Geoscript Groovy Cookbook

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Geometry Recipes

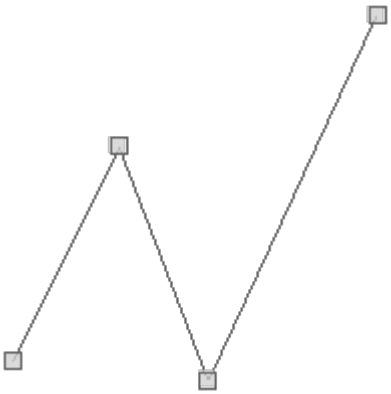
Creating Geometries

Create a Point with an XY

```
Point point = new Point(-123,46)
```

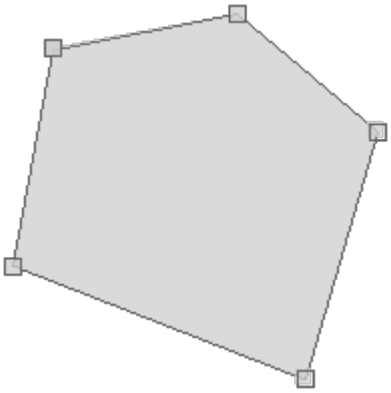
Create a LineString from Coordinates

```
LineString lineString = new LineString(
        [3.1982421875, 43.1640625],
        [6.7138671875, 49.755859375],
        [9.7021484375, 42.5927734375],
        [15.3271484375, 53.798828125]
)
```



Create a Polygon from a List of Coordinates

```
Polygon polygon = new Polygon([[
       [-101.35986328125, 47.754097979680026],
       [-101.5576171875, 46.93526088057719],
       [-100.12939453125, 46.51351558059737],
       [-99.77783203125, 47.44294999517949],
       [-100.45898437499999, 47.88688085106901],
       [-101.35986328125, 47.754097979680026]
]])
```

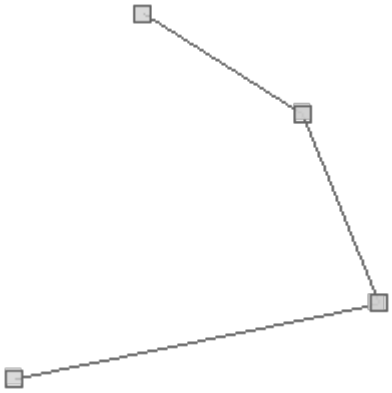


Create a MultiPoint with a List of Points

```
MultiPoint multiPoint = new MultiPoint([
        new Point(-122.3876953125, 47.5820839916191),
        new Point(-122.464599609375, 47.25686404408872),
        new Point(-122.48382568359374, 47.431803338643334)
])
```

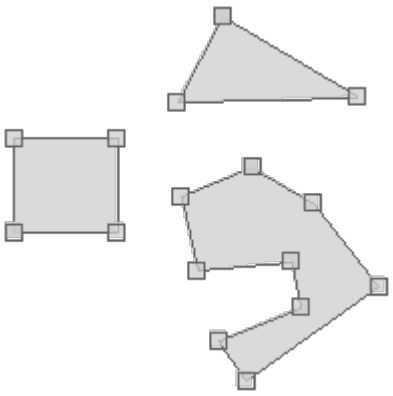
Create a MultiLineString with a List of LineStrings

```
MultiLineString multiLineString = new MultiLineString([
        new LineString (
                [-122.3822021484375, 47.57837853860192],
                [-122.32452392578125, 47.48380086737799]
        ),
        new LineString (
                [-122.32452392578125, 47.48380086737799],
                [-122.29705810546874, 47.303447043862626]
        ),
        new LineString (
                [-122.29705810546874, 47.303447043862626],
                [-122.42889404296875, 47.23262467463881]
        )
])
```



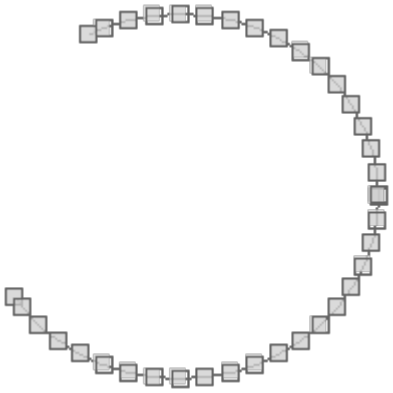
Create a MultiPolygon with a List of Polygons

```
MultiPolygon multiPolygon = new MultiPolygon(
    new Polygon ([[
            [-122.2723388671875,  47.818687628247105],
            [-122.37945556640624, 47.66168780332917],
            [-121.95373535156249, 47.67093619422418],
            [-122.2723388671875,  47.818687628247105]
    ]]),
    new Polygon ([[
            [-122.76672363281249, 47.42437092240516],
            [-122.76672363281249, 47.59505101193038],
            [-122.52227783203125, 47.59505101193038],
            [-122.52227783203125, 47.42437092240516],
            [-122.76672363281249, 47.42437092240516]
    ]]),
    new Polygon ([[
            [-122.20367431640624, 47.543163654317304],
            [-122.3712158203125,  47.489368981370724],
            [-122.33276367187499, 47.35371061951363],
            [-122.11029052734374, 47.3704545156932],
            [-122.08831787109375, 47.286681888764214],
            [-122.28332519531249, 47.2270293988673],
            [-122.2174072265625,  47.154237057576594],
            [-121.904296875,      47.32579231609051],
            [-122.06085205078125, 47.478232163128851],
            [-122.20367431640624, 47.543163654317304]
    ]])
)
```



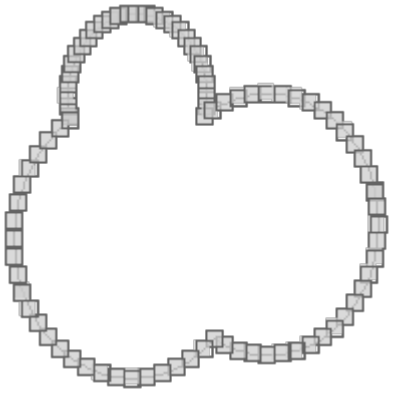
Create a CircularString with a List of Points

```
CircularString circularString = new CircularString([
        [-122.464599609375, 47.247542522268006],
        [-122.03613281249999, 47.37789454155521],
        [-122.37670898437499, 47.58393661978134]
])
```



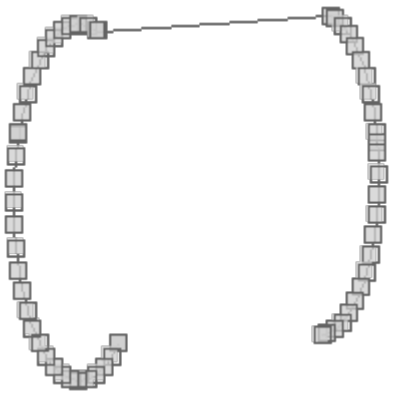
Create a CircularRing with a List of Points

```
CircularRing circularRing = new CircularRing([
        [-118.47656249999999, 41.508577297439324],
        [-109.6875, 57.51582286553883],
        [-93.8671875, 42.032974332441405],
        [-62.57812500000001, 30.14512718337613],
        [-92.10937499999999, 7.36246686553575],
        [ -127.265625, 14.604847155053898],
        [-118.47656249999999, 41.508577297439324]
])
```



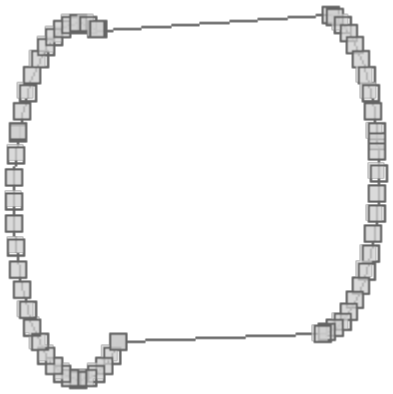
Create a CompoundCurve with a List of CircularStrings and LineStrings

```
CompoundCurve compoundCurve = new CompoundCurve([
    new CircularString([
            [27.0703125, 23.885837699862005],
            [5.9765625, 40.17887331434696],
            [22.5, 47.98992166741417],
    ]),
    new LineString([
            [22.5, 47.98992166741417],
            [71.71875, 49.15296965617039],
    ]),
    new CircularString([
            [71.71875, 49.15296965617039],
            [81.5625, 39.36827914916011],
            [69.9609375, 24.5271348225978]

    ])
])
```



Create a CompoundRing with a connected List of CircularStrings and LineStrings

```
CompoundRing compoundRing = new CompoundRing([
        new CircularString([
                [27.0703125, 23.885837699862005],
                [5.9765625, 40.17887331434696],
                [22.5, 47.98992166741417],
        ]),
        new LineString([
                [22.5, 47.98992166741417],
                [71.71875, 49.15296965617039],
        ]),
        new CircularString([
                [71.71875, 49.15296965617039],
                [81.5625, 39.36827914916011],
                [69.9609375, 24.5271348225978]

        ]),
        new LineString([
                [69.9609375, 24.5271348225978],
                [27.0703125, 23.885837699862005],
        ])
])
```



Procesing Geometries

Get the area of a Geometry

```
Polygon polygon = new Polygon([[
    [-124.80, 48.92],
    [-126.21, 45.33],
    [-114.60, 45.08],
    [-115.31, 51.17],
    [-121.99, 52.05],
    [-124.80, 48.92]
]])
double area = polygon.area
println area
```

```
62.4026
```

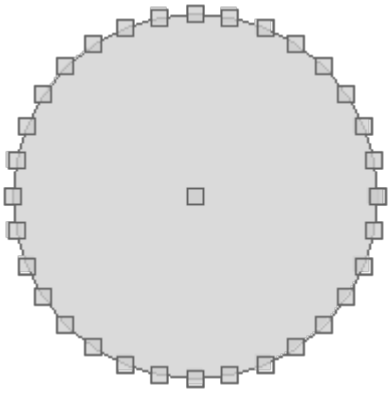
Get the length of a Geometry

```
LineString lineString = new LineString([-122.69, 49.61], [-99.84, 45.33])
double length = lineString.length
println length
```

```
23.24738479915536
```

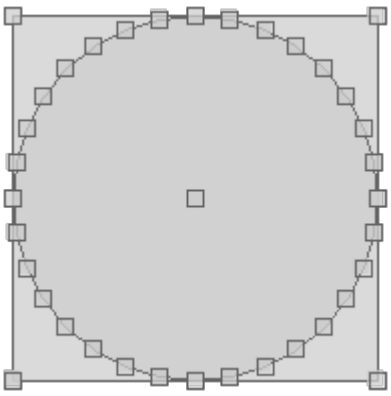
Buffer a Point

```
Point point = new Point(-123,46)
Geometry bufferedPoint = point.buffer(2)
```



Get Bounds from a Geometry

```
Point point = new Point(-123,46)
Polygon polygon = point.buffer(2)
Bounds bounds = polygon.bounds
```

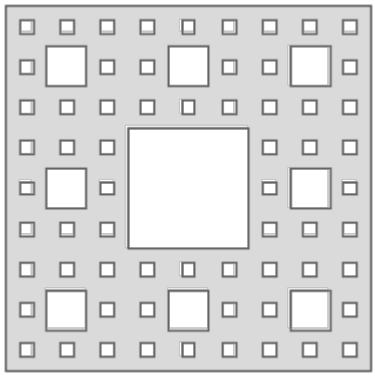


Create a Geometry of a String

```
Geometry geometry = Geometry.createFromText("Geo")
```

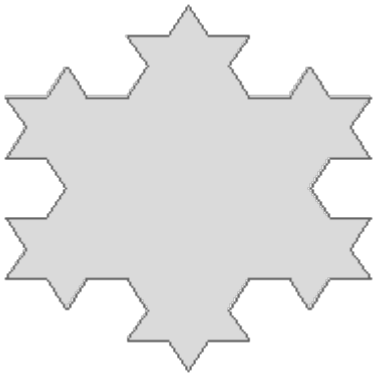
Create a Sierpinski Carpet in a given Bounds and with a number of points

```
Bounds bounds = new Bounds(21.645,36.957,21.676,36.970, "EPSG:4326")
Geometry geometry = Geometry.createSierpinskiCarpet(bounds, 50)
```



Create a Kock Snowflake in a given Bounds and with a number of points

```
Bounds bounds = new Bounds(21.645,36.957,21.676,36.970, "EPSG:4326")
Geometry geometry = Geometry.createKochSnowflake(bounds, 50)
```



Reading and Writing Geometries

The geoscript.geom.io package has several Readers and Writers for converting geoscript.geom.Geometry to and from strings.

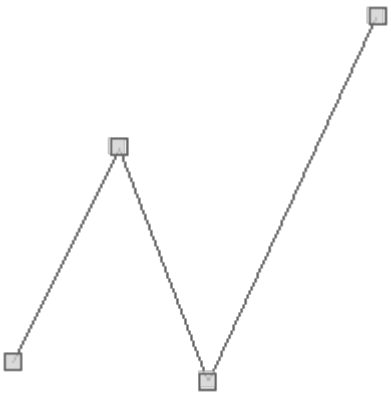
WKT

Read a Geometry from WKT using the WktReader

```
String wkt = "POINT (-123.15 46.237)"
WktReader reader = new WktReader()
Geometry geometry = reader.read(wkt)
```

Read a Geometry from WKT using the Geometry.fromWKT() static method

```
String wkt = "LINESTRING (3.198 43.164, 6.7138 49.755, 9.702 42.592, 15.327 53.798)"
Geometry geometry = Geometry.fromWKT(wkt)
```



Get the WKT of a Geometry

```
Geometry geometry = new Point(-123.15, 46.237)
String wkt = geometry.wkt
println wkt
```

```
POINT (-123.15 46.237)
```

Write a Geometry to WKT using the WktWriter

```
Geometry geometry = new LineString(
        [3.198, 43.164],
        [6.713, 49.755],
        [9.702, 42.592],
        [15.32, 53.798]
)
WktWriter writer = new WktWriter()
String wkt = writer.write(geometry)
println wkt
```

```
LINESTRING (3.198 43.164, 6.713 49.755, 9.702 42.592, 15.32 53.798)
```

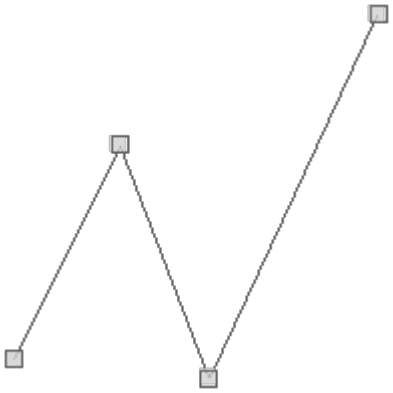
GeoJSON

Read a Geometry from GeoJSON using the GeoJSONReader

```
String json = '{"type":"Point","coordinates":[-123.15,46.237]}'
GeoJSONReader reader = new GeoJSONReader()
Geometry geometry = reader.read(json)
```

Read a Geometry from GeoJSON using the Geometry.fromGeoJSON() static method

```
String json =
'{"type":"LineString","coordinates":[[3.198,43.164],[6.713,49.755],[9.702,42.592],[15.
32,53.798]]}'
Geometry geometry = Geometry.fromGeoJSON(json)
```



Get the GeoJSON of a Geometry

```
Geometry geometry = new Point(-123.15, 46.237)
String json = geometry.geoJSON
println json
```

```
{"type":"Point","coordinates":[-123.15,46.237]}
```

