

# ArcGIS for Developers

A complete mapping and analytics platform for developers

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# What you can do with ArcGIS platform



## Data Visualization

Create rich interactive data visualizations with ArcGIS APIs and SDKs in 2D or 3D.



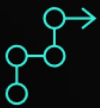
## Ready-to-use Maps and Data

Access a collection of global geographic information from Esri, its partners and open data providers, including maps, apps, and data layers.



## Geocoding

Convert your addresses and place names into coordinates and put them on a map.



## Directions

Optimize routes and generate turn-by-turn directions, react to real-time traffic conditions, route multiple vehicles to multiple destinations.



## Offline

View maps, search locations or addresses, find routes between two or more locations, or edit your datasets without a network connection.



## Demographics and Lifestyle Data

Get facts about the people, places, and businesses in a specific area or within a certain distance or drive time from a location.

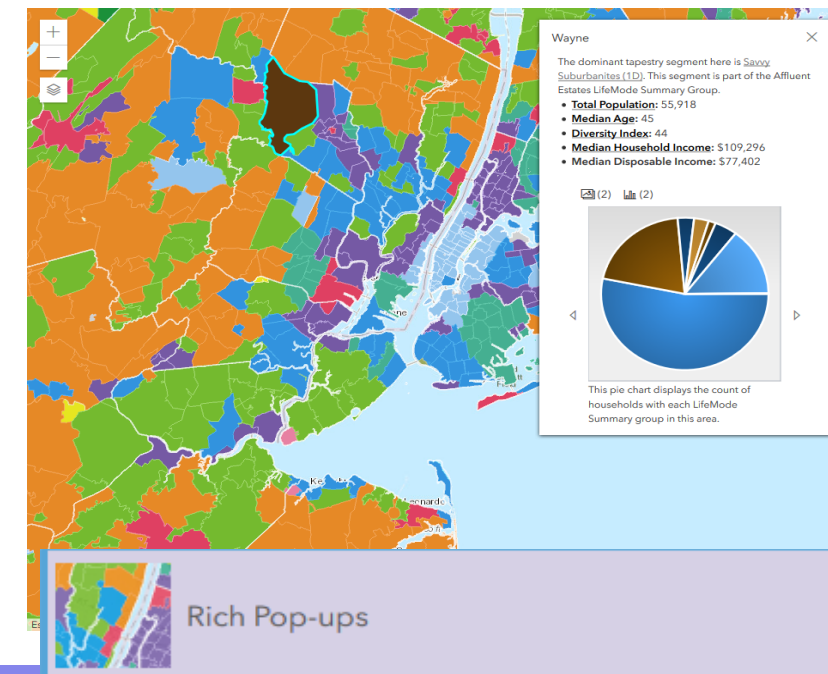
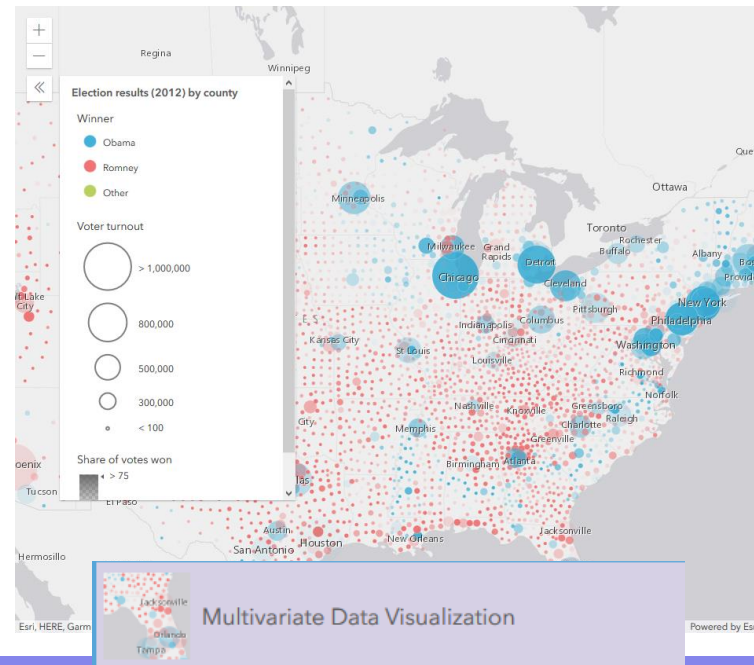
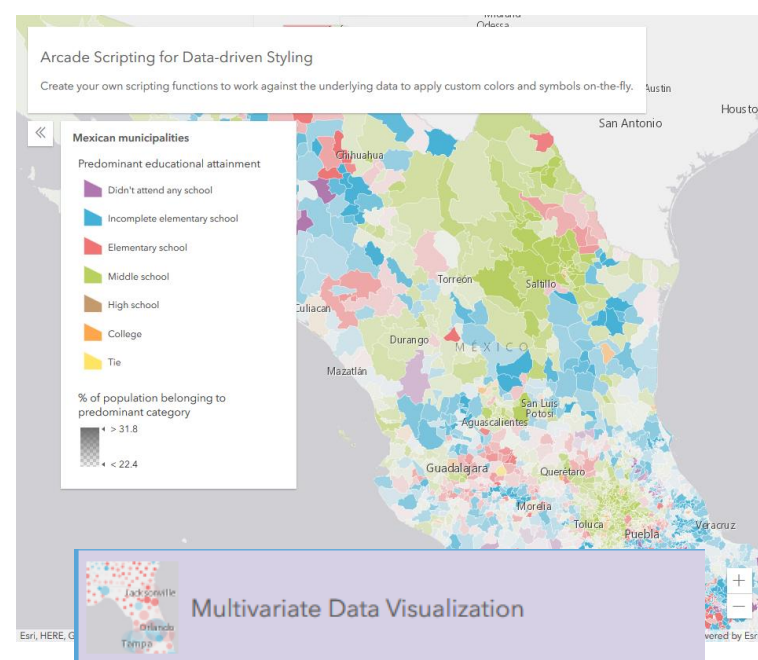


## Spatial Analysis

Gain insight into your data by understanding spatial relationships and patterns using the ArcGIS Spatial Analysis service.

