

Source identification with gtsrcid

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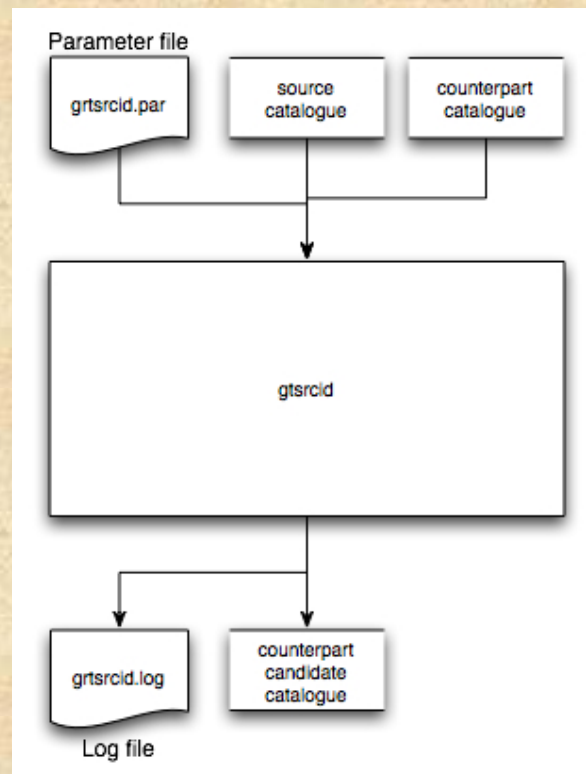
Purpose of gtsrcid

- Identification of LAT point sources using publically available counterpart candidate catalogues (CDS, HEASARC)
- Evaluate probability of chance coincidence between LAT point source and astronomical catalogues of potential counterparts (à la Mattox et al. 1997, ApJ, 481, 95)
see presentation of Vincent Lonjou
- Client computer tool, should not be computationally intensive

gtsrcid philosophy - 1

Simple executable that finds counterparts for a **catalogue of sources** using a **catalogue of potential counterparts**

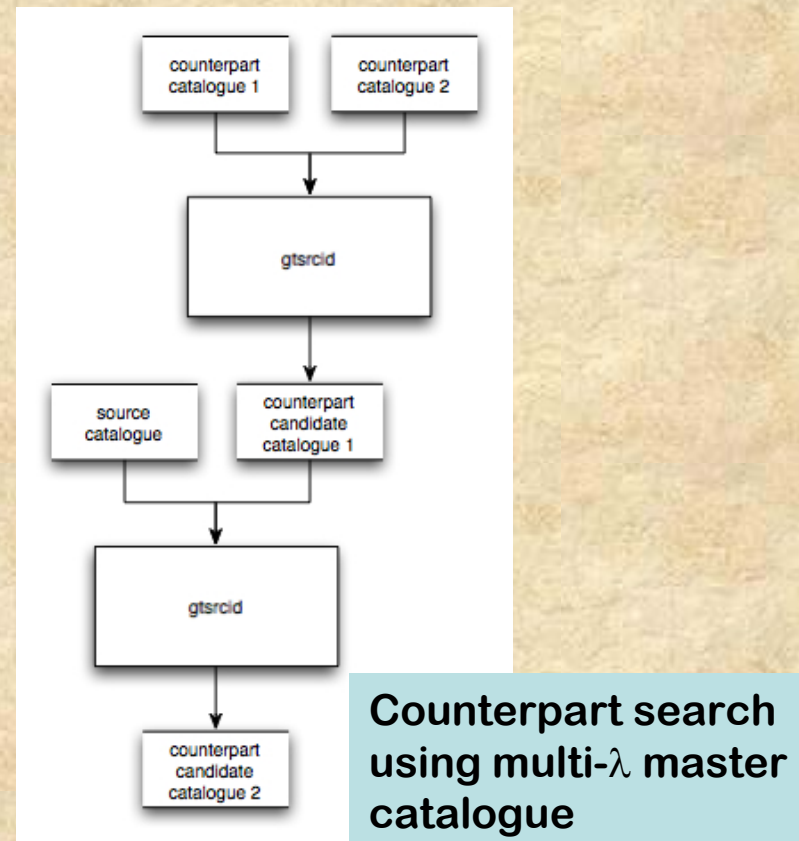
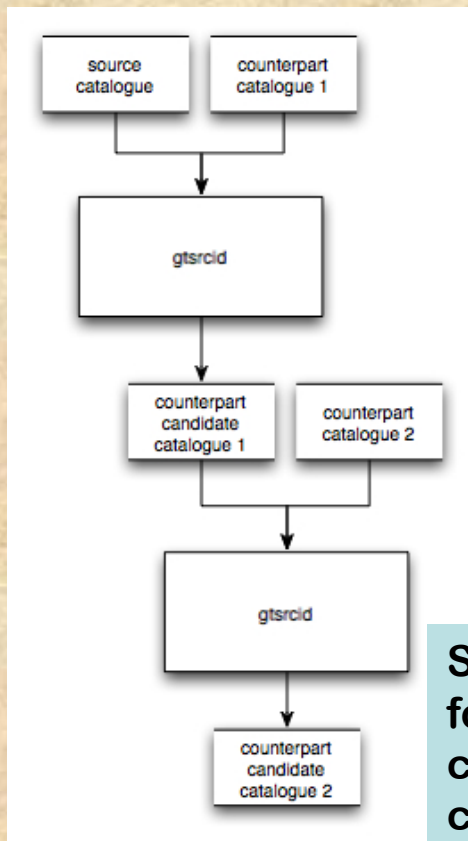
- simple and understandable interface
- small number of parameters