Write a Geometry to GeoJSON using the GeoJSONWriter

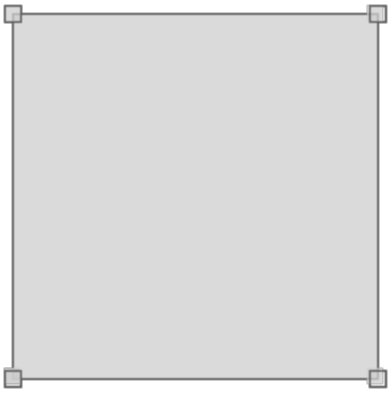
```
Geometry geometry = new LineString(
        [3.198, 43.164],
        [6.713, 49.755],
        [9.702, 42.592],
        [15.32, 53.798]
)
GeoJSONWriter writer = new GeoJSONWriter()
String json = writer.write(geometry)
println json
```

```
{"type":"LineString","coordinates":[[3.198,43.164],[6.713,49.755],[9.702,42.592],[15.3
2,53.798]]}
```

Creating Bounds

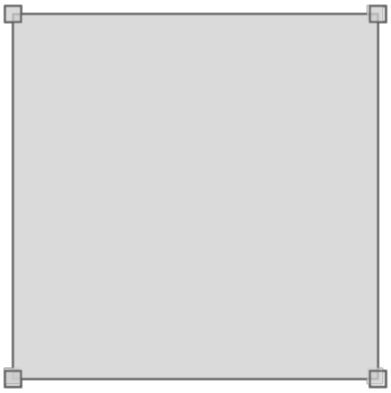
Create a Bounds from four coordinates (minx, miny, maxx, maxy) and a projection.

```
Bounds bounds = new Bounds(-127.265, 43.068, -113.554, 50.289, "EPSG:4326")
```



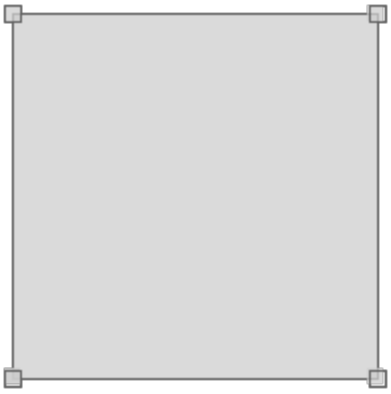
Create a Bounds from four coordinates (minx, miny, maxx, maxy) without a projection. The projection can be set later.

```
Bounds bounds = new Bounds(-127.265, 43.068, -113.554, 50.289)
bounds.proj = new Projection("EPSG:4326")
```



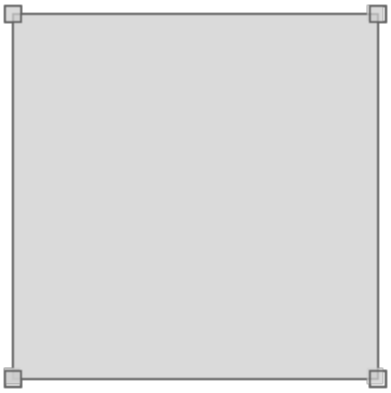
Create a Bounds from a string with commas delimiting minx, miny, maxx, maxy and projection values.

```
Bounds bounds = Bounds.fromString("-127.265,43.068,-113.554,50.289,EPSG:4326")
```



Create a Bounds from a string with spaces delimiting minx, miny, maxx, maxy and projection values.

```
Bounds bounds = Bounds.fromString("12.919921874999998 40.84706035607122 15.99609375
41.77131167976407 EPSG:4326")
```



Getting Bounds Properties

Create a Bounds and view it's string representation

```
Bounds bounds = new Bounds(-127.265, 43.068, -113.554, 50.289, "EPSG:4326")
String boundsStr = bounds.toString()
println boundsStr
```

```
(-127.265,43.068,-113.554,50.289,EPSG:4326)
```

Get the minimum x coordinate

```
double minX = bounds.minX
println minX
```

```
-127.265
```

Get the minimum y coordinate

```
double minY = bounds.minY
println minY
```

```
43.068
```

Get the maximum x coordinate

```
double maxX = bounds.maxX
println maxX
```

```
-113.554
```

Get the maximum y coordinate

```
double maxY = bounds.maxY
println maxY
```

```
50.289
```

Get the Projection

```
Projection proj = bounds.proj
println proj.id
```

```
EPSG:4326
```

Get the area

```
double area = bounds.area
println area
```

```
99.00713100000004
```

Get the width

```
double width = bounds.width
println width
```

```
13.710999999999999
```

Get the height

```
double height = bounds.height
println height
```

```
7.221000000000004
```

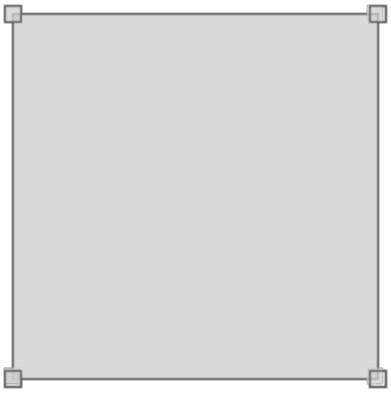
Get the aspect ratio

```
double aspect = bounds.aspect
println aspect
```

```
1.8987674837280144
```

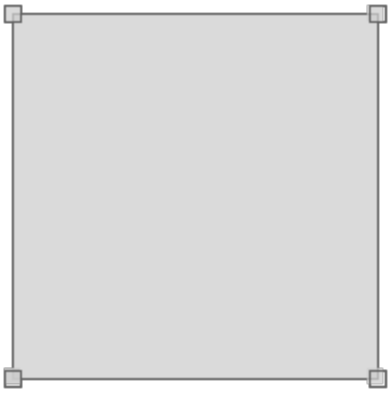
A Bounds is not a Geometry but you can get a Geometry from a Bounds

```
Bounds bounds = new Bounds(-122.485, 47.246, -122.452, 47.267, "EPSG:4326")
Geometry geometry = bounds.geometry
```



You can also get a Polygon from a Bounds

```
Bounds bounds = new Bounds(-122.485, 47.246, -122.452, 47.267, "EPSG:4326")
Polygon polygon = bounds.polygon
```



Get the four corners from a Bounds as a List of Points

```
Bounds bounds = new Bounds(-122.485, 47.246, -122.452, 47.267, "EPSG:4326")
List<Point> points = bounds.corners
```

Processing Bounds

Reproject a Bounds from one Projection to another.

```
Bounds bounds = new Bounds(-122.485, 47.246, -122.452, 47.267, "EPSG:4326")
println bounds
```

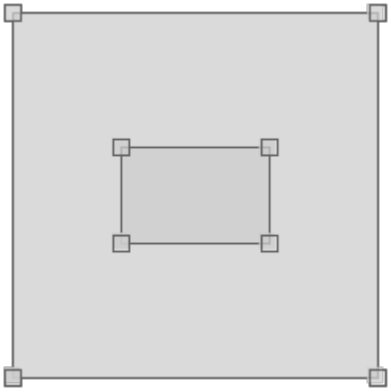
```
(-122.485,47.246,-122.452,47.267,EPSG:4326)
```

```
Bounds reprojectedBounds = bounds.reproject("EPSG:2927")
println reprojectedBounds
```

```
(1147444.7684517875,703506.223164177,1155828.120242509,711367.9403610165,EPSG:2927)
```

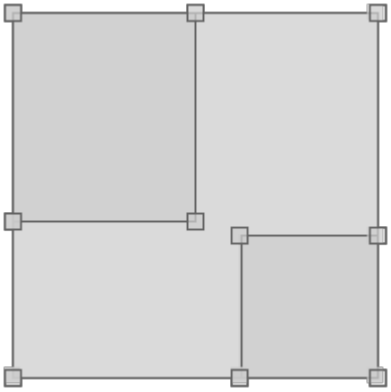
Expand a Bounds by a given distance

```
Bounds bounds1 = new Bounds(-127.265, 43.068, -113.554, 50.289, "EPSG:4326")
Bounds bounds2 = new Bounds(-127.265, 43.068, -113.554, 50.289, "EPSG:4326")
bounds2.expandBy(10.1)
```



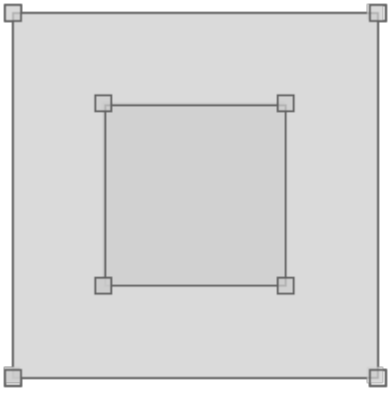
Expand a Bounds to include another Bounds

```
Bounds bounds1 = new Bounds(8.4375, 37.996162679728116, 19.6875, 46.07323062540835,
"EPSG:4326")
Bounds bounds2 = new Bounds(22.5, 31.952162238024975, 30.937499999999996,
37.43997405227057, "EPSG:4326")
bounds1.expand(bounds2)
```



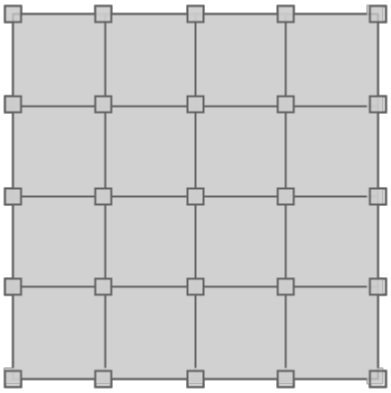
Scale an existing Bounds some distance to create a new Bounds

```
Bounds bounds1 = new Bounds(-127.265, 43.068, -113.554, 50.289, "EPSG:4326")
Bounds bounds2 = bounds1.scale(2)
```



Divide a Bounds into smaller tiles or Bounds

```
Bounds bounds = new Bounds(-122.485, 47.246, -122.452, 47.267, "EPSG:4326")
List<Bounds> subBounds = bounds.tile(0.25)
```



Calculate a quad tree for this Bounds between the start and stop levels. A Closure is called for each new Bounds generated.

```
Bounds bounds = new Bounds(-180, -90, 180, 90, "EPSG:4326")
bounds.quadTree(0,2) { Bounds b ->
    println b
}
```

```
(-180.0,-90.0,180.0,90.0,EPSG:4326)
(-180.0,-90.0,0.0,0.0,EPSG:4326)
(-180.0,0.0,0.0,90.0,EPSG:4326)
(0.0,-90.0,180.0,0.0,EPSG:4326)
(0.0,0.0,180.0,90.0,EPSG:4326)
```

Determine whether a Bounds is empty or not. A Bounds is empty if it is null or it's area is 0.

```
Bounds bounds = new Bounds(0,10,10,20)
println bounds.isEmpty()
```

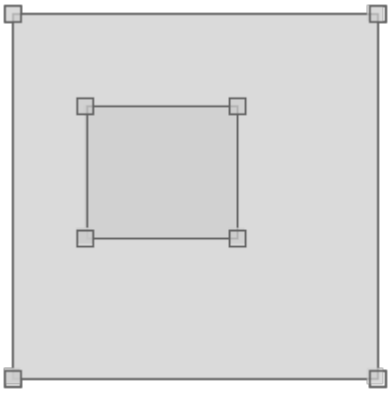
```
false
```

```
Bounds emptyBounds = new Bounds(0,10,10,10)
println emptyBounds.isEmpty()
```

```
true
```

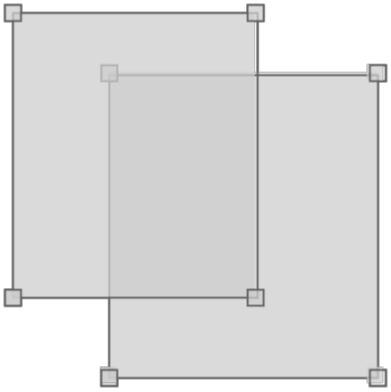
Determine if a Bounds contains another Bounds

```
Bounds bounds1 = new Bounds(-107.226, 34.597, -92.812, 43.068)
Bounds bounds2 = new Bounds(-104.326, 37.857, -98.349, 40.913)
println bounds1.contains(bounds2)
```



```
true
```

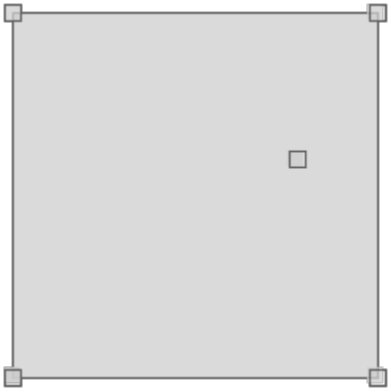
```
Bounds bounds3 = new Bounds(-112.412, 36.809, -99.316, 44.777)
println bounds1.contains(bounds3)
```



```
false
```

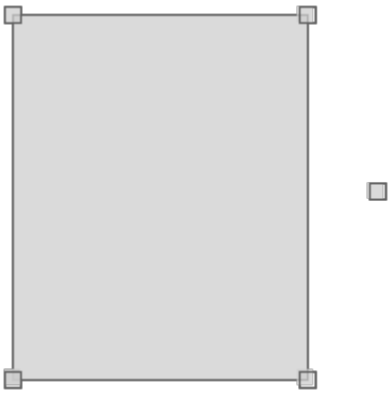
Determine if a Bounds contains a Point

```
Bounds bounds = new Bounds(-107.226, 34.597, -92.812, 43.068)
Point point1 = new Point(-95.976, 39.639)
println bounds.contains(point1)
```



```
true
```

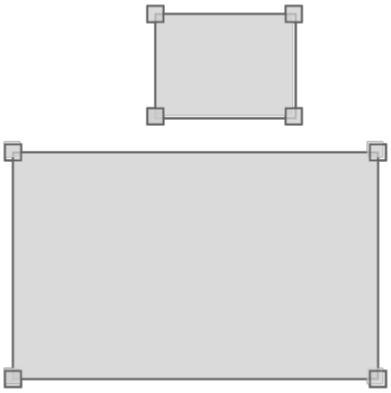
```
Point point2 = new Point(-89.384, 38.959)
println bounds.contains(point2)
```



```
true
```

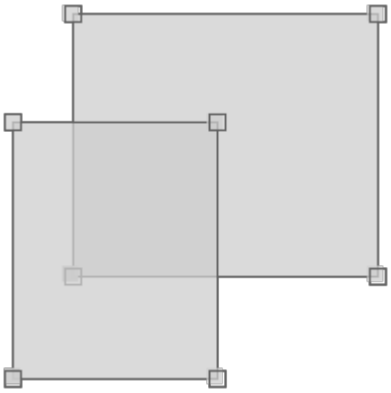
Determine if two Bounds intersect

```
Bounds bounds1 = new Bounds(-95.885, 46.765, -95.788, 46.811)
Bounds bounds2 = new Bounds(-95.847, 46.818, -95.810, 46.839)
println bounds1.intersects(bounds2)
```



```
false
```

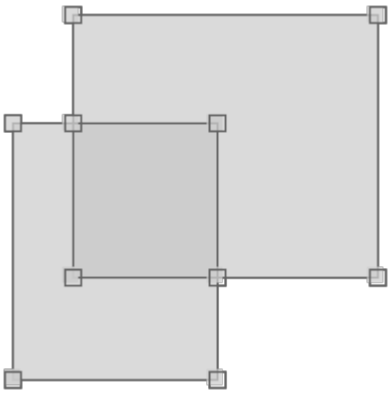
```
Bounds bounds3 = new Bounds(-95.904, 46.747, -95.839, 46.792)
println bounds1.intersects(bounds3)
```



```
true
```

