Virtual Observatory Resources for Education and Teaching

Chenzhou Cui

Chinese Virtual Observatory (China-VO)

National Astronomical Data Center (NADC)

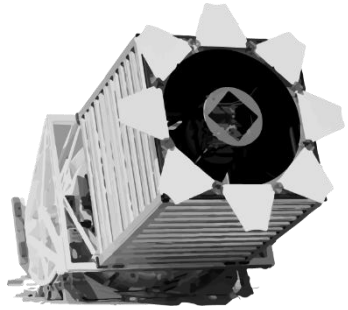
National Astronomical Observatories, Chinese Academy of Sciences (NAOC)

Contents

- Virtual Observatory (VO) and IVOA
- VO Resources
  - IVOA website and wiki pages
  - Curriculums and Tutorials
  - Schools, Meetings and Workshops
- Astroinformatics Resources
- Lessons Learned and Summary

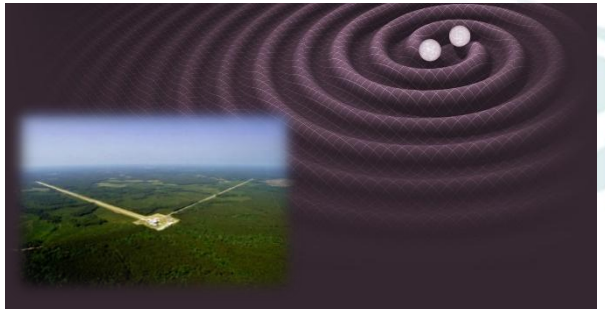
Astronomy: a Data-driven Science

- TBs era
  - 2dFGRS
  - SDSS
  - LAMOST
  - Gaia
- PBs to EBs era
  - FAST/FASTA
  - SKA
  - Vera Rubin Observatory LSST
  - Euclid
  - …
- Astronomy is entering an era of big data where the data sets are too large to download and analyze using users' own facilities.









The Idea of Virtual Observatory

Vision of the VO:

- The Web is *transparent*. The goal of the Virtual Observatory is to achieve the same feeling for astronomical data - that it is all available to explore in a single transparent system.
- Astronomical datasets, tools, services should work seamlessly together.
- The VO allows astronomers to interrogate multiple data centers in a seamless and transparent way, provides new powerful analysis and visualization tools within that system, and gives data centers a standard framework for publishing and delivering services using their data.
- Like the World Wide Web, the VO is not a fixed system, but rather a *way of doing things.*

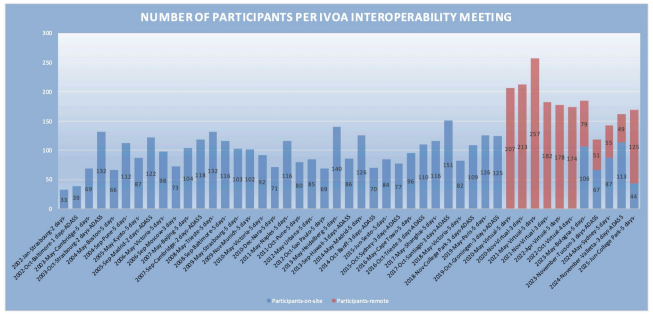
Virtual Observatory (VO) is a data-intensively online astronomical research and education environment, taking advantages of advanced information technologies to achieve seamless, global access to astronomical information.

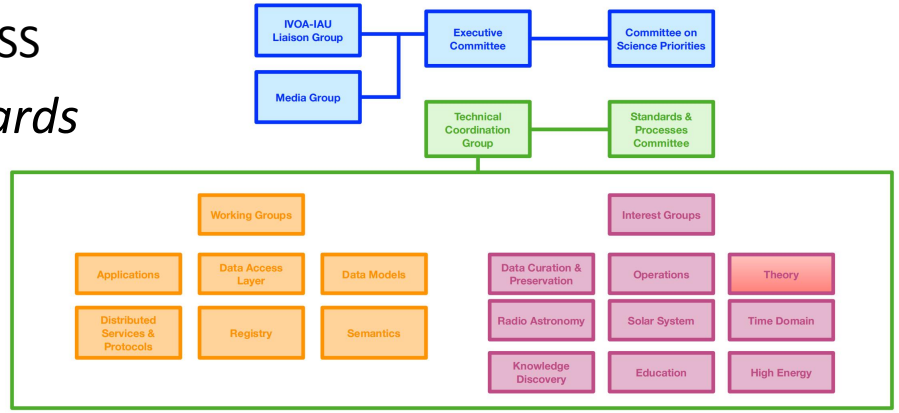
-- my words

International Virtual Observatory Alliance

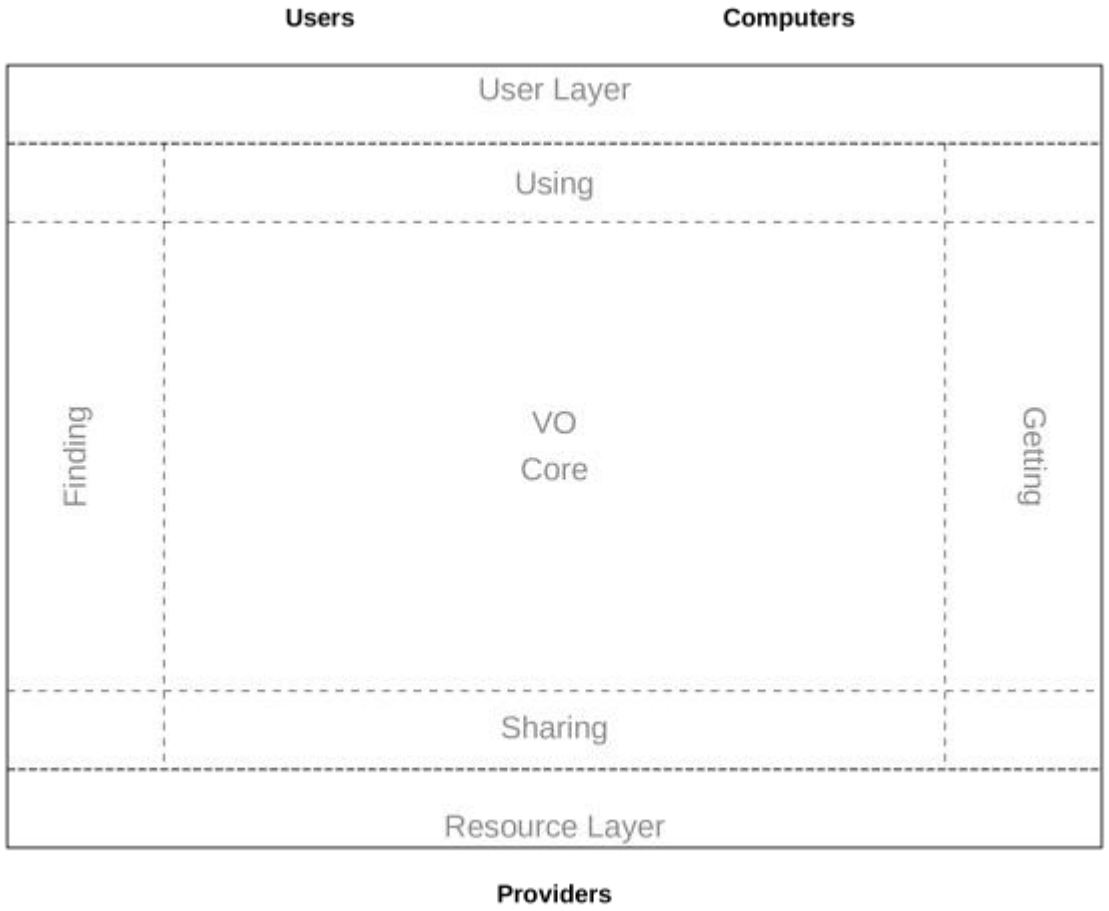
- An organisation that debates and agrees the technical standards that are needed to make the VO possible, A focal point for VO aspirations, a framework for discussing and sharing VO ideas and technology.

- Created in 2002
- Currently 23 member VO projects
- 6 Working Groups, 8 Interest Groups
- 2 Interoperability meetings per year
  - May & Oct/Nov with ADASS
- *~ 46 interoperability standards*

