Kiel AG Tagung 2015 Puzzler: Solutions

The Classic Solution

(Involving downloads of full catalogs, so it's certainly not the preferred way of doing this)

1. Start TOPCAT, open VO/Cone Search. We're looking for a catalogue of radio quasars, so let's try "quasar catalogue radio" and check "Descr" in Match Fields so you catch catalog that only mention radio in the description[1].
2. You could use something else, but we suggest from the matches shown you go for the Veron catalog of AGNs and quasars, which is present in several editions; the one with the short name VI/258 will do. Try to download the whole of it: choose RA and Dec to 0 both, and a Radius of 180 degrees. You'll see you only got 50000 rows back, which means you hit VizieR's match limit, but let's not be worried by this now – it's uncool to download entire catalogs anyway, and if we find one quasar, we're already happy.[2]
3. Do the analogous thing for OH masers; here, we recommend the "Database of Circumstellar OH Masers". Again, pull the entire table using the 0/0/180 trick.
4. Match the two tables; in TOPCAT, do Joins/Pair Match; configure the tables you want matched and select 2 arcminutes of "Max Error".
5. You should get back a few rows, most of which have a mark in Veron's nR (non-detection in radio) column. At least one doesn't: The quasar is "SDSS J08143+0835" at 123.5792, 8.5961, the maser "IRAS 08116+0843".

The Better Solution

When you face tasks of the type "filter out all X of type Y", it's a good idea to think whether Simbad's TAP interface is up to the task. The big advantage of this approach is that you don't need to download both full catalogs, each containing 99.9% material irrelevant to you.

Let's first try a solution where we still keep the smaller catalog locally – in this case, the OH Masers – and have Simbad look for nearby quasars. To do that:

1. Get the full OH Maser catalog as described in the classic solution. Set it as TOPCAT's current table (by clicking on its entry in the main window).
2. Go to VO/TAP from TOPCAT's menu. In Keywords, enter "Simbad", select the resulting match and hit "Enter Query" at the bottom of the window.
3. In the table selector in the TAP Dialog's "Enter Query" tab, select the table "public.basic".
4. From the pop-up below the "Examples" button in that dialog, choose "Upload Join".
5. The query TOPCAT generated for you needs some fixes: A larger match radius in the CIRCLE (as we want to find QSOs within 2 arcminutes), and a constraint on the types of Simbad objects.
6. Hence, browse the Simbad object types as discussed on `http://simbad.u-strasbg.fr/simbad/sim-display?data=otypes` (if nobody is around to give you that URL, you can get there from the Reference URL given in the row in TOPCAT's "Select Service" tab).

   The resulting query (modulo the name of the upload table; fix the number to match TOPCAT's ordinal number for your OH maser table) would look like this:

```
SELECT
   TOP 1000
   *
   FROM "public".basic AS db
   JOIN TAP_UPLOAD.t2 AS tc
   ON 1=CONTAINS(POINT('ICRS', db.ra, db.dec),
                 CIRCLE('ICRS', tc.raj2000, tc.dej2000, 2./60.))
WHERE db.otype='QSO'
```

[1] A preferable alternative would be to use a more capable registry interface like `http://dc.g-vo.org/WIRR` that lets you directly constrain the waveband – but of course, that makes you more dependent on correct metadata from the publishers, too.

[2] But if you ever need this, here's a hack: For VizieR tables, just append something like "&-out.max=200000" to the cone URL in TOPCAT's text field to raise the match limit. Several other services support the same thing, just with MAXREC instead of -out.max. Yes, this desperately needs standardisation.

It should execute within in a few seconds. This returns a few dozen rows, where, due to the way the OH maser table is organised, most candidate quasars are combined with several sub-sources of the masers.

7. To throw out duplicates, do Joins/Pair Match, and select your result table for *both* Table 1 and Table 2. For the rest, the defaults should do. You'll get a result table of a about a dozen candidates.

8. But: Are those quasars radio sources? The one from the Classic solution is in there, though Simbad calls it SDSS J081418.97+083545.8. In an ideal world, we could have had an extra constraint "AND db.otype='Radio"' in our Simbad query and be done with it. That, however, doesn't work; even Simbad isn't perfect. So, we need some manual filtering.

9. The good way to do that would be to locate a TAP service with a suitable radio survey and to perform another upload join with that. That's still a bit tricky to do these days (should be better next year this time). However, if you have just a dozen objects or so, you can use TOPCAT's VO/Multicone facility (which does one request per row, so don't use that for big tables.). Interestingly, I couldn't find any matches for our sources in the radio surveys I tried. Advice is welcome. However, you can locate – for instance – the Veron QSO catalog as in the classic solution (or just look for Veron directly). If you match with the 13th edition, you'll get the nR column, and you'll again find the (perhaps unique) solution given above.

Another Better Solution

Of course, Simbad knows about the Masers, too, and in principle we could solve (almost) the entire problem in one go by locating Simbad's TAP service as discussed in the "Better Solution", selecting the public.basic table again and then hit "Examples/Sky Pair Match". Edit the query – you'll want to match basic with itself; the match radius should be 2 arcminutes, course we need to write the conditions on our object types (see above on where to find those). We want to match QSO and Maser, so the entire query becomes:

```
SELECT
   TOP 1000
   *
   FROM public.basic AS m
   JOIN "public".basic AS b
   ON 1=CONTAINS(POINT('ICRS', m.ra, m.dec),
                 CIRCLE('ICRS', b.ra, b.dec, 2/60.))
WHERE b.otype='QSO' and m.otype='Maser'
```

Unfortunately, this query takes very long because Simbad's database engine chooses a bad query plan, and some standards tricks to make it notice there's a better one don't currently work due to software bugs. Some of this should be fixed soon, after which this would be the preferred way (you'd still have to filter out the radio-quiet ones).