UNB

XML-based languages for Geography & Mapping

- GML – Geography Markup Language
- SVG – Scalable Vector Graphics
- KML – Keyhole Markup Language

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XML and Data

- XML…
  - Has been built to support traditional applications (office and banking)
- What about applications involving **non-traditional** data ?
  - Other formats … **based on XML** have been proposed
  - E.g.,
    - Open GIS Consortium (OGC) recently published the **Geography Markup Language** (GML)

XML Infrastructure

- XML Syntax
  - XML is a textual representation of data
  - Consists of…
    - **Elements**
    - **Attributes**

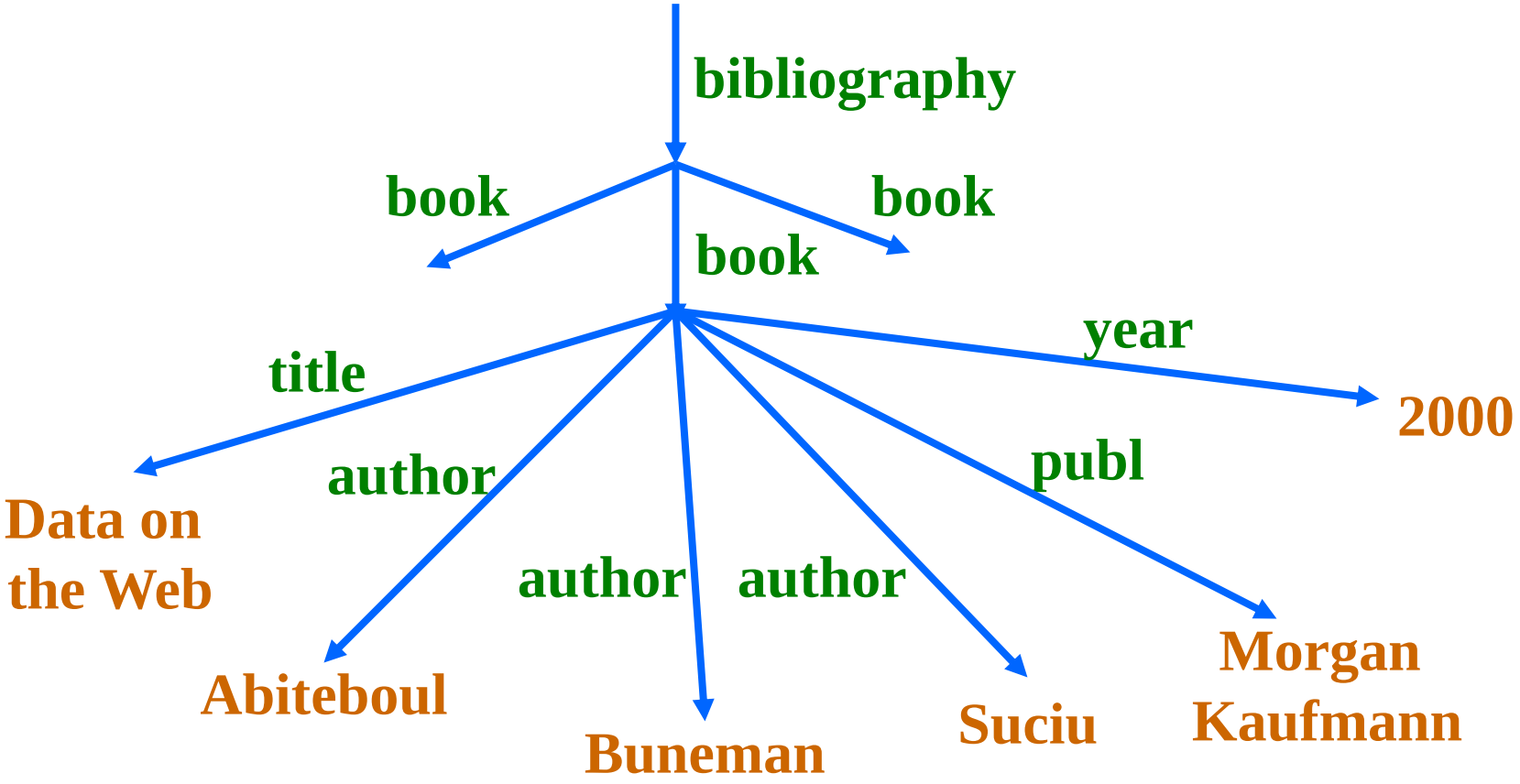
XML Infrastructure

- XML Syntax example (nested elements)

```
<bibliography>
   <book>
      <title>Data on the Web</title>
      <author>Abiteboul</author>
      <author>Buneman</author>
      <author>Suciu</author>
      <publ>Morgan Kaufmann</publ>
      <year>2000</year>
   </book>
   …
</bibliography>
```

XML Infrastructure

- XML diagram (**tree**) example …



XML Infrastructure

- XML Syntax
  - XML allows to associate **attributes** with elements, e.g.,

```
<book price="40" currency="Euro">
   <title>Data on the Web</title>
   <author>Abiteboul</author>
   …
</book>
```

  - Attributes are alternative ways to represent data

XML Infrastructure

- XML Syntax
  - XML allows to associate **unique identifiers** to elements as the value of a certain attribute
  - Using the attribute **idref** it is possible to **refer to** that element
  - This is an XML mechanism for describing

