



The ESO VO Polygons Tool

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Polygons in the interoperable VO context

1.- I'll show typical mistakes when serializing a polygon, impacting interoperability.

2.- I'll demo a tool to visualise and examine spherical polygons, circles, union of polygons and of circles.

Quiz

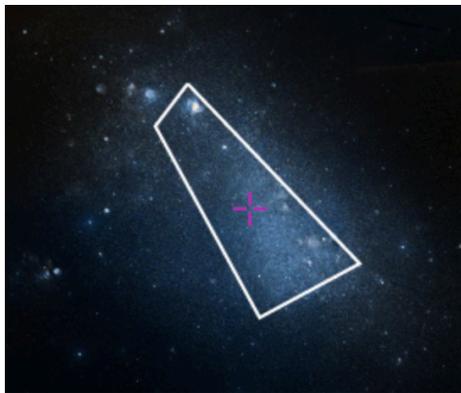
Given image below,
what's the DALI geometry of night/day boundary projected onto the sky?



Typical polygon mistakes/issues

Issue 1

Wrongly ordered vertices => **crossing segments** => **complex polygon**



Meant CCW

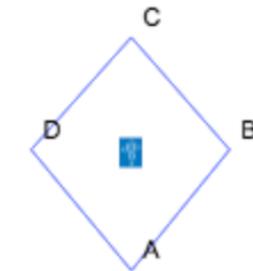


Mistaken

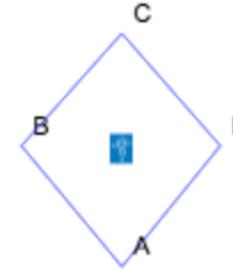
- Headedness: undefined (one part of a crossing segment is CCW, the other CW)
- In ADQL constraint:
 - **SQLServer** throws error “**polygon invalid**”
 - **ORACLE** accepts it (but I do not know how to interpret the query results)
 - e.g., a footprint entirely outside of the polygon (even outside of the repaired polygon)

Polygon **provided** with the wrong headedness

Issue 2



Meant CCW



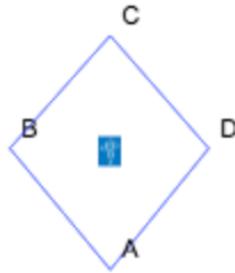
Provided CW

Why is that important?

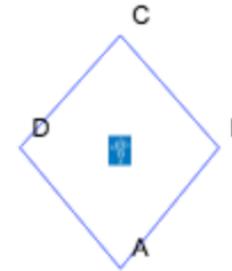
- Any valid polygon defines two areas of the sky;
- Headedness defines which part is inside the polygon and which one outside (walk along AB, then BC, ...: “inside” is at your left)
- In a constraint like: `1=CONTAINS(s_region, POLYGON(...))`
wrong polygon headedness means searching “outside” instead of “inside”

Polygon **interpreted** with the wrong headedness

Issue 3

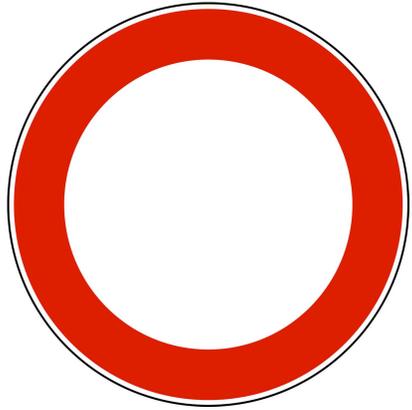


Provided and meant CW



Interpreted by DBMS as CCW

- *The database returns whatever it considers “inside”*
- **Some DBMSes always consider “inside” the smaller part, however the polygon is provided (CW or CCW)**



Interoperability at stake

Taking a polygon from one data centre to place a query constraint onto another data centre can only work if all implementations respect the same definitions.

Spherical Polygon defined in STC v1.33

1. Ordered list	Ordered list of vertices.
2. Implicit closure	The last vertex in the list connects back to the first.
3. Great circles	Vertices are connected by the (shorter) great circle segment.
4. Less than 180°	Polygon sides must be shorter than 180 degrees to avoid ambiguities; add a vertex when necessary.
5. Left of	Internal part of the polygon is the one to the left of the lines connecting neighboring vertices (that is, in the ordered list), as seen from the centre of the sphere (left-handed celestial reference system).
6. Closed region	The boundaries are considered part of the region
CCW	The inside of the region is defined as that part of coordinate space that is encircled by the polygon in a counter-clockwise sense
CW	<i>The inside of the region is defined as that part of coordinate space that is encircled by the polygon in a clockwise sense [not expressed this way, but see considerations in the area calculations (and errata)]</i>
NOT	Negation operation is a simple matter of reversing the order of the vertex list

