INNOVATIVE SOLUTIONS
BY OPEN SOURCE EXPERTS

camp to camp

INNOVATIVE SOLUTIONS
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Kurven nach SQL MM/3 in PostGIS, GeoServer und QGIS:

Eine runde Sache

Stand: 2022-02-10

Inhalt

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- “Klassische” Geometrien aus Linien-Segmenten
- Circular Arcs
- Anwendungen
  - PostGIS
  - GeoServer
  - QGIS
  - GDAL

“Klassische” Geometrietypen

- OGC Simple feature access - Part 1: Common Architecture (06-103r4), 2011
- ISO 19125-1:2004 Geographic information -- Simple feature access -- Part 1: Common architecture

Geometrietypen (klassisch)

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- POINT
- LINESTRING
- POLYGON

- MULTIPOINT
- MULTILINESTRING
- MULTIPOLYGON

- GEOMETRYCOLLECTION

Geometrien visualisieren mit JTS Testsuite

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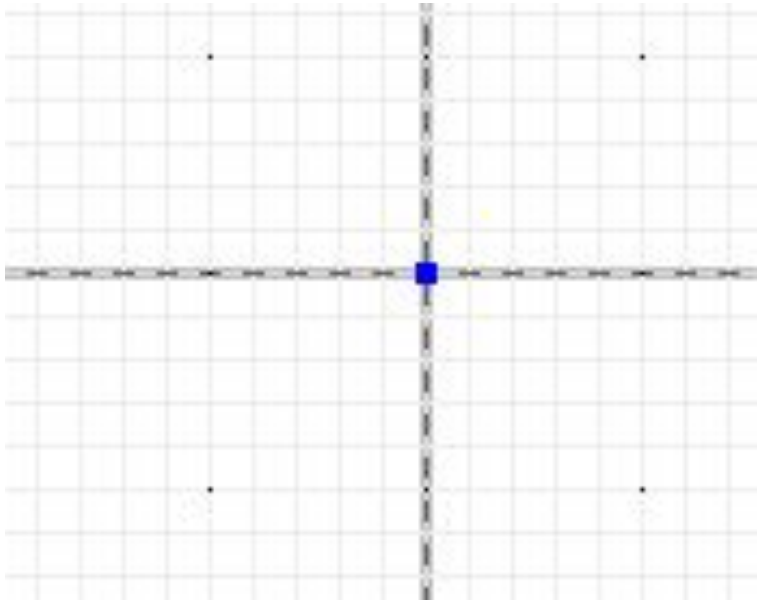
```
java -jar $HOME/.m2/repository/org/locationtech/jts/jts-app/1.18.2/jts-app-1.18.2.jar
```

POINT

POINT(0 0)



LINESTRING

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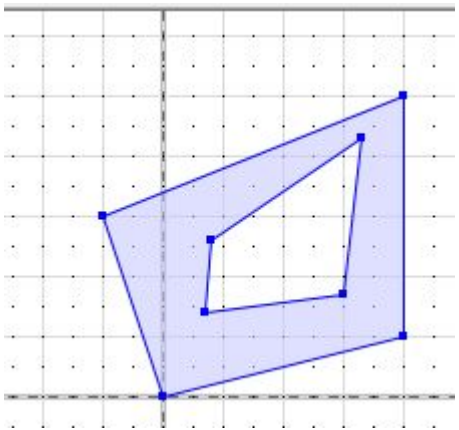
LINESTRING (0 0, 1 7, 5 3)

POLYGON

POLYGON ((0 0, 4 1, 4 5, -1 3, 0 0),
(0.8 2.6, 0.7 1.4, 3 1.7, 3.3 4.3, 0.8 2.6))



MULTIPOINT

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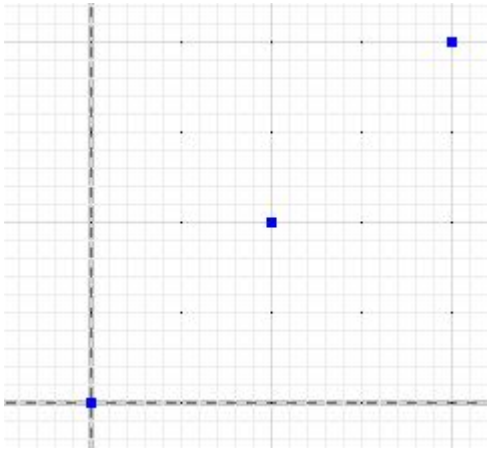
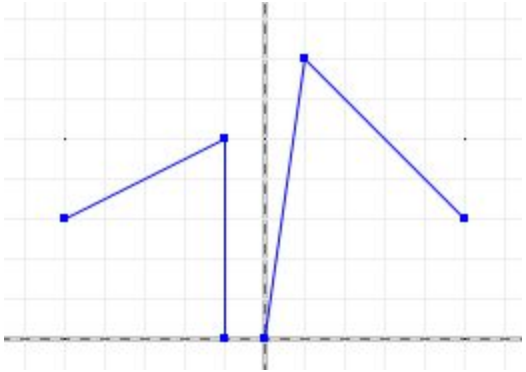
MULTIPOINT ((0 0), (1 1), (2 2))



