Related Content Finder: A Search Engine that works!

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Abstract

Search has become indispensable in our electronic and networked virtual communities. This has led to a large compounded growth in the search product markets, where Google is very visible to the general market. The question being asked by many, “Are these search engines finding what people want?”. This presentation discusses this topic in the context of a relatively new search technology called the Relational Content Finder or RCF developed by my company Lawrence Technologies, LLC.

RCF is integrated into the Synthetix® products marketed by Syngence. Synthetix is fast becoming the dominate search product in their particular market segment of litigation support, since it has been integrated into most of the litigation document tool venders. The Synthetix customers are dominantly “tech-gnostic” lawyers and paralegals who demand easy to use yet reliable search technology, using “search by example”.

Outline

- Approaches to Search
- Full-Text Boolean Search
  - Optional, required, excluded terms
  - Divergence, convergence
  - Recall *versus* Precision
  - Boolean Search Problems
- Related Content Finder
  - Description of RCF approach
  - RCF scores and ranking
  - High recall *and* ranked precision
  - RCF advantages and disadvantages
  - RCF Application Scenarios
- Summary

Approaches to Search

- Attribute search (table of contents)
  - Format, keywords, metadata, status, etc
- Category search (indexes)
  - Use fields such as title, author, dates, etc
- Full-text Search (reading)
  - Boolean combinations of terms
- Concept Search (meaning)
  - Clustering, synonyms, natural language
- Search by Example (similarity)
  - Find similar documents
- Combinations of above

Full-Text Boolean Search

- ***Optional*** terms means logical OR
  - Example: termA termB termC
  - Means: OR(termA, termB, termC)
  - Produces: growing set size or *divergent*
- ***Required*** terms (“+”) means logical AND
  - Example: +termA +termB +termC
  - Means: AND(termA, termB, termC)
  - Produces: shrinking set size or *convergent*
- ***Excluded*** term (“–”) means logical NOT
  - Example: –termA +termB +termC
  - Means: AND(NOT(termA), termB, termC)
  - Produces: restricts to exclude terms

Divergent and Convergent

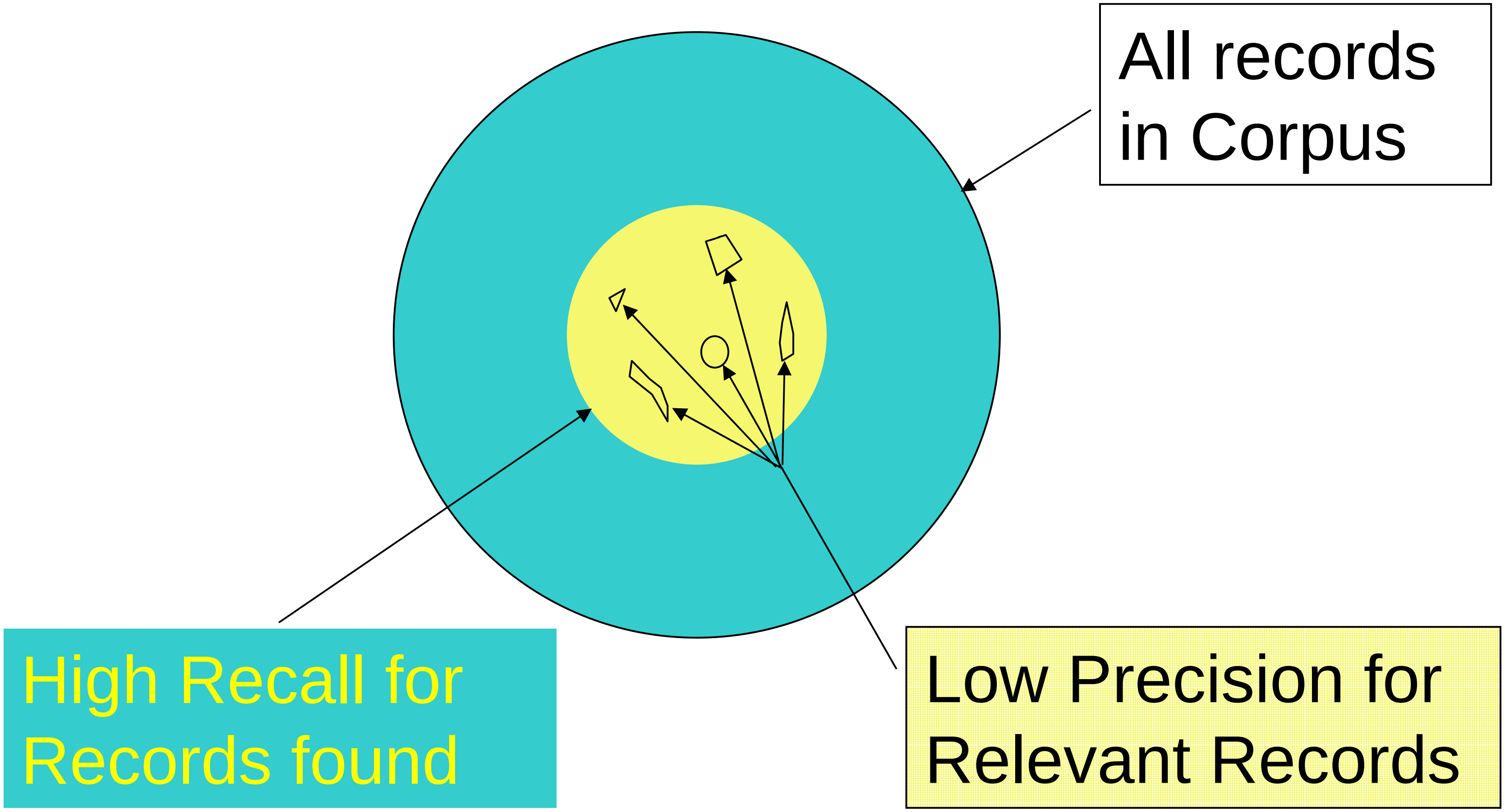
	Recall	Precision	Results
OR Logic	High	Low	Too many
AND Logic	Low	High	May miss

