Ubiquiti: Software for Data Analytics & Diagnostics

Applications in Healthcare

About Ubiquiti

Ubiquiti provides analytics, diagnostics and search software with customized domain-specific ontologies to help utilize domain-knowledge in a novel approach.

Both structured and unstructured data are handled (eg, narrative text with its semantics) – and Ubiquiti has a proven and strong track-record in delivering solutions.

Overview of Ubiquiti Inc.

- **Solutions: Data analysis software & associated services**
  - Encoding, data mining, reporting, alerting, forecasting, and diagnostics
  - Organizes and analyzes both structured and unstructured information in the context of domain-specific ontologies, with unique approach to text encoding & analysis
  - Modular – easily integrates with other software
- **Major Industries: Transportation and Healthcare**
  - Strong track record in transportation industry (automotive, fleets, aviation)
  - Now expanding into healthcare (payers, providers, pharmaceuticals)
- **Corporate Background: Successful and growing**
  - Operational since 2000, with offices in the US and overseas
  - Privately-held, self-funded, profitable
  - Enthusiastic customer references

Examples with Healthcare Ontologies

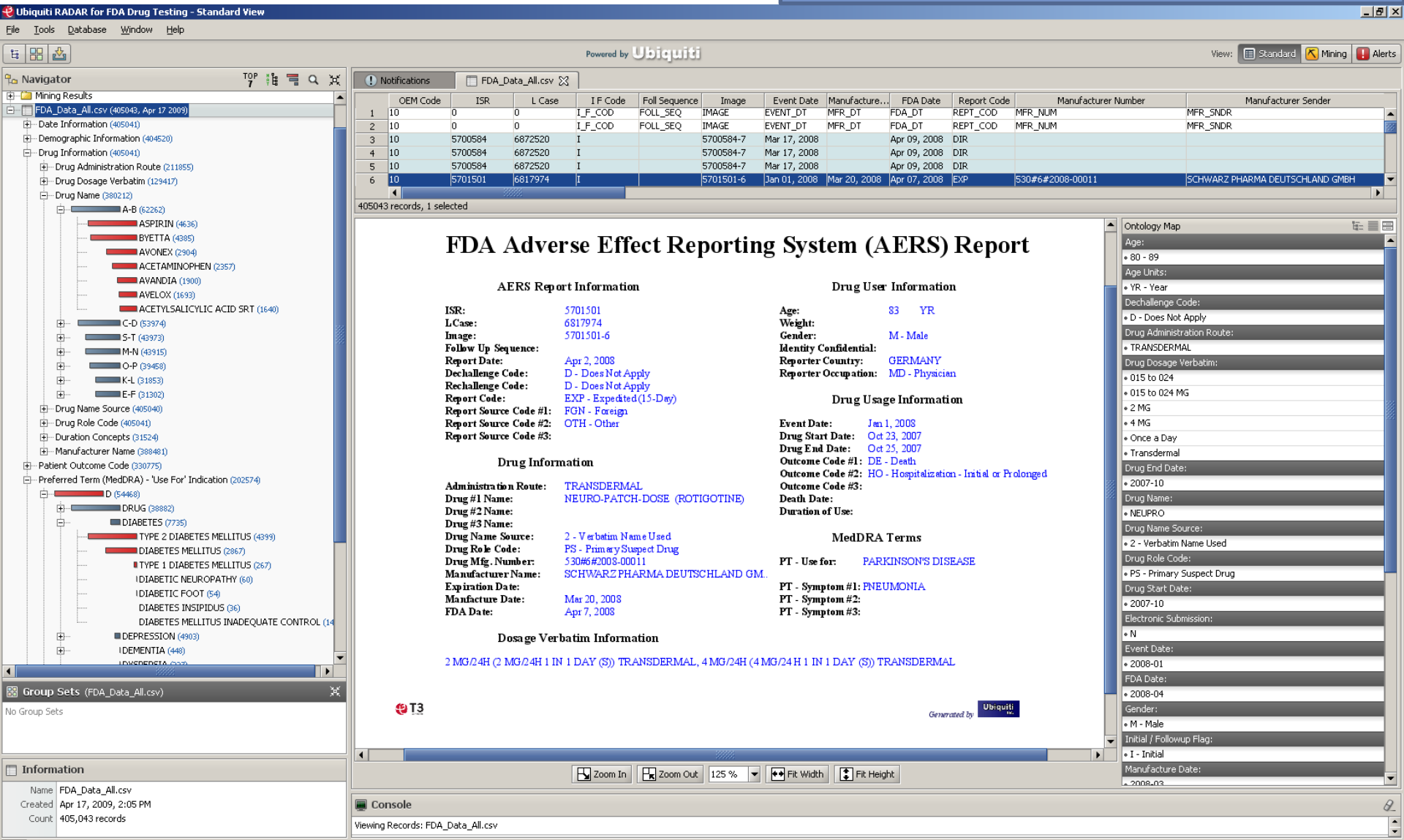
- Finding Previously Unknown but Useful Patterns in Data
  (eg, Mining of "Adverse Event Reports" for Pharma/FDA)
- Automating Flagging of Known Issues in Data
  (eg, Alerts for Claims Overpayments for Payers)
- Analytics, including text, on Patient Charts/EMRs
  (eg, Encoding, Outcomes Analysis etc. for Providers)
- Enabling Technologies: Ontologies & Text Analytics
- More Possibilities…1: Data-Driven Diagnostics
- More Possibilities…2: Generalized Models & Search

Examples …1: For Pharma-related Industry

- Surveillance applications, eg, for adverse events from pharmaceutical use; monitoring of epidemics; clustering, categorization, search, mining of clinical trial reports
- (Sub)sequence analyses & mining data for bio-informatics
- Group documents concerning compounds (eg, proteins), ailments (eg, 'flu) into functional, structural, ... ontologies
- Handling large quantities of sales, marketing, feedback information very rapidly
- Customized text technologies for pharmaceutical-specific issues, opportunities and problems

An AERS Data Record

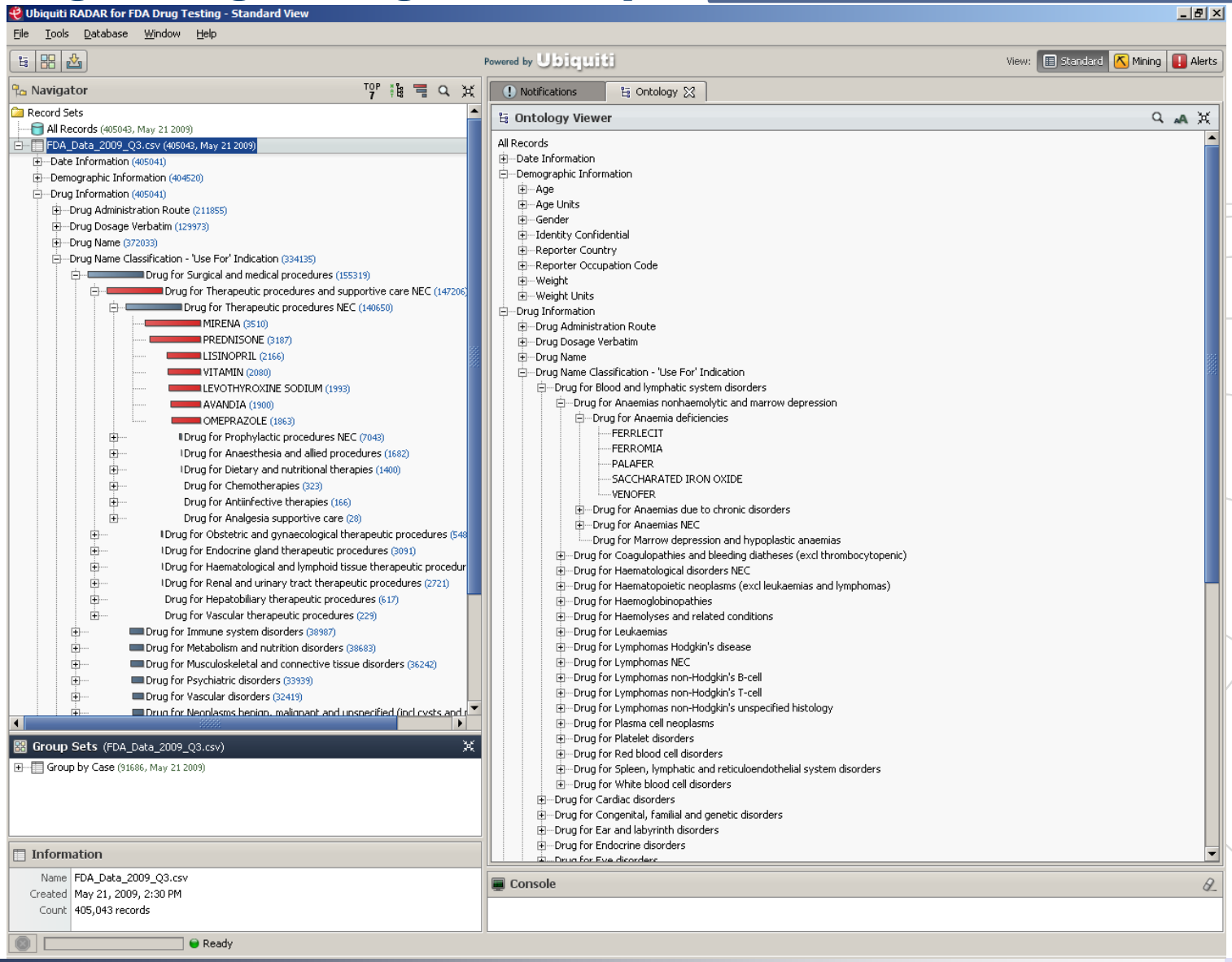
Used one calendar quarter of Adverse Events Reporting System (AERS) data publicly available from FDA



Ubiquiti Inc.

