The Virtual Observatory

A short introduction to the VO

M. Castro Neves[1]

[1]German Astrophysical Virtual Observatory, ARI, ZAH, Universität Heidelberg

PUNCH TA6 Meeting 31/08/2023

The Virtual Observatory

- What is the VO, and what it is NOT
- VO comply to FAIR principles:
  - Finding data
  - Accessing data
  - Using (and re-using) data interoperably
- short demonstration

What is the VO ... NOT

The VO is not

- a data warehouse
- a portal
- a database

What is the VO

The VO is

- "an ecosystem of mutually compatible datasets, resources, services, and software tools which use a common set of technologies and a common set of standards." *
- Like the World Wide Web, you can browse through the VO services to find data almost transparently because data models, protocols use VO Standards to be interoperable.

* https://www.ivoa.net/deployers/intro_to_vo_concepts.html

IVOA - International Virtual Observatory Alliance

Is an organization that debates and agrees the technical standards that are needed to make the VO possible. `http://www.ivoa.net`

Figure: IVOA Member organizations

VO in European Projects

Euro-VO:

- The VO had significant EU funding from the start (∼2004), but always on a project basis (EuroVO, EuroVO Aida, EuroVO ICE, Cosadie, Asterics, Escape).
- ESCAPE: Work Package CEVO:Connecting ESFRI projects to EOSC through VO framework
  - integration of the VO Registry into the EOSC e-infrastructure - VO Registry enters the EOSC Marketplace (DataCite Metadata, which does not contain all of the interesting VO Resource Metadata)

Many of these projects included also the organization of VO schools, science forums and data provider workshops for data users (scientists, students, etc), VO developers and data providers (datacenters, institutions and projects wanting to add data to VO, or already running VO-services).

VO complies to FAIR principles

FIND data:

- data providers register their services in the VO registry (service identifier, and metadata).
- data users can query the registry to find the data they need (like Yellow Pages...), e.g. :
  - "which services have resources with X-Ray spectra?"
  - "give me time series resources"
  - "where do I find quasar data?"

VO complies to FAIR principles

ACCESS data:

- Queries are made using metadata from to standard data models, complying to standard access protocols, for example:
  - Simple Image Access (SIA)
  - Simple Spectral Access (SSA)
  - Simple Cone Search (SCS)
  - Table Access Protocol(TAP) for directly querying database tables, using ADQL (Astronomical Data Query Language)

VO complies to FAIR principles

Use data INTEROPERABLY:

- using standardized data formats, data models
- different services can be queried using same protocols, data uses same data models
- existing applications can query/handle data from different VO services
- some client applications/libraries: Aladin, Topcat, Splat, Cassis, EsaSKy, pyVO, etc

  (`https://www.ivoa.net/astronomers/applications.html`)
- also possible: send data beween open applications with SAMP (Simple Application Message Protocol)

VO complies to FAIR principles

REUSE data:

- queries to VO services can be repeated, data is there
- assignments of DOIs to datasets
- IVOA workgroup "Data Curation and Preservation"
- professional data curation in stable data centres