- *Recall* is the percentage of *relevant* records that are *located*.

- *Precision* is the percentage of *retrieved* records that are *relevant*.

Recall versus Precision

- ***Recall*** is the percentage of *relevant* records that are *located*.
- ***Precision*** is the percentage of *retrieved* records that are *relevant*.



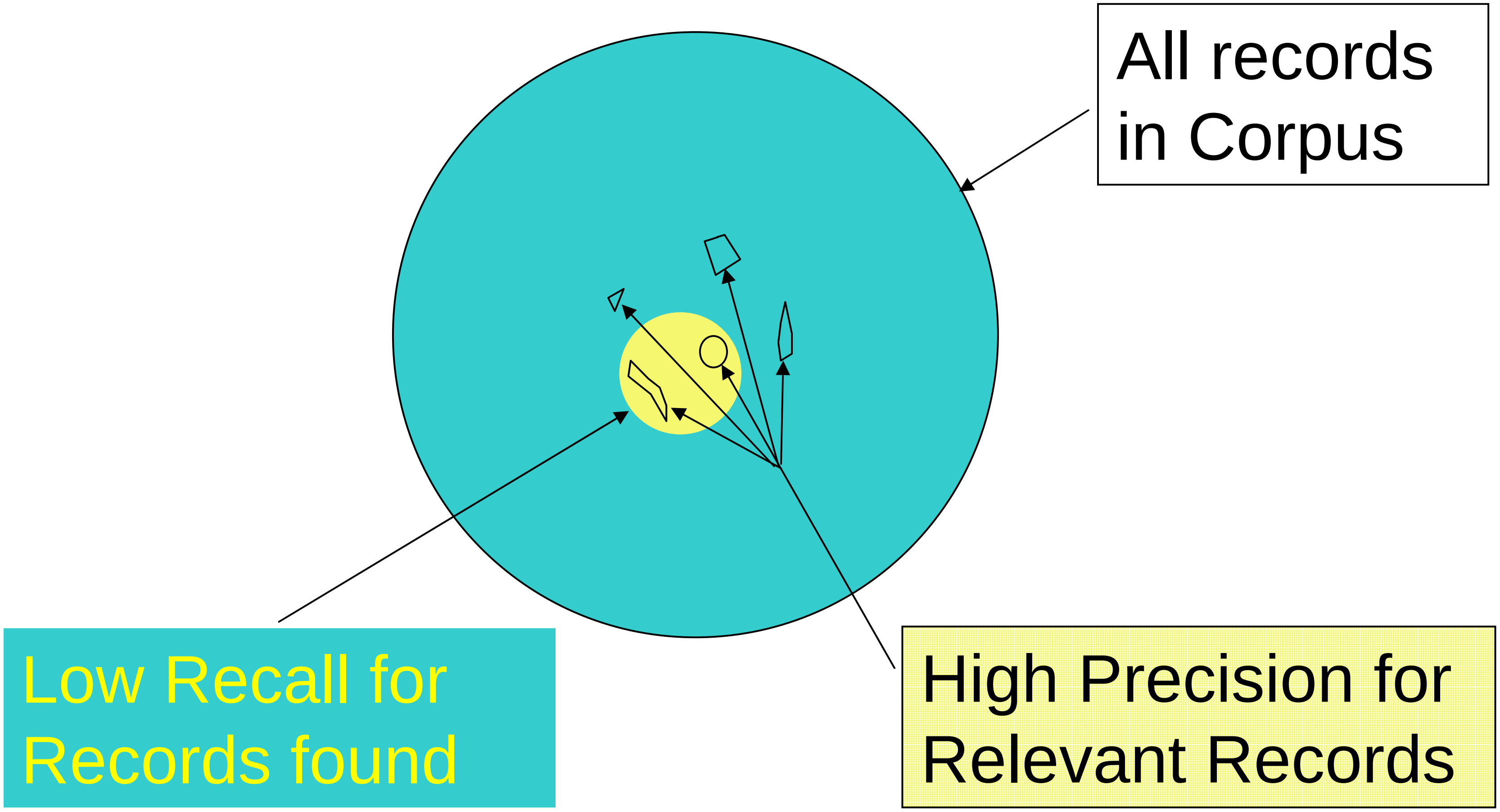
All records in Corpus

High Recall for Records found

Low Precision for Relevant Records

Recall versus Precision (cont)

- ***Recall*** is the percentage of *relevant* records that are *located*.
- ***Precision*** is the percentage of *retrieved* records that are *relevant*.



All records in Corpus

Low Recall for Records found

High Precision for Relevant Records

Boolean Search Problems

Blair & Maron: *Com. of the ACM*, Mar, ‘85

- *“An Evaluation of Retrieval Effectiveness for a Full-Text Document-Retrieval System”*
- Six-month study of full-text retrieval using a 350,000 page full text database
- *Users found less than 20% of relevant records*, even though believed results were good.
- User manually trades off recall versus precision
- User can't retrieve/find a known document

