Challenge #1: Identification of the Messier 4 cluster in the proper motion space with TOPCAT

Using GAIA DR2 proper motions, identify the members of the globular cluster Messier 4 (M4) in a radius of 0.3 degrees and determine their mean parallax.
Tip: Explore the **Graphics** window.

What is the mean distance to the M4 cluster?

Challenge #2: Identification of the Hyades cluster in the 3D velocity space with ADQL on TOPCAT

1) Use TAP Query to download Gaia DR2 basic astrometric data (and some photometry) of the nearby sources (within ~ 66 pc) with good determinations of parallaxes (parallax over error > 5). Calculate the absolute magnitudes.
Tips: To avoid downloading a very big table, query only for the columns you will need (coordinates, proper motions, parallax, radial velocity, mean magnitudes and BP-RP colour).

2) Identify the members of the Hyades cluster in the 3D velocity space.
Tips: Convert the astrometric quantities of Gaia into coordinates in the 3D velocity space (see **Help | Available Functions**). Explore the **Graphics | Cube Plot** window.

3) Construct a colour-magnitude diagram (absolute G-magnitude versus BP-RP colours).

Challenge #3: Match Gaia and HST observations with TOPCAT

1) Find the Gaia positions of the stars in the cluster NGC346 in a radius of 1 degree and do a crossmatch with their position in the Hubble Space Telescope observations. Visualize the cross-match results.
Tip: Use the Vizier catalogue *"J/ApJs/166/549"* for the HST data and explore the **VO | CDS Upload X-Match** window for the crossmatch with Gaia DR2.

2) Repeat the same crossmatch but this time by retrieving Gaia data in a region of radius "0.05" degrees. Plot the results.
Tip: Explore the **VO | Cone Search** and the **Joins | Pair Match** windows.

Challenge #4: Construct a local HR Diagram with Gaia data using ADQL and TOPCAT

1) Use TAP query to download all the nearby Gaia sources (within 100pc) with good parallaxes (parallax over error > 10) and small BP and RP magnitude errors (magnitude over error > 10). Calculate their absolute magnitudes and plot the results in an HR diagram (absolute G-magnitude versus BP-RP colours).
Tips: To avoid downloading a very big table, query only for the columns you will need (coordinates, parallax, mean magnitudes, BP-RP colour, astrometry excess factor, BP-RP excess factor).
Important: For better performance, run your ADQL query in "Asynchronous" mode.

2) Clean your HR diagram, removing sources with unreliable astrometric and photometric data, so that the Main Sequence and the white dwarf sequence are clearly separated.
Tips: Explore the different columns to see which ones can be used to exclude bad data points (you may need to build additional graphs, or use the "Aux" mode in the "Form" tag of the **Graphics | Plane Plot** window).

Challenge #5: Construct a local HR Diagram using ADQL and STILTS

Reproduce the HR Diagram of the Challenge #4 but this time using STILTS.
Tip: Use the same query and filtering conditions as in the previous challenge.
Important: For better performance, set "sync=false" in your ADQL query.

Solutions in Bonus Material: Exploring Gaia data with TOPCAT and STILTS

(https://svo.cab.inta-csic.es/docs/files/svo/Public/Education/Tutorials/tutorial-topcat-stilts_asterics.pdf)