gtsrcid philosophy - 2

Implement sophistication (à la Mattox et al.) by

- subsequent executions of gtsrcid
- deriving new quantities



gtsrcid parameters

```
#
# Source Catalogue information
#=====
srcCatName, s,a,"3EG.fits",,"Source catalogue name"
srcCatPrefix,s,a, "3EG",,"Source catalogue column prefix"
srcCatQty, s,a, "*" ,,"Source catalogue quantities to be written"
srcPosError, r,h, 0.0 ,,"Source position uncertainty (deg)"
#
# Counterpart Catalogue information
#=====
cptCatName, s,a,"radio_whitel.4GHz.tsv",,"Counterpart catalogue name"
cptCatPrefix,s,a, "WB14",,"Counterpart catalogue column prefix"
cptCatQty, s,a, "*" ,,"Counterpart catalogue quantities to be written"
cptPosError, r,h, 0.0138888 ,,"Counterpart position uncertainty (deg)"
#
# Output Catalogue information
#=====
outCatName, s,a, "result.fits",,"Output catalogue name"
outCatQty01,s,h, "RATIO = @$3EG F$ / @$WB14 S1.4$",,"New output catalogue quantity 1"
outCatQty02,s,h, "PROB_RATIO = exp(-0.5*((RATIO-0.11)/0.11)^2)",,"New output catalogue quantity 2"
outCatQty03,s,h, " ",,"New output catalogue quantity 3"
outCatQty04,s,h, " ",,"New output catalogue quantity 4"
outCatQty05,s,h, " ",,"New output catalogue quantity 5"
outCatQty06,s,h, " ",,"New output catalogue quantity 6"
outCatQty07,s,h, " ",,"New output catalogue quantity 7"
outCatQty08,s,h, " ",,"New output catalogue quantity 8"
outCatQty09,s,h, " ",,"New output catalogue quantity 9"
#
# Task parameters
#=====
probMethod,s,a, "POSITION * PROB_RATIO",,"Probability method"
probThres, r,a, 0.01 ,,"Probability threshold"
maxNumCtp, i,a, 100 ,,"Maximum number of counterpart candidates"
select01, s,h, "$@WB14_Sp+index$ > -0.5",,"Selection cirterium 1"
select02, s,h, " ",,"Selection cirterium 2"
select03, s,h, " ",,"Selection cirterium 3"
select04, s,h, " ",,"Selection cirterium 4"
select05, s,h, " ",,"Selection cirterium 5"
select06, s,h, " ",,"Selection cirterium 6"
select07, s,h, " ",,"Selection cirterium 7"
select08, s,h, " ",,"Selection cirterium 8"
select09, s,h, " ",,"Selection cirterium 9"
#
# Standard parameters
#=====
chatter,i,h, 4,0,4,"Chattiness of output"
clobber,b,h, yes ,,"Overwrite existing output catalogue ?"
debug, b,h, no ,,"Debugging mode activated"
mode, s,h, "ql",,"Mode of automatic parameters"
```