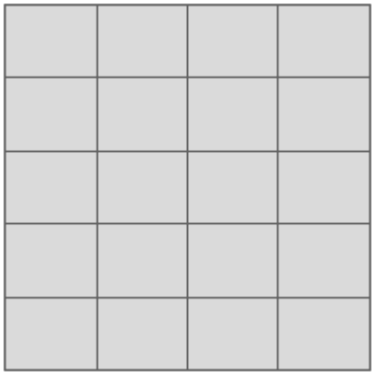
Calculate the intersection between two Bounds

```
Bounds bounds1 = new Bounds(-95.885, 46.765, -95.788, 46.811)
Bounds bounds2 = new Bounds(-95.904, 46.747, -95.839, 46.792)
Bounds bounds3 = bounds1.intersection(bounds2)
```



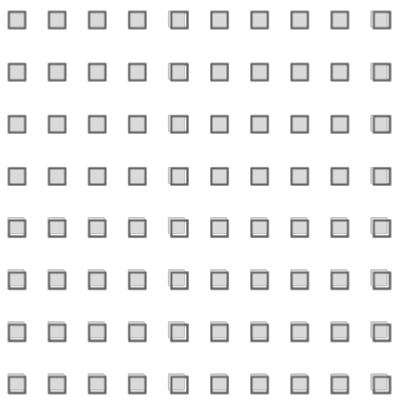
Generate a grid from a Bounds with a given number of columns and rows and the polygon shape. Other shapes include: polygon, point, circle/ellipse, hexagon, hexagon-inv).

```
Bounds bounds = new Bounds(-180,-90,180,90,"EPSG:4326")
Geometry geometry = bounds.getGrid(5,4,"polygon")
```



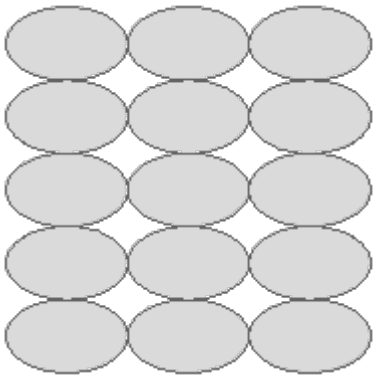
Generate a grid from a Bounds with a given number of columns and rows and a point shape. A Closure that is called with a geometry, column, and row for each grid cell that is created.

```
Bounds bounds = new Bounds(-180,-90,180,90,"EPSG:4326")
List geometries = []
Geometry geometry = bounds.generateGrid(10,8,"point") { Geometry g, int col, int row
->
    geometries.add(g)
}
```



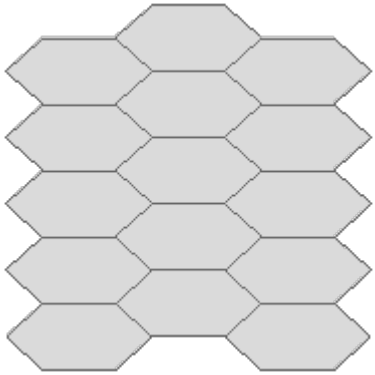
Generate a grid from a Bounds with a given cell width and height and a circle/ellipse shape.

```
Bounds bounds = new Bounds(-180,-90,180,90,"EPSG:4326")
Geometry geometry = bounds.getGrid(72.0,72.0,"circle")
```



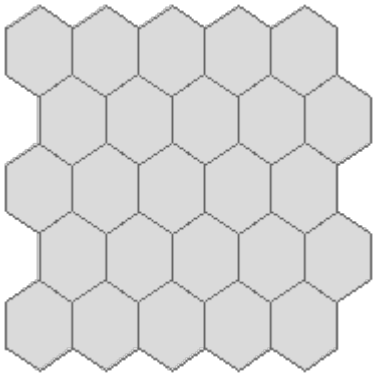
Generate a grid from a Bounds with a given cell width and height and a hexagon shape. A Closure is called with a geometry, column, and row for each grid cell generated.

```
Bounds bounds = new Bounds(-180,-90,180,90,"EPSG:4326")
List geometries = []
Geometry geometry = bounds.generateGrid(72.0,72.0,"hexagon") { Geometry g, int col,
int row ->
    geometries.add(g)
}
```



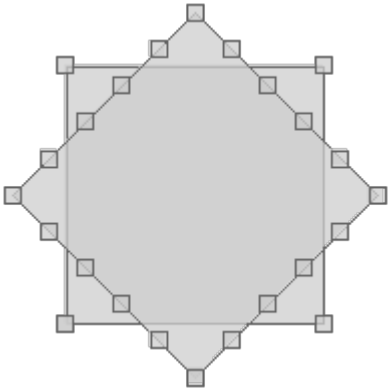
Generate a grid from a Bounds with a given cell width and height and an inverted hexagon shape.

```
Bounds bounds = new Bounds(-180,-90,180,90,"EPSG:4326")
Geometry geometry = bounds.getGrid(5,5,"hexagon-inv")
```



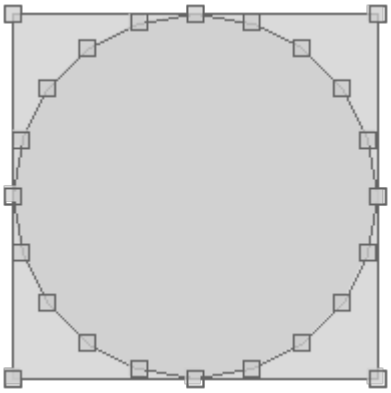
Create a rectangle from a Bounds with a given number of Points and a rotation angle in radians.

```
Bounds bounds = new Bounds(0,0,20,20)
Polygon polygon = bounds.createRectangle(20,Math.toRadians(45))
```



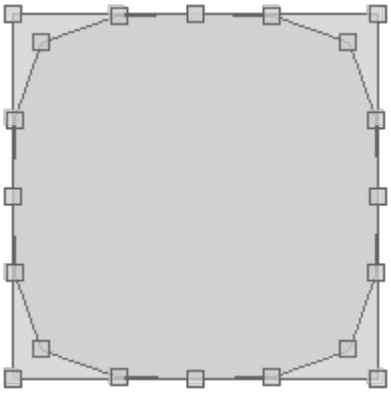
Create an ellipse from a Bounds. The default number of points is 20 and the default rotation angle in radians is 0.

```
Bounds bounds = new Bounds(0,0,20,20)
Polygon polygon = bounds.createEllipse()
```



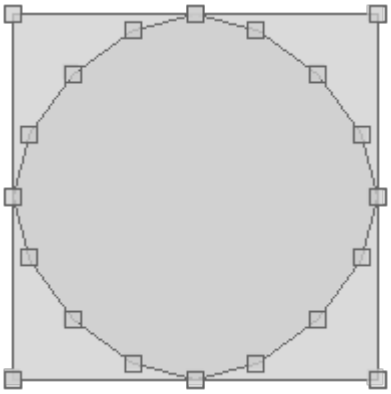
Create a squircle from a Bounds. The default number of points is 20 and the default rotation angle in radians is 0.

```
Bounds bounds = new Bounds(0,0,20,20)
Polygon polygon = bounds.createSquircle()
```



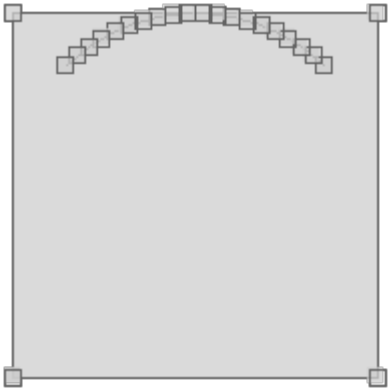
Create a super circle from a Bounds with a given power. The default number of points is 20 and the default rotation angle in radians is 0.

```
Bounds bounds = new Bounds(0,0,20,20)
Polygon polygon = bounds.createSuperCircle(1.75)
```



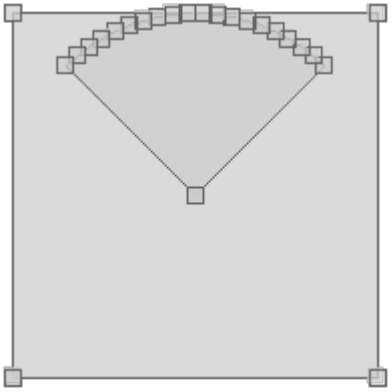
Create an arc from a Bounds with a start angle and angle extent. The default number of points is 20 and the default rotation angle in radians is 0.

```
Bounds bounds = new Bounds(0,0,20,20)
LineString lineString = bounds.createArc(Math.toRadians(45), Math.toRadians(90))
```



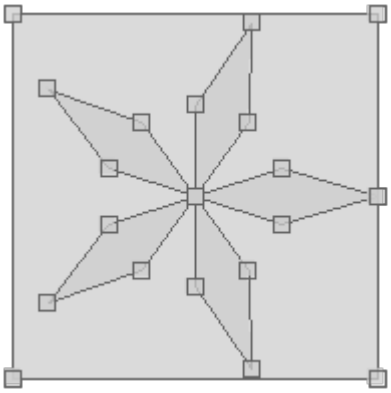
Create an arc polygon from a Bounds with a start angle and angle extent. The default number of points is 20 and the default rotation angle in radians is 0.

```
Bounds bounds = new Bounds(0,0,20,20)
Polygon polygon = bounds.createArcPolygon(Math.toRadians(45), Math.toRadians(90))
```



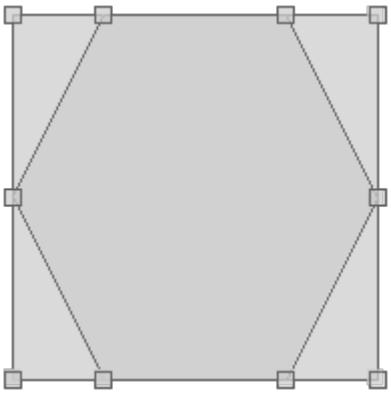
Create a sine star from a Bounds with a number of arms and an arm length ratio. The default number of points is 20 and the default rotation angle in radians is 0.

```
Bounds bounds = new Bounds(0,0,20,20)
Polygon polygon = bounds.createSineStar(5, 2.3)
```



Create a hexagon from a Bounds that is either inverted (false) or not (true).

```
Bounds bounds = new Bounds(0,0,20,20)
Polygon polygon = bounds.createHexagon(false)
```



Projection Recipes

Creating Projections

Create a Projection from an EPSG Code

```
Projection proj = new Projection("EPSG:4326")
println proj.wkt
```

```
GEOGCS["WGS 84",
  DATUM["World Geodetic System 1984",
    SPHEROID["WGS 84", 6378137.0, 298.257223563, AUTHORITY["EPSG","7030"]],
    AUTHORITY["EPSG","6326"]],
  PRIMEM["Greenwich", 0.0, AUTHORITY["EPSG","8901"]],
  UNIT["degree", 0.017453292519943295],
  AXIS["Geodetic longitude", EAST],
  AXIS["Geodetic latitude", NORTH],
  AUTHORITY["EPSG","4326"]]
```

Create a Projection from a WKT Projection String

```
      Projection proj = new Projection("""GEOGCS["WGS 84",
DATUM["World Geodetic System 1984",
  SPHEROID["WGS 84", 6378137.0, 298.257223563, AUTHORITY["EPSG","7030"]],
  AUTHORITY["EPSG","6326"]],
PRIMEM["Greenwich", 0.0, AUTHORITY["EPSG","8901"]],
UNIT["degree", 0.017453292519943295],
AXIS["Geodetic longitude", EAST],
AXIS["Geodetic latitude", NORTH],
AUTHORITY["EPSG","4326"]]""")
```

```
GEOGCS["WGS 84",
  DATUM["World Geodetic System 1984",
    SPHEROID["WGS 84", 6378137.0, 298.257223563, AUTHORITY["EPSG","7030"]],
    AUTHORITY["EPSG","6326"]],
  PRIMEM["Greenwich", 0.0, AUTHORITY["EPSG","8901"]],
  UNIT["degree", 0.017453292519943295],
  AXIS["Geodetic longitude", EAST],
  AXIS["Geodetic latitude", NORTH],
  AUTHORITY["EPSG","4326"]]
```

Create a Projection from well known name

```
Projection proj = new Projection("Mollweide")
println proj.wkt
```

```
PROJCS["Mollweide",
  GEOGCS["WGS84",
    DATUM["WGS84",
      SPHEROID["WGS84", 6378137.0, 298.257223563]],
    PRIMEM["Greenwich", 0.0],
    UNIT["degree", 0.017453292519943295],
    AXIS["Longitude", EAST],
    AXIS["Latitude", NORTH]],
  PROJECTION["Mollweide"],
  PARAMETER["semi-minor axis", 6378137.0],
  PARAMETER["Longitude of natural origin", 0.0],
  UNIT["m", 1.0],
  AXIS["Easting", EAST],
  AXIS["Northing", NORTH]]
```

Get a List of all supported Projections (this is really slow)

```
List<Projection> projections = Projection.projections()
```

```
EPSG:4326
EPSG:4269
EPSG:26918
EPSG:2263
EPSG:2927
...
```

Getting Projection Properties

Get the id

```
Projection proj = new Projection("EPSG:4326")
String id = proj.id
```

```
EPSG:4326
```

Get the srs

```
String srs = proj.srs
```

```
EPSG:4326
```

Get the epsg code

```
int epsg = proj.epsg
```

```
4326
```

Get the WKT

```
String wkt = proj.wkt
```

```
GEOGCS["WGS 84",
  DATUM["World Geodetic System 1984",
    SPHEROID["WGS 84", 6378137.0, 298.257223563, AUTHORITY["EPSG","7030"]],
    AUTHORITY["EPSG","6326"]],
  PRIMEM["Greenwich", 0.0, AUTHORITY["EPSG","8901"]],
  UNIT["degree", 0.017453292519943295],
  AXIS["Geodetic longitude", EAST],
  AXIS["Geodetic latitude", NORTH],
  AUTHORITY["EPSG","4326"]]
```

Get the Bounds in the native Projection

```
Bounds bounds = proj.bounds
```

```
(-180.0,-90.0,180.0,90.0,EPSG:4326)
```

Get the Bounds in the EPSG:4326

```
Bounds geoBounds = proj.geoBounds
```

```
(-180.0,-90.0,180.0,90.0,EPSG:4326)
```

Using Projections

Transform a Geometry from one projection to another using the Projection static method with strings

```
Geometry epsg4326Geom = new Point(-122.440, 47.245)
Geometry epsg2927Geom = Projection.transform(epsg4326Geom, "EPSG:4326", "EPSG:2927")
println epsg2927Geom
```

```
POINT (1158609.2040371667 703068.0661327887)
```

Transform a Geometry from one projection to another using the Projection static method with Projections

```
Projection epsg4326 = new Projection("EPSG:4326")
Projection epsg2927 = new Projection("EPSG:2927")
Geometry epsg4326Geom = new Point(-122.440, 47.245)
Geometry epsg2927Geom = Projection.transform(epsg4326Geom, epsg4326, epsg2927)
println epsg2927Geom
```

```
POINT (1158609.2040371667 703068.0661327887)
```