    Graphs rather than **trees**

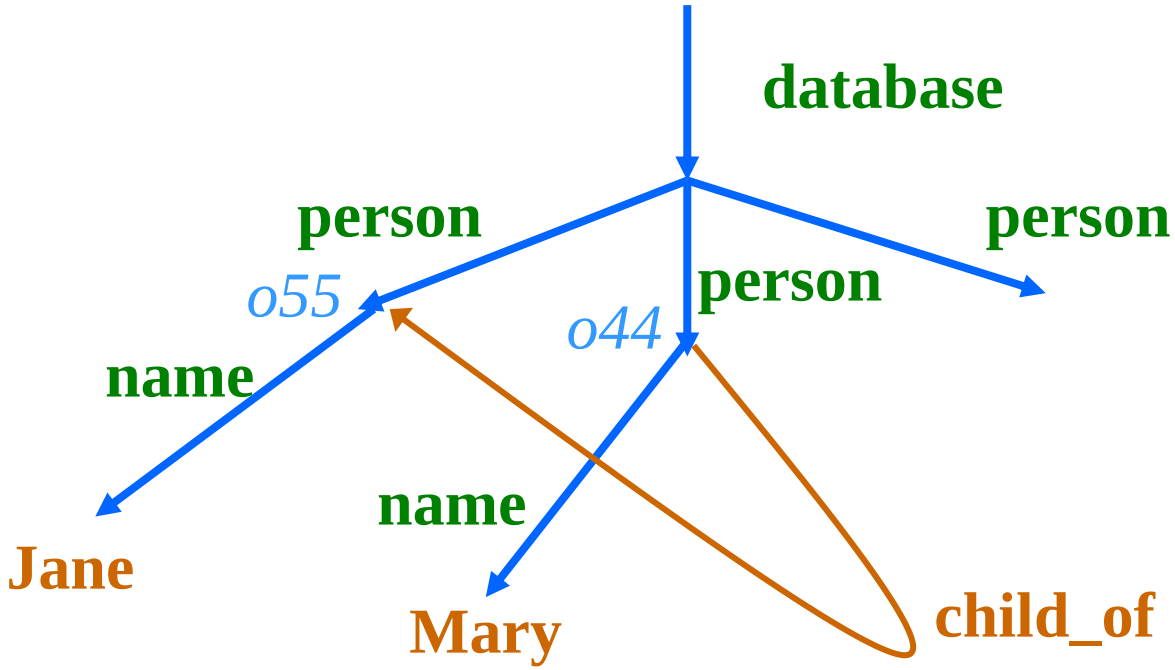
XML Infrastructure

- XML Syntax example

```
<database>
    <person id="o55">
        <name>Jane</name>
    </person>
    <person id="o44">
        <name>Mary</name>
        <child_of idref="o55"/>
    </person>
    …
</database>
```

XML Infrastructure

- XML diagram (**graph**) example …



XML and Databases

- Structuring XML with…
  - **Document Type Definitions (DTD)…**
  - **XML Schema Definitions (XSD)**…

XML and Databases

```
<parcel id= "P123x">
    <owner>John Smith</owner>
    <area>1200</area>
</parcel>
```

- Structuring XML with…
  - **Document Type Definitions (DTD)**…

```
<!ELEMENT parcel (owner, area)>
<!ATTLIST parcel id CDATA>
<!ELEMENT owner (#PCDATA)>
<!ELEMENT area (#PCDATA)>
```

XML and Databases

```
<parcel id= "P123x">
    <owner>John Smith</owner>
    <area>1200</area>
</parcel>
```

- Structuring XML with…
  - **XML Schema Definitions (XSD)**…

```
<schema xmlns="http://www.w3.org/2001/XMLSchema">
   <element name="parcel">
      <complexType>
         <sequence>
            <element name="owner" type="string"/>
            <element name="area" type="unsignedInt"/>
         </sequence>
         <attribute name="id">
            <simpleType>
               <restriction base="string">
                  <pattern value="P\d{3}[A-Za-z]{1}"/>
               </restriction>
            </simpleType>
         </attribute>
      </complexType>
   </element>
</schema>
```

Geographic Applications

- XML …
  - has been adopted widely in geography
  - It is already a standard for geo-data sharing
- Main formats …
  - **GML**
    - Geography Markup Language
  - **SVG**
    - Scalable Vector Graphics
  - **KML**
    - Keyhole Markup Language

an appropriate schema definition

Geographic Applications

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an appropriate schema definition

Geography Markup Language (GML)

- An **XML-based** encoding standard
  - for **transport and storage** of geo-information
  - including both spatial and non-spatial features
- Developed by …
  - the Open Geospatial Consortium – **OGC**

    { >300 companies, government agencies and universities }

http://www.opengeospatial.org/

Geography Markup Language (GML)

http://www.opengeospatial.org/

Geography Markup Language (GML)

- **GML versions …**
  - Initial release: GML specification
    - based on DTD; not used anymore
  - Feb. 2000: GML2 specification
    - based on XMLSchema
  - Current (since 2003): **GML3** specification
    - based on XMLSchema; includes spatial relationships, 3D geometry, and time

Geography Markup Language (GML)

- GML is **Text**…
  - Like XML encoding…
    - GML represents geo-info in the form of **text**
  - Some year ago…
    - This might be censurable
  - Today…
    - This is desirable!
  - Text has advantages
    - Easy to inspect / Easy to change
  - Text formats for geography…
    - have been employed in the past (e.g., SAIF, VRML)

Geography Markup Language (GML)

- What is so different about GML ?
  - There are already…
    - Many encoding standards for GI
      - COGIF, SAIF, DLG, SDTS
  - Why GML ?
    - A simple text based encoding
    - Based on a common model of geography
      - OGC Abstract Specification
      - Developed and agreed by the vast majority of all GIS vendors
    - GML is based on XML

Geography Markup Language (GML)

- GML provides
  - A **rich schema** for describing various **geometry types**
  - Three non-spatial attributes (properties) for each geographic entity (feature)
    - **fid (identifier)**
    - **name**
    - **description**

Geography Markup Language (GML)

