Outline

• Problem Statement
  – Best effort retrieval vs automated reformulation
• Query Evaluation Architecture
• Query Understanding Models
  – Data Sources
Standard IR Assumptions

• Queries are well-formed expressions of intent
  – Best effort response to the query as given

• Users will reformulate
  – If results do not meet information need

• Actually, queries often contain errors
  – Misspelling
  – Incorrect terms

• Users can’t reformulate if they don’t understand what’s wrong
  – Miss good content
  – Dead ends
Problem Definitions

• Best Effort Retrieval
  – Find the most relevant results for the user query
    • Segmentation
    • Stemming/Synonym expansion
    • Term deletion

• Automated Query Reformulation
  – Modify the user query to produce more relevant results for the inferred intent
    • Spell correction
    • Term deletion
Spelling Correction

![Bing search results for 'blare house'](https://www.bing.com/search?q=blare+house)

**Welcome to Blair House - Home Page**

Blair House is the official state guest house for the President of the United States. It is located at 1651-1653 Pennsylvania Avenue NW in Washington, D.C., opposite the Old...

**Welcome to Blair House - Home Page**

Browse the guestbook: Visit specific rooms: From the time Francis Preston Blair and Eliza Blair moved into their new home, it was a politically significant address.

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Recourse Link
Stemming

Equivalent Forms

Blended Results
Abbreviations

Federated Results

Term Expansion
Term Relaxation

Key term extraction

Incorrect intent
Term Relaxation

Incorrect Terminology

Related searches:
- Bowker's test
- Change tutorial
- What is a diploid chromosome
- What is a diploid
- Bowker's test tutorial
- Bowker's test of change tutorial
- Diploid chromosome
- Diploid

Relaxed Query

Related searches:
- Bowker test
- Bowker's test of change tutorial
- Bowker's test
- McNemar's test
- Kappa test
- Bowker
- Bowker test
- Bowker test tutorial
Key Concepts

• Win/Loss ratios
  – Automated reformulations are errorful
    • Wins are queries whose results improve
    • Losses are queries whose results degrade
  – Related to precision
    • But not all valid reformulations change results

• Pre vs Post result analysis
  – Query alternatives generated pre-results
  – Blending decisions are post results
Matching and Ranking

• Sequence of select, rank, prune steps
• L0: Boolean logic
• L1: IR score
• L2/L3/L4: Machine learned

Learning to Rank Using Gradient Descent, Burges et al., ICML 2005
Query Annotation

- NLP query annotation
  - Offline analysis
- Ambiguity preserving
  - Multiple interpretations
- Backend Independent
  - Shared
- Structure and Attributes
  - Syntax and semantics
Query Planning

\[
\{\text{un} \mid \text{“united nations”}\}\ \text{jobs} \rightarrow \\
\text{L3-merge(L2-rank([un jobs]),} \\
\text{L2-rank([“united nations” jobs])}
\]

or

\[
\{\text{un} \mid \text{“united nations”}\}\ \text{jobs} \rightarrow \\
\text{L3-cascade(threshold, L2-rank([un jobs]),} \\
\text{L2-rank([“united nations” jobs])}
\]
Design Considerations

• **Efficiency**
  – Query plan can generate multiple backend queries
    • Merged in L3
  – Some queries are cheaper than others
    • Query reduction can improve performance

• **Relevance**
  – L3 merging has maximal information
    • But is costly

• **Multiple query plan strategies**
  – Depending on query analysis confidence
Query Analysis Models

• Noisy Channel Model

\[
\text{arg max } \{ P(\text{rewrite} \mid \text{query}) \} = \\
\text{arg max } \{ P(\text{rewrite})P(\text{query} \mid \text{rewrite}) \}
\]

• Example: Spelling
  – Language Model: Likelihood of the correction
  – Translation Model: Likelihood of the error occurring
Language Models

• Based on Large-Scale Text Mining
  – Unigrams and N-grams
  – Probability of query term sequence
    • Favor queries seen before
    • Avoid nonsensical combinations

• 1T n-gram resource
  – Multi-Style Language Model for Web Scale Information Retrieval
    Wang et al., SIGIR 2010
  – SCOPE: Easy and Efficient Parallel Processing of Massive Data Sets
    Chaiken et al., PVLDB 2008
Translation Models

• Training set of aligned pairs
  – E.g. misspelling/correction; surface/stemmed

• Query log analysis
  – Session reformulation → associated queries
  – Co-click → associated queries
  – Manual Annotation

• Many application-specific models
  – Random Walks on the Click Graph
    Craswell et al., SIGIR 2007
  – Context sensitive synonym discovery for web search queries
    Wei et al., CIKM 2009
  – Context sensitive stemming for web search
    Peng et al, SIGIR 2007
Summary

• Query Understanding is critical to Web Search
  – Affects most queries
  – Can radically improve results

• Trade-off between relevance and efficiency
  – Rewrites can be costly
  – Win/loss ratio is the key metric

• Especially important for tail queries
  – No meta-data to guide matching and ranking