Transform a Geometry from one projection to another using two Projections

```
Projection fromProj = new Projection("EPSG:4326")
Projection toProj = new Projection("EPSG:2927")
Geometry geom = new Point(-122.440, 47.245)
Geometry projectedGeom = fromProj.transform(geom, toProj)
println projectedGeom
```

```
POINT (1158609.2040371667 703068.0661327887)
```

Transform a Geometry from one projection to another using a Projections and a String

```
Projection fromProj = new Projection("EPSG:4326")
Geometry geom = new Point(-122.440, 47.245)
Geometry projectedGeom = fromProj.transform(geom, "EPSG:2927")
println projectedGeom
```

```
POINT (1158609.2040371667 703068.0661327887)
```

Using Geodetic

Create a Geodetic object with an ellipsoid

```
Geodetic geodetic = new Geodetic("wgs84")
println geodetic
```

```
Geodetic [SPHEROID["WGS 84", 6378137.0, 298.257223563]]
```

Calculate the forward and back azimuth and distance between the given two Points.

```
Geodetic geodetic = new Geodetic("clrk66")
Point bostonPoint = new Point(-71.117, 42.25)
Point portlandPoint = new Point(-123.683, 45.52)
Map results = geodetic.inverse(bostonPoint, portlandPoint)
double forwardAzimuth =  results.forwardAzimuth
println forwardAzimuth
```

```
-66.52547810974724
```

```
double backAzimuth = results.backAzimuth
println backAzimuth
```

```
75.65817457195088
```

```
double distance = results.distance
println distance
```

```
4164050.4598800642
```

Calculate a new Point and back azimuth given the starting Point, azimuth, and distance.

```
Geodetic geodetic = new Geodetic("clrk66")
Point bostonPoint = new Point(-71.117, 42.25)
Map results = geodetic.forward(bostonPoint, -66.531, 4164192.708)
Point point = results.point
println point
```

```
POINT (-123.6835797667373 45.516427795897236)
```

```
double azimuth = results.backAzimuth
println azimuth
```

```
75.65337425050724
```

Place the given number of points between starting and ending Points

```
Geodetic geodetic = new Geodetic("clrk66")
Point bostonPoint = new Point(-71.117, 42.25)
Point portlandPoint = new Point(-123.683, 45.52)
List<Point> points = geodetic.placePoints(bostonPoint, portlandPoint, 10)
points.each { Point point ->
    println point.wkt
}
```

```
POINT (-75.41357382496236 43.52791689304304)
POINT (-79.8828640042499 44.63747566950249)
POINT (-84.51118758826816 45.565540142641005)
POINT (-89.27793446221685 46.300124344169255)
POINT (-94.15564606698499 46.83102721803566)
POINT (-99.11079892605703 47.15045006457598)
POINT (-104.10532353179985 47.25351783423774)
POINT (-109.09873812691617 47.13862709798196)
POINT (-114.05062990603696 46.80756425557422)
POINT (-118.92312608779855 46.26537395700513)
```

Using Decimal Degrees

Create a new DecimalDegrees from a longitude and latitude

```
DecimalDegrees decimalDegrees = new DecimalDegrees(-122.525619, 47.212023)
println decimalDegrees
```

```
-122° 31' 32.2284" W, 47° 12' 43.2828" N
```

Create a new DecimalDegrees from a Point

```
DecimalDegrees decimalDegrees = new DecimalDegrees(new Point(-122.525619,47.212023))
println decimalDegrees
```

```
POINT (-122.52561944444444 47.212022222222224)
```

Create a new DecimalDegrees from a Longitude and Latitude string

```
DecimalDegrees decimalDegrees = new DecimalDegrees("-122.525619, 47.212023")
println decimalDegrees
```

```
-122° 31' 32.2284" W, 47° 12' 43.2828" N
```

Create a new DecimalDegrees from two strings with glyphs

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122\u00B0 31' 32.23\" W",
"47\u00B0 12' 43.28\" N")
println decimalDegrees
```

```
-122° 31' 32.2300" W, 47° 12' 43.2800" N
```

Create a new DecimalDegrees from two strings

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122d 31m 32.23s W", "47d 12m
43.28s N")
println decimalDegrees
```

```
-122° 31' 32.2300" W, 47° 12' 43.2800" N
```

Create a new DecimalDegrees from a single Degrees Minutes Seconds formatted string

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122d 31m 32.23s W, 47d 12m 43.28s
N")
println decimalDegrees
```

```
-122° 31' 32.2300" W, 47° 12' 43.2800" N
```

Create a new DecimalDegrees from a single Decimal Degree Minutes formatted string with glyphs

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122\u00B0 31.5372' W, 47\u00B0
12.7213' N")
println decimalDegrees
```

```
-122° 31' 32.2320" W, 47° 12' 43.2780" N
```

Create a new DecimalDegrees from a single Decimal Degree Minutes formatted string

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122d 31.5372m W, 47d 12.7213m N")
println decimalDegrees
```

```
-122° 31' 32.2320" W, 47° 12' 43.2780" N
```

Get degrees minutes seconds from a DecimalDegrees object

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122d 31m 32.23s W", "47d 12m
43.28s N")
Map dms = decimalDegrees.dms
println "Degrees: ${dms.longitude.degrees}"
println "Minutes: ${dms.longitude.minutes}"
println "Seconds: ${dms.longitude.seconds}"
```

```
Degrees: -122
Minutes: 31
Seconds: 32.22999999998388
```

```
println "Degrees: ${dms.latitude.degrees}"
println "Minutes: ${dms.latitude.minutes}"
println "Seconds: ${dms.latitude.seconds}"
```

```
Degrees: 47
Minutes: 12
Seconds: 43.280000000006396
```

Convert a DecimalDegrees object to a DMS String with glyphs

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122d 31m 32.23s W", "47d 12m
43.28s N")
println decimalDegrees.toDms(true)
```

```
-122° 31' 32.2300" W, 47° 12' 43.2800" N
```

Convert a DecimalDegrees object to a DMS String without glyphs

```
println decimalDegrees.toDms(false)
```

```
-122d 31m 32.2300s W, 47d 12m 43.2800s N
```

Get degrees minutes from a DecimalDegrees object

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122d 31m 32.23s W", "47d 12m
43.28s N")
Map dms = decimalDegrees.ddm
println "Degrees: ${dms.longitude.degrees}"
println "Minutes: ${dms.longitude.minutes}"
```

```
Degrees: -122
Minutes: 31.537166666666398
```

```
println "Degrees: ${dms.latitude.degrees}"
println "Minutes: ${dms.latitude.minutes}"
```

```
Degrees: 47
Minutes: 12.72133333333344
```

Convert a DecimalDegrees object to a DDM String with glyphs

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122d 31m 32.23s W", "47d 12m
43.28s N")
println decimalDegrees.toDdm(true)
```

```
-122° 31.5372' W, 47° 12.7213' N
```

Convert a DecimalDegrees object to a DDM String without glyphs

```
println decimalDegrees.toDdm(false)
```

```
-122d 31.5372m W, 47d 12.7213m N
```

Get a Point from a DecimalDegrees object

```
DecimalDegrees decimalDegrees = new DecimalDegrees("122d 31m 32.23s W", "47d 12m
43.28s N")
Point point = decimalDegrees.point
```

```
POINT (-122.52561944444444 47.212022222222224)
```

Spatial Index Recipes

Using STRtree

Create a STRtree spatial index

```
STRtree index = new STRtree()
```

Insert Geometries and their Bounds

```
index.insert(new Bounds(0,0,10,10), new Point(5,5))
index.insert(new Bounds(2,2,6,6), new Point(4,4))
index.insert(new Bounds(20,20,60,60), new Point(30,30))
index.insert(new Bounds(22,22,44,44), new Point(32,32))
```

Get the size of the index

```
int size = index.size
println size
```

```
4
```

Query the index

```
List results = index.query(new Bounds(1,1,5,5))
results.each { Geometry geometry ->
    println geometry
}
```

```
POINT (4 4)
POINT (5 5)
```

Using Quadtree

Create a Quadtree spatial index

```
Quadtree index = new Quadtree()
```

Insert Geometries and their Bounds

```
index.insert(new Bounds(0,0,10,10), new Point(5,5))
index.insert(new Bounds(2,2,6,6), new Point(4,4))
index.insert(new Bounds(20,20,60,60), new Point(30,30))
index.insert(new Bounds(22,22,44,44), new Point(32,32))
```

Get the size of the index

```
int size = index.size
println size
```

```
4
```

Query the index with a Bounds

```
List results = index.query(new Bounds(1,1,5,5))
results.each { Geometry geometry ->
    println geometry
}
```

```
POINT (30 30)
POINT (32 32)
POINT (5 5)
POINT (4 4)
```

Query the entire index

```
List allResults = index.queryAll()
allResults.each { Geometry geometry ->
    println geometry
}
```

```
POINT (30 30)
POINT (32 32)
POINT (5 5)
POINT (4 4)
```

Remove an item from the index

```
Geometry itemToRemove = allResults[0]
boolean removed = index.remove(itemToRemove.bounds, itemToRemove)
println "Removed? ${removed}"
println "Size = ${index.size}"
```

```
Removed = true
Size = 3
```

Using GeoHash

Encode a Point as a String

```
GeoHash geohash = new GeoHash()
Point point = new Point(112.5584, 37.8324)
String hash = geohash.encode(point)
println hash
```

```
ww8p1r4t8
```

Decode a Point from a String

```
GeoHash geohash = new GeoHash()
Point point = geohash.decode("ww8p1r4t8")
println point
```

```
POINT (112.55838632583618 37.83238649368286)
```

Encode a Point as a Long

```
GeoHash geohash = new GeoHash()
Point point = new Point(112.5584, 37.8324)
long hash = geohash.encodeLong(point)
println long
```

```
4064984913515641
```

Decode a Point from a Long

```
GeoHash geohash = new GeoHash()
Point point = geohash.decode(4064984913515641)
println point
```

```
POINT (112.55839973688126 37.83240124583244)
```

Decode a Bounds from a String

```
GeoHash geohash = new GeoHash()
Bounds bounds = geohash.decodeBounds("ww8p1r4t8")
println bounds
```

```
(112.55836486816406,37.83236503601074,112.5584077835083,37.83240795135498)
```

Decode a Bounds from a Long

```
GeoHash geohash = new GeoHash()
Bounds bounds = geohash.decodeBounds(4064984913515641)
println bounds
```

```
(112.55836486816406,37.83236503601074,112.5584077835083,37.83240795135498)
```

Find neighboring geohash strings

```
GeoHash geohash = new GeoHash()
String hash = "dqcjq"
String north     = geohash.neighbor(hash, GeoHash.Direction.NORTH)
String northwest = geohash.neighbor(hash, GeoHash.Direction.NORTHWEST)
String west      = geohash.neighbor(hash, GeoHash.Direction.WEST)
String southwest = geohash.neighbor(hash, GeoHash.Direction.SOUTHWEST)
String south     = geohash.neighbor(hash, GeoHash.Direction.SOUTH)
String southeast = geohash.neighbor(hash, GeoHash.Direction.SOUTHEAST)
String east      = geohash.neighbor(hash, GeoHash.Direction.EAST)
String northeast = geohash.neighbor(hash, GeoHash.Direction.NORTHEAST)
String str = """
             | ${northwest} ${north} ${northeast}
             | ${west} ${hash} ${east}
             | ${southwest} ${south} ${southeast}
             |""".stripMargin()
println str
```

```
 dqcjt dqcjw dqcjx
 dqcjm dqcjq dqcjr
 dqcjj dqcjn dqcjp
```

Find neighboring geohash longs

```
GeoHash geohash = new GeoHash()
long hash = 1702789509
long north     = geohash.neighbor(hash, GeoHash.Direction.NORTH)
long northwest = geohash.neighbor(hash, GeoHash.Direction.NORTHWEST)
long west      = geohash.neighbor(hash, GeoHash.Direction.WEST)
long southwest = geohash.neighbor(hash, GeoHash.Direction.SOUTHWEST)
long south     = geohash.neighbor(hash, GeoHash.Direction.SOUTH)
long southeast = geohash.neighbor(hash, GeoHash.Direction.SOUTHEAST)
long east      = geohash.neighbor(hash, GeoHash.Direction.EAST)
long northeast = geohash.neighbor(hash, GeoHash.Direction.NORTHEAST)
String str = """
             | ${northwest} ${north} ${northeast}
             | ${west} ${hash} ${east}
             | ${southwest} ${south} ${southeast}
             |""".stripMargin()
println str
```

```
 1702789434 1702789520 1702789522
 1702789423 1702789509 1702789511
 1702789422 1702789508 1702789510
```

Find all neighboring geohash strings

```
GeoHash geohash = new GeoHash()
String hash = "dqcjq"
Map neighbors = geohash.neighbors(hash)
String north     = neighbors[GeoHash.Direction.NORTH]
String northwest = neighbors[GeoHash.Direction.NORTHWEST]
String west      = neighbors[GeoHash.Direction.WEST]
String southwest = neighbors[GeoHash.Direction.SOUTHWEST]
String south     = neighbors[GeoHash.Direction.SOUTH]
String southeast = neighbors[GeoHash.Direction.SOUTHEAST]
String east      = neighbors[GeoHash.Direction.EAST]
String northeast = neighbors[GeoHash.Direction.NORTHEAST]
String str = """
             | ${northwest} ${north} ${northeast}
             | ${west} ${hash} ${east}
             | ${southwest} ${south} ${southeast}
             |""".stripMargin()
println str
```

```
 dqcjt dqcjw dqcjx
 dqcjm dqcjq dqcjr
 dqcjj dqcjn dqcjp
```

Find all neighboring geohash longs

```
GeoHash geohash = new GeoHash()
long hash = 1702789509
Map neighbors = geohash.neighbors(hash)
long north     = neighbors[GeoHash.Direction.NORTH]
long northwest = neighbors[GeoHash.Direction.NORTHWEST]
long west      = neighbors[GeoHash.Direction.WEST]
long southwest = neighbors[GeoHash.Direction.SOUTHWEST]
long south     = neighbors[GeoHash.Direction.SOUTH]
long southeast = neighbors[GeoHash.Direction.SOUTHEAST]
long east      = neighbors[GeoHash.Direction.EAST]
long northeast = neighbors[GeoHash.Direction.NORTHEAST]
String str = """
             | ${northwest} ${north} ${northeast}
             | ${west} ${hash} ${east}
             | ${southwest} ${south} ${southeast}
             |""".stripMargin()
println str
```

```
 1702789434 1702789520 1702789522
 1702789423 1702789509 1702789511
 1702789422 1702789508 1702789510
```

Find all geohashes as strings within a Bounds

```
GeoHash geohash = new GeoHash()
List<String> bboxes = geohash.bboxes(new Bounds(120, 30, 120.0001, 30.0001), 8)
bboxes.each { String hash ->
    println hash
}
```