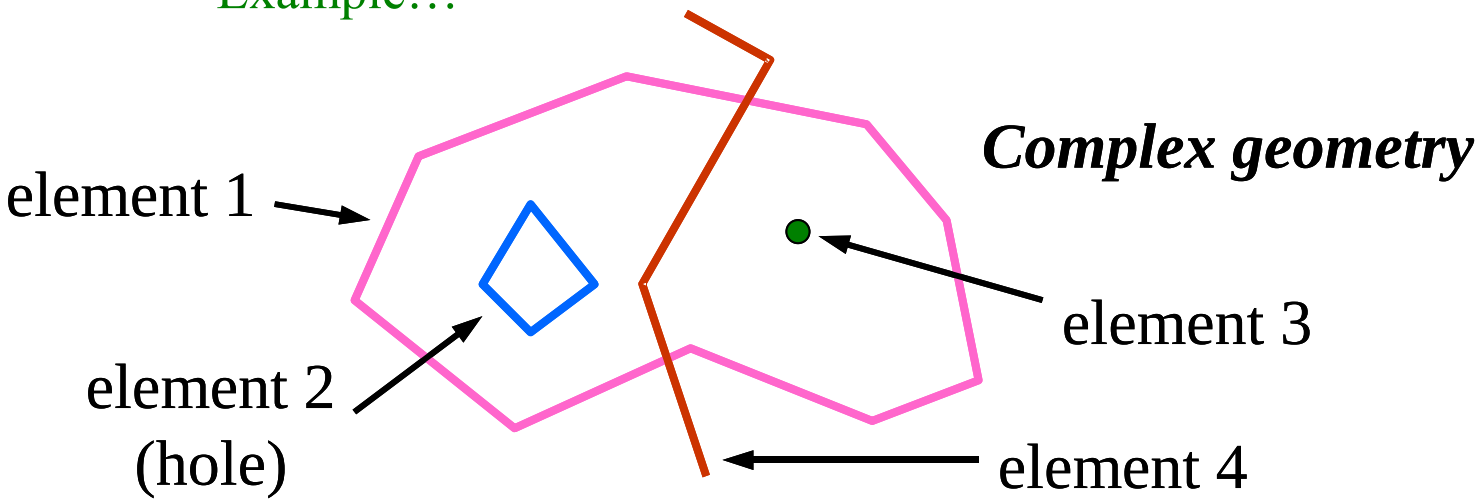
- Terminology
  - GML Encodes Geographic Features
    - GML is based on…
      - The OGC abstract model of geography
    - Feature = Entity
      - A list of properties and geometry
    - Feature Property
      - Usual Name / type / value description
    - Feature Geometry
      - Basic building blocks
        - » points, lines, curves, surfaces and polygons
      - Current version
        - » 3D geometry / topological relationships / Time

Geography Markup Language (GML)

- GML Encodes Geographic Features
  - GML encoding allows …
    - Quite complex features
  - A feature can be …
    - Composed of other features
  - Example…
    - A Railway Station (RS)
      - is a single feature
    - composed of other features
      - Platforms
      - Ticket halls
      - Bus and taxi ways
      - Cafeterias and restaurants

Geography Markup Language (GML)

- GML Encodes Geographic Features
  - Same applies to geometry
    - A geometrically complex feature
    - composed of many geometric elements
      - Points / Line strings / Polygons
      - Example…



Geography Markup Language (GML)

- GML Encodes Feature Geometry

```
<MiddleSchool ID ="145l">
    <extentOf
        <Polygon srsName="epsg:27354">
            <outerBoundaryIs>
                <LinearRing>
                    <coordinates>
                        491888.99,5458045.99 491904.72,5458044.91
                        491908.42,5458064.58 491924.61,5458064.33
                        491925.62,5458079.59 491977.66,5458120.36
                    </coordinates>
                </LinearRing >
            </outerBoundaryIs>
        </Polygon>
    </extentOf>
</MiddleSchool >
```

Geography Markup Language (GML)

- GML Encodes Feature Properties

```
<feature ID ="145l">
      <name>Balmoral Middle School</description>
      <description>Middle School</description>
      <extentOf
            <Polygon srsName="epsg:27354">
                  <outerBoundaryIs>
                        <LinearRing>
                              <coordinates>
                                    …
                              </coordinates>
                        </LinearRing >
                  </outerBoundaryIs>
            </Polygon>
      </extentOf>
</feature >
```

Properties (other than geometry)

Geography Markup Language (GML)

- GML Encodes Feature Properties

```
<feature ID ="145l">
    <name>Balmoral Middle School</description>
    <description>Middle School</description>
    <NumStudents>987</NumStudents>
    <NumFloors>3</NumFloors>
    <extentOf
        <Polygon srsName="epsg:27354">
            <outerBoundaryIs>
                <LinearRing>
                    <coordinates>
                        …
                    </coordinates>
                </LinearRing >
            </outerBoundaryIs>
        </Polygon>
    </extentOf>
</feature >
```

Properties

(other than geometry)

Application specific attributes to be stored in the **application schema**

GML Schemas

- A GML document
  - describes the content related to a specific geographic application domain
  - Hence, it must be compliant with both
    - GML (base) Schema
    - GML Application Schema

GML (vs) Application Schema

- GML Schema
  - It is **horizontal** and not focused on a specific application domain
  - It provides **common constructs** and concepts which may be used by all the different application domains

GML (vs) Application Schema

- GML Schema
  - Basic geometry (0d, 1d, 2d, 3d)
  - Coordinate reference systems
  - Topology
  - Temporal information and dynamic features
  - Units, measures and values
  - Directions
  - Observations
  - Coverages
  - Default styling
  - etc.

