Presentation of:

Knowledge discovery by automated identification and ranking of implicit relationships

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What is knowledge discovery?

Knowledge Discovery is "the nontrivial process of identifying valid, novel, potentially useful, and ultimately understandable patterns in data" (Fayyad, Piatetsky-Shapiro, and Smyth 1996).
Background: Literature Mining for knowledge discovery

- Information overload
- Millions of journal articles recording scientific findings
- No one can read them all: need automated approaches
Contribution of Swanson

- “undiscovered public knowledge”
- “non-interactive literatures”
- A-B-C model
Past work: Swanson and others who use co-occurrence

- **Swanson**
  - based on keywords in titles

- **Others**
  - MeSH terms
  - Mapping text to UMLS concepts

In both cases the size of the domain is a problem.
Approach in this paper

- Use the A – B – C model as a basis
  - Choose the A terms
  - Literature mining to find associations to A terms (B entities)
  - Query B objects to find relationships to other objects – C
  - Look at implicit (not explicit) A-C relationships
  - Rank relationships to find the statistically exceptional ones
The A Set

Data Sources:
- OMIM - diseases and clinical phenotypes
- HGNC - genes
- LocusLink - genes
- MeSH - chemical compounds and drugs

33,539 unique objects (85,234 including synonyms)
Identify Relationships

- Co-occurrence in MEDLINE record
  - Abstract
  - sentence
- Caveat – co-occurrence may not always the existence of a biologically meaningful relationship
- Need a way to estimate the importance of co-occurrence
Importance of Co-occurrence

- Fuzzy logic – not 0 or 1, somewhere in between
- Score based on frequency
- Calculate expected value based on relative connectivity
  - Assume a random network
  - How far does this relationship deviate
Implementation: estimate of precision and recall

- (Why are they putting this section here?)
- In general, precision and recall measurements are difficult in text-mining
  - Gold standard
  - Test corpus
Precision

- Manual estimation based on sample
- Looked at 25 randomly selected MEDLINE records
  - Found that 2 objects co-mentioned within the same sentence were more likely related (83%) than objects mentioned in abstract (53%)
  - Sentence co-mentions alone misses relationships (43%)
Trivial vs. non-trivial relationships

- Found non-persistent relationships
  - In first half of MEDLINE but not in second half
  - Assumed false or not interesting relationships

- Rates similar to power decay function

- Decided OK to use as error probability
Recall

- Studied recall rates using abstracts vs. full text articles
  - Chose 4 objects, one of each type, had to have 2 review articles in last 3 yrs
  - Compared objects

- Results
  - 30 objects in the literature not in database, for various reasons
  - 141 of 181 objects in database (78%)
  - 98% could have been because terms were in abstracts (spelling errors)
12,037,763 MEDLINE records

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Created a network of 3,482,204 unique relationships between objects

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Obs/Exp calculated

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Cardiac Hypertrophy

- An example – why?
- Looked at compounds with implicit relationships to cardiac hypertrophy
- Cholopromazine ranked high
- Mouse trials showed CPZ lowers hypertrophy
- A relationship between cardiac hypertropy/CPZ not mentioned previously in literature
Discussion

- A new relationship was found
- Shortcomings of method
  - Finding uninteresting relationships
  - Time consuming to find nature of relationship
  - Comparison to random network model assumes text is non-random. Is it?
  - Method has utility as information increases
Comments

- Confusing paper
  - Structure
  - Formulas
  - GDB and Genome Ontology – were they used?

- Why cardiac hypertrophy? Did it come to the top in results or was it originally a disease of interest?
Text Mining Issues

- Evaluation of methods – precision/recall
- The human component – someone must decide whether connection is interesting and potentially useful
- Collaboration