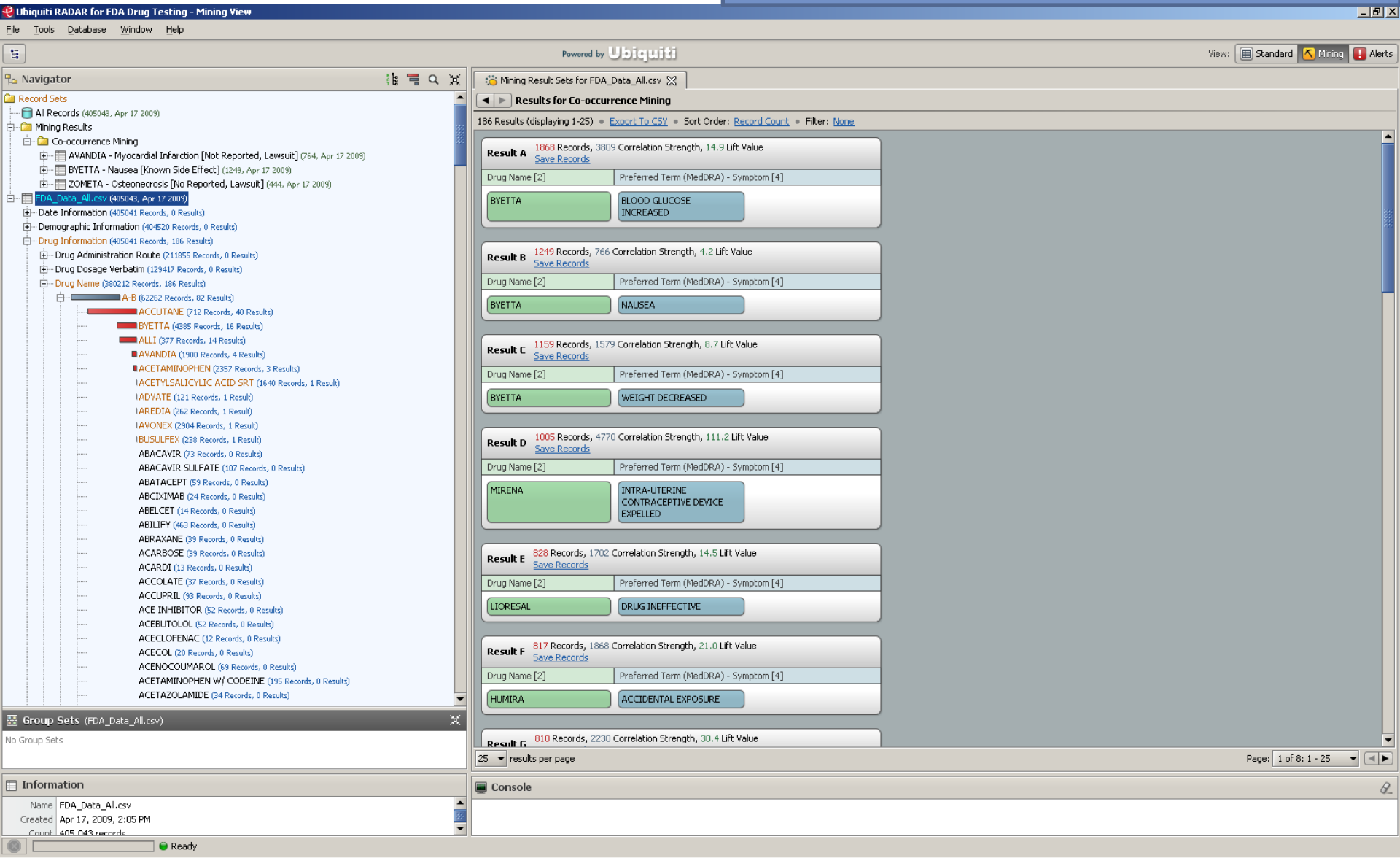
Using Drug Usage Groups

Used relevant pharma ontologies to enable analytics at multiple levels of detail, and for different information aspects



Co-occurrence Mining

Several data mining techniques; rapidly identify numerous salient adverse events



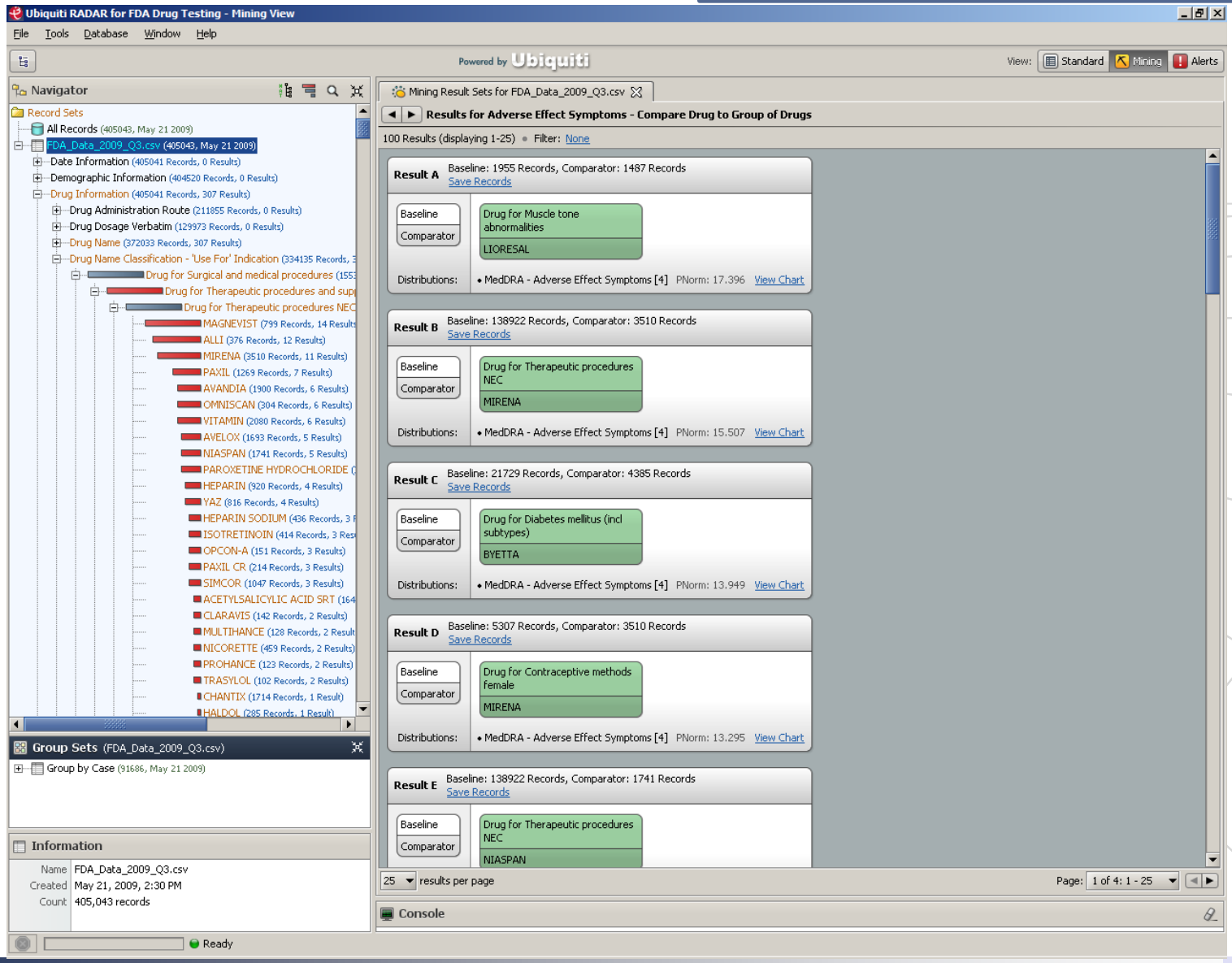
Validation of Findings

Using publicly available Internet sources:

- Drug AVANDIA: Lawsuit for causing Mycardial Infarction
- Drug BYETTA: Several sources indicate Nausea side-effect
- Drug ZOMETA: Lawsuit for causing Osteonecrosis
- Drug LIORESAL: Several sources indicate the side-effects

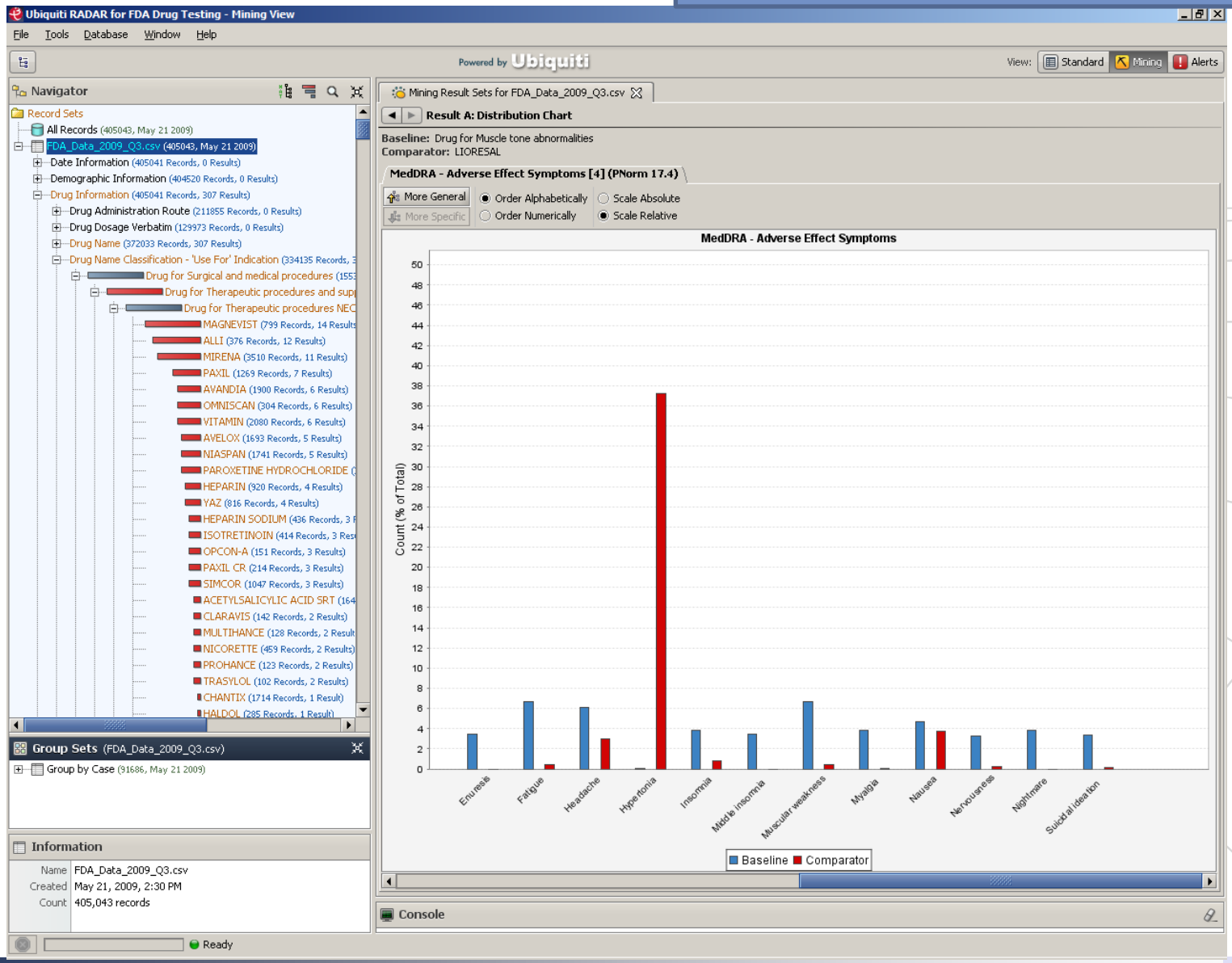
"Distribution Differences"

