SQL Server 2008 Spatial Data

Agenda

- Who am I
- Introductions to Spatial Data
- New Data Types Geometry and Geography
- Spatial References
- Spatial Operations
- Examples
- More Information
- Q & A

Who Am I

- Scott Heffron
- Company
  - CTR-SQL: Choose The Right - SQL
  - www.CTR-SQL.com

Introductions to Spatial Data

Why Should I care about Spatial Data

- 80 – 90% of all data has a spatial element to it
  - Where are your customers
  - Where are you assets
  - Where are potential customers
  - Where are crimes happening
  - Where are the risks
  - Where are the complaints coming from

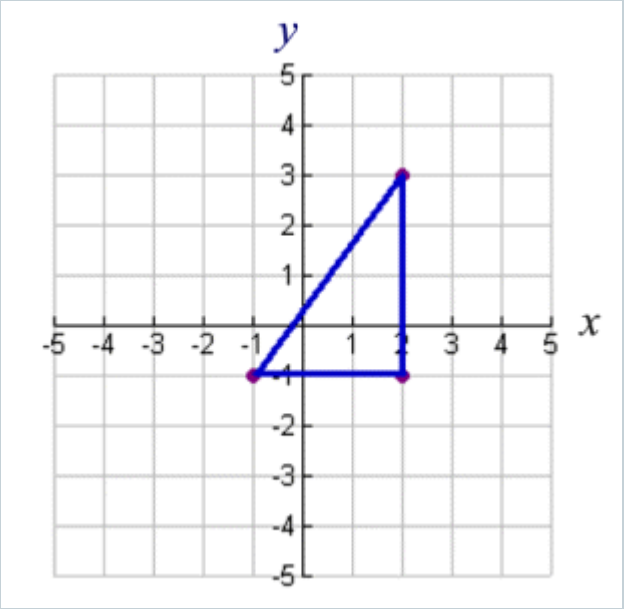
SQL Server History

- SQL Server 2005
  - Introduction to SQLCLR
  - Allowed for Rich User Defined
    - Create a single object
      - With multiple data points
      - Perform Calculations internally
      - Store in a single row in a table

New Data Types - Geometry and Geography

Geometry

- High School Geometry
  - Mathematical Proofs
  - Construction using a compass and straight-edge
  - Cartesian Coordinate system



SQL Server Geometry

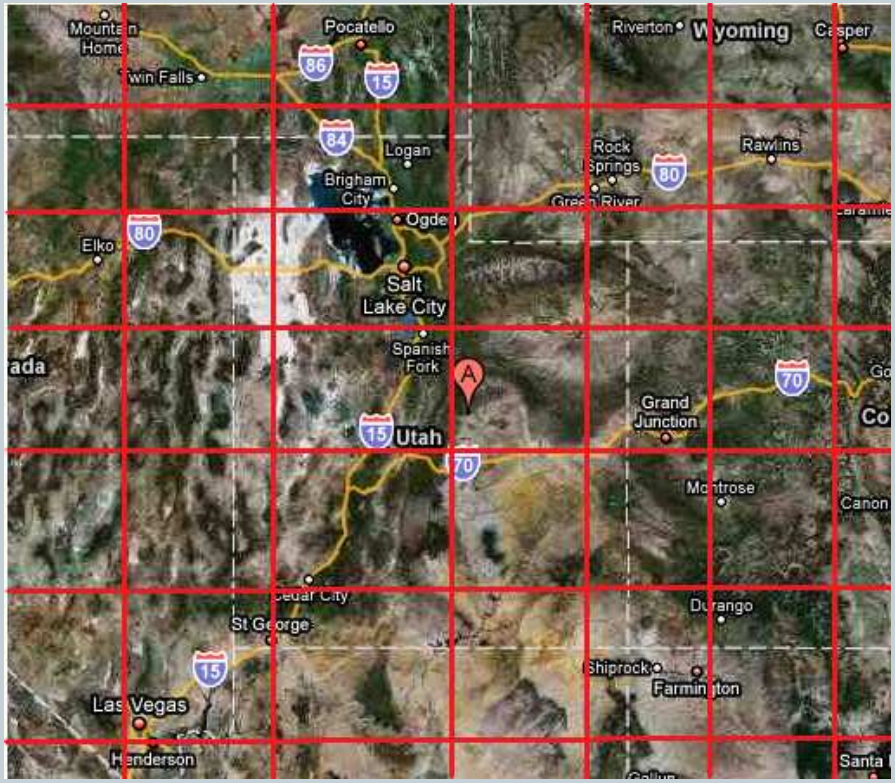
- Planar Spatial Data Type
- Implemented as CLR data type
- Euclidean (flat) coordinate system
- Standards defined by Open Geospatial Consortium (OGC)
- Microsoft extensions

