Guide to GIS for Honolulu Hackers (part 1)

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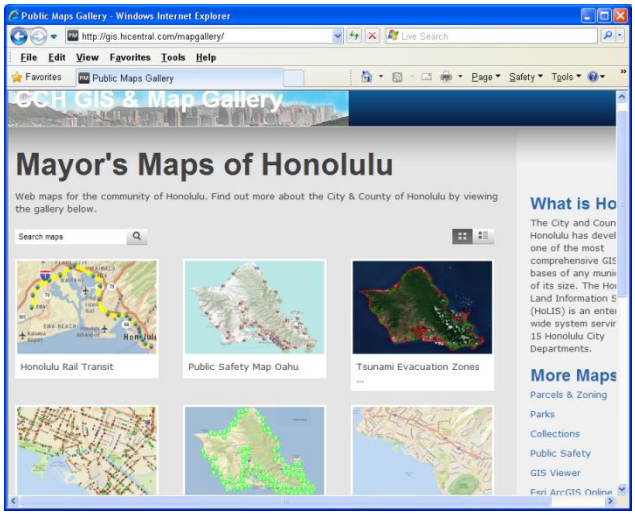
OK, maybe you've heard that a lot of City and County of Honolulu (CCH) data is publically available through REST map services published by HOLIS (Honolulu Land Information System), the Department of Planning and Permitting (DPP) GIS group. Perhaps you've even seen the "intelligent web maps" gallery of "Mayor's Maps" they've published:

http://gis.hicentral.com/mapgallery/



Or perhaps you've used their "focused map applications" to find information on parcels, parks, refuse collection or public safety:

http://gis.hicentral.com/

If you haven't tried any of the above, try them now.

GIS 101

Before you can start creating your own intelligent web maps or focused map applications, you need to know a bit about GIS, or geographic information systems. Here's a great summary article by Dennis Hollier on "GIS in Hawaii" from the December 2011 issue of Hawaii Business:

http://www.hawaiibusiness.com/Hawaii-Business/December-2011/GIS-in-Hawaii/

If you don't read the entire article right now, at least read the final paragraph:

"Nowadays, almost every government agency tells at least part of its story in a public layer or a database accessible through GIS. This has given rise to an unprecedented cascade of government information into private hands."

Rather than give you an entire course in GIS, here's all you need to know to get started:

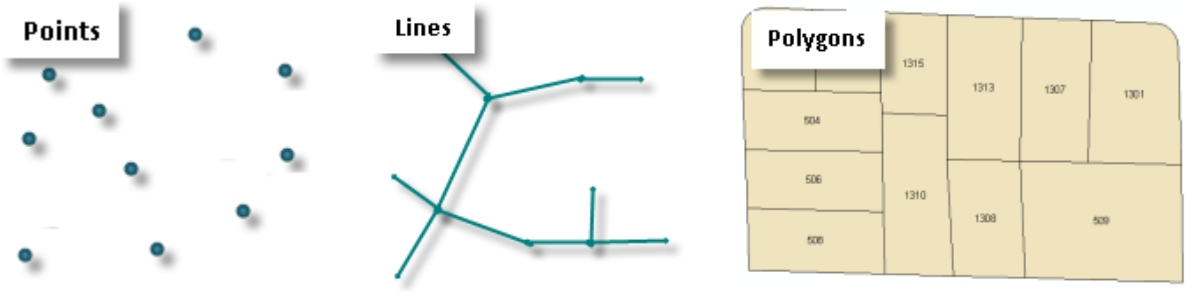
GIS = ((maps + data) * analysis) ^ web

Let's break it into parts:

MAPS GIS = ((**maps** + data) * analysis) ^ web

FEATURES

It has been said that 90% of government data has a spatial component. This means it can be put on a map. In GIS we put data on a map using features that are either points (one X,Y coordinate), lines (a series of X,Y coordinates that are connected), or polygons (a series of X,Y coordinates that enclose an area. Point features are used to represent something at a single location like a well or an antenna. Line features are used to represent linear features like streets or streams. Polygon features are used to represent areas like tax parcels or zoning areas.