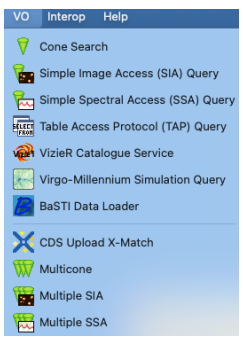
Short demonstration

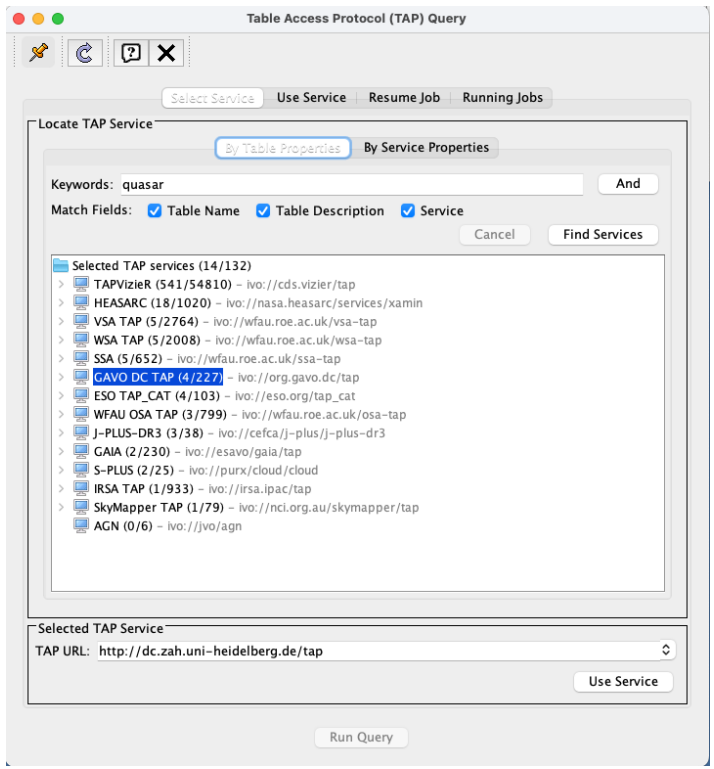
1. Start TOPCAT (`http://www.star.bris.ac.uk/mbt/topcat/`)
2. Open the VO → TAP dialog, in there look for Quasar
3. Select the GAVO TAP service that has the veronqso schema, a catalogue of quasars, and hit "Use service"
4. Locate the veronqsos.data table and investigate its column metadata
5. Run a (trivial) query against that by letting TOPCAT come up with a sample query: Example → cone selection, then change the cone to use 189, 62 as the center and 15 degrees as the radius
6. Hit Graphics → Sky Plot
7. Hit Graphics → Plane Plot and plot the redshift z vs. the brightness Vmag
8. Click on points in the diagrams and watch TOPCAT update the selection in the other – that also works between VO-enabled applications.
9. Start Aladin (`https://aladin.cds.unistra.fr/AladinDesktop/`), and in TOPCAT, do Views → Activation Actions and check "Send coordinates"
10. In Aladin, select DSS and zoom in to a field of view of a few arcminutes. Then in TOPCAT, click on an object with a Vmag of something like 20. In Aladin, you should see a very faint counterpart
11. In Aladin, navigate to Image → X-ray → XMM and add the XMM False Color plane (note how there are green and orange data collections: the green ones are the ones that may have data for the area shown)
12. Note how most quasars will be prominent in X-rays even if inconspicuous optically – these are strange beasts!

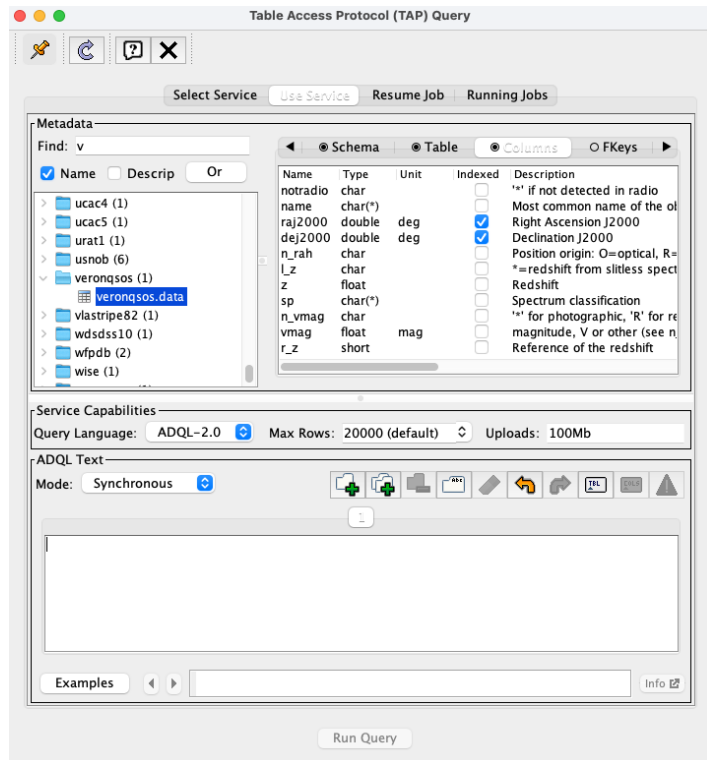
What you saw was the co-operation of about a dozen software components – clients and services standards