Geometry In SQL 2008

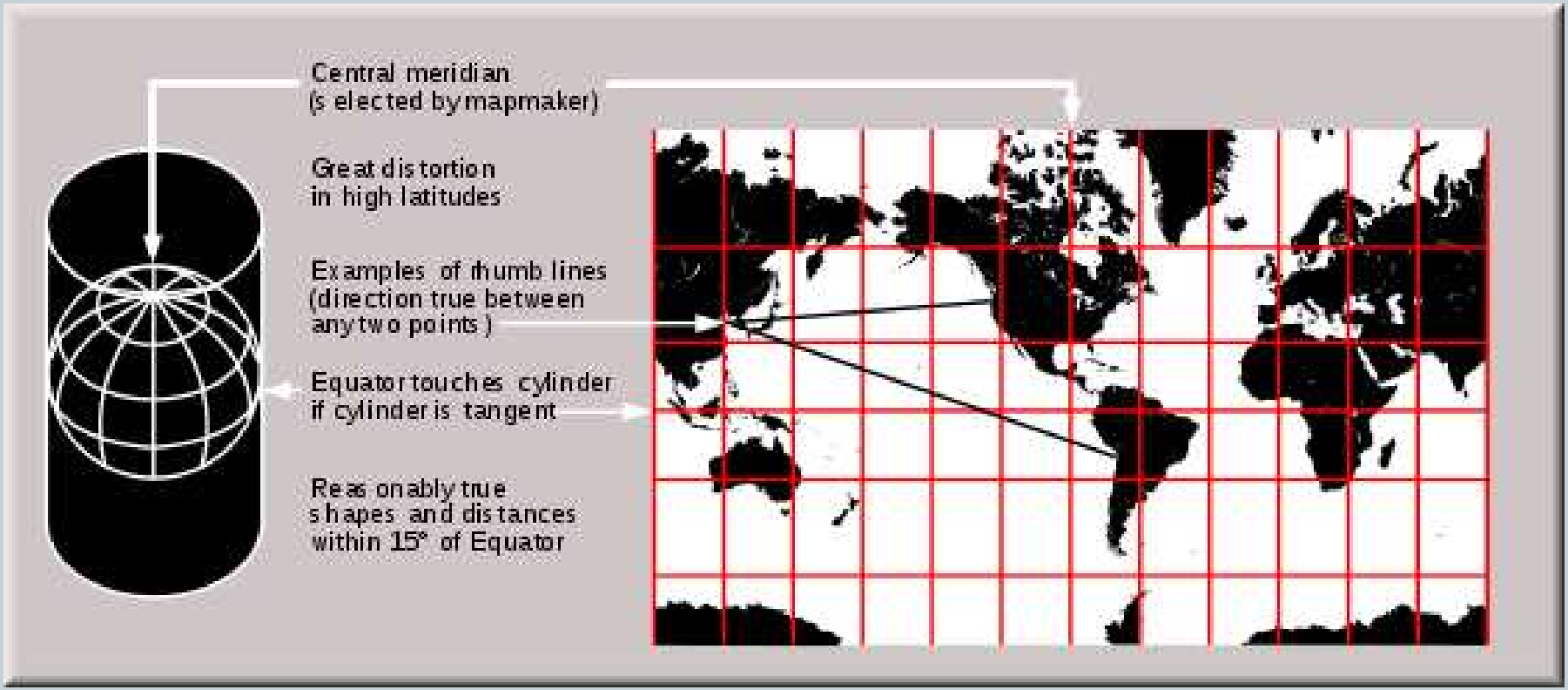
- Represents information is a 2 dimensional plane
- Units are completely user defined
  - Inches
  - Miles
  - Pixels
  - Meters

