

# The CDS Intro tutorial

---

2nd ESCAPE - Virtual Observatory School

February 2022

Tutors: Stefania Amodeo, Sébastien Derriere





# In this tutorial



Centre de Données astronomiques de Strasbourg  
*Strasbourg astronomical Data Center*

Gather information and data on specific astronomical objects using the CDS tools:



Object database



Catalogue database



Interactive sky atlas



Cross-match service

<https://cds.unistra.fr>



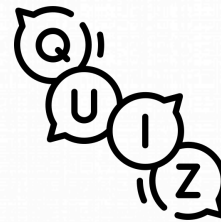


# Plan

1. Intro to CDS services and guided exercises (~1h)
2. CDS services in a python Jupyter notebook (~1h)



It's your turn!



It's quiz time!

- Ask questions on the zoom chat
- Questions can be answered on-air or in a breakout room



# The CDS portal

*Entry point to all services*

The screenshot shows the CDS portal interface. On the left is a vertical sidebar with a 'Close' button at the top. Below it are several colored buttons: a teal search button with a magnifying glass icon, a green 'Object (Simbad)' button, a dark blue 'Object (NED)' button, a purple 'Images' button, a dark purple 'Aladin Lite' button, an orange 'Catalogues' button, a dark blue 'Tabular data' button, a teal 'Bibliography' button, and a purple 'Photometric points' button. The main content area has a dark header with links: 'Portal', 'Simbad', 'VizieR', 'Aladin', 'X-Match', 'Other ~', and 'Help'. In the top right of the main area are links for 'Login', 'My data', and 'Preferences'. The main content area contains a 'Target:' section with a search box labeled 'Object name or position' and a teal search button. Below the search box is a dropdown menu set to 'J2000' followed by the text 'position :'. A link for a 'Guided tour' is provided below the search area. The footer of the page includes the copyright notice '© Université de Strasbourg/CNRS' and social media icons for Facebook, YouTube, Twitter, and LinkedIn, along with a 'Contact' link.

« Close

Portal Simbad VizieR Aladin X-Match Other ~ Help

Login My data Preferences

Target:

Object name or position

J2000 position :

Guided tour: click for an interactive introduction of the CDS portal.

© Université de Strasbourg/CNRS

f y t li Contact

<https://cdsportal.unistra.fr>





# The CDS portal

*Entry point to all services*



Open the [CDS Portal](#) and make a query for 12 01 53.002 -18 52 03.32 (NGC4038).

The result provides an overview of the information and data available for this object.

Click on [More info in Simbad](#) to see the full SIMBAD information on this object in a new tab.

<https://cdsportal.unistra.fr>



# SIMBAD

*The reference database for the identification of astronomical objects*

Basic Info

Hierarchy:  
environment  
(parents, children,  
siblings)

Literature on  
the object

The screenshot displays the SIMBAD database interface for the object NGC 4038. The top navigation bar includes links for Portal, Simbad, Vizier, Aladin, X-Match, Other, and Help. The main content area is titled 'NGC 4038' and features a 'Basic Info' section with various query modes (Identifier, Coordinate, Criteria, Reference, Basic, Script submission, TAP, Output options, Help). The 'Basic data' section provides detailed information about the object, including its coordinates, radial velocity, and morphological type. A 'Hierarchy' section shows a diagram of the object's environment, with parents, children, and siblings. The 'Identifiers (23)' section lists various catalog entries for the object. The 'References (1293 between 1850 and 2022) (Total 1293)' section provides a list of references and a search interface for finding literature on the object.

Aladin Lite  
widget

Alternative  
identifiers

<http://simbad.cds.unistra.fr/simbad/>



# SIMBAD

*The reference database for the identification of astronomical objects*



The main Object Type of NGC4038 is Galaxy in Pairs of Galaxies (GiP).

Note the list of “Other object types”. These types are drawn for the literature and are stored in SIMBAD using a hierarchical classification scheme. The full list of Object Types can be found here: <https://simbad.cds.unistra.fr/simbad/sim-display?data=otypes> .

In the Hierarchy section, use the “parents” button to identify the name of the galaxy pair. Sorting by the number of references can help bring out the most important ones.

Follow the link to the SIMBAD entry of the Antennae galaxy pair. There click on the children button to identify the name of the two galaxies making up the galaxy pair. Again the number of references might help to find them.