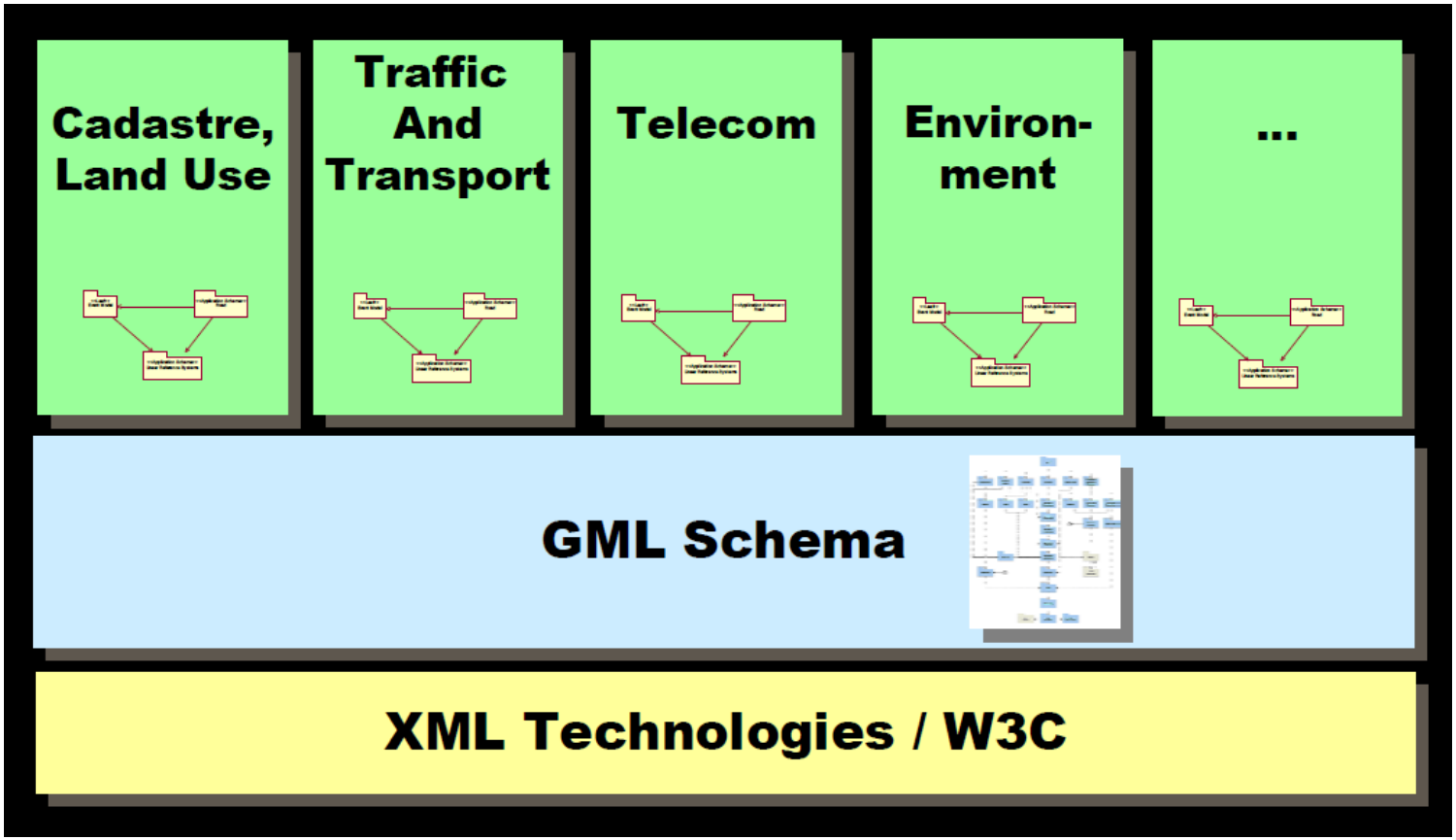
GML (vs) Application Schema

- Application Schema
  - It **extends** the GML Schema
  - It offers all additional features required by the application domain

    - GML (Feature) Schema
      - It support feature collections (as feature types)
      - It includes common properties
        - **fid (identifier)**
        - **name**
        - **description**

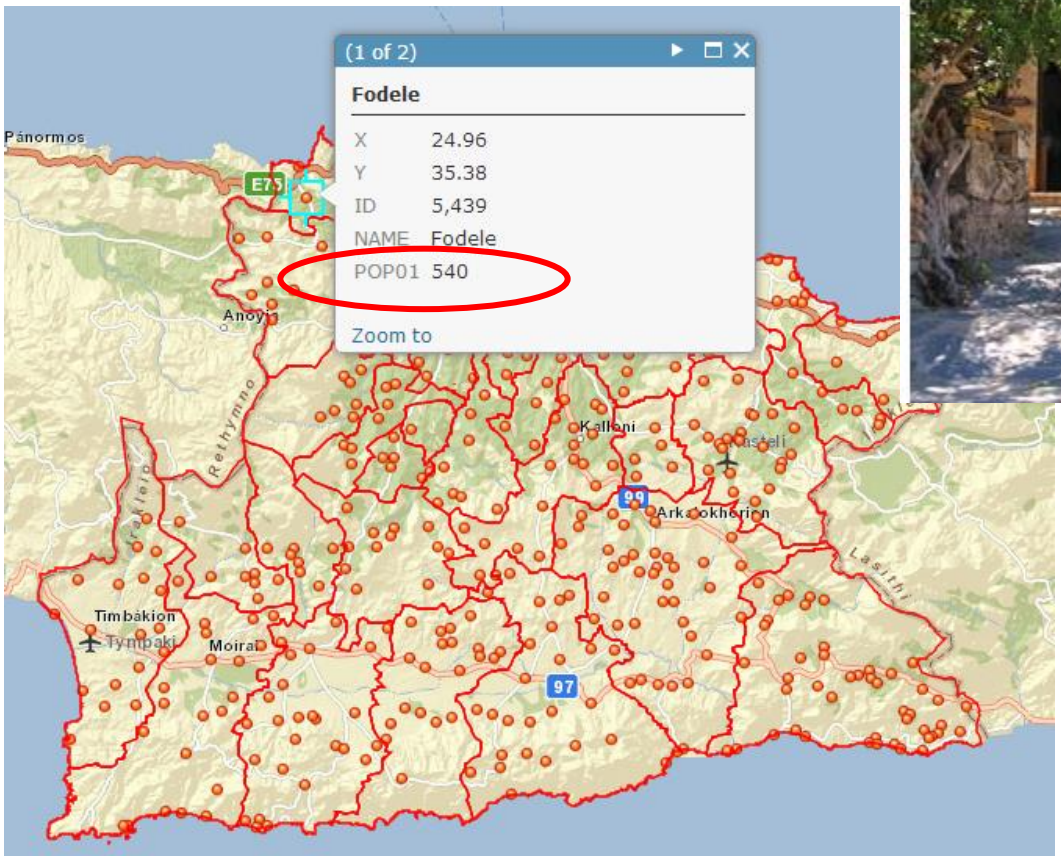
GML (vs) Application Schema

- Application Schema



Example GML document

El Greco, born Doménikos Theotokópoulos, (1541 – 7 April 1614) was a painter, sculptor and architect of the Spanish Renaissance. "El Greco" (The Greek) was a nickname



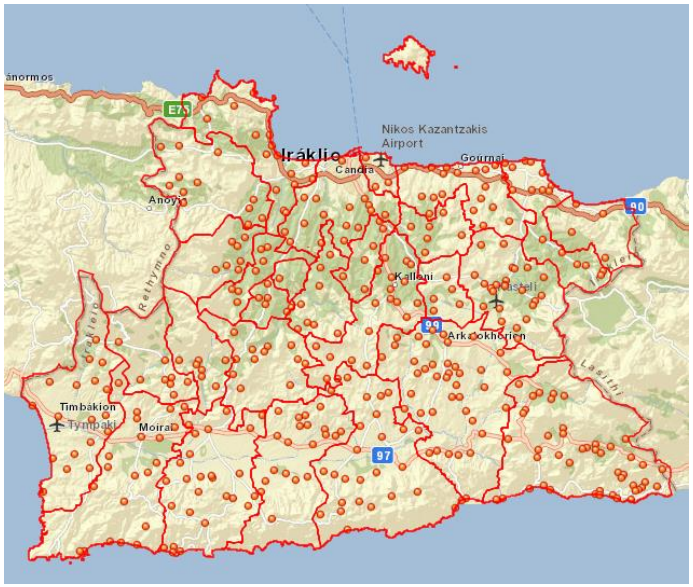
Example GML document

- GML format can accommodate …
  - **fid (identifier)**
  - **name**
  - **description**

```
<ogr:towns fid="towns.3">
   <ogr:geometryProperty>
      <gml:Point>
         <gml:coordinates>24.96,35.38</gml:coordinates>
      </gml:Point>
   </ogr:geometryProperty>
   <ogr:ID>5439</ogr:ID>
   <ogr:NAME>Fodele</ogr:NAME>
</ogr:towns>
```