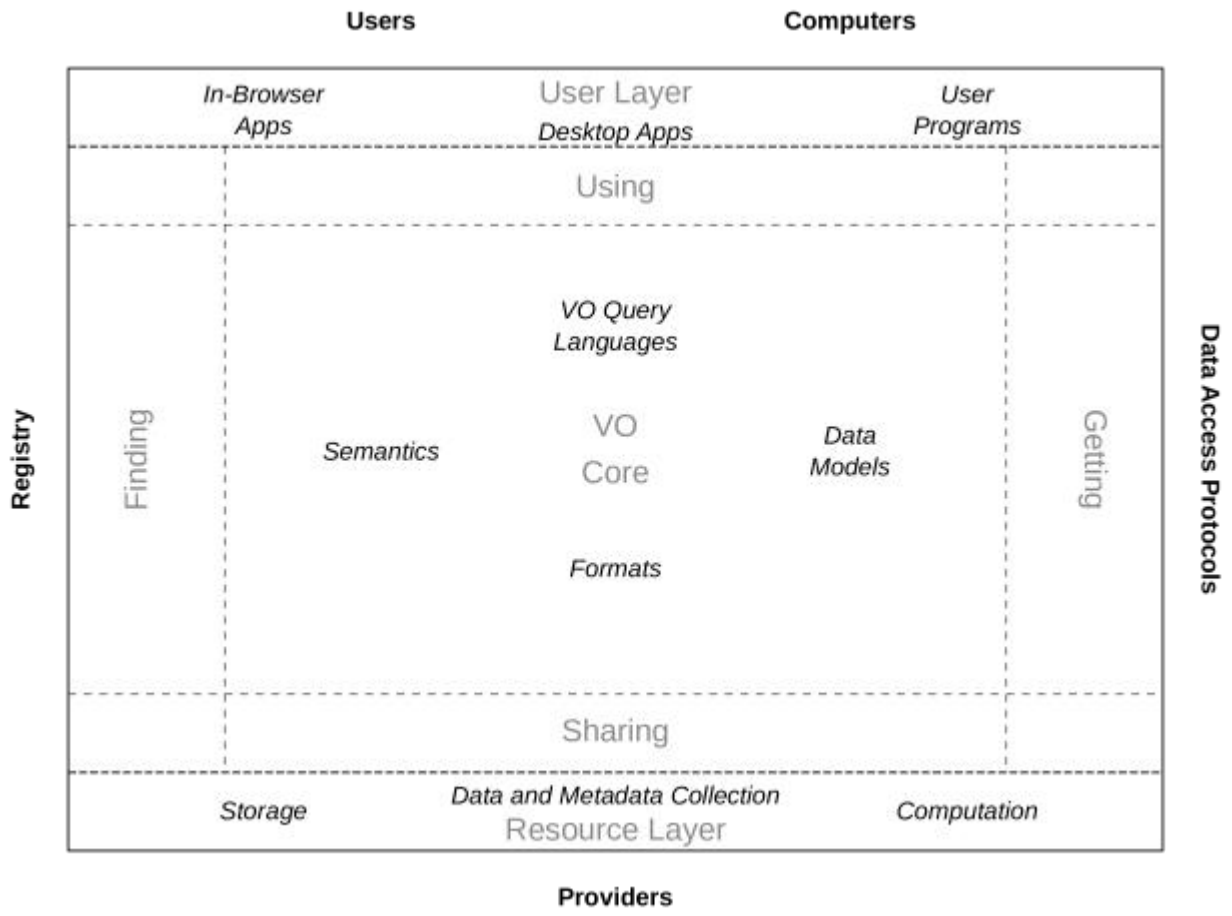




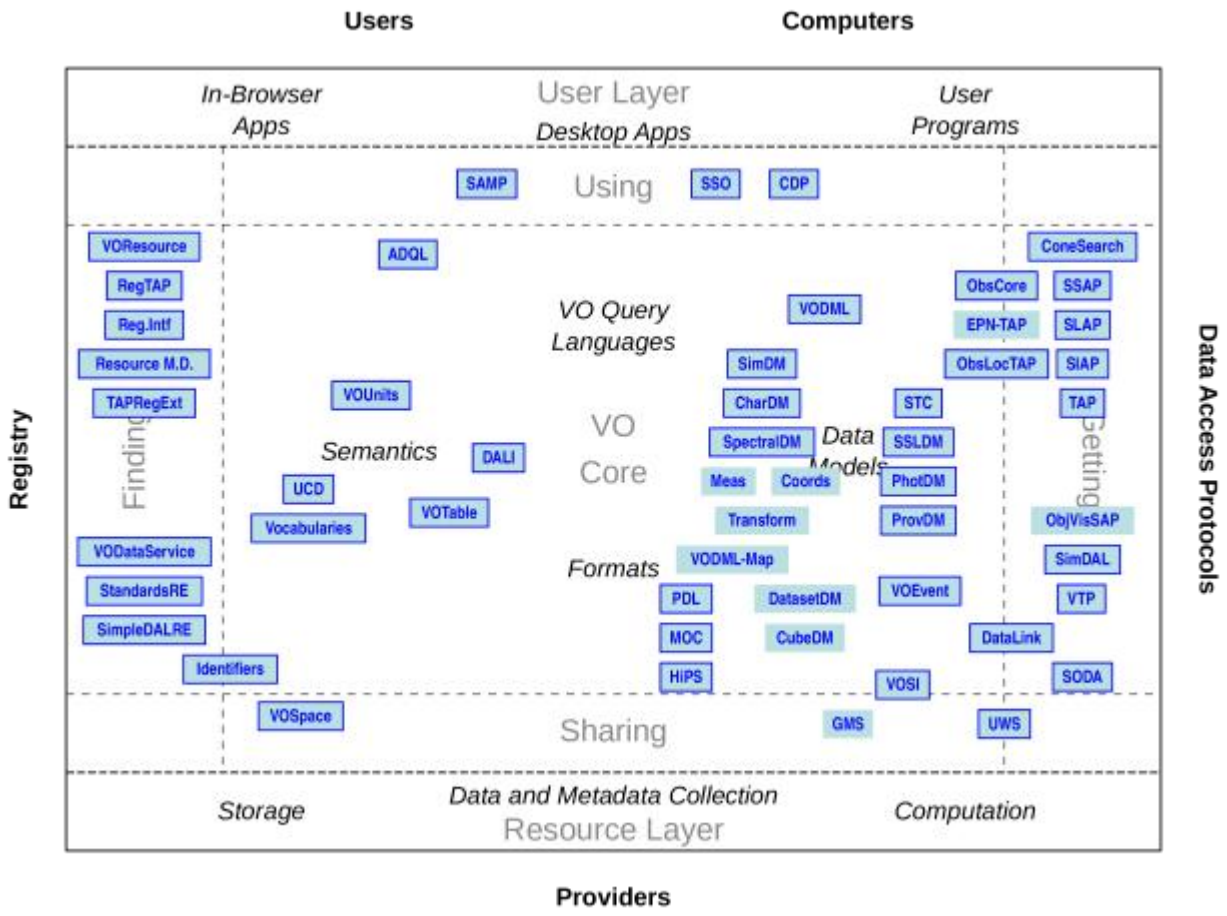
IVOA Architecture Level 0



IVOA Architecture Level 1

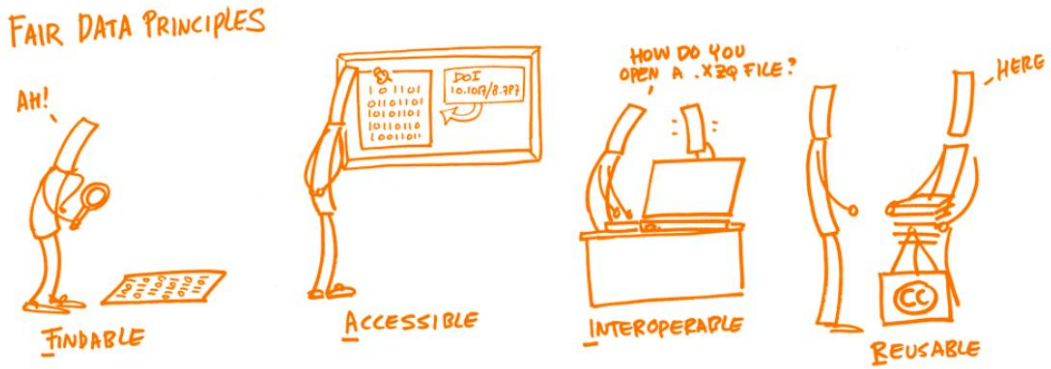


IVOA Architecture Level 2

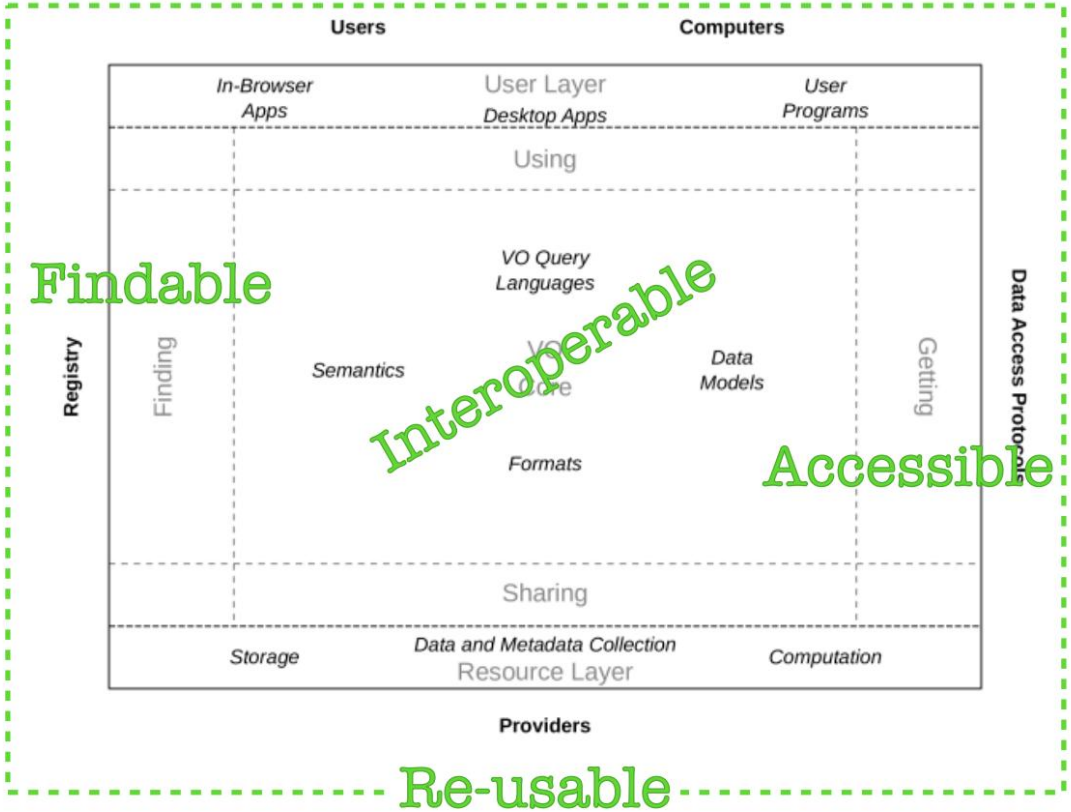


IVOA Architecture – FAIR Data

The Virtual Observatory has been FAIR from the beginning!

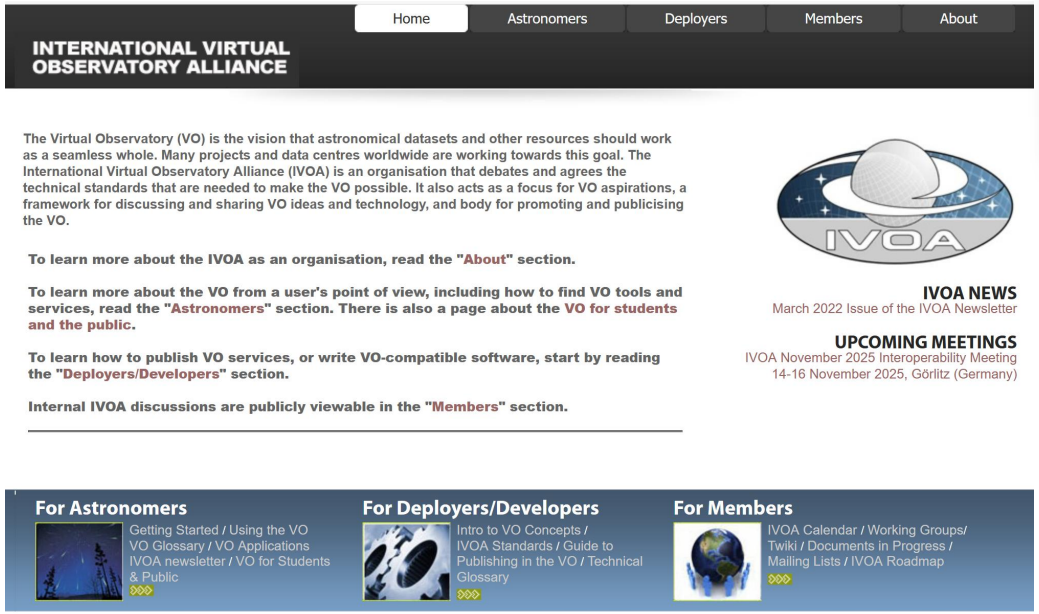


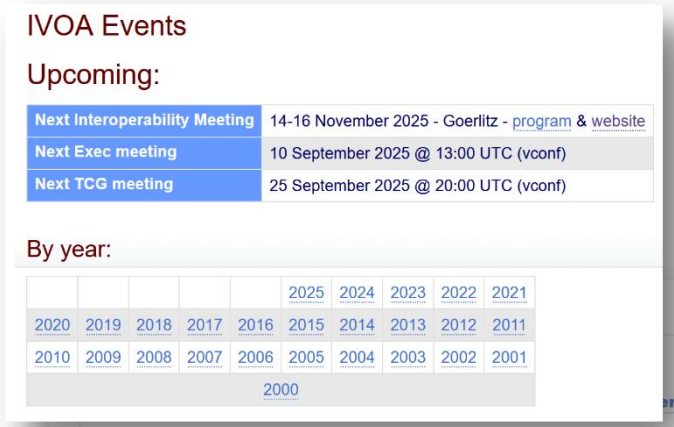
https://www.fosteropenscience.eu/learning/assessing-the-fairness-of-data/



IVOA Website and Wiki Pages

https://www.ivoa.net/





IVOA Education Interest Group

TWiki > IVOA Web > IvoaTCG > IvoaEducation (2024-11-17, ShanshanLi)

IVOA Interest Group in Education (Edu IG)

Contents

https://wiki.ivoa.net/twiki/bin/view/IVOA/IvoaEducation

Your contributions are welcome!

TWiki > IVOA Web > IvoaTCG > IvoaEducation > EduResourcesTutorials (2025-05-06, AdaNebot)

Existing IVOA Education Resources and Tutorials

IVOA Note

International Virtual Observatory Alliance

Educational Resources in the Virtual Observatory

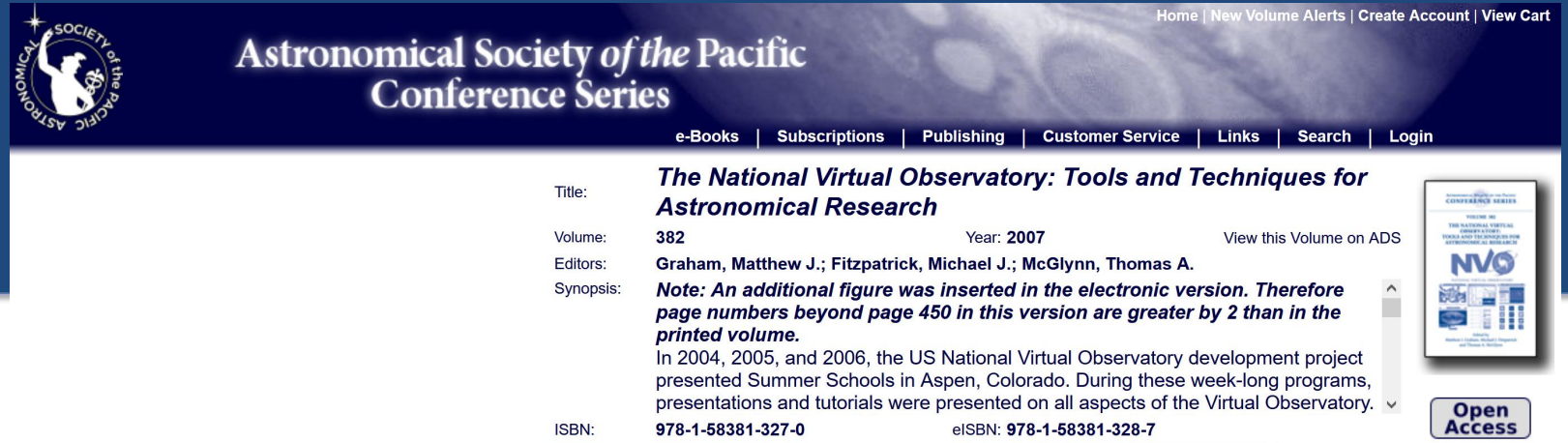
Version 1.0

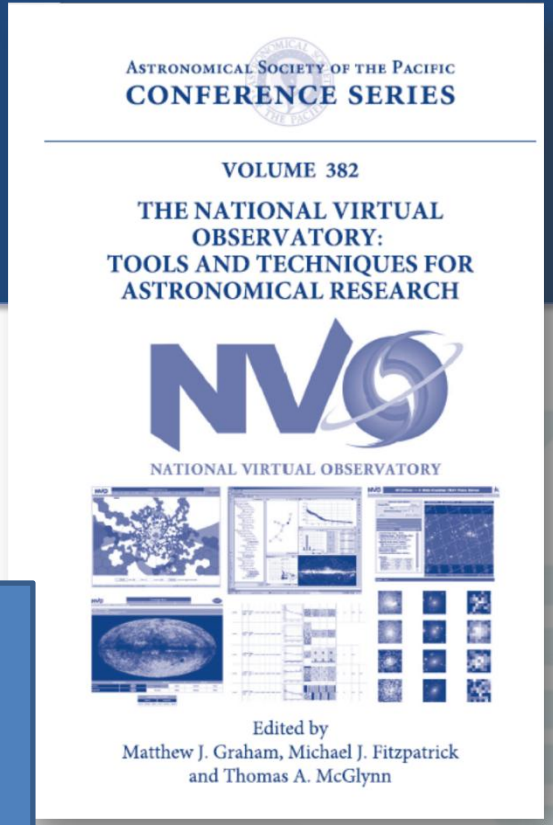
18-03-12

Contents

IVOA Newcomers

- Starting point and materials to start grabbing the basics of the IVOA and the VO world
  - **Part 1 of the tutorial**
  - will introduce to some of the VO standards following a multimessenger use case from the user's perspective.
  - **Part 2 of the tutorial**
  - will show selected steps of the 1st part tuorial from the perspective of the dataprovider. The question here is: what does it need from the perspective of a dataprovide to enable the user experience of part 1 ?
- https://wiki.ivoa.net/twiki/bin/view/IVOA/IVOANewcomers
- https://hendhd.github.io/ivoa_newcomers/