MULTILINESTRING

MULTILINESTRING ((0 0, 1 7, 5 3),
(-1 0, -1 5, -5 3))



MULTIPOLYGON

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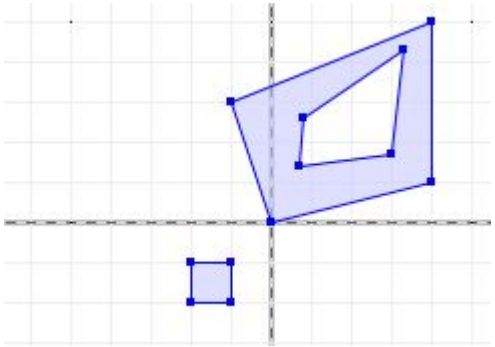
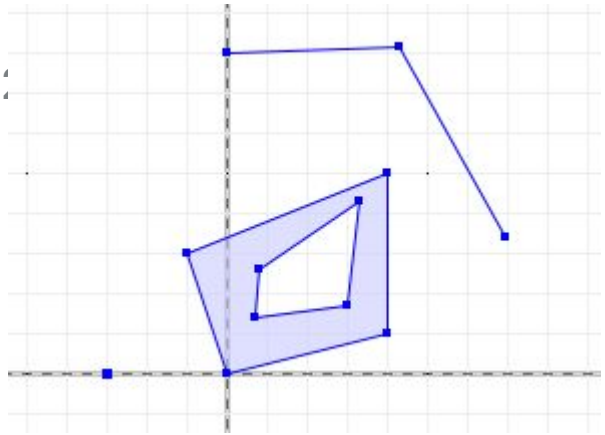
MULTIPOLYGON (((0 0, 4 1, 4 5, -1 3, 0 0),
(0.8 2.6, 0.7 1.4, 3 1.7, 3.3 4.3, 0.8 2.6)),
((-1 -1, -2 -1, -2 -2, -1 -2, -1 -1)))

