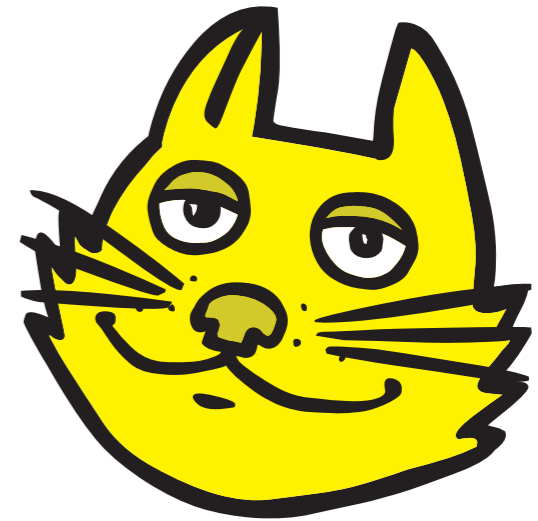


# Crossmatching with TOPCAT

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\$Id: xmatch.tex,v 1.5 2021/03/25 13:24:20 mbt Exp \$



# Outline

- Introduction to crossmatching with TOPCAT
  - Capabilities, regimes, techniques
- Demo with dataset 1: Pleiades with Gaia and 2MASS
  - Internal pair match
  - CDS X-Match window
  - TAP Upload match
- *Questions?*
- Demo with dataset 2: NGC346 with Gaia and HST
  - Ironing out problems with matching
- *Questions?*

# Crossmatching

## What is crossmatching:

- Identify which objects in one table correspond to which objects in another table
- ... typically in different observational regimes (e.g. wavelength)
- ... typically on basis of sky position (closest objects match)
- ... typically to combine observations, e.g. multi-wavelength photometry

## TOPCAT crossmatching options:

- Provides several options for identifying “nearby” objects in two tables, multiple tables or a single table
- Various criteria for what counts as “nearby”
- Various options for what to do with matches; mostly create new table joining input tables
- (But also various things it *doesn't* do e.g. match probabilities, proper handling of differing length scales)

## TOPCAT post-processing:

- Crossmatching is usually one step in a scientific workflow
- Lots of capabilities for looking at and understanding the results

# Options and Regimes

## Internal Matching

- Both/all files loaded into TOPCAT
- Works well up to  $\sim 1$  million rows each
- Pretty fast ( $\leq$  couple of minutes)
- Quite flexible (sky, Cartesian, exact, 3D, ellipses, errors, combinations...)
- Works for two tables, within a single table, 3, 4, 5 tables

## External Matching

- One or both tables too big to download
- Several options, with different pros and cons:
  - ▷ CDS X-Match  
(any VizieR table, sky match, fast, easy)
  - ▷ Multiple cone search  
(many tables available, sky match, slow)
  - ▷ TAP  
(few tables available, flexible, tricky)

Usually Internal Matching is better/easier if tables are small enough

The image displays two windows from the TOPCAT software interface. The 'Sky Plot' window shows a scatter plot of celestial objects with a grid. The x-axis represents Right Ascension (RA) from 11h30 to 11h00, and the y-axis represents Declination (Dec) from 22 to 24. Two data series are plotted: 'Abell' (pink dots) and 'NGC' (cyan dots). The 'Match Tables' window is overlaid on the Sky Plot, showing the configuration for a sky match. It includes the following settings:

- Match Criteria:** Algorithm: Sky, Max Error: 2.5 arcsec.
- Table 1:** Table: 8: mgc.fits, RA column: MGC\_ALPHA\_J2000 (degrees), Dec column: MGC\_DELTA\_J2000 (degrees).
- Table 2:** Table: 3: 2mass\_xsc.fits, RA column: RArad (radians), Dec column: DECrad (radians).
- Output Rows:** Match Selection: Best match, symmetric; Join Type: 1 and 2.

The Match Tables window also shows a progress bar and status text: 'Consolidating potential match groups...', 'Locating inter-table pairs...', 'Elapsed time for match: 74 seconds', and 'Match succeeded'. The Sky Plot window has a toolbar with icons for window management, layers, subsets, plot, export, and help. The bottom of the Sky Plot window shows a status bar with '+19:53', 'Count: 138 / 12,667', and navigation buttons for Pan, Zoom, and Zoom.

## Demo 1: Gaia vs 2MASS Pleiades

Gaia data from GAVO DC TAP service:

```
WITH reg AS (  
    SELECT ra, dec, ra_error, dec_error, pmra, pmdec, pmra_error, pmdec_error,  
           parallax, parallax_error, dr2_radial_velocity, dr2_radial_velocity_error,  
           phot_g_mean_mag, phot_bp_mean_mag, phot_rp_mean_mag, phot_bp_mean_mag-phot_rp_mean_mag AS bp_rp  
    FROM gaia.edr3lite  
    WHERE 1=CONTAINS(POINT(ra, dec), CIRCLE(56.75, 24.1166, 3))  
)  
SELECT * FROM reg  
WHERE SQRT(POWER((pmra - 19.7)/2.7, 2) + POWER((pmdec + 45.3)/3.1, 2)) < 1
```

2MASS data from GAVO DC TAP service:

```
SELECT RAJ2000, DEJ2000, errMaj, errMin, errPA, mainId, Jmag, Hmag, Kmag  
FROM twomass.data \  
WHERE 1=CONTAINS(POINT(RAJ2000,DEJ2000), CIRCLE(56.75, 24.1166, 3))
```

## Demo 2: Gaia vs. HST NGC 346

Gaia data from Gaia-ARI Cone Search service:

<https://gaia.ari.uni-heidelberg.de/cone/search?ra=14.771207&dec=-72.1759&sr=0.05&verb=1>

HST data (Gouliermis et al., 2006ApJS..166..549G) from VizieR:

[http://vizier.u-strasbg.fr/viz-bin/votable?-source=J%2fApJS%2f166%2f549&-oc.form=dec&-out.meta=Dhul  
&-c=14.771207+-72.1759&-c.rd=1.0&-out.add=\\_RAJ%2C\\_DEJ%2C\\_r&-out.max=100000](http://vizier.u-strasbg.fr/viz-bin/votable?-source=J%2fApJS%2f166%2f549&-oc.form=dec&-out.meta=Dhul&-c=14.771207+-72.1759&-c.rd=1.0&-out.add=_RAJ%2C_DEJ%2C_r&-out.max=100000)