# Data Visualization with ArcGIS

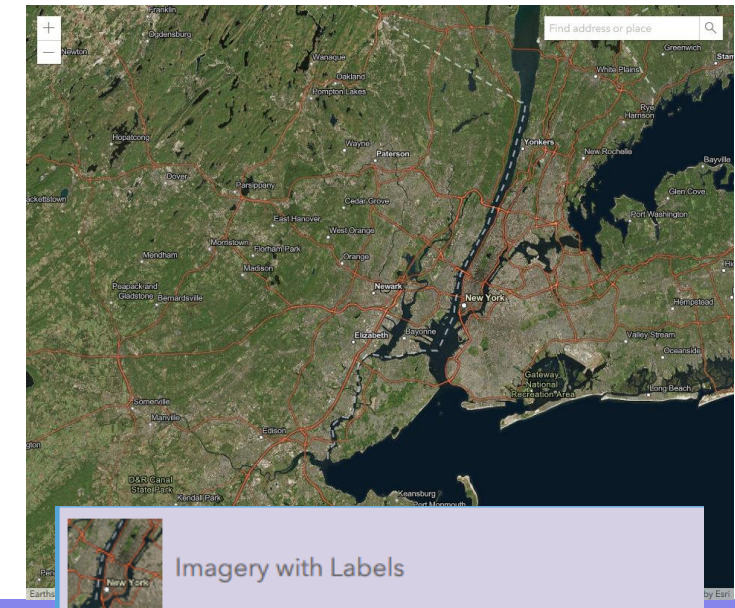
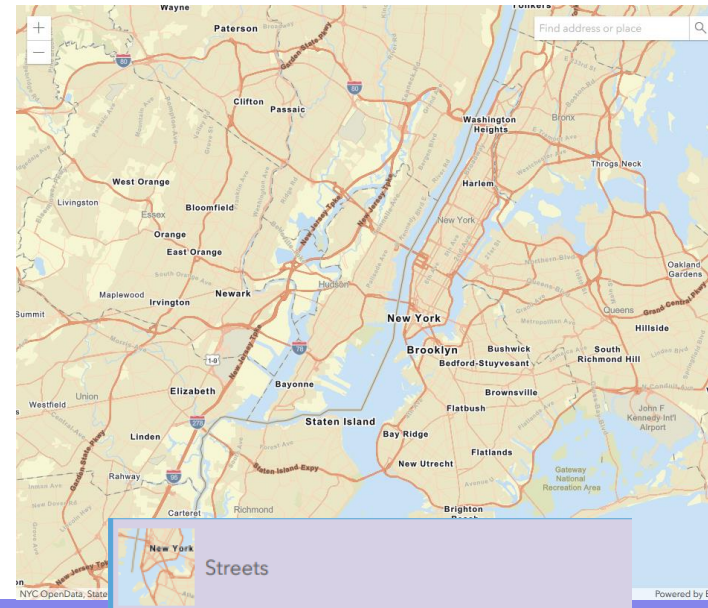
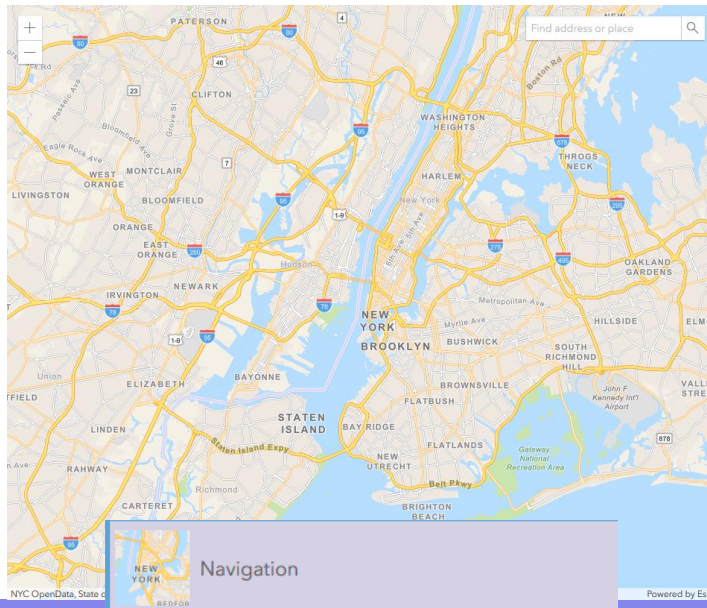
- Create rich interactive intelligent data visualizations in 2D or 3D:
  - Rich pop-ups
  - Data-driven styling
  - Display labels and callouts
  - Performant rendering in WebGL





# Access Maps and Data

- Access a collection of global geographic information from Esri, its partners, and open data providers.
  - Wide variety of vector basemaps
  - Additional OpenStreetMap based vector basemaps
  - Comprehensive and authoritative geospatial content
  - Open data from a variety of organizations



- [Try the DevLabs →](#)

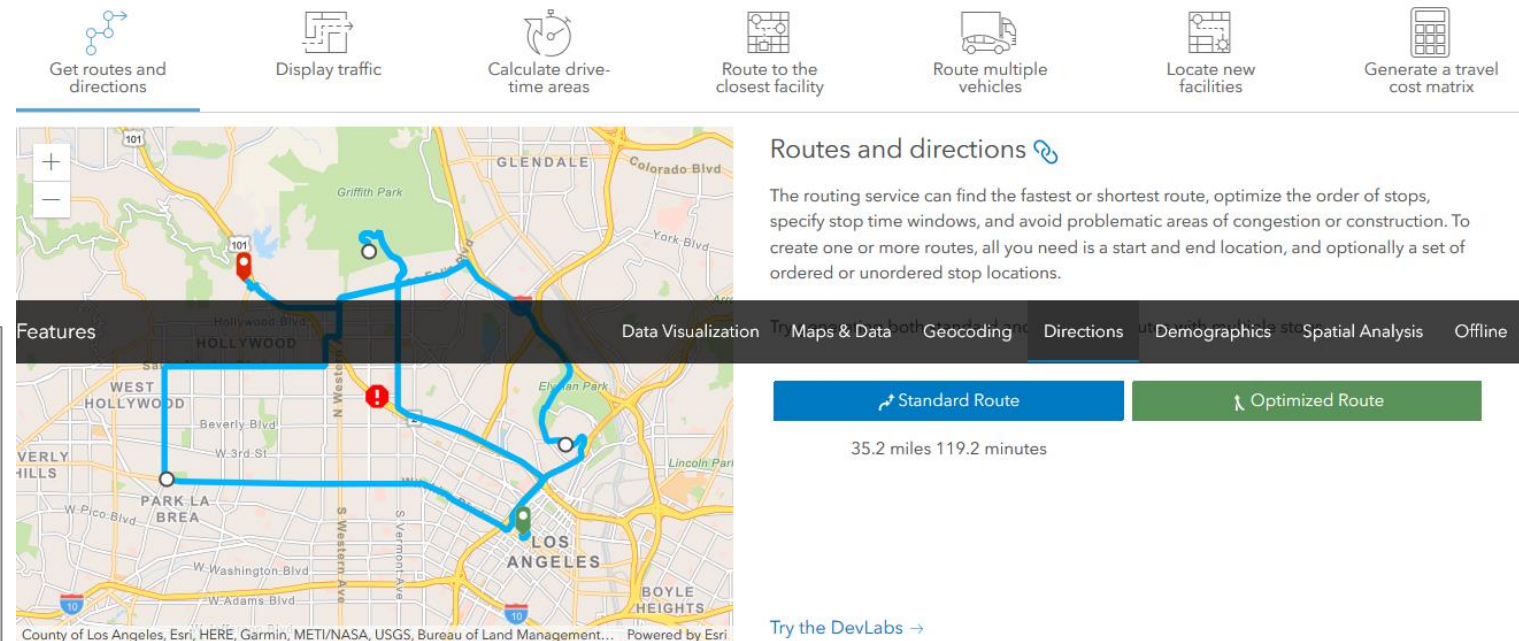




# Routing and Directions

- Optimize routes and generate turn-by-turn directions, react to real-time traffic conditions, route multiple vehicles to multiple destinations, and increase the overall efficiency of your daily workflows.
  - Global coverage
  - Localized directions
  - Use your own data
  - Route multiple vehicles
  - Work offline

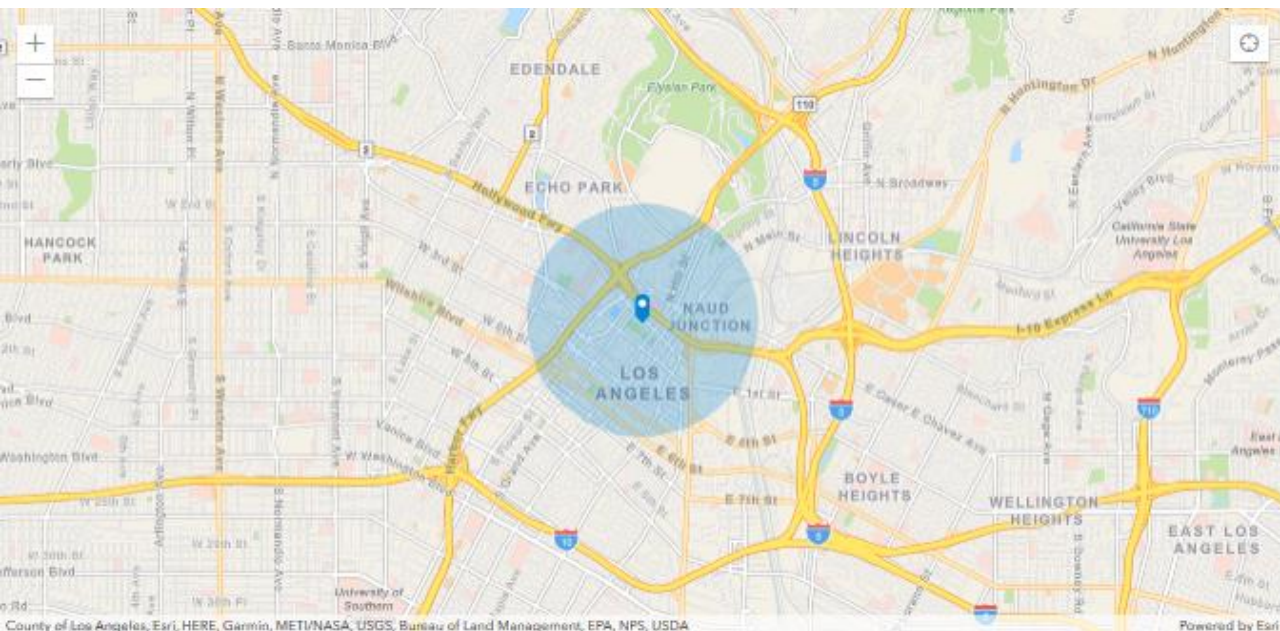
- Display and use traffic data
- Modify routes with restrictions and barriers
- Industry-leading reference data



