Science Priorities for the VO

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http://wiki.ivoa.net/twiki/bin/view/IVOA/IvoaSciencePriorities

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Motivation: to enable more science!

What we do here has the goal of improving human's knowledge about the Universe

How do we do it best? By understanding in detail our users.

Timeline of a scientific paper

Make hypothesis

- Motivation
- *Visualization*
- Creativity
- Knowledge

Obtain data to test hypothesis

- *Simple / easy* access to *reliable* and *relevant* data

Analyze data to create new theory

- *Fast* computation on new data
- *Easy* comparison between data and models/ theory

Revise existing data with new theory

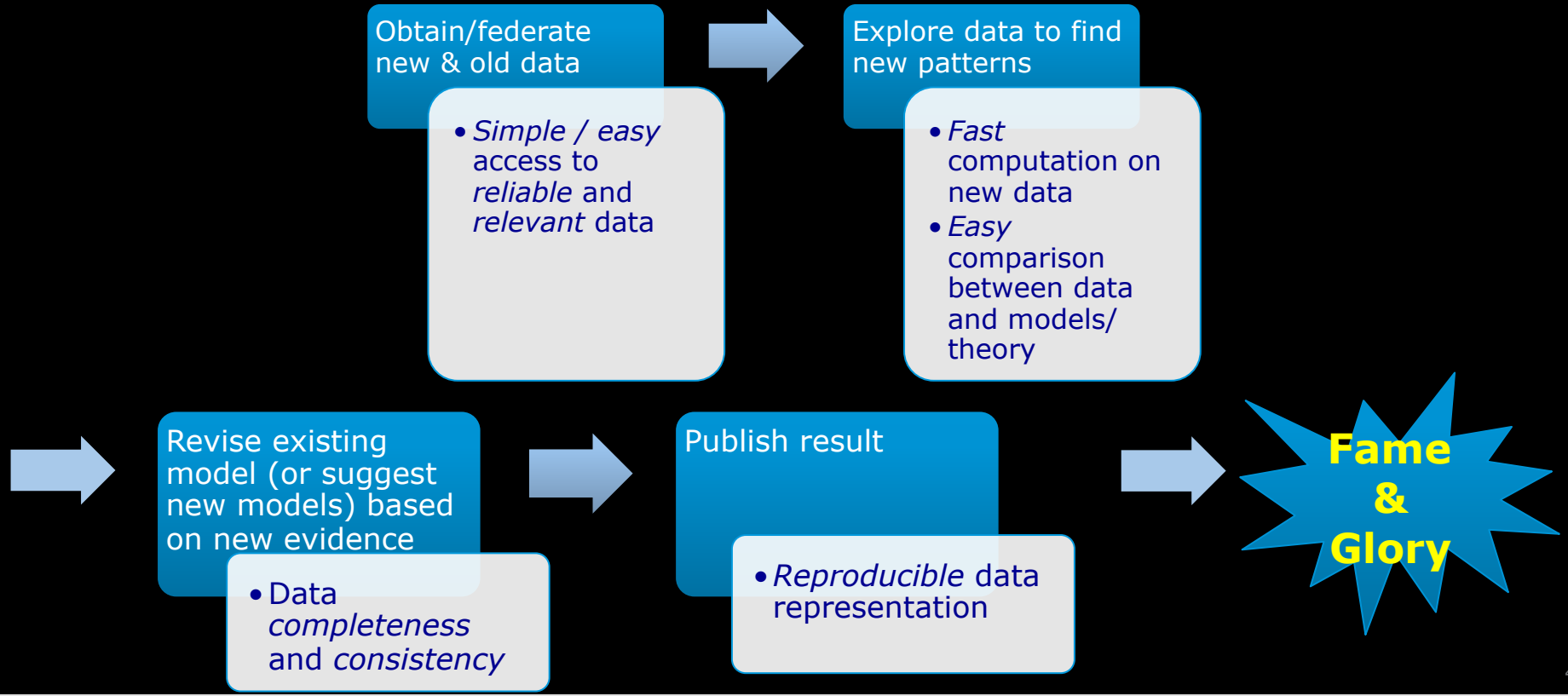
- Data *completeness* and *consistency*

Publish result

- *Reproducible* data representation

Fame & Glory

Timeline of a scientific paper (II)



Science is about revising the data

re-search

Tension between data homogeneity and completeness

The most advanced ultimate data query system should enable a dialogue with the user, like in the movie “her” (2013)

Current scientific priorities at IVOA

Time-domain astronomy: light-curves -> see new proposed TIMESYS

Multi-dimensional data: spectral or time cubes (sky + wavelength/frequency or sky + time)

New priorities discussed in CSP:

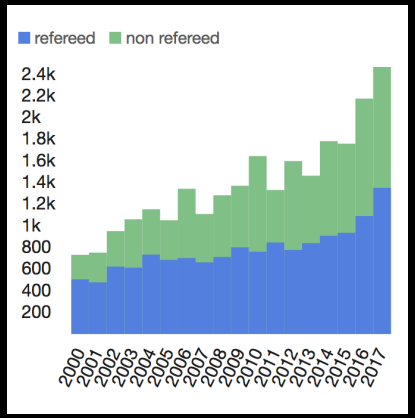
- One (*or more?*) IVOA(-*powered*) portal(*s*):
  - Assess and - if needed - try to improve **data discoverability** through the registry (can we gauge what our users think of this issue before the next InterOp?)
  - make software available to data providers to link to such registry

