

# SQL Spatial Stretches Out In SQL Server 2012

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# About Bob Beauchemin

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# Outline

- ✦ Spatial Types
- ✦ Spatial Methods
- ✦ Spatial Aggregates
- ✦ Optimizations
- ✦ Diagnostics

# Spatial Data

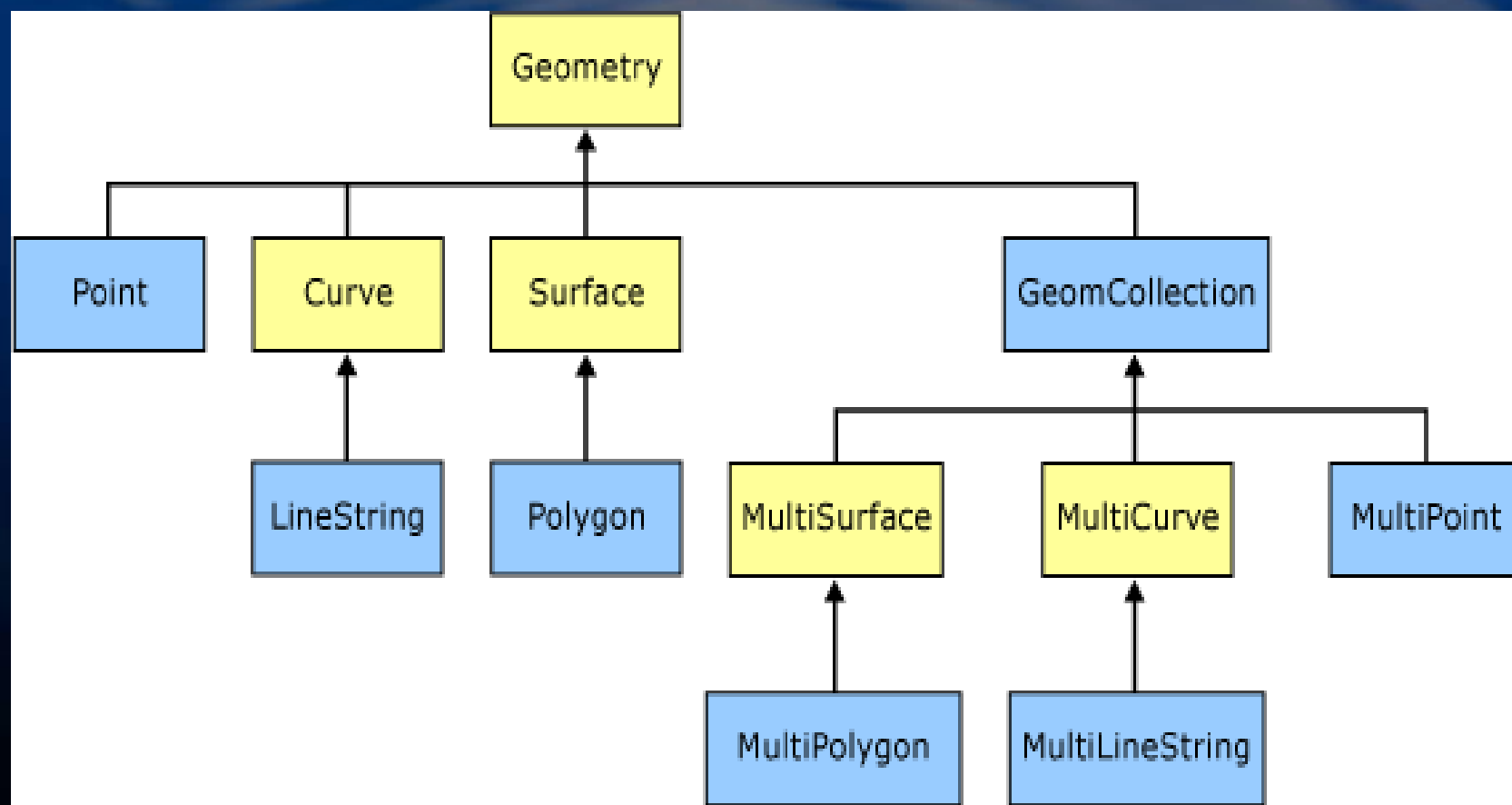
- ✦ Spatial data provides answers to location-based queries
  - ✦ Which roads intersect the Microsoft campus?
  - ✦ Does my land claim overlap yours?
  - ✦ List all of the Italian restaurants within 5 kilometers
- ✦ Spatial data is part of almost every database
  - ✦ If your database includes an address