http://resources.arcgis.com/en/help/main/10.1/index.html#//00v200000010000000

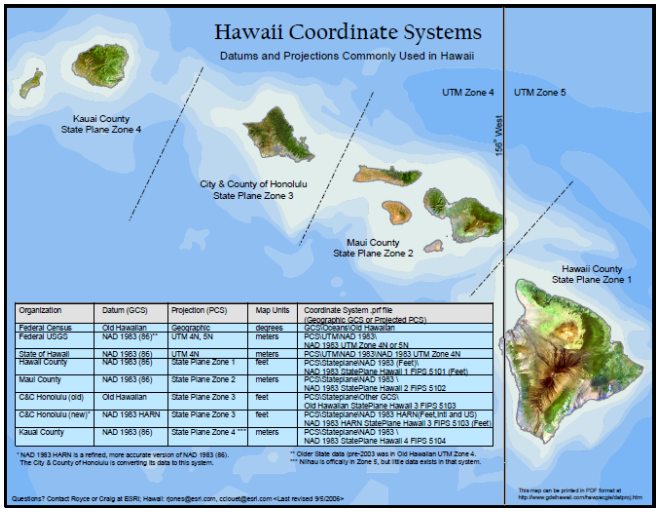
COORDINATES

The X,Y coordinates used to represent features are stored in a coordinate system. The most commonly know coordinate system uses longitude (X) and latitude (Y). Longitude values range from minus 180 to plus 180 degrees and latitude values range from minus 90 to plus 90 degrees. This is a geographic coordinate system (GCS). The two most common GCS used in Hawaii are named WGS84 and NAD83 HARN. These are spherical coordinate systems that locate a position on a spherical globe.

To show features on a flat map, we change the spherical coordinates into flat, or projected, coordinates (PCS). The two most common PCS used in Hawaii are "UTM" (Universal Transverse Mercator) and "State Plane". However, to use our Hawaii data on the web (which is international), the most common PCS is "WGS 1984 Web Mercator (Auxiliary Sphere)".

In most cases you will be working with map services and the coordinate system information will be handled automatically, but if you start working with raw data you may need to learn more about coordinate systems. Here's a link to a good reference on coordinate systems for Hawaii:

http://www.gdsihawaii.com/hawpacgis/docs/HawaiiCooSys.pdf



DATA GIS = ((maps + **data**) * analysis) ^ web

ATTRIBUTES

A key value of GIS is that not only does it put features on a map, it also stores information (attributes) about each of those features. A point feature such as a well might have attributes such as depth of the well, diameter of the well, who drilled the well, etc. A line feature such as a street might have attributes such as street name, address range, direction (one way streets), etc. A polygon feature such as a tax parcel might have attributes such as TMK (tax map key number), owner, permit data, etc. These attributes are usually stored in a relational database.

It is the combination features and their related attribute (maps + data) that provides a great deal of the power of GIS. A map feature can be symbolized by any of its attributes. For example, a tax parcel could be symbolized by its land value, showing higher value parcel using a brighter color. A big part of the value of GIS comes from being able to quickly create different types of maps based on different data. Cartographers are experts at doing this.

ANALYSIS GIS = ((maps + data) * **analysis**) ^ web

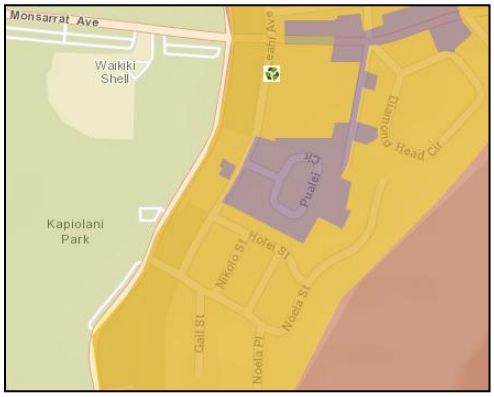
Once you have features and attributes stored in a GIS, not only can you quickly create different types of maps for visualization, you also can perform analysis on that data. You can use proximity analysis to find out what things are near what other things. You can use geospatial analysis to see if there are significant spatial patterns in the data and to make predictions in areas of sparse or unknown data. You can use temporal analysis to look for patterns or change over time. Analysis is the "force multiplier" of GIS.

