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.

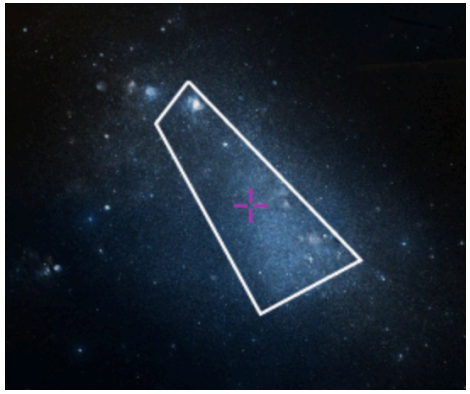
2.- I'll demo a tool to visualise and examine spherical polygons, circles, union of polygons and of circles.

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**



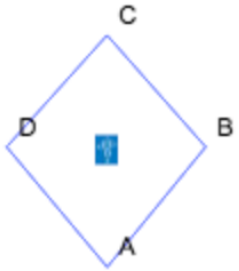
Meant CCW

Mistaken

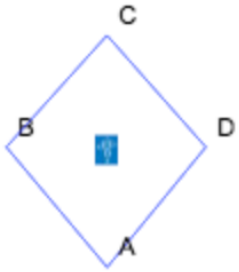
- Headedness: undefined (one part of a crossing segment is CCW, the other CW)
- In ADQL constraint:
  - **SQLServer throws error “polygon invalid”**
  - **ORACLE (ALMA) accepts it and returns doubtful results**
    - e.g., a footprint entirely outside of the polygon (even outside of the repaired polygon)

Polygon **provided** with the wrong headedness

Issue 2



Meant CCW



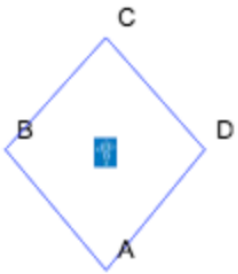
Provided CW

Why is that important?

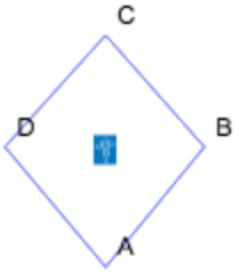
- Any valid polygon defines two areas of the sky;
- Headedness defines which part is inside the polygon and which one outside (walk along AB, then BC, …: “inside” is at your left)
- In a constraint like: 1=CONTAINS(s_region, POLYGON(…))
  wrong polygon headedness means searching ”outside” instead of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

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^{o}”

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

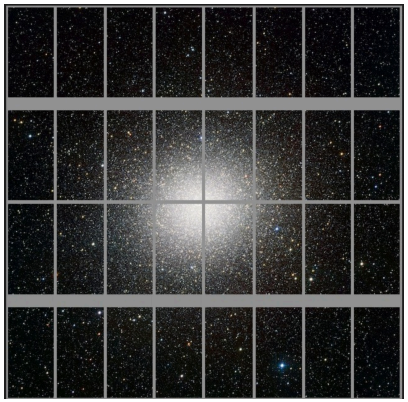
"to the left of": always defined!

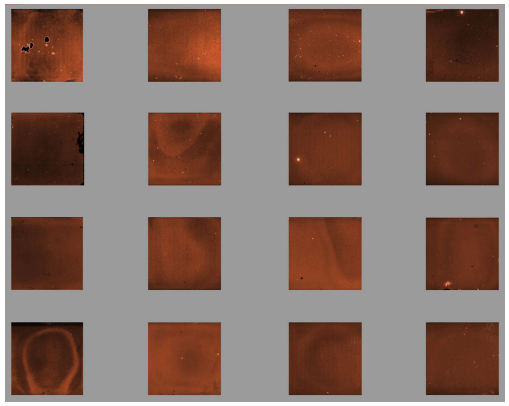
"CCW" and "CW": **not always defined**!

- 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)

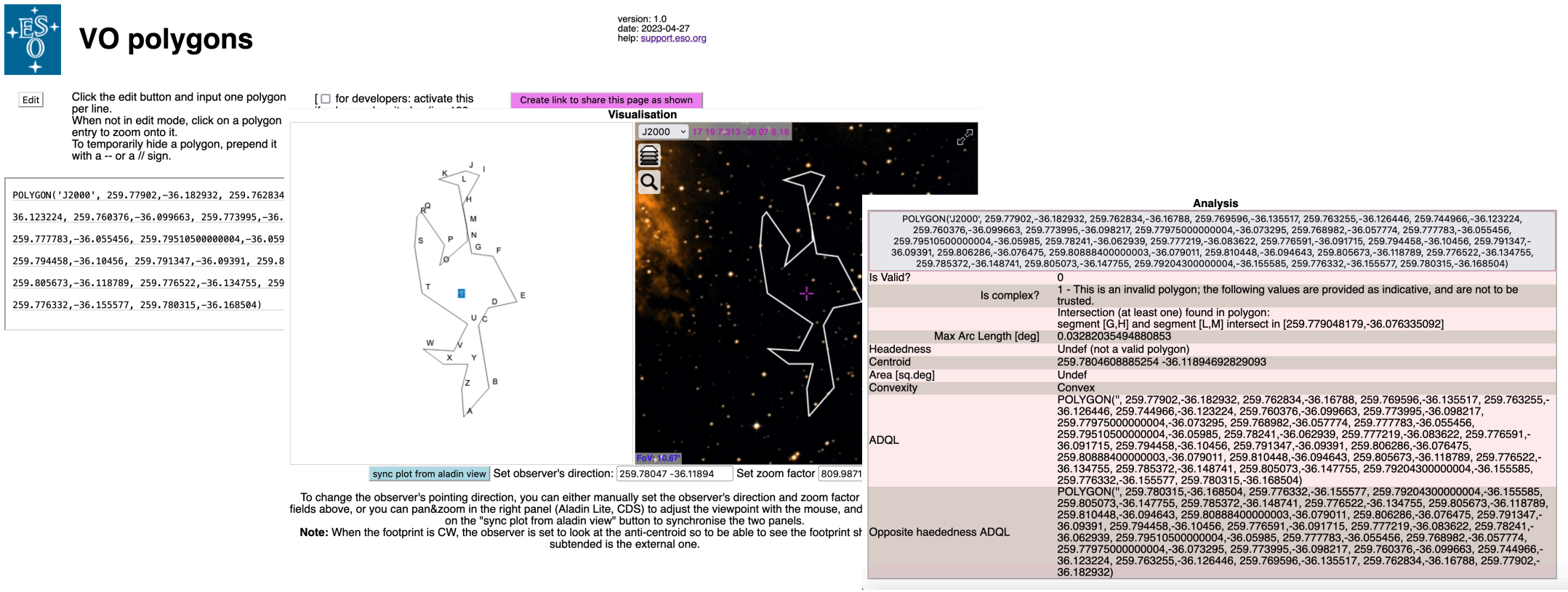
Footprints of ESO's immediate interest





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



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!