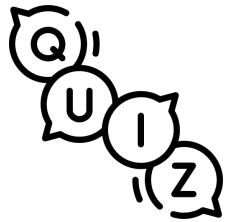
<http://simbad.cds.unistra.fr/simbad/>





# SIMBAD

*The reference database for the identification of astronomical objects*



- How is NGC4038 “parent” classified?
- What is the name of the other galaxy of the pair?
- Which survey measured the angular size of NGC4038 and at which wavelength?

<http://etc.ch/ijif>



# Aladin

*The interactive sky atlas for access, visualisation and analysis of astronomical images, surveys, catalogues, databases and related data*

Command line

Available data → 27326  
in view out view

Collection → 27401  
Image → 497  
Data base → 4  
SIMBAD Astronomica  
HyperLeda (Lyon-Meur  
Sky Body Tracker  
The NASA/IPAC Extrac  
Catalog → 25616  
Cube → 27  
Ancillary → 74  
Outreach → 50  
Others → 1133

Data discovery tree

Search data

Command

Frame ICRS Projection Aitoff

DSS PanSTARRS SDSS 2MASS GALEX Gaia Simbad NED +

DSS2 color

Main viewing window

18.11' x 9.302'

Toolbar

Current view

Table viewing window

| MAIN_ID       | OTYPE   | RA           | DEC          | C00... | C00... | C... | PMRA | PMDEC | B     | V | R    | J    | H     |
|---------------|---------|--------------|--------------|--------|--------|------|------|-------|-------|---|------|------|-------|
| NAHE Antennae | IG      | 12 01 53.170 | -18 52 37.92 |        |        |      |      |       |       |   |      | 8.11 | 7.399 |
| NGC 4038      | G1nP... | 12 01 53.002 | -18 52 03.32 |        |        |      |      |       | 10.91 |   | 9.74 |      |       |
| NGC 4039      | G1nP... | 12 01 53.8   | -18 53 06    |        |        |      |      |       | 11.08 |   | 9.77 |      |       |

3 sel / 1064 src 472Mb

<https://aladin.cds.unistra.fr/aladin.gml>



# Aladin

*The interactive sky atlas for access, visualisation and analysis of astronomical images, surveys, catalogues, databases and related data*

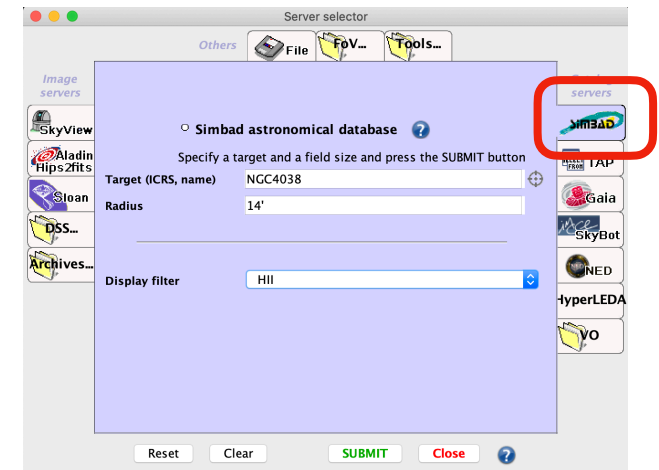


Open [Aladin](#)

Type “NGC4038” in the “Command” box and press Enter. By default, Aladin will display a DSS colour image. Other images can be displayed by selecting them in the left column. For example, select the PanSTARRS DR1 and 2MASS colour images one after another to see a higher resolution image and an image at infrared wavelength of the galaxy pair. You can zoom in and out by scrolling your mouse.

We want to look for available data related to HII regions in these interacting galaxies. Use the SERVER SELECTOR window, which can be opened via File → Open server selector...

Select the SIMBAD tab in the SERVER SELECTOR and query for HII within 14 arcmin around NGC 4038.