Planar Map of Utah

- X/Y coordinates on a planar grid
- Different Projections

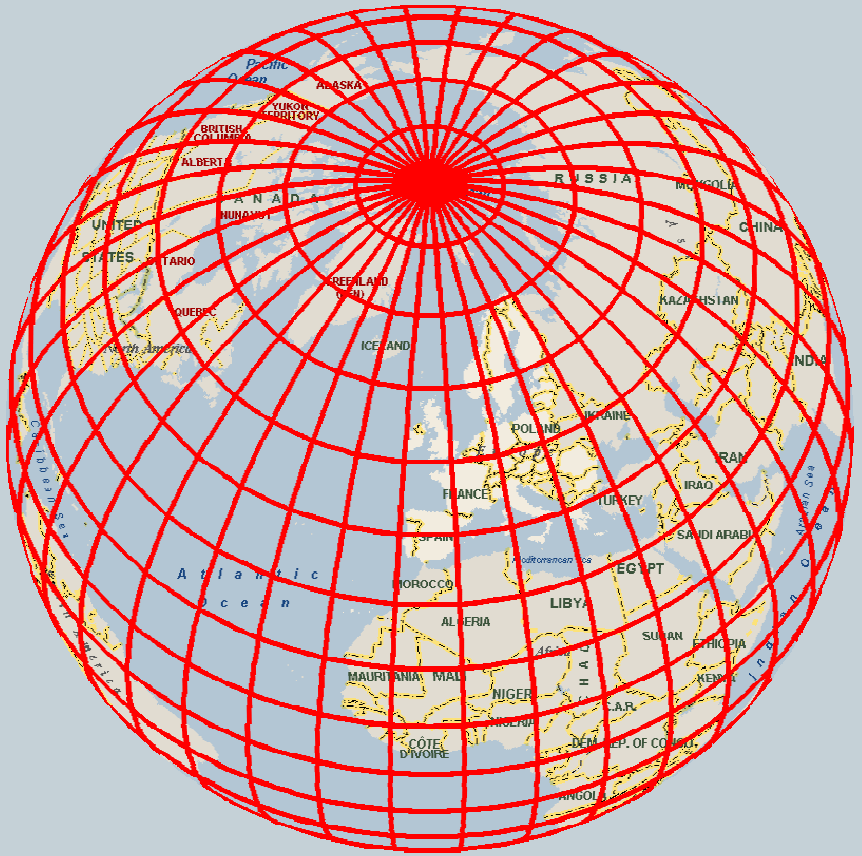


Planar Map of the World



Geography

- Geodetic coordinates
- Covers larger areas
- International datasets
- Approximation
  - Earth actually flattened sphere (oblate spheroid)
- Different models
  - Airy 1830 (used by OS)
  - WGS84 (used by GPS)



Geography Data Type

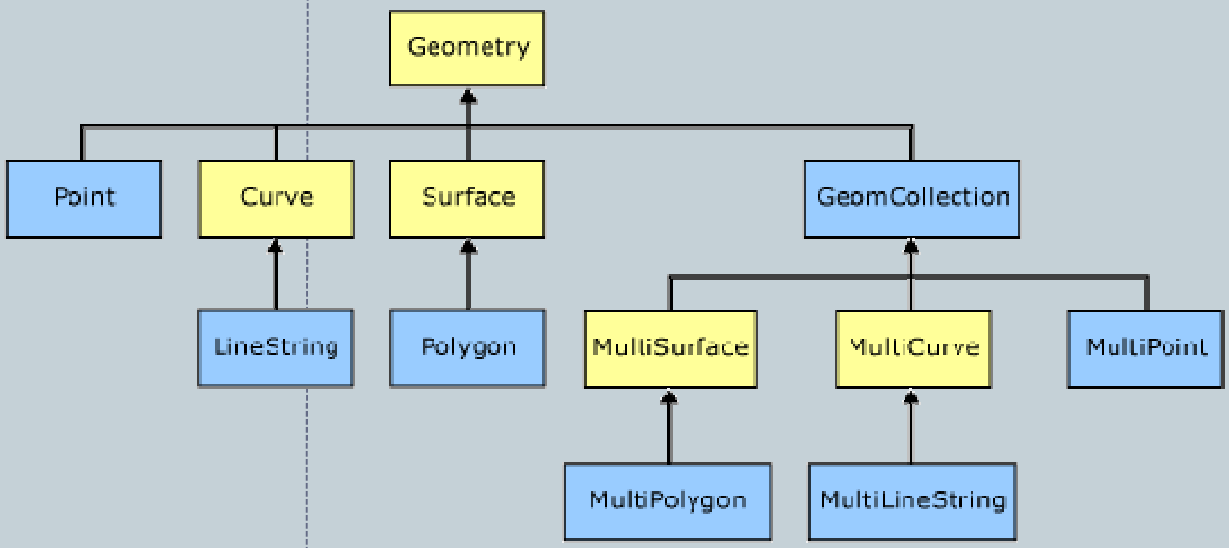
- Use Latitude and Longitude angles to identify points on the earth
  - Latitude – Measures how far North/South of the Equator a point is.
  - Longitude – Measures how far East/West of a Prime Meridian a point is.
- This type of coordinate system can be used to identify points on any sized "ball", be it a golf ball, the Earth, the Sun, or even the Jazz basketball.

