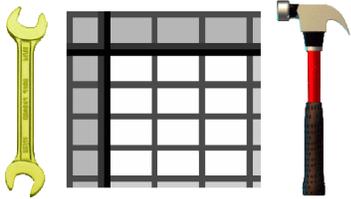


# STILTS



## The STIL Tool Set

<http://www.starlink.ac.uk/stilts/>

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### Introduction

STILTS is a package of command-line tools for tables, based on STIL, the Starlink Tables Infrastructure Library. It offers various format conversion, data and metadata manipulation, and processing functions for astronomical catalogues or other tables, and can deal with data in many formats including VOTable, FITS, relational database, CSV and ASCII.

The software is:

- pure Java (J2SE >= 1.4)
- open source (GPL)
- efficient
- robust
- scalable (most functions not limited by memory)
- fully documented

It provides a non-graphical counterpart to the GUI table analysis program TOPCAT, and can be used in shell scripts, interactively from the command-line, or as part of server-based services or workflows.

There is a tutorial and reference document in HTML and PDF format, and comprehensive help is available using the `help` flags of the commands themselves.

The package currently comprises these generic table commands:

- tcat** - concatenater
- tcopy** - format converter
- tpipe** - multi-purpose pipeline processor
- tmatch2** - pairwise crossmatcher

and these VOTable-specific commands:

- votcopy** - encoding converter
- votlint** - validator

### Acknowledgements & Status

The bulk of the work for STILTS was performed under the now-terminated Starlink project. Development and support will continue, funded by the UK Particle Physics and Astronomy Research Council.

### tpipe

**tpipe** performs general-purpose table-processing pipeline operations; it's like a Unix pipeline, but for processing streams of table data and metadata rather than bytes. Operations, which can be combined freely, include:

- coordinate conversion
- row selection
- data sampling
- metadata display/editing
- column calculations
- column rearrangement
- row sorting
- statistical calculations
- blank value substitution

The algebraic expression language used for column calculation and row selection is powerful, extensible and straightforward to use.

Example: selections and column calculations on an ASCII table writing the result to a VOTable:

```
stilts tpipe \
  in=some_data.cat ifmt=ascii \
  cmd='badval 999.9 *MAG' \
  cmd='select OBJ_CLASS==3' \
  cmd='select pmra*pmra+pmdec*pmdec<0.5' \
  cmd='addcol I_V IMAG-VMAG' \
  cmd='sort -down Z_ABS' \
  ofmt=votable-binary out=data1.vot
```

Quick look at the statistics for a sample of rows for some columns from a FITS file:

```
stilts tpipe
  in=survey.fits ifmt=votable \
  cmd='keepcols "flux vel vel_err qual"' \
  cmd='every 1000' \
  mode=stats
```

### tmatch2

**tmatch2** performs crossmatching between two tables. The matching options are flexible:

- select *best* or *all* matched pairs
- error radius *constant* or *per-row*
- choose join type: *both*, *either*, *unmatched*, ...
- various error geometries: *celestial sphere*, *isotropic/anisotropic Cartesian* in 1, 2 or many dimensions, *exact match* of ID value; or any combination of these
- performance scales as  $O(N \log M)$
- fast - match two  $10^5$ -row tables in ~30 sec

Example: locate all matches within 3 arcsec and 0.5 blue magnitudes, returning only matched pairs:

```
stilts tmatch2 in1=mgc.fits in2=6dfgs.xml \
  matcher=sky+1d params='3 0.5' \
  values1='ra dec bmag' \
  values2='RA2000 DEC2000 B_MAG' \
  join=1and2 find=all \
  out=pairs.fits
```

### tcopy

**tcopy** converts between different table formats (in fact it's just a cut-down form of **tpipe**).

Supported input/output formats include:

- FITS (binary and ASCII tables)
- VOTable (all encodings)
- relational databases (via SQL queries)
- plain ASCII
- Comma-Separated Values

You can convert from any one of these to any other (and a number of additional ones for output).

Compressed data (.gz, .Z, .gzip2) and streams from URLs are handled automatically.

You can use **tcopy** to convert from legacy formats to VOTable/FITS or vice versa, turn SQL queries into tabular data files, populate relational databases from FITS files, provide a choice of output formats for tables returned from a web service, ...

Example:

```
stilts tcopy \
  ifmt=votable ofmt=fits out=cone.fit \
  'http://data.org/cone?ra=123.4&dec=21'
```

### votcopy

**votcopy** converts the data encoding for VOTable documents between TABLEDATA, BINARY and FITS. This can be useful to view the data in a BINARY-formatted one or to reduce the size of a TABLEDATA formatted one prior to transmission over the network (BINARY & FITS are much more compact).

### votlint

**votlint** checks VOTable documents for illegal constructs and probable errors, providing much better checks than schema/DTD validation can offer. It's very easy to make mistakes when writing VOTables and often hard to spot them except by seeing that software doesn't do what you expect. **votlint** is designed for writers and users of programs which generate or consume VOTables to ensure that documents published to the VO are legal and mean what the author intended.

### Related Software



#### STIL

<http://www.starlink.ac.uk/stil/>

Starlink Tables Infrastructure Library  
Public table/VOTable API underlying STILTS.



#### TOPCAT

<http://www.starlink.ac.uk/topcat/>

Tool for OPERations on Catalogues And Tables  
GUI view/edit/analysis tool based on STIL.

STILTS commands	Table input formats	Table output formats	tpipe output modes	tpipe filters	tmatch2 matchers	tmatch2 join types	votcopy encodings	tpipe expression operations
tcat	(auto)	(auto)	out	addcol	sky	1and2	tabledata	null value handling
tcopy	fits	jdbc	tosql	addskycoords	skyerr	1or2	binary	array element access
tmatch2	fits-plus	fits-basic	meta	badval	sky3d	all1	fits	arithmetic operators: +, -, *, /
tpipe	votable	fits-plus	stats	cache	exact	all2	empty	conditional operators: ?, ==, &&,   , ...
votcopy	ascii	votable-tabledata	count	delcols	1d	1not2		trigonometry: sin, cos, tan, exp, log, ...
votlint	csv	votable-tabledata	topcat	every	2d	2not1		maths: abs, max, min, round, ...
	wdc	votable-binary-inline		explodecols	3d	1xor2		string: concat, startsWith, substring, length, ...
		votable-binary-href		explodeall	nd			regular expression: matches, replace, ...
		votable-fits-href		head	...			time coords: MJD/ISO8601/Julian/Besselian conversions
		votable-fits-inline		keepcols	tail			sky coords: skyDistance, deg/rad/sexagesimal conversions
								extend using Java classes at runtime