# Spatial Data Types

- ✦ The Open Geospatial Consortium defines a hierarchy of spatial types
- ✦ Spatial types supported by SQL Server 2008
  - ✦ Point
  - ✦ Linestring
  - ✦ Polygon
  - ✦ MultiPoint
  - ✦ MultiLinestring
  - ✦ MultiPolygon
  - ✦ GeomCollection
  - ✦ Non-instanciable classes based on these



# OGC Hierarchy of Spatial Types



# Spatial Types - SQL Server 2012

- ◆ Additional types: From SQL-MM spec
  - ◆ CircularString
  - ◆ CompoundCurve
  - ◆ CurvePolygon
- ◆ Additional custom type
  - ◆ Fullglobe
- ◆ Type limit removed
  - ◆ Geography instances can be  $> 1$  hemisphere
- ◆ New SRID 104001
  - ◆ Earth Unit Sphere (unit of measure is radian)
  - ◆ Faster calculations at expense of precision

# Data Type Precision

- ◆ Internal binary format
  - ◆ Uses 48 bits in SQL Server 2012
  - ◆ Uses 27 bits in SQL Server 2008, R2



# Spatial Types

- ✦ Many properties and methods
- ✦ OGC-compliant methods begin with ST
  - ✦ From SQL-MM spec
- ✦ SQL Server-specific methods do not
  - ✦ Geometry specific methods
  - ✦ Extensions
- ✦ Geometry implements all OGC methods
  - ✦ Geography implements most of them

# New Methods

- ✦ New standard methods on geography
  - ✦ STWithin, STContains, STOverlaps
    - ✦ Can use spatial index
  - ✦ STConvexHull
  - ✦ IsValid, MakeValid
  - ✦ ReorientObject
- ✦ New methods on geography and geometry
  - ✦ ShortestLineTo
  - ✦ IsValidDetailed
- ✦ Compatibility
  - ✦ MinDbCompatibilityLevel
  - ✦ STLength works on Invalid Linestrings
    - ✦ i.e. overlapping GPS data

# New Methods - 2

- ◆ New Methods and Curves
  - ◆ BufferWithCurves()
  - ◆ STNumCurves() and STCurveN()
  - ◆ STCurveToLine() and CurveToLineWithTolerance()
- ◆ New Properties for Z and M properties
  - ◆ HasM
  - ◆ HasZ
- ◆ And AsBinary with Z and M properties
  - ◆ AsBinaryZM

# Using .NET with Spatial

- ◆ Spatial Types live in .NET library
  - ◆ Microsoft.SqlServer.Types
- ◆ Library Useable on Server or Client
  - ◆ Server procs, functions, triggers, UDT, UDAgg
  - ◆ Client code in any .NET language
- ◆ Types called SqlGeometry, SqlGeography
- ◆ Also contains spatial builder classes

# Spatial Builder

- ◆ Classes
  - ◆ SqlGeometryBuilder
  - ◆ SqlGeographyBuilder
- ◆ Interfaces
  - ◆ IGeometryBuilder
  - ◆ IGeographyBuilder



# Spatial Builder Methods

## ◆ Methods

- ◆ SetSrid - must be called first
- ◆ BeginGeometry, EndGeometry
- ◆ BeginGeography, EndGeography
- ◆ BeginFigure, EndFigure
- ◆ AddLine
- ◆ Populate

## ◆ Properties

- ◆ ConstructedGeometry, ConstructedGeography

# SQL Server 2012 Spatial Builder

- ◆ Client library updated
  - ◆ Additional types and methods
  - ◆ IGeometrySink110
  - ◆ IGeographySink110
- ◆ Additional Deserialize method