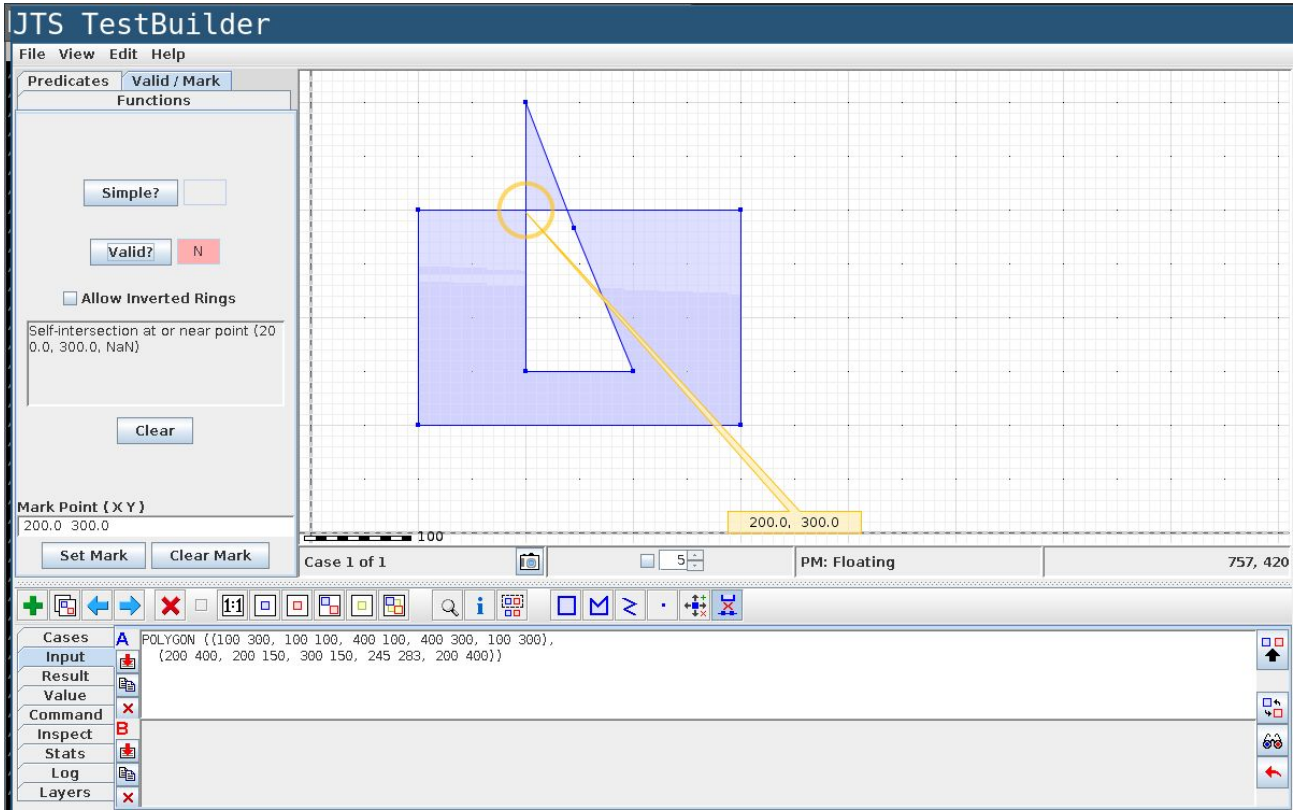


GEOMETRYCOLLECTION

GEOMETRYCOLLECTION (
POINT (-3 0),
  POLYGON ((0 0, 4 1, 4 5, -1 3, 0 0),
      (0.8 2.6, 0.7 1.4, 3 1.7, 3.3 4.3, 0.8 2
  LINESTRING (0 8, 4.3 8.15, 6.95 3.4))



JTS: Validierung



JTS: Leider keine ARCS.

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https://github.com/locationtech/jts/issues/443

jnh5y commented on Aug 27, 2019 — Contributor

@dr-jts I don't mean to disagree with closing this ticket. For future reference, do we want JTS 1.x to support these extended types? And if not, is it something worth discussing for JTS 2.0?

For folks looking for this support, I'd note that GeoTools does have a WKTReader that will handle arcs. Not sure how geometric/topological operations are handled with those geometries.

dr-jts commented on Aug 27, 2019 — Contributor

I guess some would like to see this supported. It's quite a bit of work, so absent budget and resources it's unlikely to get done soon.

I did label this with the FUTURE milestone, with the idea that it wouldn't get lost.

Circular Arcs

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“SQL/MM Part 3”

ISO 13249-3
Information technology — SQL Multimedia and Application Packages - Part 3: Spatial.

ARC-Geometrietypen

-
- CIRCULARSTRING
- COMPOUNDCURVE
- CURVEPOLYGON

-
- MULTICURVE
- MULTISURFACE
- GEOMETRYCOLLECTION

- POINT
- LINESTRING
-
- POLYGON

- MULTIPOINT
- MULTILINESTRING
- MULTIPOLYGON
- GEOMETRYCOLLECTION

Wiederholung: Aufbau Line/LineString

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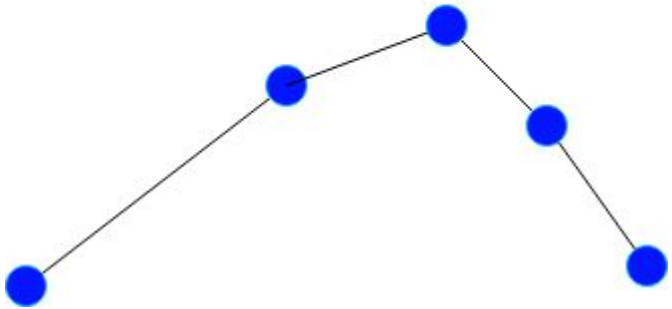
- Sind immer Linien-Segmente
- Eine Linie wird durch 2 Punkte bestimmt (in der Ebene paarweise verschieden).
- Für jedes nächste Segment wird **ein weiterer Punkt** benötigt.

LINESTRING(x0 y0, x1 y1)



LINESTRING(x0 y0, x1 y1, x2 y2, x3 y3, x4 y4)