Example mining techniques – enabled by using ontologies – include new ones such as "distribution differences"



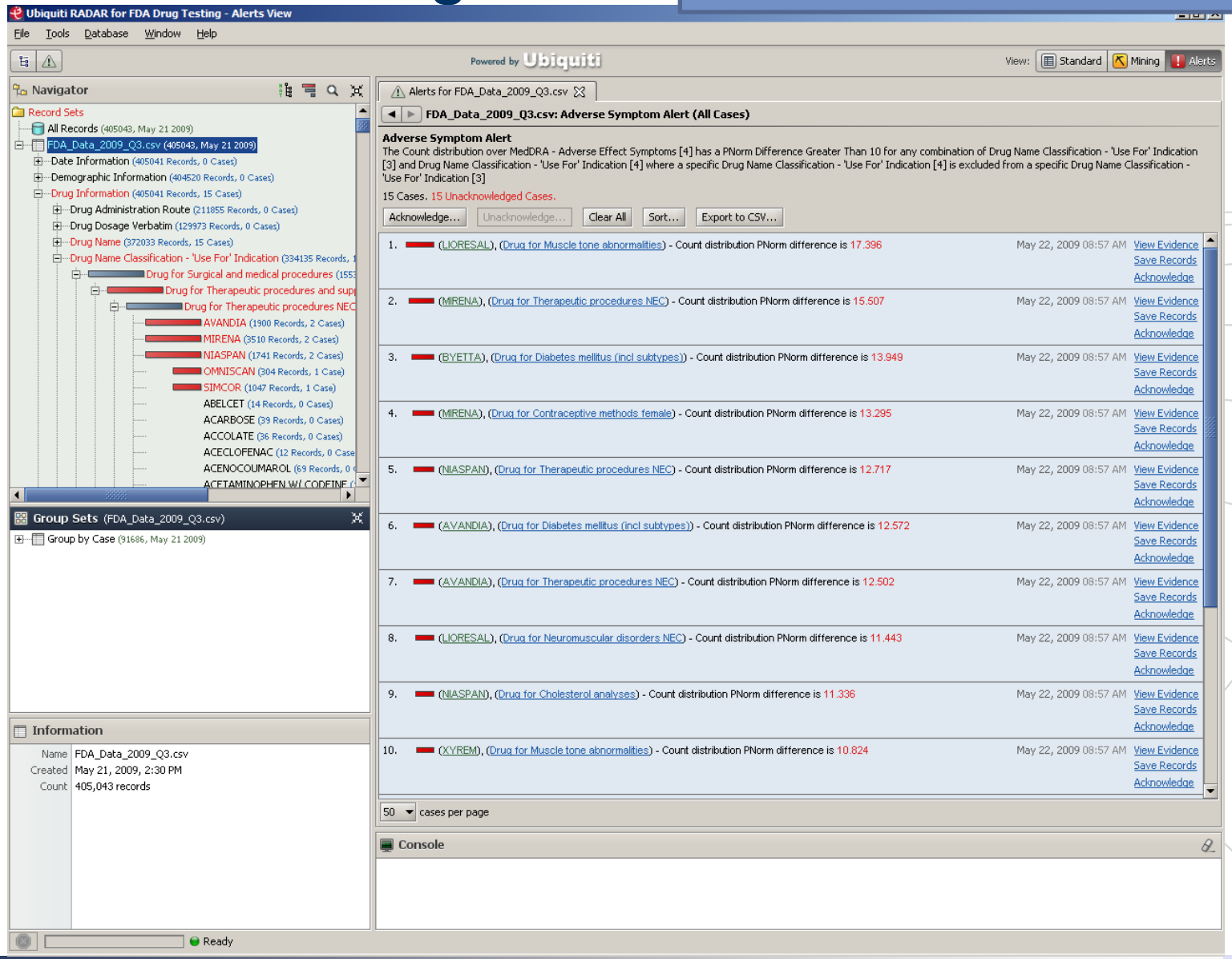
"Distribution Difference"

Distribution difference results seen in more detail



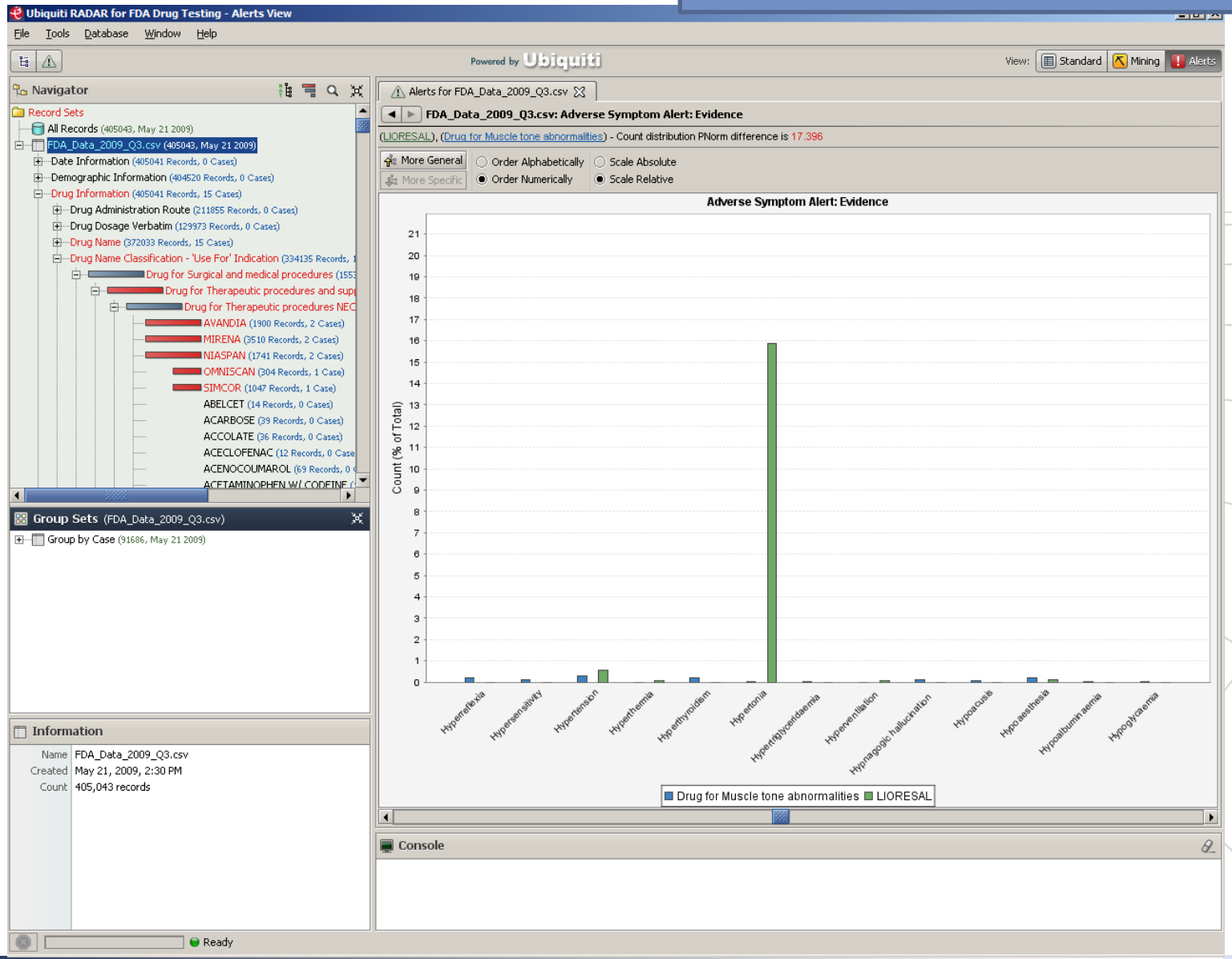
Automated Mining …

Analytics can be "operationalized" via sophisticated automated alerts



Automated Alert Detail

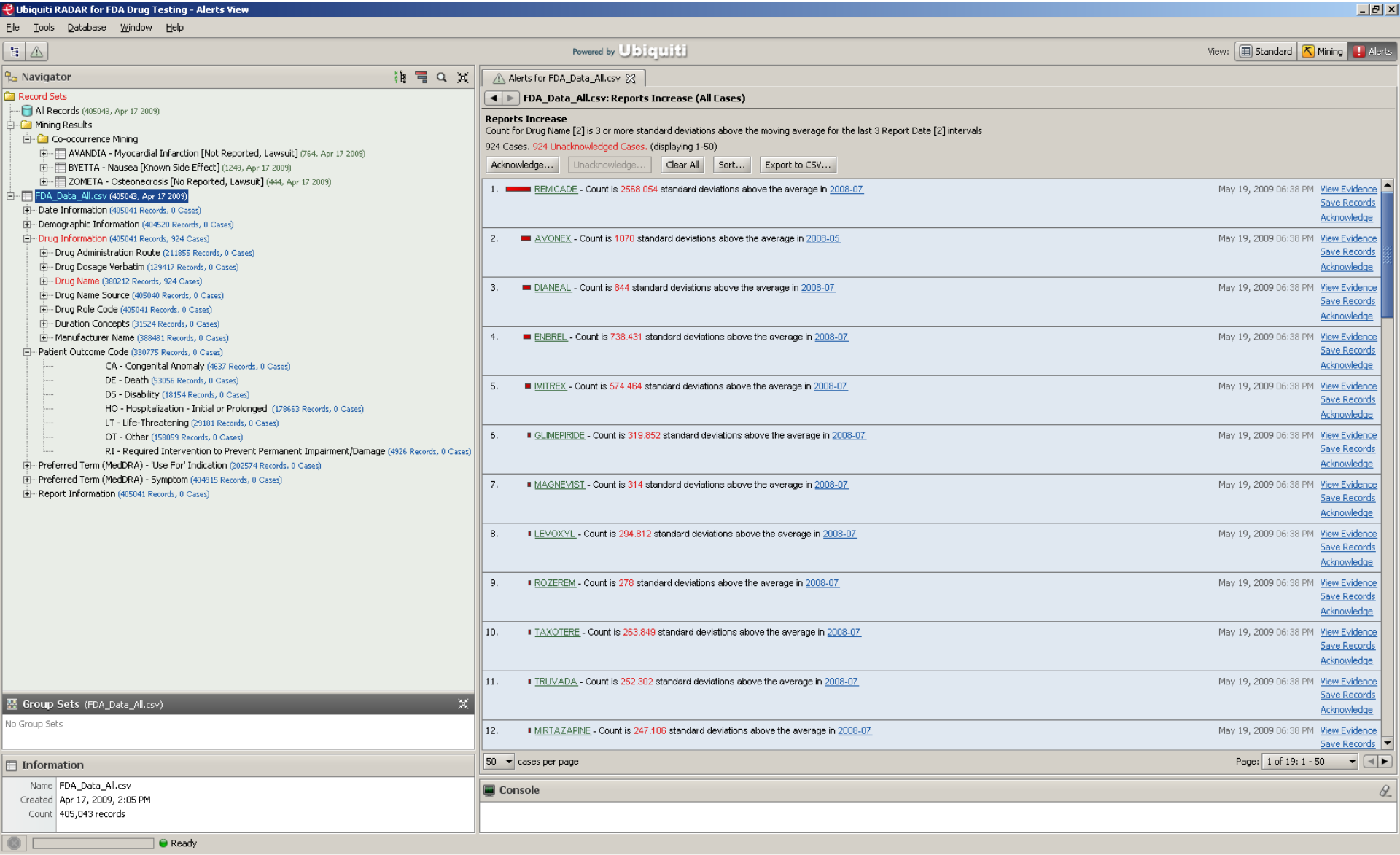
Detail on operationalized mining results



Ubiquiti Inc.