  - **… and geometry description**
  - **population (pop01)** → application schema

GML Schema & Application Schema

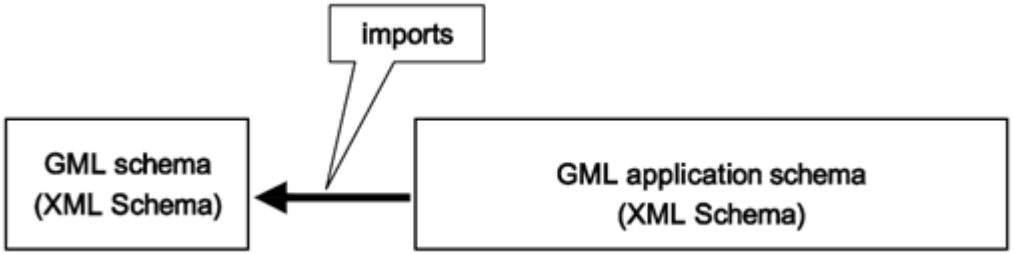


GML encoding

GML file

data file
.gml
(instance)

GML Application Schema
.xsd
(schema)



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    - Scalable Vector Graphics
  - **KML**
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an appropriate schema definition

Scalable Vector Graphics (SVG)

- SVG …
  - language for describing…
    - two-dimensional graphics and
    - graphical applications
  - it is based on the XML standard
    - emphasis on the **visualization**
  - it describes…
    - **Content + Map Symbols + …**

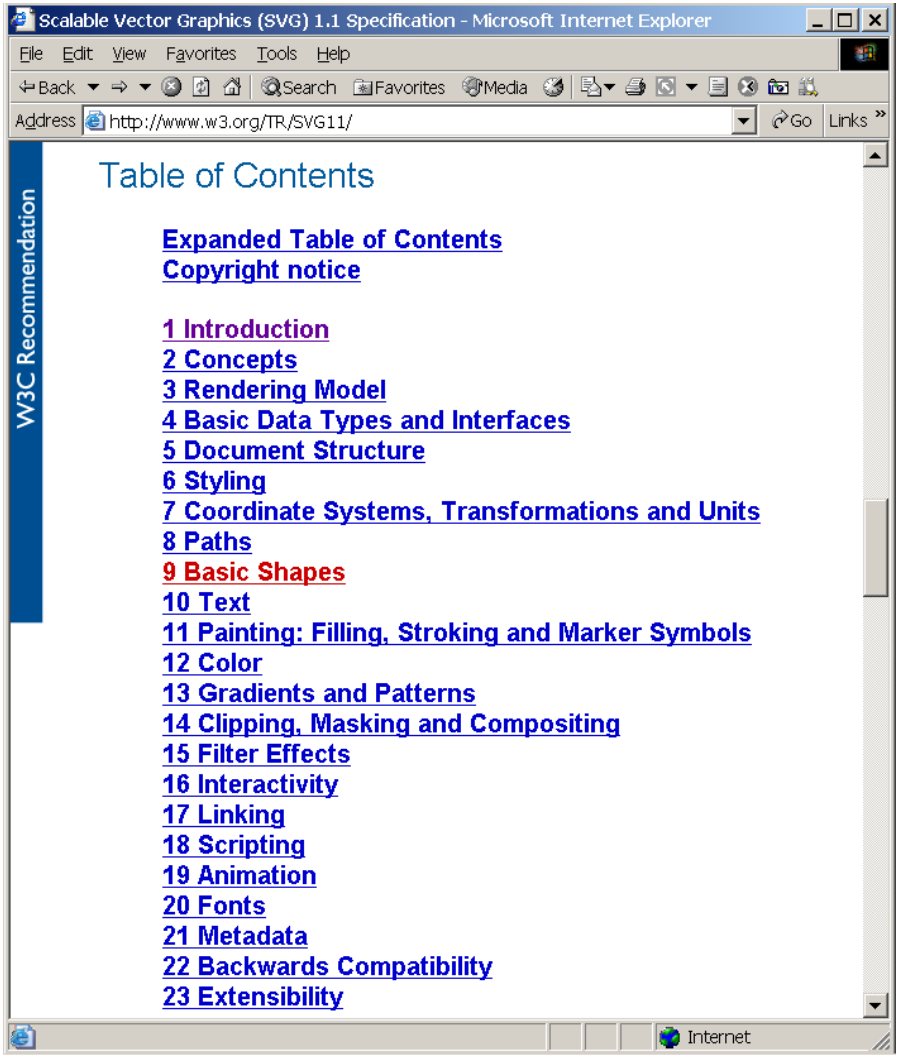
Scalable Vector Graphics (SVG)