Aufbau von Circular Arcs

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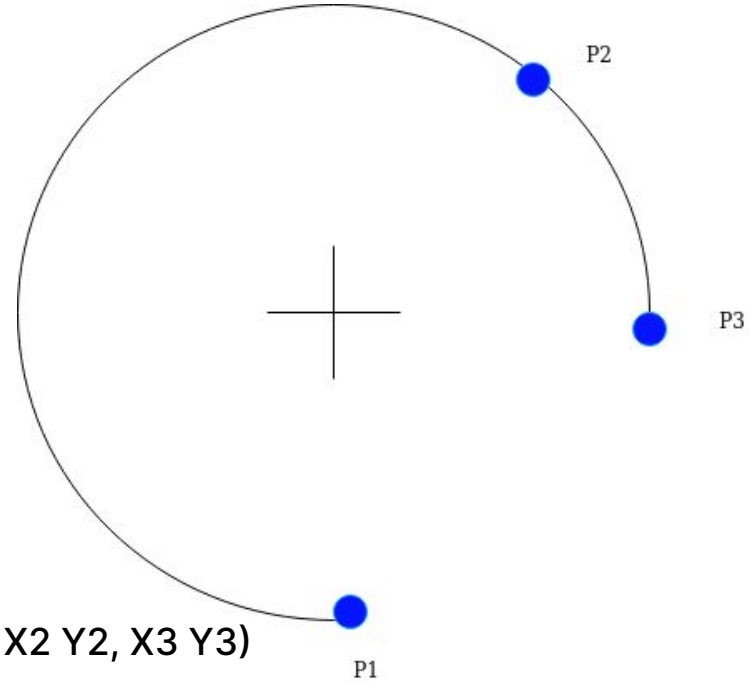
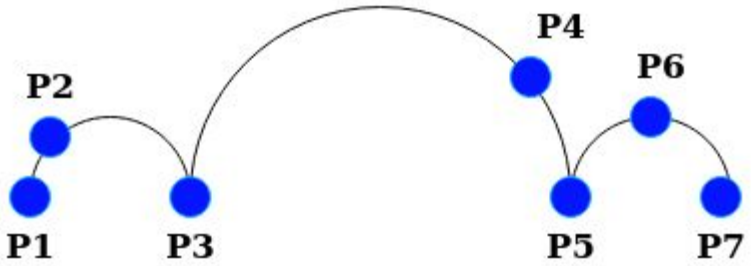
- Bestehen aus Kreis-Segmenten
- Ein Kreis(-Segment) wird durch 3 Punkte bestimmt (in der Ebene paarweise verschieden)
- P2 kann beliebig auf dem Kreis-Segment liegen



CIRCULARSTRING(X1 Y1, X2 Y2, X3 Y3)

CIRCULARSTRING

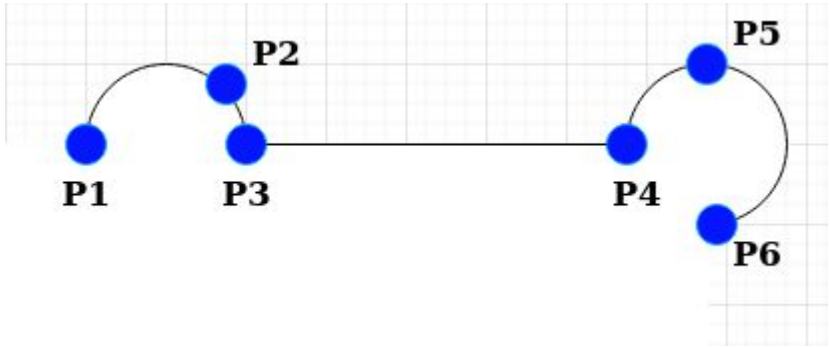
- Für jedes weitere Kreis-Segment:
- Der letzte Punkt dient als Startpunkt
- Es werden **zwei weitere Punkte** hinzugefügt
- ⇒ Immer UNGERADE Anzahl an Punkten.



CIRCULARSTRING(P1, P2, P3, P4, P5, P6, P7)

COMPOUNDCURVE
= LINESTRING + CIRCULARSTRING

```
COMPOUNDCURVE(
  CIRCULARSTRING(-1 0, sin(π/4) cos(π/4), 1 0),
  LINESTRING(1 0, 6 0),
 CIRCULARSTRING(6 0, 7 1, 7 -1)
)
```



COMPOUNDCURVE
Kurzschreibweise

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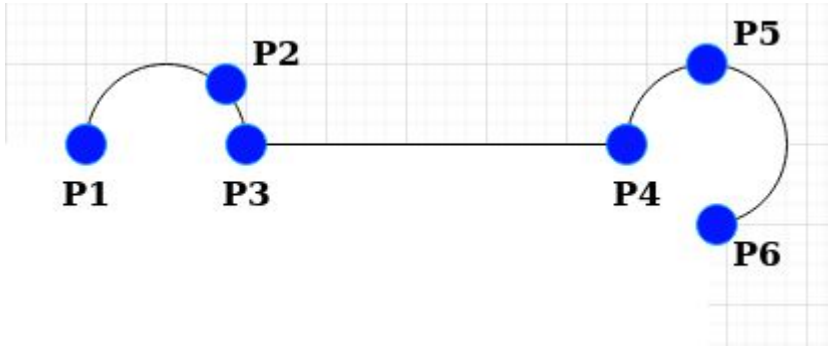
```
COMPOUNDCURVE(
  CIRCULARSTRING(-1 0, sin(π/4) cos(π/4), 1 0),
  (1 0, 6 0),                    ←—  LINESTRING kann weggelassen werden
 CIRCULARSTRING(6 0, 7 1, 7 -1)
)
```



CURVEPOLYGON

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Wie “normales” Polygon,
nur statt LINESTRING verwende
CIRCULARSTRING bzw. COMPOUNDCURVE

CURVEPOLYGON(1)