More suggestions:

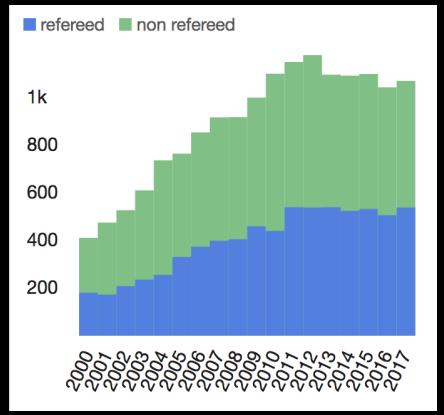
- Python reference implementations prioritized for major services?
- Standard for science platforms? (check scienceplatfoms.slack.com)
- Virtual Reality/Advanced Reality standards?
- Other growing areas/priorities?

Upcoming scientific priorities at IVOA

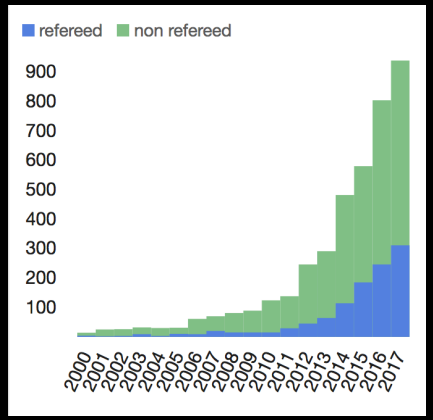
Gravitational waves



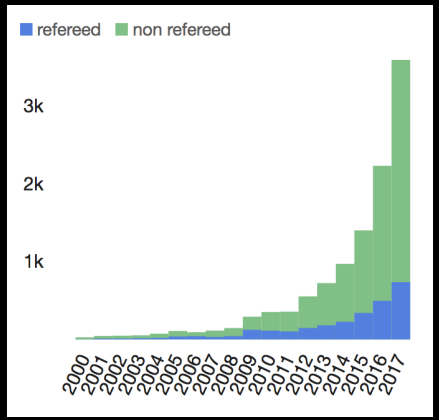
Multi-wavelength



Python



Machine learning



Queries in ADS for articles containing those key-words as a function of time

Python, astronomy and the IVOA

- A large and ever-growing fraction of astronomical research today is done with Python, therefore it is essential that VO resources are visible and easy to use with that programming language.

- There are several python packages related to VO: pyvo, astroquery, ..
- Astropy has grown rapidly in the last few years. Astroquery is a module inside astropy to query data services, and it contains most of the services represented at the IVOA

- The CSP believes that the IVOA should develop or contribute to python packages that make full power of the data models by e.g. mapping coordinate info directly into astropy.skycoord structures to illustrate the power of the standards.

The evolution of astropy in the last few years

https://youtu.be/TLuVM4j561E

Data services queriable via astropy/astroquery

Available Services

If you're new to Astroquery, a good place to start is the A Gallery of Queries:

- A Gallery of Queries

The following modules have been completed using a common API:

- ALMA Queries (`astroquery.alma`)
- Atomic Line List (`astroquery.atomic`)
- Besancon Queries (`astroquery.besancon`)
- ESASky Queries (`astroquery.esasky`)
- ESO Queries (`astroquery.eso`)
- Gaia TAP+ (`astroquery.gaia`)
- GAMA Queries (`astroquery.gama`)
- HEASARC Queries (`astroquery.heasarc`)
- IRSA Image Server program interface (IBE) Queries (`astroquery.ibe`)
- IRSA Queries (`astroquery.irsa`)
- IRSA Dust Extinction Service Queries (`astroquery.irsa_dust`)
- MAGPIS Queries (`astroquery.magpis`)
- MAST Queries (`astroquery.mast`)
- Minor Planet Center Queries (`astroquery.mpc`)
- NASA ADS Queries (`astroquery.nasa_ads`)
- NED Queries (`astroquery.ned`)
- NIST Queries (`astroquery.nist`)
- NRAO Queries (`astroquery.nrao`)
- NVAS Queries (`astroquery.nvas`)
- SIMBAD Queries (`astroquery.simbad`)
- Skyview Queries (`astroquery.skyview`)
- Splatalogue Queries (`astroquery.splatalogue`)
- UKIDSS Queries (`astroquery.ukidss`)
- Vamdc Queries (`astroquery.vamdc`)
- VizieR Queries (`astroquery.vizier`)
- VO Simple Cone Search (`astroquery.vo_conesearch`)
- VSA Queries (`astroquery.vsa`)
- xMatch Queries (`astroquery.xmatch`)

These others are functional, but do not follow a common & consistent API:

- ALFALFA Queries (`astroquery.alfalfa`)
- CosmoSim Queries (`astroquery.cosmosim`)
- Exoplanet Orbit Database (`astroquery.exoplanet_orbit_database`)
- Fermi Queries (`astroquery.fermi`)
- HITRAN Queries (`astroquery.hitran`)
- JPL Horizons Queries (`astroquery.jplhorizons`)
- LAMDA Queries (`astroquery.lamda`)
- NASA Exoplanet Archive (`astroquery.nasa_exoplanet_archive`)
- OAC API Queries (`astroquery.oac`)
- OGLE Queries (`astroquery.ogle`)
- Open Exoplanet Catalogue(`astroquery.open_exoplanet_catalogue`)
- SDSS Queries (`astroquery.sdss`)
- Spitzer Heritage Archive (`astroquery.sha`)

There are also subpackages that serve as the basis of others.

- WFAU Queries (`astroquery.wfau`)

Data services queriable via astropy/astroquery

Catalogs

The first serve catalogs, which generally return one row of information for each source (tl
catalogs that *each* have one row for each source)

- ALFALFA Queries (`astroquery.alfalfa`)
- GAMA Queries (`astroquery.gama`)
- IRSA Image Server program interface (IBE) Queries (`astroquery.ibe`)
- IRSA Queries (`astroquery.irsa`)
- IRSA Dust Extinction Service Queries (`astroquery.irsa_dust`)
- MAST Queries (`astroquery.mast`)
- NED Queries (`astroquery.ned`)
- OGLE Queries (`astroquery.ogle`)
- Open Exoplanet Catalogue(`astroquery.open_exoplanet_catalogue`)
- SDSS Queries (`astroquery.sdss`)
- Spitzer Heritage Archive (`astroquery.sha`)
- SIMBAD Queries (`astroquery.simbad`)
- UKIDSS Queries (`astroquery.ukidss`)
- VSA Queries (`astroquery.vsa`)
- VizieR Queries (`astroquery.vizier`)
- xMatch Queries (`astroquery.xmatch`)
- VO Simple Cone Search (`astroquery.vo_conesearch`)
- NASA Exoplanet Archive (`astroquery.nasa_exoplanet_archive`)
- Exoplanet Orbit Database (`astroquery.exoplanet_orbit_database`)

Archives

Archive services provide data, usually in FITS images or spectra. They will generally return a table listing the available data first.

- ALFALFA Queries (`astroquery.alfalfa`)
- ALMA Queries (`astroquery.alma`)
- ESO Queries (`astroquery.eso`)
- Fermi Queries (`astroquery.fermi`)
- Gaia TAP+ (`astroquery.gaia`)
- HEASARC Queries (`astroquery.heasarc`)
- IRSA Image Server program interface (IBE) Queries (`astroquery.ibe`)
- IRSA Queries (`astroquery.irsa`)
- MAGPIS Queries (`astroquery.magpis`)
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- NED Queries (`astroquery.ned`)
- NRAO Queries (`astroquery.nrao`)
- NVAS Queries (`astroquery.nvas`)
- SDSS Queries (`astroquery.sdss`)
- Spitzer Heritage Archive (`astroquery.sha`)
- UKIDSS Queries (`astroquery.ukidss`)
- VSA Queries (`astroquery.vsa`)
- Skyview Queries (`astroquery.skyview`)

Simulations

Simulation services query databases of simulated or synthetic data

- Besancon Queries (`astroquery.besancon`)
- CosmoSim Queries (`astroquery.cosmosim`)

Other

There are other astronomically significant services, e.g. line list and atomic/molecular cross section and collision rate services, that don't fit the above categories.

- Atomic Line List (`astroquery.atomic`)
- LAMDA Queries (`astroquery.lamda`)
- NIST Queries (`astroquery.nist`)
- Splatalogue Queries (`astroquery.splatalogue`)
- NASA ADS Queries (`astroquery.nasa_ads`)
- Vamdc Queries (`astroquery.vamdc`)
- HITRAN Queries (`astroquery.hitran`)
- TAP/TAP+ (`astroquery.utils.tap`)
- JPL Horizons Queries (`astroquery.jplhorizons`)

Python, astronomy and the IVOA

- The development of astropy and pyvo are based on github and follow the open source principles in which anyone can contribute to the code and there is a small group of coordinators that look after the overall evolution of the packages.

- While there are Python packages to access the IVOA data infrastructure, they are often not produced nor maintained by the original data providers and therefore lack consistency or robustness.

- Has anything interesting happened on this since the Victoria InterOp?

The IVOA needs you

- We need active and enthusiastic scientists at the Committee of Science Priorities!!
- Talk to us if you are interested!!

Final recommendations from the CSP

- Always ask the question: how is the *final* user going to use this?
- Always follow the users' workflow to the paper and keep the big picture ("is data provenance clear? Can I explain/make a plot of this?")
- Connect to the future generation of users where they are: e.g. Python, github, open source projects, social media, online open fora, connected to new big astronomy projects, using mobile devices and expecting quick answers

Thanks!

Committee on Science Priorities : csp@ivoa.net

(#csp on ivoa.slack.com)