Discovery Facilitation Via Latent Semantic Indexing

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Office of Naval Research
Quantitative Methods in Defense & National Security QMDNS 2007
NAVSEA WARFARE CENTERS DAHLGREN

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What is a Discovery?

- A discovery is a new idea that can positively impact the state of the art of a particular technical area.
- We are trying to find discoveries by looking for associations among
  - Articles
  - Terms or concepts
- Our discoveries are in different stages of vetting
  - Checking in core literature
  - Checking in existent literature
  - Validation by a domain expert
  - Checking for the idea in the patent database
  - Scientific studies

Archimedes

A Theoretical Birds Eye View

Science Citation Index®

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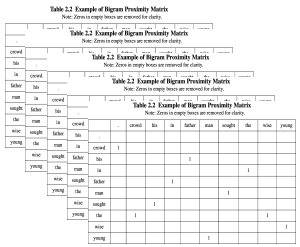
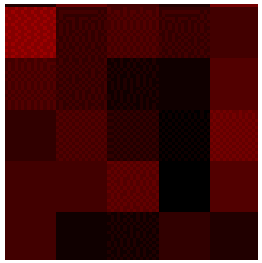
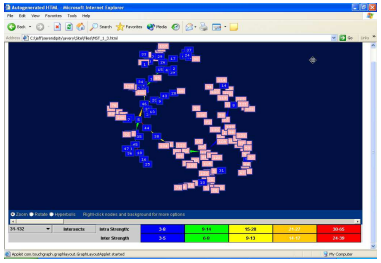






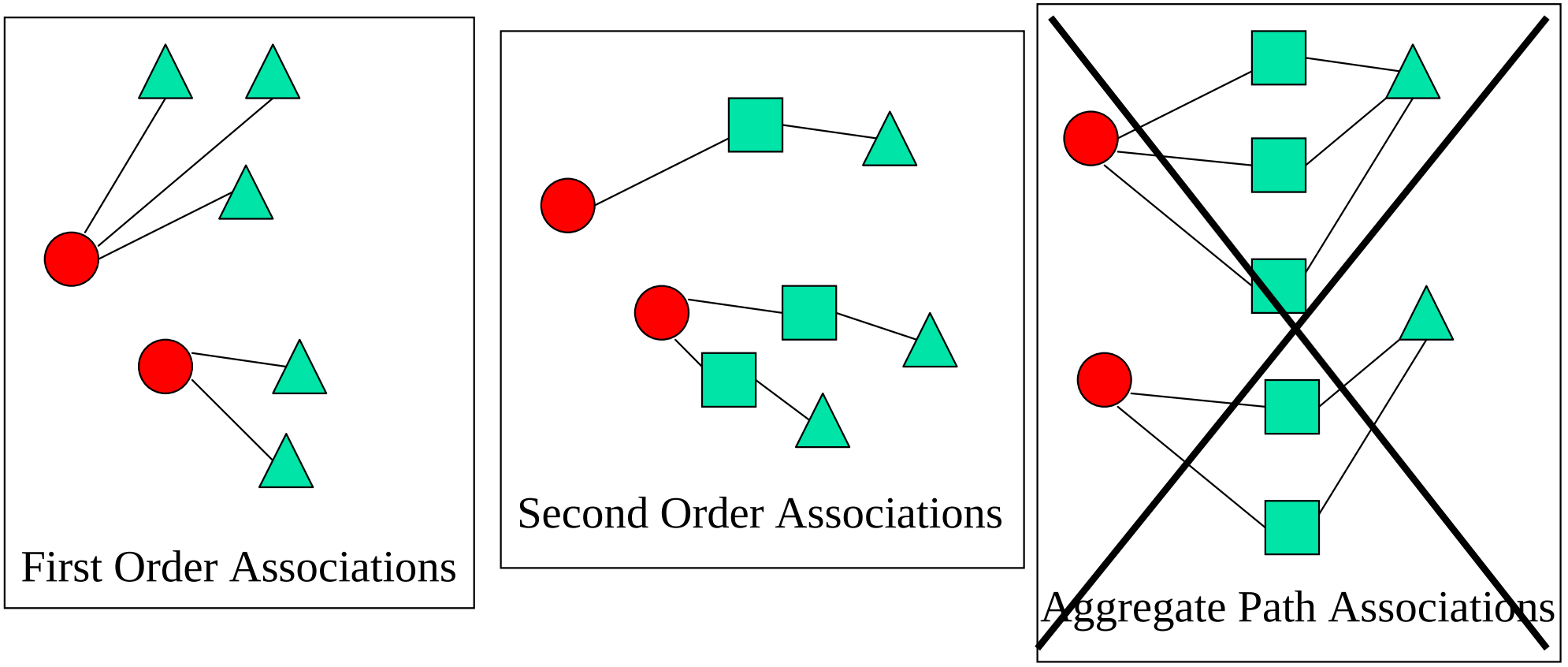
Our Input Data

Document Encoding
- Capture Meaning
- Deal With Synonyms

Measure Document Similarities

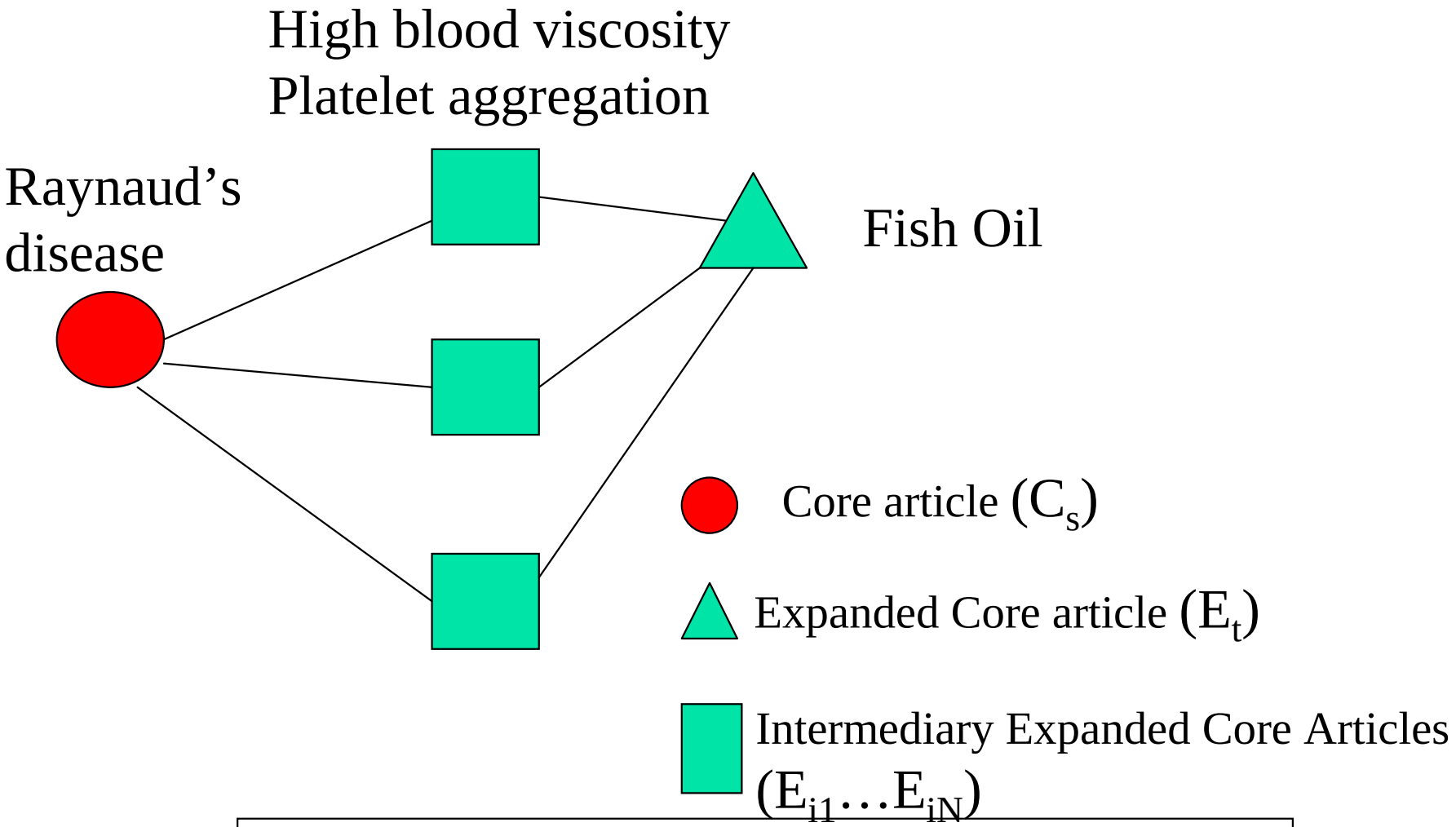
Make Discoveries
- Clustering
- Identify Associations

Identifying Associations Among Articles (Our Candidate Discoveries)



The expanded core articles contain our candidate discoveries.