Short demonstration

1. Start TOPCAT (`http://www.star.bris.ac.uk/mbt/topcat/`)
2. Open the VO → TAP dialog, in there look for Quasar
3. Select the GAVO TAP service and hit “Use service”
4. Locate the veronqsos.data table and investigate its column metadata

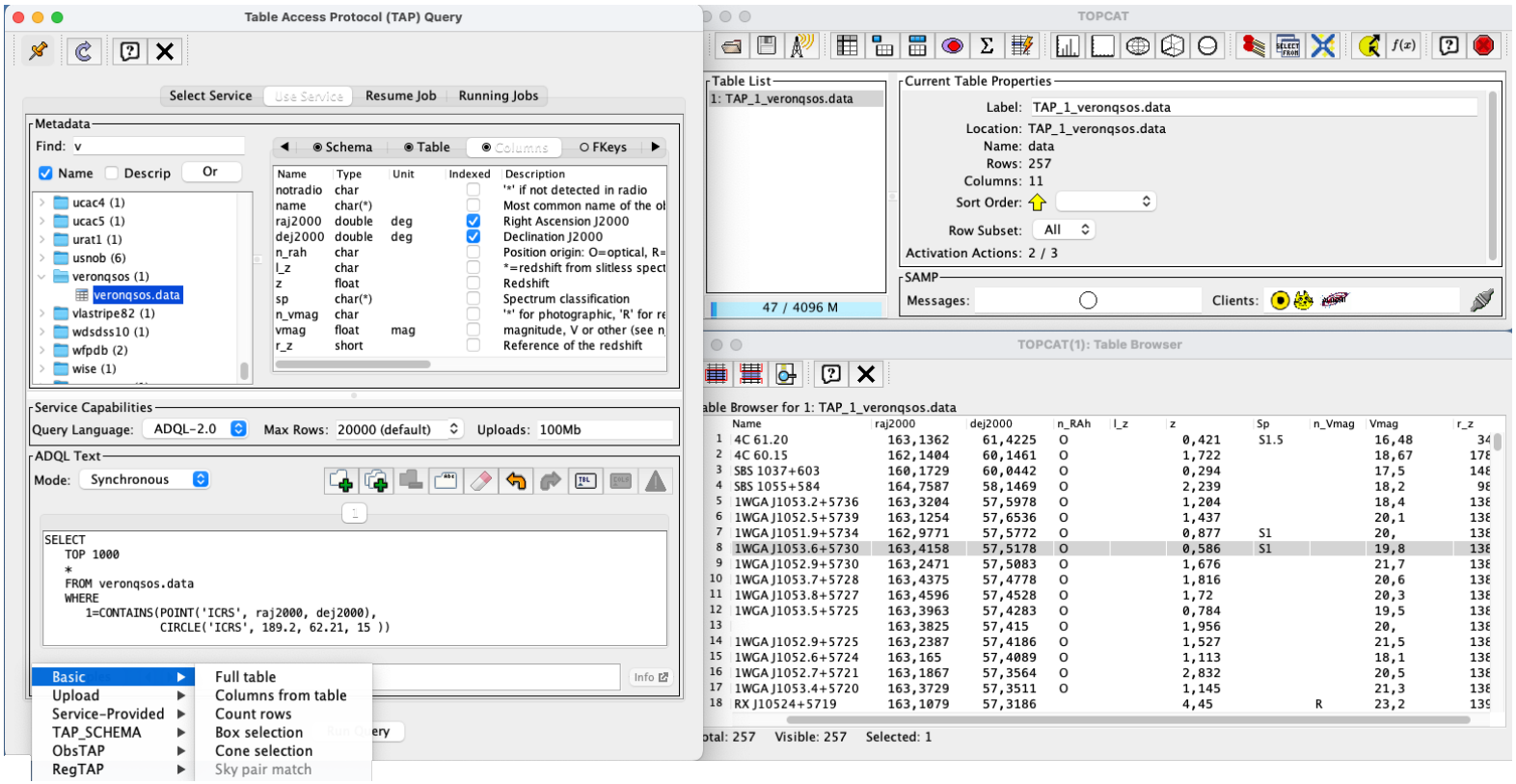