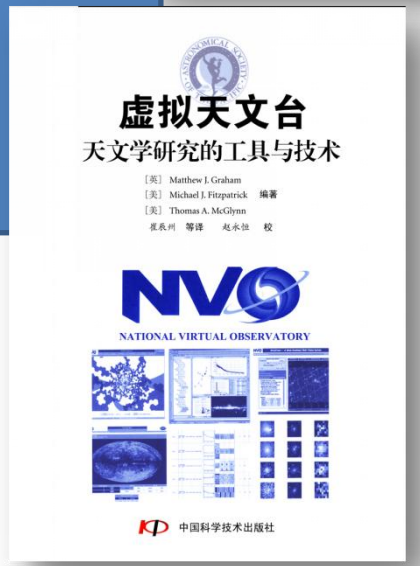


- 59 chapters, 3 appendixes, published by ASP in 2007

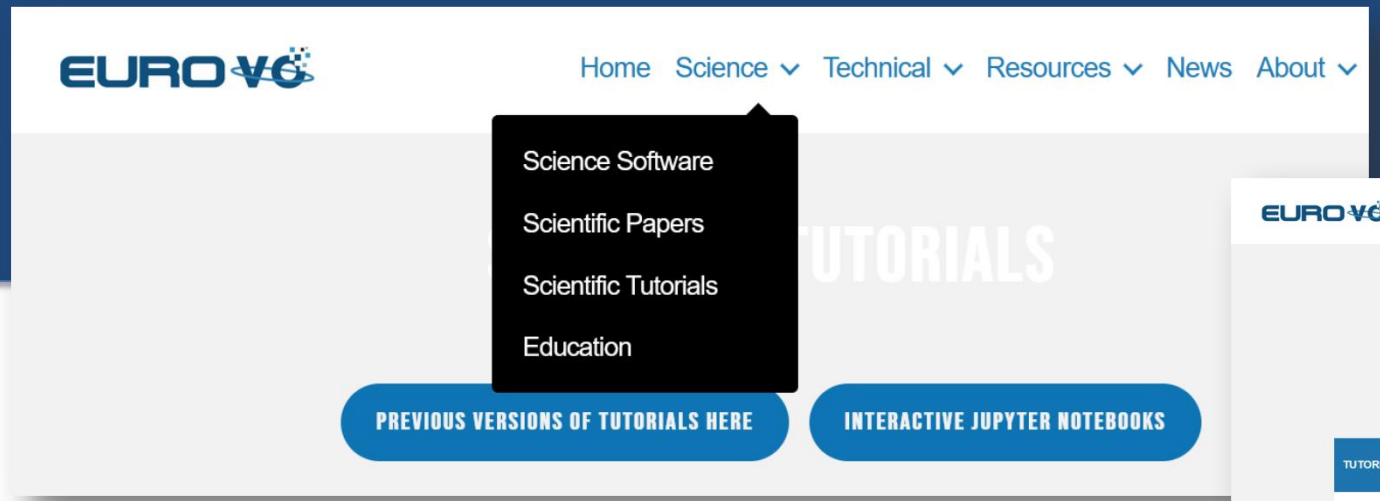
Prologue: The Virtual Observatory—A New Environment for Astronomical Research
Section 1. An Introduction to VO Tools
Section 2. Science with the Virtual Observatory
Section 3. Technologies and Protocols
Section 4. Discovering and Registering Resources in the VO
Section 5. Accessing Data in the VO
Section 6. Publishing Data in the VO
Section 7. Foundation Technologies

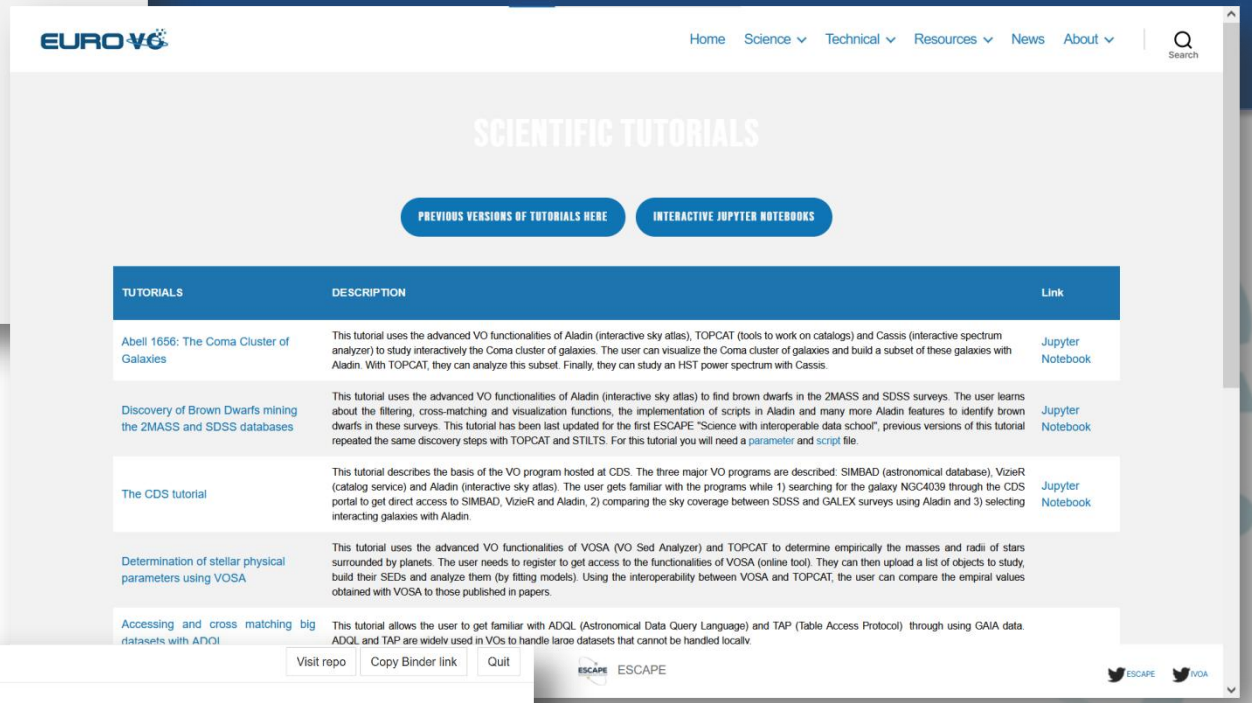
In 2004, 2005 and 2006, the US National Virtual Observatory development project presented Summer Schools in Aspen, Colorado. This volume is a collection of the Summer School lectures and tutorials. These materials are still relevant.

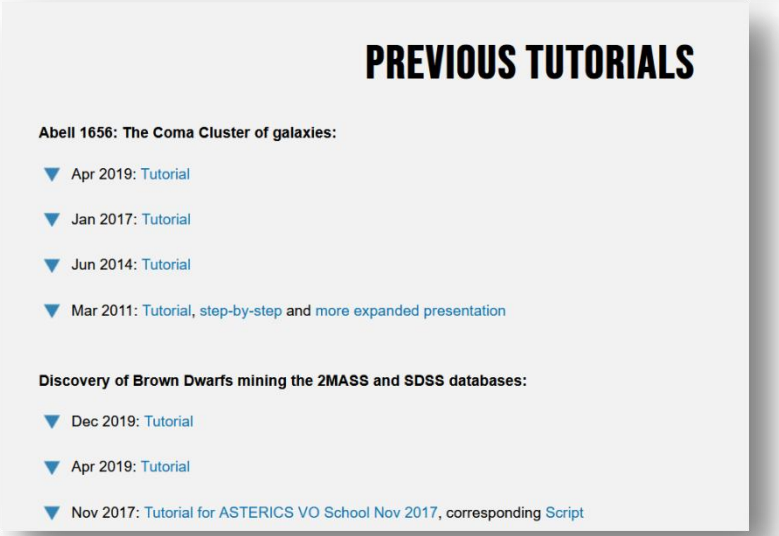
http://www.aspbooks.org/a/volumes/table_of_contents/?book_id=420

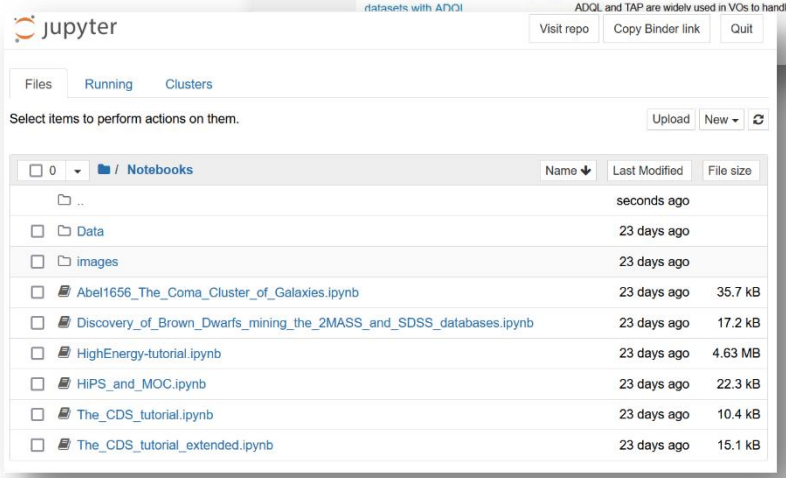


Published in Chinese in 2010





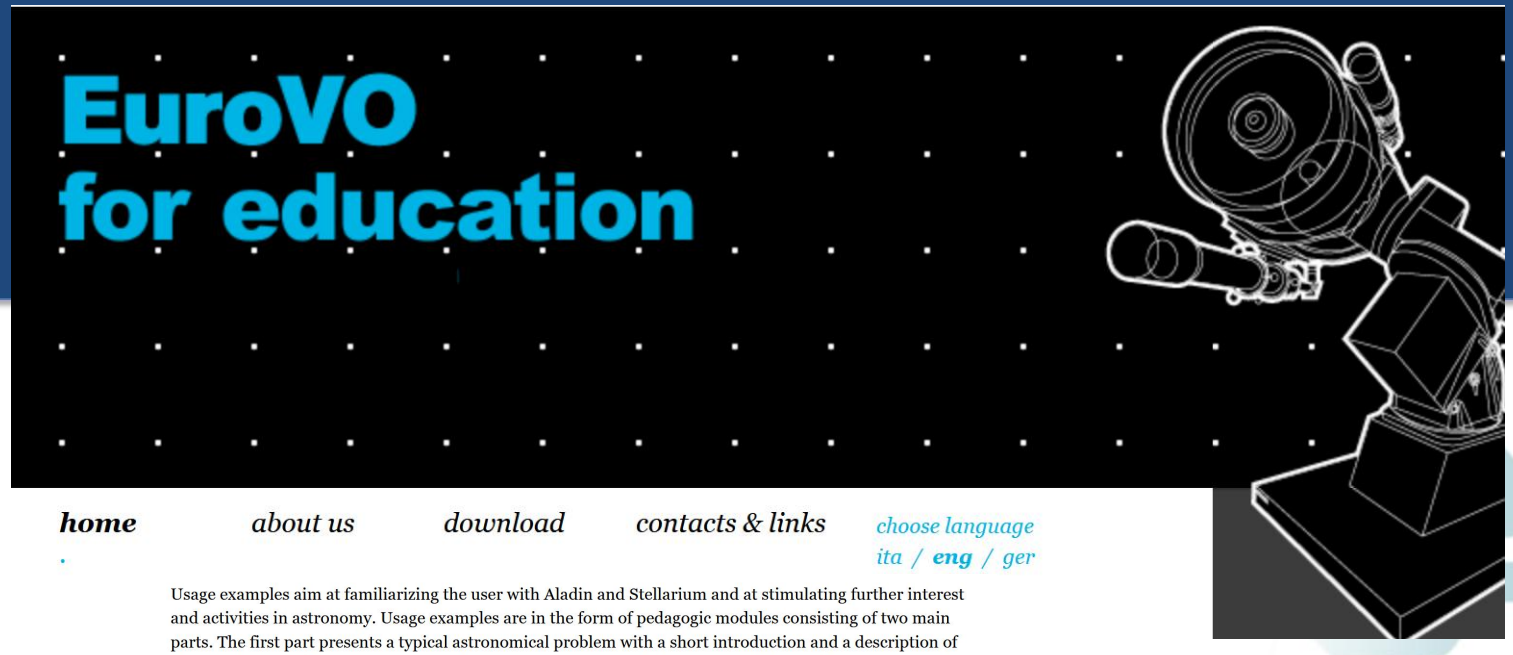




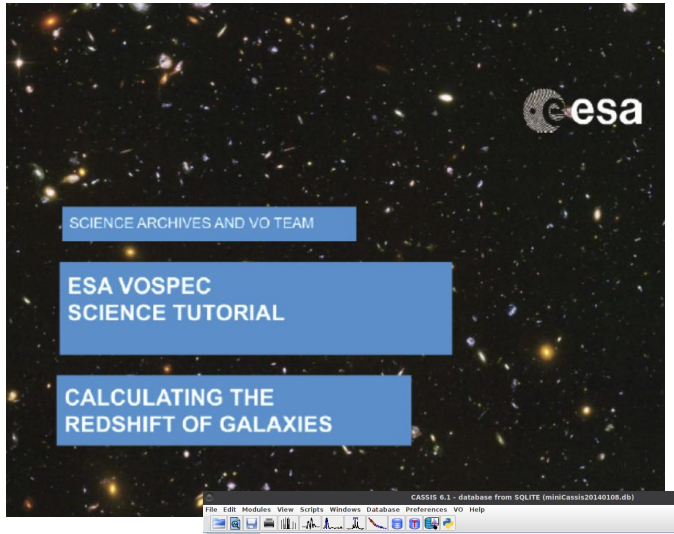
https://www.euro-vo.org/scientific-tutorials/

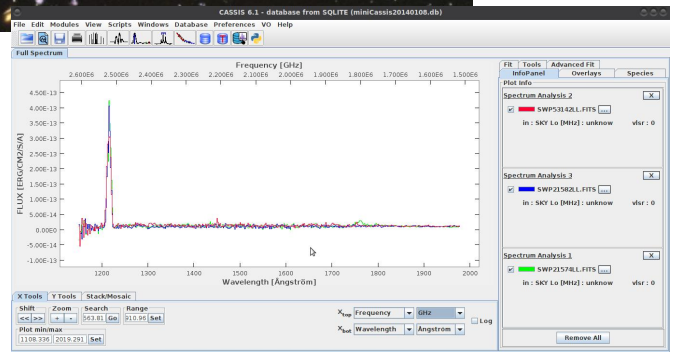
- EuroVO for education is a project developed within the framework of the EuroVO with the aim of diffusing EuroVO data and software to the public, in particular students, teachers and astronomy enthusiasts.
- Usage examples are in the form of pedagogic modules consisting of two main parts. The first part presents a typical astronomical problem with a short introduction and a description of the solution found by astronomers, or, in some cases, an expanded treatment of the problem. The second part is a step-by-step guide to the commands needed to reach the solution of the problem with Aladin or Stellarium.
- The EuroVO resources are now maintained and upgraded/updated by VObs.it at INAF-OA Trieste.