# Demographics and Lifestyle Data

- Get facts about the people, places, and businesses in a specific location. Query and display information from a large collection of authoritative data sets including population, income, housing, consumer behavior, and the natural environment.
  - Global coverage
  - Industry leading authoritative content
  - Enrich your data with demographics
  - Query thousands of variables

- Generate PDF reports
- Enrich your data with demographics
- Query thousands of variables



## Query Demographic Data

The GeoEnrichment Service supports a variety of input types such as points, addresses or areas to help you discover the demographics of different study areas.

Try selecting a city or clicking on the map to search for the demographics within 1 mile of a location.

Los Angeles, USA

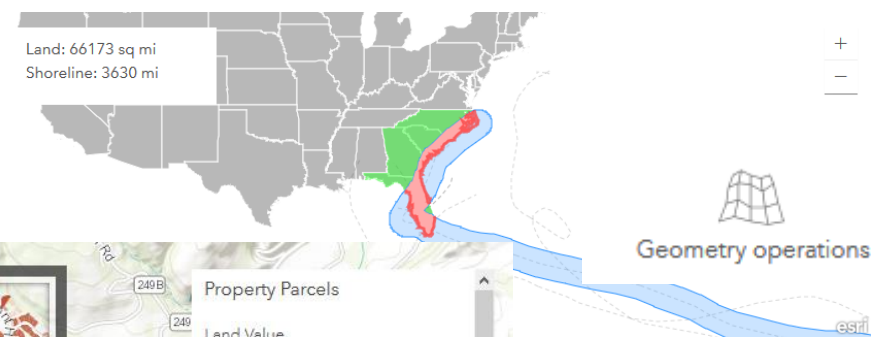
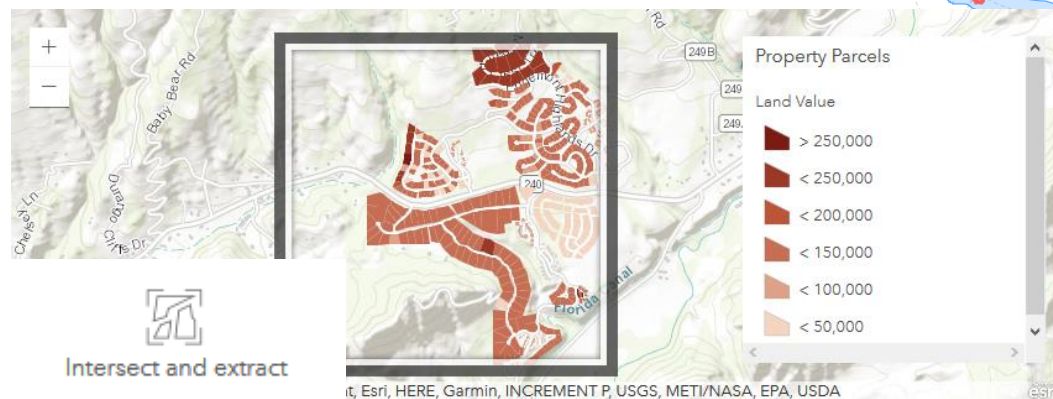
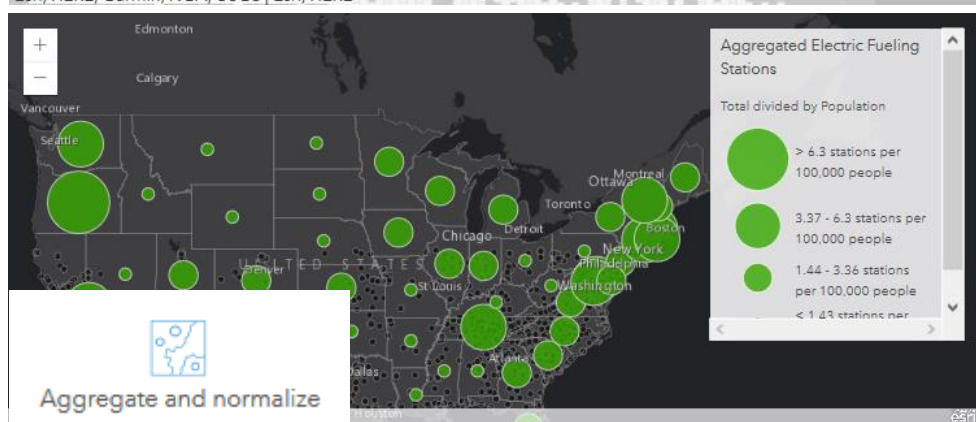
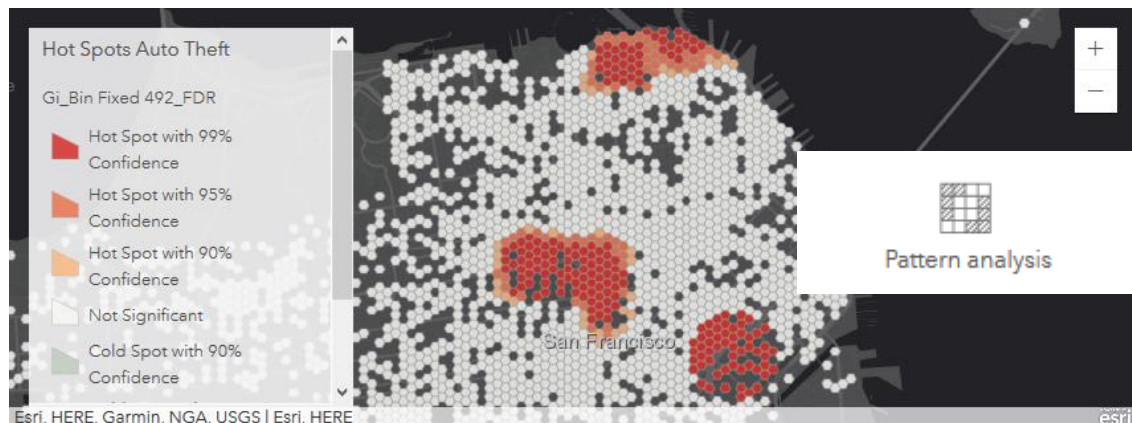
Total Population	64,822
Total Households	28,145
Average Household Size	1.85
Male Population	38,755
Female Population	26,067

[Try the DevLabs](#)

# Spatial Analysis

- Gain insight into your data by understanding spatial relationships and patterns.
  - Identify **patterns** in your data
  - Determine the best location

- Learn more about your location
- Dozens of analysis tools
- Easily use results in your apps





# Work Offline

- Build native applications that can **download maps** for use when your device goes offline. Match your business needs to one of the offline workflows to maximize your productivity.
  - Display maps
  - Edit and sync data
  - Search and geocode

- Get **routes and directions**
- Perform **analysis**



Workflows that match your business [🔗](#)

Use the *preplanned workflow* to plan map areas in advance then download optimized data to your mobile users.

Use the *on-demand workflow* to define the exact area of a map to take offline.

Use the *services workflow* to build apps that can download specific maps and layers, on request, to your device.

[Learn more about offline workflows](#)

[Try the DevLabs →](#)

# Core Concepts

## What is ArcGIS?

Explore key components of the ArcGIS Platform and learn how to leverage them in your apps.

## Web Maps

Learn about creating and displaying web maps, a JSON format for sharing 2D maps.

## Web Scenes

Learn about creating and displaying web scenes, a JSON format for sharing 3D scenes.