Identifying Associations Among Concepts



Swanson, D. R., 1986. Fish Oil, "Raynaud's syndrome, and undiscovered public knowledge," *Perspectives in Biology and Medicine*, 30(1), 7-18.

Obtaining the Water Purification Article Set

- Obtained from the Science Citation Index and PubMed databases.
- Records directly and indirectly related to water purification were retrieved using an iterative query formulation process to generate a complex query.
- Duplicate records between the two databases were removed.
  - This turns out to be more problematic than one might first assume, our methodologies still need improvement.
- 61,945 total records

Core and Expanded Core Articles

- A core article is an article that is directly related to the problem of interest (i.e. a snippet of the query).
  - WATER PURIFICATION, WATER TREATEMENT, WATER RECYCLING, WATER DISINFECTION, WATER DESALINATION,…
- An expanded core article is an article that is related to the core either directly or indirectly i.e. first order associations, second order associations, aggregate associations.
  - BIODEGRADATION, DECHLORINATION, IMMOBILIZED METAL, NITRIFYING, PHYTOREMEDIATION, ADVANCED OXIDATION, ANAEROBIC TREATMENT, BIOLOGICAL DEGRADATION,…
- Article sets were provided by Rob Rushenberg of DDL-Omni
- The articles were originally not labeled as core or expanded core
- We divided the article sets into core and expanded core based on their containment of a set of particular query terms.

Denoising and Stemming

- These steps are performed prior to subsequent document encoding steps.

- Various approaches to denoising are possible.
  - Simplest consists of removal of all words that appear on a stopper or noise word list.
  - the, a, an, …
- Stemming transforms a given word into its base this reduces the number of words that we have to keep track of
  - walking → walk
  - walked → walk

- Denoising can be corpus dependent.
  - For example one can remove frequent or infrequent words.

Bag of Words Encoding

Technical Memo Example

Titles:

c1: *Human* machine *interface* for Lab ABC *computer* applications
c2: A *survey* of *user* opinion of *computer system response time*
c3: The *EPS user interface* management *system*
c4: *System* and *human system* engineering testing of *EPS*
c5: Relation of *user*-perceived *response time* to error measurement

m1: The generation of random, binary, unordered *trees*
m2: The intersection *graph* of paths in *trees*
m3: *Graph minors* IV: Widths of *trees* and well-quasi-ordering
m4: *Graph minors*: A *survey*

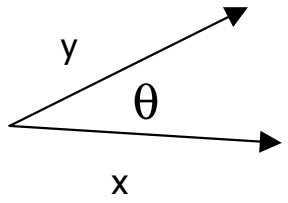
Terms	Documents								
	c1	c2	c3	c4	c5	m1	m2	m3	m4
human	1	0	0	1	0	0	0	0	0
interface	1	0	1	0	0	0	0	0	0
computer	1	1	0	0	0	0	0	0	0
user	0	1	1	0	1	0	0	0	0
system	0	1	1	2	0	0	0	0	0
response	0	1	0	0	1	0	0	0	0
time	0	1	0	0	1	0	0	0	0
EPS	0	0	1	1	0	0	0	0	0
survey	0	1	0	0	0	0	0	0	1
trees	0	0	0	0	0	1	1	1	0
graph	0	0	0	0	0	0	1	1	1
minors	0	0	0	0	0	0	0	1	1

A sample dataset consisting of the titles of 9 technical memoranda. Terms occuring in more than one title are italicized. There are two classes of documents - five about human-computer interaction (c1-c5) and four about graphs (m1-m4). This dataset can be described by means of a term by document matrix where each cell entry indicates the frequency with which a term occurs in a document.

Measuring Similarity in the Vector Space Encoding Scheme

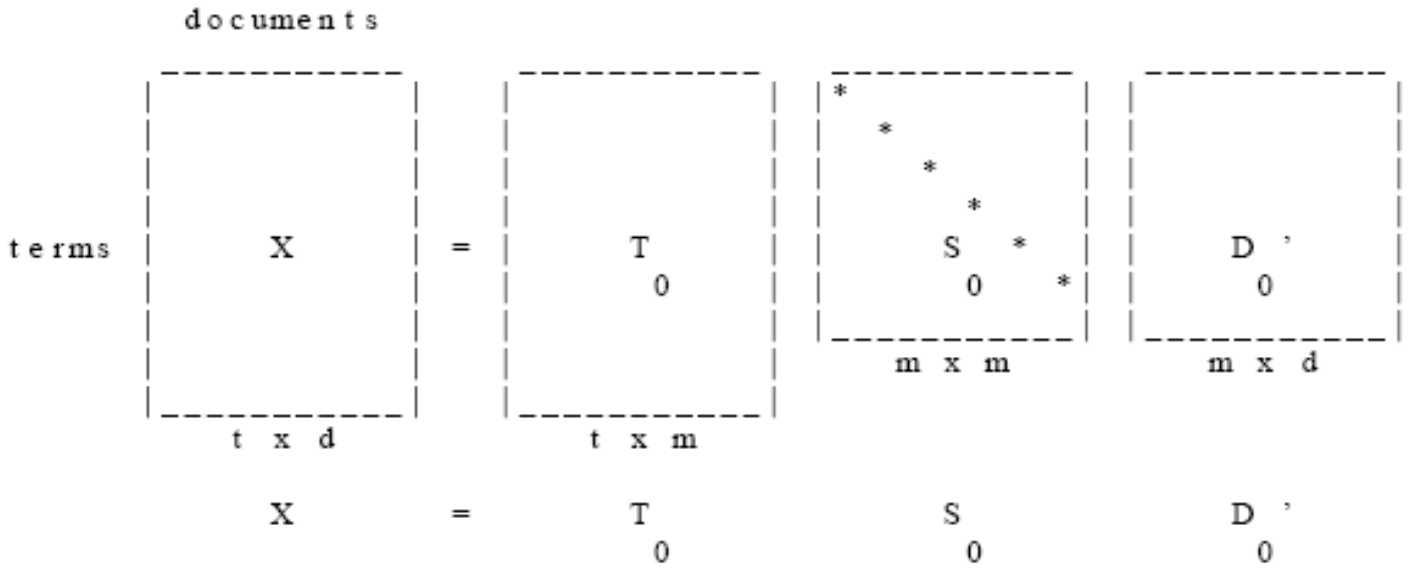
- Given a vector encoding of a document, a column of the bag of words encoding, we can measure the similarity of two documents via a cosine measure (remember the cosine of an angle θ is close to 1 when the angle is near 0).

$$\cos(\theta) = \frac{x.y}{\|x\|\|y\|}$$



- This can be converted to a dissimilarity measure via several different ways including
  - d(x,y) = 1 –s(x,y)

Full Rank Latent Semantic Indexing (LSI) – Singular Decomposition on the Term Document Matrix



Singular value decomposition of the term x document matrix, X. Where :

T_0 has orthogonal, unit-length columns ($T_0'T_0=I$)

D_0 has orthogonal, unit-length columns ($D_0'D_0=I$)