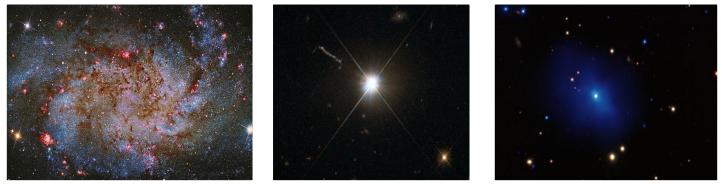
http://vo-for-education.oats.inaf.it



Tutorial: "Calculating the Redshift of Galaxies"







Derian Jesús Dorado-Daza has been working with translation (to Spanish) and updating some tutorials for VO Education. He used CASSIS for updating the tutorial "Calculating the Redshift of Galaxies"

Teaching/Learning Goal: "The overall goal of this tutorial is to compare the spectra of different galaxies, calculate their redshifts and hence search for evidence of the expansion of the Universe."

Tools and Services from VO:

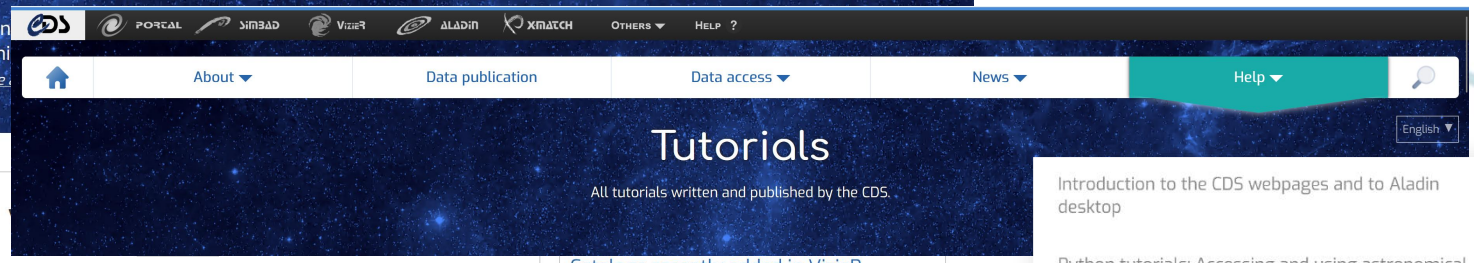
- **CASSIS**: This tool allows the query, download and analysis of spectra from different databases and services, using protocols and communication standards established in the framework of the Virtual Observatory.
- **NIST Atomic Spectra Database Service**: Database for radiative transitions and energy levels in atoms and atomic ions, for the most of the known chemical elements.
- **NASA/IPAC Extragalactic Database (NED)**: Database of multiwavelength data for extragalactic objects, providing a systematic, ongoing fusion of information integrated from hundreds of large sky surveys and tens of thousands of research publications
- **Topcat**: Widely known tool for analysis, manipulation and visualization of astronomical source catalogues and other tables.

Acknowledgments:

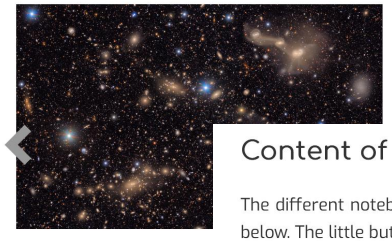
- Tutorial created by Phil Furneaux (Lancaster University) and Deborah Baines (Science Archives Team scientist – ESA).
- The tutorial is based on analysis carried out with the CASSIS software (http://cassis.irap.omp.eu; Vastel et al. 2015 http://adsabs.harvard.edu/abs/2015sf2a.conf..313V). CASSIS has been developed by IRAP-UPS/CNRS .

This tutorial can be found online at: http://vo-for-education.oats.inaf.it/

Courtesy of Derian Jesus Dorado-Daza, derianjesus@gmail.com



Key numbers	
20,156,875	SIMBAD objects
26,603	VizieR catalogs
1,346	HiPS
39,250	MOCs
452,319	biblio. references
25,949	acronyms



Catalogs recently added in VizieR

Mailbox outage

Content of the tutorials

The different notebooks are in the `Notebooks` folder of the github repository. You can also consult them as webpages by clicking on their titles in the list below. The little buttons indicate which services or Python libraries are used in each tutorial.

1. Introduction to using the CDS services with Python

   Simbad Aladin Vizier Xmatch astroquery units

   We show how to call Simbad, Aladin Lite, Vizier and X-match in a Jupyter Notebook.

2. First steps with the Multi-Order Coverage data structure

   Vizier Aladin MOCpy astroquery units | coordinates

   We explore Arp's Catalog of peculiar Galaxies and extract the galaxies explored both in the SDSS and GALEX surveys by using MOCs. This tutorial highlights two python modules for querying data: astroquery and pyvo.

3. The Simple Spectral Access Protocol to explore Abel 1656

   Aladin Vizier Xmatch SSA Simbad astroquery units | coordinates | io | tables specutils pyvo

   This tutorial focuses on the Coma Cluster of Galaxies. In particular, we search for redshift information of galaxies in the spatial vicinity of the cluster centre. To get this information we get catalogues with measured redshifts and a spectrum, from which we measure a redshift. It uses the Simple Spectral Access (SSA) protocol of the virtual observatory.

4. Combining the CDS services to study gamma-ray and high energy spectral bands

   Simbad Aladin Xmatch Vizier astroquery units | coordinates | tables

- Introduction to the CDS webpages and to Aladin desktop
- Python tutorials: Accessing and using astronomical data from Python
  - How to use the tutorials
  - Content of the tutorials
- Video tutorials
  - Introducing the Aladin stack
  - Aladin SIMBAD pointer tutorial
- HiPS tutorials
  - ADASS Tutorial
  - OV-France tutorial
- PDF tutorials
  - Visualizing starlight polarization maps with Aladin
  - SIMBAD introduction tutorial
- Use of VO tools for education

https://cds.unistra.fr/help/tutorials

Email: Pass: Login

Spanish Virtual Observatory

CENTRO DE ASTROBIOLOGÍA CSIC INTA

EXCELENCIA MARÍA DE MAEZTU

ESCAPE

Home | Archives | VO Science | Tools and Services | Big Data | Education & Outreach | Dissemination | Help Desk

- Near Earth Asteroids Precovery
- Pro-Am collaborations
- Teaching Astronomy with the VO
- Undergraduate & graduate projects
- SVO schools and meetings

Tweets by ObsVirtEsp

SVO Meetings

Tutorial_Altair (PDF)

XX aniversario SVO (18 junio 2024)

Talleres on-line

- Aladin: visualización y análisis de imágenes y catálogos.
  - Youtube (en español)
  - Local file (en español)
  - Tutorial. (in English)
- TOPCAT: Manejo de tablas en el Observatorio Virtual
  - Youtube (en español)
  - Tutorial (in English).
- VOSA: Estimación de parámetros físicos mediante el ajuste de distribuciones espectrales de energía (
  - Youtube (en español)

Escuelas SVO

- XXV Escuela SVO. IAA. Granada. Noviembre 2025
- XXIV Escuela SVO. Programas de Máster y Doctorado en Astrofísica. Noviembre 2024
- XXIII Escuela SVO (VIII VO School). Federación de Associaciones Astronómicas de España. Noviembre 2023
- I Escuela Latinoamericana (VII Virtual VO School). Marzo 2023

Enseñando Astronomía con el Observatorio Virtual

Si haces uso de los recursos disponibles en esta página, te agradeceríamos que nos lo hicieras saber escribiendo a: esm@cab.inta-csic.es

!!! Muchas gracias!!!

Casos prácticos Euro-VO

En esta página podéis encontrar enlaces a una serie de prácticas de Astronomía (marco de los proyectos Euro-VO y SVO.

El objetivo de estas prácticas es que el alumno use datos reales de archivos en s una misma estructura: tras una breve descripción del caso científico y de las h metodología de análisis.

Relación de casos prácticos (actualizados a julio de 2023)

- Título: "El diagrama H-R del cúmulo de las Pléyades". (.docx) (.pdf)
- Título: "Distancia a Andrómeda" (.docx) (.pdf)
- Título: "Distancia a la Nebulosa del Cangrejo". (.docx) (.pdf)
- Título: "La Secuencia de Hubble". (.docx) (.pdf)
- Título: "Confirmación de una Supernova en la Galaxia NGC4995". (.docx) (.
- Título: "Movimiento propio de la estrella de Barnard". (.docx) (.pdf)

Casos prácticos del Máster de Astronomía y Astrofísica de la Universidad Int

Education

Limited Access

PhD Thesis

- Title: Integración de archivos y herramientas radioastronómicas en la arquitectura del Observatorio Virtual"
  - Author: Juan de Dios Santander Vela
  - Instituto de Astrofísica de Andalucia -CSIC, Granada, Spain
  - Supervisors: Lourdes Verdes-Montenegro, Enrique Solano
  - Date: May 2009
  - Mark: Sobresaliente "cum laude"

Master Thesis

- Title: "Identificación y caracterización de objetos ultrafríos en los cartografiados J-PLUS y J-PAS".
  - Author: David López Justo
  - Affiliation: Universidad Internacional de Valencia
  - Supervisor: Miriam Cortés Contreras, Enrique Solano Márquez
  - Year: 2019-2020
  - Mark: Sobresaliente 9
- Title: "Técnicas de Visión Artificial e Inferencia Bayesiana aplicada a imágenes multirrango de campos cosm
  - Author: María José Márquez Sánchez
  - Affiliation: Dpt. Inteligencia Artificial ETSI Informática - UNED
  - Supervisor: Luis Manuel Sarro
  - Year: 2008-2009
  - Mark: Matrícula de Honor (10/10)
- Title: "Evaluation of unsupervised clustering algorithms for variable stars data".
  - Affiliation: Dpt. Inteligencia Artificial ETSI Informática - UNED
  - Supervisor: Luis Manuel Sarro
  - Year: 2008-2009
  - Details: Authorship and mark preserved in fulfilment of the Spanish Data Protection Law. The manusc
- Title: "Identificación y caracterización de enanas marrones de tipo T utilizando una metodología de Observat
  - Author: Miriam Aberasturi Vega
  - Affiliation: LAEX-CAB / INTA-CSIC.
  - Supervisor: Enrique Solano
  - Year: 2008-2009
  - Mark: 8.5 / 10

Proyecto fin de carrera

https://svo.cab.inta-csic.es/main/index.php

GERMAN ASTROPHYSICAL VIRTUAL OBSERVATORY

German Astrophysical Virtual Observatory

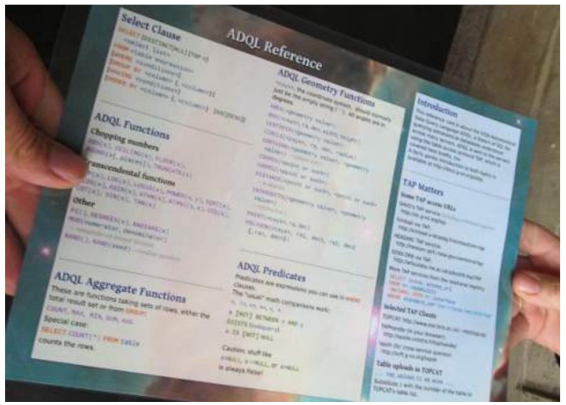
Services

Hand-Outs/Tutorials:

- Astronomical Data Query Language (ADQL) Reference Card
- ADQL Hands-on Course
- GAVO Tutorials

The AQDL Reference Card (pdf) briefly gives an overview of the SQL dialect used in the VO. It is most useful when used with a more gentle course, e.g., our short ADQL course.

We're handing out nice and shiny copies of these at conferences, VO days and similar events:



Mini-Tutorials

ere we collect our mini-tutorials for download which we present occasionally e.g. at S-Meetings. Longer versions can also be used for VO-Days and workshops.

ouble? Want more explanations? Searching for more demos? Please contact us via vo@ari.uni-heidelberg.de.

- add-pms.pdf - Crossmatch with *TOPCAT* and TAP
- astrometric-calib-aladin.pdf - Astometric calibration using *Aladin*
- gavo_plates.pdf - Image discovery with Aladin 10 (and a bit of what to do with discovered images)
- registry-data-discovery.pdf - Data discovery with the registry
- topcat-aladin-together.pdf - *TOPCAT* and *Aladin* working together
- pyvo.pdf - Astropy and the VO
- simulations.pdf - Accessing simulation databases and visualising results with *TOPCAT*
- simulations-short-dachs.pdf - A shorter version, using a subset of the data in DaCHS, accessing the data directly from TOPCAT using TAP and ADQL
- simulations-teachers.pdf - Another simulations tutorial, adjusted for a teacher-workshop. Deals with density fields and dark matter halos. Includes instructions for plotting with *Gnuplot*, in case *TOPCAT* is not available.
- rave.pdf - Downloading and viewing RAVE data with *TOPCAT* and *Aladin*; Filter for Aladin: RAVE-Map-Aladin.ajs
- Using TAP to access Gaia gog data
- Compute Redshifts of Quasars Using Splat VO - Downloads
- uwsintro.pdf - First steps for interacting with a UWS web service from the command line to retrieve data from a database. Uses httpie and/or uws-client.