## Layers

Explore the different types of layers in ArcGIS and determine which is best for your use case.

## Apps, APIs and SDKs

Discover the types of applications you can build with ArcGIS and compare API and SDK options.

## REST API

Learn about the low level REST API that powers the ArcGIS Platform.

## Security and Authentication

Learn how to authenticate with the ArcGIS Platform to access user content and premium services.

## Licensing and Deployment

Once you have built your app learn how to license and deploy it.

## Features and Geometries

Learn how ArcGIS represents geometries like points lines and polygons in a common JSON format.

## Spatial References

Understand how ArcGIS works with different coordinate systems, such as WGS84 and Web Mercator.

## Common Data Types

Reference of common data structures used across the ArcGIS Platform.

# What is ArcGIS

- ArcGIS is a platform for organizations to create, manage, share, and analyze spatial data.
  - **ArcGIS Online and ArcGIS Enterprise**
    - **ArcGIS Online** - Import data, create and manage content, manage users, create groups, share content
    - **MapViewer** - Create and style 2D maps, edit data, perform analyses
    - **SceneViewer** - Create and style 3D scenes, create slides
    - **ArcGIS REST API**



# What is ArcGIS

## – ArcGIS Desktop

- ArcGIS Pro and ArcMap are part of our ArcGIS Desktop suite and allow users to publish and manage data and maps in conjunction with ArcGIS Online and ArcGIS Enterprise.

## – ArcGIS Apps

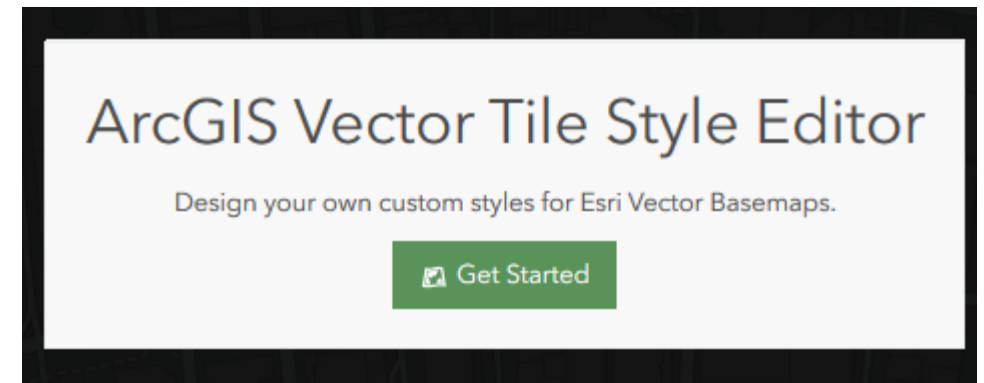
- Collector for ArcGIS - Mobile data collection app
- Navigator for ArcGIS - Highly customizable mobile routing solution
- Operations Dashboard for ArcGIS - Monitor assets in real-time and customize your dashboard.
- Explorer for ArcGIS - Discover and view GIS data in your organization.
- Workforce for ArcGIS - Mobile and web app for coordinating field work
- Survey123 For ArcGIS - Lightweight data collection and surveys

# What is ArcGIS

- **ArcGIS for Developers Tools**

- **ArcGIS Developer Dashboard** - manage apps, setup authentication, monitor credit usage, import data
- **ArcGIS Vector Tile Style Editor** - create custom styles for basemaps
- **Create a new dataset** - define a new point, line or polygon feature class for your application

The screenshot shows the ArcGIS for Developers dashboard for a public account. The top navigation bar includes links for Dashboard, Get Started, Documentation, Pricing, and Support. The user profile section identifies the user as Catalin Negru (catalin.negru, ArcGIS Public Account). A central menu offers options: New App, New Layer, Import Data, New Basemap Style, New Web Map, Documentation, ArcGIS DevLabs, and ArcGIS Online. Below this, the 'Applications' section displays a message: 'You cannot create or manage applications on ArcGIS for Developers with a public account. Please use ArcGIS Online to manage your content.' It also provides links to sign up for a free ArcGIS for Developers account or an ArcGIS Online trial. The 'Layers' section shows a similar message: 'You cannot create or manage layers on ArcGIS for Developers with a public account. Please use ArcGIS Online to manage your content.' It also provides links to sign up for a free ArcGIS for Developers account or an ArcGIS Online trial. On the left, there are sections for 'Tips' (encouraging users to try ArcGIS DevLabs) and 'APIs, SDKs, & Data' (offering downloads for APIs, SDKs, and custom data like StreetMap Premium).



# What is a web map?

- Web maps are an Esri specification that allow different applications, APIs, and SDKs to create, edit, and display maps.
- Can be used in:
  - ArcGIS Online, ArcGIS Pro, Navigator, Collector, Storymaps, Esri's configurable apps, apps made with Runtime SDKs or the JavaScript API, and many other products.
- Web map specification:
  - is in JavaScript Object Notation (JSON)
- Creating a web map:
  - ArcGIS Online, ArcGIS Pro, ArcGIS API for JavaScript, ArcGIS Runtime SDKs
    - The abbreviated JSON format of this full example of a web map of parks, trails and trailheads in Los Angeles.

```
{
  "operationalLayers":[
    {
      "id":"Parks_and_Open_Space",
      "layerType":"ArcGISFeatureLayer",
      "url":"https://services3.arcgis.com/GVgbJbqm8hXASVYi/arcgis/rest/services/Parks_and_Open",
      "visibility":true,
      "opacity":0.51,
      "title":"Parks and Open Space",
      "itemId":"f2ea5d874dad427294641d2d45097c0e",
      "layerDefinition":{" /* ... */ },
      "popupInfo":{" /* ... */ }
    },

    /* ... */
  ],
  "baseMap":{
    "baseMapLayers":[
      {
        "id":"VectorTile_2559",
        "type":"VectorTileLayer",
        "layerType":"VectorTileLayer",
        "title":"World Navigation Map",
        "styleUrl":"https://www.arcgis.com/sharing/rest/content/items/e19e9330bf08490ca8353d76",
        "itemId":"e19e9330bf08490ca8353d76b5e2e658",
        "visibility":true,
        "opacity":1
      },

      /* ... */
    ],
    "title":"World Navigation Map"
  },
  "spatialReference":{" /* ... */ },
  "authoringApp":"WebMapView",
  "authoringAppVersion": "6.2",
  "version": "2.12",
  "applicationProperties":{" /* ... */ }
}
```



# What is a web map?

- **Advantages:**

- **Standardization** for map sharing
- **Consistent** map functionality and visualization
- **Common standards** for applications that create, edit, and consume the web map specification

- **The benefits of web maps:**

- **accessible** and looks the same in other applications
- reduce development time
- the web map specification defines how to display pop-ups for a layer and do **not require writing custom code**

# Layers

- The primary content of applications:
  - based on services exposed via:
    - the ArcGIS REST API, GeoJSON, CSV or other **files** available on disk or over a network
    - also be created in the application itself – for example, by **graphics** that store arbitrary user input
  - logical collections of geographic data: used to create maps and applications
    - two types: **feature layers** or **tile layers**
- Feature layers:
  - store geographic features (points, lines, polygons)
  - edit or update attributes
  - synchronize with offline databases
- Tile layers:
  - pre-generated
  - composed of cached tiles stored on a server
  - Example: vector tile basemaps

## Core ArcGIS Layer types

Layer Type	REST API Service	Hosted In		Cached <sup>[2]</sup>	Use Cases
		ArcGIS Online <sup>[1]</sup>	ArcGIS Enterprise		
Feature Layer	<a href="#">Feature Service</a>	✓	✓		Querying, rendering, and editing, vector geographic information.
Tile Layer	<a href="#">Map Service</a>	✓	✓	✓	Basemaps and other complex datasets that change infrequently. Tiles can be kept in sync with feature layers for operational data.
Vector Tile Layer	<a href="#">Vector Tile Service</a>	✓	✓	✓	Basemaps and other complex datasets that change infrequently. Tiles can be kept in sync with feature layers for operational data.
Dynamic Map Layer	<a href="#">Map Service</a>		✓		Complex data sets that change frequently or need complex rendering requirements.
Image Layer	<a href="#">Image Service</a>		✓		Rendering and analyzing satellite or other imagery data.
Scene Layer	<a href="#">Scene Service</a>	✓	✓	✓	Displaying and rendering 3D datasets.