5 sections:

- Source catalogue parameters
- Counterpart catalogue parameters
- Output catalogue parameters
- gtsrcid task parameters
- ScienceTools standard parameters

gtsrcid parameters

- source catalogue -

```
#
# Source Catalogue information
#=====
srcCatName,  s,a,"3EG.fits",,, "Source catalogue name"
```

```
#
# Source Catalogue information
#=====
srcCatName,  s,a,"3EG.fits",,, "Source catalogue name"
srcCatPrefix,s,a,  "3EG",,, "Source catalogue column prefix"
srcCatQty,   s,a,  "*",,, "Source catalogue quantities to be written"
srcPosError, r,h,  0.0,, "Source position uncertainty (deg)"
```

```
outCatQty03,s,h,  "",,, "New output catalogue quantity 3"
```

- Source catalogue name (either FITS or TSV format)
- Prefix for source catalogue quantities
"3EG" RAJ2000 ⇒ @3EG_RAJ2000
- Source catalogue quantities that should be copied in result catalogue
"*" copies all quantities
"RAJ2000,DEJ2000" copies RAJ2000 and DEJ2000
- Source position uncertainty if not found in catalogue

```
mode,  s,h,"ql",,, "Mode of automatic parameters"
```

gtsrcid parameters

- counterpart catalogue -

```
#
# Source Catalogue information
#=====
srcCatName, s,a,"3EG.fits",,"Source catalogue name"
srcCatPrefix,s,a, "3EG",,"Source catalogue column prefix"
srcCatQty, s,a, "*" ,,"Source catalogue quantities to be written"
srcPosError, r,h, 0.0 ,,"Source position uncertainty (deg)"
#
# Counterpart Catalogue information
#=====
cptCatName, s,a,"radio_whitel.4GHz.tsv",,"Counterpart catalogue name"
cptCatPrefix,s,a, "WB14",,"Counterpart catalogue column prefix"
cptCatQty, s,a, "*" ,,"Counterpart catalogue quantities to be written"
cptPosError, r,h, 0.0138888 ,,"Counterpart position uncertainty (deg)"
#
```

```
#
# Counterpart Catalogue information
#=====
cptCatName, s,a,"radio_whitel.4GHz.tsv",,"Counterpart catalogue name"
cptCatPrefix,s,a, "WB14",,"Counterpart catalogue column prefix"
cptCatQty, s,a, "*" ,,"Counterpart catalogue quantities to be written"
cptPosError, r,h, 0.0138888 ,,"Counterpart position uncertainty (deg)"
#
```

- symmetric to source catalogue parameters

```
maxNumCtp, i,a, 100 ,,"Maximum number of counterpart candidates"
select01, s,h,"$@WB14_Sp+index$ > -0.5",,"Selection cirterium 1"
select02, s,h, " ,,"Selection cirterium 2"
select03, s,h, " ,,"Selection cirterium 3"
select04, s,h, " ,,"Selection cirterium 4"
select05, s,h, " ,,"Selection cirterium 5"
select06, s,h, " ,,"Selection cirterium 6"
select07, s,h, " ,,"Selection cirterium 7"
select08, s,h, " ,,"Selection cirterium 8"
select09, s,h, " ,,"Selection cirterium 9"
#
# Standard parameters
#=====
chatter,i,h, 4,0,4,"Chattiness of output"
clobber,b,h, yes ,,"Overwrite existing output catalogue ?"
debug, b,h, no ,,"Debugging mode activated"
mode, s,h,"ql",,"Mode of automatic parameters"
```

gtsrcid parameters

- output catalogue -

```
#  
# Source Catalogue information
```

- Output catalogue FITS filename
- Formulae to derive new quantities (max. 9)

```
outCatName      "RATIO = @$3EG_F$ / @$WB14_S1.4$"
```

evaluate for each counterpart candidate the ratio between the quantity **F** in the 3EG (=source) catalogue and the quantity **S1.4** in the WB14 (=counterpart) catalogue and assign the result to the new quantity **RATIO** (use \$\$ to bracket non alphanumeric char's)