```
wtm6dtm6
wtm6dtm7
```

Find all geohashes as longs within a Bounds

```
GeoHash geohash = new GeoHash()
List<Long> bboxes = geohash.bboxesLong(new Bounds(120, 30, 120.0001, 30.0001), 40)
bboxes.each { long hash ->
    println hash
}
```

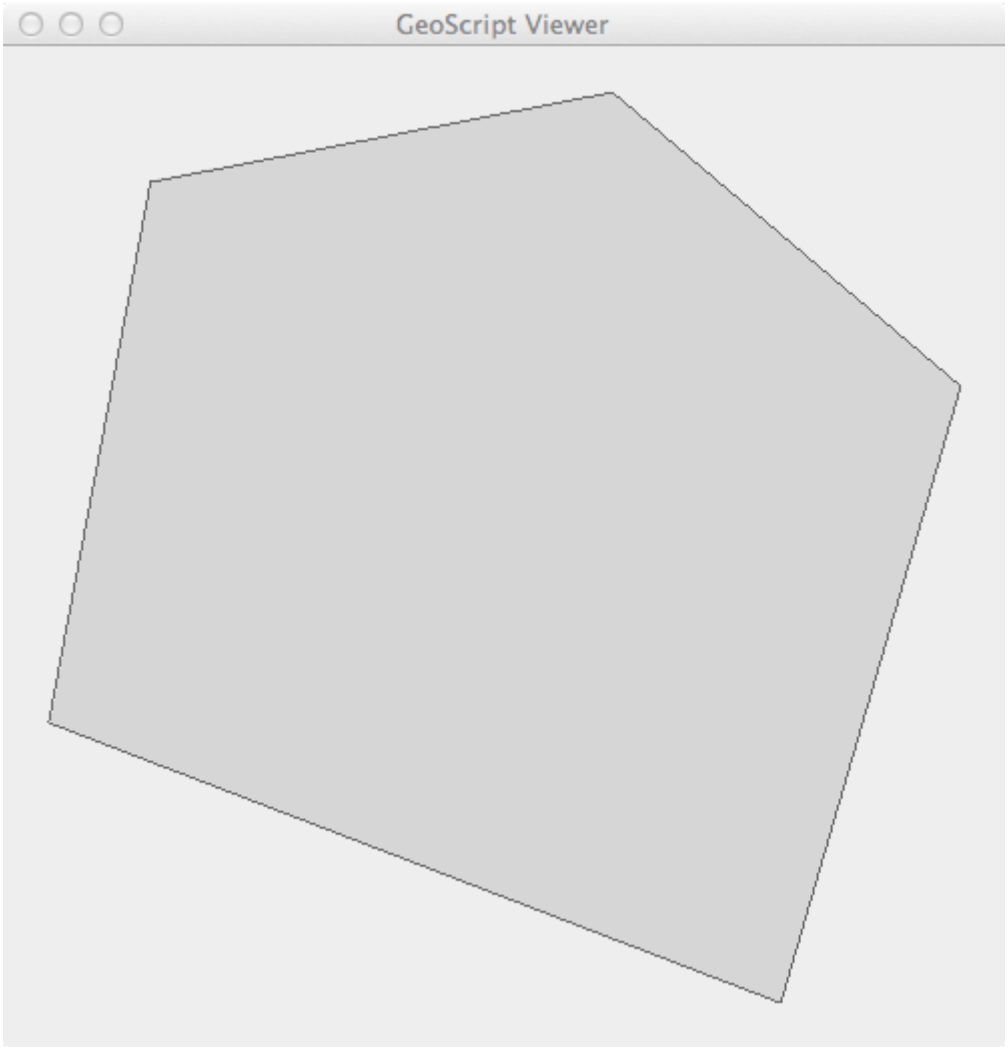
```
989560464998
989560464999
```

Viewer Recipes

Drawing geometries

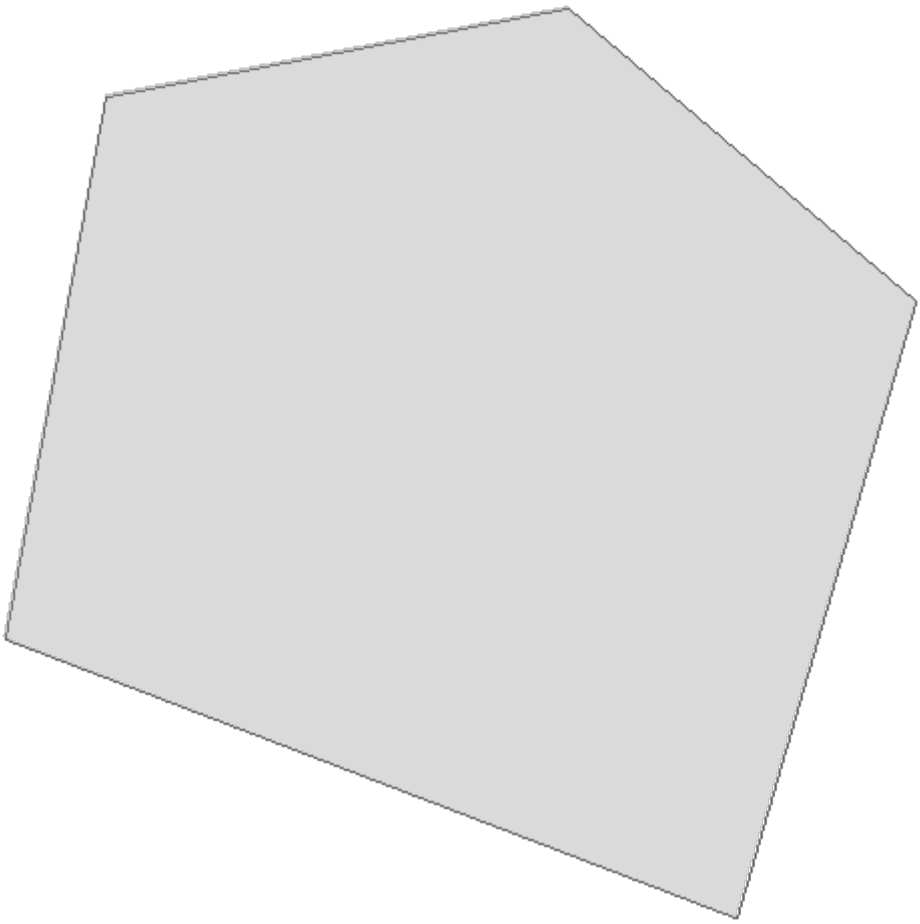
Draw a geometry in a simple GUI

```
Polygon polygon = new Polygon([[
       [-101.35986328125, 47.754097979680026],
       [-101.5576171875, 46.93526088057719],
       [-100.12939453125, 46.51351558059737],
       [-99.77783203125, 47.44294999517949],
       [-100.45898437499999, 47.88688085106901],
       [-101.35986328125, 47.754097979680026]
]])
Viewer.draw(polygon)
```



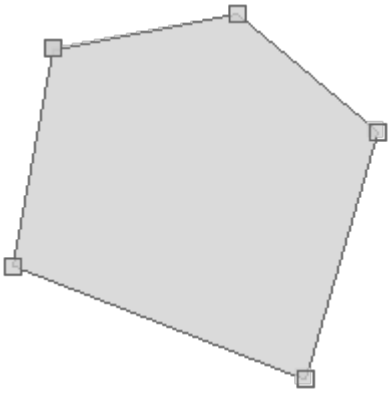
Draw a geometry to an image

```
Polygon polygon = new Polygon([[
       [-101.35986328125, 47.754097979680026],
       [-101.5576171875, 46.93526088057719],
       [-100.12939453125, 46.51351558059737],
       [-99.77783203125, 47.44294999517949],
       [-100.45898437499999, 47.88688085106901],
       [-101.35986328125, 47.754097979680026]
]])
BufferedImage image = Viewer.drawToImage(polygon)
```



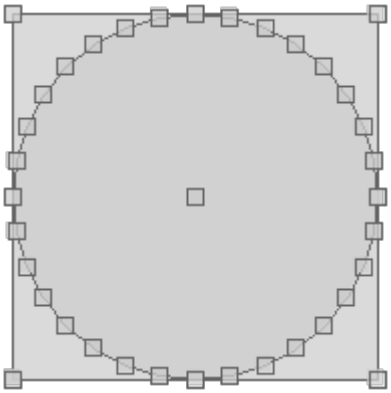
Draw a geometry to an image with options

```
Polygon polygon = new Polygon([[
       [-101.35986328125, 47.754097979680026],
       [-101.5576171875, 46.93526088057719],
       [-100.12939453125, 46.51351558059737],
       [-99.77783203125, 47.44294999517949],
       [-100.45898437499999, 47.88688085106901],
       [-101.35986328125, 47.754097979680026]
]])
BufferedImage image = Viewer.drawToImage(
        polygon,
        size: [200,200],
        drawCoords: true,
        fillCoords: true,
        fillPolys: true
)
```



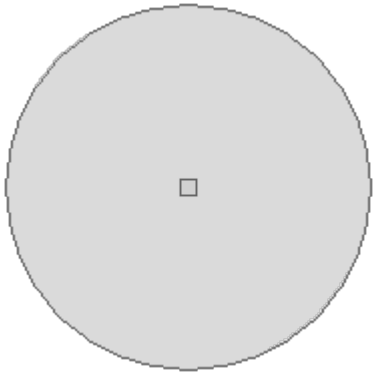
Draw a List of geometries to an image

```
Point point = new Point(-123.11, 47.23)
Geometry buffer = point.buffer(4)
Geometry bounds = buffer.bounds.geometry
BufferedImage image = Viewer.drawToImage(
        [bounds, buffer, point],
        size: [200,200],
        drawCoords: true,
        fillCoords: true,
        fillPolys: true
)
```



Draw a List of Geometries to a File

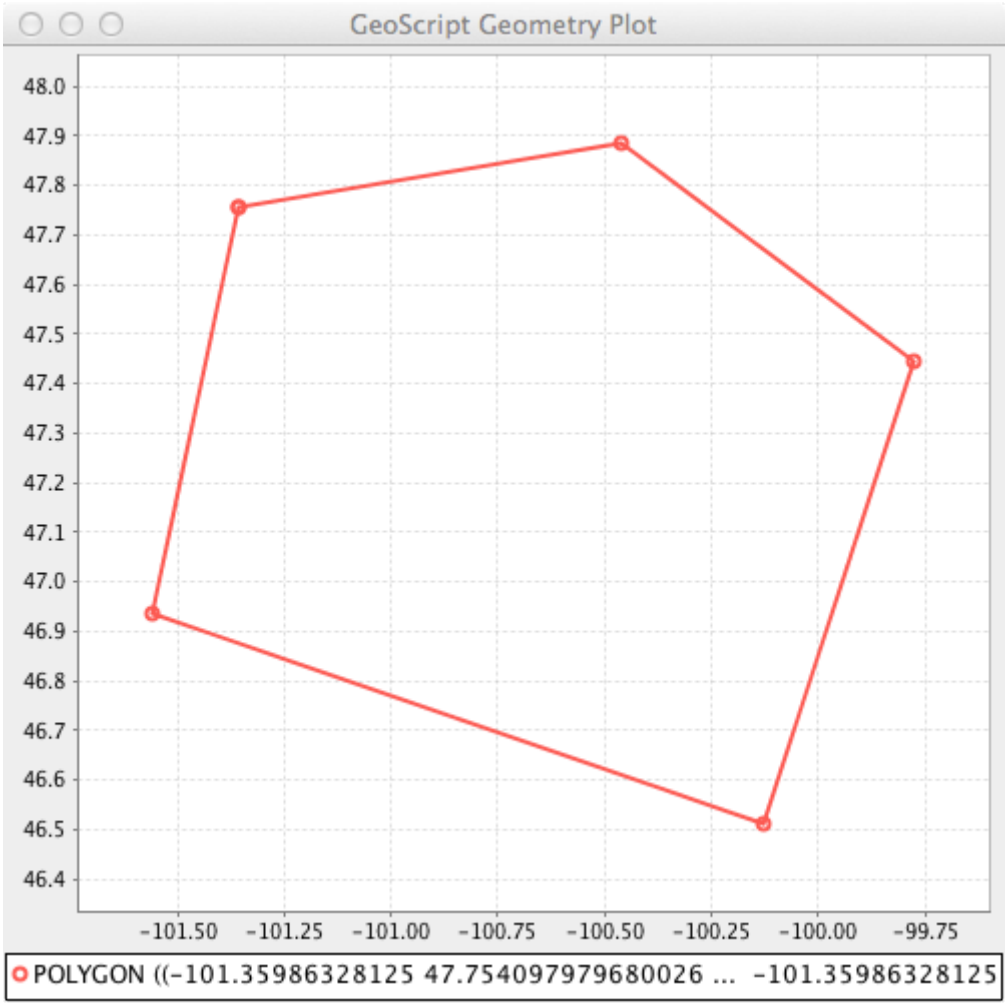
```
Point point = new Point(-123.11, 47.23)
Geometry buffer = point.buffer(4)
File file = new File("geometry.png")
Viewer.drawToFile([buffer, point], file, size: [200,200])
```



Plotting geometries

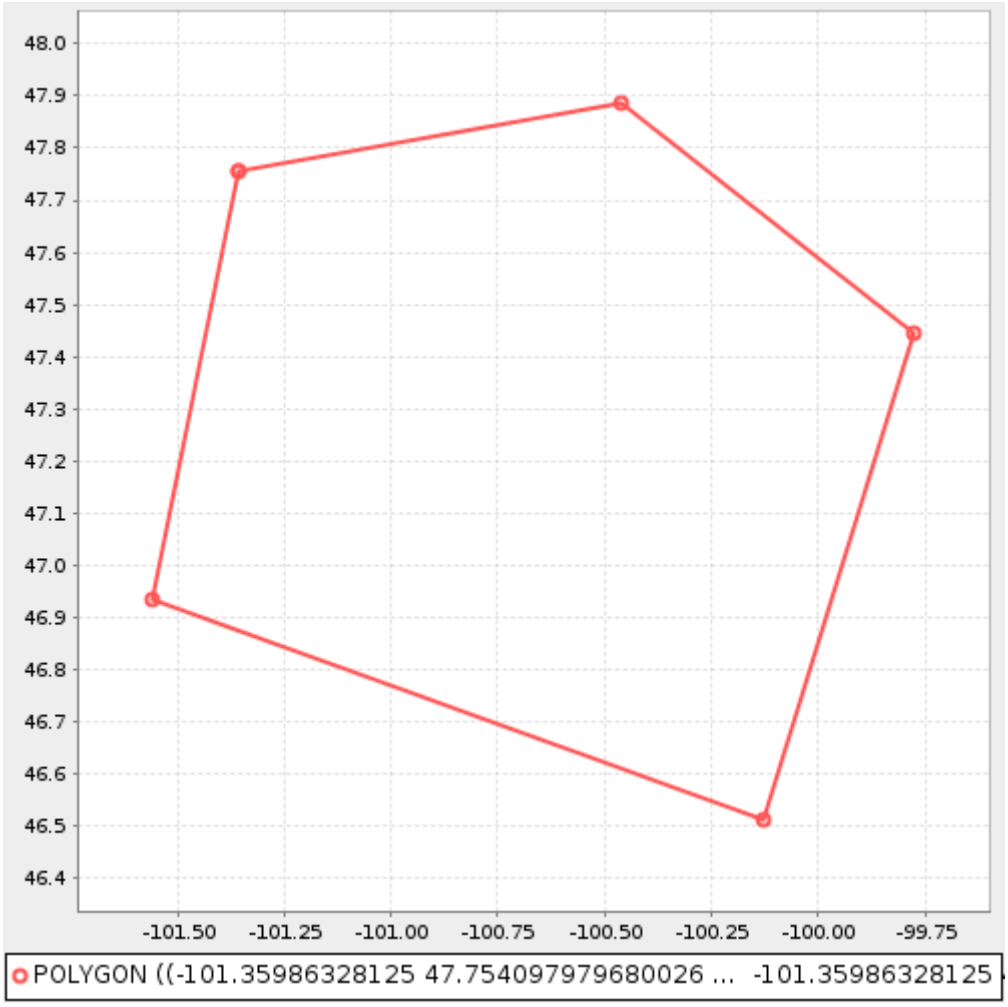
Plot a geometry in a simple GUI