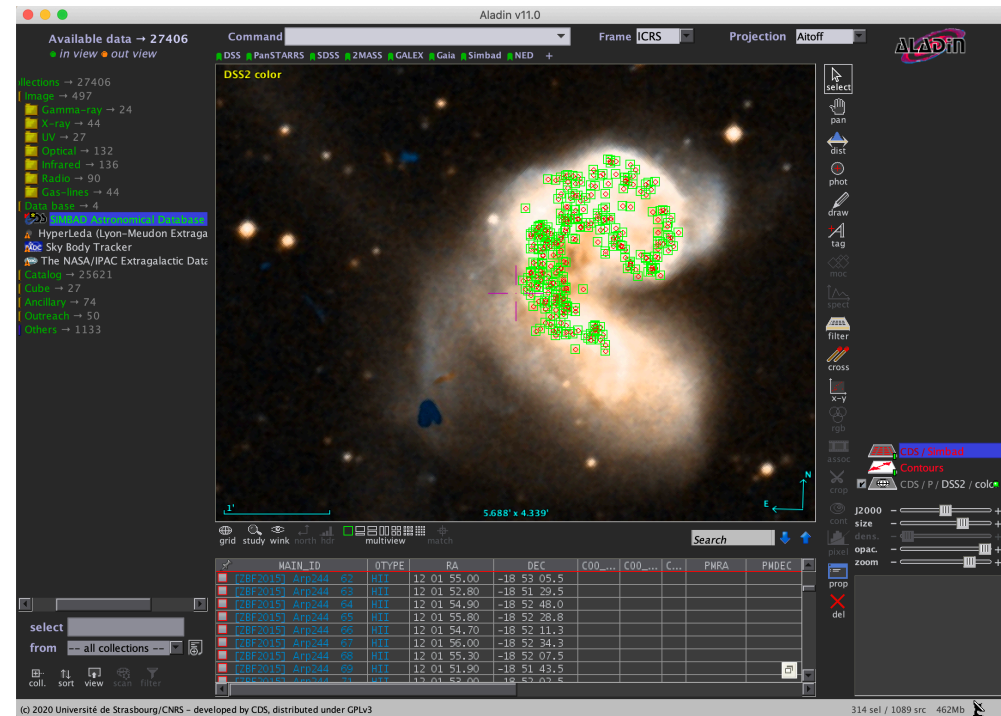




# Aladin - SIMBAD - VizieR



Using the Select tool (top of the toolbar), select some of the SIMBAD points either by clicking on one point or by holding the left mouse button and drawing a rectangle. The sources within the rectangle are then selected and displayed as a table below the image. Note that the data point belonging to a row in the table blinks in the main viewing window when hovering over the table row with the mouse.



We notice that many sources belong to the reference [ZBF 2015]. Click on one of them to load related data in SIMBAD in your web browser. Scroll down to the “References” section in SIMBAD, display them and identify [ZBF 2015]. Open the catalogue in [VizieR](#) following the link to [J/MNRAS/451/1307](#).



# VizieR

The catalogue service for the CDS reference collection of astronomical catalogues and tables published in academic journals

Target

Readme

Submit button

Restrictions on column values

The screenshot displays the VizieR web interface. At the top, there's a navigation bar with links to Portal, Simbad, VizieR, Aladin, X-Match, Other, and Help. The main heading is "VizieR". Below it, there are tabs for "Simple Target" and "List Of Targets". The "Simple Target" tab is active, showing a search form with fields for "Target Name (resolved by Sesame) or Position:" (set to "Clear"), "Target dimension:" (set to "2 arcmin"), and a radio button for "Radius" (selected). A note states: "NB: The epoch used for the query is the original epoch of the table(s)". Below the search form, there's a section for "Simple Constraint" with a table of constraints. The table has columns for "Show", "Sort", "Join tables", "Column", "Constraint", and "Explain (UCD)". The constraints listed are: (ALL) recno, (ALL) Arp, (ALL) Name, (ALL) RAJ2000, (ALL) DEJ2000, (1) Size, (1) Orient, (1) fl\_245, (1) fl\_ST6, (1) fl\_ST5, and (1) APG. Each constraint has a checkbox and a radio button. The "APG" constraint is highlighted. To the left of the main form, there's a "Search Criteria" sidebar with "Keywords" (arp), "Tables" (VII/74A, ..table2, VII/192, ..arpord), and "Preferences" (max: 50, HTML Table, All columns, Compute, Distance q, Position angle θ, Distance (x,y), Galactic, J2000, B1950, Ecl. J2000, default, Sort by Distance, + order -, No sort, Position in: Sexagesimal, Decimal °, Truncated prec., Mirrors: CDS, France). A "Submit" button is located at the bottom right of the constraints table.