WEB GIS = ((maps + data) * analysis) ^ **web**

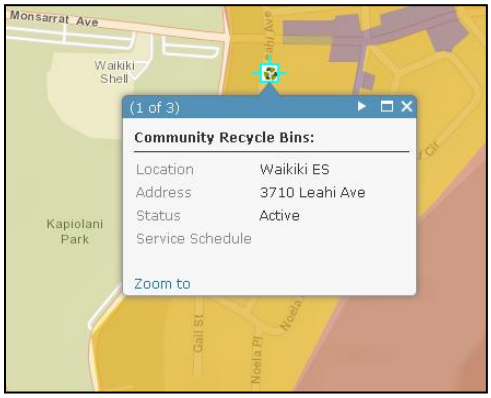
Features (maps) and their related attributes (data) have been used by desktop GIS users for visualization and analysis for several decades now. What is changing is that now that same power of GIS is becoming available over the internet using the web. The power of GIS is now available to citizens using intelligent web maps and focused map applications. The power of GIS is also available to developers who can create their own intelligent web maps and focused map applications. Here is what you need to know.

MAP SERVICES

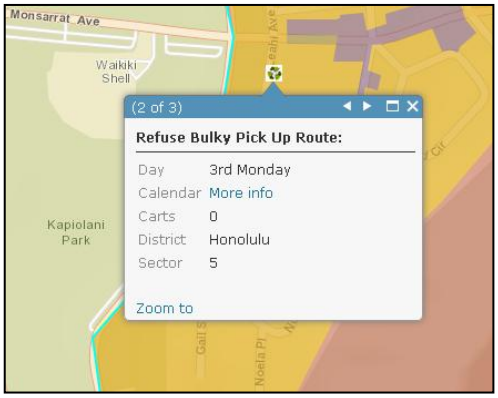
While the City and County of Honolulu does have an FTP site where you can download their GIS data, there is a more efficient way of consuming city GIS data using map services. The intelligent web maps and focused map applications you tried using the links back on page 1 all depend on map services published by HOLIS. These map services are available to you as a developer also. Let's take a look at one right now, the intelligent web map called "Refuse Pickup, Drop-off and Recycling". Here's the link, give it a try:
http://cchnl.maps.arcgis.com/home/webmap/viewer.html?webmap=e4f97615917e4245918bf6b06280a98c



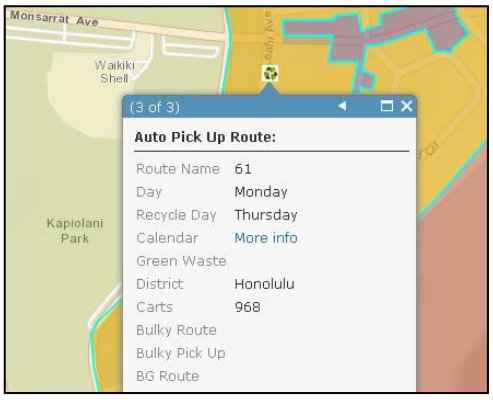
In this example I've moved to an area near the Waikiki Shell. I can see there is a basemap that shows the streets and some place names. Some areas on the basemap are colored in and represent polygon features that outline refuse collection areas. There are also point features like the community recycling bin on Leahi Ave. This intelligent web map has been set up so that if you click on the map you will see the attributes (data) related to that spot on the map.



I have clicked on the spot where the community recycling bin is located. The web map returns information (attributes) about that feature. In this example the bin is at Waikiki Elementary School at 3710 Leahi Ave and it is active. Notice that it says "(1 of 3)" in the upper left corner of the window. I click the right-pointing triangle on the upper right.