```
Polygon polygon = new Polygon([[
       [-101.35986328125, 47.754097979680026],
       [-101.5576171875, 46.93526088057719],
       [-100.12939453125, 46.51351558059737],
       [-99.77783203125, 47.44294999517949],
       [-100.45898437499999, 47.88688085106901],
       [-101.35986328125, 47.754097979680026]
]])
Viewer.plot(polygon)
```



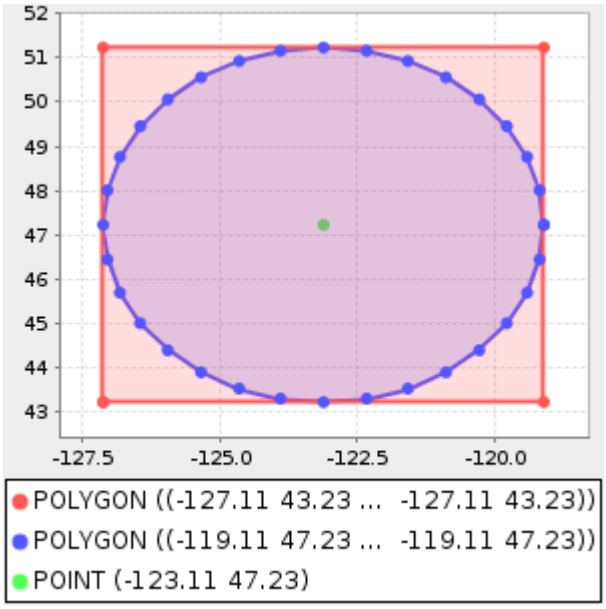
Plot a Geometry to an image

```
Polygon polygon = new Polygon([[
       [-101.35986328125, 47.754097979680026],
       [-101.5576171875, 46.93526088057719],
       [-100.12939453125, 46.51351558059737],
       [-99.77783203125, 47.44294999517949],
       [-100.45898437499999, 47.88688085106901],
       [-101.35986328125, 47.754097979680026]
]])
BufferedImage image = Viewer.plotToImage(polygon)
```



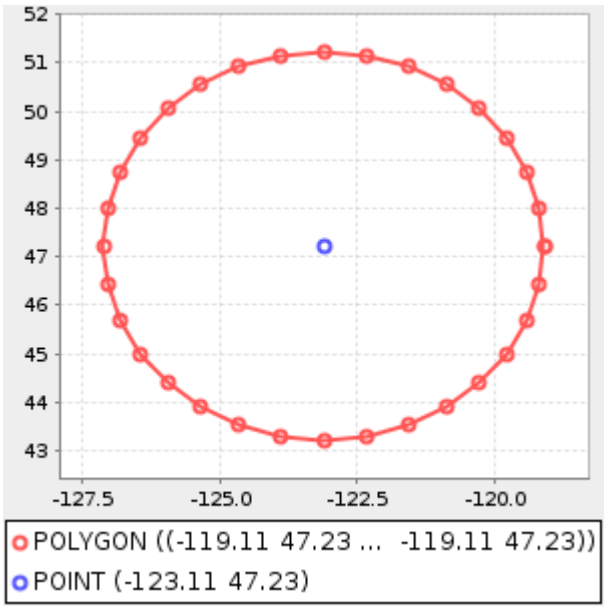
Plot a List of Geometries to an image

```
Point point = new Point(-123.11, 47.23)
Geometry buffer = point.buffer(4)
Geometry bounds = buffer.bounds.geometry
BufferedImage image = Viewer.plotToImage(
        [bounds, buffer, point],
        size: [300,300],
        drawCoords: true,
        fillCoords: true,
        fillPolys: true
)
```



Plot a Geometry to a File

```
Point point = new Point(-123.11, 47.23)
Geometry buffer = point.buffer(4)
File file = new File("geometry.png")
Viewer.plotToFile([buffer, point], file, size: [300,300])
```

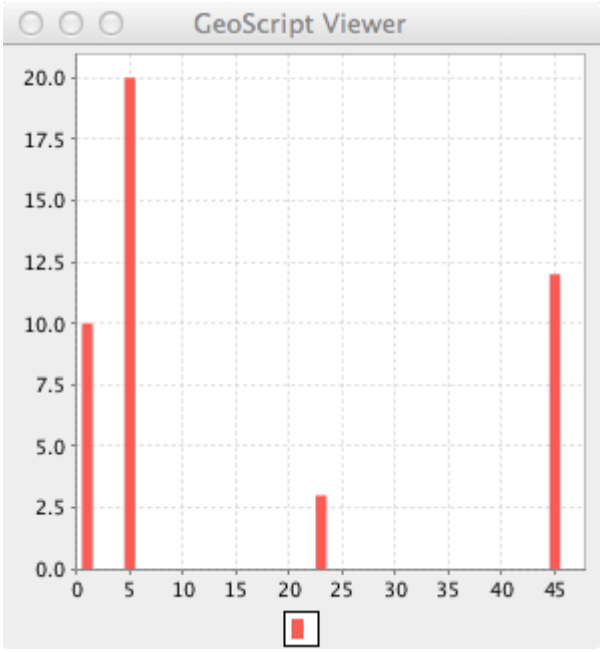


Plot Recipes

Processing Charts

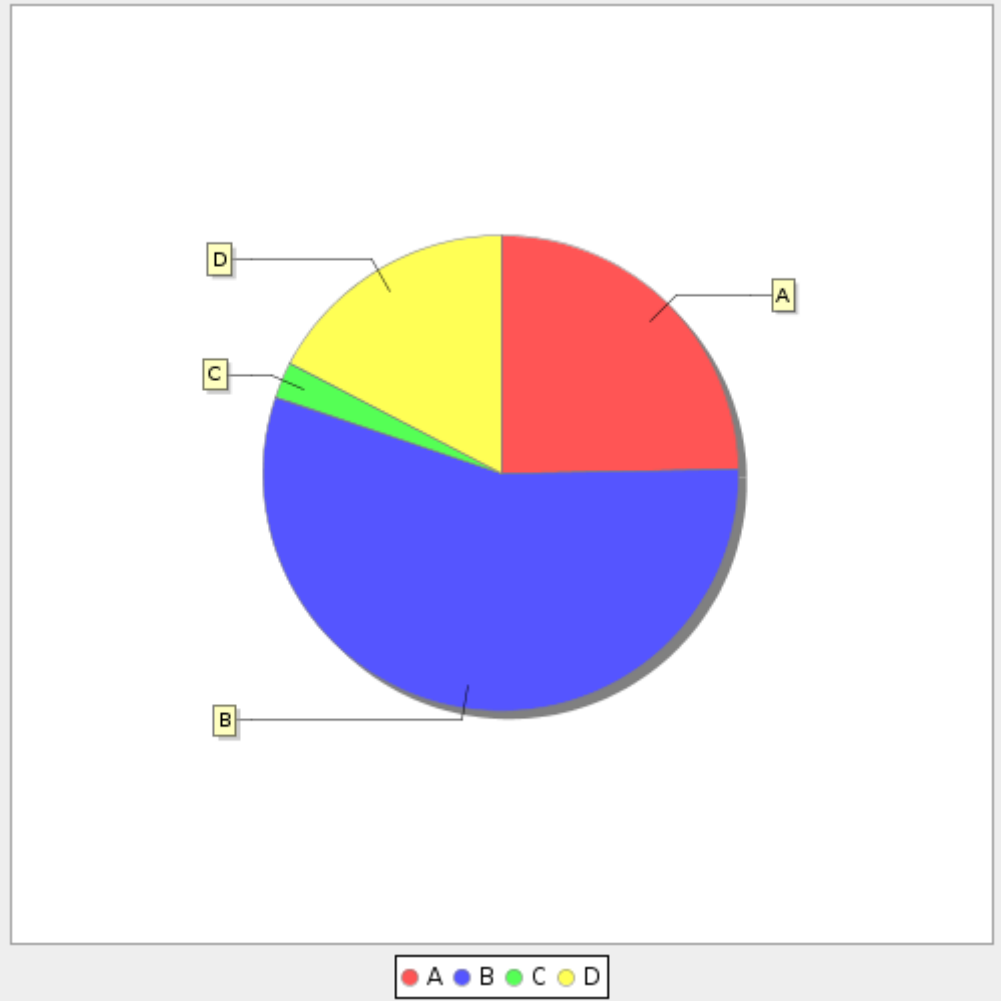
Show a chart in a GUI

```
List data = [
        [1,10],[45,12],[23,3],[5,20]
]
Chart chart = Bar.xy(data)
```



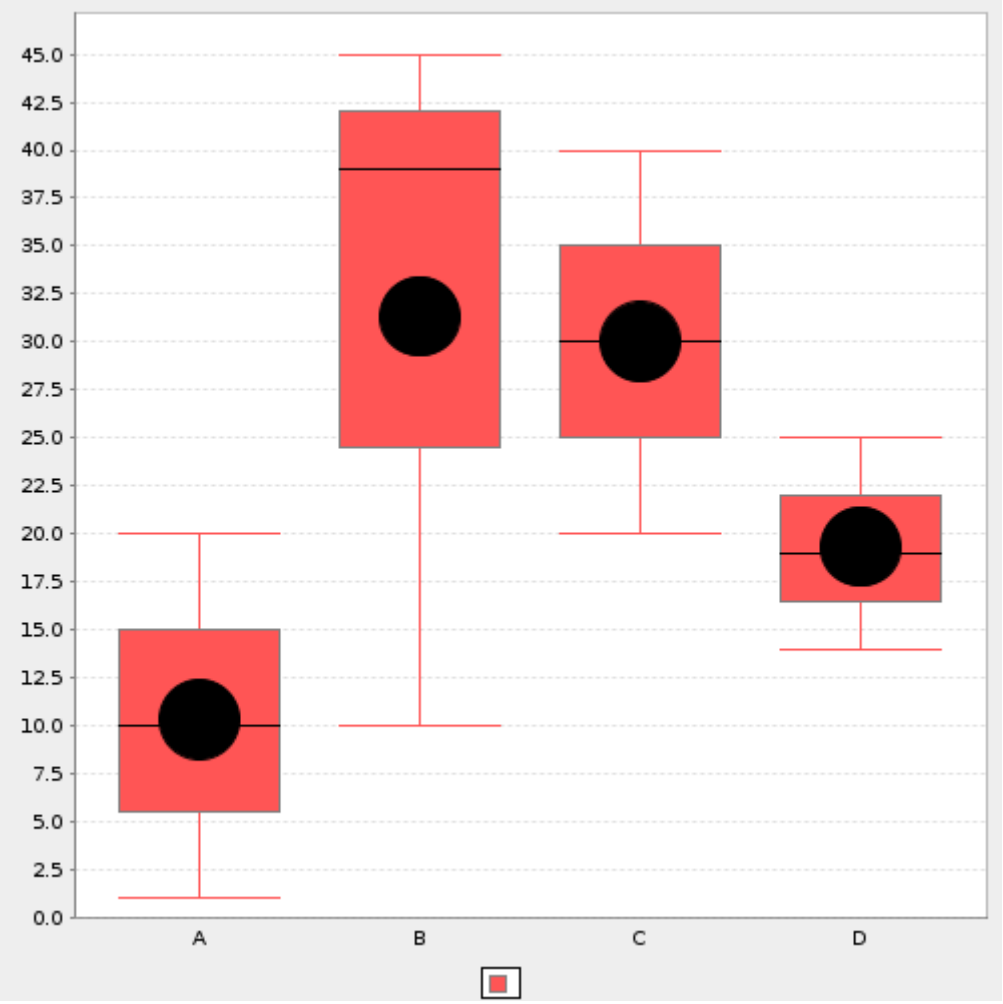
Get an image from a chart

```
Map data = [
        "A":20,"B":45,"C":2,"D":14
]
Chart chart = Pie.pie(data)
BufferedImage image = chart.image
```



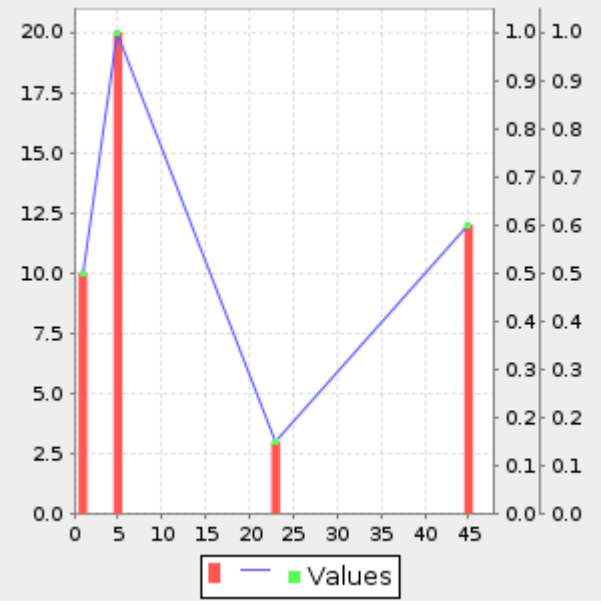
Save a chart to a file

```
Map data = [
        "A":[1,10,20],
        "B":[45,39,10],
        "C":[40,30,20],
        "D":[14,25,19]
]
Chart chart = Box.box(data)
File file = new File("chart.png")
chart.save(file)
```



Overlay multiple charts

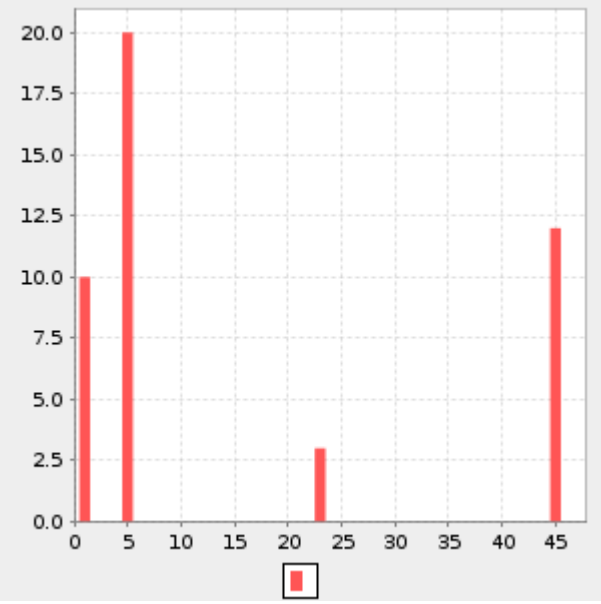
```
List data = [
        [1,10],[45,12],[23,3],[5,20]
]
Chart chart1 = Bar.xy(data)
Chart chart2 = Curve.curve(data)
Chart chart3 = Regression.linear(data)
chart1.overlay([chart2,chart3])
```



Creating Bar Charts

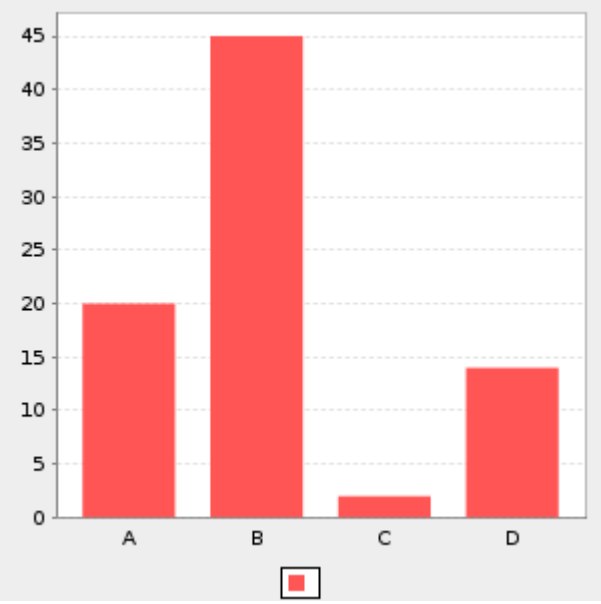
Create a basic bar chart