S_0 is the diagonal matrix of singular values

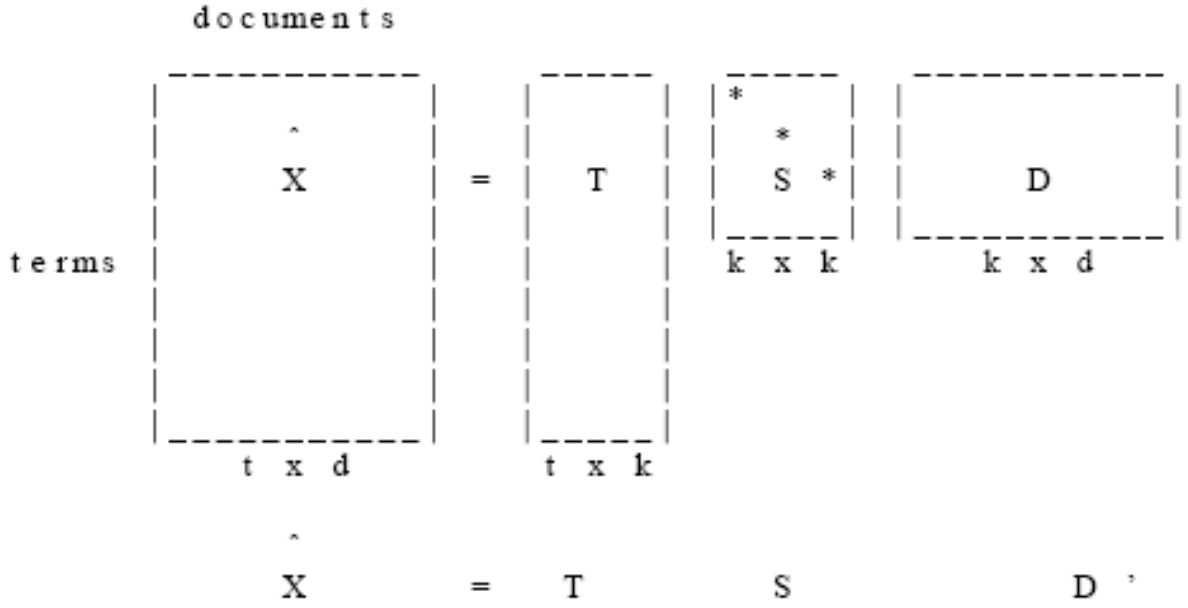
t is the number of rows of X

d is the number of columns of X

m is the rank of X ($\leq \min(t, d)$)

Deerwester, S., Dumais, S., Landauer, T., Furnas, G., Harshman, R., 1990," Indexing by Latent Semantic Analysis," *Journal of the American Society of Information Science*, vol. 41, no. 6, pages 391-407.

Partial Rank LSI – A Strategy to Denoise Corpora and Deal With Synonyms



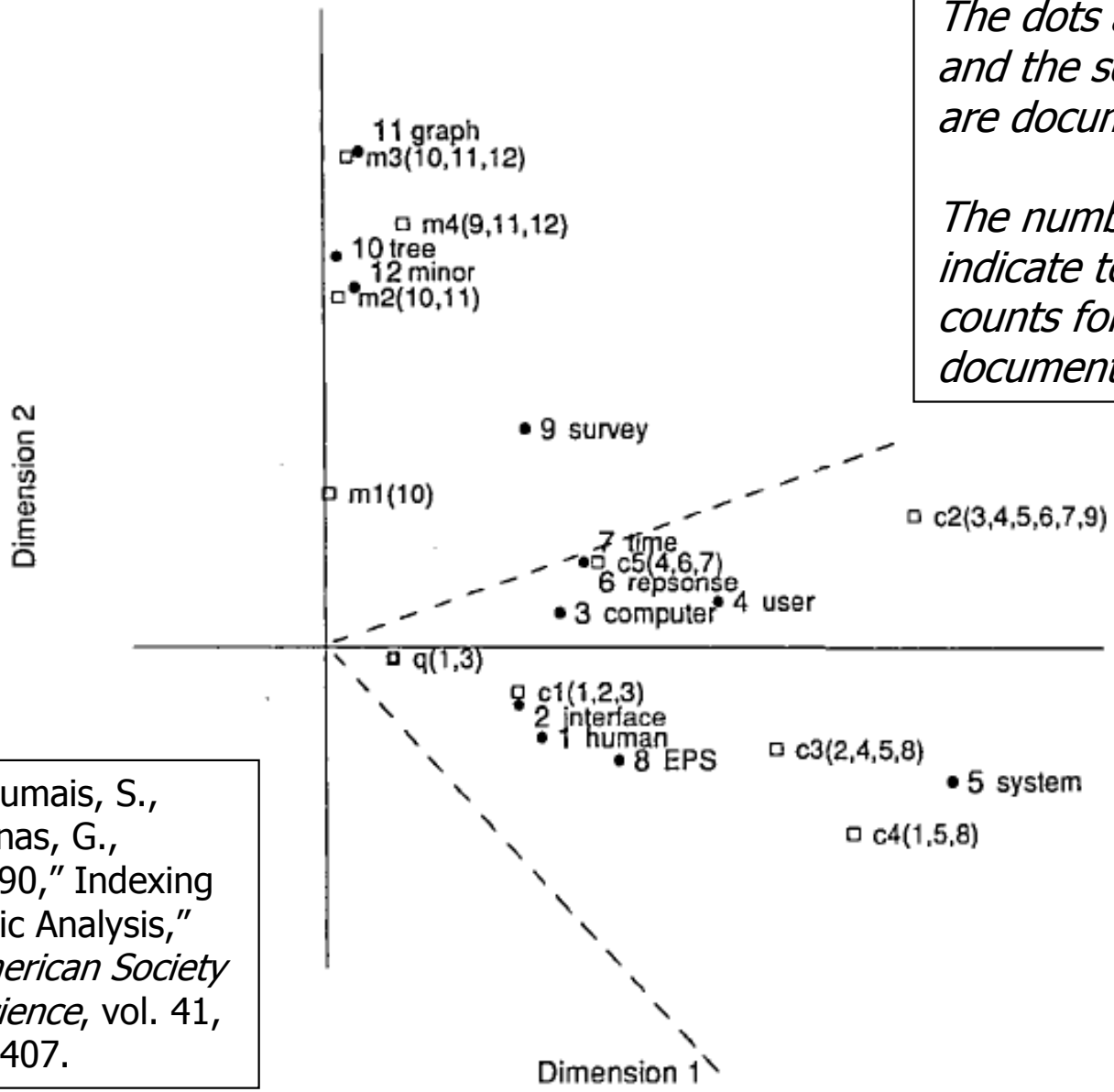
Deerwester, S., Dumais, S., Landauer, T., Furnas, G., Harshman, R., 1990," Indexing by Latent Semantic Analysis," *Journal of the American Society of Information Science*, vol. 41, no. 6, pages 391-407.

This provides us with a way to render (the words and documents Together in a space of dimension k that is much smaller than d. Reduces the influence of non-informative words, mathematically deals with the synonymy problem.