Spatial Reference IDentifiers (SRIDs)

- All spatial data has an SRID
- SRIDs must match for spatial operations
  - Null returned if SRIDs don't match
- Geometry can have an SRID of 0
  - Not Geography

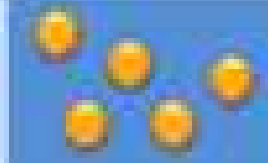
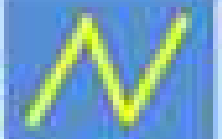
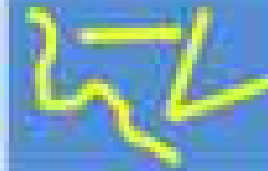
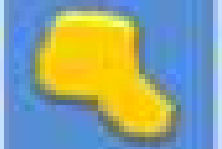
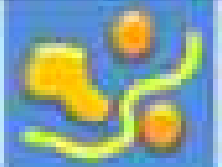
Types of Spatial Types

- Point
- LineString
- Polygon
- GeomCollection
- MultiPolygon
- MultiLineString
- MultiPoint

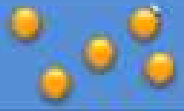
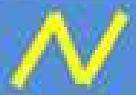
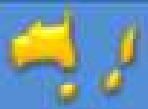
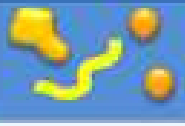


Spatial References

Geometry Types

Type		Type		Common Usages
POINT		MULIPOINT		Tree, Pole, Hydrant, Valve
LINESTRING		MULTILINESTRING		Road, River, Railway, Pipeline
POLYGON		MULTIPOLYGON		Cadastre, Park, Administrative Boundary
COLLECTION				Graphics, Markups

Geometry Type Text Representations

Geometry Type		Well Known Text (WKT)
POINT		POINT(10 20)
MULTIPOINT		MULTIPOINT(10 20, 15 15, 20 15)
LINESTRING		LINESTRING (10 30, 15 15, 25 40)
MULTILINESTRING		MULTILINESTRING ((40 40, 30 30), (15 15, 9 9))
POLYGON		POLYGON ((10 10, 40 10, 40 30, 50 30, 50 50, 30 50, 30 40, 10 40, 10 10))
MULTIPOLYGON		MULTIPOLYGON (((40 30, 50 30, 50 50, 30 50, 30 40, 40 40, 40 30)), ((10 10, 40 10, 40 30, 30 30, 30 40, 10 40, 10 10)))
COLLECTION		GEOMETRYCOLLECTION(POINT(10,20), LINESTRING(40 40, 30 30), POLYGON((15 15, 30 15, 30 30, 15 30, 15 15)))

Spatial Operators

Operators for Geometry

STArea	STDimension	STIntersection	STNumPoints	STWithin
STAsBinary	STDisjoint	STIntersects	STOverlaps	STX
STAsText	STDistance	STIsClosed	STPointN	STY
STBoundary	STEndpoint	STIsEmpty	STPointOnSurface	
STBuffer	STEnvelope	STIsRing	STRelate	
STCentroid	STEquals	STIsSimple	STSrid	
STContains	STExteriorRing	STIsValid	STStartPoint	
STConvexHull	STGeometryN	STLength	STSymDifference	
STCrosses	STGeometryType	STNumGeometries	STTouches	
STDifference	STInteriorRingN	STNumInteriorRing	STUnion	

Operators of Geography

STArea	STDimension	STIntersection	STNumPoints	~~STWithin~~
STAsBinary	STDisjoint	STIntersects	STOverlaps	~~STX~~
STAsText	STDistance	STIsClosed	STPointN	~~STY~~
~~STBoundary~~	STEndpoint	STIsEmpty	~~STPointOnSurface~~	
STBuffer	~~STEnvelope~~	~~STIsRing~~	~~STRelate~~	
~~STCentroid~~	STEquals	~~STIsSimple~~	STSrid	
~~STContains~~	~~STExteriorRing~~	~~STIsValid~~	STStartPoint	
~~STConvexHull~~	STGeometryN	STLength	STSymDifference	
~~STCrosses~~	STGeometryType	STNumGeometries	~~STTouches~~	
STDifference	~~STInteriorRingN~~	~~STNumInteriorRing~~	STUnion	

What's with the 'ST'

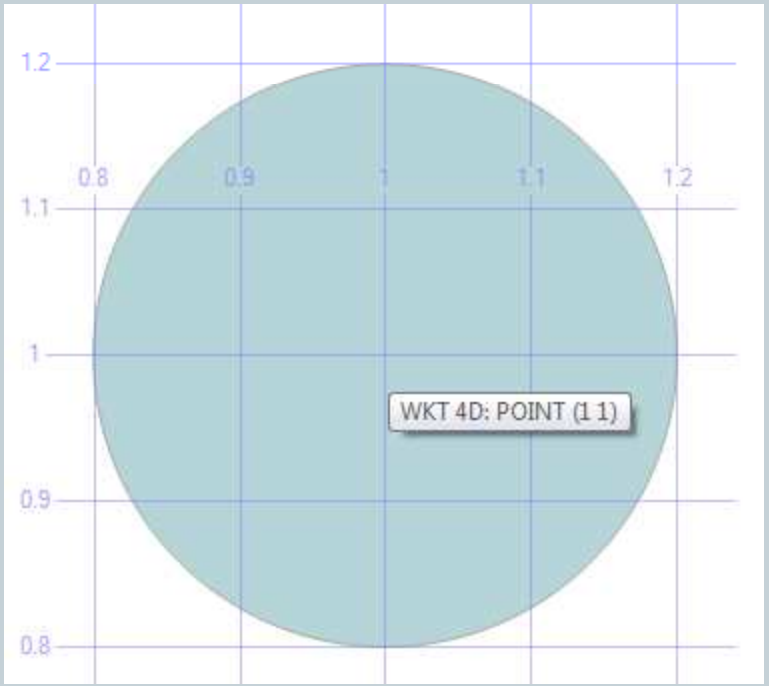
- Comes from the SQL Multimedia (SQL/MM): Part 3 Spatial spec and stands for "spatial-temporal"
- SQL/MM prefixes standard methods with "ST_" not "ST"
- Other Vendors
  - ESRI use "ST_"
  - DB2
    - Spatial extender also use "ST_"
    - Non-standard methods appear to leave off the "ST_"
  - Oracle Spatial uses "SDO_"