```
List data = [
        [1,10],[45,12],[23,3],[5,20]
]
Chart chart = Bar.xy(data)
```



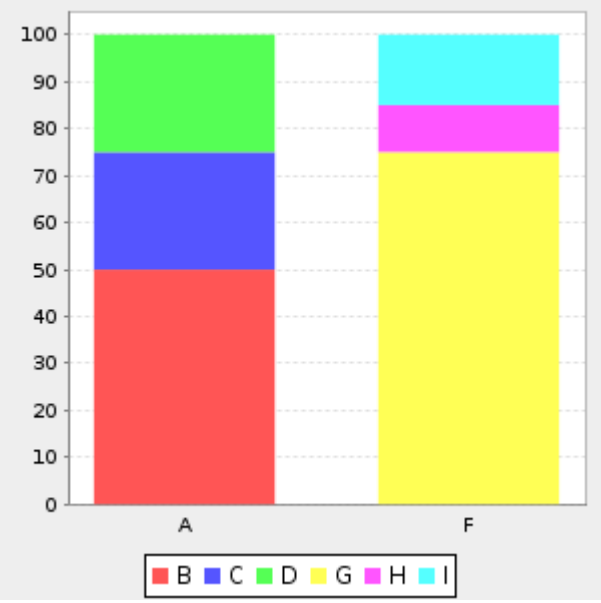
Create a bar chart with categories

```
Map data = [
        "A":20,"B":45,"C":2,"D":14
]
Chart chart = Bar.category(data)
```



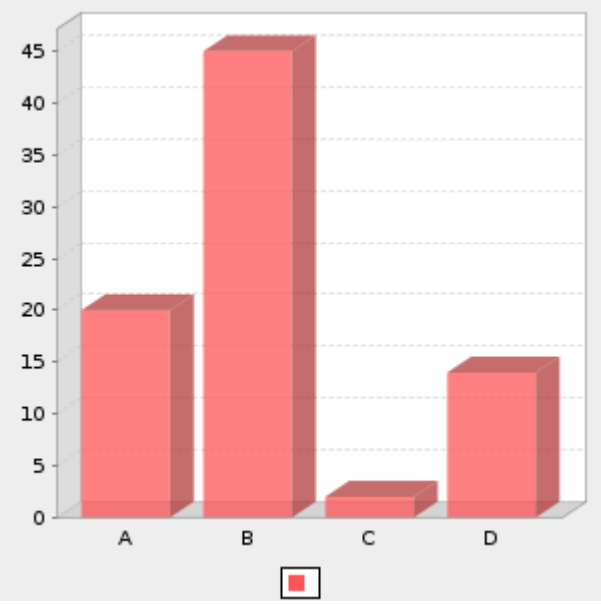
Create a stacked bar chart with two series of data

```
Map data = [
        "A": ["B":50,"C":25,"D":25],
        "F": ["G":75,"H":10,"I":15]
]
Chart chart = Bar.category(data, stacked: true)
```



Create a 3D bar chart with categories

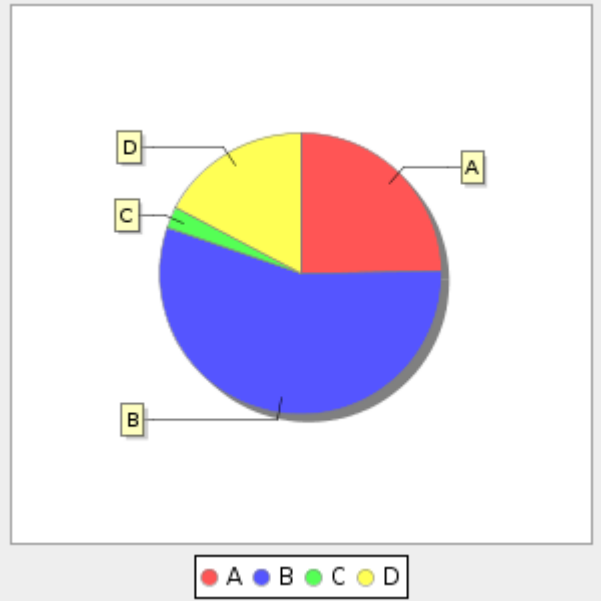
```
Map data = [
        "A":20,"B":45,"C":2,"D":14
]
Chart chart = Bar.category(data, trid: true)
```



Creating Pie Charts

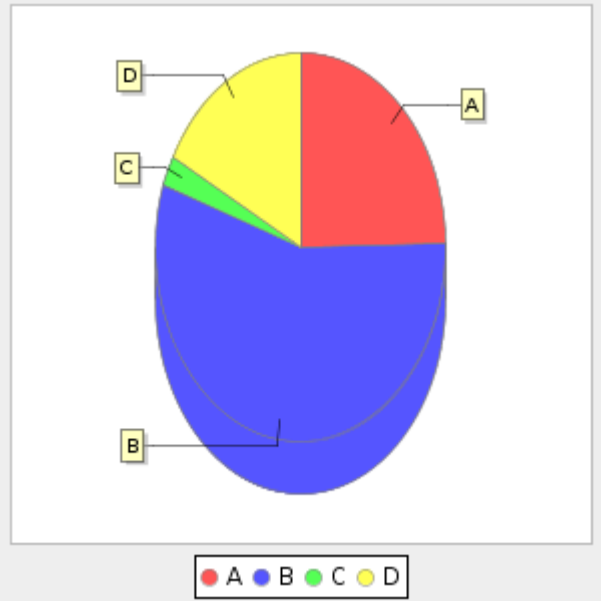
Create a pie chart

```
Map data = [
        "A":20,"B":45,"C":2,"D":14
]
Chart chart = Pie.pie(data)
```



Create a 3D pie chart

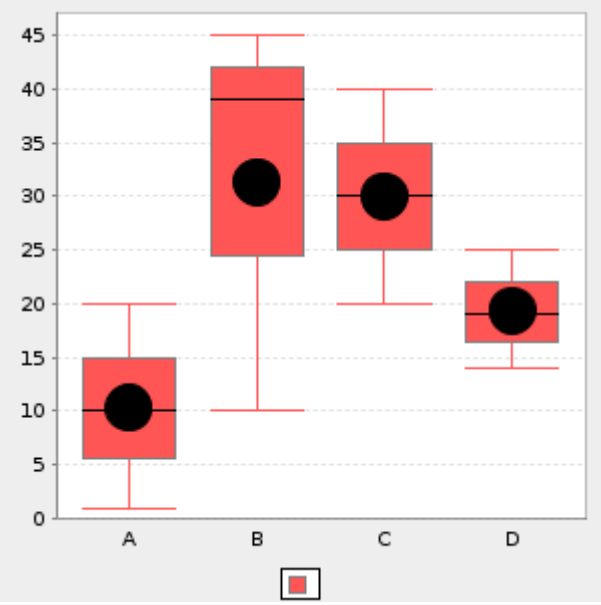
```
Map data = [
        "A":20,"B":45,"C":2,"D":14
]
Chart chart = Pie.pie(data, trid: true)
```



Creating Box Charts

Create a box chart

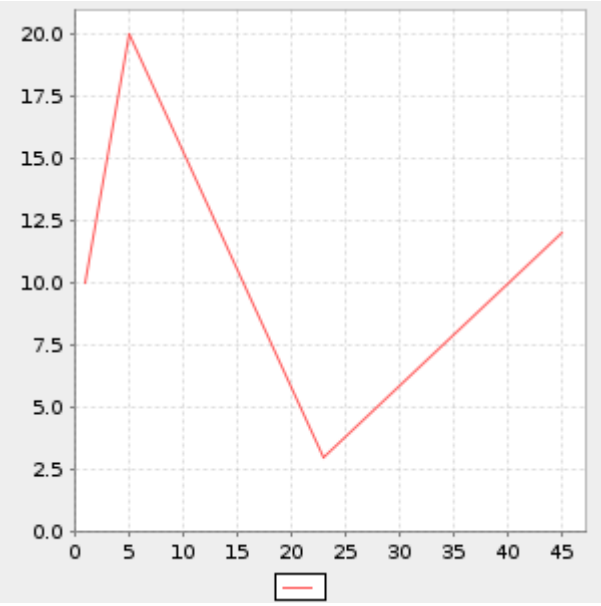
```
Map data = [
        "A":[1,10,20],
        "B":[45,39,10],
        "C":[40,30,20],
        "D":[14,25,19]
]
Chart chart = Box.box(data)
```



Creating Curve Charts

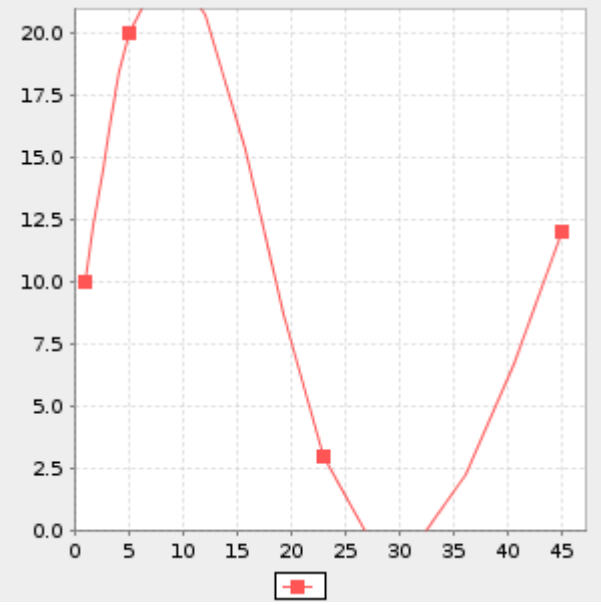
Create a curve chart

```
List data = [
        [1,10],[45,12],[23,3],[5,20]
]
Chart chart = Curve.curve(data)
```



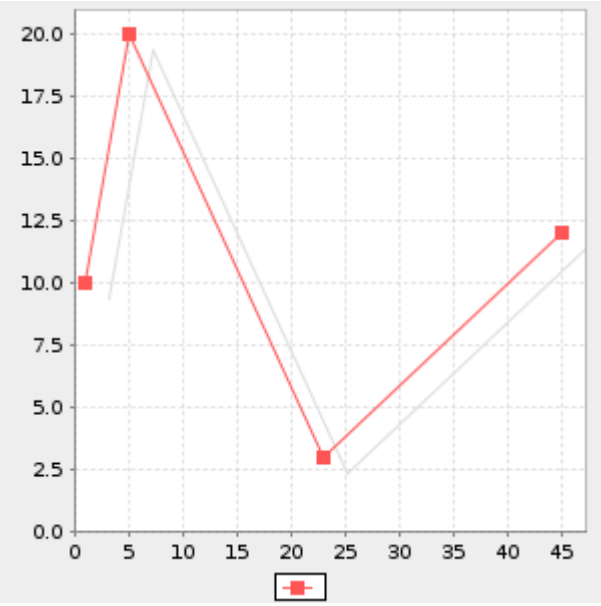
Create a smooth curve chart

```
List data = [
        [1,10],[45,12],[23,3],[5,20]
]
Chart chart = Curve.curve(data, smooth: true)
```



Create a 3D curve chart

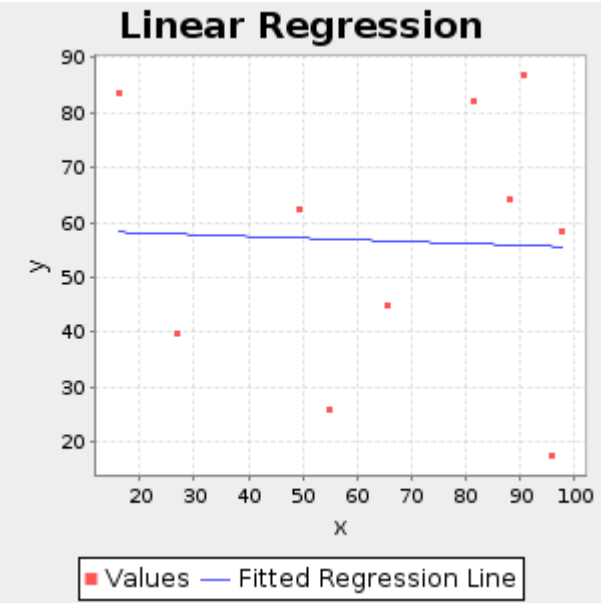
```
List data = [
        [1,10],[45,12],[23,3],[5,20]
]
Chart chart = Curve.curve(data, trid: true)
```



Creating Regression Charts

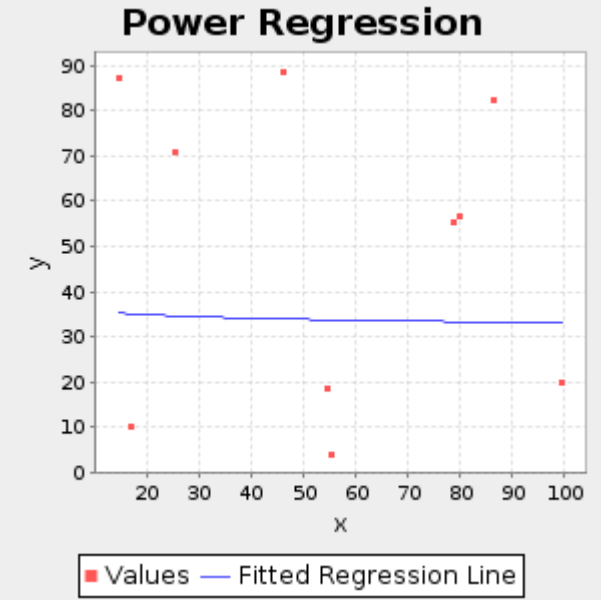
Create a linear regression chart

```
MultiPoint mulitPoint = Geometry.createRandomPoints(new Bounds(0,0,100,100).geometry,
10)
List data = mulitPoint.geometries.collect{ Point pt ->
    [pt.x, pt.y]
}
Chart chart = Regression.linear(data)
```



Create a power regression chart

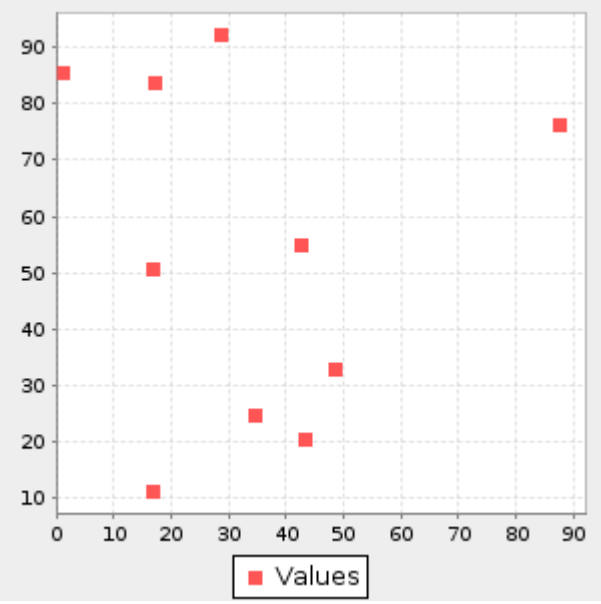
```
MultiPoint mulitPoint = Geometry.createRandomPoints(new Bounds(0,0,100,100).geometry,
10)
List data = mulitPoint.geometries.collect{ Point pt ->
    [pt.x, pt.y]
}
Chart chart = Regression.power(data)
```



Creating Scatter Plot Charts

Create a scatter plot chart