| Show                                | Sort                  | Join tables                      | Column        | Constraint  | Explain (UCD)  |
|-------------------------------------|-----------------------|----------------------------------|---------------|-------------|--|
| <input type="checkbox"/>            | <input type="radio"/> | <input type="radio"/>            | (ALL) recno   |             | Record number assigned by the VizieR team. Should Not be used for identification. (meta.record)    |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input checked="" type="radio"/> | (ALL) Arp     |             | (i) Arp number from original catalog (meta.id;meta.main)   |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input checked="" type="radio"/> | (ALL) Name    | (char)      | Common name (group or brightest) (Note) (meta.id)  |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input type="radio"/>            | (ALL) RAJ2000 | "h:m:s" (i) | Right Ascension J2000 (pos.eq.ra;meta.main)  |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input type="radio"/>            | (ALL) DEJ2000 | "d:m:s" (i) | Declination J2000 (pos.eq.dec;meta.main)   |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input type="radio"/>            | (1) Size      | arcmin      | Long dimension of Arp's original photo (Note) (phys.angSize)                                       |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input type="radio"/>            | (1) Orient    | (char)      | [N,S,E,W,?] Orientation of Arp photo (Note) (meta.note)  |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input type="radio"/>            | (1) fl_245    | 2.54cm (n)  | Focal length for CB245 CCD Camera (Note 1) (instr.tel.focalLength)                                 |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input type="radio"/>            | (1) fl_ST6    | 2.54cm (n)  | Focal length for SBIG ST6 CCD Camera (Note 1) (instr.tel.focalLength)                              |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input type="radio"/>            | (1) fl_ST5    | 2.54cm (n)  | Focal length for SBIG ST5 CCD Camera (Note 1) (instr.tel.focalLength)                              |
| <input checked="" type="checkbox"/> | <input type="radio"/> | <input type="radio"/>            | (1) APG       | APG (char)  | Values from the original Arp's catalog of Peculiar Galaxies (Arp 1966, Cat. VII/74) (meta.ref.url) |

<https://vizier.cds.unistra.fr/index.gml>





# VizieR

*The catalogue service for the CDS reference collection of astronomical catalogues and tables published in academic journals*



Query the **VizieR** table associated with the article J/MNRAS/451/1307 containing the physical properties of the HII regions in interacting and isolated galaxies (2299 rows).

Inspect the table columns and their description. As we are interested in the interacting galaxies only, apply the constraints “int” to n\_Name.

You can download the catalogue for future use by changing the output format in “Preferences”. Choose one between VOTable and FITS which are standard formats recognised by most tools.

Remember to set the max number of rows to “unlimited” (default is 50) and then click on the “Submit” Button.

The screenshot shows the VizieR web interface. On the left, the 'Search Criteria' panel has 'Keywords' set to 'J/MNRAS/451/1307' and 'Tables' set to 'HIIreg'. The 'Preferences' panel shows 'max' set to 'unlimited' and 'VOTable' selected. The main panel shows the 'Simple Constraint' tab with a query by constraints applied on columns. The 'n\_Name int' constraint is highlighted with a red box. The 'Submit' button is also highlighted with a red box. The table of constraints is as follows:

| Show                                | Sort                  | Column   | Constraint | Explain (UCD)   |
|-------------------------------------|-----------------------|----------|------------|---|
| <input type="checkbox"/>            | <input type="radio"/> | recno    |            | Record number assigned by the VizieR team. Should Not be used for identification. (meta.record) |
| <input checked="" type="checkbox"/> | <input type="radio"/> | Seq      |            | [1/303] Consecutive number in catalog, within the galaxy (meta.id:meta.main)                    |
| <input checked="" type="checkbox"/> | <input type="radio"/> | n_Name   | int        | Indicates interacting or isolated galaxy (meta.code:src.morph)                                  |
| <input checked="" type="checkbox"/> | <input type="radio"/> | Name     |            | Galaxy name (meta.id.parent)  |
| <input checked="" type="checkbox"/> | <input type="radio"/> | Nf       |            | (b) Number of FITS images for this galaxy (meta.ref.url)  |
| <input checked="" type="checkbox"/> | <input type="radio"/> | RAJ2000  | "h:m:s"    | (b) Right Ascension (J2000) (pos.eq.ra:meta.main)   |
| <input checked="" type="checkbox"/> | <input type="radio"/> | DEJ2000  | "d:m:s"    | (b) Declination (J2000) (pos.eq.dec:meta.main)  |
| <input checked="" type="checkbox"/> | <input type="radio"/> | logLHa   | [10-7W]    | [35/41] Log of H $\alpha$ luminosity (erg/s) (phys.luminosity:em.line.Halpha)                   |
| <input type="checkbox"/>            | <input type="radio"/> | e_logLHa | [10-7W]    | [0.006/0.4] Log of H $\alpha$ luminosity error (stat.error)                                     |
| <input checked="" type="checkbox"/> | <input type="radio"/> | R        | pc         | [16/481] Globular radius (phys.size.radius)   |
| <input type="checkbox"/>            | <input type="radio"/> | e_R      | pc         | [1/50] Radius error (stat.error)  |





# VizieR - Aladin



You can also continue your investigation using the CDS-VO tools. Set back the output format to “HTML Table” and submit the query.