I now see a second page of information. These are attributes of the Bulky Item Pickup Area, a polygon feature, for this location. The polygon area is outlined in blue. I can see that bulky item pickup is on the third Monday of every month for this location and for every location within the blue outlined polygon. I can also click the "More info" for a link to a webpage with more information.



If I click the right-pointing triangle again, I will see information on a third feature, the Automated Pick Up Route, also a polygon feature, for this location. I can see that for this location, and all locations within the polygon, their general refuse pickup day (gray bin) is Monday. Their recycle yard waste pickup (green bin) and recycle cardboard/paper pickup day (blue bin) is Thursday and again there is a link I can click if I want more information.

To understand how to make an intelligent web map like this, you need to understand map services. Here's a link to the page that shows the map services used to create this web map along with some other information:

http://cchnl.maps.arcgis.com/home/item.html?id=e4f97615917e4245918bf6b06280a98c

The "Map Contents" area shows the map services that were used to create this intelligent web map.

The bottom service, "Streets", is a "basemap" service that underlies the other services. Basemap services usually show things like streets and place names.

The other services provide specific information on different features and their corresponding attributes.

Let's look at one of those services, the one used to draw and show information about the community recycling bins. The service is called "Drop-Off Recycle Comm Bins". Click on the link for the service. The link is:

http://services.arcgis.com/tNJpAOha4mODLkXz/arcgis/rest/services/Refuse_Drop_Recycle_Comm_Bins/FeatureServer/0

The link actually points to a layer within the service. Each layer is one particular feature type with a unique set of attributes.

"Geometry Type" tells you this map service layer is a set of points.

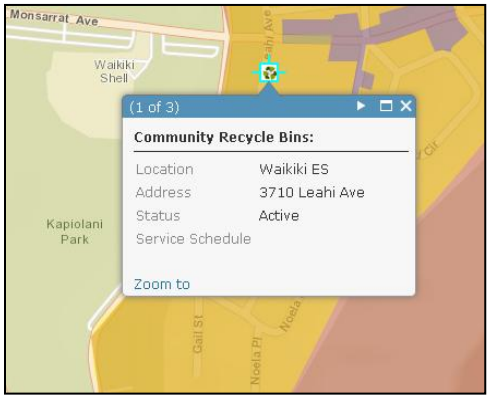
"Min.Scale" and "Max.Scale" are for layers that are only shown at certain map scales. If there are zeros for both values then the map service layer is drawn at all scales.

There is more information which has to do with the coordinate system and other things. We can ignore those for now. Move on down to where you see "Fields:".

Fields:

- FID *(type: esriFieldTypeInteger, alias: FID, SQL Type: sqlTypeInteger, nullable: false, editable: false)*
- OBJECTID *(type: esriFieldTypeInteger, alias: OBJECTID, SQL Type: sqlTypeInteger, nullable: true, editable: true)*
- OBJECTID_1 *(type: esriFieldTypeInteger, alias: OBJECTID_1, SQL Type: sqlTypeInteger, nullable: true, editable: true)*
- LOCATION *(type: esriFieldTypeString, alias: LOCATION, SQL Type: sqlTypeNVarchar, length: 40, nullable: true, editable: true)*
- SVS_SCH *(type: esriFieldTypeString, alias: SVS_SCH, SQL Type: sqlTypeNVarchar, length: 50, nullable: true, editable: true)*
- ADDRESS *(type: esriFieldTypeString, alias: ADDRESS, SQL Type: sqlTypeNVarchar, length: 50, nullable: true, editable: true)*
- STATUS *(type: esriFieldTypeString, alias: STATUS, SQL Type: sqlTypeNVarchar, length: 7, nullable: true, editable: true)*

"Fields:" identifies the attributes (data) that are available for each of the point features. It shows the data type and data length as well as any pre-defined aliases. This is the source of the information in the popup window when I clicked on the location earlier.