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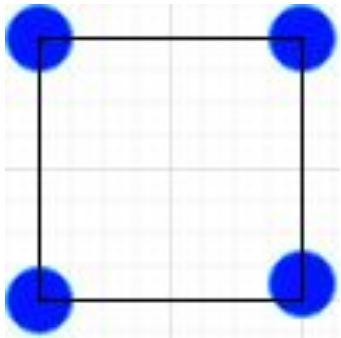
CURVEPOLYGON(
 LINESTRING(0 0, 0 2, 2 2, 2 0)
)

oder:

CURVEPOLYGON((0 0, 0 2, 2 2, 2 0))



CURVEPOLYGON(2)

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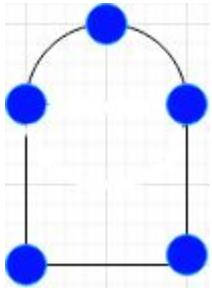
```
CURVEPOLYGON(
  COMPOUNDCURVE(
    (0 0, 0 2),
    CIRCULARSTRING(0 2, 1 3, 2 2),
    (2 2, 2 0, 0 0)
  )
)
```



PostGIS

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- Unterstützt alle ARC-Geometrietypen
- ABER: Ausgabe ist Approximation als “Standard-Geometrie”
- Grund: GEOS unterstützt keine Arcs.
- Wie gut/vollständig ist die Implementierung in PostGIS?

PostGIS (Beispiel)

```
CREATE TABLE fossgis_curvepolygon(
  id serial PRIMARY KEY,
  name VARCHAR NOT NULL,
  description VARCHAR);

SELECT
AddGeometryColumn('','fossgis_curvepolygon','geom','25832','CURVEPOLYGON',2);
```

PostGIS (Beispiel)

```
INSERT INTO fossgis_curvepolygon(name, geom) VALUES
('torbogen',
ST_Translate(
      St_GeomFromEWKT('SRID=25832;CURVEPOLYGON(COMPOUNDCURVE((0 0, 0
2),CIRCULARSTRING(0 2, 1 3, 2 2), (2 2, 2 0, 0 0)))')
      ,484000, 5628700)
);
```