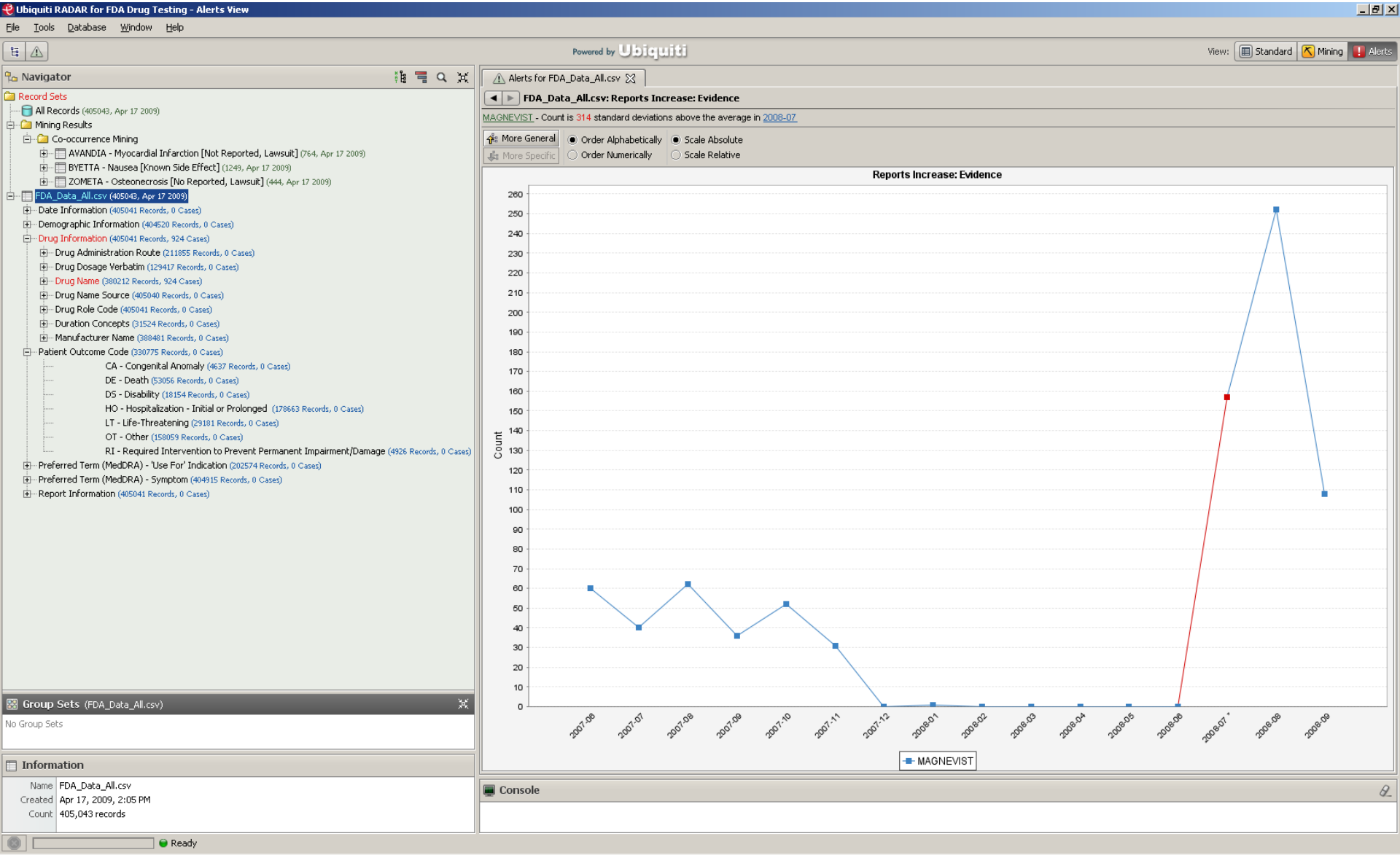
Unexpected Increases

Another example of operationalized analytics



Detail on the Increase

Detail on operationalized analytics



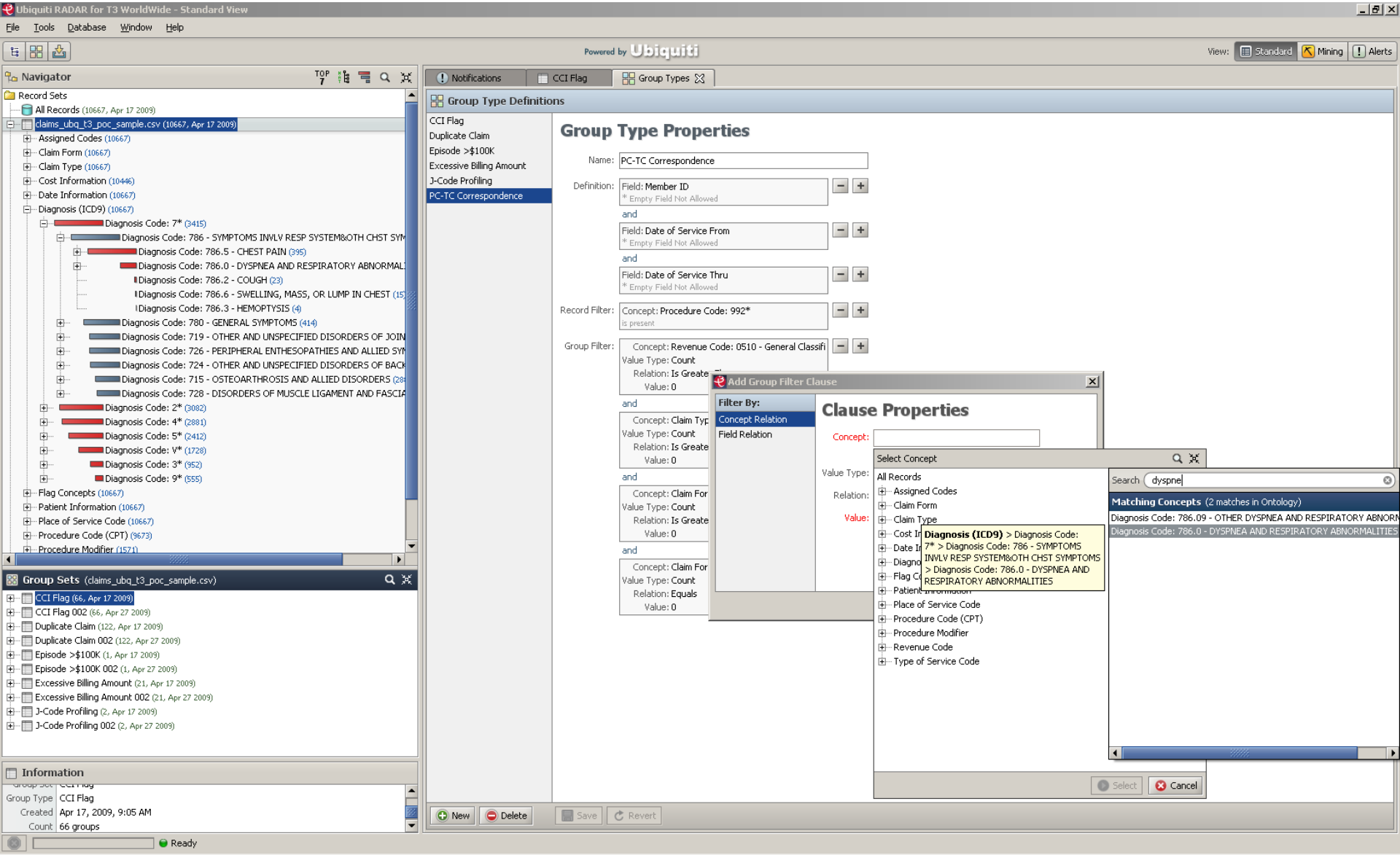
Specific Examples for Payers & Providers

- Automated audit of codes assigned for patient charts based on the transcribed dictations. *(Payer side)*
- (Semi-)automated assignment of standard codes for patient charts with transcribed dictations. *(Provider side)*
- Potentially creating a (semi-)automated clearing-house to replace current Provider-Payer revenue cycle.
- Process (i.e., cluster/categorize/search/mine/link) medical literature
- Analyses & mining of extracted data for research
- Eg, see more in *UTHSC_Talk_Abstract* (presented at School of Health Information Sciences, Univ. Texas)