- Results from preceding new quantities may be used

```
#  
# Output Catalogue information  
#=====
```

outCatName, s, a,	"result.fits",,,	"Output catalogue name"
outCatQty01, s, h,	"RATIO = @\$3EG_F\$ / @\$WB14_S1.4\$"	,"New output catalogue quantity 1"
outCatQty02, s, h,	"PROB_RATIO = exp(-0.5*((RATIO-0.11)/0.11)^2)"	,"New output catalogue quantity 2"
outCatQty03, s, h,	"",,,	"New output catalogue quantity 3"
outCatQty04, s, h,	"",,,	"New output catalogue quantity 4"
outCatQty05, s, h,	"",,,	"New output catalogue quantity 5"
outCatQty06, s, h,	"",,,	"New output catalogue quantity 6"
outCatQty07, s, h,	"",,,	"New output catalogue quantity 7"
outCatQty08, s, h,	"",,,	"New output catalogue quantity 8"
outCatQty09, s, h,	"",,,	"New output catalogue quantity 9"

gtsrcid parameters

- main task parameters -

- Definition of counterpart probability

```
arcCatName      "POSITION" catalogue name  
arcCatPrefix    "POSITION" catalogue column prefix  
arcCatQty       "POSITION" source catalogue quantities to be written  
arcPosError     "POSITION * PROB_RATIO" #
```

use positional coincidence only
use positional coincidence and
derived quantity probability

- Threshold level for counterpart candidates

- Maximum number of counterpart candidates per source

- Output catalogue quantity selection criteria (max. 9)

```
#  
# Task parameters  
#=====  
probMethod, s, a, "POSITION * PROB_RATIO",,, "Probability method"  
probThres, r, a, 0.01,,,"Probability threshold"  
maxNumCtp, i, a, 100,,,"Maximum number of counterpart candidates"  
select01, s, h, "$@WB14_Sp+index$ > -0.5",,, "Selection cirterium 1"  
select02, s, h, "",,,,"Selection cirterium 2"  
select03, s, h, "",,,,"Selection cirterium 3"  
select04, s, h, "",,,,"Selection cirterium 4"  
select05, s, h, "",,,,"Selection cirterium 5"  
select06, s, h, "",,,,"Selection cirterium 6"  
select07, s, h, "",,,,"Selection cirterium 7"  
select08, s, h, "",,,,"Selection cirterium 8"  
select09, s, h, "",,,,"Selection cirterium 9"
```