# Spatial Aggregates

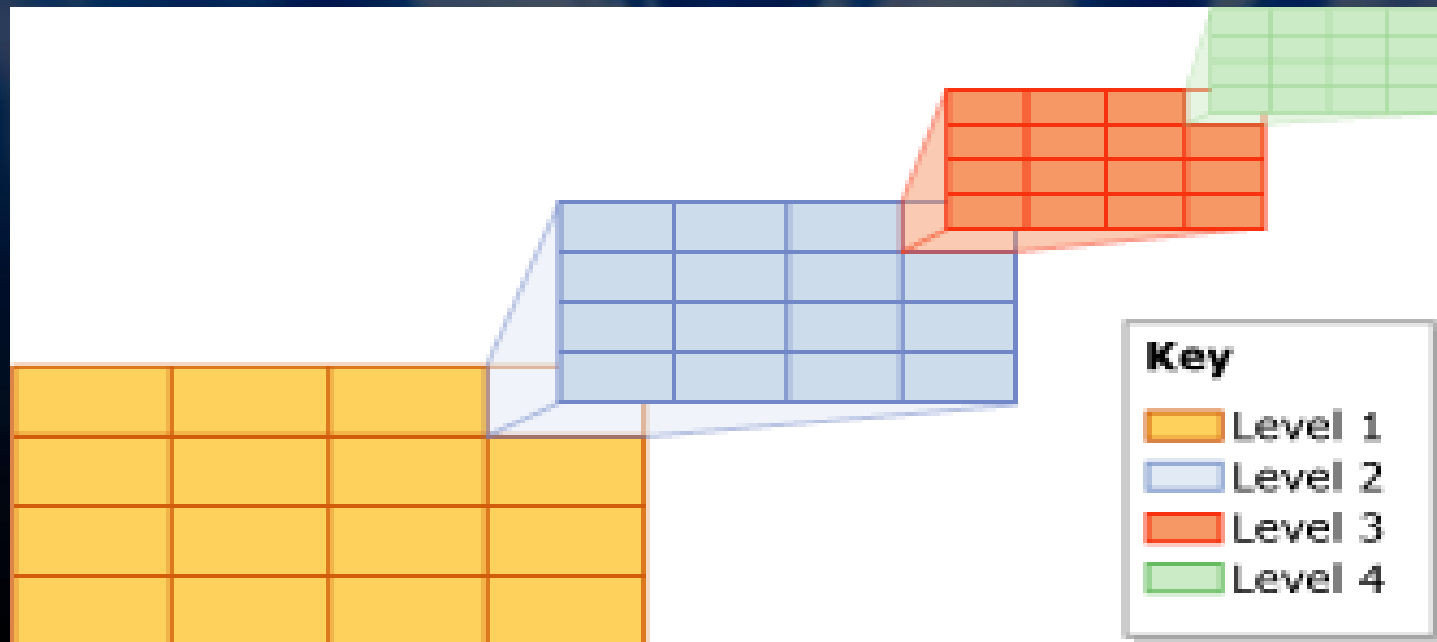
- ◆ SQLCLR-based Aggregates
  - ◆ UnionAggregate
  - ◆ EnvelopeAggregate
  - ◆ CollectionAggregate
  - ◆ ConvexHullAggregate
- ◆ These follow the "SQLCLR Aggregate pattern"
  - ◆ Must call methods using a list on client

# Spatial Indexes

- ✦ SQL Server Spatial Indexes Based on B-Trees
  - ✦ Uses tessellation to tile 2D to linear
  - ✦ Divides space into grids (uses Hilbert algorithm)
  - ✦ Two gridding algorithms
    - ✦ GEOMETRY\_GRID and GEOGRAPHY\_GRID
- ✦ Meant as a first level of row elimination
  - ✦ Can produce false positives
  - ✦ Never false negatives