Related Content Finder

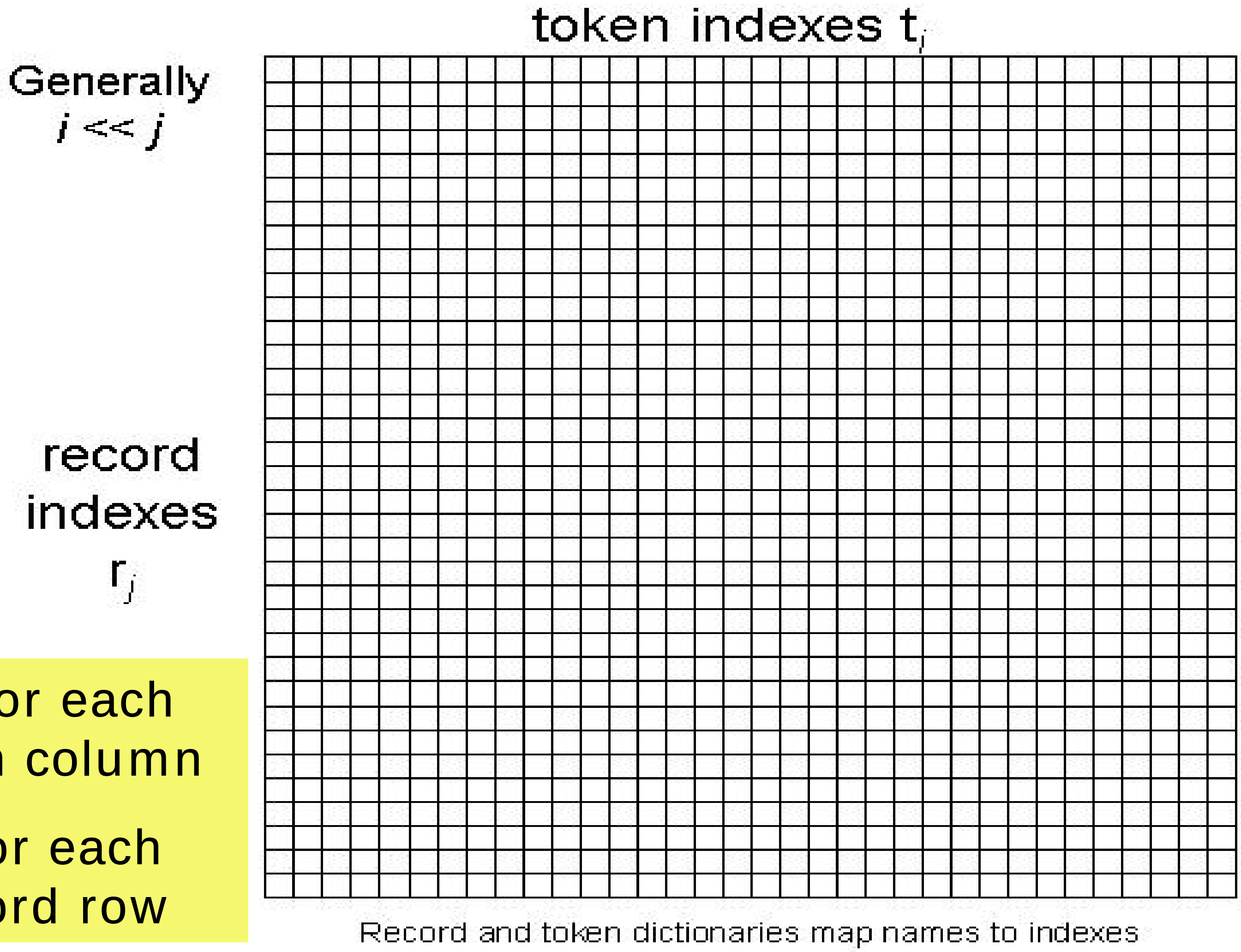
Approach:

- "Search by example" reinvents full-text
- Finds records "like" some example page
- Word count features act as fingerprint
- Scoring using information theory
- Ranking based on sorting record scores

Goals:

- High recall (all pages essentially have score)
- High precision (ranking of all records)