gtsrcid parameters

- standard parameters -

```
#  
# Source Catalogue information  
#=====
```

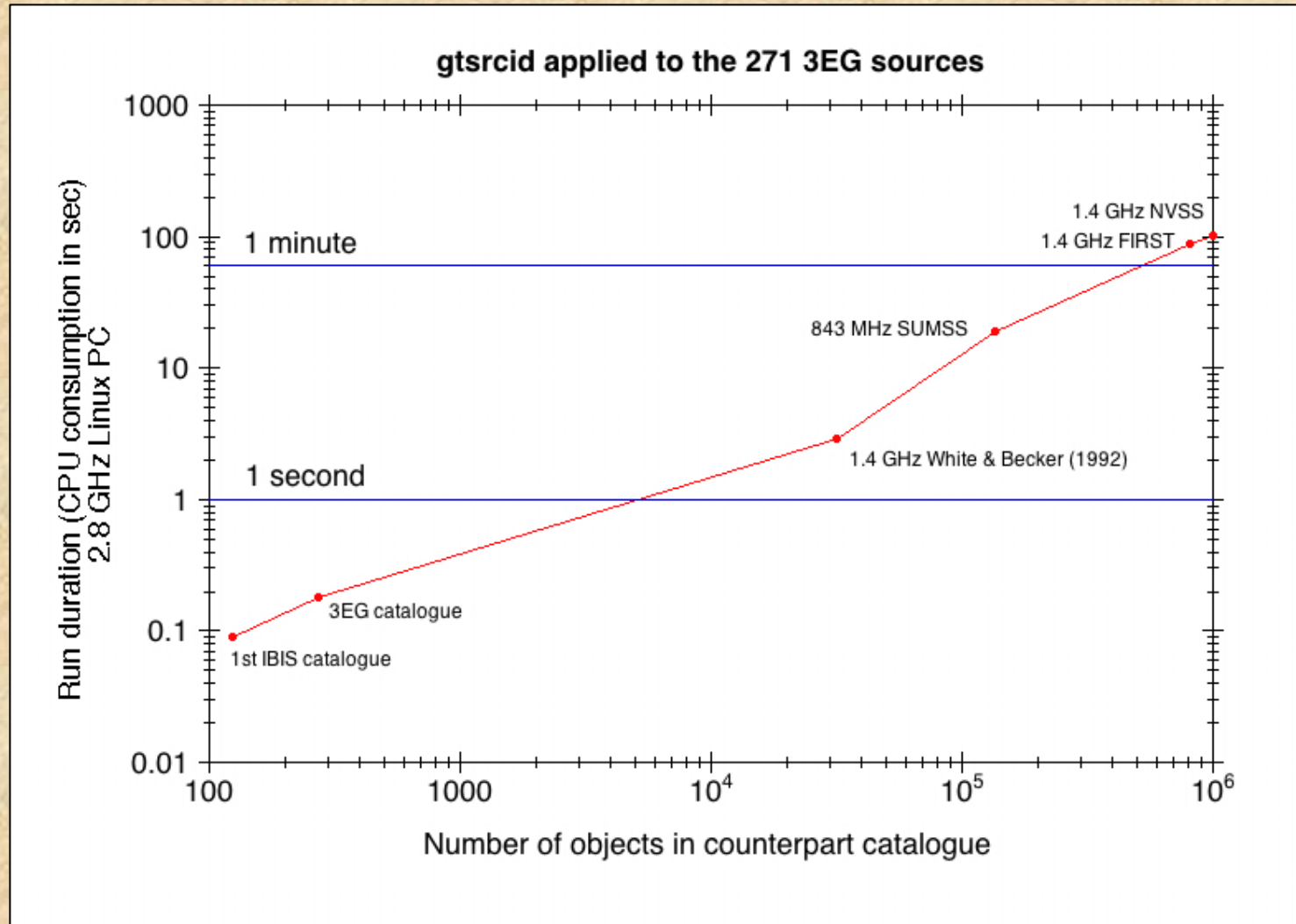
- **Verbosity of gtsrcid**
 - "0" no run information and errors are logged
 - "1" only errors are logged
 - "2" concise run information is logged
 - "3" log summary information about all counterpart candidates
 - "4" log detailed information about all counterpart candidates
- Allow overwriting of existing output catalogue
- gtsrcid code debug mode (very high chattiness of U9!)
- Mode of automatic parameters (ql = query and learn)

```
#  
# Standard parameters  
#=====
```

chatter	,i,h,	4,0,4,	"Chattiness of output"
clobber	,b,h,	yes,,	"Overwrite existing output catalogue ?"
debug	,b,h,	no,,	"Debugging mode activated"
mode	,s,h,	"ql",,	"Mode of automatic parameters"

```
_____
```

gtsrcid benchmark



gtsrcid v1r0p3 limitations - 1

- Generic access (including correct handling of positional uncertainties) is so far limited to a small number of catalogues (3EG, ROSAT, Veron, Green SNR)
- For other catalogues Unified Content Descriptors (UCDs) are needed (FITS keywords **TBCOL** or **TBUCD**):

Right Ascension: UCD = **POS_EQ_RA_MAIN**

Declination: UCD = **POS_EQ_DEC_MAIN**

Error radius: UCD = **ERROR**

Name = **PosErr** or **ErrorRad**

(for a catalogue downloaded in FITS format from CDS using VizieR it is in general sufficient to change the positional error column name to **PosErr** or **ErrorRad**)

gtsrcid v1r0p3 limitations - 2

- No direct Web access has been implemented so far
- Source and counterpart catalogues are loaded in memory (both have to fit within your computer resources)
- Counterpart catalogue objects < 10,000,000,000
- Positional coincidence probability based on exponential probability law

$$P_{\text{pos}} = \exp \left(\frac{-\varphi}{\sqrt{\theta_{\text{src}}^2 + \theta_{\text{cpt}}^2}} \right)$$

$$\varphi = \arccos (\sin \delta_{\text{src}} \sin \delta_{\text{cpt}} + \cos \delta_{\text{src}} \cos \delta_{\text{cpt}} \cos(\alpha_{\text{src}} - \alpha_{\text{cpt}}))$$

(but see Vincent's presentation for a work around)

gtsrcid working example

see now the presentation of Vincent Lonjou