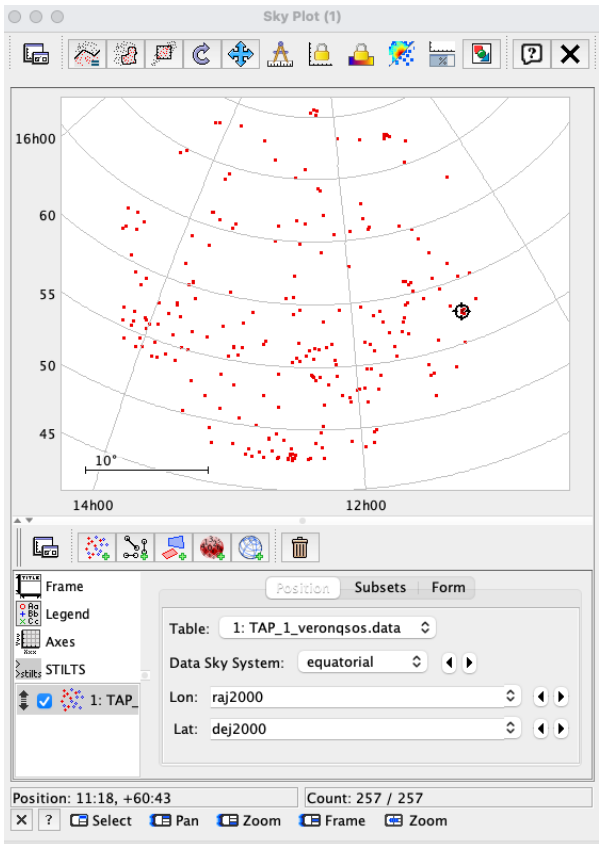
Short demonstration

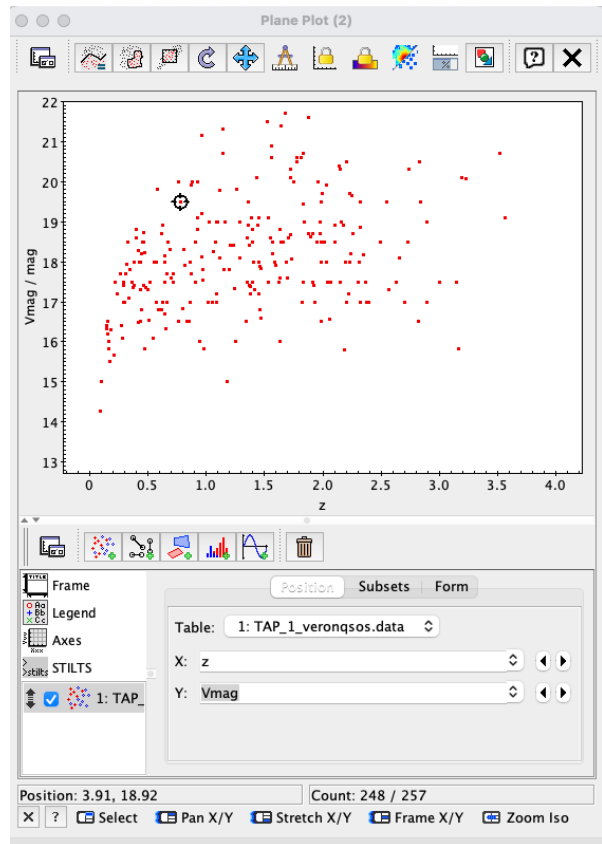
5. Run a (trivial) query against that by letting TOPCAT come up with a sample query: Example → cone selection, then change the cone to use 189, 62 as the center and 15 degrees as the radius