Here is a HTML rendition of the notes for a

It's allowed to cut-and-paste the queries…

Also, there's a PDF version that you can prir

The queries and problems in the text are sup

ADQL: Contents

https://www.g-vo.org/pmwiki/About/Services

GERMAN ASTROPHYSICAL VIRTUAL OBSERVATORY

German Astrophysical Virtual Observatory

Services

VOTT: Virtual Observatory Text Treasures

VOTT is a formatted list of educational/outreach texts on using the VO: use cases, tutorials, courses, and such. VOTT contains material for all settings, from pre-school to graduate. It is generated from the documents known to the VO Registry.

Material for school and outreach use (“general public”).

More advanced material suitable for, say, advanced high school students or amateur astromers.

material targeted at university students and researchers wanting to learn about the VO.

Sort by: Author Min. Content Level Date Checked

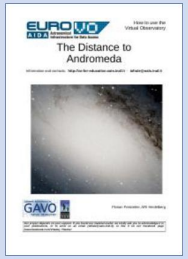
https://dc.g-vo.org/VOTT

Freistetter, F.

Distance of the Andromeda galaxy

Within this use case for high school students and adanced amateurs you measure the linear distance of the Andromeda Galaxy following the steps of the astronomers who first measured it, climbing an important step of the so-called cosmic distance ladder. The use case requires the identification of variable stars of the Cepheid class and the determination of the relation between their period and their intrinsic luminosity.

[en] [it] [de] [es] [fr] [jp]



Sort by: Author Min. Content Level Date Checked

Demleitner, M.

The GAVO VO Puzzlers

The GAVO puzzlers are little training problems solvable by standard VO techniques (data discovery, SIAP, Cone Search, TAP). They assume some familiarity with common astronomical concepts (they were originally given out during meetings of the German Astronomische Gesellschaft) but are designed to be solvable using common, standard tools and in reasonable time. Solutions are also given.

[en]

Demleitner, M.; Heinl, H.

A Short Course on ADQL

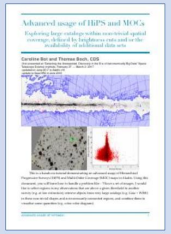
This is a course on the Virtual Observatory's main query language ADQL (short for Astronomical Data Query Language), which is a SQL dialect standardised so users do not have to learn new languages each time they want to use a new resource. We also introduce the basic aspects of the Table Access Protocol TAP, which

Bot, C.; Boch, T.

Advanced Usage of HiPS and MOCs

This course introduces advanced usage of Hierarchical Progressive Surveys (HiPS) and Multi-Order Coverage (MOC) maps in Aladin. Using this document, you will learn how to handle a problem like : “I have a set of images. I would like to select regions in my observations that are above a given threshold in another survey (e.g. at low extinction), retrieve objects from very large catalogs (e.g. Gaia + WISE) in these non-trivial shapes and not-necessarily-connected regions, and combine them to visualise some quantities (e.g. color color diagram).“

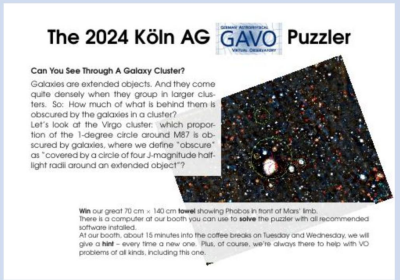
[en]



GAVO Puzzlers

Every year, several hundred astronomers congregate in a city in Germany or Austria for the annual meeting of the Astronomische Gesellschaft. GAVO is there, too, and since 2014 we've always brought a prize with us (usually soft and fuzzy). That prize went to someone (drawn at random, of course) who could solve The Puzzler â€“ a little, hopefully entertaining, astronomy-inspired problem solvable using VO tools.

Here are the puzzlers from the last years â€“ and some proposed solutions (don't spoil it for you by peeking at these too soon). Of course, no prizes are to be won any more. But you'll probably still learn something about the VO by trying these.



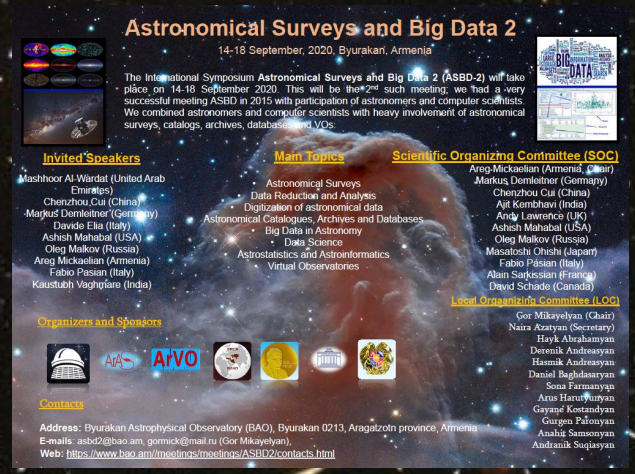
...hints that (hopefully) help you solve the puzzler...

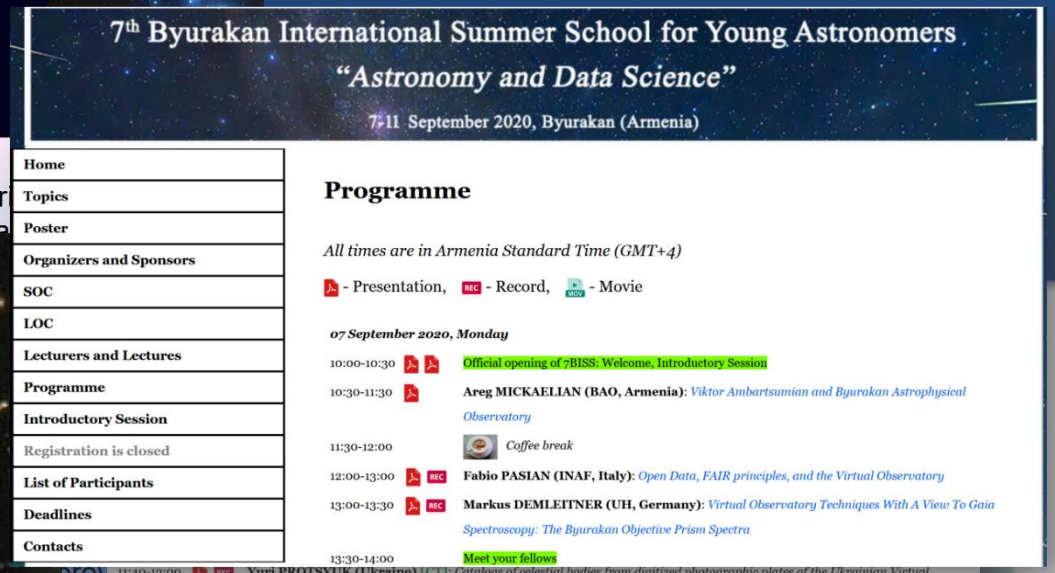
...and a proposed solution

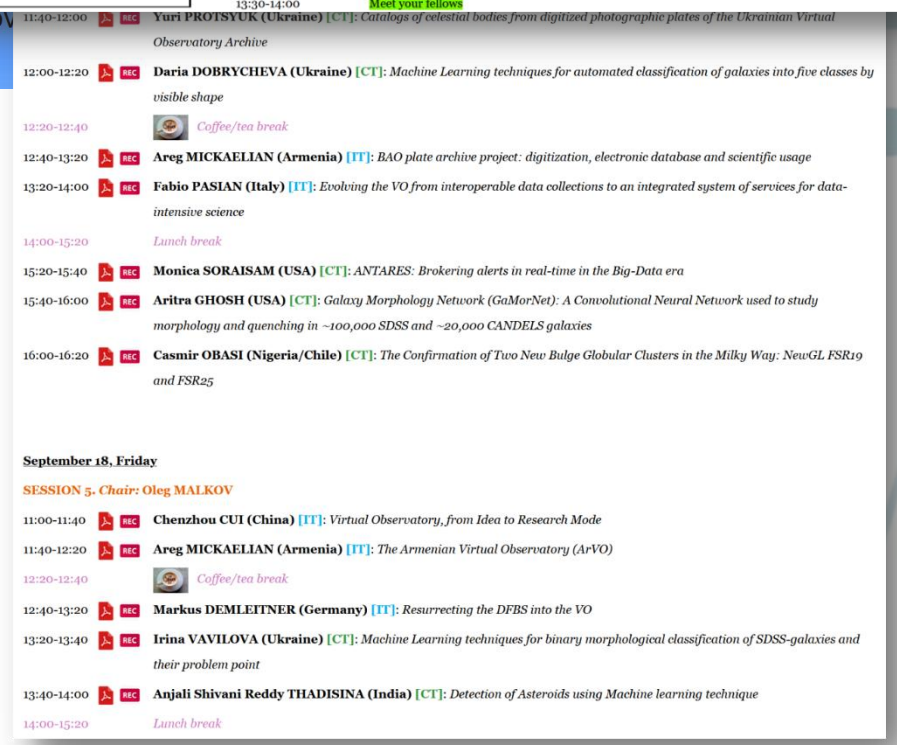
ArVO – Armenian Virtual Observatory

Meetings and Events:

- 7th Byurakan International Summer School (7BISS), *07-11.09.2020, Byurakan, Armenia*
- Astronomical Surveys and Big Data 2 (ASBD-2), *14-18.09.2020, Byurakan, Armenia*







https://www.bao.am/meetings/meetings/SS2020/index.html
https://www.bao.am/meetings/meetings/ASBD2/index.html

ArVO 4RASS & ASBD-3

https://www.bao.am/meetings/meetings/ASBD3/
https://www.bao.am/meetings/meetings/4RASS/

VO講習会2015如月

- 開催日 ： 2015年2月26日(木)、27日(金) (両日とも10:00~
- 参加申込締切 ： 2015年2月12日(木)
- 旅費補助申請締切 ： 2015年1月26日(月)
- 会場 ： 国立天文台三鷹キャンパス 南棟二階共同利用室
- 講師 ： 白崎 裕治 (国立天文台 天文データセンター)
  川口 俊宏 (国立天文台 天文データセンター)
  川崎 渉 (国立天文台 チリ観測所)

VO講習会2014睦月

Announcement

日程： 2014年1月27日(月)、
応募締切： 2014年1月17日(
会場： 国立天文台三鷹キャン

- 1st circular
- 講習会参加者への連絡

プログラム

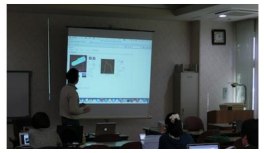
1月27日 (月)		
10:00 - 10:20	VO概論	白崎
10:20 - 11:50	JVOポータル利用法	白崎
11:50 - 13:00	昼休み	
13:00 - 13:30	ALMAWebQL利用法	江口
13:30 - 14:30	Vissage利用法	川崎
14:30 - 14:50	休憩	
14:50 - 17:20	VOツール利用法	TOPCAT: 小宮 Aladin: 江口 Specview: 小宮

Announcement

- final circular
- 2nd circular
- 1st circular

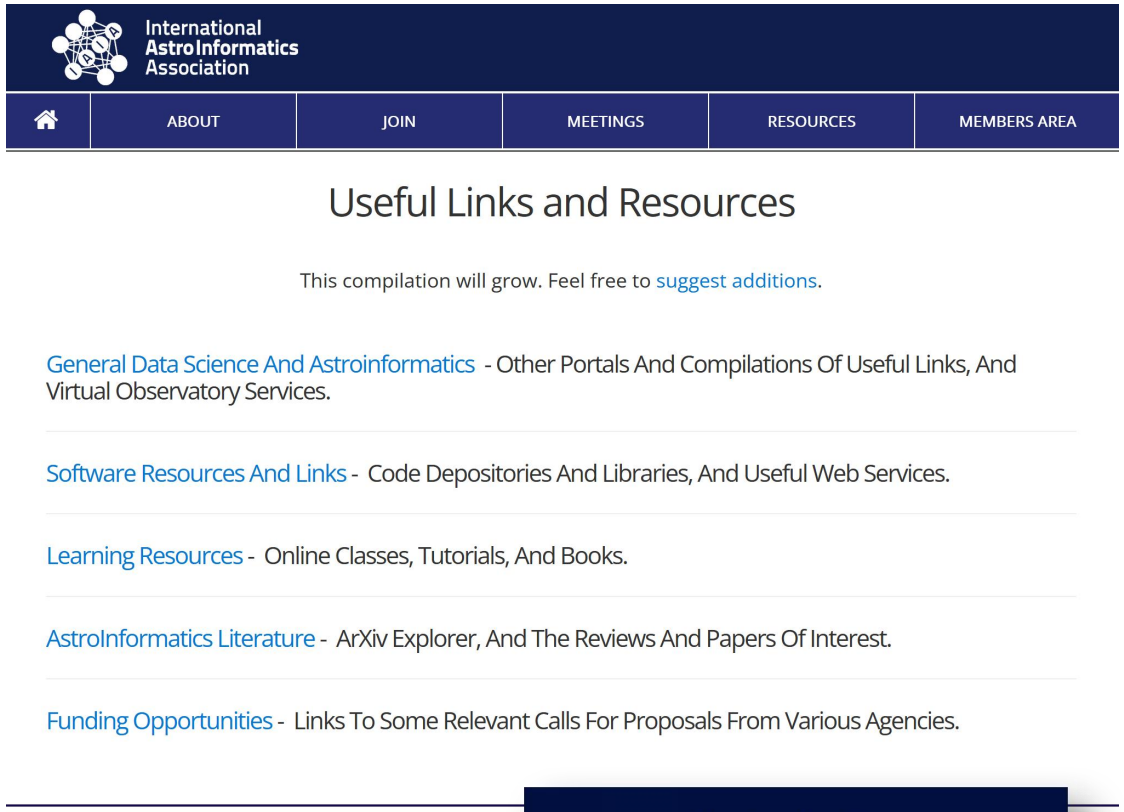
プログラム

一日目 2/26 (木)			
10:00 - 10:20	VO概論	白崎	pptx pdf
10:20 - 11:50	JVOポータル利用法(前半)	白崎	pptx pdf
11:50 - 13:00	昼休み		
13:00 - 13:30	JVOポータル利用法(後半)	白崎	
13:30 - 14:30	Vissage利用法	川崎	ppt pdf
14:30 - 15:00	休憩		
15:00 - 15:40	VOツール利用法 (TOPCAT)	白崎	pptx pdf
15:40 - 16:20	VOツール利用法 (Aladin)	川口	
16:20 - 17:00	VOツール利用法 (Specview)	白崎	pptx pdf