Our Toy Document Collection in LSI Space (A Mathematical Way to Deal With the Problem of Synonyms)

The dots are terms and the squares are documents

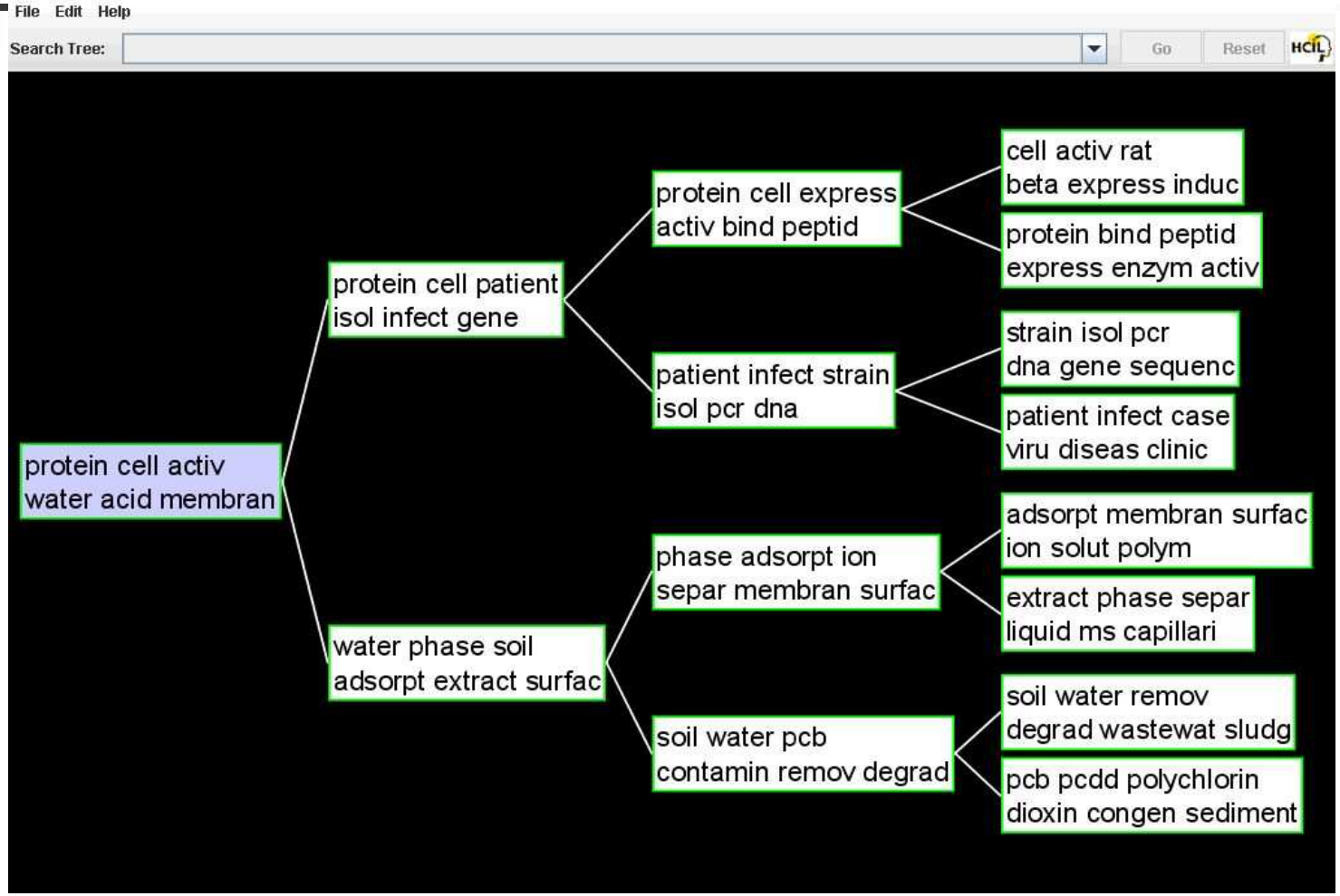
The numbers indicate term counts for this document



Deerwester, S., Dumais, S., Landauer, T., Furnas, G., Harshman, R., 1990," Indexing by Latent Semantic Analysis," *Journal of the American Society of Information Science*, vol. 41, no. 6, pages 391-407.

FIG. 1. A two-dimensional plot of 12 Terms and 9 Documents from the sampe TM set. Terms are represented by filled circles. Documents are shown as open squares, and component terms are indicated parenthetically. The query ("human computer interaction") is represented as a pseudo-document at point q. Axes are scaled for Document-Document or Term-Term comparisons. The dotted cone represents the region whose points are within a cosine of .9 from the query q. All documents about human-computer (c1–c5) are "near" the query (i.e., within this cone), but none of the graph theory documents (m1–m4) are nearby. In this reduced space, even documents c3 and c5 which share no terms with the query are near it.

CLUTO Clustering of the Full Article Set



Obtaining a Convenient Graph Embedding Via the Fiedler Projection (Validation of the Core/Expanded Core Labeling)

1. Build a graph from the information collection (k nearest neighbor for example).
2. Consider the associated adjacency matrix A and graph diagonal matrix D (obtained based on the degree of each node).
3. Form the graph Laplacian $L = D - A$ or the normalized graph Laplacian

$$\Im(G) = D^{-1/2} L D^{-1/2}$$

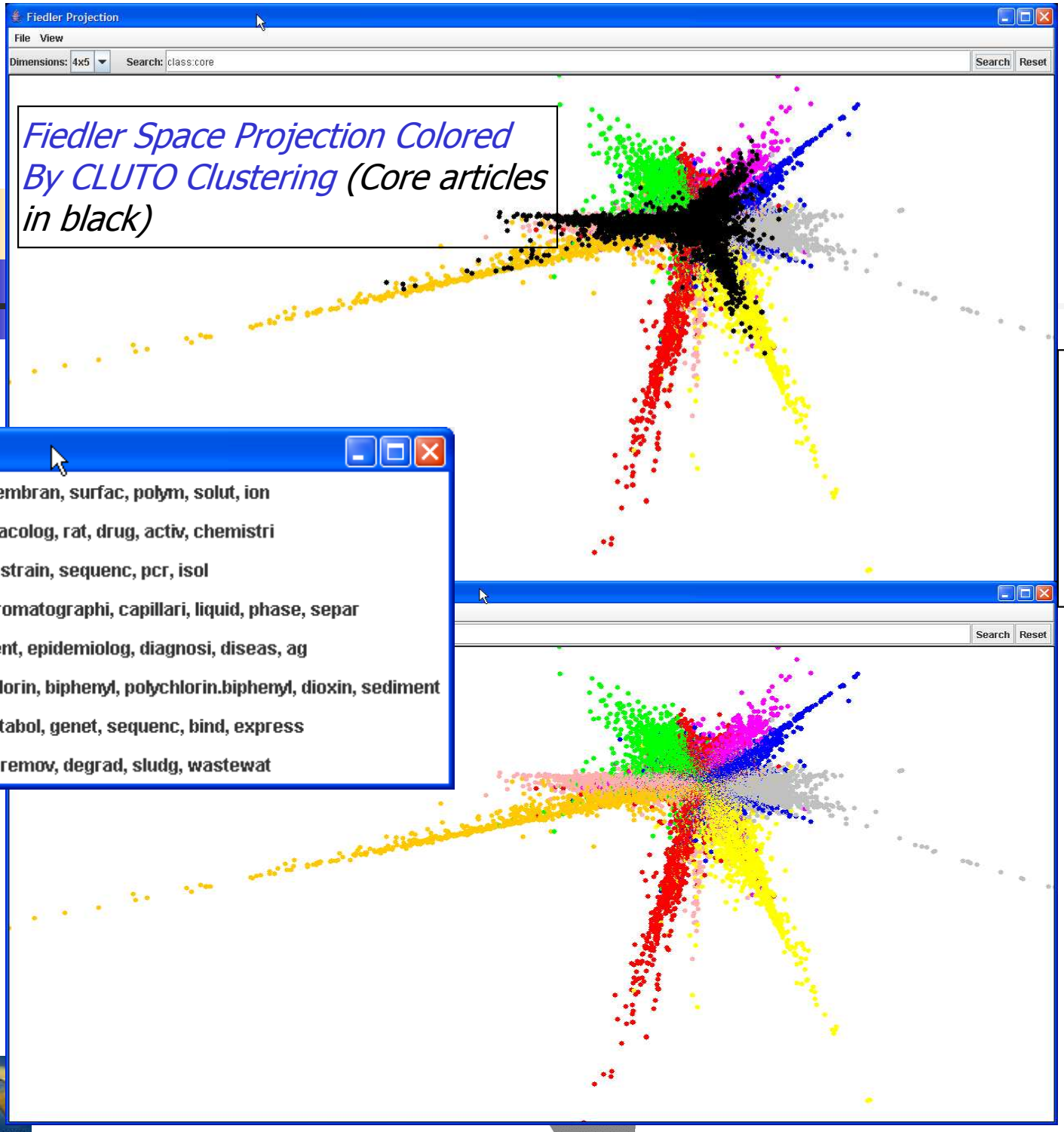
4. Compute the spectrum of the normalized Laplacian

$$\lambda_0 \leq \lambda_1 \leq \cdots \leq \lambda_{n-1}.$$

5. Form the p-dimensional Fiedler projection using the first p non-zero eigenvectors.

Fiedler, M. (1973), "Algebraic connectivity of graphs," Czechoslovak Mathematical Journal, 23 (98):298-305.