Spherical polygons across standards

STC v1.33, 2007: the only standard with complete definition (but do not use C/CW)

ADQL v2.0, 2008: **Missing:** “Less than 180°”

TAP 1.0, 2010: *section 6, xtype=adql:region,*

<region> ::= <position> | <circle> | <box> | <polygon> | <union> | <intersection> | <not>

STC-S v1.0 Working Draft, 2013: **Missing:** “implicit closure”

DALI v1.1, 2017: **Missing:** “Implicit closure”, “Less than 180°”

TAP v1.1, 2019: *strongly recommends DALI syntax, accepting STC-S*

ADQL v2.1, 2023: *refers to DALI 1.1, and to a future DALI version for regions*

UNION are not (yet) supported by DALI, hence ESO still uses the STC-S convention

Note on polygon definition

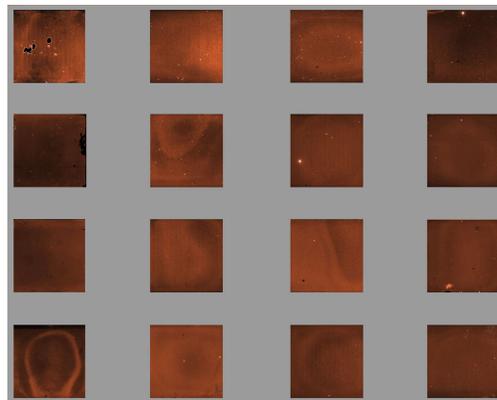
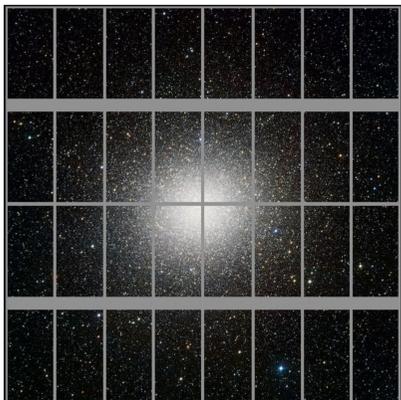
“to the left of”: always defined!

“CCW” and “CW”: **not always defined!**

- Is a meridian CW or CCW? Observer in the centre of the sphere can't tell.
- Same for all great circles, onto which...
- ...CW or CCW depends on the direction in which the observer looks.
 - Equator with increasing RAs: 0,0 90,0 180,0 270,0
is CCW if the observer looks North, CW otherwise.
 - Equator with decreasing RAs: 0,0 270,0 180,0 90,0
is CW if the observer looks North, CW otherwise.
- Notice that when posing an ADQL query, the direction in which the observer looks is not specified. Databases seem to use the “to the left” definition (*).

(*) actually “to the right” (geography vs astronomy), but we reverse DB LONG=(180-RA)

Footprints of ESO's immediate interest



**POINT, CIRCLE, POLYGON,
UNION OF POLYGONS, UNION OF CIRCLES,
(POLYGONS WITH HOLES)**

Observatory	Product type	Footprint type
La Silla, Paranal	spectrum, visibility	Point
La Silla, Paranal	image, image tile, cube, catalog tile	Polygon
La Silla, Paranal	image pawprint	Union of polygons
La Silla, Paranal	source table	None
ALMA	image, cube	Circle, Union of circles, Polygon, Union of polygons Polygons with holes



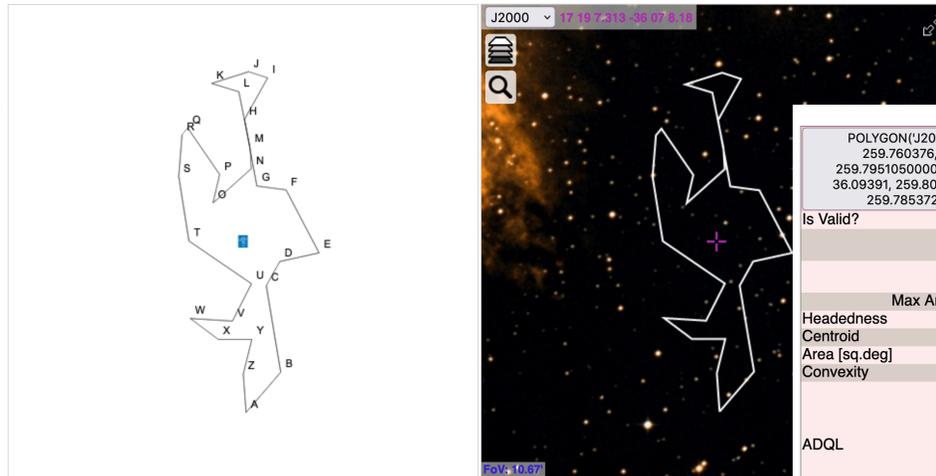
VO polygons

version: 1.0
date: 2023-04-27
help: support.eso.org

Click the edit button and input one polygon per line.
When not in edit mode, click on a polygon entry to zoom onto it.
To temporarily hide a polygon, prepend it with a -- or a // sign.