We want to visualise the galaxies in this catalogue. We notice that there are many HII regions associated to each galaxy and the column “Seq” lists an id number for the HII regions in each catalog, starting from 1. Add a new constraint by clicking on “Modify query” on the left box. Apply Seq=1 and re-submit the query. Now we have one set of coordinates for each interactive galaxy in the study. For a quick view, start AladinLite and double-click on the check-boxes in the aladin column.



Send to VO tools



For further inspection, send this catalogue to your Aladin Desktop by clicking on the antenna on the top-right corner and allow the browser to connect to the SAMP hub. Then click on the newly appeared grey Broadcast button and go to your Aladin Desktop.

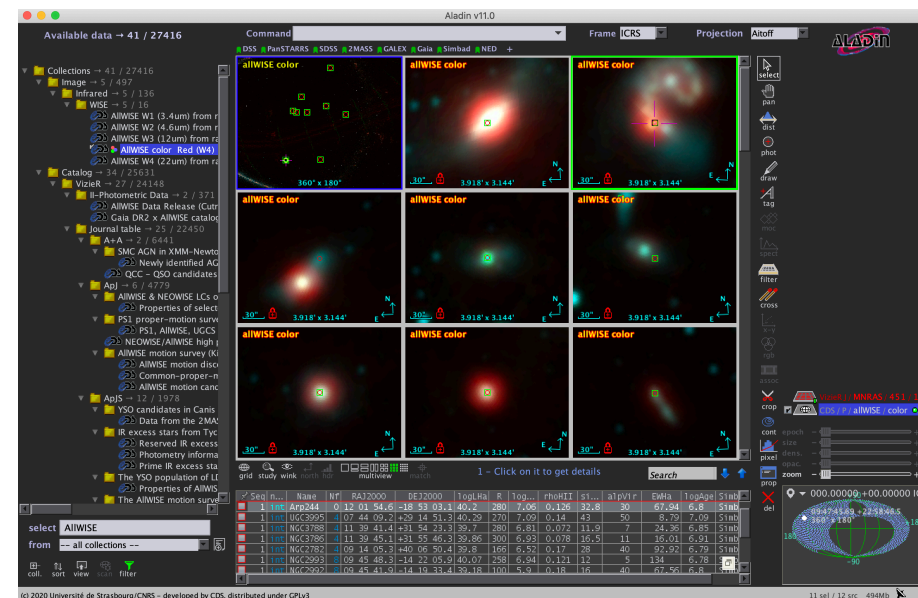


# Aladin



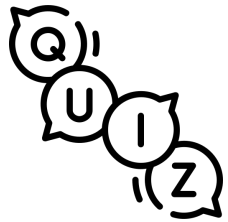
A new plane view from Vizier should appear on the Aladin Desktop. Zoom out until you can see the regions. We are also interested in infrared data for this sample, we can check if there are available images from the AllWISE survey. Type “AllWISE” in the select box and all the relevant data sets will appear in the Data Tree. Note that Data sets in the Data Tree are colour coded in green or orange depending on whether or not they are available in the region currently visible in the main viewing window.

Load “AllWISE color” in Collections - Image → Infrared → WISE → AllWISE color. Now select all the sources from the Vizier catalog by double-clicking its name in the stack of planes on the right (or equivalently, by drawing a rectangle that contains them all). Finally, make thumbnails of the galaxies hosting the HII regions: Tool → Thumbnail view generator... set the thumbnail size to 4 arcmin.





# VizieR



Now that we have looked at the galaxies, we are interested in using the image fits files released by Zaragoza-Cardiel+, 2015 for our own studies.

- What are the typical sizes of the fits images?
- What is the approximate resolution of the images?