# Spatial Index Grid Hierarchy

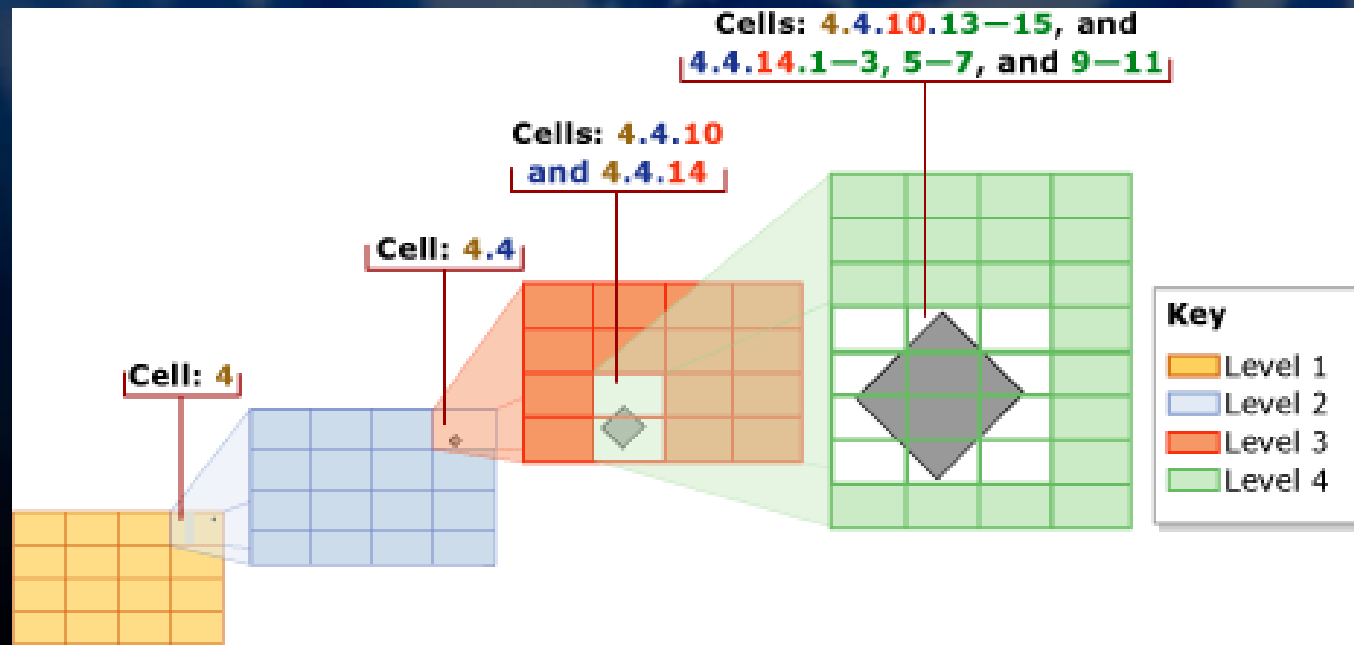
- ◆ Specify four grid levels
  - ◆ Low (4x4), medium (8x8), or high (16x16) density
  - ◆ Specify bounding box (Geometry\_Grid only)





# Spatial Index Population Rules

- ◆ Covering Rule
- ◆ Cells-Per-Object Rule
  - ◆ Specify `cells_per_object` maximum on index definition
- ◆ Deepest-Cell Rule



# Auto-Grid Indexes

- ✦ Allows "general best" index
  - ✦ For products that always add default index
- ✦ Specify Geometry/Geography\_Auto\_Grid
  - ✦ Grid density not specifiable
- ✦ Index is 8-level
  - ✦ Not 4-level like original grid
  - ✦ Density is HLLLLLLL

# Spatial Index

- ✦ Compression support
  - ✦ Page/row compression for spatial indexes
- ✦ SPATIAL\_WINDOW\_MAX\_CELLS hint
  - ✦ For the "query sample" tessellation step
  - ✦ Defaults changed in SQL Server 2012
- ✦ Nearest neighbor query plan
  - ✦ Requires STDistance in predicate
  - ✦ Requires order by and top clauses

# Spatial Performance Optimizations

- ✦ Various optimization in all parts of spatial
  - ✦ Spatial index build faster for point data
  - ✦ Spatial Method Optimization
    - ✦ STIntersects, STWithin, STContains, and STOverlaps optimized with a point operand
    - ✦ STDistance between two points
    - ✦ STBuffer - faster, less memory consumed
  - ✦ SQLCLR Aggregates more performant

# Index Diagnostic Procedures

- ✦ Evaluates index against query sample
  - ✦ `sp_help_spatial_geometry_index(_xml)`
  - ✦ `sp_help_spatial_geography_index(_xml)`
- ✦ Provides
  - ✦ Information about the index itself
  - ✦ Information about the query sample
  - ✦ How efficient the query index is when used against the query sample
- ✦ Helps decision on index parameters



# Histogram Stored Procedures

- ◆ `sp_help_spatial_geometry_histogram`
- ◆ `sp_help_spatial_geography_histogram`
  - ◆ Distribution of spatial objects in grid
  - ◆ Specify `cell_size` and `sampling percent`
  - ◆ Results can be plotted

# Summary

- ◆ SQL Server 2012 rounds out spatial support
  - ◆ New spatial types
  - ◆ New methods and aggregates
  - ◆ More indexing choices
  - ◆ More plan control, new plans
  - ◆ New diagnostic procedure
  - ◆ More precise binary format
  - ◆ Performance improvements throughout