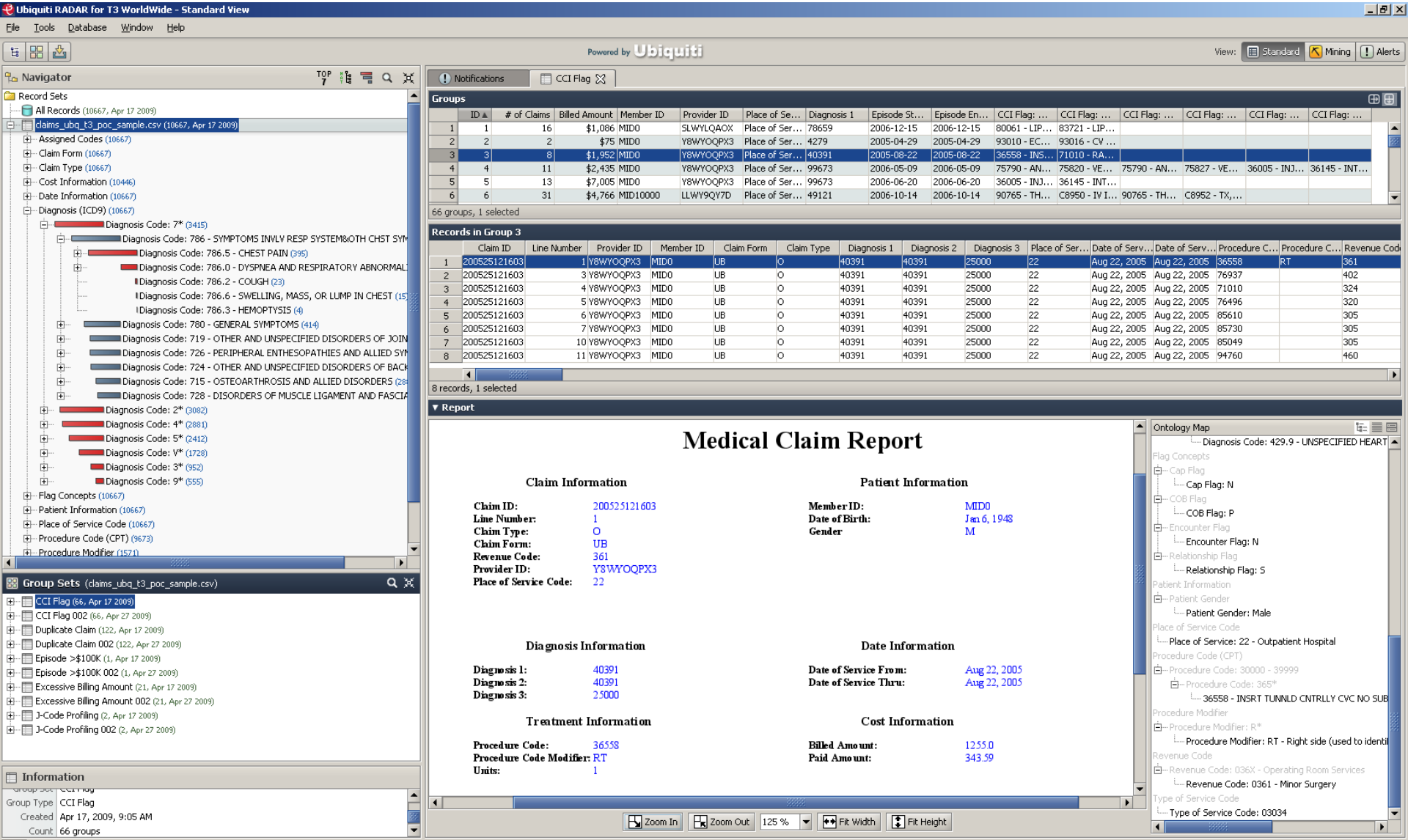
Examples …2: for Payers

- For auditing payments by Payers
- Using scrubbed health insurance claims data
- Ontologies enable setting complex rules at multiple levels of detail, and for a variety of different information aspects
- Rules suggested by experience in over-payment analyses

Setting Complex Rules with Ontology Grouping



Easily Obtaining Over-Payment Cases for Audit



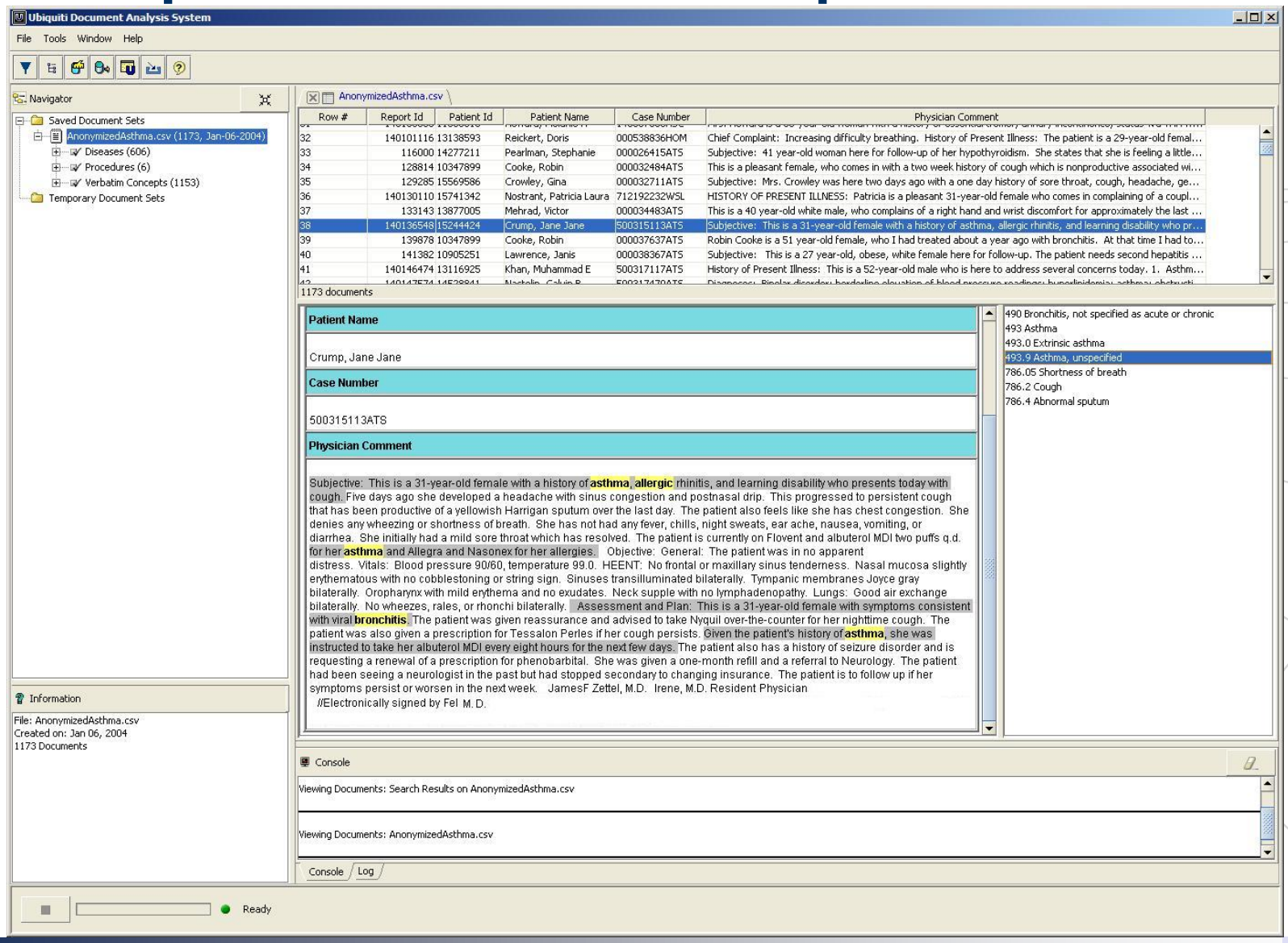
Examples …3: for Providers

- To assess Outcomes, Quality Metrics, Under-charges etc. by Providers
- Using scrubbed Patient Charts/EMRs data
- Interactions with the Univ. Texas School for Health Information Sciences
- Ubiquiti software usable for NIH-funded CTSA research (Clinical & Translational Science Awards)

Example from Anonymized Patient Record

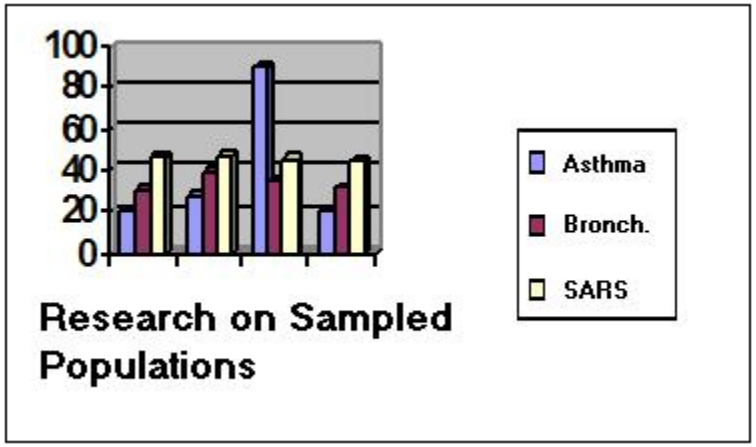
Subjective: This is a 31-year-old female with a history of asthma, allergic rhinitis, and learning disability who presents today with cough. Five days ago she developed a headache with sinus congestion and postnasal drip. This progressed to persistent cough that has been productive of a yellowish Harrigan sputum over the last day. The patient also feels like she has chest congestion. She denies any wheezing or shortness of breath. She has not had any fever, chills, night sweats, ear ache, nausea, vomiting, or diarrhea. She initially had a mild sore throat which has resolved. The patient is currently on Flovent and albuterol MDI two puffs q.d. for her asthma and Allegra and Nasonex for her allergies. Objective: General: The patient was in no apparent distress. Vitals: Blood pressure 90/60, temperature 99.0. HEENT: No frontal or maxillary sinus tenderness. Nasal mucosa slightly erythematous with no cobblestoning or string sign. Sinuses transilluminated bilaterally. Tympanic membranes Joyce gray bilaterally. Oropharynx with mild erythema and no exudates. Neck supple with no lymphadenopathy. Lungs: Good air exchange bilaterally. No wheezes, rales, or rhonchi bilaterally. Assessment and Plan: This is a 31-year-old female with symptoms consistent with viral bronchitis. The patient was given reassurance and advised to take Nyquil over-the-counter for her nighttime cough. The patient was also given a prescription for Tessalon Perles if her cough persists. Given the patient's history of asthma, she was instructed to take her albuterol MDI every eight hours for the next few days. The patient also has a history of seizure disorder and is requesting a renewal of a prescription for phenobarbital. She was given a one-month refill and a referral to Neurology. The patient had been seeing a neurologist in the past but had stopped secondary to changing insurance. The patient is to follow up if her symptoms persist or worsen in the next week. JamesF Zettel, M.D. Irene, M.D. Resident Physician //Electronically signed by Fel M.D.