Examples

Single-Point Projection

```
DECLARE @p2D as Geometry = 'POINT( 1 1 )';

-- AsTextZM doesn't display dimensions that aren't used
SELECT @p2D.STBuffer(0.2) as Geo, @p2D.AsTextZM() as [WKT 4D]
GO
```

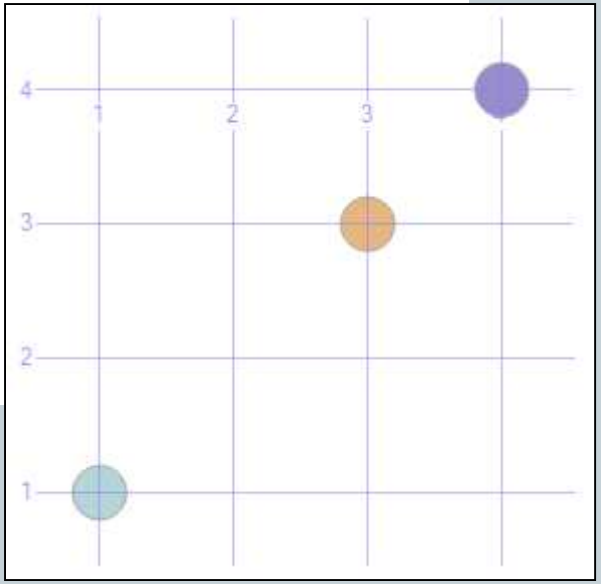


Demo
on
Single Point Projection

Many Single Point Projection

```
DECLARE @p2D as Geometry = 'POINT( 1 1 )';
DECLARE @p3D as Geometry = 'POINT( 3 3 4 )';
DECLARE @p4D as Geometry = 'POINT( 4 4 4 5 )';

-- AsTextZM doesn't display dimensions that aren't used
SELECT @p2D.STBuffer(0.2) as Geo
     , @p2D.AsTextZM() as [WKT 4D]
UNION ALL
SELECT @p3D.STBuffer(0.2)
     , @p3D.AsTextZM()
UNION ALL
SELECT @p4D.STBuffer(0.2)
     , @p4D.AsTextZM()
GO
```