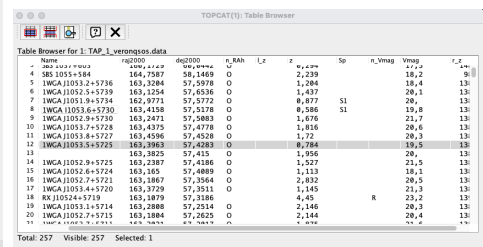


Short demonstration

6. Hit Graphics → Sky Plot
7. Hit Graphics → Plane Plot and plot the redshift z vs. the brightness Vmag
8. Click on points in the diagrams and watch TOPCAT update the selection in the other – that also works between VO-enabled applications.

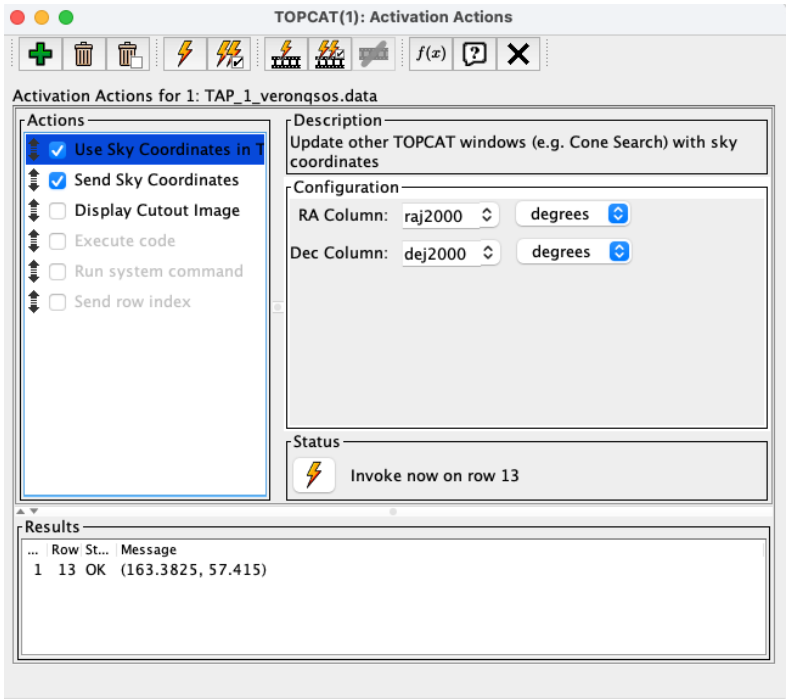






Short demonstration

9. Start Aladin (`https://aladin.cds.unistra.fr/AladinDesktop/`), and in TOPCAT, do Views → Activation Actions and check "Send coordinates"



Short demonstration

10. In Aladin, select DSS and zoom in to a field of view of a few arcminutes. Then in TOPCAT, click on an object with a Vmag of something like 20. In Aladin, you should see a very faint counterpart

Short demonstration

11. In Aladin, navigate to Image → X-ray → XMM and add the XMM False Color plane (note how there are green and orange data collections: the green ones are the ones that may have data for the area shown)
12. Note how most quasars will be prominent in X-rays even if inconspicuous optically – these are strange beasts!