# Working with layers

- In APIs and SDKs:
  - adding many different types of layers to maps
  - each layer type is implemented as a class
  - will be documented as part of your chosen API or SDK
- ArcGIS REST API:
  - All core ArcGIS layer types are backed by a **service** hosted on an instance of ArcGIS Server
  - Clients like the ArcGIS APIs and SDKs interact with these services via the ArcGIS REST API
  - You can also use the REST API to build your applications and create new and unique functionality manually
- In Web Maps:
  - can be added to a web maps **basemapLayers** or **operationalLayers** properties and referenced:
    - by their item id in ArcGIS Online or ArcGIS Enterprise
    - or by the URL to their REST API Service

# Creating layers

- Feature Layers
  - ArcGIS DevLabs: Import CSV, GeoJSON, Shapefile or File GeoDatabase
  - ArcGIS DevLabs: Define a schema for a new empty Feature Layer
  - ArcGIS Online: Publish feature layers from a variety of formats
  - ArcGIS Enterprise: Publish features
  - ArcGIS Pro: Create and share feature layers with ArcGIS Pro
- Tile Layers:
  - ArcGIS Online: Publish tiles
  - ArcGIS Pro: Publish tiles
- Vector Tile Layers:
  - ArcGIS Pro: Publish scene layers
- Dynamic Map Layers:
  - ArcMap: Publish a map service

# APIs, SDKs and Apps

- Types of apps:
  - extend an existing ArcGIS application like ArcGIS Pro;
  - customize a configurable application;
  - create a completely custom application from scratch.
- ArcGIS apps:
  - ArcGIS Desktop - A desktop suite of GIS apps including ArcGIS Pro and ArcMap
  - Collector for ArcGIS - Mobile data collection app
  - Navigator for ArcGIS - Highly customizable, mobile routing solution
  - Operations Dashboard for ArcGIS - Realtime, customizable dashboard
  - Explorer for ArcGIS - Discover and view GIS data in your organization
  - Workforce for ArcGIS - Mobile and web app for coordinating field work
  - Survey123 For ArcGIS - Lightweight app for data collection and surveys



# Configurable apps and app builders

- ArcGIS Online and ArcGIS Enterprise include pre-built configurable applications to customize and extend:
  - can be downloaded and customized by developers;
  - a comparison of configurable apps.
- Web AppBuilder :
  - uses a WYSIWYG widget-based interface;
  - Web AppBuilder Developer Edition
- AppStudio:
  - publishes mobile applications based on templates;
  - AppStudio Standard
- Custom apps:
  - a variety of APIs and SDKs targeting different use cases and platforms

## Choosing an ArcGIS API or SDK

- Native strategies:
  - offer the best **device integration**
  - the most out-of-the-box **functionality** for apps that have both connected and offline workflows,
  - they require **native development** skills.
  - use ArcGIS Runtime SDKs to create native apps.

# Choosing an ArcGIS API or SDK

- Web strategies:
  - use HTML, JavaScript, and CSS
  - **hosted** on a web server
  - **delivered** to the user's device or desktop using its web browser.
  - are best if you don't know which devices your users have
  - use ArcGIS Maps SDK for JavaScript to create web client solutions.

# Choosing an ArcGIS API or SDK

- User and team needs:
  - Who is the target **audience** (internal or consumer public)?
  - What **functionality** (mapping, advanced spatial analysis, etc.) is required to support the application?
  - Are your users sometimes disconnected and do they need the app to **run offline**?
  - What **skills** does your current development team have?
  - What **data and web services** are required to support the application?
  - Are there requirements for **device integration**, such as use of the device's GPS, compass, media, calendar, contacts, text messaging (SMS), notifications, etc.?

# General differences across platforms

Consideration	Native strategy	Web strategy
Which devices do your users prefer?	Target each operating system (OS) and deliver the best native experience. This means writing an app for each OS or taking advantage of <a href="#">cross-platform development</a> options.	Build a single web application for use in browsers on all devices.
What skills do you have?	Requires skills developing on each native platform (for example, Objective-C for iOS, Java for Android, and .NET for Windows). However, several Runtime SDKs provide <a href="#">cross-platform development</a> options.	Requires HTML, JavaScript, and CSS knowledge.
Do you want to distribute the app through a store (App Store, Google Play, Windows Store, Amazon)?	Distribution through a store is supported.	Distribution through a store is supported with use of additional frameworks <sup>[1]</sup> .
Access to device capabilities	Access to all device capabilities (touch, GPS, compass, calendar, media, contacts, camera, and so on)	Limited to what the browser running the app supports. For example GPS is supported on most modern browsers. Some mobile browsers also allow accessing the camera and using the devices compass.
Performance	Native performance	Typically less than native performance.
Maintenance across multiple devices and desktops	App updates require ad-hoc, enterprise, or store distribution.	App updates are immediately available to all users on all devices <sup>[2]</sup> .



## Cross-platform development with ArcGIS

	Android	iOS	Windows	macOS	Linux
ArcGIS Runtime SDK for Android	✓				
ArcGIS Runtime SDK for iOS		✓			
ArcGIS Runtime SDK for Java <sup>[1]</sup>			✓	✓	✓
ArcGIS Runtime SDK for macOS				✓	
ArcGIS Runtime SDK for .NET <sup>[2]</sup>	✓	✓	✓		
ArcGIS Runtime SDK for Qt <sup>[3]</sup>	✓	✓	✓	✓	✓
ArcGIS API for JavaScript <sup>[4]</sup>	✓	✓	✓	✓	✓
Web AppBuilder for ArcGIS <sup>[4]</sup>	✓	✓	✓	✓	✓
AppStudio for ArcGIS <sup>[5]</sup>	✓	✓	✓	✓	✓
ArcGIS REST API <sup>[6]</sup>	✓	✓	✓	✓	✓

# Hybrid strategies

- Use a mix of web app content
  - (HTML, JavaScript, and CSS) and
  - **native components** to build native applications
  - includes **frameworks** such as Apache Cordova or Electron.
- Often used if:
  - Expanded access to **native device capabilities**:
    - such as push notifications, contacts and calendars and
    - storage is desirable.
  - Development teams have
    - extensive experience with web apps and
    - little experience with native apps.
- The main approach is to **embed web content into a native application**:
  - API such as WebView (on Android) or WKWebView (on iOS)

# The ArcGIS REST API

- ArcGIS provides a rich set of
  - geospatial, mapping, and administrative **functionality**
  - through **web services** that are exposed
  - through the ArcGIS **REST API**
- Premium ArcGIS Online APIs:
  - Geocoding and place search, Directions and routing, Demographic and lifestyle data Spatial analysis, Elevation analysis

# The ArcGIS REST API

- ArcGIS Server REST API:
  - allows to work with **services** published to either ArcGIS Enterprise or ArcGIS Online
  - Ex: import data into ArcGIS Online, a Feature Layer is created that is hosted on an instance of ArcGIS Server
    - access layer with the ArGIS REST API provided by ArcGIS Server.
- Types of layers and services provided by ArcGIS Server:
  - Feature Services
  - Map Services
  - Geoprocessing Services
  - Image Services

# Authentication in ArcGIS

- The application requires authentication when it tries to:
  - Access a user's private content
  - Create, edit, and publish content
  - Access premium content and services
- Security methodologies:
  - OAuth 2.0 (OAuth):
    - The platform determines user authenticity and
    - a token is supplied to the client app



# Authentication in ArcGIS

- Token-based:
  - app provides a valid username and password for the user
  - In the response, you receive a token that is included with requests for secured content on the portal for authenticated resources
- Public Key Infrastructure (PKI):
  - public and private digital keys support authentication and secure communication over insecure networks
  - the use of ArcGIS Web Adaptors
- HTTP/Windows Authentication (HTTP basic, HTTP digest or Integrated Windows Authentication (IWA))

## Features and Geometries in ArcGIS

- Dedicated JSON specification to define geographic data for use on the map:
  - **Points** define a single location on the map, such as a user's location
  - **Polylines** define a series of points representing a line, such as a road or a river
  - **Polygons** define closed shapes, such as the outline of a lake