<http://etc.ch/ijif>



# X-Match

*Efficient cross-matching of sources in very large catalogues*

The screenshot shows the CDS X-Match Service web interface. At the top, there is a navigation bar with links to Portal, Simbad, Vizier, Aladin, X-Match, Other, and Help. Below this, the 'CDS X-Match Service' header is followed by buttons for 'X-match', 'Tables management', and 'Documentation'. A blue arrow points from the 'Tables management' button to the text 'Upload your table (VOTable, FITS, CSV)'. The main section is titled 'Choose tables to cross-match' and contains two input fields. The first field contains 'vizier\_votable\_ZBF2015.vot' and has buttons for 'VizieR', 'SIMBAD', and 'My store'. The second field contains 'AllWISE' and has buttons for 'VizieR', 'SIMBAD', and 'My store'. Below these fields, there are two boxes: one for 'vizier\_votable\_ZBF2015.vot' with 2,299 rows, and another for 'AllWISE Data Release (Cutri+ 2013)' with 747,634,026 rows and a small image of a galaxy. A blue arrow points from the 'Cross-match criteria/area' text to the 'Show options' button. Below this is a 'Begin the X-Match' button. The bottom section is titled 'Visualize and manage your cross-match jobs' and contains a table with the following data:

| Table 1                    | Table 2 | Options  | Begin               | Status    | Actions                    |
|----------------------------|---------|--|---------------------|-----------|----------------------------|
| vizier_votable_ZBF2015.vot | AllWISE | fixed radius<br>radius: 30 arcsec<br>area: All sky | 10/02/2022 at 14:57 | completed | <a href="#">Get result</a> |

A blue arrow points from the 'Download result' text to the 'Get result' button. A tooltip for the 'Get result' button shows the following information: 'Job executed in 5s', '< 1s to correlate', '4s to generate file', 'Result: 7,219 rows (2MB)', and a 'Delete' button.

<http://cdsxmatch.u-strasbg.fr/>



# VizieR - X-Match



From the [VizieR](#) query page in your browser, you can forward the entire catalog directly to [X-Match](#) by clicking on “Fast Xmatch with large catalogs or Simbad” on the top-right. It will be automatically loaded into X-Match.



Alternatively, you can use the catalogue previously downloaded. Upload it in “Tables management” and select the RA, Dec columns with the correct units in “Add metadata”. Then go back to the X-match main page and select your catalogue from “My store”.



Select “AllWISE” as table to cross-match and review/modify the options (radius/area). When the cross-match is completed, you can download the result as a CSV, ASCII, or VOTable file.





# Summary

We have gathered information on a specific object with 

We have visualised it through survey images at different wavelengths with   
and we have obtained the bibliographic reference of additional data of interest  
related to the same object, which we have inspected with  as well.

We have obtained the entire catalog and the images published by the authors  
using , where we have selected a sample of objects (HII regions in  
interacting galaxies) which we have again visualised with 

In order to have complementary data, we have cross-matched the catalogue  
from  with another large catalogue using 

The whole process was extremely fast. Now we have plenty of data and  
information to progress with our research!





# Automate all this with Jupyter Notebooks

Excellent tool to share and reproduce research outputs

Interactive execution of Python code

Find the notebook on Binder (no installation required):

<https://mybinder.org/v2/gh/cds-astro/tutorials/master?filepath=Notebooks>

wait a moment for everything to load, then click on the link to [CDS\\_Intro\\_tutorial.ipynb](#)

Or download the notebook from Github and run it on your machine:

[https://github.com/cds-astro/tutorials/blob/master/Notebooks/CDS\\_Intro\\_Tutorial.ipynb](https://github.com/cds-astro/tutorials/blob/master/Notebooks/CDS_Intro_Tutorial.ipynb)

More on Python and Notebooks:

Enrique Garcia, LAPP/CNRS

<https://escape2020.github.io/school2021/posts/clase03/>



# Tips for Jupyter Notebooks



```
In [ ]: Simbad.  
        add_votable_fields  
In [ ]: cache_location  
        get_field_description  
In [ ]: get_votable_fields  
        list_votable_fields  
In [ ]: list_wildcards  
        query_bibcode  
In [ ]: query_bibcode_async  
        query_bibobj  
In [ ]: query_bibobj_async
```

Type the name of a module followed by a dot in a code cell; then press 'tab' to see and select the available functions for that module.

```
In [ ]: Simbad.query_region()  
In [ ]: Signature: Simbad.query_region(self, *args, **kwargs)  
Docstring:  
In [ ]: Queries the service and returns a table object.  
In [ ]: Serves the same function as `query_region`, but  
        only collects the response from the Simbad server and returns.  
In [ ]: Parameters  
        -----  
In [ ]: coordinates : str or `astropy.coordinates` object
```

Once selected a function, click inside the parenthesis and press 'shift' + 'tab' to see the related documentation, the required/optional input parameters, what the function returns etc.

More on Python and Notebooks:

Enrique Garcia, LAPP/CNRS

<https://escape2020.github.io/school2021/posts/clase03/>