Example Auto-Coded in Ubiquiti Software



Auto-Assign Standard Reimbursement Codes

Automated Coding:	*Confidence*
490 Bronchitis, not acute/chronic	95 %
493 Asthma	95 %
493.0 Extrinsic Asthma	93 %
493.9 Asthma, unspecified	85 %
786.5 Shortness of Breath	95 %
786.2 Cough	90%
786.4 Abnormal sputum	92%



- ✓ "Automate" the Revenue Cycle
- ✓ Identify "Top 10" cost issues
- ✓ Reduce unpaid claims
- ✓ Reduce turnaround times
- ✓ Identify co-occurring issues
- ✓ Detect emerging problems
- ✓ Understand patient needs
- ✓ Identify geographical issues

CUT COSTS, IMPROVE CARE …!

Potential Data Analyses

- **Searching** based on content in data
- **Clustering** based on information content
- **Mining** to discover hidden patterns
- **Statistics** based on distribution of data
- Use **Ubiquiti tools**

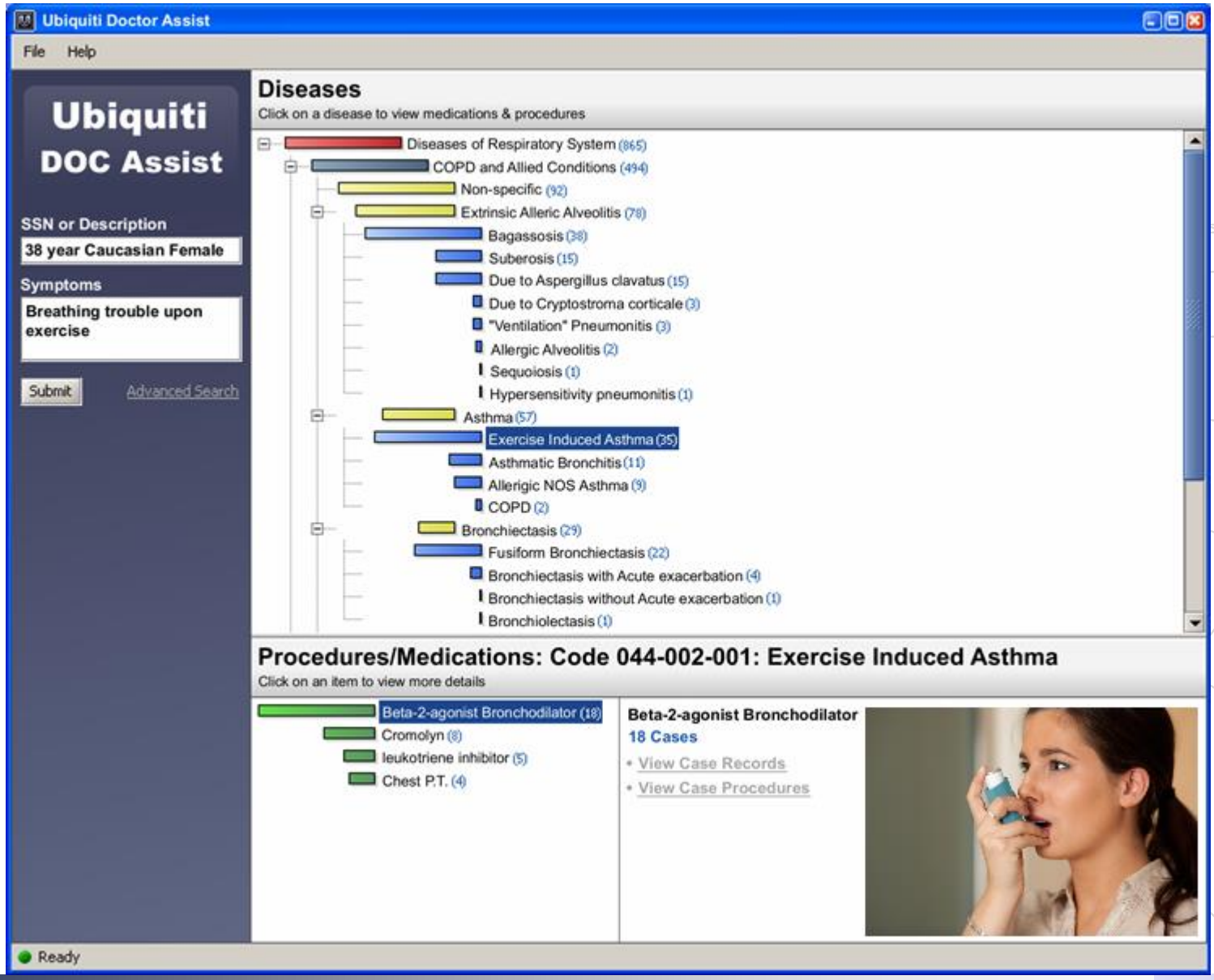
  and/or

  Other Statistical/Mining/OLAP tools
  (e.g., Cognos, WebFocus, SAS, Excel etc.)

More Possibilities …1: Diagnostics

- **EMRs, Outcomes, Claims** data forms *Knowledge Base*
  - Captures **all** medical professionals' experiences.
  - Captures **all** geographical regions.
  - Captures **all** periods of time.
- **Build decision support apps; For Each New Case** use existing Knowledge Base
  - Find ***similar*** records in symptoms, demography, health history...
  - Suggest ***tests & procedures*** based on retrieved records
  - Report ***differential diagnoses*** based on tests & records
  - Report ***possible therapies*** based on diagnoses & records
  - Indicate ***potential outcomes*** based on statistical information
- **Use knowledge-base for Decision Support**
  - For providers, to promote *Evidence-Based Medicine*. Could be built into EMRs, as add on to online info sites like UpToDate, …
  - For payers, could be used to enforce better EBM in case management…
  - For consumers, could be used for search and reference lookup experience on health info sites
- **Simple interface** (eg, Google) – anytime & anywhere

Diagnostics Illustrated



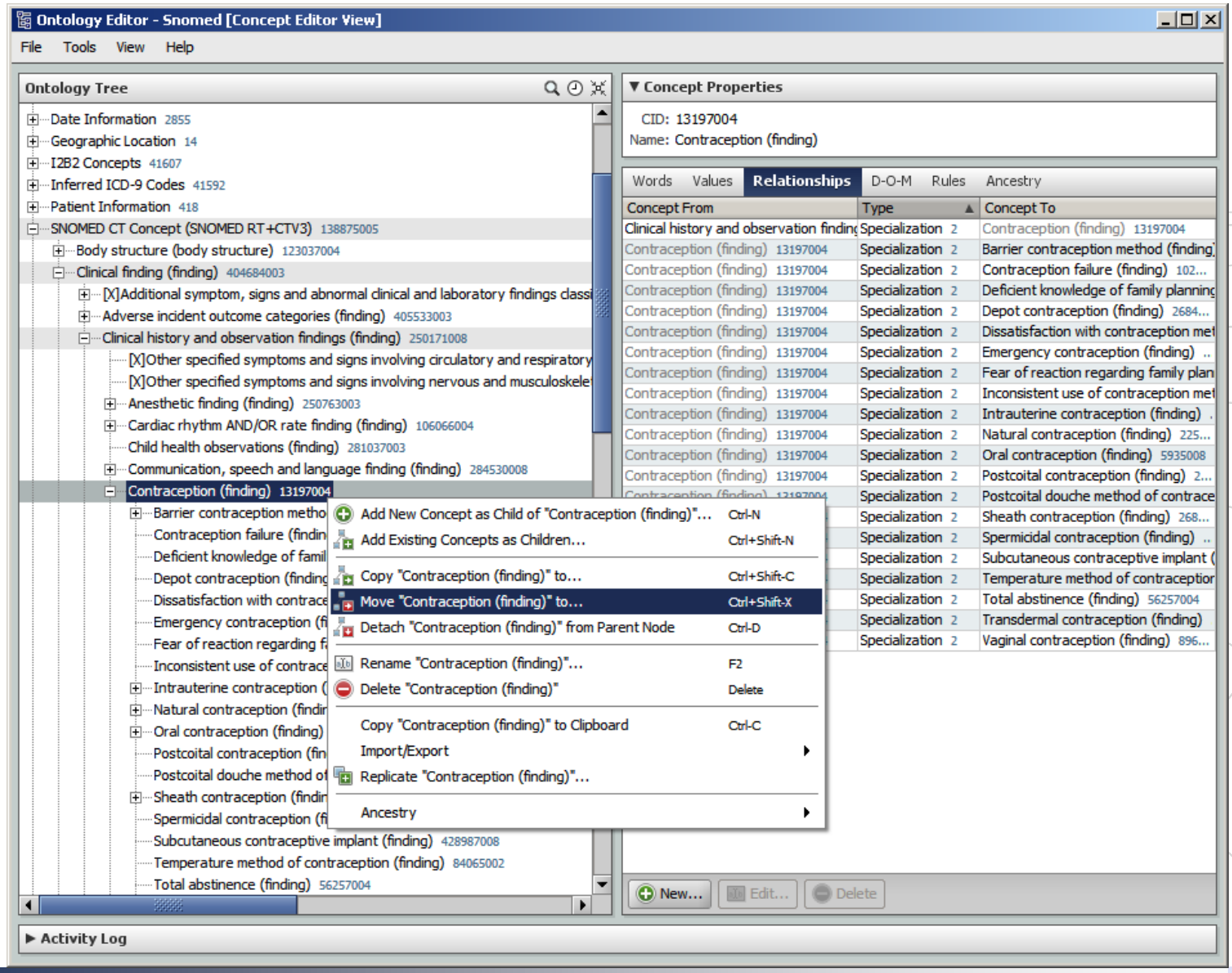
More Possibilities …2: Generalizations & Search

- **EMRs, Outcomes, Claims** *Knowledge Base* for:
  - Generalized similarity-search
  - Using instance-based machine-learning
  - Data-driven analog to more common "Model-Based" approaches (perhaps better; building accurate complex models is difficult)
- **Knowledge Base** may be tapped for:
  - Anywhere & anytime search for health-related data
  - Ontology-based guided search for desired information
  - Domain-specificity useful for better information navigation
  - Ontology enables closer match with user-preferences

