



STATE OF THE ART

STEVE PEPPE TAKES A LOOK AT THE LATEST JAVASCRIPT TOOLS FOR GEOSPATIAL ANALYSIS AND ADVANCED MAPS

In the past year, a wealth of new web tools has emerged to help with web-based GIS and spatial analysis. While Google, ArcGIS and Nokia Here have long provided APIs for maps and geospatial analysis features, they can be expensive, onerous to learn and lock the map developer to a single solution. Fortunately, there are now a number of useful and modular JavaScript libraries for doing GIS, spatial statistics and cartography.

Many of the tools I'll discuss are built in cooperation with Mapbox, CloudMade and MapZen. However, I specifically want to talk about simple tools for specific goals, not products or platforms. Mapbox's superb new library, Turf, covers many of these topics, but there are plenty of other libraries that provide the same features and more. These tools can be added as packages to Node or used for analysis in a web browser. Data visualisation libraries, such as D3.js and Processing, are invaluable for displaying and interacting with the results of these GIS functions. Leaflet also has excellent libraries for cartography and map presentation.

Here, then, is my list of the best of these GIS libraries and what they achieve. You can find working examples of all of them at <http://codepen.io/stevepepple/blog/javascript-geospatial-examples>

3D and geometry

3D GIS is an expansive field, which is natural as we live 3D space. Web technologies, including WebGL and the HTML5 3D canvas,

have opened up web apps to exciting possibilities for 3D maps and spatial visualisation.

Three.js (<http://threejs.org>)

Three is a JavaScript library for geometric and mesh objects with WebGL. Three GeoJSON provides a simple way to render GeoJSON objects on 3D planes and spheres. (GeoJSON is a format for encoding a variety of geographic data structures.)

OSM Buildings (<http://osmbuildings.org/>)

The OSM Buildings project allows the map designer to represent buildings as 3D objects on a 2D map. The project uses OpenLayers and Leaflet.



Tom Holderness used OSM Buildings to map London, UK (<https://github.com/talltom/3DLondon>)

Sylvester (<http://sylvester.jcoglan.com>)

Sylvester is a library for geometry, vector, and matrix maths in JavaScript, including modelling infinite lines in 3D space.

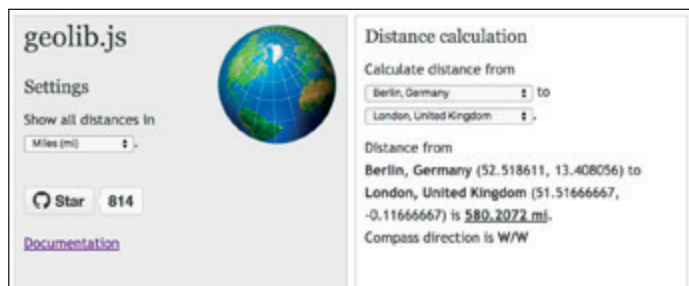
Distance and measurement

It's especially useful to have small, focused libraries that perform distance, measurement, and conversion operations, such as finding the area of a geofence or converting miles to kilometres.

Geolib (<https://github.com/manuelbieh/Geolib>)

Geolib provides distance and estimated time calculations between two latitude-latitude coordinates. A handy feature of Geolib is 'order by distance', which sorts a list or array by distance. The library also supports elevation.

Turf, which is described in the next section, also provides a distance function to calculate the great-circle distance between points. Additionally, Turf calculates area, distance along a path and the midpoint between points.



Geolib provides distance and estimated time calculations between two latitude-latitude coordinates

Geo features and points

Much of the work in GIS involves working with point, shapes, symbols and other features. The well-established Leaflet library and newcomer Turf make it much easier to work with a variety of features, including collections of many features.

Leaflet.js (<http://leafletjs.com>)

Leaflet is simply the best option for working with the display of points, symbols, and all types of features on web and mobile devices. The library supports rectangles, circles, polygons, points, custom markers, and a wide variety of layers. It performs quickly, handles a variety of formats and makes the styling of map features easy. The library also has a rich ecosystem of third-party plug-ins.

Turf.js (<http://turfjs.org>)

Turf is a library from Mapbox for geospatial analysis. One of its best features is the ability to create a collection of features and then spatially analyse, modify (geoprocess), and simplify it before using Leaflet to present the data.

Both Geolib and Turf can calculate the path length, feature centre and points inside a feature.



Turf makes it easy to calculate population density across a large set of features

Simple Map D3 (<http://code.minnpost.com/simple-map-d3/>)

There is a slight learning curve to Turf and Leaflet, as they are powerful and flexible tools. An even simpler tool for creating choropleth maps is Simple Map D3. With just a few lines of code, the library creates choropleths and other symbology by simply defining a GeoJSON object and data attribute.