PostGIS: Geometrie-Operationen

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```
INSERT INTO fossgis_curvepolygon(name,geom) VALUES ('clipped',
(SELECT St_AsText(
ST_Difference(
(SELECT geom from fossgis_curvepolygon WHERE name='rectangle100' ),
(SELECT geom from fossgis_curvepolygon WHERE name='circle' ))
)));
```

ERROR: Geometry type (Polygon) does not match column type (CurvePolygon)

POLYGON((484100 5628820,484200 5628820,484200 ……. ⚡

GeoServer

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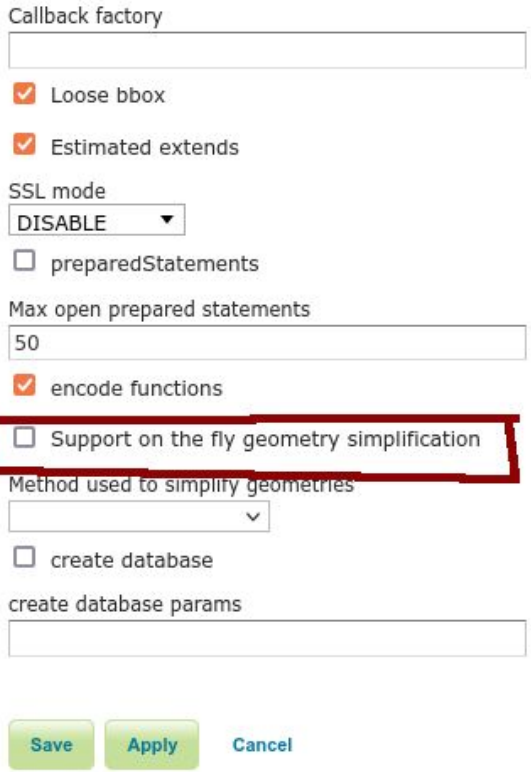
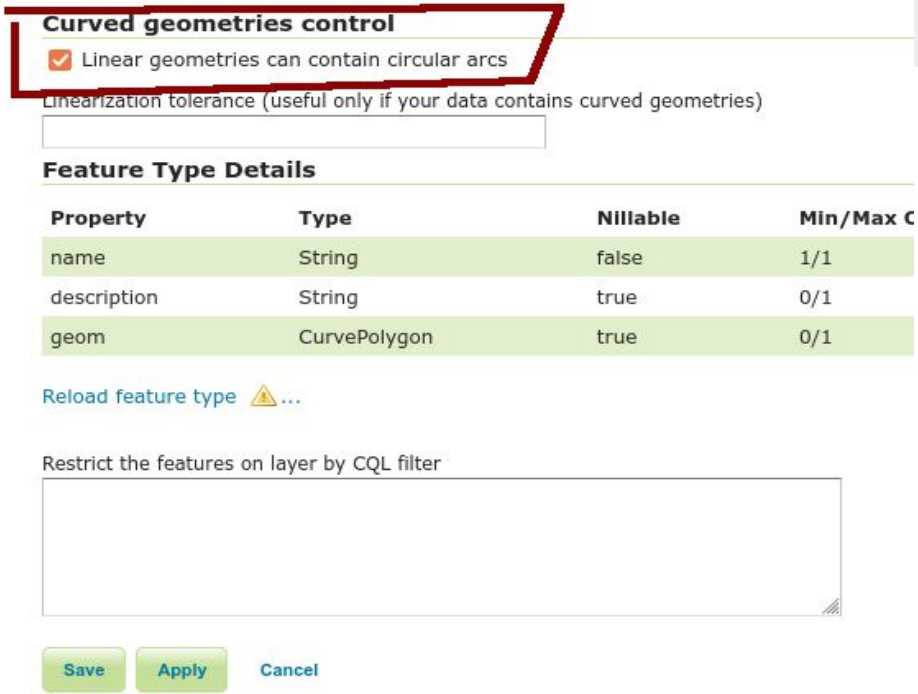
DataStore:



Layer:



GeoServer

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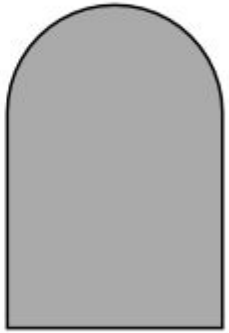

GeoServer

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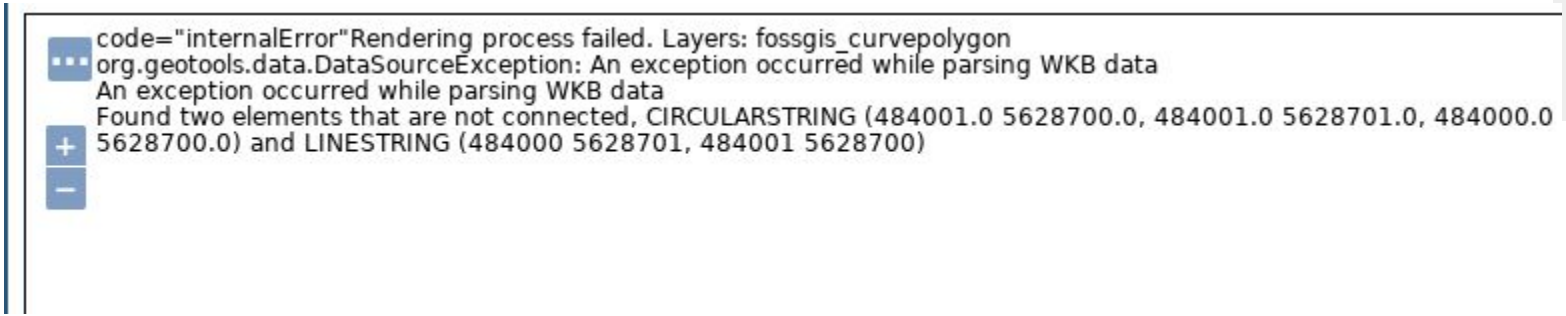


GeoServer

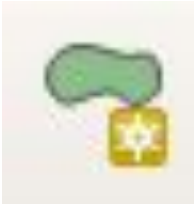
GeoServer

QGIS (direkt auf PostGIS)