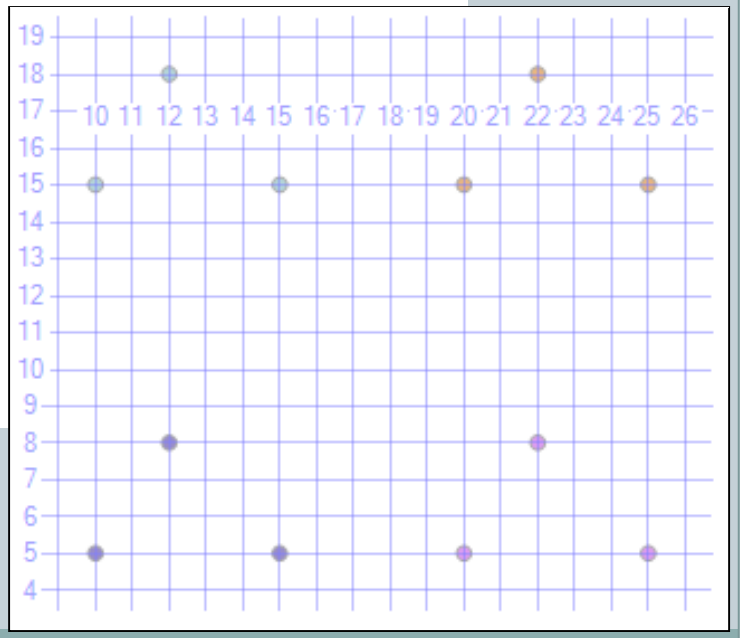


Demo
on
Multi Single Point Projection

MultiPoint Projection

```
DECLARE @g  as GEOMETRY = 'MULTIPOINT(12 18, 15 15, 10 15)'
DECLARE @Br as GEOMETRY = 'MULTIPOINT( (22 18), (25 15), (20 15))'
DECLARE @3D as GEOMETRY = 'MULTIPOINT( (12 8 10), (15 5 5), (10 5 7))'
DECLARE @4D as GEOMETRY = 'MULTIPOINT( (22 8 10 78), (25 5 5 43), (20 5 7 27))'

-- Display only 2D --
SELECT @g.STBuffer(0.2) as Geo
     , @g.STAsText() as WKT
     , 'X,Y Points without Bracketing pairs' as Comment
UNION ALL
SELECT @Br.STBuffer(0.2)
     , @Br.STAsText()
     , 'X,Y Points with Bracketing pairs - Preferred'
UNION ALL
SELECT @3D.STBuffer(0.2)
     , @3D.STAsText()
     , 'Points that store a Z Dimension'
UNION ALL
SELECT @4D.STBuffer(0.2)
     , @4D.STAsText()
     , 'Points that store Z & M(measure) Dimensions'
```

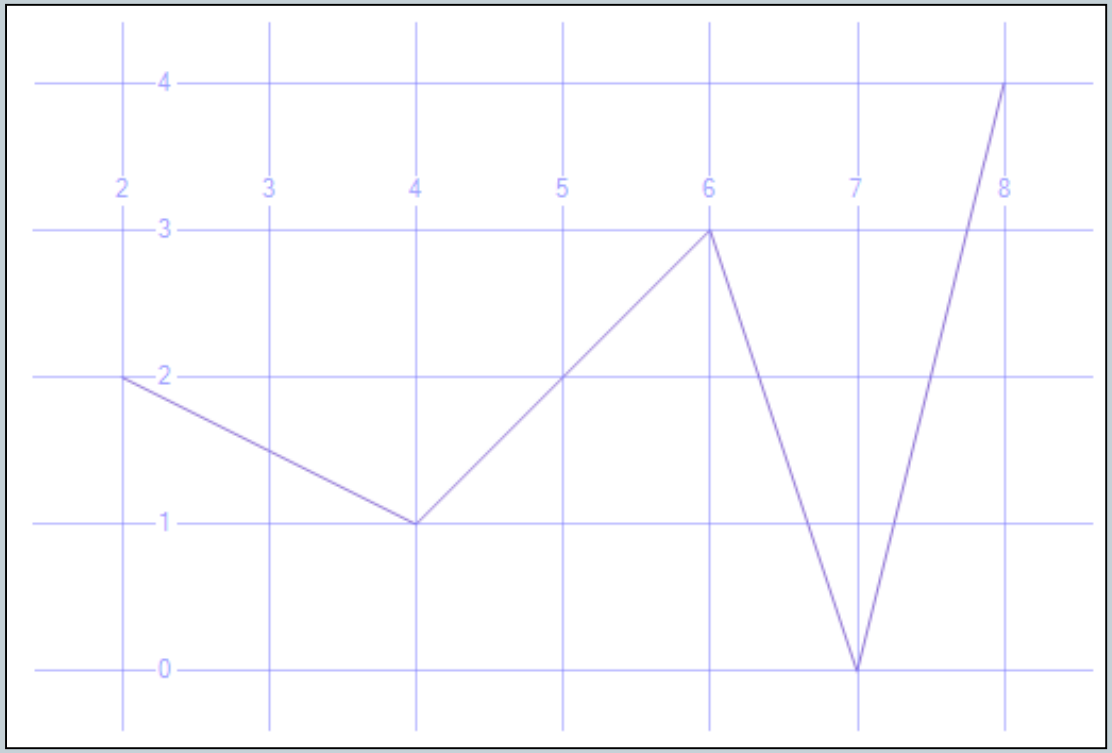


Demo
on
MultiPoint Projection

LineString Projection

```
DECLARE @L2D as Geometry = 'LINESTRING( 2 2, 4 1, 6 3, 7 0, 8 4)';

SELECT @L2D as Geo
     , @L2D.AsTextZM() as [WKT 4D]
```