Points

Turf provides a number of different operations for points, including finding the centroid point in a feature and creating a rectangle or polygon that encompasses all points. Turf provides many statistics for a collection of points, such as the average based on value of each point. It also provides some excellent spatial analysis functions for points.

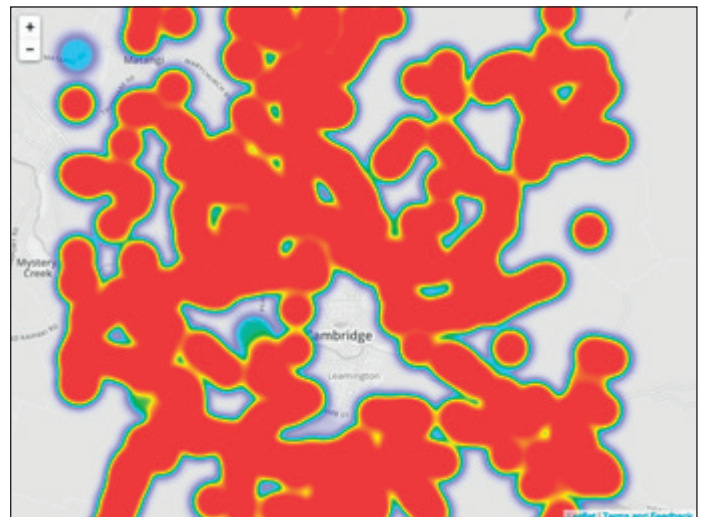
Marker Cluster for Leaflet

(<https://github.com/Leaflet/Leaflet.markercluster>)

Leaflet.js is great for visualising the results from Turf or a collection of points that is large, being able to handle hundreds of points. However, there are plugins, such as Marker Cluster and Mask Canvas, that you can use if you need to handle hundreds of thousands of points.

Heat for Leaflet (<https://github.com/Leaflet/Leaflet.heat>)

If you want to create a heat map from point data, there's a Leaflet plugin called Heat. This library creates a dynamic heat map from thousands of points.



Heat lets you create a dynamic heat map from thousands of points

Geocoding

Routing, geocoding and reverse geocoding locations requires an online service, such as Google or Nokia Here. But recent libraries make the implementation easier. There are also suitable open source alternatives.

The HTML5 Geolocation API provides a simple method getting a device's GPS location (with the user's permission). Location-aware web applications can use Turf spatial analysis methods for advanced techniques such as geofencing a location inside or outside a map feature. Turf is also indispensable for searching a local database or collection of objects, as it has a filter function that finds a feature matching a name or value.

GeoSearch for Leaflet (<http://smeijer.github.io/GeoSearch/>)

GeoSearch is a Leaflet plug-in for geocoding using the ArcGIS, Google or OpenStreetMaps geocoders. Once the control is added to the base map, it will automatically use the select geocoder to show the best search result on the map. The library is designed to be extensible to other third-party services.

Geo for Node.js (<https://github.com/feliperazeek/geonode>)

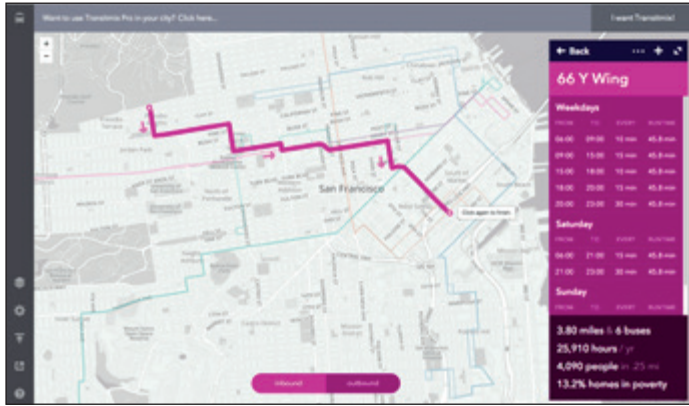
Felipe Oliveira's Geo for Node.js uses Google's Geocode API for geocoding and reverse geocoding. It additionally supports the Geohash system for URL encoding of latitude-longitude coordinates.

Routing

As with geocoding, there are a myriad routing and direction services, but they will cost you. However, there is a reliable, open source alternative.

MapZen OSRM (<https://mapzen.com/blog/osrm-services>)

MapZen's Open Source Routing Machine (OSRM) provides a free service for routing cars, bicycles and pedestrians.



Transport planning tool Transit Mix (www.transitmix.net) cleverly uses the MapZen OSRM routing tool to create routes

Networks and spatial analysis

If you want to go even further with geospatial analysis and geoprocessing using web tools, there are a few more resources and utilities available. That number is set to increase – I'm excited to see Turf and other libraries continuing to produce exploratory analysis tools for kernel density, spatial distribution, elevation, path selection, viewsheds, and so on.