Search as Sparse Matrix

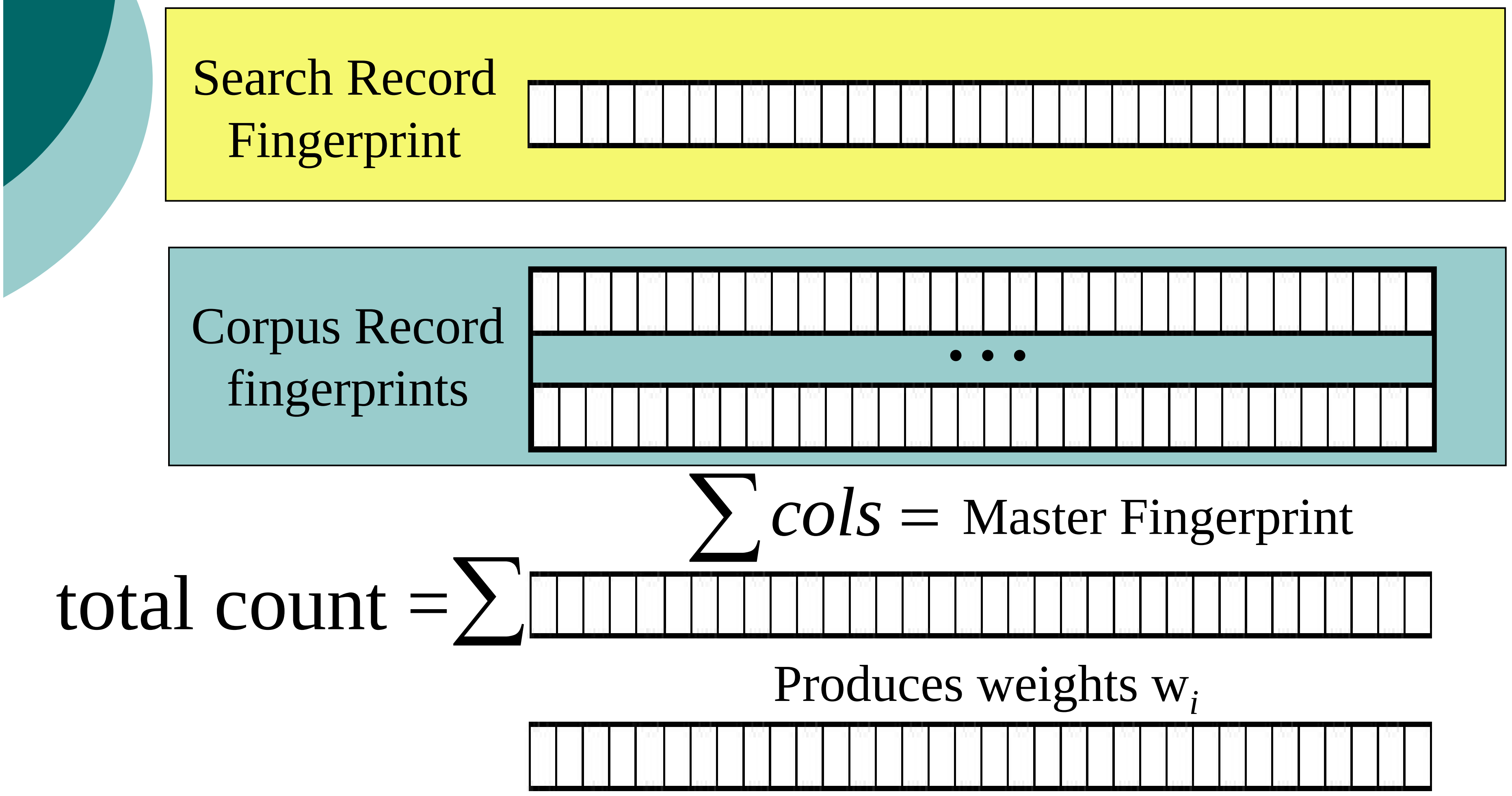


Entries c_{ji} are either a bit or count

w_i for each token column

s_j for each record row

Search as fingerprint match



Search Record Fingerprint

Corpus Record fingerprints

$\sum cols =$ Master Fingerprint

total count $=\sum$

Produces weights w_i

Huffman Weights for Tokens

$$w_i = -\log\left(\frac{Count_{token\ i}}{Total_{tokens}}\right) = \log(Total) - \log(Count_i)$$

For Count t_i	w_i with $\log_2$	w_i with $\log_{10}$
1 = $\log(10^6)$	19.93 bits	6.00
10	16.60 bits	5.00
100	13.28 bits	4.00
1000	9.96 bits	3.00
10000	6.64 bits	2.00
100000	3.32 bits	1.00
500000	1.00 bit	0.30

