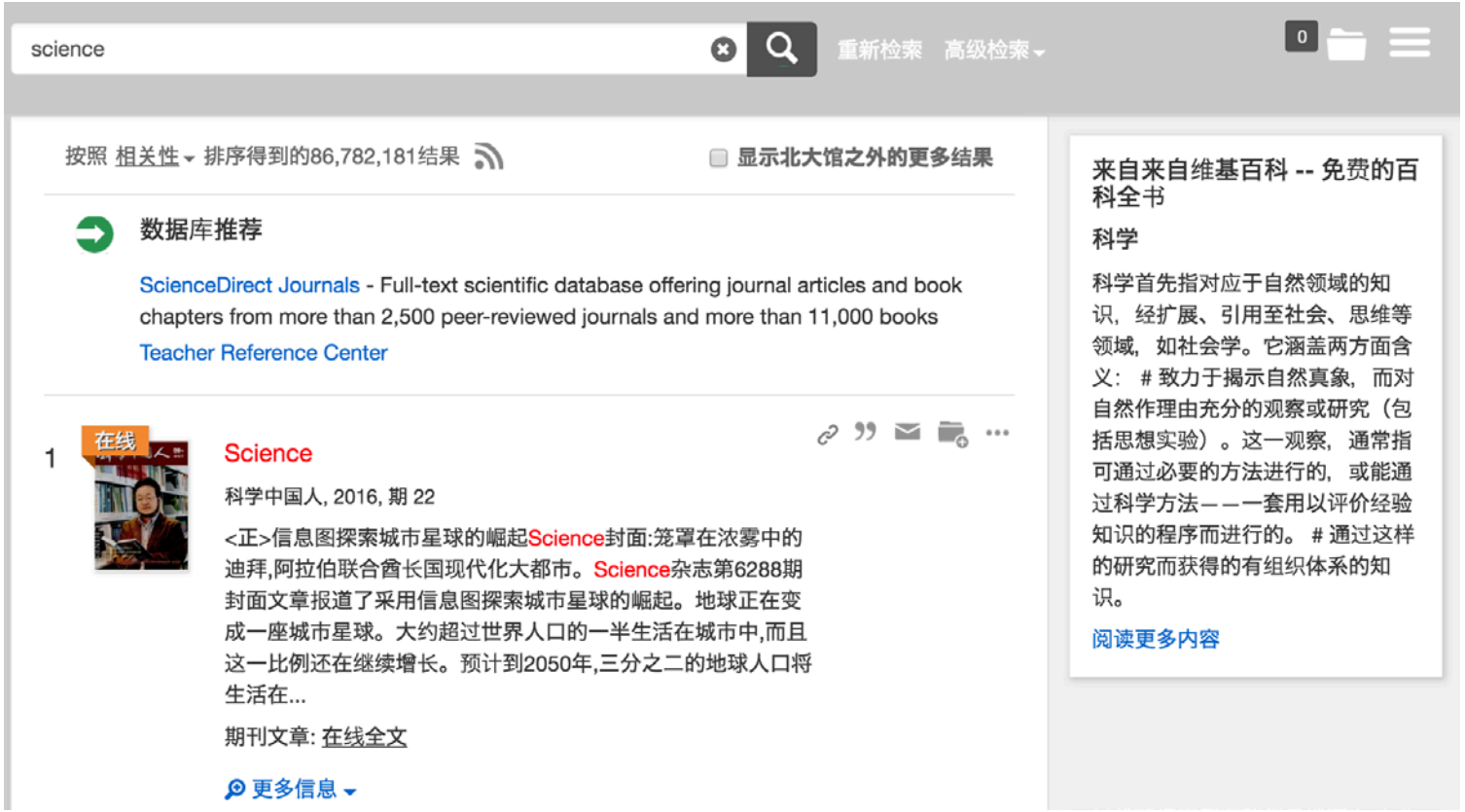
- Approaches such as character normalization and synonym mappings expend search results so that more items are discovered.
- However, this could cause non-relevant results being returned.
- Solution: “Verbatim Match Boosting” is an approach which boosts rankings/scores of items where the matching between the query and indexed string are verbatim.
  - Example: If query=科學 (“science” traditional), a match with “科學” gets a higher score than a match with “科学” (“science” simplified) *if everything else is equal.*

Search Suggestions for CJK – Did You Mean …?

- CJK supporting Search Suggestion feature based on language-specific dictionaries
- Example: q=山山大学 (non-existent/misspelled university name)
  - From Chinese UI: Summon suggests “山东大学” (“Shandong University” – existing university in China) using Chinese dictionary
  - From Japanese UI: Summon suggests “山形大学” (“Yamagata University” – existing university in Japan) using Japanese dictionary

More Advanced CJK Discovery Features

- Topic/subject exploration



Future Directions – from Multilingual Search to Multilingual Discovery

- Feedback from native-speakers is crucial in improving CJK search features and relevance
- Keeping abreast of latest technologies in Natural Language Processing (Information Extraction, Machine Translation, etc.) technologies for CJK languages
- Ideas for more innovative discovery features for all languages including CJK – e.g., expand metadata using NLP technologies, more advanced topic/subject/concept exploration features, query expansions, query suggestions, etc.

THANK YOU

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