```
CURVEPOLYGON(
CIRCULARSTRING(105 110, 110 115, 115 110, 110 105, 105 110))
```

```
CURVEPOLYGON(
COMPOUNDCURVE(
CIRCULARSTRING(185 105, 185 115, 185 105)))
```

Digitizing Toolbar



Shape Digitizing Toolbar

QGIS

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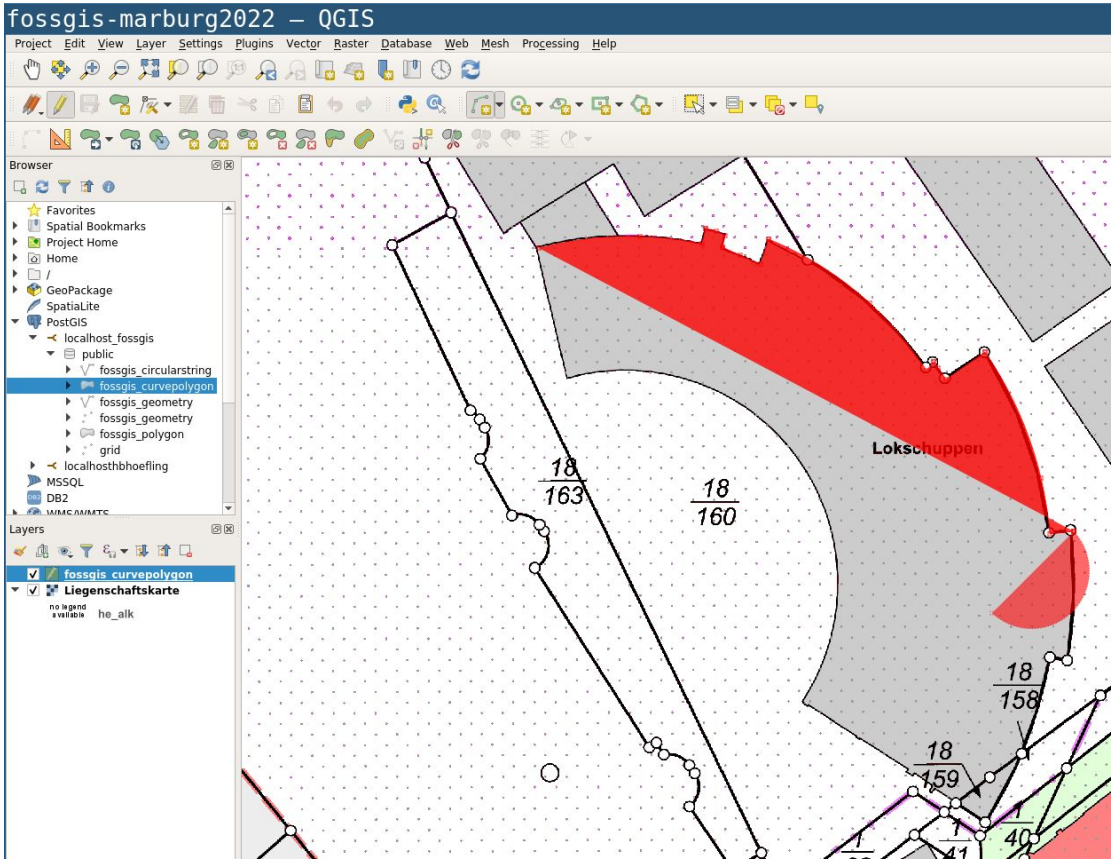

Hintergrund:
Liegenschaftskarte

Hessisches Landesamt für Bodenmanagement und Geoinformation
Lizenz:
DL-DE->Zero-2.0

QGIS

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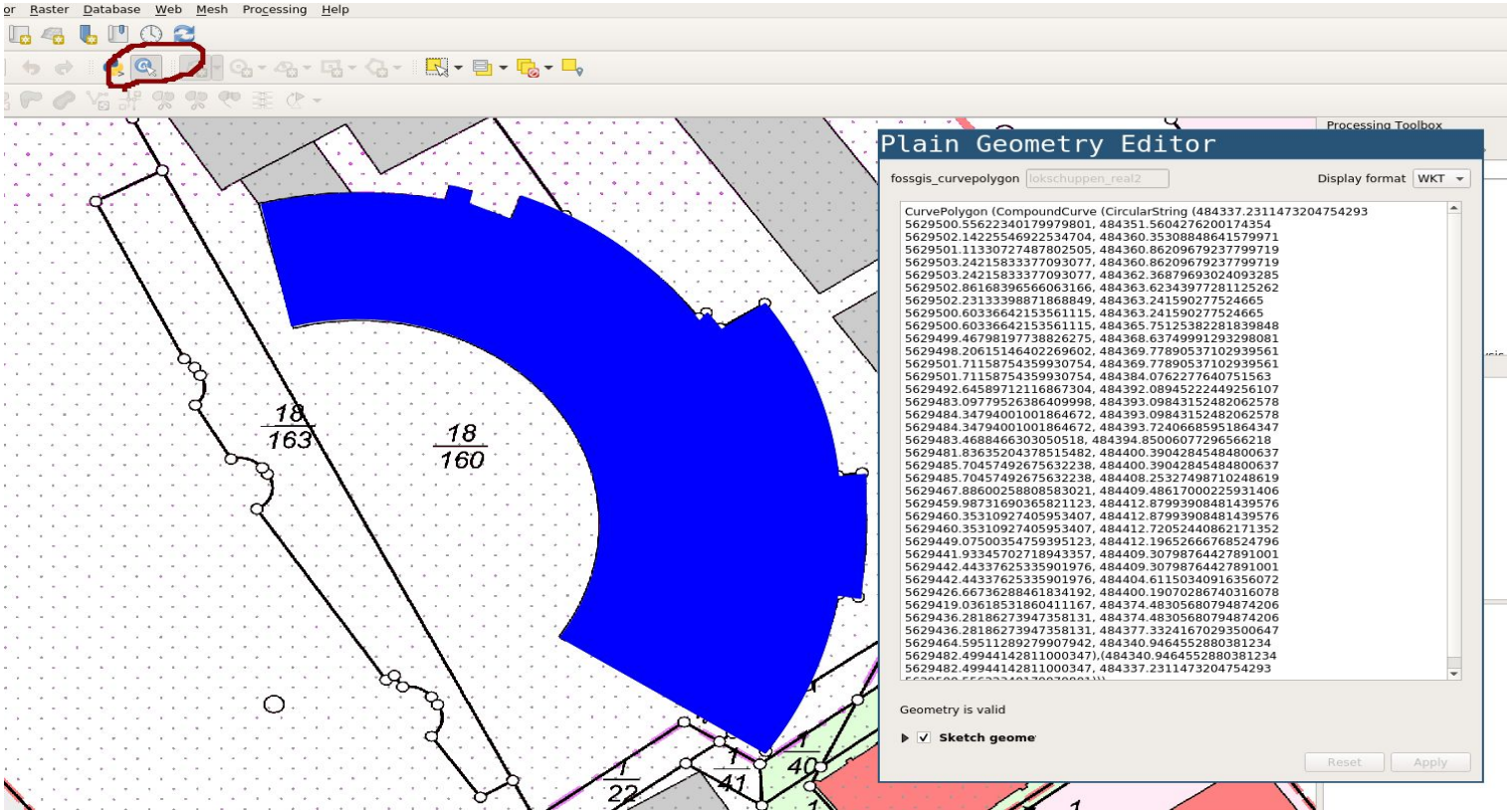

GDAL

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```
#!bin/python3

# Small example on how to work with GDAL and ARC CURVES.

#https://gdal.org/api/python.html

from osgeo import gdal
from osgeo import ogr
from osgeo import osr
from osgeo import gdal_array
from osgeo import gdalconst

# Source: https://gdal.org/development/rfc/rfc49_curve_geometries.html

## Union:
g1 = ogr.CreateGeometryFromWkt('CURVEPOLYGON(COMPOUNDCURVE(CIRCULARSTRING (0 0,1 1,2 0),(2 0,0 0)))')
g2 = ogr.CreateGeometryFromWkt('CURVEPOLYGON(COMPOUNDCURVE(CIRCULARSTRING (0 0,1 -1,2 0),(2 0,0 0)))')
g3 = g1.Union(g2)
assert g3.ExportToWkt() == 'CURVEPOLYGON (CIRCULARSTRING (0 0,1 1,2 0,1 -1,0 0))'
print(g1)
print(g2)
print('UNION: ', end="")
print(g3)
print("")

## Buffer:
g1 = ogr.CreateGeometryFromWkt('POINT(1 2)')
g2 = g1.Buffer(0.5)
g3 = g2.GetCurveGeometry()
assert g3.ExportToWkt() == 'CURVEPOLYGON (CIRCULARSTRING (1.5 2.0,0.5 2.0,1.5 2.0))'