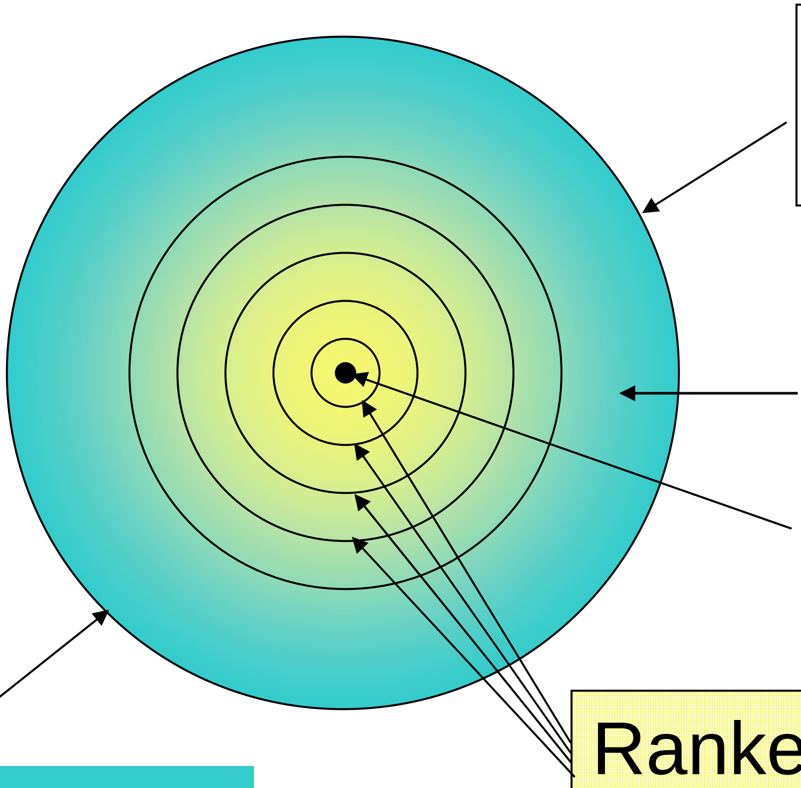
Computed for 1,000,000 total tokens

RCF Scoring and Ranking

- Compute score for search records based on counts and weights
- Compute scores for each record by computing distance to search record
- Normalize results so exact match (or perfect subset) scores 100%
- Sort records by score and display

*USPTO has allowed RCF scoring formulas

RCF Recall and Precision



All records in Corpus

Zero Scores

Exact Matches

All Records scored

Ranked Precision for Relevant Records

High Recall and Ranked Precision!!

Mimic Ranking with Boolean

$$
or\left(\begin{array}{l}
and\left(termA, termB, termC\right), \\
\\
and\left(termA, termB, -termC\right), \\
and\left(termA, -termB, termC\right), \\
or\ and\left(-termA, termB, termC\right), \\
\\
and\left(termA, -termB, -termC\right), \\
and\left(-termA, termB, -termC\right), \\
and\left(-termA, -termB, termC\right)
\end{array}\right)
\begin{array}{l}
\left\{3\ at\ a\ time\ means\ highest\ ranking\right\} \\
\\
\left\{\begin{array}{l} \\ 2\ at\ a\ time\ means\ medium\ ranking \\ \\ \end{array}\right\} \\
\\
\left\{\begin{array}{l} \\ 1\ at\ a\ time\ means\ lower\ ranking \\ \\ \end{array}\right\}
\end{array}
$$

Number of sub-expressions explodes with lots of terms!!

