CHIP Internship Report

DynaMedex Information Retrieval

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Agenda

• Intro to DynaMedex
• Information Retrieval Overview
• DynaMedex Search Ecosystem
• DynaMedex Search Functionality Analysis Project
DynaMedex seamlessly combines the clinical expertise and extensive, curated disease content of EBSCO’s DynaMed, with the comprehensive depth and breadth of drug information of IBM’s Micromedex.
DynaMedex Intended Users

- Physicians
- Pharmacists
- Nurse Practitioners
- Other Clinicians
DynaMedex Business Environment – Search Function

Regulatory fit – how well the organization adopts to and complies with laws and regulations.

Economic fit – how well the organization fits within the larger economy.

Market fit – how well the organization’s products or services suit the market(s) it is pursuing.

Competitive fit – how effective the organization is in its market compared to its competitors.
Key Performance Indicator (KPI) – Search Functionality

Key Performance Indicators (KPIs) are the key factors that enable (or prevent) company outcomes (i.e. increased profit) from being achieved.

KPIs provide immediate feedback on what is happening currently and provide early warnings of emerging results.

Evaluating the status of DynaMedex’s search functionality is critical to affecting EBSCO’s growth now and in the future.
What is Information Retrieval?³

Information Retrieval (IR)

Finding material (usually documents) of an unstructured nature (usually text) that satisfies an information need from within large collections (usually stored on computers)
Inverted Index

For each term, we have a list that records which documents the term occurs in.

Each term and associated document IDs are conventionally called a posting.

The list is then called a postings list (or inverted list) and all the posting lists taken together are referred to as the postings.

- **Cardiac**: 1, 3, 5, 23, 45, 90
- **Covid**: 6, 22, 24, 30, 31, 60
- **Hypertension**: 1, 3, 8, 9, 23, 45
Ad hoc retrieval task terms

- Information need: the **topic** about which the user desires to know more
- Query: what the user **conveys to the computer** in an attempt to communicate the information need
- Relevance: document that the **user perceives as containing information of value** with respect to their personal information need
Assessing Effectiveness of an IR System

Precision
What fraction of the returned results are relevant to the information need?

Recall
What fraction of the relevant documents in the collection were returned by the system?
Search Ecosystem

- Content Transformation
- Semantic Enrichment
- Indexing
- Search Prep
- Search Runtime
- Knowledge Graph
- User Feedback
- Expert Feedback
- Medical Search Platform
- Query Intelligence
- Click Thru Rates
- Conversion Rates
- A/B Testing
- Judgment Lists
- Graph Curation
- Surveys & Experiments
Query Intelligence

QUERY INTELLIGENCE

BREAST CANCER

SEMANTIC RECOMMENDATION

CLICK-THRU RECOMMENDATION

EBSCO
Search Feedback Project
Background

- Improving search is a continuous quality improvement project for EBSCO Clinical Decisions.
- Frontline users are asked to complete scripted and freeform searches in both products.
- Goal: Gather and analyze feedback from frontline users to understand current state search performance and make recommendations to improve results so frontline users can find the answers to their clinical questions as quickly as possible.
Using standardized, structured data collection form, participants were asked to conduct 50 prescriptive and 10 freeform searches

Prescriptive Searches

- Users entered pre-specified search terms in both DMX and Competitor product (n=50)
  - Common disease or drug acronyms, short form searches, long form searches, and study name acronyms
  - Search terms proposed from historical DynaMed search logs and reviewed by SQUINT SMEs
- For each application, participants were asked the following
  - Evaluate the list of search results
  - Rank top 10 search results in each (scale 1-5)
  - State which result set they preferred/why
  - Comment on how search could be improved for DMX

Freeform Searches

Think of patient or clinical question you need to answer. Describe the search term(s) you entered to answer the question. Evaluate search results in both applications (n=10)
11 physicians were recruited; 8 completed survey

<table>
<thead>
<tr>
<th>Level of experience</th>
<th>Practice Setting</th>
<th>DM/X</th>
<th>Competitor Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Attending Family Medicine/Group practice</td>
<td>Experienced</td>
<td>Experienced</td>
</tr>
<tr>
<td>2</td>
<td>Fellow, Pulm/CC Academic medical center</td>
<td>None</td>
<td>3+ years</td>
</tr>
<tr>
<td>3</td>
<td>Resident Family Medicine (ambulatory, hospital)</td>
<td>None</td>
<td>3+ years</td>
</tr>
<tr>
<td>4</td>
<td>Resident Family Medicine (ambulatory)</td>
<td>None</td>
<td>3+ years</td>
</tr>
<tr>
<td>5</td>
<td>Resident Community hospital</td>
<td>&lt;6 months</td>
<td>3+ years</td>
</tr>
<tr>
<td>6</td>
<td>Attending Academic medical center</td>
<td>1-3 years experience MDX; rarely uses DM/X</td>
<td>3+ years</td>
</tr>
<tr>
<td>7</td>
<td>Attending Family Medicine</td>
<td>3+ years</td>
<td>3+ years</td>
</tr>
<tr>
<td>8</td>
<td>Attending Family Medicine, large hospital system</td>
<td>3+ years experience DM; none for MDX</td>
<td>3+ years</td>
</tr>
</tbody>
</table>
Prescriptive Search Results
When asked directly, participants preferred market competitor compared to DynaMedex (DMX) for all prescriptive searches.