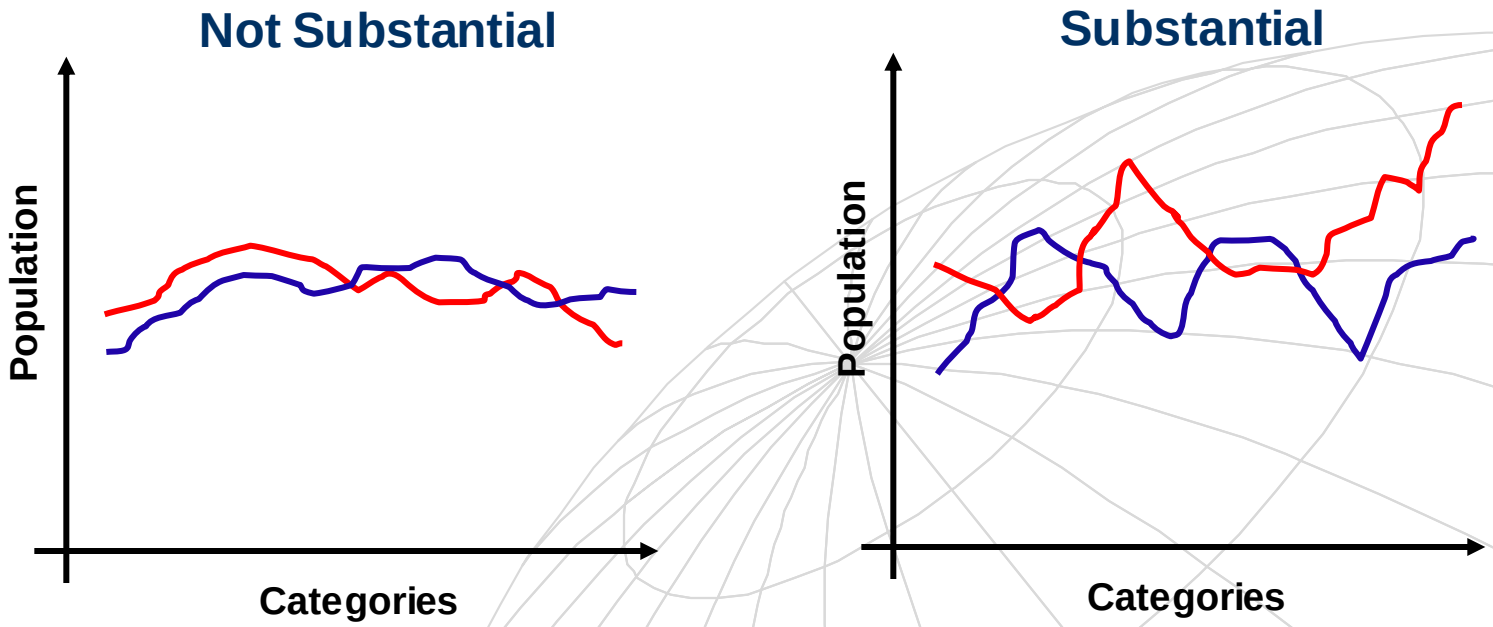
Outline of Key Differentiating Technologies

- Using Ontologies as an integral part of Analytics
- Utilizing automated Text Analytics with Ubiquiti-proprietary *Statistical NLP* (Natural Language Processing) techniques
- Use of Domain-specific Similarity Search techniques (based on statistical distribution of data)

Ubiquiti Ontology Creating/Maintaining software



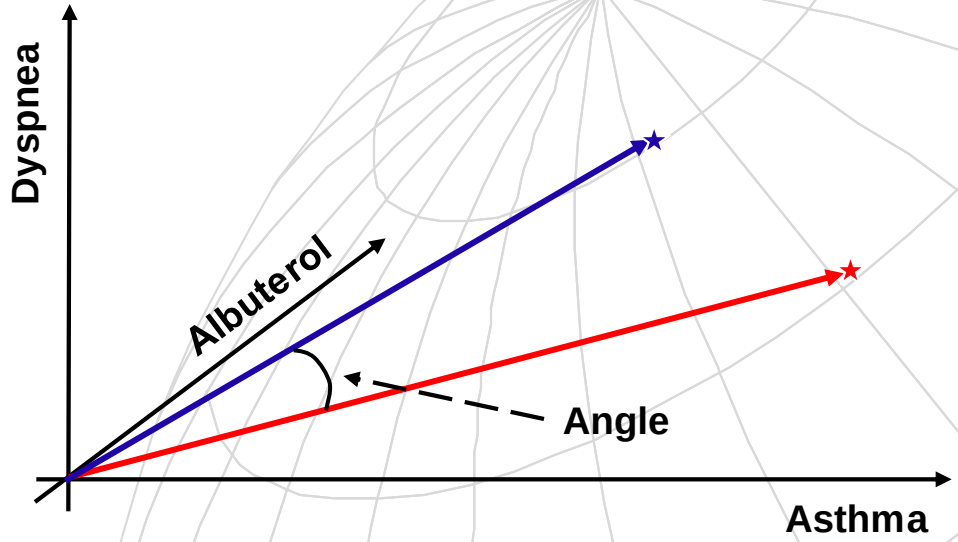
“Substantial” Distribution Differences



Difference measured by K-L or P norms; empirically assessed.

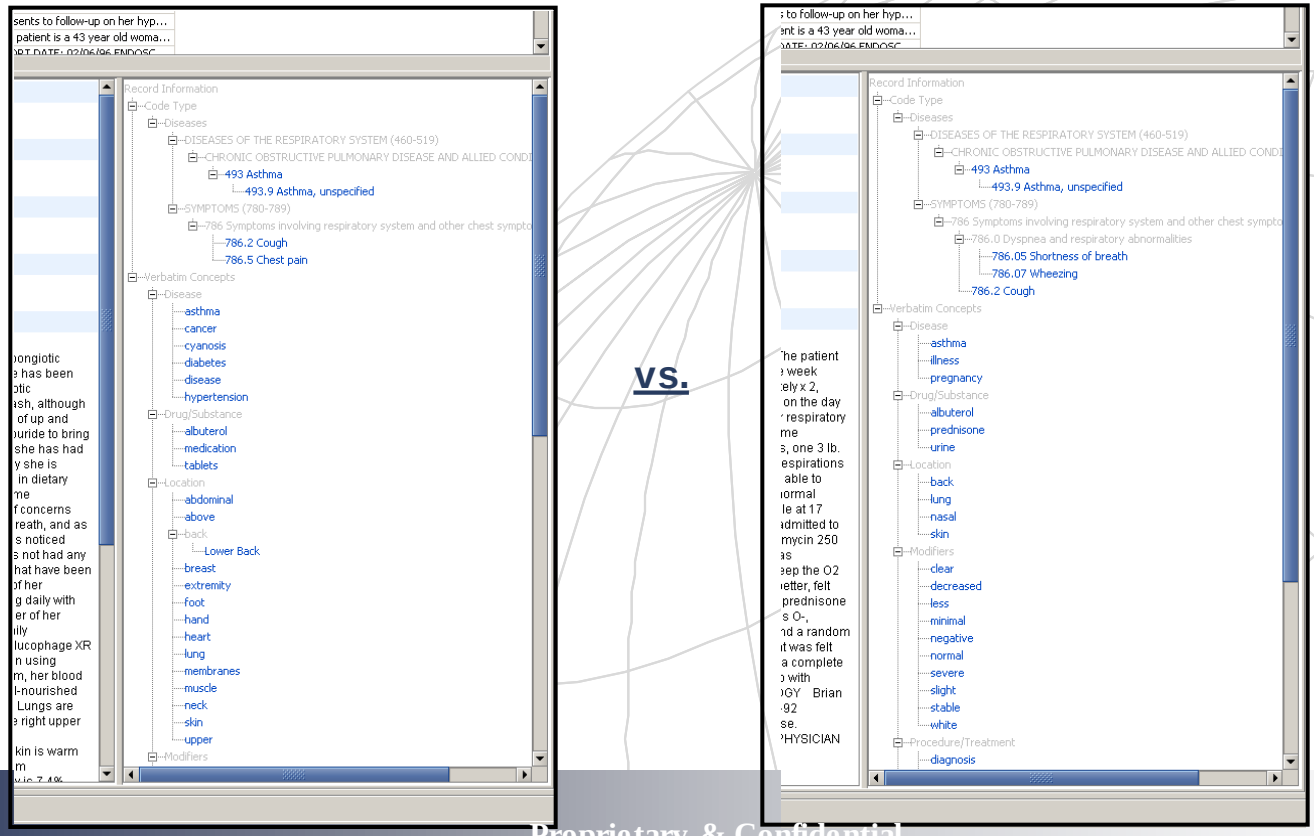
Similarity-based Search: Individual Records …1

- **Basic Idea:** Find records **"similar"** to a given record. (E.g., with Google-bar, select some text & invoke Google search).
- **Usual approaches** – based on "vector" of words or "tokens". Similarlity based on angle between vectors. Not too effective (e.g., since co-located words do have relationships).



Similarity-based Search: Individual Records …2

- **Ontology-based approach** – based on "ontology-maps" and similarity between them. Use concepts (instead of words), dispense with artificial orthogonality, leverage the ontology. But more complex and compute-intensive.



Concept-Based Clustering/Categorization

Clustering & categorization of documents automatically organizes into similar groups.

Concept-based **improves results** over word-based – the latter only approximate concept-based clustering.

- Concept-relationships: a **means to group similar documents** – even if words are different.
- **Intuitive organization** of clusters based on concept relationships, with descriptive cluster labels.

Concept-Based Search

User-specifies **words *and/or* concepts** for search.

Filtering / ranking based on words ***and*** concepts.

- **Special criteria easily added** where desired.
- Automatically achieve
  - **word disambiguation**
  - **specialization of concepts**
  - **filtering and ranking**
- Metadata modification is easy; also, **changes reflected immediately** in the results.