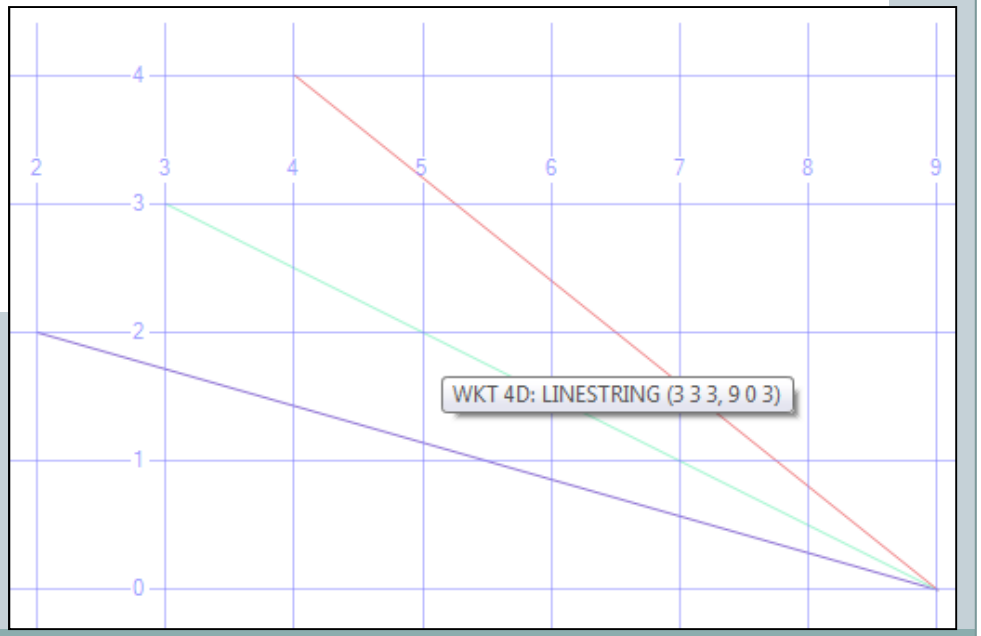


Demo
on
Line String Projection

Multi-LineString Projection

```
DECLARE @L2D as Geometry = 'LINESTRING( 2 2, 9 0 )';
DECLARE @L3D as Geometry = 'LINESTRING( 3 3 3, 9 0 3 )';
DECLARE @L4D as Geometry = 'LINESTRING( 4 4 4 4, 9 0 4 4 )';

SELECT @L2D as Geo
     , @L2D.AsTextZM() as [WKT 4D]
UNION ALL
SELECT @L3D
     , @L3D.AsTextZM()
UNION ALL
SELECT @L4D
     , @L4D.AsTextZM()
```

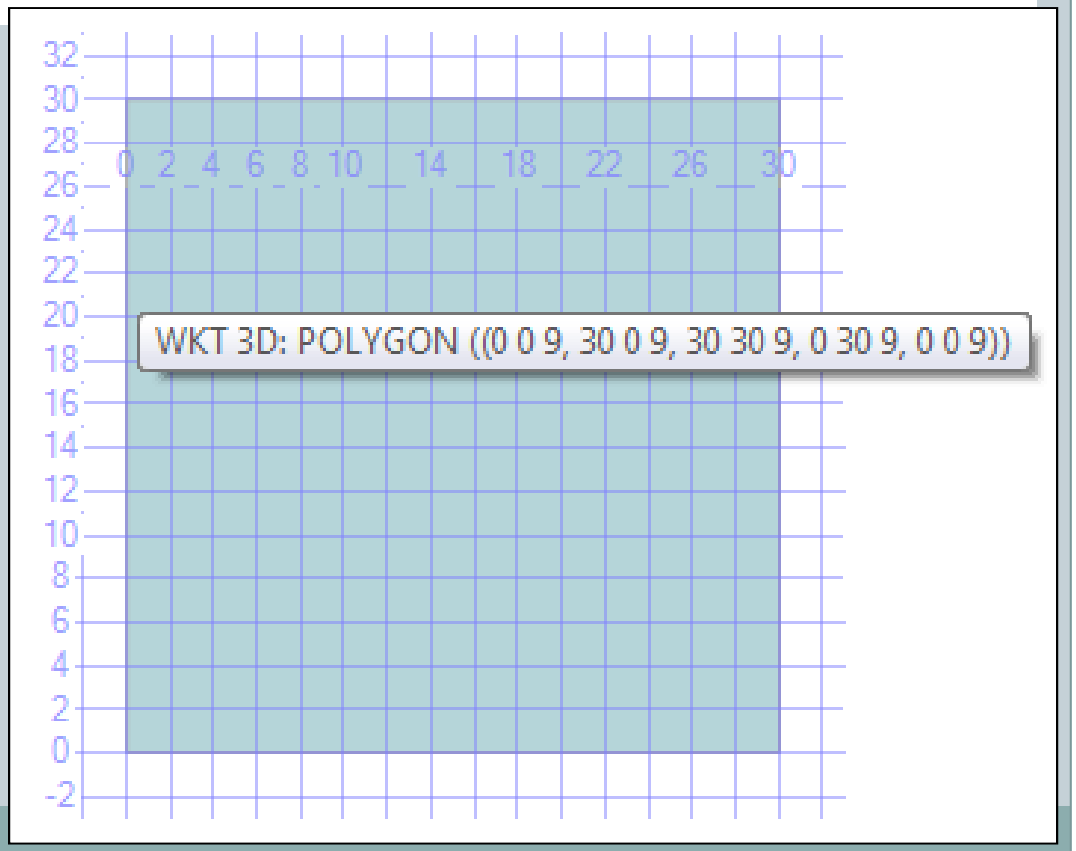


Demo
on
Line String Multiple Projection

Polygon Projection

```
DECLARE @g as GEOMETRY = 'POLYGON( (0 0 9, 30 0 9, 30 30 9, 0 30 9, 0 0 9) )';

SELECT @g as geo
     , @g.AsTextZM() as [WKT 3D]
GO
```