"Which search result do you prefer?"

<table>
<thead>
<tr>
<th></th>
<th>DMX</th>
<th>Competitor</th>
<th>Tie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference count</td>
<td>30%</td>
<td>42%</td>
<td>28%</td>
</tr>
</tbody>
</table>

- 5- great; 4- good; 3- neutral; 2- not good enough; 1- poor
Subgroup analysis: DMX and Competitor performed equally on Acronyms

9 disease (e.g., COPD, DVT, TORCH) and 3 drug (K2, Fen fen, BCP)
DISEASE ACRONYMS

<table>
<thead>
<tr>
<th>Disease Acronym</th>
<th>DMX</th>
<th>Competitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>copd</td>
<td>4.9</td>
<td>4.5</td>
</tr>
<tr>
<td>dvt</td>
<td>4.5</td>
<td>4.1</td>
</tr>
<tr>
<td>siadh</td>
<td>3.4</td>
<td>4.5</td>
</tr>
<tr>
<td>aki</td>
<td>4.3</td>
<td>4.4</td>
</tr>
<tr>
<td>afib</td>
<td>4.8</td>
<td>4.1</td>
</tr>
<tr>
<td>tavr</td>
<td>3.8</td>
<td>4.4</td>
</tr>
<tr>
<td>torch</td>
<td>3.4</td>
<td>3.4</td>
</tr>
<tr>
<td>aiha</td>
<td>4.9</td>
<td>4</td>
</tr>
<tr>
<td>pals</td>
<td>2.9</td>
<td>4.6</td>
</tr>
</tbody>
</table>
DRUG ACRONYMS

<table>
<thead>
<tr>
<th></th>
<th>DMX</th>
<th>Competitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>K2</td>
<td>2.8</td>
<td>4</td>
</tr>
<tr>
<td>fen fen</td>
<td>3.6</td>
<td>2.4</td>
</tr>
<tr>
<td>BCP</td>
<td>4.1</td>
<td>4.4</td>
</tr>
</tbody>
</table>

K2 | fen fen | BCP |
Subgroup analysis: In almost 60% of cases, search results for study name acronyms were ranked the same in both DMX and Competitor, although in majority of remaining cases, participants preferred Competitor.
<table>
<thead>
<tr>
<th>STUDY NAME ACRONYMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAST</td>
</tr>
<tr>
<td>DMX</td>
</tr>
<tr>
<td>Competitor</td>
</tr>
</tbody>
</table>
Subgroup analysis: DMX outperformed Competitor for short form (i.e., one word) searches

11 disease (e.g., hypertension, pancreatitis), 3 drug (e.g., Augmentin, Wellbutrin, clindamycin)
SHORT FORM SEARCH

<table>
<thead>
<tr>
<th>Condition</th>
<th>DMX</th>
<th>Competitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>4.9</td>
<td>4.9</td>
</tr>
<tr>
<td>Depression</td>
<td>4.5</td>
<td>4.25</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>4.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Influenza</td>
<td>5</td>
<td>4.8</td>
</tr>
<tr>
<td>Shingles</td>
<td>4.6</td>
<td>4.9</td>
</tr>
<tr>
<td>Hypocalcemia</td>
<td>4.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Hyperthyroidism</td>
<td>4.4</td>
<td>4.3</td>
</tr>
<tr>
<td>Type 2 Diabetes</td>
<td>4.4</td>
<td>4.4</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>3.4</td>
<td>3.9</td>
</tr>
<tr>
<td>Bronchitis</td>
<td>4.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Psoriasis</td>
<td>3.8</td>
<td>4.4</td>
</tr>
</tbody>
</table>
Subgroup analysis: Competitor outperformed DMX on long form (i.e., multi-word) searches

N=14 (e.g., fungal infections in knee replacement; Cushing syndrome diagnostic approach)
<table>
<thead>
<tr>
<th>Topic</th>
<th>DMX</th>
<th>Competitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differential diagnosis of abdominal pain</td>
<td>3.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Adhesive capsulitis of the shoulder</td>
<td>3.8</td>
<td>4.8</td>
</tr>
<tr>
<td>Antioxidants for cardiovascular disease prevention</td>
<td>3.7</td>
<td>4.5</td>
</tr>
<tr>
<td>Bisphosphonates to treat osteoporosis</td>
<td>4.8</td>
<td>4.7</td>
</tr>
<tr>
<td>Cushing syndrome diagnostic approach</td>
<td>4</td>
<td>4.2</td>
</tr>
<tr>
<td>Eosinophilic esophagitis in adults</td>
<td>4.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Fungal infections in knee replacement</td>
<td>1</td>
<td>3.7</td>
</tr>
<tr>
<td>Hyperglycemic hyperosmolar states in adults</td>
<td>4.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Interferon beta for multiple sclerosis</td>
<td>4.2</td>
<td>4.7</td>
</tr>
<tr>
<td>Long term effects of alcohol abuse</td>
<td>2.3</td>
<td>2.7</td>
</tr>
<tr>
<td>Stress dose steroids</td>
<td>4.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Placenta accreta surgical management</td>
<td>4.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Lithium overdose</td>
<td>4.5</td>
<td>3.8</td>
</tr>
<tr>
<td>Surgery for locally advanced breast cancer</td>
<td>4.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>
Example: “Adhesive capsulitis shoulder”

