Using Multi-partite Graphs for Recommendation and Discovery

Michael J. Kurtz, Alberto Accomazzi, and Edwin Henneken

Harvard-Smithsonian Center for Astrophysics
Networks

- 11% Physical Review E
- The $200 billion algorithm
- 6 degrees of separation
- Bacon number $\rightarrow$ 4
- Erdos number $\rightarrow$ 3
- Gray number $\rightarrow$ 2
Friendship Networks

Moody/Newman
Networks

• Objects have properties
• Which is the object, which is the property
  • Do authors have papers
  • Or do papers have authors
• Weighted links \( \rightarrow \) Factor analysis, classification mathematics
A Bipartite Network
Article Networks
Pavlos Protopapas - Time Series Center

- stars
- observations
- series of observations $\Rightarrow$ time series
- similarity measure for TS
- groups of similar TS $\Rightarrow$ stars
- papers on stars from SIMBAD
- KW for papers from ADS
- KW $\Rightarrow$ proto-classification of TS/star
Papers

- Papers
- Authors
- Readers
- Key words
- Words
- Organizations
- References
- Date
- Data, …
Search

- Different searches from the same query can give very different results
- There is no best answer for all cases
Figure 6: Obsolescence of articles from the four main astronomy journals (Astrophysical Journal, Astronomical Journal, Monthly Notices of the Royal Astronomical Society, and Astronomy and Astrophysics) by frequent ADS users and by Google users in terms of actual use.
Search

• Filter, rank on properties, which properties, what is the goal?
• User decides (or default)
• Example: “weak lensing” 2217 papers in ADS, how to rank on properties?
SAO/NASA ADS Astronomy Query Form for Michael Kurtz

Databases to query:  
- **Astronomy**  
- **Physics**  
- **arXiv e-prints**

**Authors:** (Last, First M, one per line)  
- □ **SIMBAD**  
- □ **NED**  
- □ **ADS Objects**
- □ Exact name matching  
- □ Require author for selection
- ( □ OR □ AND □ simple logic)

**Publication Date** between    
and

**Enter Title Words**
(Combine with: □ OR □ AND □ simple logic □ boolean logic)

**Enter Abstract Words/Keywords**
(Combine with: □ OR □ AND □ simple logic □ boolean logic)
"weak lensing"

Return **200** items starting with number 1

**Full Text Search:** Search OCRd text of scanned articles

**myADS:** Personalized notification service

**Private Library** and **Recently read articles** for Michael Kurtz
FILTERS

Select References From:
- All bibliographic sources
- All refereed articles
- All non-refereed publications

Select/deselect publications: (',', ' separated list)

Select References With:
- A bibliographic entry
- At least one of the following (OR):
  - All of the following (AND):
  - None of the following (NOT):
    - Abstracts
    - Data Links
    - Full Text Articles
    - Scanned Articles
    - arXiv e-print
    - Table of Contents
    - Citations
    - Electronic Articles
    - Mail Order Links
    - References
    - Other related articles
    - SIMBAD Objects
    - NED Objects
    - PDS Information
    - Author Comments
    - Library Links
    - Multimedia
    - Also-read
    - HEP/SPIRES Links

Select References In:
- All Groups
- At least one of the following groups (OR):
- All of the following groups (AND):
  - ARI
  - CfA
  - CfHT
  - Chandra
  - ESO/Lib
  - ESO/Telescopes
  - GBST
  - Gemini
  - Helioseismology
  - HST
  - ISO
  - IUE
  - Reck
  - Leiden
  - LPI
  - NCSA/ADIL
  - ROSAT
  - SDO
  - SMA
  - Spitzer
  - Subaru
  - USNO
  - VSGC
  - XMM

Entry Date:
Since: Day(DD) Month(MM) Year(YYYY)
Before: Day(DD) Month(MM) Year(YYYY)
Min Score: 

Send Query  Return Query Form  Store Default Form  Clear
### Sorting
- Sort by score
- Sort by normalized score
- Sort by citation count
- Sort by normalized citation count
- Sort by first author name
- Sort by number of authors
- Sort by date (most recent first)
- Sort by date (oldest first)
- Sort by entry date
- Sort by page (ToC sort)

### Format
- HTML abstracts
- plain text abstracts
- BIBTEX reference list
- short list format
- generic tagged abstracts
- EndNote format
- ProCite format
- Refman format
- RefWorks format
- MEDIARS format
- Dublin Core XML
- XML abstracts
- XML references
- VOTables
- RSS
- AASTeX
- Icarus
- MNRAS
- SoPh
- Link
- Custom

### Settings

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- **Require Field for Selection**

- **Synonym Replacement**

- **Relative Weights**

- **Use For Weighting**

- **Weighted Scoring**

- [Send Query](#)  [Return Query Form](#)  [Store Default Form](#)  [Clear](#)
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Search

• Different goals require different search
• User decides on goal
ADS Topic Search

"weak lensing"

e.g.: "dark energy", "extrasolar planets", "weak lensing", "spin hall"

Keyword Search:  
- Most relevant
- Most recent
- Most important

Subject Area Search:  
- Most popular
- Most useful
- Most instructive

ADS Home | Abstract Search | Help
### Query Results from the ADS Database

Retrieved 200 abstracts, starting with number 1. Total number selected: 2357.