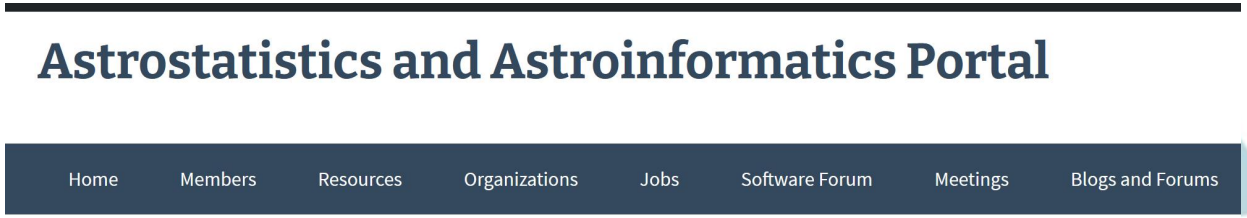


http://jvo.nao.ac.jp/voschool.html

Resources for Astroinformatics



http://astroinformatics.info/resources



- **On-line courses**
- You are here: Home / Resources / On-line courses
- A vast array of courses in statistics and computational methods are available online. Some have fixed schedules and charge tuition, others are flexible and free. We list a selection of these courses here. Listing does not imply any assurance or approval by ASAIP.
- The Astrostatistics and Astroinformatics Portal (https://asaip.psu.edu) is a new Web site serving the cross-disciplinary communities of astronomers, statisticians and computer scientists.

https://asaip.psu.edu/resources/on-line-courses/

Astrostatistics and Astroinformatics Portal

Home | Members | Resources | Organizations | Jobs | Software Forum | Meetings | Blogs and Forums

You are here: Home

Welcome to ASAIP

The Astrostatistics and Astroinformatics Portal (https://asaip.psu.edu) is a new Web site serving the cross-discip
scientists. It is intended to foster research into advanced methodologies for astronomical research, and to prom
The WWW public is welcome to read materials in ASAIP. Use the navigation bar above, or the search box at the u

The ASAIP provides searchable abstracts to Recent Papers in the field, several discussion Forums, various resou
and access to various Web resources such as on-line courses, books, jobs and blogs. The site will be used for pul

Software tutorials

You are here: Home / Resources / Software tutorials

On-line resources, particularly for R and Python, for statistical analysis and programming.

Introduction to R programming

Series of 21 ~4-minute video tutorials on R programming by GoogleDevelopers.

Software carpentry

Software Carpentry's mission is to help scientists and engineers get more research done in less time and with less pain by teaching them basic lab skills for scientific computing. The organization provides short 2-day workshops worldwide to teach modern software skills.

On-line courses

You are here: Home / Resources / On-line courses

A vast array of courses in statistics and computational methods are available online. Some have fixed schedules and charge tuition, others are flexible and free. We list a selection of these courses here. Listing does not imply any assurance or approval by ASAIP.

Coursera: Data-driven Astronomy

Science is undergoing a data explosion, and astronomy is leading the way. Modern telescopes produce terabytes of data per observation, and the simulations required to model our observable Universe push supercomputers to their limits. To analyse this data scientists need to be able to think computationally to solve problems. In this course you will investigate the challenges of working with large datasets: how to implement algorithms that work; how to use databases to manage your data; and how to learn from your data with machine learning tools. The focus is on practical skills – all the activities will be done in Python 3. Course content includes: discovering pulsars in radio images, managing data and algorithms, SQL queries, regression, machine learning classification. The course is created by The University of Sydney AU.

Employment advice from the AAS

Advice from the AAS The American Astronomical Society Committee on Employment encourages astronomers who seek positions in industry to learn more statistics and informatics.

Statistics.com

Starting in 2003, the Institute for Statistics Education now offers over a hundred courses through the Web site Statistics.com. A typical course is 4-5 weeks in duration, costs around $400, and is taught by an author of a major textbook or monograph. We list here courses related to astrostatistics in the areas of: training in the R software environment; Bayesian methodology; and general statistical modeling.

https://asaip.psu.edu/

Ay 119: Astroinformatics - Spring 2025

Open to everyone interested - students from any field are welcome.

Caltech | Department of Astronomy

Instructors:

- George Djorgovski [djorgovski]
- Ashish Mahabal [ashish]
- Matthew Graham [mjg]
- Santiago Lombeda [santiago]
- [name] at caltech dot edu

https://sites.astro.caltech.edu/ay119/

https://sites.astro.caltech.edu/~george/ay119/

Read this first: how it will work (pdf)

Discussion sessions: Wednesdays, 10-11 am PDT Zoom link [code=

Facebook discussion group

Schedule by the week:

- The Week of March 29: George: Introduction
  - George's lecture about the Astronomy Data Landscape, from the KISS short c
  - Alternative/supplementary viewing: George's introductory lecture "Exploring slides (pdf) [Note: a lot of repetition from the previous link]
  - Explore the IAIA resources page
  - Explore the past Astroinformatics conferences. Most have videos and slides o
  - FB Astroinformatics page
- The Week of April 5: Ashish: Best Programming Practices
  - Watch Ashish's lectures here, but note some updates.
  - Assignment
  - Dataset for the assignment: dsfp_ztf_feats.npy
  - Software Carpentry on Github
- The Week of April 12: Matthew: Regression and Bayesian Statistics
  - Regression: Video [login with your Caltech credentials] * slides (pdf)
  - Bayesian Statistics: Video [login with your Caltech credentials]* slides (pdf)
  - Exercises: Python notebook
  - Optional: for a frequentist perspective watch Amy Braverman's lectures here

Ay 119: Methods of Computational Science - Spring 2016

Open to everyone interested - students from any field are welcome.

This class is offered in a *flipped classroom mode*: all lectures and other materials are available on-line.

Return to search

Astronomy

Term : Spring 2025

Catalog Year : 2024-2025

AST 520 - Astroinformatics: Big Data In Astronomy

Description: This course provides training in the fundamentals of astroinformatics: applying "big data" techniques to research topics in astronomy. Course material will include case studies of astroinformatics projects that exist presently and that are coming in the future; tutorials in computational approaches; exposure to relevant statistical approaches; and training in creating informatics research topics. The course will conclude with a term project in which students will apply the skills they have learned to existing data sets. Letter grade only.

Units: 3

No sections currently offered.

Prerequisite: Admission to Astronomy and Planetary Science PhD

AST 520 - Astroinformatics: Big Data In Astronomy

ɔtion
urse provides training in the fundamentals of
formatics: applying "big data" techniques to
:h topics in astronomy. Course material will
e case studies of astroinformatics projects that
resently and that are coming in the future;
ls in computational approaches; exposure to
ıt statistical approaches; and training in
g informatics research topics. The course will
de with a term project in which students will
he skills they have learned to existing data
ɛtter grade only. Class Notes: - NAUFlex: In
and Remote. This class is delivered
onously with a mix of in-person and remote
ɛssions. Students and faculty meet at specific
with some students participating in-person at
ɛd physical locations and other students
ɔating remotely. Enrollment Requirements:
uisite: Admission to Astronomy and Planetary
e PhD.

Recent Professors
Chadwick Trujillo

Open Seat Checker
Get notified when AST 520 has an open seat

Schedule Planner
Add AST 520 to your schedule

Recent Semesters
Spring 2021, Spring 2019

Offered
TuTh

Avg. Class Size
15

Avg. Sections
1

https://catalog.nau.edu/Courses/course?courseId=011813&term=1251

BE BOLD. Shape the Future.
New Mexico State University
NMSU Astronomy

Astronomy 630: Astrostatistics

- **General Information**

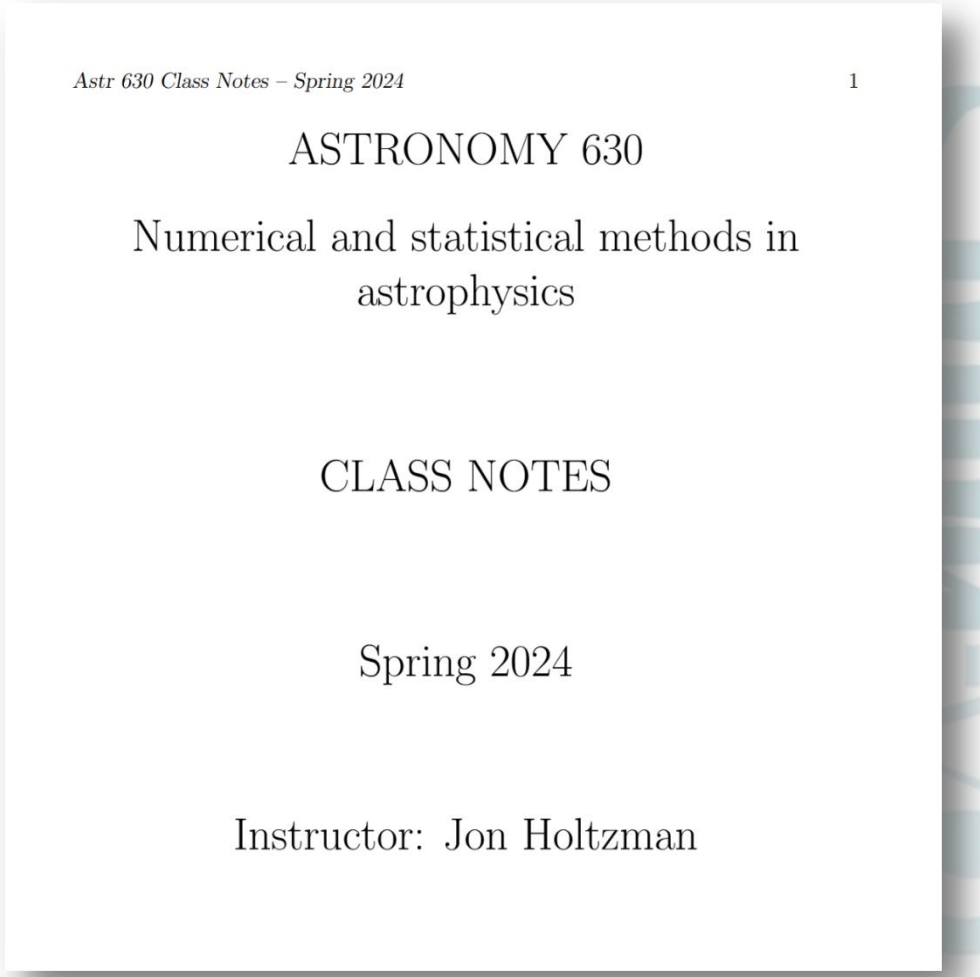
  Instructor: Jon Holtzman
  Class Times: Tuesday and Thursday, 10:30 - 11:15
  Location: AY 119

- **Syllabus for Spring 2020**

- **Lecture notes(PDF)**

Software toolkits

- scikit-learn (Python)
- astro-ml (Python)



http://astronomy.nmsu.edu/holtz/a630/index.html
http://astronomy.nmsu.edu/holtz/

University of Belgrade

Faculty of Mathematics

Bachelor studies - Astronomy and Astrophysics

Module Astroinformatics

- The studies last **4 years** and have the extent of **240 ECTS**
- This Study Program became active since the 2015/16. school year

1st Year

1st Semester			
	Course name	No. of hours	E
1.	Programming 1	3+3	
2.	Introduction to Computer Organization and Architecture 1	3+2	
3.	Discrete Structures 1	3+2	
4.	Linear Algebra and Analytic Geometry	3+3	
5.	General Astronomy 1	2+2+1	
2nd Semester			
	Course name	No. of hours	E
1.	Programming 2	3+3	
2.	Introduction to Computer Organization and Architecture 2	3+2	
3.	Discrete Structures 2	3+2	
4.	Analysis 1	3+3	
5.	General Astronomy 2	2+2+1	
Total		54	

2nd Year

3rd Semester			
	Course name	No. of hours	E
1.	Data Structures and Algorithms	3+2	
2.	Introduction to Web and Internet Technologies	3+2	6
3.	General Astrophysics 1	2+2+1	6
4.	Geometry	3+2	6
5.	Analysis 2	3+2	6
4th Semester			
	Course name	No. of hours	ECTS
1.	Design and Analysis of Algorithms	3+2	6
2.	Object-Oriented Programming	3+2	6

3rd Year

5th Semester			
	Course name	No. of hours	ECTS
1.	Operating Systems	3+2	6
2.	Rational Mechanics 1	2+3	6
3.	Ephemeris Astronomy 1	2+3	6
4.	Astronomical Data Processing 1	3+2	6
5.	Introduction to Numerical Mathematics	2+3	6
6th Semester			
	Course name	No. of hours	ECTS
1.	Practical Astronomy	2+3	6
2.	Artificial Intelligence	2+3	6
3.	Introduction to Celestial Mechanics	3+2	6
4.	A course from optional block AI1	2+3	6
5.	Stellar Astronomy	3+2	6
Total		50	60

4th Year

7th Semester			
	Course name	No. of hours	ECTS
1.	Relational Databases	2+3	6
2.	Computer Graphics	2+3	6
3.	Solar System Dynamics	3+2	6
4.	A course from optional block AI2	2+0	3
5.	Probability	2+3	6
6.	Seminar paper	0+0+2	2
8th Semester			
	Course name	No. of hours	ECTS
1.	Planetary Astronomy	2+3	5
2.	A course from optional block AI3	2+3	5
3.	A course from optional block AI4	2+2	5
4.	Astronomical Data Processing 2	2+2	5
5.	A course from optional block AI5	2+2	5
6.	Statistics	2+3	6
Total		51	60