for developers: activate this

Visualisation



```
POLYGON('J2000', 259.77902,-36.182932, 259.762834
36.123224, 259.760376,-36.099663, 259.773995,-36.
259.777783,-36.055456, 259.79510500000004,-36.059
259.794458,-36.10456, 259.791347,-36.09391, 259.8
259.805673,-36.118789, 259.776522,-36.134755, 259
259.776332,-36.155577, 259.780315,-36.168504)
```

Set observer's direction: 259.78047 -36.11894 Set zoom factor 809.9871

To change the observer's pointing direction, you can either manually set the observer's direction and zoom factor fields above, or you can pan&zoom in the right panel (Aladin Lite, CDS) to adjust the viewpoint with the mouse, and on the "sync plot from aladin view" button to synchronise the two panels.

Note: When the footprint is CW, the observer is set to look at the anti-centroid so to be able to see the footprint if subtended is the external one.

Analysis

POLYGON(J2000; 259.77902,-36.182932, 259.762834,-36.16788, 259.769596,-36.135517, 259.763255,-36.126446, 259.744966,-36.123224, 259.760376,-36.099663, 259.773995,-36.098217, 259.77975000000004,-36.073295, 259.768982,-36.057774, 259.777783,-36.055456, 259.79510500000004,-36.05985, 259.78241,-36.062939, 259.777219,-36.083622, 259.776591,-36.091715, 259.794458,-36.10456, 259.791347,-36.09391, 259.806286,-36.076475, 259.80888400000003,-36.079011, 259.810448,-36.094643, 259.805673,-36.118789, 259.776522,-36.134755, 259.785372,-36.148741, 259.805073,-36.147755, 259.79204300000004,-36.155585, 259.776332,-36.155577, 259.780315,-36.168504)	
Is Valid?	0
Is complex?	1 - This is an invalid polygon; the following values are provided as indicative, and are not to be trusted.
	Intersection (at least one) found in polygon: segment [G,H] and segment [L,M] intersect in [259.779048179,-36.076335092]
Max Arc Length [deg]	0.03282035494880853
Headedness	Undef (not a valid polygon)
Centroid	259.7804608885254 -36.11894692829093
Area [sq.deg]	Undef
Convexity	Convex
ADQL	POLYGON(" 259.77902,-36.182932, 259.762834,-36.16788, 259.769596,-36.135517, 259.763255,-36.126446, 259.744966,-36.123224, 259.760376,-36.099663, 259.773995,-36.098217, 259.77975000000004,-36.073295, 259.768982,-36.057774, 259.777783,-36.055456, 259.79510500000004,-36.05985, 259.78241,-36.062939, 259.777219,-36.083622, 259.776591,-36.091715, 259.794458,-36.10456, 259.791347,-36.09391, 259.806286,-36.076475, 259.80888400000003,-36.079011, 259.810448,-36.094643, 259.805673,-36.118789, 259.776522,-36.134755, 259.785372,-36.148741, 259.805073,-36.147755, 259.79204300000004,-36.155585, 259.776332,-36.155577, 259.780315,-36.168504)
Opposite headedness ADQL	POLYGON(" 259.780315,-36.168504, 259.776332,-36.155577, 259.79204300000004,-36.155585, 259.805073,-36.147755, 259.785372,-36.148741, 259.776522,-36.134755, 259.805673,-36.118789, 259.810448,-36.094643, 259.80888400000003,-36.079011, 259.806286,-36.076475, 259.791347,-36.09391, 259.794458,-36.10456, 259.776591,-36.091715, 259.777219,-36.083622, 259.78241,-36.062939, 259.79510500000004,-36.05985, 259.777783,-36.055456, 259.768982,-36.057774, 259.77975000000004,-36.073295, 259.773995,-36.098217, 259.760376,-36.099663, 259.744966,-36.123224, 259.763255,-36.126446, 259.769596,-36.135517, 259.762834,-36.16788, 259.77902,-36.182932)

ESO VO Polygons Tool

while the emphasis is on polygons, other footprints are also supported

https://archive.eso.org/programmatic/vo_polygons/examples/examples.html

Thanks!