JSNetworkX (<http://felix-king.de/JSNetworkX/>) and D3 (<http://d3js.org>)

D3 is a JavaScript library for manipulating documents based on data and Mike Dewar's book, *Getting Started with D3*, includes a number of examples of using D3 with maps and spatial analysis. One of the more interesting examples is the creation of a directed graph of the New York Metro by analysing the Google Transit specification for MTA with JSNetworkX.



A directed graph of the New York Metro created by analysing the Google Transit specification for MTA using JSNetworkX and D3

Turf.js (<http://turfjs.org>)

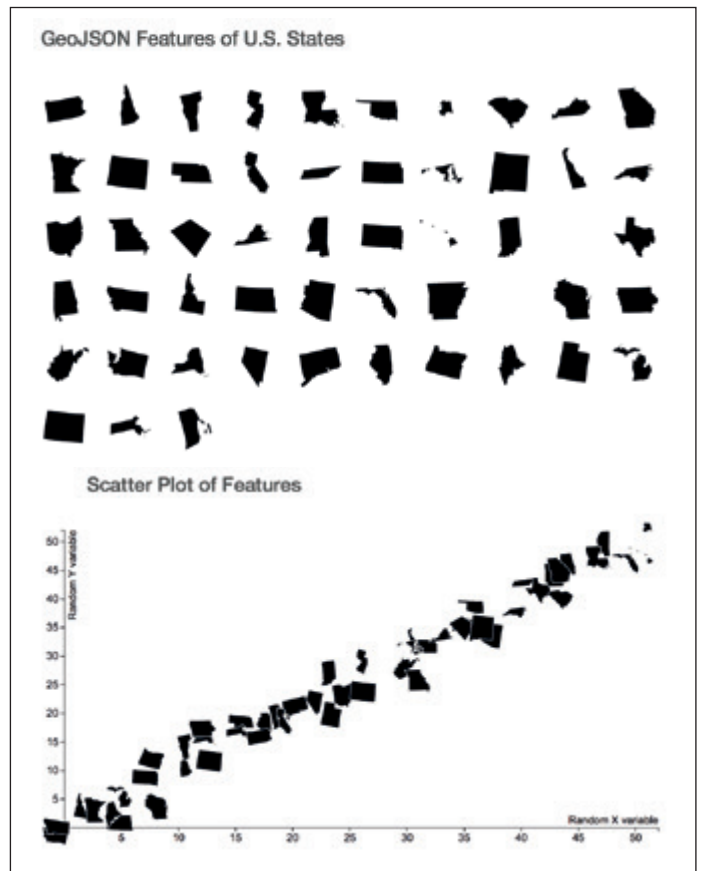
Turf provides a number of spatial analysis functions, including buffers, classification, interpolation, and triangulated irregular networks (TINs). One really nice feature is the ability to join data spatially using the tag method. Turf also provides geoprocessing tools for clipping data, merging data, dissolving data, and returning the intersection or union of two datasets. In addition, it can manipulate and invert features.

Simplify.js (<http://mourner.github.io/simplify-js>)

Turf uses Vladimir Agafonkin's Simplify to perform polyline simplification. The library can be used to process files online or offline.

d3 Geo Exploder (<http://bsouthga.github.io/d3-exploder/>)

Ben Southgate's d3.geo.exploder enables you to move and resize GeoJSON features to other shapes, such as a grid or a scatter plot.



d3.geo.exploder enables you to move and resize features to other shapes, such as a scatter plot

I'M EXCITED TO SEE TURF AND OTHER LIBRARIES CONTINUING TO PRODUCE EXPLORATORY ANALYSIS TOOLS

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OTHER MODULAR UTILITIES

CartoDB (<http://cartodb.com/>): An open source tool that allows for the storage and visualisation of geospatial data on the web.

Geo5 (<http://geo5.org/#intro>): For geo-related HTML5 documents, including offline maps for mobile applications.

Mapstraction (<http://mapstraction.com/>): A service that acts as a common API between ArcGIS, Google, Leaflet, Nokia, Cloud-Made, and several other services.

MetaCRS and Proj4js (<http://wiki.osgeo.org/wiki/MetaCRS>): Convert between coordinate systems.

Polymaps (<http://polymaps.org/>): A Javascript library for dynamic, interactive maps. It uses SVG and can be easily styled with CSS.

Shp2stl (<https://github.com/dougmcune/shp2stl>): Converts geo data into 3D models that can be rendered or 3D printed.

ToGeoJSON (<https://github.com/mapbox/togeojson>): Converts KML and GPX to GeoJSON, in a browser or with Node.js.