- A **W3C** standard (current version 1.1)…
  - http://www.w3.org/Graphics/SVG/

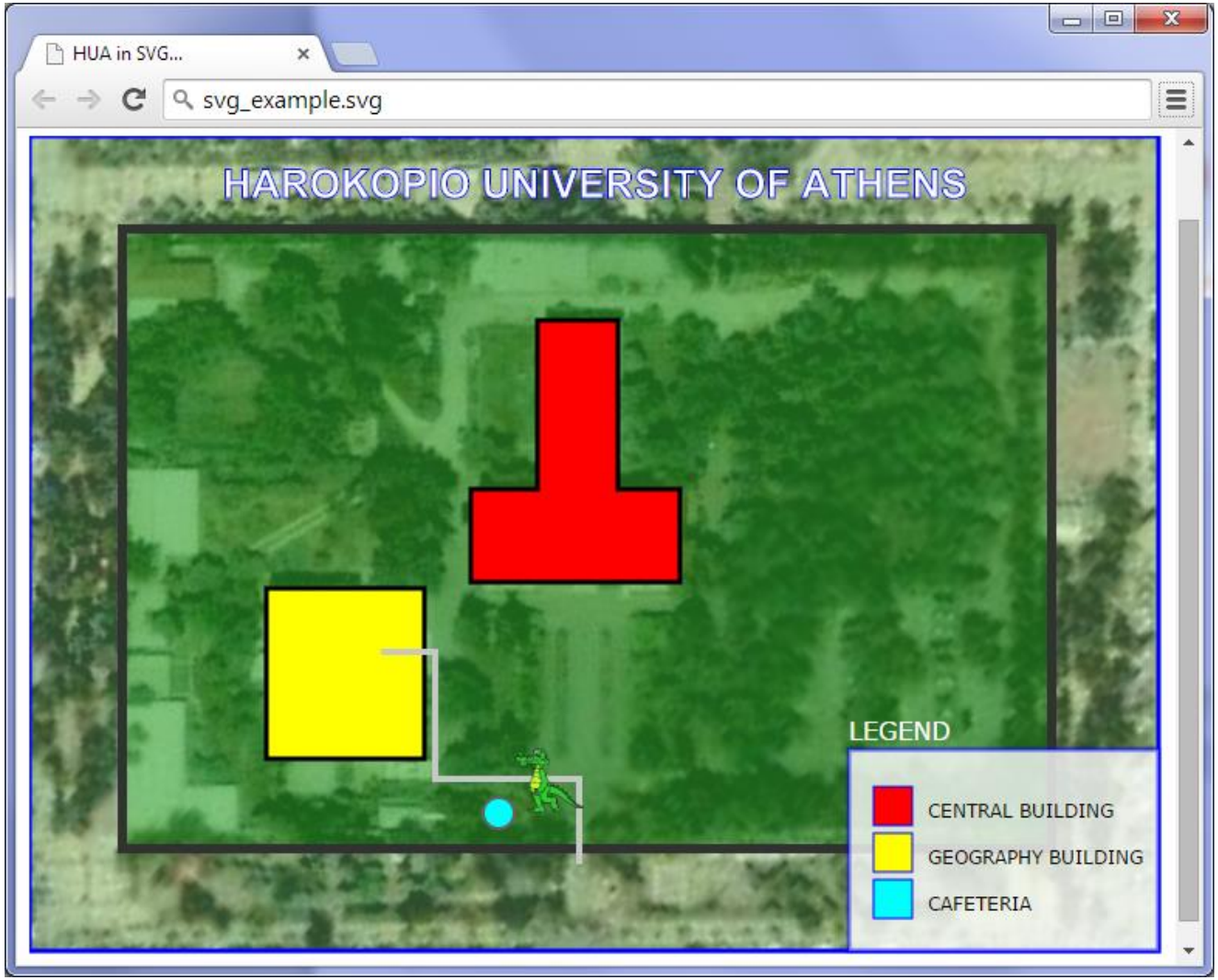
- SVG Document Type Declaration (DTD)

```
<!DOCTYPE svg PUBLIC "-//W3C//DTD SVG 1.1//EN“
"http://www.w3.org/Graphics/SVG/1.1/DTD/svg11.dtd">
```

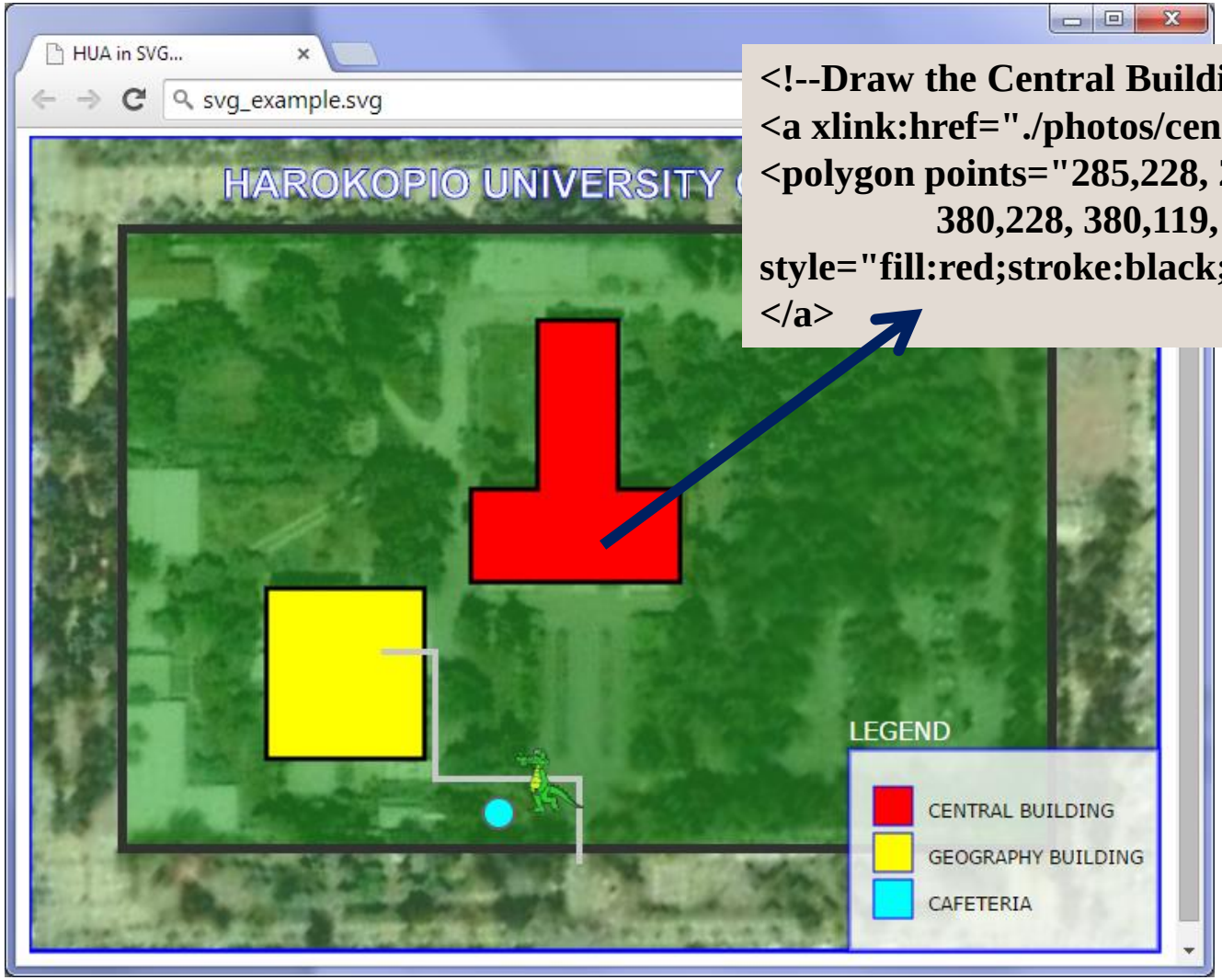
Scalable Vector Graphics (SVG)