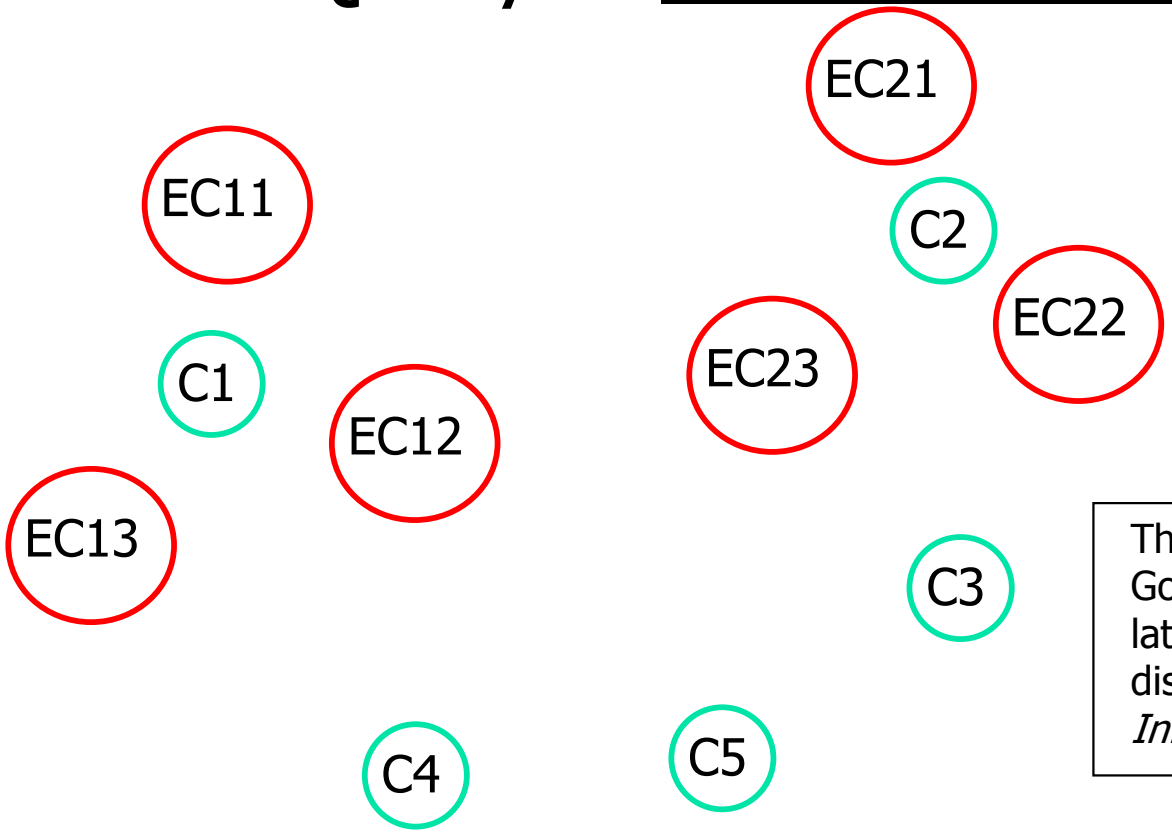
Fiedler Space Projection Colored By CLUTO Clustering (Core articles in black)



Evidence for the correct identification of the core documents.

Discovering Intersecting Article to Article Associations Via Queries in LSI Space

- Query = membrane fouling



LSI Document Space

This approach has its inspirations in: Gordon, M. D., and Dumais, S., 1998,"Using latent semantic indexing for literature-based discovery," *Journal of the American Society for Information Science*, 49(8): 674-685.

Candidate Discoveries - I

- First LSI query is on membrane fouling
- First returned core article
  - Diagnosis of fouling problems of NF and RO membrane installations by a quick scanDESALINATION biofouling; fouling; scaling; diagnosis; membranes; reverse osmosis; nanofiltration; drinking water; autopsyWATER Controlling fouling of membrane filtration installations (nanofiltration and reverse osmosis) is a major challenge for the water industry. Fouling affects the plant performance and increases the costs of plant operation. Diagnosis of the type(s) and extent of fouling is the essential first step for controlling fouling in order to maintain plant performance. A quick scan of the installation for the diagnosis of fouling involves an on-site study of a membrane element (autopsy), including evaluation of data of pretreatment. Comparison of the results of the quick scan with the database with results of autopsies related to plant performance (NPD, MTC), chemicals dosed (e.g. scale inhibitor) would show whether fouling is present and elucidates the types and extent of fouling present. The database also enables the evaluation of the risk on biofouling. Diagnosis of the type of fouling enables directed and more effective actions for prevention and control of (bio)fouling. Studies at (pilot) plants showed that operational problems can be caused by other types of fouling than expected for and that dosed chemicals can pose a risk for (bio)fouling. These case studies emphasize the significance of diagnosis of the type of fouling. Also, tools for prevention and prediction and studying the effect of cleaning strategies on fouling are presented.

Candidate Discoveries - II

- **The endoplasmic reticulum membrane is permeable to small molecules.**
- **Author:** Le Gall S; Neuhof A; Rapoport T
- **Institution:** Department of Cell Biology
- **Journal:** Mol Biol Cell
- **Class:** Expanded Core
- **Year:** 2004
- **Keywords:** Biotin/metabolism; ; **Cell Membrane**/*physiology; ; **Cell Membrane Permeability**/*physiology; ; **Endoplasmic Reticulum**/*physiology; ; **Golgi** Apparatus/*physiology; ; Hela **Cells**; ; Humans; ; Intracellular **Membranes**/*physiology; ; **Protein** Transport/physiology; ; Research Support, Non-U.S. Gov't
- **Score:** 1.0
- The **lumen** of the **endoplasmic reticulum** (**ER**) **differs** from the **cytosol** in its **content** of **ions** and other small **molecules**, but it is **unclear** whether the **ER membrane** is as **impermeable** as other **membranes** in the **cell**. Here, we have tested the **permeability** of the **ER membrane** to small, **nonphysiological molecules**. We **report** that **isolated ER vesicles** allow different **chemical modification reagents** to **pass** from the outside into the **lumen** with little **hindrance**. In **permeabilized cells**, the **ER membrane** allows the **passage** of a small, **charged modification reagent** that is **unable** to **cross** the **plasma membrane** or the **lysosomal** and **trans-Golgi membranes**. A **larger polar reagent** of **approximately 5 kDa** is **unable** to **pass** through the **ER membrane**. **Permeation** of the small **molecules** is **passive** because it **occurs** at **low temperature** in the **absence** of **energy**. These **data** indicate that the **ER membrane** is **significantly** more **leaky** than other **cellular membranes**, a **property** that may be **required** for **protein folding** and other **functions** of the **ER**.

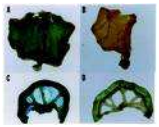
- So a membrane based on the endoplasmic reticulum membrane may offer an approach to mitigate membrane fouling.