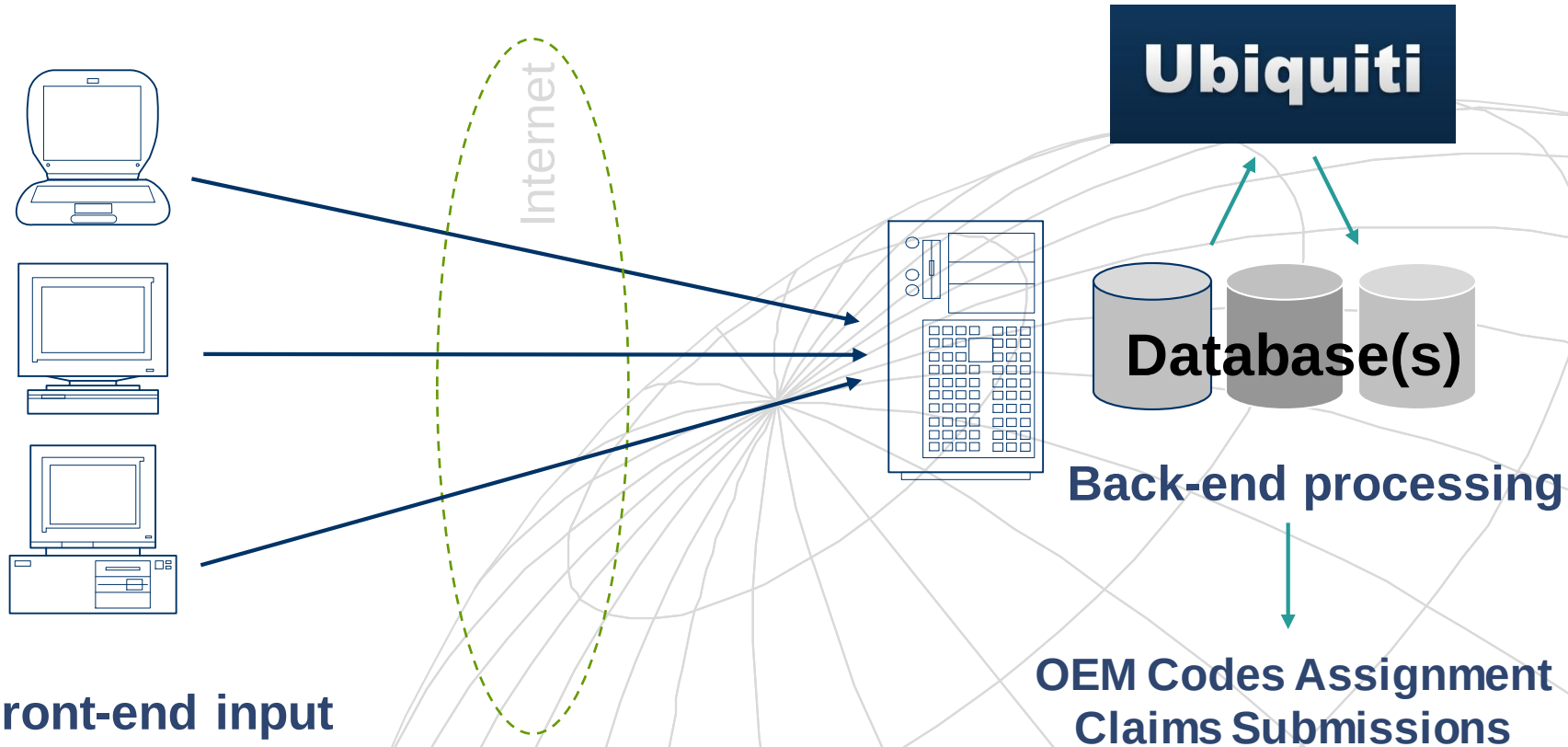
Concept-Based Text “Mining”

Finding trends, patterns and outliers in text documents.

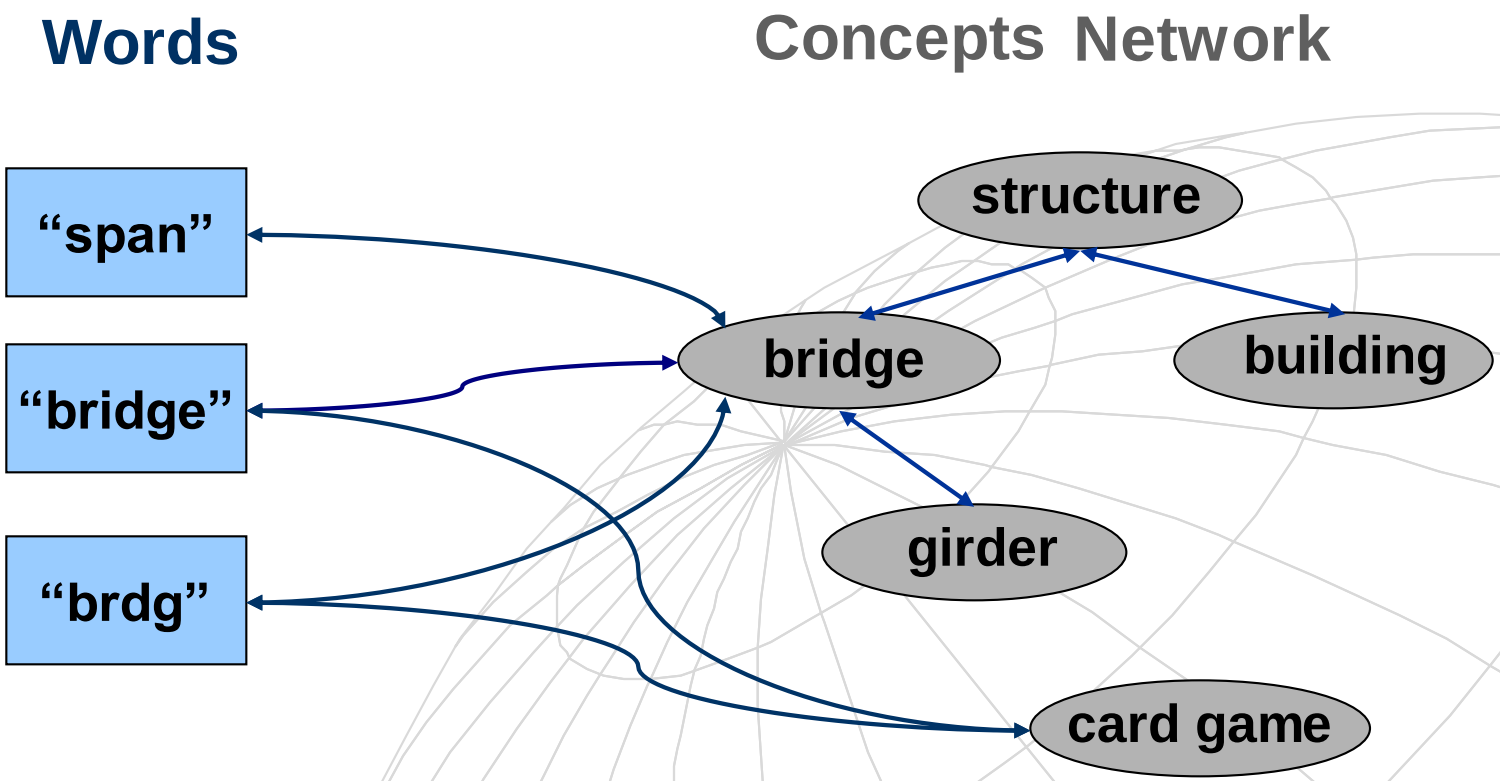
- For any word-based text mining technique, Ubiquiti can provide a **concept-based equivalent** which leverages concepts and their relationships.
- ***“Concept-based OLAP”***
  - Analyze mining results interactively.
  - Concept-based clustering allows examining of the mining results at varying levels of granularity.

Infrastructure Architecture

(No need for change!)

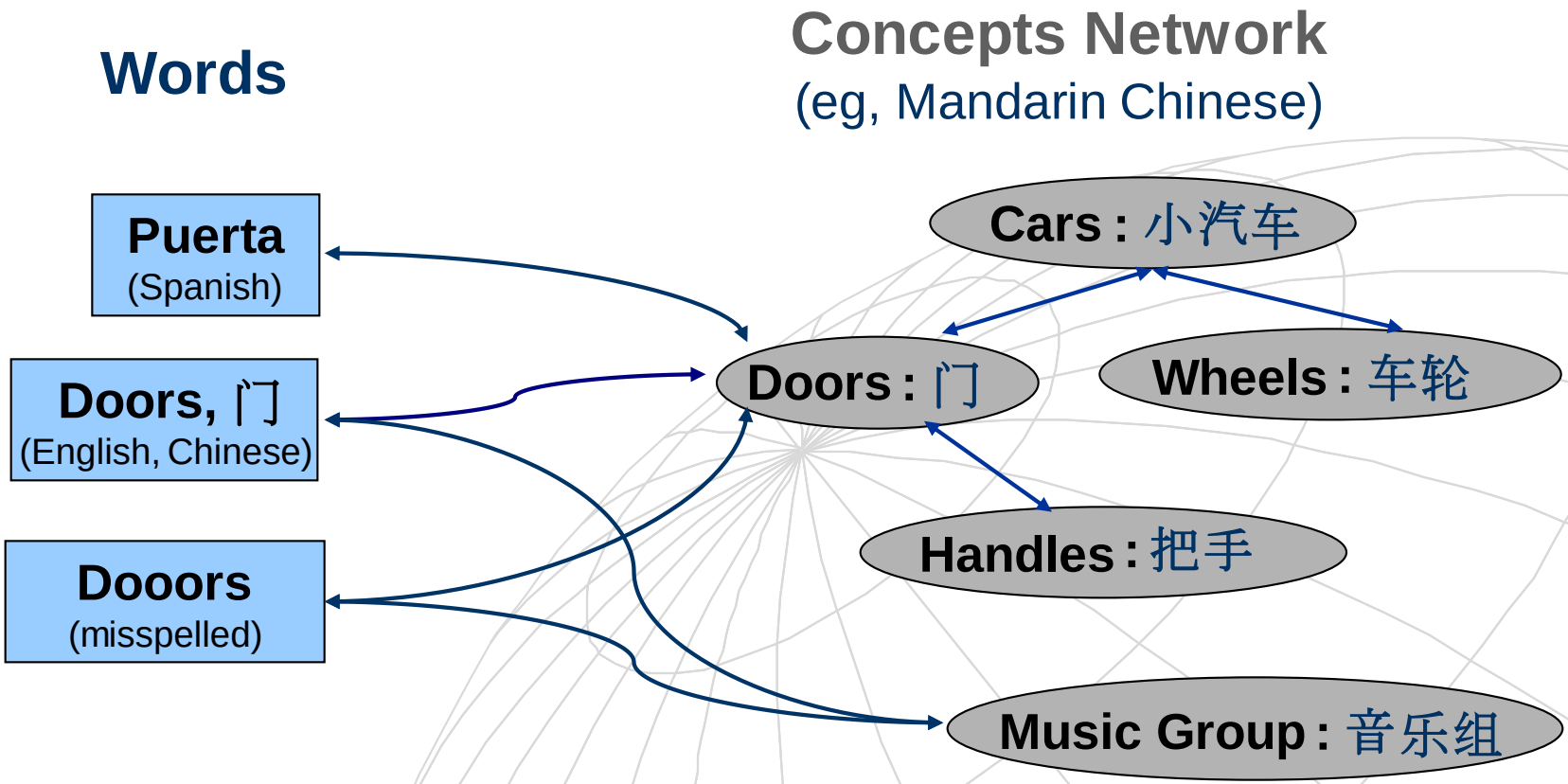


Enabling Technology for Text



High Accuracy, Language Independent

Technology for Non-English Languages



Ubiquiti is used in the Americas, Europe, China, Australia

Thanks for your Interest. Contact Ubiquiti for more details.

Decision Support with Text

Web: www.ubiquiti.com
Email: info@ubiquiti.com
Phone: (734) 997-8800
Fax: (413) 622-3123

Ubiquiti Inc.
303 Detroit Street
Suite 202
Ann Arbor, MI 48104