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<td>2007MNRAS.381..702B</td>
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<td>Benjamin, Jonathan; Heymans, Catherine; Semboloni, Elisabetta; van Waerbeke, Ludovic; Hoekstra, Henk; Erben, Thomas; Gladders, Michael D.; Hetterscheidt, Marco; Mellier, Yannick; Yee, H. K. C.</td>
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Keyword Search:
- Most relevant
- Most recent
- Most important
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Keyword Search:

- Most relevant
- Most recent
- Most important

= Most cited
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2nd Order Operators

• Use the properties of the results of an initial query to form a new query

• Example: People who bought **these books** also bought

• In ADS using cites and reads since 1996
Subject Area Search:

- Most popular
- Most useful
- Most instructive
1. Get most recent 200 papers containing phrase
2. Find all readers who read one or more of these papers within the last three months
3. Find all papers read by these readers
4. Sort by frequency of use
### Also-read Articles from the ADS Database

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Subject Area Search:

- Most popular
- Most useful
- Most instructive
1. Get most relevant 200 papers containing phrase
2. Find all papers cited in the reference sections of those papers
3. Sort by frequency
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Subject Area Search:

- Most popular
- Most useful
- Most instructive
1. Get most important (cited) 200 papers containing phrase
2. Find all papers which cite any of these papers
3. Sort by number of papers cited
The Citation database in the ADS is **NOT** complete. Please keep this in mind when using the ADS Citation lists.

Retrieved **200** abstracts, starting with number 1. Total number selected: **5825**. Total citations: **16885**

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Browse

• User mediated, but not intended to solve an immediate need
KURTZ, MICHAEL J - Citations: 132 (total 2600)

2009arXiv0909.3849A: Assef,+: Low Resolution Spectral Templates For AGNs and Galaxies From 0.03 -- 30 microns
2009arXiv0909.1318M: Merritt: The Distribution of Stars and Stellar Remnants at the Galactic Center
2009arXiv0908.2996S: Shaw,+: Optical Spectroscopy of Bright Fermi LAT Blazars

+REDSHIFT COSMOLOGY, etc - Recent Papers

2009arXiv0909.3849A: Assef,+: Low Resolution Spectral Templates For AGNs and Galaxies From 0.03 -- 30 microns
2009arXiv0909.3550K: Krick,+: The IRAC Dark Field; Far- Infrared to X-ray Data
2009arXiv0909.3853B: Bean: A weak lensing detection of a deviation from General Relativity on cosmic scales
2009arXiv0909.3517G: Gonzalez,+: The Stellar Mass Density and Specific Star Formation Rates of the Universe at z~7
**REDSHIFT COSMOLOGY, etc - Most Popular**


2009arXiv0907.1660P: Percival,+: Baryon Acoustic Oscillations in the Sloan Digital Sky Survey Data Release 7 Galaxy Sample

2009arXiv0907.1659R: Reid,+: Cosmological Constraints from the Clustering of the Sloan Digital Sky Survey DR7 Luminous Red Galaxies


2009MNRAS.tmp.1256C: Cardamone,+: Galaxy Zoo Green Peas: discovery of a class of compact extremely star-forming galaxies

**REDSHIFT COSMOLOGY, etc - Most Cited**

2003MNRAS.344.1000B: Bruzual,+: Stellar population synthesis at the resolution of 2003


1998ApJ...500..525S: Schlegel,+: Maps of Dust Infrared Emission for Use in Estimation of Reddening and Cosmic Microwave Background Radiation Foregrounds


2000AJ....120.1579Y: York,+: The Sloan Digital Sky Survey: Technical Summary
User-Based Browse

1. Create hierarchal system of user clusters based on shared papers referenced by read papers

2. For each (sub) cluster get all reads by group members

3. Sort top of most-read list by date (latest to the top)

4. Iterate
HOT TOPICS
Planets
Solar Corona
Protostars
Circunstellar Disks
MW Dwarf Galaxies
Black Holes
X-Rays
Gamma Rays
Galaxy Formation
CMB