Endoplasmic reticulum 

Candidate Discoveries - III

- **Transport of ions across peritoneal membrane**
- **Author:** Islam, N; Bulla, NA; Islam, S **Institution:** Aligarh Muslim Univ **Country:** India **Journal:** BIOCHIMICA ET BIOPHYSICA ACTA-BIOMEMBRANES **Class:** ExpandedCore **Year:** 2004 **Keywords:** transport of **ion**; thermodynamic parameter; entropy of activation; free; **energy** of activation; activation **energy**; peritoneal **membrane**; SHAKER POTASSIUM CHANNEL; SEMIPERMEABLE **MEMBRANES**;; SARCOPLASMIC-**RETICULUM**; COMPOSITE **MEMBRANES**; CHLOROPLAST EXTRACT;; CELLULOSE ACETATE; CALCIUM CHANNELS; REVERSE OSMOSIS; CA2+ PUMP;; BILAYERS **Score:** 0.7477426 The electrical conductance of **ions** across the peritoneal **membrane** of young buffalo (**approximately** 18-24 months old) has been recorded. Aqueous solutions of NaF, NaNO3, NaCl, Na2SO4, KF, KNO3, KCl, K2SO4, MgCl2, CaCl2, CrCl3, MnCl2, FeCl3, COCl2, and CiCl(2) were used. The conductance values have been found to increase with increase in concentration as well as with **temperature** (15 to 35 degreesC) in these cases. The slope of plots of specific conductance, K, versus concentration exhibits a decrease in its values at relatively higher concentrations compared to those in extremely dilute solutions…

- A Peritonieal-like membrane may offer up new approaches to the defeat of membrane fouling and to the facilitation of selective transport of ions across membranes.



peritoneal membrane

Candidate Discoveries - IV

- Another expanded core article associated with this article in LSI space.
- Several dibromotyramine derivatives including moloka'iamine were selected as potential zebra mussel (Dreissena polymorpha) antifoulants due to the noteworthy absence of fouling observed on sponges of the order Verongida. Sponges of the order Verongida consistently produce these types of bromotyrosine-derived secondary metabolites. Previously reported antifouling data for the barnacle Balanus amphitrite(EC50 = 12.2 microM) support the results reported here that the compound moloka'iamine may be a potential zebra mussel antifoulant compound (EC50 = 10.4 microM). The absence of phytotoxic activity of the compound moloka'iamine toward Lemna pausicostata and, most importantly, the compound's significant selectivity against macrofouling organisms such as zebra mussels suggest the potential utility of this compound as a naturally derived antifoulant lead.

- So **moloka'iamine or some of its derivatives** may be a potential antifouling agent to defeat fouling on filtration membranes

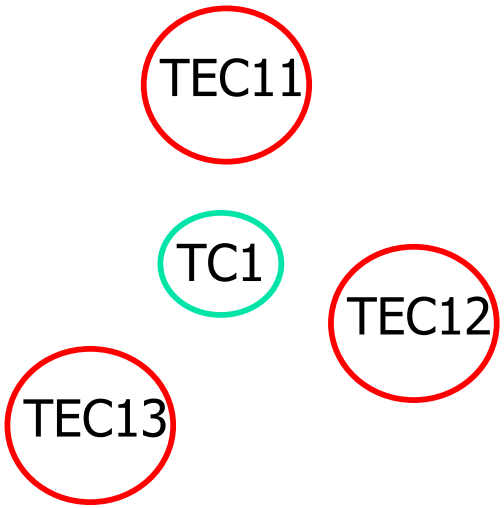
Candidate Discoveries - V

- Another expanded core article associated with this article in LSI space.
- In this work, we show the potent antifouling effects of two compounds, barettin (cyclo[(6-bromo-8-entryptophan)arginine]) (1), isolated as a Z/E mixture (87/13), and 8,9-dihydrobarettin (cyclo[(6-bromotryptophan)arginine]) (2), isolated from the marine sponge Geodia barretti. The compounds were isolated guided by their ability to inhibit the settlement of cyprid larvae of the barnacle Balanusimprovisus, and their structures were determined by means of mass spectrometry, NMR, and quantitative amino acid analysis. The activities of these brominated diketopiperazine-like cyclic dipeptides are in the range of antifouling agents in use today, as shown by their EC(50) values of 0.9 and 7.9 microM, respectively. However, contrary to today's antifouling agents, the effects of barettin and 8,9-dihydrobarettin are nontoxic and reversible. A small set of synthetic analogues, including l-arginine, l-tryptophan, 5-bromo-d,l-tryptophan, 6-bromo-d,l-tryptophan, and 6-fluoro-d,l-tryptophan, were tested for possible structure-activity relationships. None of these compounds showed any effect at a concentration of 10 microM. We hypothesize that the isolated compounds are part of the sponge's chemical defense to deter fouling organisms. This theory is supported by the fact that barettin is found in water exposed to living specimens of G. barretti in concentrations that completely inhibit barnacles from settling.

- So **barettin (cyclo[(6-bromo-8-entryptophan)arginine]) and 8,9-dihydrobarettin (cyclo[(6-bromotryptophan)arginine])** may be a potential antifouling agent to defeat fouling on membranes

Discovering Intersecting Term to Term Associations Via Distances in LSI Term Space

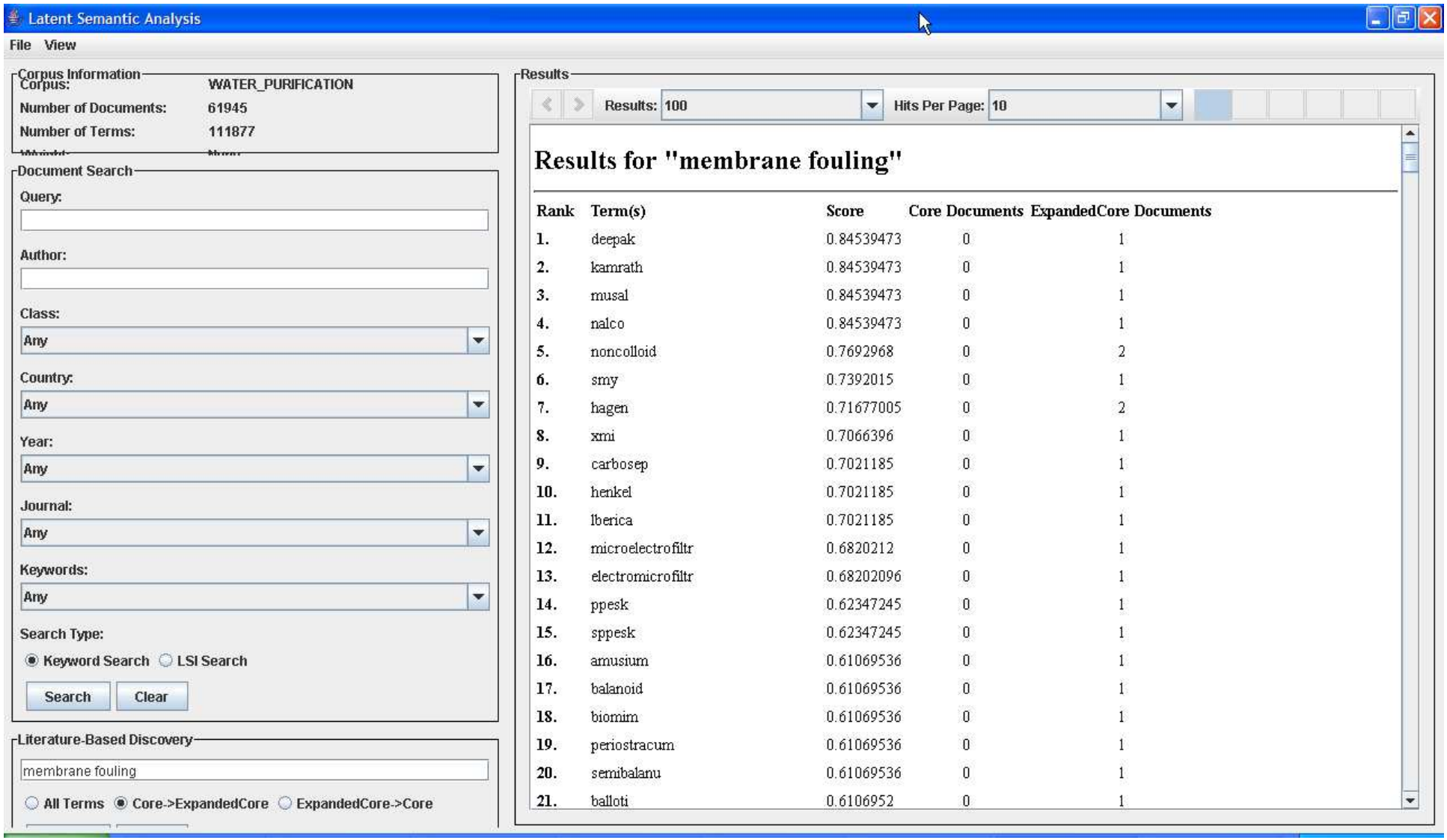
- Query = membrane fouling



LSI Term Space

This approach is a modified version of the one developed in:
Gordon, M. D., and Dumais, S., 1998,"Using latent semantic indexing for literature-based discovery," *Journal of the American Society for Information Science*, 49(8): 674-685.