# Features and Geometries in ArcGIS

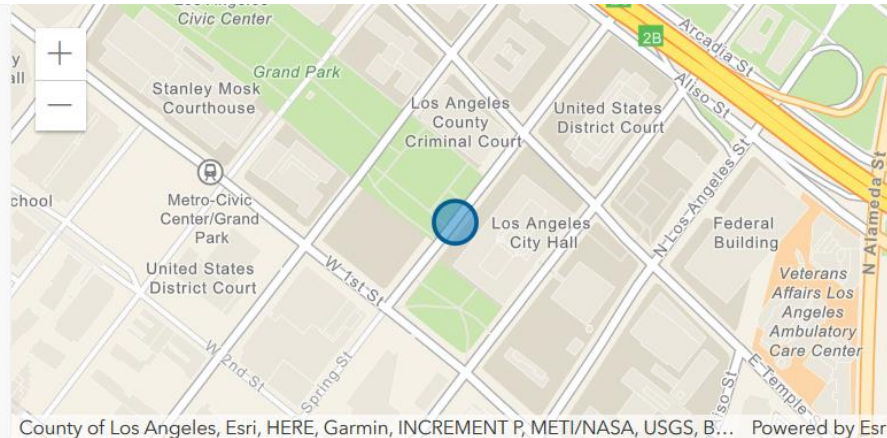
- **Extents** define closed rectangular shapes, such as the outline of a building.
- **Features** consist of a geometry (point, line or polygon) and additional attributes (like a name) and a symbol that represents how the feature is rendered on the map.
- **Feature Sets** define a series of features of the same geometry, such as polygons representing US states.
- **Feature Collections** can define a series of feature sets as well as common rendering rules and information about the attributes each feature contains.

# Points

- Represent a single specific location:
  - such as an address, users location, or asset.
  - are required to have at least three properties:
    - x - The location of the point along the x axis
    - y - The location of the point along the y axis
    - spatialReference - Defines the measurement system used to locate the polygon on a model of the Earth

- may also optionally contain z and m properties.
  - z refers to elevation
  - m represents an arbitrary linear measurement that is independent of point's location.

```
{  
  "x": -118.24354,  
  "y": 34.05389,  
  "spatialReference": {  
    "wkid": 4326  
  }  
}
```



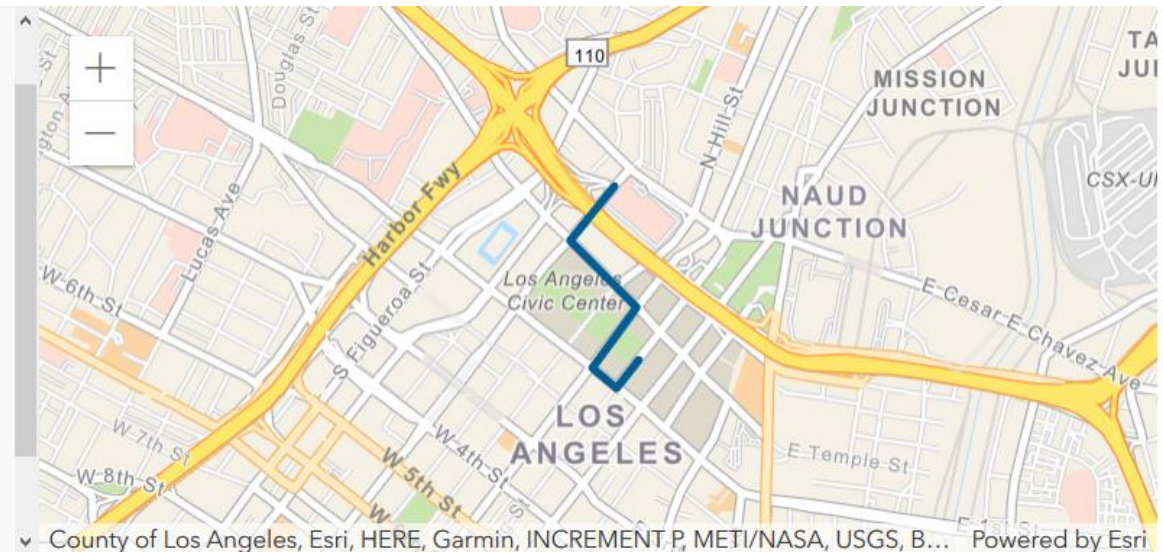
- **wkid** or Well Known ID) identifies the spatial reference used to articulate the point's location.
- **4326** is the standard system commonly used by GPS

The x axis represents longitude and the y axis represents latitude.

# Polylines

- Represent unclosed lines between two or more points:
  - A line might represent a wall or barrier, a trail or road or a route between two locations;
  - Polylines can include individual segments that do not touch;
  - Have two key top-level properties:
    - paths - An array of paths, each path is an array of coordinates pairs in [x, y] format.
    - spatialReference
    - Each coordinate pair can also have a z and/or m as the third or fourth item in the coordinate array.
    - If a polyline has z and/or m in it's coordinates the hasZ and/or hasM properties will be present and set to true

```
"paths": [  
  [  
    [ -118.24354, 34.05389 ],  
    [ -118.24446, 34.05294 ],  
    [ -118.24554, 34.05364 ],  
    [ -118.24358, 34.05576 ],  
    [ -118.24448, 34.05649 ],  
    [ -118.24643, 34.05814 ],  
    [ -118.24454, 34.06001 ]  
  ],  
  "spatialReference": {  
    "wkid": 4326
```



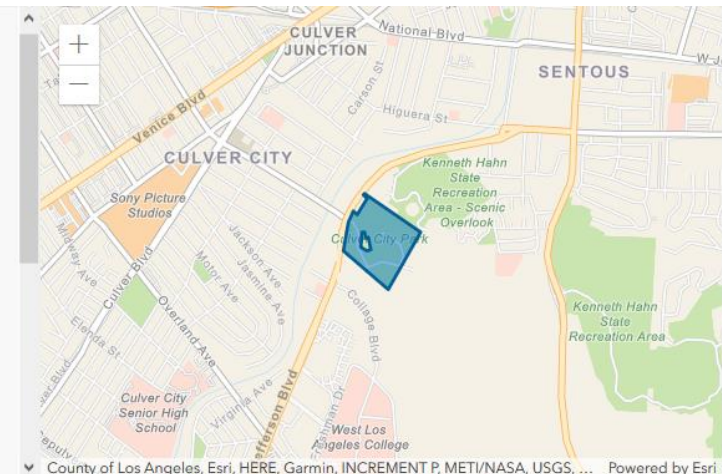


# Polygons

- Represent closed and filled shapes such as state or country boundaries, parks or building footprints
- Can include both holes and non-overlapping geometries
- Have two key top-level properties:
  - rings - An array of rings
    - clockwise rings are filled and
    - counterclockwise rings are considered holes
    - each ring is an array of [x, y] coordinate pairs
  - spatialReference

```
{
  "rings": [
    [
      -118.38516, 34.01270 ],
      -118.38827, 34.01489 ],
      -118.38813, 34.01602 ],
      -118.38797, 34.01648 ],
      -118.38760, 34.01712 ],
      -118.38733, 34.01696 ],
      -118.38696, 34.01749 ],
      -118.38662, 34.01789 ],
      -118.38689, 34.01805 ],
      -118.38683, 34.01812 ],
      -118.38295, 34.01592 ],
      -118.38516, 34.01270 ]
    ],
    [
      -118.38661, 34.01486 ],

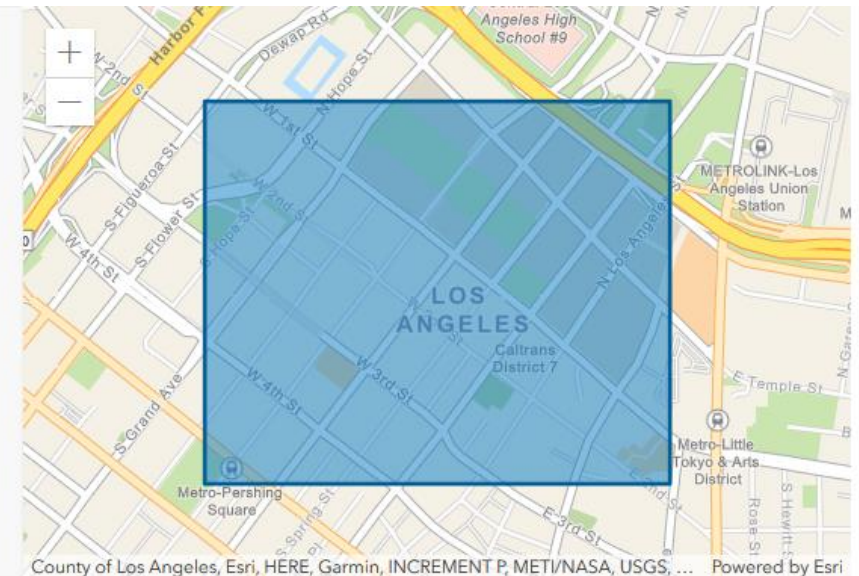
```