```
MultiPoint mulitPoint = Geometry.createRandomPoints(new Bounds(0,0,100,100).geometry,
10)
List data = mulitPoint.geometries.collect{ Point pt ->
    [pt.x, pt.y]
}
Chart chart = Scatter.scatterplot(data)
```



Feature Recipes

Creating Fields

Create a Field with a name and a type

```
Field field = new Field("name", "String")
println field
```

```
name: String
```

Create a Geometry Field with a name and a geometry type and an optional projection

```
Field field = new Field("geom", "Point", "EPSG:4326")
println field
```

```
geom: Point(EPSG:4326)
```

Create a Field with a List of Strings (name, type, projection)

```
Field field = new Field(["geom", "Polygon", "EPSG:4326"])
println field
```

```
geom: Polygon(EPSG:4326)
```

Create a Field from a Map where keys are name, type, proj

```
Field field = new Field([
        "name": "geom",
        "type": "LineString",
        "proj": new Projection("EPSG:4326")
])
println field
```

```
geom: LineString(EPSG:4326)
```

Access a Field's properties

```
Field field = new Field("geom", "Point", "EPSG:4326")
println "Name = ${field.name}"
println "Type = ${field.typ}"
println "Projection = ${field.proj}"
println "Is Geometry = ${field.geometry}"
```

```
Name = geom
Type = Point
Projection = "EPSG:4326
Is Geometry = true
```

Creating Schemas

Create a Schema from a list of Fields

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
println schema
```

```
cities geom: Point(EPSG:4326), id: Integer, name: String
```

Create a Schema from a list of Lists

```
Schema schema = new Schema("cities", [
        ["geom", "Point", "EPSG:4326"],
        ["id", "Integer"],
        ["name", "String"]
])
println schema
```

```
cities geom: Point(EPSG:4326), id: Integer, name: String
```

Create a Schema from a list of Maps

```
Schema schema = new Schema("cities", [
        [name: "geom", type: "Point", proj: "EPSG:4326"],
        [name: "id",   type: "Integer"],
        [name: "name", type: "String"]
])
println schema
```

```
cities geom: Point(EPSG:4326), id: Integer, name: String
```

Create a Schema from a string

```
Schema schema = new Schema("cities", "geom:Point:srid=4326,id:Integer,name:String")
println schema
```

```
cities geom: Point(EPSG:4326), id: Integer, name: String
```

Getting Schema Properties

Get the Schema's name

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
], "https://github.com/jericks/geoscript-groovy-cookbook")
String name = schema.name
println name
```

```
cities
```

Get the Schema's geometry Field

```
Field geomField = schema.geom
println geomField
```

```
geom: Point(EPSG:4326)
```

Get the Schema's Projection

```
Projection proj = schema.proj
println proj
```

```
EPSG:4326
```

Get the Schema's URI

```
String uri = schema.uri
println uri
```

```
https://github.com/jericks/geoscript-groovy-cookbook
```

Get the Schema's specification string

```
String spec = schema.spec
println spec
```

```
geom:Point:srid=4326,id:Integer,name:String
```

Getting Schema Fields

Get the Schema's Fields

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
List<Field> fields = schema.fields
fields.each { Field field ->
    println field
}
```

```
geom: Point(EPSG:4326)
id: Integer
name: String
```

Get a Field

```
Field nameField = schema.field("name")
println nameField
```

```
name: String
```

Get a Field

```
Field idField = schema.get("id")
println idField
```

```
id: Integer
```

Check if a Schema has a Field

```
boolean hasArea = schema.has("area")
println "Has area Field? ${hasArea}"

boolean hasGeom = schema.has("geom")
println "Has geom Field? ${hasGeom}"
```

```
false
true
```

Modifying Schemas

Change the projection of a Schema

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Schema reprojectedSchema = schema.reproject("EPSG:2927", "cities_spws")
```

```
cities_spws geom: Point(EPSG:2927), id: Integer, name: String
```

Change the geometry type of a Schema

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Schema polyognSchema = schema.changeGeometryType("Polygon", "cities_buffer")
```

```
cities_buffer geom: Polygon(EPSG:4326), id: Integer, name: String
```

Change a Field definition of a Schema

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Schema guidSchema = schema.changeField(schema.field('id'), new Field('guid','String'),
'cities_guid')
```

```
cities_guid geom: Point(EPSG:4326), guid: String, name: String
```

Change Field definitions of a Schema

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Schema updatedSchema = schema.changeFields(
        [
            (schema.field('id'))   : new Field('guid','String'),
            (schema.field('name')) : new Field('description','String')
        ], 'cities_updated')
```

```
cities_updated geom: Point(EPSG:4326), guid: String, description: String
```

Add a Field to a Schema

```
Schema schema = new Schema("countries", [
        new Field("geom", "Polygon", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Schema updatedSchema = schema.addField(new Field("area", "Double"), "countries_area")
```

```
countries_area geom: Polygon(EPSG:4326), id: Integer, name: String, area: Double
```

Add a List of Fields to a Schema

```
Schema schema = new Schema("countries", [
        new Field("geom", "Polygon", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Schema updatedSchema = schema.addFields([
        new Field("area", "Double"),
        new Field("perimeter", "Double"),
], "countries_areaperimeter")
```

```
countries_areaperimeter geom: Polygon(EPSG:4326), id: Integer, name: String, area:
Double, perimeter: Double
```

Remove a Field from a Schema

```
Schema schema = new Schema("countries", [
        new Field("geom", "Polygon", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String"),
        new Field("area", "Double")
])
Schema updatedSchema = schema.removeField(schema.field("area"), "countries_updated")
```

```
countries_updated geom: Polygon(EPSG:4326), id: Integer, name: String
```

Remove a List of Fields from a Schema

```
Schema schema = new Schema("countries", [
        new Field("geom", "Polygon", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String"),
        new Field("area", "Double")
])
Schema updatedSchema = schema.removeFields([
        schema.field("area"),
        schema.field("name")
], "countries_updated")
```

```
countries_updated geom: Polygon(EPSG:4326), id: Integer
```

Create a new Schema from an existing Schema but only including a subset of Fields

```
Schema schema = new Schema("countries", [
        new Field("geom", "Polygon", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String"),
        new Field("area", "Double")
])
Schema updatedSchema = schema.removeFields([
        schema.field("area"),
        schema.field("name")
], "countries_updated")
```

```
countries_updated geom: Polygon(EPSG:4326), name: String
```

Combining Schemas

Combining two Schemas results in a Map with two values: schema and fields. The schema property contains the new Schema. The fields property is List of two Maps which both contain a mapping between the fields of the original Schema and the newly created Schema.

Optional arguments to the Schema.addSchema method are:

- postfixAll: Whether to postfix all field names (true) or not (false). If true, all Fields from the this current Schema will have '1' at the end of their name while the other Schema's Fields will have '2'. Defaults to false.
- includeDuplicates: Whether or not to include duplicate fields names. Defaults to false. If a duplicate is found a '2' will be added.
- maxFieldNameLength: The maximum new Field name length (mostly to support shapefiles where Field names can't be longer than 10 characters

- firstPostfix: The postfix string (default is '1') for Fields from the current Schema. Only applicable when postfixAll or includeDuplicates is true.
- secondPostfix: The postfix string (default is '2') for Fields from the other Schema. Only applicable when postfixAll or includeDuplicates is true.

Combine two Schemas with no duplicate fields and no postfixes to field names

```
Schema shopSchema = new Schema("shops", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])

Schema cafeSchema = new Schema("cafes", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String"),
        new Field("address", "String")
])

Map result = shopSchema.addSchema(cafeSchema, "business")

Schema combinedSchema = result.schema
println combinedSchema
```

```
business geom: Point(EPSG:4326), id: Integer, name: String, address: String
```

```
Map<String,String> shopSchemaFieldMapping = result.fields[0]
println shopSchemaFieldMapping
```

```
[geom:geom, id:id, name:name]
```

```
Map<String,String> cafeSchemaSchemaFieldMapping = result.fields[1]
println cafeSchemaSchemaFieldMapping
```

```
[address:address]
```

Combine two Schemas with no duplicate fields and postfixes

```
Schema shopSchema = new Schema("shops", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])

Schema cafeSchema = new Schema("cafes", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String"),
        new Field("address", "String")
])

Map result = shopSchema.addSchema(cafeSchema, "business", postfixAll: true,
includeDuplicates: false)

Schema combinedSchema = result.schema
println combinedSchema
```

```
business geom: Point(EPSG:4326), id1: Integer, name1: String, id2: Integer, name2:
String, address2: String
```

```
Map<String,String> shopSchemaFieldMapping = result.fields[0]
println shopSchemaFieldMapping
```

```
[geom:geom, id:id1, name:name1]
```

```
Map<String,String> cafeSchemaSchemaFieldMapping = result.fields[1]
println cafeSchemaSchemaFieldMapping
```

```
[id:id2, name:name2, address:address2]
```

Creating Features from a Schema

Create a Feature from a Schema with a Map of values

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature = schema.feature([
        id: 1,
        name: 'Seattle',
        geom: new Point( -122.3204, 47.6024)
], "city.1")
println feature
```

```
cities.city.1 geom: POINT (-122.3204 47.6024), id: 1, name: Seattle
```

Create a Feature from a Schema with a List of values. The order of the values must match the order of the Fields.

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature = schema.feature([
        new Point( -122.3204, 47.6024),
        1,
        'Seattle'
], "city.1")
println feature
```

```
cities.city.1 geom: POINT (-122.3204 47.6024), id: 1, name: Seattle
```

Create a Feature from a Schema with another Feature.

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature1 = new Feature([
        id: 1,
        name: 'Seattle',
        geom: new Point( -122.3204, 47.6024)
], "city.1", schema)
println feature1
Feature feature2 = schema.feature(feature1)
println feature2
```

```
cities.city.1 geom: POINT (-122.3204 47.6024), id: 1, name: Seattle
cities.city.1 geom: POINT (-122.3204 47.6024), id: 1, name: Seattle
```

Create an empty Feature from a Schema.

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature = schema.feature()
println feature
```

```
cities.fid--59892303_159e301ecef_-8000 geom: null, id: null, name: null
```

Creating Features

Create an empty Feature from a Map of values and a Schema.

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature = new Feature([
        id: 1,
        name: "Seattle",
        geom: new Point(-122.3204, 47.6024)
], "city.1", schema)
println feature
```

```
cities.city.1 geom: POINT (-122.3204 47.6024), id: 1, name: Seattle
```

Create an empty Feature from a List of values and a Schema.

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature = new Feature([
        new Point(-122.3204, 47.6024),
        1,
        "Seattle"
], "city.1", schema)
println feature
```

```
cities.city.1 geom: POINT (-122.3204 47.6024), id: 1, name: Seattle
```

Create an empty Feature from a Map of values. The Schema is inferred from the values.

```
Feature feature = new Feature([
  id: 1,
  name: "Seattle",
  geom: new Point(-122.3204, 47.6024)
], "city.1")
println feature
```

```
feature.city.1 id: 1, name: Seattle, geom: POINT (-122.3204 47.6024)
```

Getting Feature Properties

Get a Feature's ID

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature = new Feature([
        new Point(-122.3204, 47.6024),
        1,
        "Seattle"
], "city.1", schema)

String id = feature.id
println id
```

```
city.1
```

Get a Feature's Geometry

```
Geometry geometry = feature.geom
println geometry
```

```
POINT (-122.3204 47.6024)
```

Get a Feature's Bounds

```
Bounds bounds = feature.bounds
println bounds
```

```
(-122.3204,47.6024,-122.3204,47.6024,EPSG:4326)
```

Get a Feature's attributes

```
Map attributes = feature.attributes
println attributes
```

```
[geom:POINT (-122.3204 47.6024), id:1, name:Seattle]
```

Getting Feature Attributes

Get an attribute from a Feature using a Field name

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature = new Feature([
        new Point(-122.3204, 47.6024),
        1,
        "Seattle"
], "city.1", schema)

int id = feature.get("id")
println id
```

```
1
```

Get an attribute from a Feature using a Field

```
String name = feature.get(schema.field("name"))
println name
```

```
Seattle
```

Set an attribute of a Feature using a Field name and a new value

```
feature.set("name", "Tacoma")
println feature["name"]
```

```
Tacoma
```

Set an attribute of a Feature using a Field and a new value

```
feature.set(schema.field("name"), "Mercer Island")
println feature["name"]
```

```
Mercer Island
```

Set attributes of a Feature using a Map of new values

```
feature.set([id: 2])
println feature["id"]
```

```
2
```

Set a new Geometry value

```
feature.geom = new Point(-122.2220, 47.5673)
println feature.geom
```

```
POINT (-122.222 47.5673)
```

Reading and Writing Features

Get a GeoJSON String from a Feature

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature = new Feature([
        new Point(-122.3204, 47.6024),
        1,
        "Seattle"
], "city.1", schema)

String geojson = feature.geoJSON
println geojson
```

```
{"type":"Feature","geometry":{"type":"Point","coordinates":[-
122.3204,47.6024]},"properties":{"id":1,"name":"Seattle"},"id":"city.1"}
```

Write a Feature to GeoJSON

```
Schema schema = new Schema("cities", [
        new Field("geom", "Point", "EPSG:4326"),
        new Field("id", "Integer"),
        new Field("name", "String")
])
Feature feature = new Feature([
        new Point(-122.3204, 47.6024),
        1,
        "Seattle"
], "city.1", schema)

GeoJSONWriter writer = new GeoJSONWriter()
String geojson = writer.write(feature)
println geojson
```

```
{"type":"Feature","geometry":{"type":"Point","coordinates":[-
122.3204,47.6024]},"properties":{"id":1,"name":"Seattle"},"id":"city.1"}
```

Get a Feature from GeoJSON

```
String geojson = '{"type":"Feature","geometry":{"type":"Point","coordinates":[-
122.3204,47.6024]},"properties":{"id":1,"name":"Seattle"},"id":"city.1"}'
Feature feature = Feature.fromGeoJSON(geojson)
println feature
```

```
feature.city.1 id: 1, name: Seattle, geometry: POINT (-122.3204 47.6024)
```

Read a Feature from GeoJSON

```
GeoJSONReader reader = new GeoJSONReader()
String geojson = '{"type":"Feature","geometry":{"type":"Point","coordinates":[-
122.3204,47.6024]},"properties":{"id":1,"name":"Seattle"},"id":"city.1"}'
Feature feature = reader.read(geojson)
println feature
```

```
feature.city.1 id: 1, name: Seattle, geometry: POINT (-122.3204 47.6024)
```