Optional block AI1			
	Course name	No. of hours	ECTS
1.	Programming Language Paradigms	3+2	6
2.	Positional Astronomy	2+3	6
Optional block AI2			
	Course name	No. of hours	ECTS
1.	English Language 1	2+0	3
2.	Computer Science and Society	2+0	3
Optional block AI3			
	Course name	No. of hours	ECTS
1.	Basic software tools in astronomy	2+3	5
2.	Theoretical Astronomy	2+3	5
3.	Introduction into Theory of Relativity and Cosmology	2+3	5
Optional block AI4			
	Course name	No. of hours	ECTS
1.	Stellar Systems Dynamics	2+2	5
2.	Ephemeris Astronomy 2	2+2	5
3.	Practical Methods of Astronomical Observations	2+2	5
Optional block AI5			
	Course name	No. of hours	ECTS
1.	Introduction to Astrobiology	2+2	5
2.	Teaching Methodology in Mathematics and Computer Science	2+2	5

http://www.matf.bg.ac.rs/eng/cp/33/bachelor-studies---astronomy-and-astrophysics-p--module-astroinformatics--p-/

S3 – Astroinformatics – Astrostatistics and Machine Learning in Astronomy

Univ. Belgrade **Prof Dr. A. Kovačević**	**Astroinformatics – Astrostatistics and Machine Learning in Astronomy (S3, elective, 6 ECTS)**
Learning Outcomes:	This course will address following learning priorities: Communication, Critical Thinking, Information Literacy, Self-Directed Learning, and Technology Use. Upon completion of this course, students will be able to handle and apply tools and techniques for processing large data in their original research areas as well as for eventual applications in the space industry.
Knowledge and Understanding:	**Astroinformatics** is an interdisciplinary field of study involving the combination of astronomy , data science , informatics , and information / communications technologies.The primary focus of this course is on the world wide distributed collection of digital astronomical databases, image archives, and research tools used for analyzing these astronomical observations.
Applying Knowledge and Understanding:	All lectures and tutorials are designed to equip student to with a wide range of IT tools that are essential for the modern astronomer. These include programming, Unix scripting, database construction and use, internet technologies and data mining. Most sessions are interactive. The advantage of this is that students can continue to use all the software (e.g. scripting, databases etc) that they have been working on.
Prerequisites	Experience with Anaconda Python, SciPy, NumPy, as well as GitHub would be preferred, but is not required.
	-Large collection of images analysis: i.e. application of kernel convolution for detection of satellite galaxies of the Milky Way – Databases: Dark Energy Survey, LSST, EELT – Specific tools for accessing and mining data: Data Lab, World

Univ. Belgrade **Prof Dr. A. Kovačević**	**Astroinformatics – Astrostatistics and Machi (S3, elective, 6 ECTS)**

https://www.master-mass.eu/s3-astroinformatics-astrostatistics-and-machine-learning-in-astronomy/

IV Regional Astronomical Summer School (4RASS) , BAO, Armenia

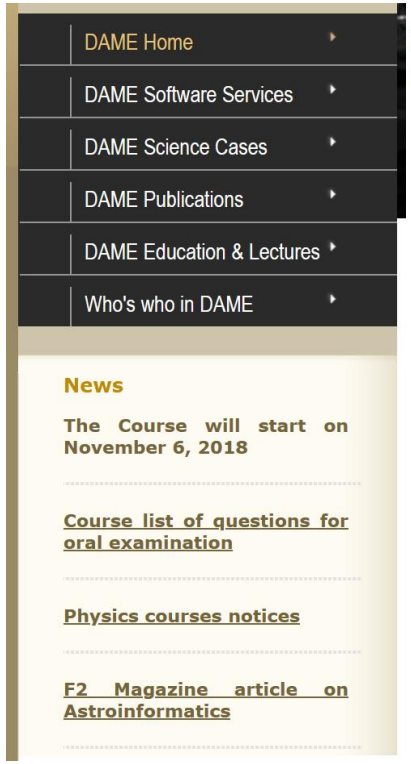
Data Mining & Exploration

We make science discovery happen

Course of Astroinformatics

PhD and M. Sc. in Physics - University Federico II of Naples

- **Tutors**: Massimo Brescia and Stefano Cavuoti
- The course of Astroinformatics of the **Master's Degree** in Physics of the University Federico II, is the first course of Astroinformatics in Europe and will address the methodological and technological challenges posed by the scientific exploitation of massive data sets produced by the new generation of telescopes and observatories. Astronomy, which already was at the forefront of Big Data science with exponentially growing data volumes and data rates, is now entering the petascale regime at optical, infrared and radio wavelengths. Astronomy is truly becoming data-driven in the ways that are both quantitatively and qualitatively different from the past. The data structures are not simple, and the procedures to gain astrophysical insights are not obvious, but the informational content of the modern data sets is so high that archival research and data mining are not merely profitable, but practically obligatory, since researchers who obtain the data can only extract a small fraction of the science that is enabled by it.
- The Course gives 8 credits but is also included into the PhD curriculum in Physics of the University Federico II.



Lectures - Download

- **Tutor lectures:**
  - Lesson 1 - E-Science and Data Warehouse
  - Lesson 2 - Data in Astronomy and use of Virtual Observatory
  - Lesson 3 - Database management
  - Lesson 4 - Introduction to MySQL
  - Lesson 5 - Introduction to Python
  - Lesson 6 - Supervised Machine Learning part I
  - Lesson 7 - Supervised Machine Learning part II
  - Lesson 8 - Supervised Machine Learning part III
  - Lesson 9 - Curse of dimensionality
  - Lesson 10 - Supervised Machine Learning part IV
  - Lesson 11 - Fuzzy Logic
  - Lesson 12 - TDA
  - Lesson 13 - Unsupervised Machine Learning
  - Lesson 14 - Fundamentals of C/C++
  - Lesson 15 - Lecture on Deep Learning
  - Lesson 16 - Lecture on Data Mining examples for galactic Physics
  - Lesson 17 - Lecture on Neural Gas applied to galactic extinction
- **General Stuff:**
  - Python exercise - material
  - Python exercise - L5 material
  - Python exercise - Python script on KNN
  - C/C++ exercises - Code examples
  - Neural Gas videos - examples

http://dame.oacn.inaf.it/astroinformatics.html

Courses

Universidad de Chile

Santiago, Chile

AS4501 - Astroinformatics	
Number of Credits	6
Offering Department	Faculty of Physical and Mathematical Sciences
Course Teacher	Francisco Förster, Valentino González
Language of Instruction	English
First Day of Class	Aug 31, 2020
Last Day of Class	Dec 21, 2020
Course Component	Lecture
Mode of Teaching	Synchronous
Meeting Time	M
Time Zone	S

U-Cursos

Astroinformática

AS4501-1 - Otoño 2025

Historial | Horario | Integrantes | Material Do... | Novedades | Presentación

Historial

Presentacion 28 de Julio a las 10:10 hrs.
Francisco Forster Buron

Nota Final 28 de Julio a las 10:10 hrs.
Francisco Forster Buron

Presentación final (Fecha entrega: 23/07/2025) 23 de Julio a las 10:22 hrs.
Francisco Forster Buron

README.rst

Machine-learning notebooks

Jupyter notebooks on machine-learning algorithms. These are supplementary material for the AS4501 "Astroinformatics" and EL4106 "Computational Intelligence" courses at Universidad de Chile.

1. Neural networks: pure-numpy multilayer perceptron (MLP), tensorflow MLP and Bayesian MLP with PyMC3
2. Support vector machines: C-SVM, nu-SVM and one-class SVM using scikit-learn
3. Boosting with decision trees: Decision trees, Adaboost and Gradient boosting using scikit-learn
4. Bagging with decision trees: Decision trees, Bagging and Random Forest using scikit-learn
5. Self organizing maps: Color clustering through SOM using Somoclu

Requirements will vary between notebooks. Incomplete list of dependecies:

- Python 3 (not tested with Python 2)
- Numpy
- Tensorflow
- PyMC3
- Theano
- Scikit-learn
- Somoclu

Astroinformatics
Course Code: AS4501
Faculty of Physical and Mathematical Sciences
University of Chile

Topics:

1. **Statistics for astronomy:** relevant distributions, parametric and non-parametric statistics, classical and Bayesian inference.
2. **Astronomical data:** sources of errors, data acquisition, basic principles of databases, applications to astronomical data
3. **Machine learning:** density estimation, classification metrics, false positives and negatives, F1-scores, ROC curves, confusion matrices, data balancing, supervised and unsupervised classification, regression.
4. **Temporal and spatial analysis:** stochastic processes, autocorrelation, autoregressive models, periodic variability, Fourier transform, wavelets and periodograms, spatial analysis, spatial correlation, tessellations, Gaussian process interpolation
5. **High performance computing (HPC):** basic principles of HPC, queue management and pipelines, massive data processing
6. **Group project:** problem identification, bibliographic search, identification of relevant variables, work methodologies, planning and distribution of tasks, data analysis, statistical analysis and physical interpretation, presentation.

https://www.u-cursos.cl/ingenieria/2025/1/AS4501/
https://github.com/phuijse/courses_notebooks

Instituto de Astrofísica de Canarias • IAC

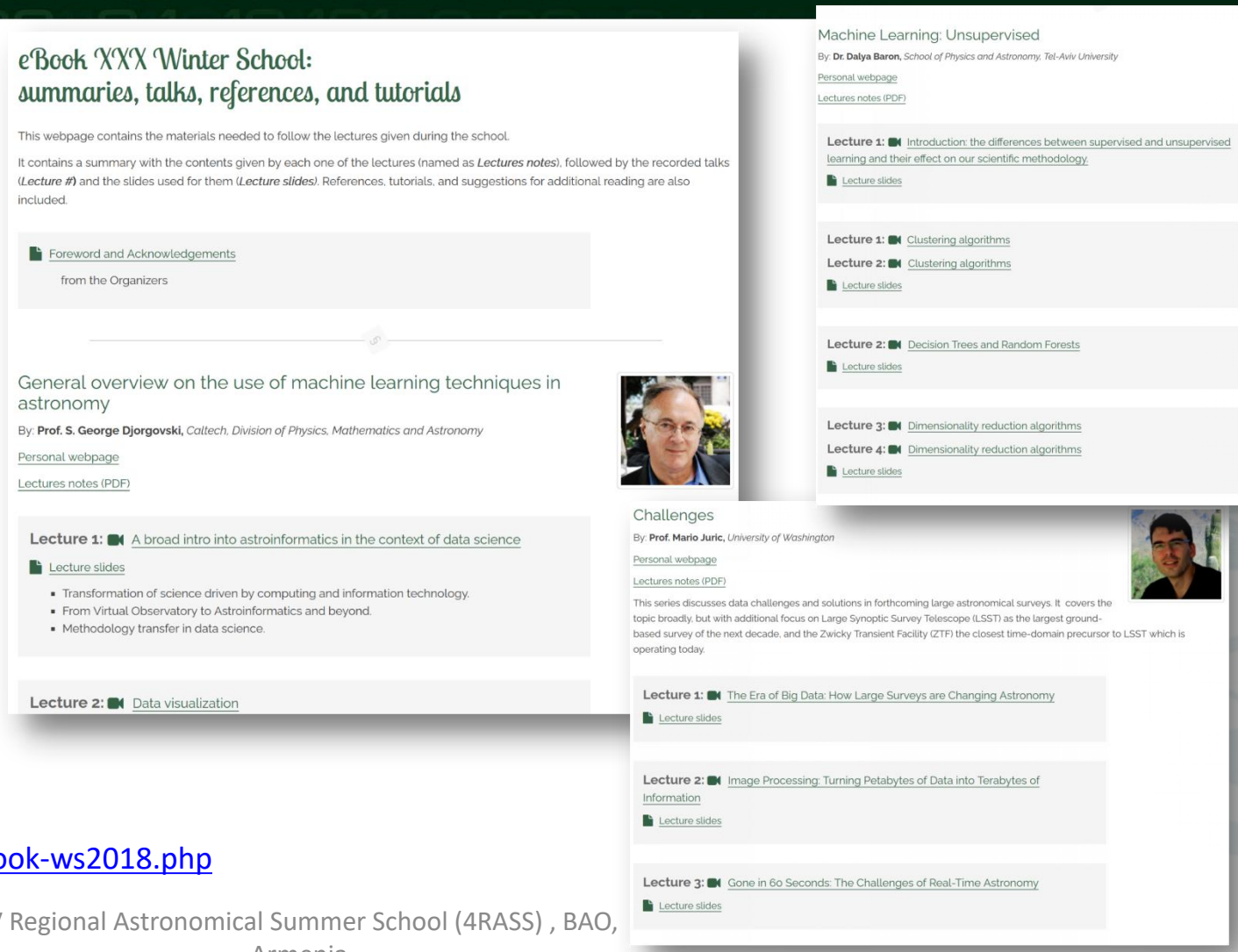
XXX Canary Islands Winter School of Astrophysics

La Laguna, Tenerife, Spain - 4-10 November 2018

Big Data analysis in astronomy

The primary aim of this XXX Winter School is to educate the next generation of astronomers in analysis techniques that can be used to digest the gigantic amounts of data that will be produced by the next generation of telescopes and surveys.