Scalable Vector Graphics (SVG)



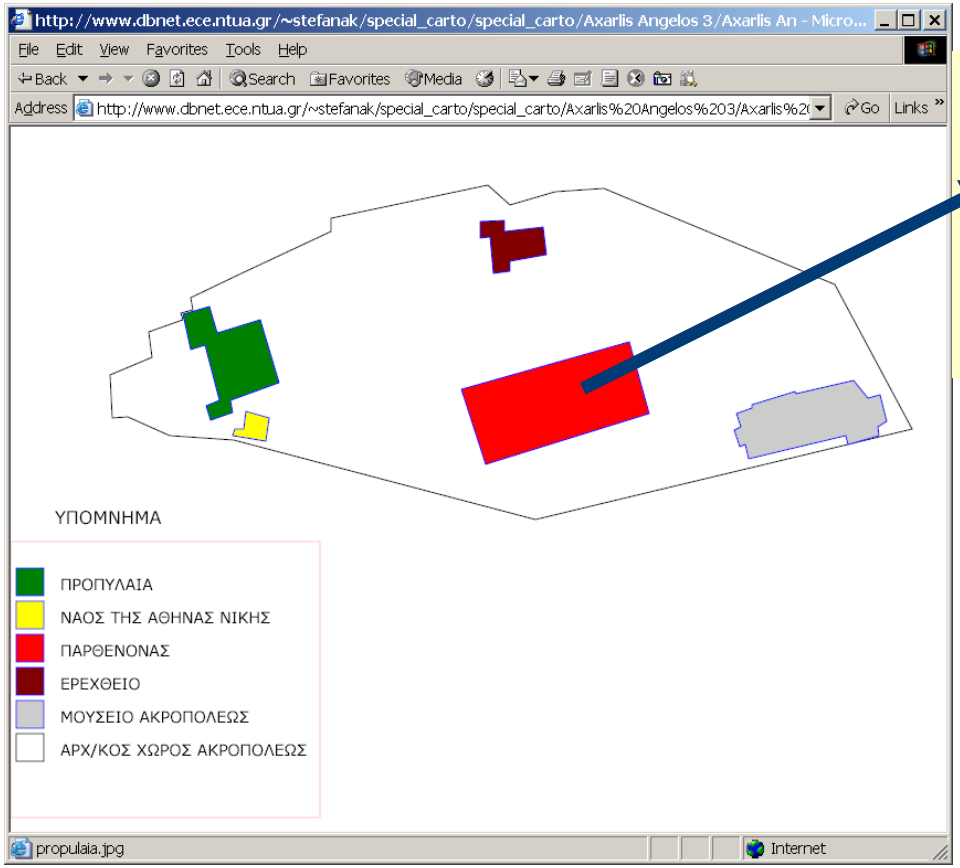
Scalable Vector Graphics (SVG)




```
<!--Draw the Central Building & create a hyperlink-->
<a xlink:href="./photos/central_building.jpg">
<polygon points="285,228, 285,288, 420,288, 420,228,
                 380,228, 380,119, 328,119, 328,228"
style="fill:red;stroke:black;stroke-width:3;"/>
</a>
```

SVG…

```
<?xml version="1.0" standalone="no"?>
<!DOCTYPE svg PUBLIC "-//W3C//DTD SVG 1.1//EN" "http://www.w3.org/Graphics/SVG/1.1/DTD/svg11.dtd">
<svg width="100%" height="100%" version="1.1" xmlns="http://www.w3.org/2000/svg">
```




```
<a xlink:href="parthenon.jpg">
<polygon points="408,238
 560,195  578,260  430,306"
style="fill:red; stroke:blue;
stroke-width:1"/> </a>
```

Scalable Vector Graphics (SVG)

- An SVG document can be created…
  - from scratch in a text editor
  - using an SVG editor
  - as an output of another program
    - e.g., ArcGIS, Adobe Illustrator, etc.

- An SVG file can be viewed …
  - in a Web browser, if an appropriate plugin is loaded
    - e.g., Adobe SVG Viewer - http://www.adobe.com/svg
  - modern web browsers offer the plugin (built-in)

Geographic Applications

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  - **KML**
    - Keyhole Markup Language

an appropriate schema definition

Keyhole Markup Language (KML)

- **KML** …
  - format to display geographic data in an Earth browser,
    - such as Google Earth, Google Maps, and Google Maps for mobile
  - adopted by **OGC**
  - it is based on the XML standard
    - emphasis on the **visualization**
  - it describes…
    - **Content + Map Symbols + View point + …**

Keyhole Markup Language (KML)

- A KML file can be created …
  - with the Google Earth user interface, or
  - from scratch …
    - use an XML or simple text editor to enter "raw" KML
- KMZ…
  - KML files and their related images (if any) can be compressed using the ZIP format into KMZ archives