# Extents

- Represent rectangular shapes that are commonly used to center the map on a particular area of interest
- Are also commonly referred to as envelopes or bounding boxes
- Have five key top level properties:
  - xmin - The lowest value of the extent along the x-axis.
  - ymin - The lowest value of the extent along the y-axis.
  - xmax - The highest value of the extent along the x-axis.
  - ymax - The highest value of the extent along the y-axis.
  - spatialReference

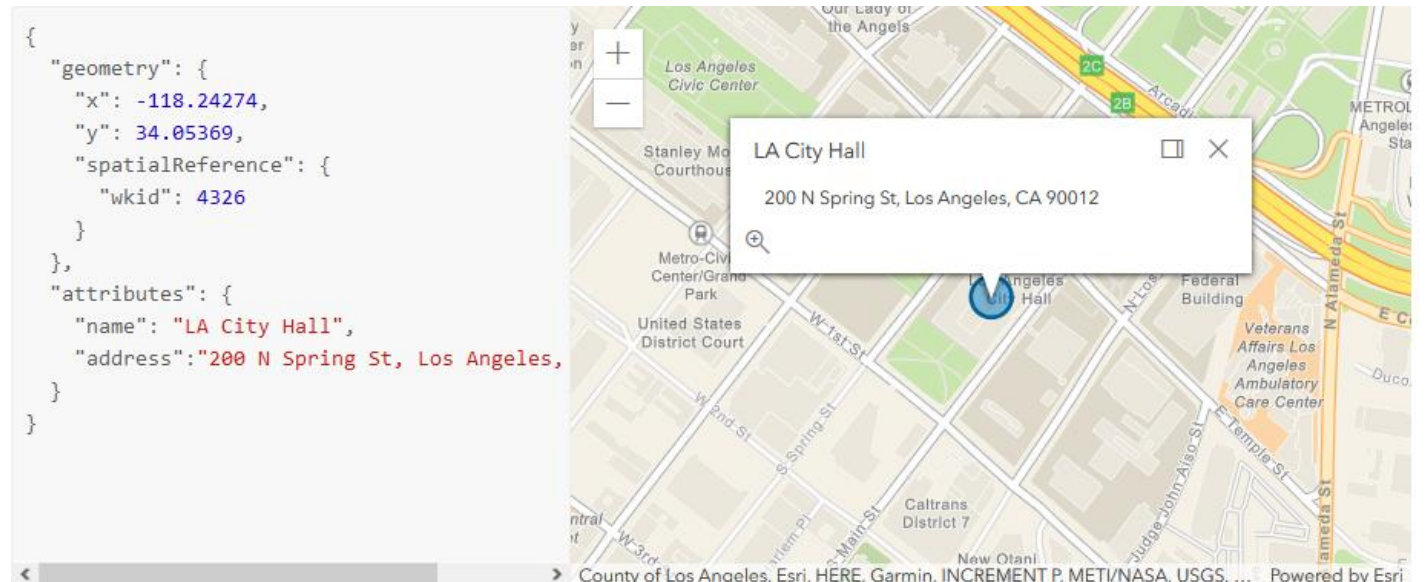
```
{  
  "xmin": -118.252655,  
  "ymin": 34.048244,  
  "xmax": -118.239434,  
  "ymax": 34.057265,  
  "spatialReference": {  
    "wkid": 4326  
  }  
}
```



# Features

- Used to associate tabular data with geographic information
- This additional information can be used to affect the rendering of the feature
- Provide additional metadata to services
  - be displayed in popups or used to filter features on the map
- Have two important top-level properties:
  - geometry - A point, polyline, polygon or extent object
  - attributes - An object of key/value pairs in JSON format to associate with the geometry

In the web map specification features can also accept a symbol property which represents how this feature will be visualized on the map



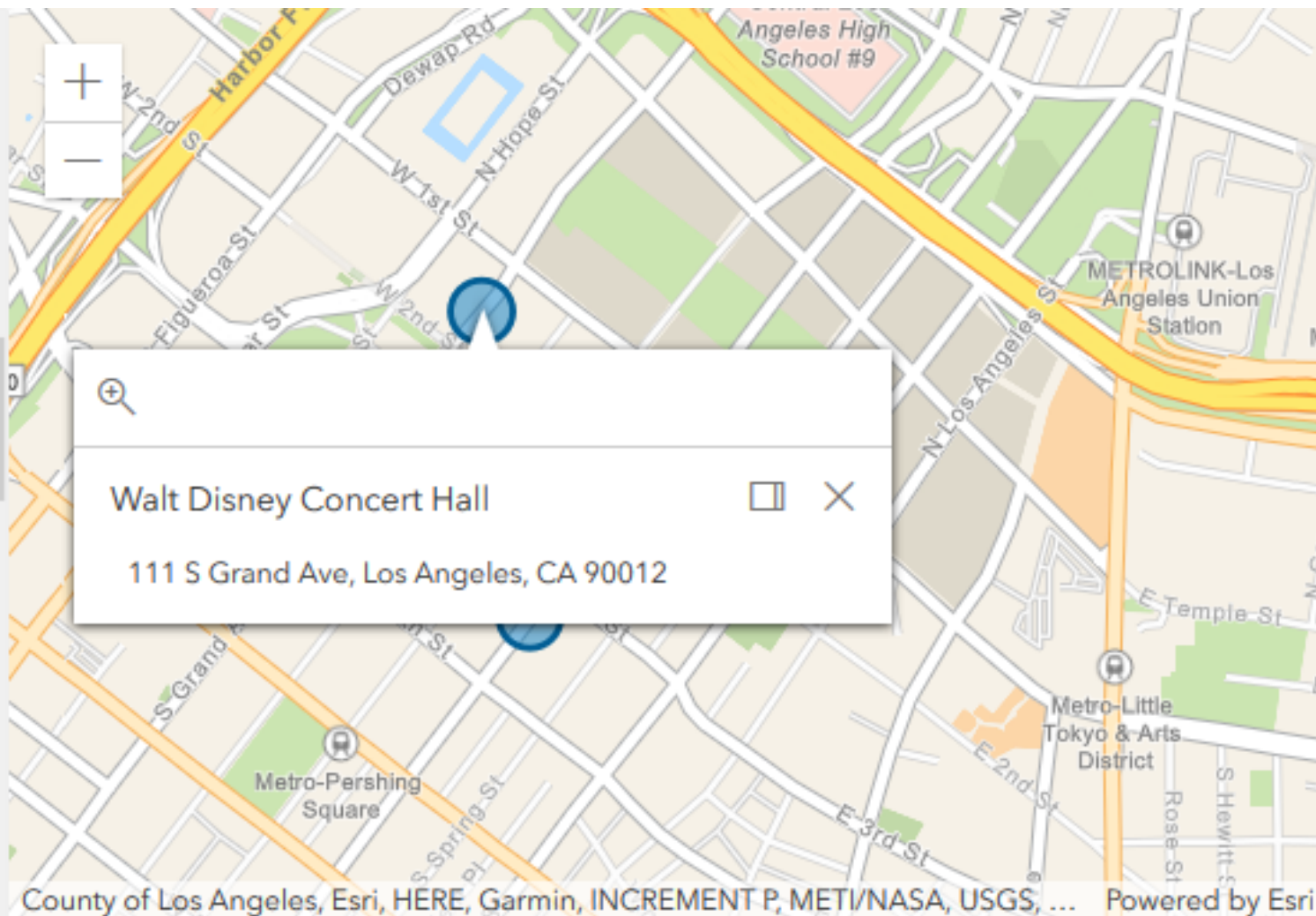
# Feature Sets

- Are groups of features that share a common geometry type, spatial reference and attribute information
- Commonly used to represent groups of similar features, especially as parameters to, or responses from API methods.
- Have two important top-level properties:
  - features - An array of features.
  - spatialReference - Defines the measurement system used to locate the features on a model of the Earth. See introduction the Introduction to Spatial Reference Systems.
  - fields - An array of objects with a name, alias and type. These fields define valid attributes of each feature.
  - objectIdField - Indicates which field holds the unique ID of the feature.
  - geometryType - Indicates the type of geometry of the features, esriGeometryPoint, esriGeometryPolyline or esriGeometryPolygon