• Pattern: <condition>
• Fairly common condition (aka frozen shoulder)

<table>
<thead>
<tr>
<th></th>
<th>DMX</th>
<th>UTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>4</td>
<td>4.7</td>
</tr>
<tr>
<td>range</td>
<td>3-5</td>
<td>4-5</td>
</tr>
<tr>
<td>mode</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

• Most relevant topic surfaced first in DMX
• Topics that followed were relevant; some irrelevant topics near the end
• Add context of diabetic patient?

Results based on 7 respondents
Some topics may be part of differential dx of shoulder pain

irrelevant
Freeform search
Results
When asked directly, participants preferred Competitor compared to DMX for freeform searches.
Comparison of overall mean scores – Acronyms, Short form search, and Long form search

**Acronyms**

- DMX: 4.7
- Competitor: 4.4

- \( n = 6 \)

**Short form search**

- DMX: 4.3
- Competitor: 4.7

- \( n = 6 \)

**Long form search**

- DMX: 3.7
- Competitor: 4.4

- \( n = 69 \)
Users tend to use long form queries for most of their searches

- Usually two or more words, often two or more concepts
  - e.g., premature atrial complex, basal cell carcinoma margin
- Most in point form, not sentence
  - e.g., occult hip fracture CT sensitivity
- Often 3 or more terms which limit DynaMed output
Examples of freeform searches

- Overactive bladder treatment
- SSRI taper
- Poison ivy treatment
- Diabetes medication GFR
  - what are GFR limits for each diabetes medications?
- Ober test
  - how do you do the test for IT band issues?
- Subclinical hyperthyroidism
  - mildly low TSH ➔ what is next best step of management
- Leukocytosis
  - Pt has leukocytosis w left shift and neutrophilic predominance; what’s the differential?
- TXA in PPH
  - Pt continued to have PPH after Pitocin, Cytotec and methergine; what’s the data behind TXA for management of PPH?
- Switching antidepressants
  - pt on Zoloft wants to switch to bupropion; what’s the best method to taper? Cross taper or direct switch?

Regular font indicates search terms entered; italicized font indicates clinical question/scenario
COMPARISON OF FREEFORM SEARCHES AGAINST SEARCH LOG

- New search (0 prior entries)
  - Ex: “ketamine refractory pain”
- 1-10 prior searches
  - Ex: “PTH ckd”
- 11-100 prior searches
  - Ex: “drug induced liver injury”
- 101-1000 prior searches
  - Ex: “insomnia treatment”
- 1000+ prior searches
  - Ex: “hyponatremia”

NEW AND 1-10 PRIOR SEARCHES COMPRISED ~60% OF FREE FORM SEARCHES
Comparison of overall means

Bar chart showing comparison between DMX and Competitor across different search categories:

- **New searches**: DMX 3.3, Competitor 4.1
- **1-10 searches**: DMX 4, Competitor 4.7
- **11-100 searches**: DMX 4.3, Competitor 4.5
- **101-1000 searches**: DMX 4.8, Competitor 4.8
- **1000+ searches**: DMX 5, Competitor 4
### Prescriptive long form searches – SWOT Analysis

| Strengths (S)                  | • Top result matches search.  
|                               | • Great range of results.  
|                               | • All relevant results.  |
| Weaknesses (W)                | • One exact result – sometimes related topics are important to users.  
|                               | • Yielding one unrelated result.  
|                               | • Unrelated entries later in the list.  |
| Opportunities (O)             | • Proximity weighing - a document is preferred to the extent that the query terms appear close to each other in the text  
|                               | • Biword indexes – Ex: cardiovascular prevention  |
| Threats (T)                   | • Brief excerpts in Competitor product explaining why the results appeared.  
|                               | • Narrow topics - DM may not have a lot of content to yield more relevant search results.  |
Conclusions

• Established current state baseline performance for DMX search as well as in comparison to main market competitor
• Overall, users preferred competitor for prescriptive searches
• Subgroup analysis:
  − DMX and Competitor approximately equal performance on *acronyms*
  − DMX slightly outperform Competitor on *short form searches*
  − Competitor outperforms DMX on *long form searches*
    • Majority of freeform searches were long form queries
  − Two applications were ranked equally for *study name acronyms* in ~60% of cases, although in remaining cases, participants preferred Competitor
Next steps

• Focus on long form searches
  − Opportunities to improve search query intelligence
    • Missed opportunities to surface topics
    • Adjust ranking
    • Minimize irrelevant topics
• Evaluate and close content gaps, as needed
• Revisit highlighting search terms in DMX
• Consider how to handle new searches (with 0 prior search log entries)
References