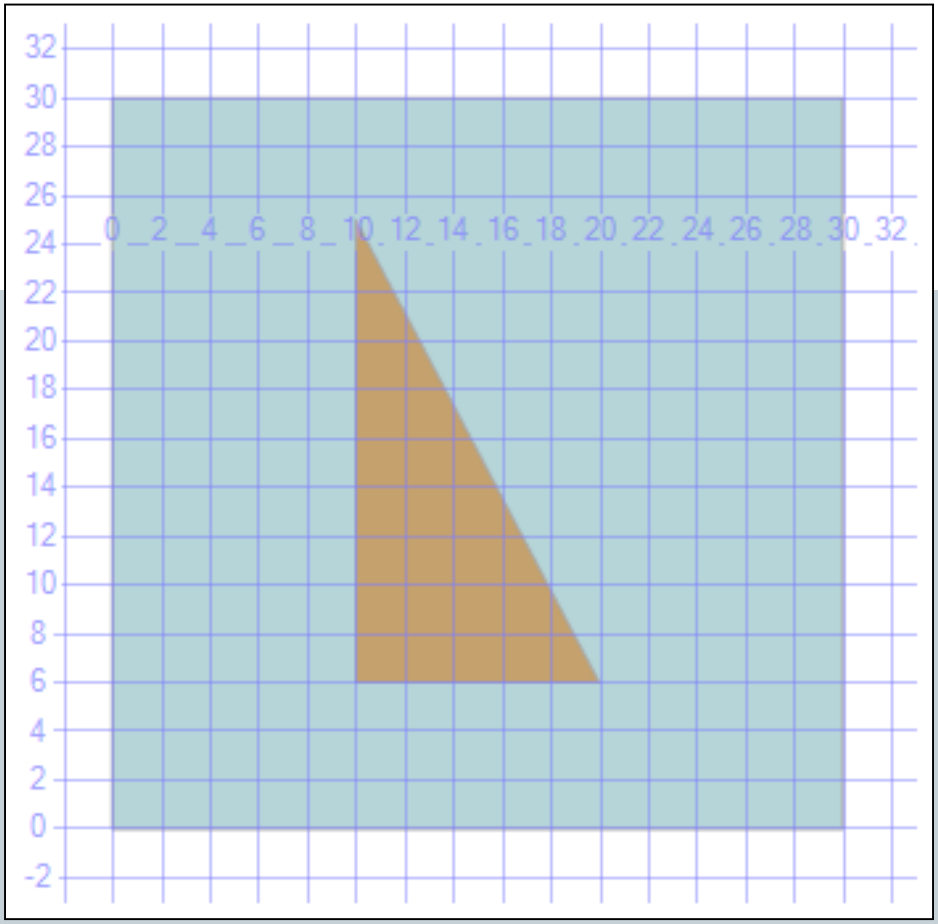


Demo
on
Polygon Projection

Polygon Inside a Polygon Projection

```
DECLARE @Square   AS GEOMETRY = 'POLYGON( (0 0 9, 30 0 9, 30 30 9, 0 30 9, 0 0 9) )';
DECLARE @Triangle AS GEOMETRY = 'POLYGON( (10 6, 10 25, 20 6, 10 6) )';

SELECT @Square as geo
     , @Square.AsTextZM()
UNION ALL
SELECT @Triangle
     , @Triangle.AsTextZM()
GO
```



Demo
on
Polygon Inside A Polygon Projection

More Information

More Information

- Geometry
  - http://msdn.microsoft.com/en-us/library/cc280487.aspx
- Geography
  - http://msdn.microsoft.com/en-us/library/cc280766.aspx
- OGC Specifications, Simple Feature Access Part 1 - Common Architecture
  - http://www.opengeospatial.org/standards/sfs
- OGC Specifications, Simple Feature Access Part 2 – SQL Options
  - http://www.opengeospatial.org/standards/gml

Tutorials

- Jason Follas
  - http://www.jasonfollas.com/blog/archive/2008/03/14/sql-server-2008-spatial-data-part-1.aspx
- David Lean
  - http://blogs.msdn.com/davidlean/archive/tags/Geometry/default.aspx

Question & Answers

Thank You

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