The eBook contains a summary with the contents given by each one of the lectures (named as ***Lectures notes***), followed by the recorded talks (***Lecture #)*** and the slides used for them (***Lecture slides)***. References, tutorials, and suggestions for additional reading are also included.



http://research.iac.es/winterschool/2018/pages/book-ws2018.php

China-VO Annual Meetings

会议日程

时间	
11月25日(周三)	13:00-20:00 报到（酒店大堂）
18:00-20:00	晚餐（餐饮楼一楼自助餐厅）
11月26日(周四)	地点：312会议室
上午第一节	主席:崔辰州（国家天文台）
07:30-08:30	现场注册
08:30-08:45	开幕致辞
08:45-09:15	时域天文学和Mephisto多色巡天（刘晓为/尔欣中，云南大学）
09:15-09:45	可视分析相关进展（袁晓如，北京大学）
9:45-10:15	合影/茶歇
上午第二节	主席:王俊峰（厦门大学）
10:15-10:30	海量光谱数据挖掘（罗阿理，国家天文台）
10:30-10:45	BASS/DESI图像巡天最新数据（邹虎，国家天文台）
10:45-11:00	天文台智能观测运行操作系统（胡义，国家天文台）
11:00-11:15	SKA 数据处理基础算法库进展（王锋，广州大学）
11:15-11:30	国家天文科学数据中心一年来工作总结与展望（崔辰州，国家天文台）
11:30-12:00	嘉宾论坛一：疫情与“在线” （主持人：崔辰州；嘉宾：宋谊、陈栋华
12:00-13:30	午餐（餐饮楼一楼自助餐厅）
下午第一节	主席:范玉峰（云南天文台）
13:30-13:45	智算中心助力科学大数据（杜怀亮，浪潮集团）
13:45-14:00	先进计算服务平台推动科技创新（王楠，曙光集团）
14:00-14:15	华为数据技术助力天文研究（陈继宁，华为）

会议日程

时间	
11月27日(周三)	13:00-
18:00-20:00	晚餐（
11月28日(周四)	地点：
上午第一节	主席:崔
08:30-09:00	现场注
09:00-09:10	开幕致
09:10-09:40	先进天
09:40-10:10	合影/茶
上午第二节	主席:盘
10:10-10:30	开放科
10:30-11:00	国家天
11:00-12:00	国台VO
12:00-12:30	嘉宾论
12:30-14:00	午餐（
下午第一节	主席:田
14:00-14:20	智慧计
机器学习在天文数据分析处理中的应用（陶一寒，国家	
嘉宾论坛一：如何促进机器学习在天文数据分析中的应	
午餐（品味餐厅）	
下午第一节	主席:季凯帆（云南天文台）
14:00-14:20	阿里人的天文情结（张戈，阿里云）

会议日程

时间	
11月21日(周三)	
18:00-20:00	
11月22日(周四)	
上午第一节	
08:30-09:00	
09:00-09:10	
09:10-09:40	
9:40-10:10	
上午第二节	
10:10-10:30	
10:30-10:50	
10:50-11:10	
11:10-11:30	
11:30-11:50	
11:50-12:10	
12:10-12:40	
12:40-14:00	
下午第一节	
14:00-14:20	

http://www.china-vo.org/events.html

China-VO Related Meetings

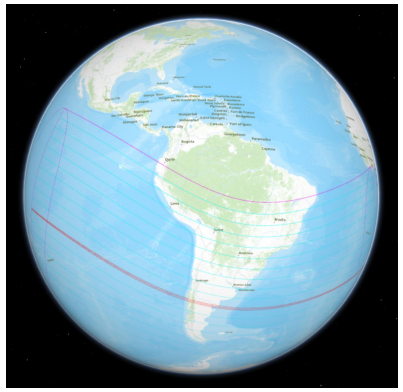
Upcoming:

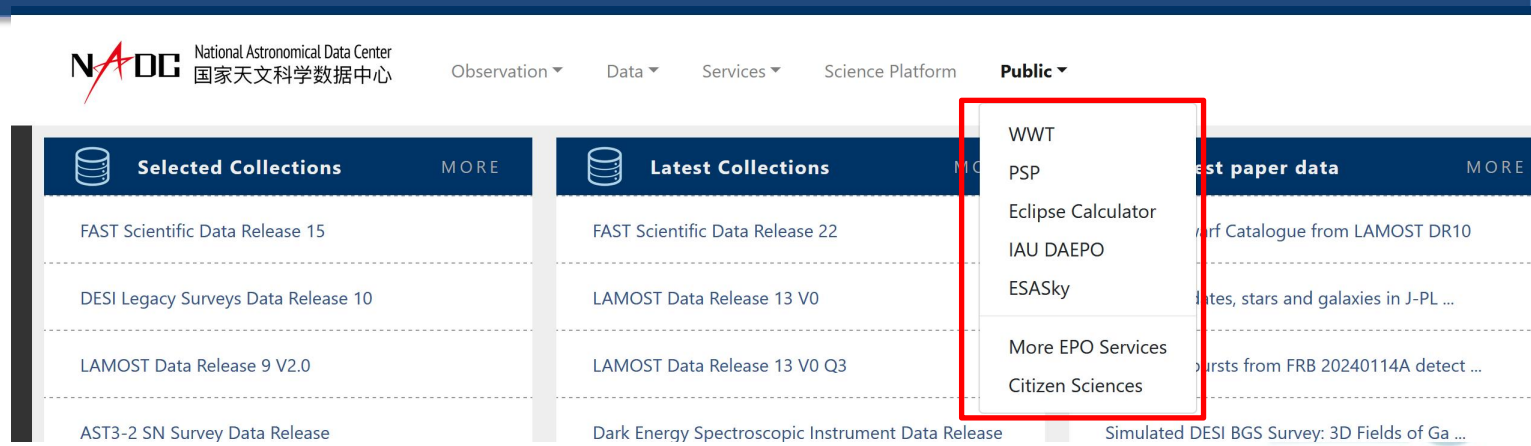
- Astroinformatics and China-VO 2025, Nov. 26-30, 2025, Haikou, Hainan

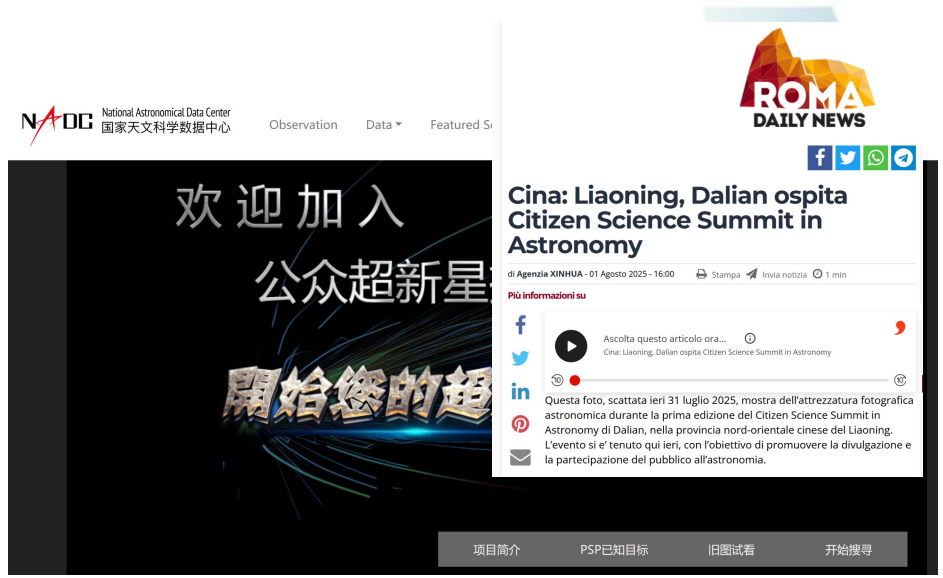
Past:

- Astroinformatics and China-VO 2024, Nov. 26 - 30, 2024, Xinchang, Zhejiang
- Astroinformatics and China-VO 2023, Oct. 10 - 14, 2023, Renhuai, Guizhou
- Astroinformatics and China-VO 2022, Apr. 19 - 23, 2023, Guilin, Guangxi
- Astroinformatics and China-VO 2021, Jul. 18 - 22, 2022, Lijiang, Yunnan
- China-VO and Astroinformatics 2020, Nov. 25- 29, 2020, Xiamen, Fujian
- China-VO and Astroinformatics 2019, Nov. 27- Dec. 01, 2019, Daqing, Heilongjiang
- China-VO and Astroinformatics 2018, Nov. 21- 25, 2018, Jingdezhen, Jiangxi
- China-VO and Astroinformatics 2017, Nov. 28- Dec. 02, 2017, Dali, Yunnan
- IVOA Interop. Spring 2017, May 14-19, 2017, Shanghai, China
- China-VO and Astroinformatics 2016, Sep. 26-30, 2016, Urumqi, Xinjiang
- China-VO and Astroinformatics 2015, Nov. 26-30, Tianshui, Gansu
- China-VO and Astroinformatics 2014, Nov. 26-30, 2014, XinChang, Zhejiang
- China-VO and Astroinformatics 2013, Nov.13-17, 2013, Ya'an, SiChuan
- China-VO and Astroinformatics 2012, Nov.28 to Dec. 2, 2012, Yichang
- China-VO and Astroinformatics 2011, November 9-13, Guiyang
- The 2nd WWT Teacher Training, July 22-26, Huhhot
- China-VO 2010, Nvo. 24-28, Lijiang Yunnan
- China-VO 2009, Nov. 26-28, Chongqing
- China-VO 2008, Nov. 27-30, TaiYuan
- China-VO 2007, Nov. 19-21, Guangzhou
- Astronomical Data Analysis Software & Systems XVII, 23-26 September 2007, London, UK
- IVOA Interoperability Meeting. May 14-18, 2007. Beijing, China
- China-VO 2006. Nov. 29 to Dec. 3, 2006
- IVOA Interoperability Meeting. Sep. 18-22, 2006. Moscow, Russia
- The 20th International CODATA Conference. 2005.10.23-25, Beijing, China
- IAU GA 26th. August 14-25, 2006. Prugue, Czech
- IVOA Interoperability Meeting. 14-19 May, 2006. Victoria, Canada
- China-VO 2005, Nov. 25-27, 2005. Weihai, Shandong
- ADASS XV and IVOA Interoperability Meeting. October 2-7. San Lorenzo de El Escorial, Spain
- IVOA Interoperability Workshop in Kyoto, May 16-20, 2005
- China-VO Internal Concentrated Study, 7-18 March 2005, Beijing
- 3rd China-VO national workshop, December 2004: Wuhan, China
- ADASS XIV, 24-27 October 2004: Pasadena, California, USA
- IVOA Interop Meeting, 27-29 September 2004: Pune, India
- Astronomical Telescopes and Instrumentation 2004, 21-25 June 2004: Glasgow, Scotland United Kingdom
- IVOA Small Projects Meeting 2003, 26-28 November 2003: Beijing, China
- The Second National VO Meeting, 25-26 September 2003: Beijing, China
- IAU XXV, 13-26 July 2003: Sydney, Australia

China-VO EPO Resources







https://nadc.china-vo.org/?&locale=en

Astroinformatics by China-VO @ UCAS

Course Outline

- Lecture 1: Introduction to VO and Astroinformatics (I)
- Lecture 2: Introduction to VO and Astroinformatics (II)
- Lecture 3: Fundamental Technologies
- Lecture 4: Fundamentals of Astronomical Scientific Data
- Lecture 5: Fundamentals of Astronomical Scientific Data: Hands-on Practice
- Lecture 6: VO Architecture and Specifications
- Lecture 7: VO Resources and Services
- Lecture 8: VO Resources and Services: Hands-on Practice
- Lecture 9: VO Data Access and Applications
- Lecture 10: VO Data Access and Applications: Hands-on Practice
- Lecture 11: Astronomical Data Visualization and Visual Analytics
- Lecture 12: How to Build a Data-Driven Research Project
- Lecture 13: Big Data and Data Science
- Lecture 14: AI and Machine Learning: DL&ML
- Lecture 15: AI and Machine Learning: LLMs
- Lecture 16: Student Project Presentations
- Lecture 17: Final Open-Book Exam

Course history

- Spring, 2024
- Spring, 2025
- Fall, 2025

https://nadc.china-vo.org/article/20240621085613

AS6095 "Astroinformatics" for Academic Year 2023

This is the web page for the course "Astroinformatics" offered at Institute of Astronomy, National Central University, from Sep/2023 to Jan/2024.

Important!

Class on 23/Sep/2023

We do not have a class on 23/Sep/2023. Instead, we discuss about the date/time of a supplementary class on

Class on 25/Sep/2023

We start the class at 17:00 on 25/Sep/2023.

Class on 02/Oct/2023

We go back to the original time-slot on 02/Oct/2023. We start the class at 09:00 on 02/Oct/2023.

1. Basic information

- Course name in English: "Astroinformatics"
- Course name in Chinese: "天文資訊分析"
- Instructor: Kinoshita Daisuke
- Classroom: S4-914

https://s3b.astro.ncu.edu.tw/ai_202309/

Astroinformatics

— About this course —

Kinoshita Daisuke
Institute of Astronomy, National Central University

11 September 2023

Beautiful Data

Beautiful Data: Introduction to Practical Data Science

Spring 2024

Instructor: Alex Szalay

TA: Sanjana Sekhar

Class times: **MW 15:00-16:15**
Class location: **Bloomberg 464**

Send mail to

- Alex Szalay,
- Sanjana Sekhar, Office hours TBD

Remote classes:

Classes will be held *live at the usual class times*. Here are links to the powerpoint of the class, and some additional reading material:

Class	Date	Presentation	Video
01	Jan 22	pptx	
02	Jan 24	pptx	mp4
03	Jan 29	pptx	mp4
04	Jan 31	pdf	mp4
05	Feb 12	pdf	mp4
06	Feb 14	pdf	mp4
07	Feb 19	pdf, pdf	mp4,mp4
08	Feb 26	pdf	mp4,mp4
09	Feb 28	pdf	mp4
10	Mar 04	pdf	mp4
11	Mar 06	pdf	mp4
12	Mar 11	pdf	mp4
13	Mar 13	pdf	mp4
15	Mar 25	pptx	mp4
16	Mar 27	pptx	mp4
17	Apr 1	pptx	
18	Apr 03	pptx	
19	Apr 10	pptx	

http://www.sdss.jhu.edu/~szalay/

Lessons Learned and Conclusion

- Tutorials and courses are very useful.
- Keep materials up-to-date is a big challenge.
- AI is very helpful for information collection, but must be used carefully.

Data-driven Astronomy EPO

https://wiki.ivoa.net/twiki/bin/view/IVOA/EduResourcesTutorials