# Feature Sets

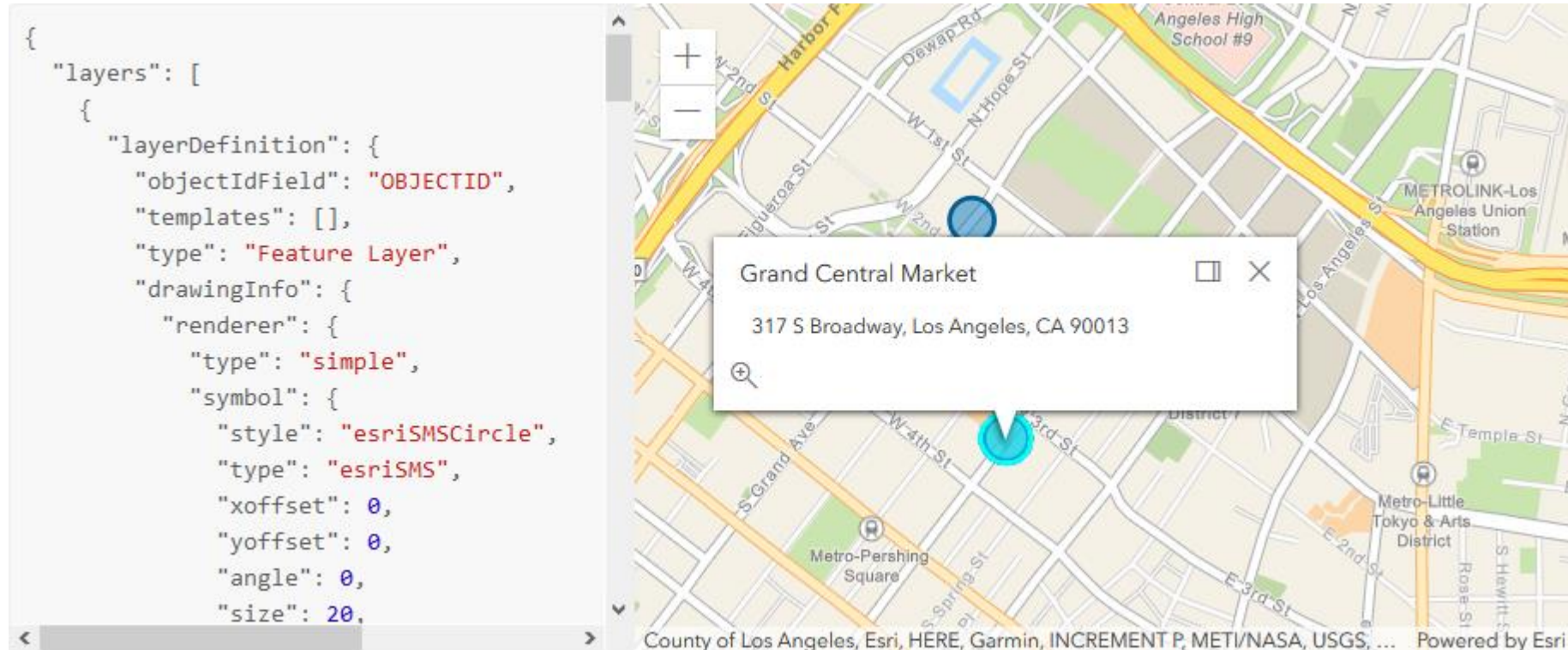
```
},  
"objectIdField": "OBJECTID",  
"geometryType": "esriGeometryPoint",  
"features": [  
  {  
    "geometry": {  
      "x": -118.24274,  
      "y": 34.05369,  
      "spatialReference": {  
        "wkid": 4326  
      }  
    },  
    "attributes": {  
      "OBJECTID": 1,  
      "name": "LA City Hall",  
      "address": "200 N Spring St, Los Angeles, CA 90012"  
    }  
  }  
],  
}
```





# Feature Collections

- Feature collections are similar to feature sets with several important differences:
  - Feature collections can have multiple layers, each layer can have its own distinctive geometry types, fields and features.
  - Feature collections can be rendered as a part of the [web map] and [web scene] specifications.
  - Feature collections can be saved as items in ArcGIS Online or ArcGIS Enterprise and shared in multiple maps or applications.



# Spatial References

- Are a key component of writing spatial applications
- Helps describe where features are located in the real world.
- Different spatial reference systems are used for different purposes
- Spatial reference and coordinate system used interchangeably although they are slightly different.
- Spatial references fall into two categories, geographic and projected:
- Geographic coordinate systems
  - uses an ellipsoidal surface to define locations on the Earth
  - are three parts to a geographic coordinate system:
    - A datum - an ellipsoidal (spheroid) model of the Earth to use. Common datums include WGS84 (used in GPS) and NAD83 (used in surveying and mapping in North America).
    - A prime meridian
    - Angular unit of measure
      - Ex: 4326 spatial reference

```
GEOGCS["GCS_WGS_1984",  
  DATUM["D_WGS_1984",  
    SPHEROID["WGS_1984",6378137,298.257223563]],  
  PRIMEM["Greenwich",0],  
  UNIT["Degree",0.017453292519943295]]
```

# Spatial References

- Projected coordinate systems
  - define a flat 2D Cartesian surface
  - as constant lengths, angles, and areas across the two dimensions
  - A projected coordinate system is always based on a geographic coordinate system that references a specific datum.
  - Ex: 3857 spatial reference

```
PROJCS["WGS_1984_Web_Mercator_Auxiliary_Sphere",  
  GEOGCS["GCS_WGS_1984",  
    DATUM["D_WGS_1984",  
      SPHEROID["WGS_1984",6378137.0,298.257223563]],  
    PRIMEM["Greenwich",0.0],  
    UNIT["Degree",0.017453292519943295]],  
  PROJECTION["Mercator_Auxiliary_Sphere"],  
  PARAMETER["False_Easting",0.0],  
  PARAMETER["False_Northing",0.0],  
  PARAMETER["Central_Meridian",0.0],  
  PARAMETER["Standard_Parallel_1",0.0],  
  PARAMETER["Auxiliary_Sphere_Type",0.0],  
  UNIT["Meter",1.0]]
```

# Using spatial references

- Generally, when using ArcGIS APIs and SDKs, conversions between different spatial references are automatically made for you
- In some cases, you do need to supply the spatial reference.
- Spatial reference is usually defined with a JSON object
- Commonly used coordinate reference systems:
  - 4326 – GPS
    - the most common spatial reference for storing a referencing data across the entire world.
    - It serves as the default for both the PostGIS spatial database and the GeoJSON standard.
    - It is also used by default in most web mapping libraries.
    - is generally assumed to be the spatial reference when talking about "latitude" or "longitude".
  - 3857 - Web Mercator:
    - the default in most web mapping libraries.
    - Web Mercator preserves a consistent direction and north is always "up" on a Web Mercator map.
    - Angles are also depicted accurately, so a 90-degree turn on a Web Mercator map will actually look like a right angle
    - il ideal for generating map tiles since it will project the world into a square that can be subdivided evenly across zoom levels. For example one tile at zoom level 1, four tiles at zoom level 2 and so on.

```
{  
  wkid: 4326  
}
```