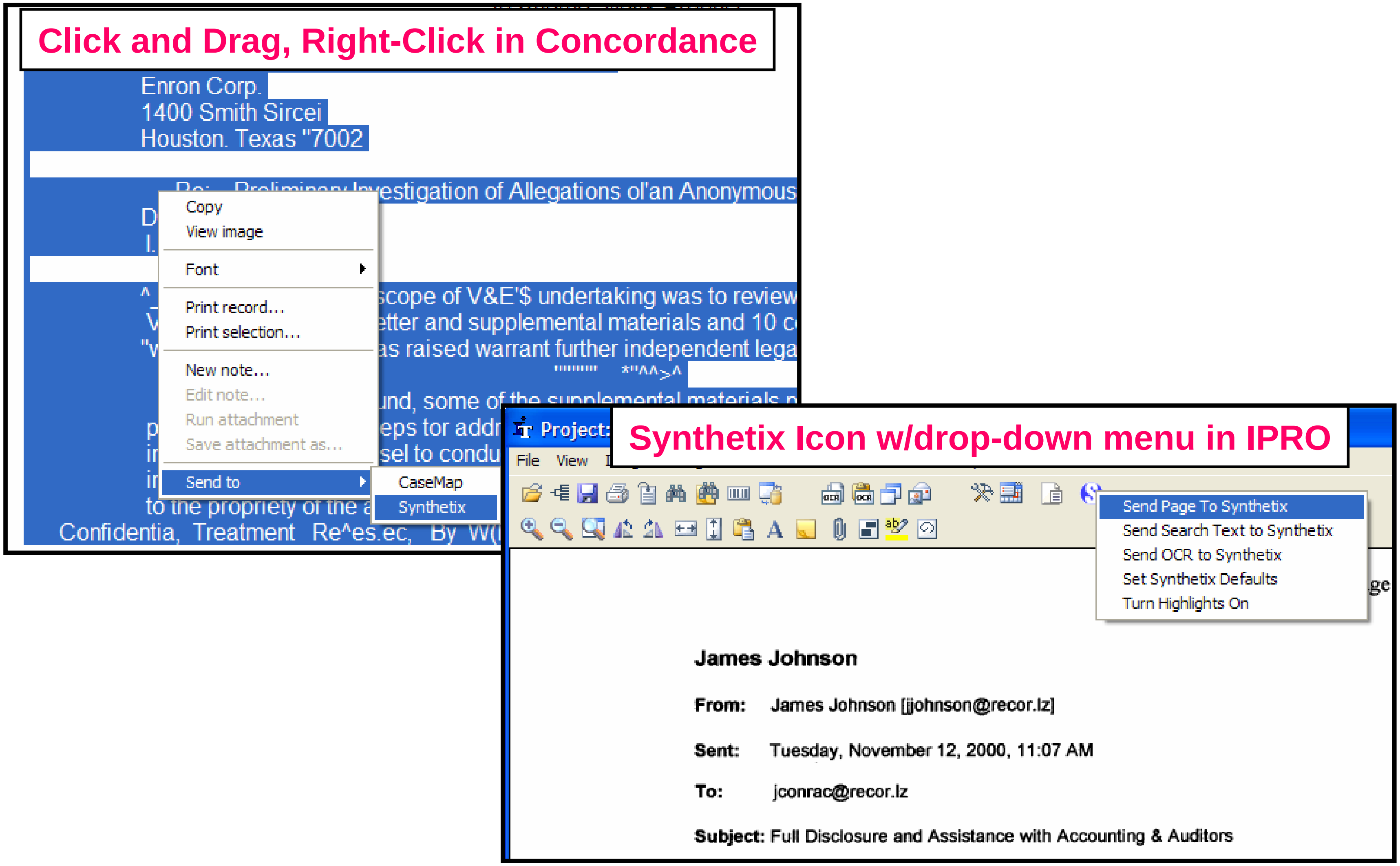
RCF Advantages/Disadvantages

- **Advantages**
  - Search engine adapts to user
  - Ease of use with minimal training (copy & paste)
  - Eliminates query restructuring to converge
  - Perfect matches/subsets rank 100% score
  - Not brittle due to versioning or noise
  - “Think it Find it” is Synthetix’s marketing slogan
- **Disadvantages**
  - Paradigm shift for user trained in Boolean search
  - Token counts rather than Boolean matrix
  - All records are scored (actually or conceptually)
  - More effort to score and rank
  - No numerical range searches

RCF Application Scenarios

- Litigation Support (Syngence.com)
  - “Find Similar” that actually works
  - Synthetic search (write the smoking gun)
  - Redaction detection (both sides)
  - Integrated with Concordance, IPRO, iCONECT, etc
- Search by example for online newspapers
- Plagiarize detection at universities
- Tokenized search in other markets
- Leverage professionals (with little training)
  - Lawyers
  - Doctors
  - Professors
  - Business executives
  - Geophysicists

Search by Example Interfaces



Click and Drag, Right-Click in Concordance

Enron Corp.
1400 Smith Sircei
Houston. Texas "7002

Re: Preliminary Investigation of Allegations ol'an Anonymous

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as raised warrant further independent lega
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to the propriety of the a
Confidentia, Treatment Re^es.ec, By W(

Synthetix Icon w/drop-down menu in IPRO

James Johnson

From: James Johnson [jjohnson@recor.lz]

Sent: Tuesday, November 12, 2000, 11:07 AM

To: jconrac@recor.lz

Subject: Full Disclosure and Assistance with Accounting & Auditors

RCF Summary

- RCF is novel “search by example”
- Linguistic feature based fingerprints
- Information theory based scoring
- Patented scoring ranking formula
- Finds perfect/near matches
- High Recall AND Ranked Precision
- Proven with 450 customers over 4 yrs.
- “Think it Find it”