The SAO/NASA Astrophysics Data System

HOT Papers

2009Natur.458...53B Boroson,+ : A candidate sub-parsec supermassive binary black hole system

2009Sci...323..754K Krumholz,+ : The Formation of Massive Star Systems by Accretion


2009ApJS..180..306D Dunkley,+ : Five-Year Wilkinson Microwave Anisotropy Probe Observations: Likelihoods and Parameters from the WMAP Data


2009ApJ...691L.142K Kormendy,+ : Correlations between Supermassive Black Holes, Velocity Dispersions, and Mass Deficits in Elliptical Galaxies with Cores

2009Natur.457..451D Dekel,+ : Cold streams in early massive hot haloes as the main mode of galaxy formation
The SAO/NASA Astrophysics Data System

HOT Papers in MW Dwarf Galaxies

2009ApJ...693L..19H Herrmann,+: Kinematic Evidence for Halo Substructure in Spiral Galaxies


2009arXiv0902.2759M Majewski,+: Galactic Dynamics and Local Dark Matter

2009arXiv0902.2591K Kirby,+: The Role of Dwarf Galaxies in Building Large Stellar Halos


HOT Papers on MW Globular Clusters

2009arXiv0904.1626A Anderson, + : Mixed Populations in Globular Clusters: Et Tu, 47 Tuc?

2009ApJ...695L..62Y Yong, + : A Large C+N+O Abundance Spread in Giant Stars of the Globular Cluster NGC 1851


2009A&A...497..755M Milone, + : Multiple stellar populations in Magellanic Cloud clusters. I. An ordinary feature for intermediate age globulars in the LMC?


2009arXiv0903.2839B Bedin, + : The End of the White Dwarf Cooling Sequence in M4: an efficient approach

2009arXiv0902.1422P Piotto : Observations of multiple populations in star clusters

2009A&A...493..959B Bellini, + : Ground-based CCD astrometry with wide field imagers. III.
Recommend

• No user interaction
• What do we know about the user’s current need?
• Example: user is currently reading an article
• Could also use history of user/similar user behavior, but not yet
Recommend

• A complicated process

1. Get normalized key words 991 E.H.

2. Make 991 dim vectors for each paper by KW frequency in the referenced papers

3. Create user vectors as sum of read papers

4. Create vector space using SVD

5. Fit papers to most significant SVD vectors (50)
6. Cluster papers (64) in the ~50 dim SVD vector space

7. Create an SVD vector sub-space for each cluster of papers

8. Fit papers in each cluster to most significant (5) SVD vectors for relevant subcluster

9. For the paper being read, find the nearest ~40 papers in the relevant sub-space

10. Use these papers to increase the S/N for the different recommender operators
Most after-read, most before-read, most co-read, most recent also-read, most also-read, most cited, most citing:

For the paper: 2005MNRAS.359..308Z, On the influence of relativistic effects on X-ray variability of accreting black holes


Most co-read: 2006ApJ...646..394M, Simultaneous Chandra and RXTE Spectroscopy of the Microquasar H1743-322: Clues to Disk Wind and Jet Formation from a Variable Ionized Outflow

Most recent also-read: 2009NewA...14..674F, What is the closest black hole to the Sun?


Most citing: 2007ARA&A..45..441M, Relativistic X-Ray Lines from the Inner Accretion Disks Around Black Holes
On the influence of relativistic effects on X-ray variability of accreting black holes

Życki, Piotr T.; Niedźwiecki, Andrzej


X-rays produced by compact flares corotating with a Keplerian accretion disc are modulated in time by Doppler effects. We improve on previous calculations of these effects by considering recent models of intrinsic X-ray variability, and we compute the expected strength of the relativistic signal in current data of Seyfert galaxies and black hole binaries. Such signals can clearly be seen in, for example, recent XMM-Newton data from MCG-6-30-15, if indeed the X-rays are produced by corotating flares concentrated toward the inner disc edge around an extreme Kerr black hole. The lack of the signal in the data collected so far gives support to models where the X-ray sources in active galaxies do not follow Keplerian orbits close to the black hole.

Keywords: accretion, accretion discs - relativity - galaxies: active - X-rays: binaries - X-rays: individual: MCG-6-30-15.

DOI: 10.1111/j.1365-2966.2005.08887.x
A Densely Interconnected World: Knowledge Engineering

- Semantic interlinking of literature with data (OAI-ORE, …)
- Connecting tools and procedures with each other and their results (Work-Flow, …)
- There is no best bridge, building, … design
Final Program

From Intelligent Networks to the Global Brain

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