Location in the popup came from the LOCATION field.

Address in the popup came from the ADDRESS field.

Status in the popup came from the STATUS field.

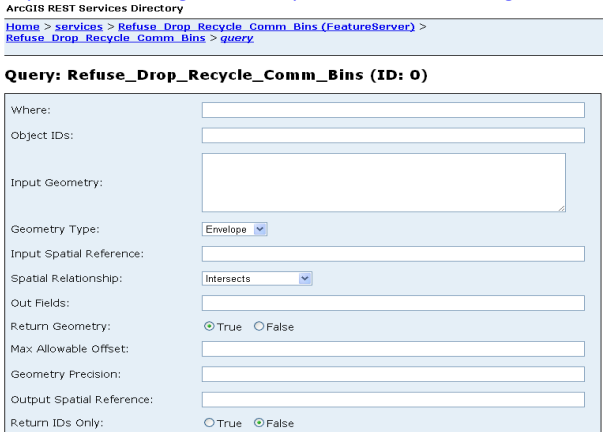
Service Schedule in the popup came from the SVS_SCH field.

The data is retrieved from the map service using a query. "Query" is a supported operation.

Supported Operations: Query

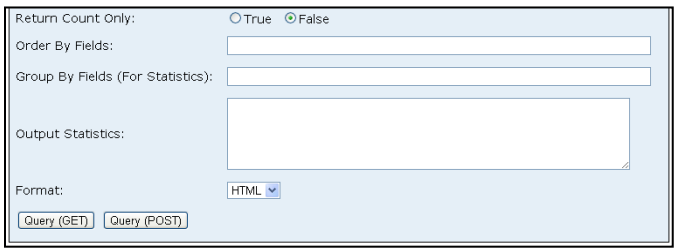
Click on the "Query" link.

http://services.arcgis.com/tNJpAOha4mODLkXz/arcgis/rest/services/Refuse_Drop_Recycle_Comm_Bins/FeatureServer/0/query



Queries are important if you're building your own focused map application using one of the Esri API's – JavaScript, Flex or Silverlight (which we'll talk about later). You can query the layer and return a filtered set of point features. You can filter based on location. There are several spatial operators that can be used.

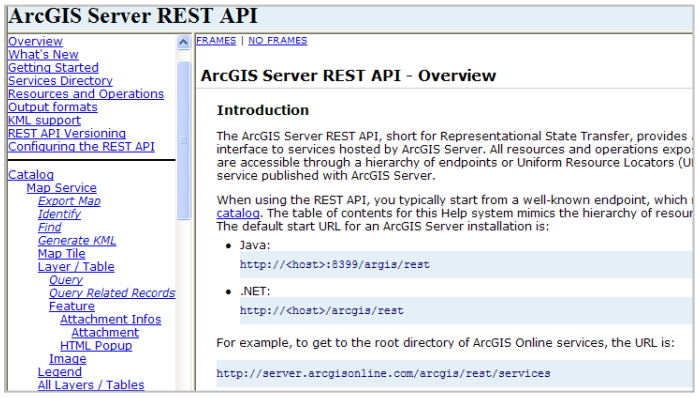
For example, a simple spatial query would be “Show me all the recycling bins with five miles of my current location”. Or you could add an attribute filter to “Show me all the recycling bins with five miles of my current location whose status is active”.



You can also control how the features are returned to you. Do you only want the ID’s of the returned features or the geometry (X,Y coordinates) also? Which fields do you want returned? And how would you like it formatted – HTML (as an HTML page), or JSON (as a JSON object).

You can get more information on all of these options and the full ArcGIS Server REST API here:

http://services.arcgisonline.com/ArcGIS/SDK/REST/index.html?overview.html



In “Guide to GIS for Honolulu Hackers (part 2)” I’ll show you how you can use ArcGIS Online resources to easily build your own intelligent web maps for Honolulu. Here’s the link to Part 2: http://gdsihawaii.com/GIS4hackers/GIS4hackersPart2.pdf.