Membrane Fouling Associations Based on LSI Distance in Term Space



Software implemented in JAVA along with SVDPACKC

Candidate Discoveries (Expanded Core Terms Associated With Membrane Fouling) - I

- amusium, Rank # 16, LSI score 0.61069536
  - amusium is a bivalve whose antifouling properties may have applications to the defeat of membrane fouling
  - Does not occur in the core collection.
  - Does mention fouling in the article.

- Foramina Rank # 245, LSI score 0.37642112
  - Pleurosigma is a diatom with a valve structure that has properties that may be highly relevant to water purification.
  - Does not occur in our core collection.
  - No mention of fouling in the article.

Term to Term Candidate Discoveries - II

- **1. Fouling deterrence on the bivalve shell mytilus galloprovincialis: A physical phenomenon?**
- **Author:** Scardino, AJ; de Nys, R
- **Institution:** James Cook Univ N Queensland
- **Country:** Australia
- **Journal:** BIOFOULING
- **Class:** ExpandedCore
- **Year:** 2004
- **Keywords:** biofouling; bivalves; Mytilus galloprovincialis;

- **Amusium** balloti;; surface microtexture; fouling deterrence; SELF-CLEANING ABILITIES; MICRO-TEXTURED SURFACES; SUBSTRATUM; HETEROGENEITY; ALGA ENTEROMORPHA; SEMIBALANUS-BALANOIDES; SETTLEMENT;; BARNACLE; RECRUITMENT; PERIOSTRACUM; ORGANISMS The physical nature of fouling deterrence by the mussel Mytilus galloprovincialis was investigated using high-resolution biomimics of the bivalve surface. The homogeneous microtextured surface of M. galloprovincialis (1.94 +/- 0.03 mum), the smooth surface of the bivalve **Amusium** balloti (0 mum), and moulds of these surfaces (biomimics) were compared with controls of smooth (0 mum) and sanded moulds, (55.4 +/- 2.7 mum) and PVC strips (0 mum) in a 12-week field trial. The shell and mould of M. galloprovincialis were fouled by significantly fewer species and had significantly less total fouling cover than the shell and mould of A. balloti over a 12-week period. However, the major effects were between surfaces with and without microtopography. Surface microtopography, be it structured as in the case of M. galloprovincialis shell and mould, or random as in the case of the sanded mould, had a lower cover of fouling organisms than treatments without microtopography after 6 weeks. There was also no difference between the effect of the M. galloprovincialis mould and the sanded mould. The strong fouling deterrent effects of both these surfaces diminished rapidly after 6 to 8 weeks while that of M. galloprovincialis shell remained intact for the duration of the experiment suggesting factors in addition to surface microtopography contribute to fouling deterrence.

- Although the fouling properties of such organisms is known to the biological community they have not, to the best of our knowledge been studied in the context of counteracting filtration membrane fouling.

Term to Term Candidate Discoveries - III

- **Valve morphogenesis in the diatom genus Pleurosigma W. Smith (Bacillariophyceae): Nature's alternative sandwich**
- **Author:** Sterrenburg, FAS; Tiffany, MA; del Castillo, MEM
- **Institution:** San Diego State Univ; Univ Autonoma Metropolitana Iztapalapa
- **Country:** USA; Mexico
- **Journal:** JOURNAL OF NANOSCIENCE AND NANOTECHNOLOGY
- **Class:** ExpandedCore
- **Year:** 2005
- **Keywords:** Pleurosigma; morphogenesis; silicate deposition; sandwich structure
- The loculate ("chambered") valve structure of centric diatoms like Triceratium favus Ehrenberg has been mentioned time and again in the nanostructure literature. Here we draw attention to the fundamentally different alternative sandwich model nature developed in the genus Pleurosigma, where it is nonloculate. This has so far been overlooked in nanostructural studies. We suggest some mechanical aspects that would offer interesting avenues for experimental testing. The first description of the natural fabrication process ("morphogenesis") is presented. This begins with the development of the raphe sternum, which then acts as a rigid backbone. The inner layer of the sandwich-structured valve develops next, with relatively large round single internal **foramina** not yet closed by a sieve membrane, in offset arrangement. This serves as a substrate for rows of stubby hollow pillars, also in offset arrangement. Then the outer layer of the sandwich develops and two different patterns ("coarse-mesh" and "stellate bridges") have been observed. At first, the external areolar **foramina** are relatively large and +/- oval, gradually filling up until the tiny slits characteristic of the genus remain. In Pleurosigma species with double internal areolar **foramina**, small bridges grow from the opposite margins of the single **foramina** until they fuse. The sieve-membranes then close the internal areolar **foramina**. The finished valve is a lightweight structure expected to offer excellent strength with parsimonious expenditure of the raw material-silica.

Term to Term Candidate Discoveries - III

- Triceratium favus Ehrenberg
- Study of and replication of this value structure may have applications in the water purification arena.

Candidate Associations – Expanded Core Terms Near the Core Term Membrane Fouling

- **1. A roughness-based wettability switching membrane device for hydrophobic surfaces**
- **Author:** Lee, J; He, B; Patankar, NA **Institution:** Seoul Natl Univ; Northwestern Univ **Country:** South Korea; USA **Journal:** JOURNAL OF MICROMECHANICS AND MICROENGINEERING **Class:** ExpandedCore **Year:** 2005 **Keywords:** SUPERHYDROPHOBIC STATES; WATER; FABRICATION; RESISTANCE; ELASTOMER;; LOTUS This work presents the development of a wettability switching membrane device using the surface roughness effect. We designed and fabricated a roughness switchable membrane device, consisting of a thin poly(dimethylsiloxane) (PDMS) membrane bonded on the top of a rough PDMS substrate. A thin (less than 2 μ m) PDMS membrane fabrication technique was developed. The membrane device was tested and it was found that the surface wettability can be switched from medium hydrophobic to superhydrophobic states by deflecting the membrane with a pneumatic method. The reported mechanism is the first demonstration of a we **ttability** switching mechanism using surface roughness modification. Theoretical analysis was used to explain experimental results.

- Word was ttabil with an LSI score of .607 and a rank of 22
- So adaptive membrane technology is the idea in this one.

Expanded Core Terms Near the Core Term Membrane Fouling

- **1. Development of an ultrasonic technique for in situ investigating the properties of deposited protein during crossflow ultrafiltration**
- **Author:** Li, JX; Sanderson, RD; Chai, GY; Hallbauer, DK **Institution:** Tianjin Polytech Univ; Tianjin Polytech Univ; Tianjin Polytech Univ; Univ Stellenbosch **Country:** China; China; China; South Africa **Journal:** JOURNAL OF COLLOID AND INTERFACE SCIENCE **Class:** ExpandedCore **Year:** 2005 **Keywords:** ultrasonic technique; bovine serum albumin; protein deposition;; ultrafiltration; fouling; isoelectric point; TIME-DOMAIN REFLECTOMETRY; DEAD-END ULTRAFILTRATION; CONCENTRATION; POLARIZATION; REVERSE-OSMOSIS; MICROFILTRATION MEMBRANES; HYDRAULIC; PERMEABILITY; IONIC ENVIRONMENT; FINE-STRUCTURE; CHEESE WHEY; ADSORPTION Although an amount of research has reported that a flux minimum occurrs at the **isoionic**/isoelectric points (pH 4.6-5.0) in the absence of salts in the ultrafiltration of bovine serum albumin (BSA), the real mechanism remains incompletely understood due to the lack of additional techniques in real time to detect the properties of deposited BSA (gel) layers formed during ultrafiltration (UF). An ultrasonic technique was developed as an analytical noninvasive tool to in situ investigate the properties of deposited BSA layers at pH 4.9 (**isoionic** or isoelectric point, IEP) and 6.9 during crossflow ultrafiltration. The membrane was a polysulfone (PSf) UF membrane with molecular weight cut-off (MWCO) 35 kDa. The feed used was 0.5 g/l BSA solution. Results show good correspondence between the ultrasonic signal responses and the development of BSA gel layers on the membranes. The deposit is thicker at pH 6.9 than at pH 4.9. However, the deposited gel layers are more compressible at pH 4.9 than at pH 6.9. The flux decline is mainly controlled by the density (packing) of the deposit layer. At pH 6.9, protein mainly deposits on the membrane surface. Around the isoelectric point, protein absorbs within and on the membranes. A functional relationship between acoustic signals and fouling resistance exists. The fouling resistance is mainly attributed to pore blocking or pore constriction. (c) 2004 Elsevier Inc. All rights reserved.