print(g1)
print('BUFFER.GetCurveGeometry: ', end="")
print(g3)
print("")

## Square, punch a circular hole in it:
g1 = ogr.CreateGeometryFromWkt('POLYGON((0 0, 0 4, 4 4, 4 0, 0 0))')
g2 = ogr.CreateGeometryFromWkt('CURVEPOLYGON(CIRCULARSTRING (2 1, 2 3, 2 1))')
g3 = g1.Difference(g2)
assert g3.ExportToWkt() == 'CURVEPOLYGON ((0 0,0 4,4 4,4 0,0 0),CIRCULARSTRING (2 1,2 3,2 1))'
print("Punching a circle out of a square:")
print(g3)
```

GDAL: Liefert ARCs zurück!

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guix environment --pure --ad-hoc python python-gdal -- python3 ./gdal-example.py

CURVEPOLYGON (COMPOUNDCURVE (CIRCULARSTRING (0 0,1 1,2 0),(2 0,0 0)))
CURVEPOLYGON (COMPOUNDCURVE (CIRCULARSTRING (0 0,1 -1,2 0),(2 0,0 0)))
UNION: CURVEPOLYGON (CIRCULARSTRING (0 0,1 1,2 0,1 -1,0 0))

POINT (1 2)
BUFFER.GetCurveGeometry: CURVEPOLYGON (CIRCULARSTRING (1.5 2.0,0.5 2.0,1.5 2.0))

Punching a circle out of a square:
CURVEPOLYGON ((0 0,0 4,4 4,4 0,0 0),CIRCULARSTRING (2 1,2 3,2 1))

Fazit

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- Wissen um Kurven ist noch nicht geläufig
  (ISO-Standard nicht frei zugänglich?).
- Unterstützung in PostGIS, GeoServer und QGIS vorhanden.
- Und ausbaufähig.
- Implementierung in GEOS, JTS u.a. fehlt.

Danke.

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https://github.com/bhoefling-c2c/fossgis2022_arc-curves/


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