- **Rank 56.** isoion LSI score 0.55152047
- May have application of in situ querying of water purification membranes

Expanded Core Terms Near the Core Term Membrane Fouling

- **1. Prevention of microparticle blocking in activated carbon membrane filtration with carbon whisker**
- **Author:** Bae, SD; Sagehashi, M; Sakoda, A **Institution:** Univ Tokyo **Country:** Japan **Journal:** JOURNAL OF MEMBRANE SCIENCE **Class:** ExpandedCore **Year:** 2005 **Keywords:** activated carbon membrane; carbon whisker; microparticle blocking; cake; filtration; numerical analysis; WATER-TREATMENT; FIBERS; MODEL We have developed activated carbon membranes (ACM) that can remove not only particulate matters but also dissolved organic matters. Recently, we succeeded in growing carbon whiskers on activated carbon membranes (W-ACM). **We hypothesize that the whiskers prevent the flux from lowering due to particle blocking on the membrane surface. In this study, we compared the filtration properties and blocking characteristics of ACM and W-ACM using an artificial microsphere (polymethyl methacrylate) (PMMA), particle diameter=0.8, 5, and 10 mu m) to estimate the effect of whiskers on particle filtration.** We found that the whiskers successfully prevented a reduction of penetration flux in all particle diameters; however, the prevention mechanism seems to be different according to the filtrated particle size. To clarify the mechanism, we performed numerical model analysis using a microfiltration model. In the case of 0.8 mu m particle filtration, whiskers seemed to inhibit the packing of particles into the **microholes** existing at the surface of activated carbon membrane, and with 5-10 mu m particle filtration, the packing density of the cake layer accumulated on the membrane would be reduced with the appearance of whiskers. (c) 2004 Elsevier B.V. All rights reserved.

- **140.** microhol 0.44605044

Expanded Core Terms Near the Core Term Membrane Fouling (This is Really Expanded Core!!)

- 1. M-theory inflation from multi M5-brane dynamics
- Author: Becker, K; Becker, M; Krause, A Institution: Univ Utah; Univ Maryland Country: USA; USA Journal: NUCLEAR PHYSICS B Class: ExpandedCore Year: 2005 Keywords: inflation; M-theory; HETEROTIC M-THEORY; STRING THEORY; GLUINO CONDENSATION; MEMBRANE; INSTANTONS; N=1 SUPERGRAVITY; COMPACTIFICATIONS; SUPERSYMMETRY;; DIMENSIONS; VACUA; SUPERPOTENTIALS We derive inflation from M-theory on S-1/Z(2) via the non-perturbative dynamics of N M5-branes. The open membrane instanton interactions between the M5-branes give rise to exponential potentials which are too steep for inflation individually but lead to inflation when combined together. The resulting type of inflation, known as assisted inflation, facilitates considerably the requirement of having all moduli. except the inflaton, stabilized at the beginning of inflation. During inflation the distances between the M5-branes, which correspond to the inflatons, grow until they reach the size of the S-1/Z(2) orbifold. At this stage the M5-branes will reheat the universe by dissolving into the boundaries through small instanton transitions. Further flux and non-perturbative contributions become important at this late stage, bringing inflation to an end and stabilizing the moduli. We find that with moderate values for N, one obtains both a sufficient amount of e-foldings and the right size for the spectral index. © 2005 Elsevier B.V. All rights reserved.

- **217.** inflaton 0.39573467

Some Tool #4 Candidate Associations – Expanded Core Terms Near the Core Term Membrane Fouling

- **1. Valve morphogenesis in the diatom genus Pleurosigma W. Smith (Bacillariophyceae): Nature's alternative sandwich**
- **Author:** Sterrenburg, FAS; Tiffany, MA; del Castillo, MEM **Institution:** San Diego State Univ; Univ Autonoma Metropolitana Iztapalapa **Country:** USA; Mexico **Journal:** JOURNAL OF NANOSCIENCE AND NANOTECHNOLOGY **Class:** ExpandedCore **Year:** 2005 **Keywords: Pleurosigma**; morphogenesis; silicate deposition; sandwich structure The loculate ("chambered") valve structure of centric diatoms like Triceratium favus Ehrenberg has been mentioned time and again in the nanostructure literature. Here we draw attention to the fundamentally different alternative sandwich model nature developed in the genus **Pleurosigma**, where it is nonloculate. This has so far been overlooked in nanostructural studies. We suggest some mechanical aspects that would offer interesting avenues for experimental testing. The first description of the natural fabrication process ("morphogenesis") is presented. This begins with the development of the raphe sternum, which then acts as a rigid backbone. The inner layer of the sandwich-structured valve develops next, with relatively large round single internal foramina not yet closed by a sieve membrane, in offset arrangement. This serves as a substrate for rows of stubby hollow pillars, also in offset arrangement. Then the outer layer of the sandwich develops and two different patterns ("coarse-mesh" and "stellate bridges") have been observed. At first, the external areolar foramina are relatively large and +/- oval, gradually filling up until the tiny slits characteristic of the genus remain. In **Pleurosigma** species with double internal areolar foramina, small bridges grow from the opposite margins of the single foramina until they fuse. The sieve-membranes then close the internal areolar foramina. The finished valve is a lightweight structure expected to offer excellent strength with parsimonious expenditure of the raw material-silica.

- **243.** pleurosigma 0.3764212
- Currently as implemented multiple term associations from the same article are possible.

Some Tool #4 Candidate Associations – Expanded Core Terms Near the Core Term Membrane Fouling

- **1. Self-assembled growth of C-60 nanowhiskers on anodic porous alumina membranes**
- **Author:** Qiu, T; Wu, XL; Wu, CX; Yang, X; Shao, XF; Huang, GS; Siu, GG **Institution:** Nanjing Univ; Nanjing Univ; City Univ Hong Kong **Country:** China; China; China **Journal:** APPLIED PHYSICS A-MATERIALS SCIENCE and PROCESSING **Class:** ExpandedCore **Year:** 2005 **Keywords:** INTERFACIAL PRECIPITATION METHOD; CARBON NANOTUBES; ARRAYS; FILMS;; PHOTOLUMINESCENCE; EMISSION; SILICON; SIO2 Unique structured claw-like C-60 **nanowhiskers** were fabricated on an anodic porous alumina membrane. Tips of the C-60 **nanowhiskers** are shaped like cusps, which directly extend into the nanopores of the alumina membrane. It is revealed that the surface stress of the alumina membrane with a highly ordered nanopore arrangement due to thermal treatment is responsible for self-assembled growth of the observed C-60 **nanowhiskers**. The ordering of the nanopore arrangement in the anodic porous alumina membrane helps to form the C-60 **nanowhiskers** along the nanopore channe ls. The shape and structure of the C-60 **nanowhiskers** are promising characteristics for applications in nanodevices such as field-emission tips and nanoprobes.
- **332.** nanowhisk 0.3409559 0 2
- This is related back to the nanowhisker article on preventing clogging.

Questions??

These will be handled by my assistant.