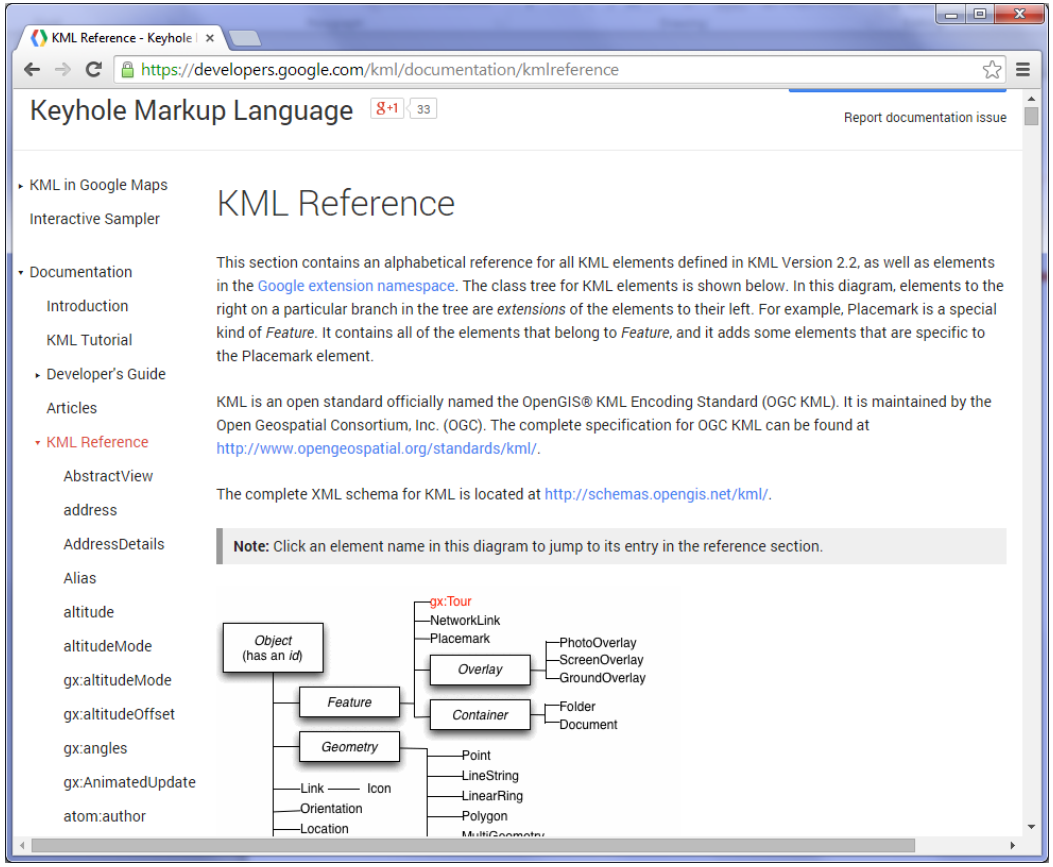
Keyhole Markup Language (KML)

- How to share KML and KMZ files…
  - you can e-mail them,
  - host them locally for sharing within a private internet, or
  - host them publicly on a web server
- Earth browsers …
  - such as Google Earth can display KML files
    - Just as web browsers display HTML files

Keyhole Markup Language (KML)

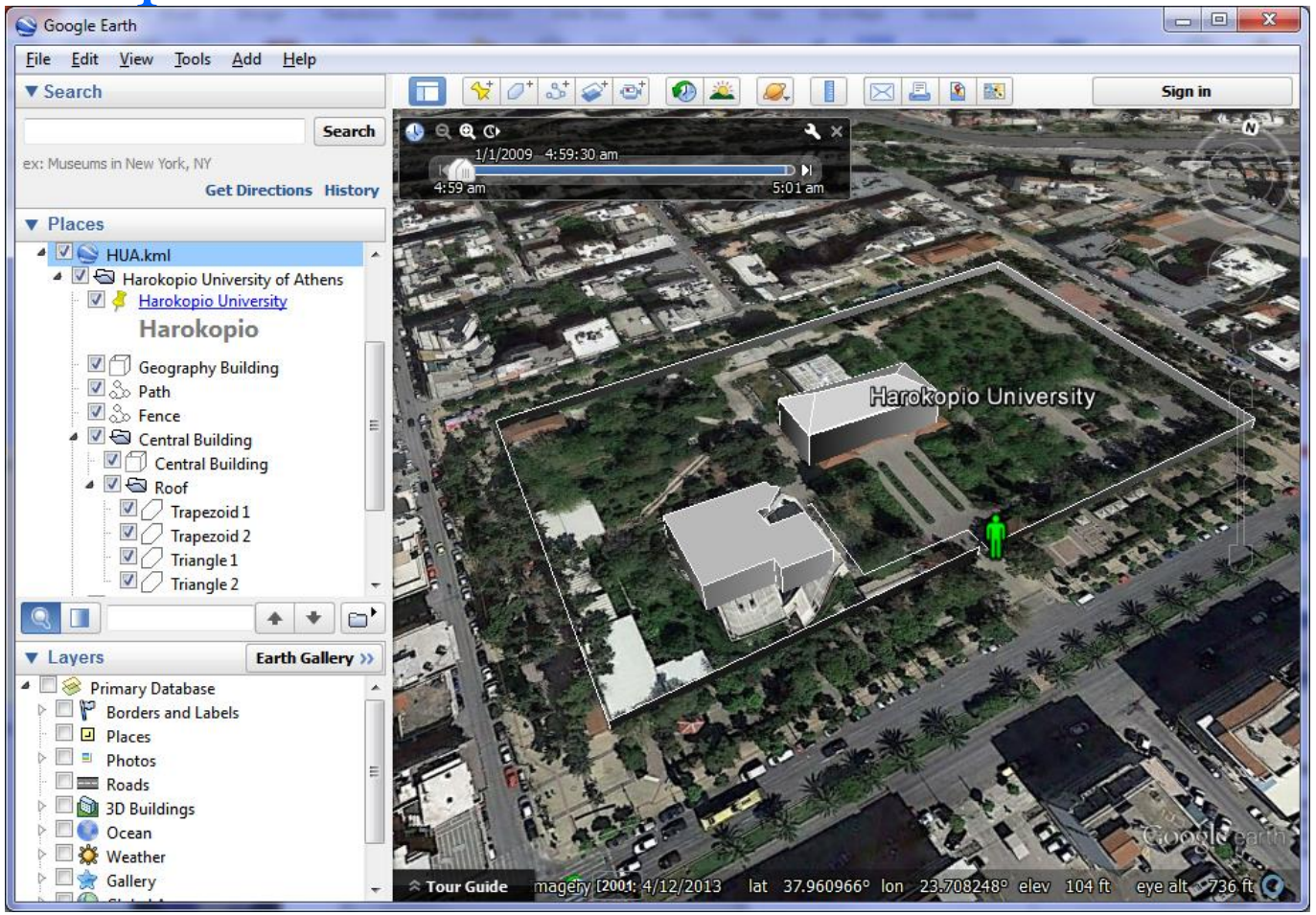
- KML Specifications…

  https://developers.google.com/kml/documentation/kmlreference

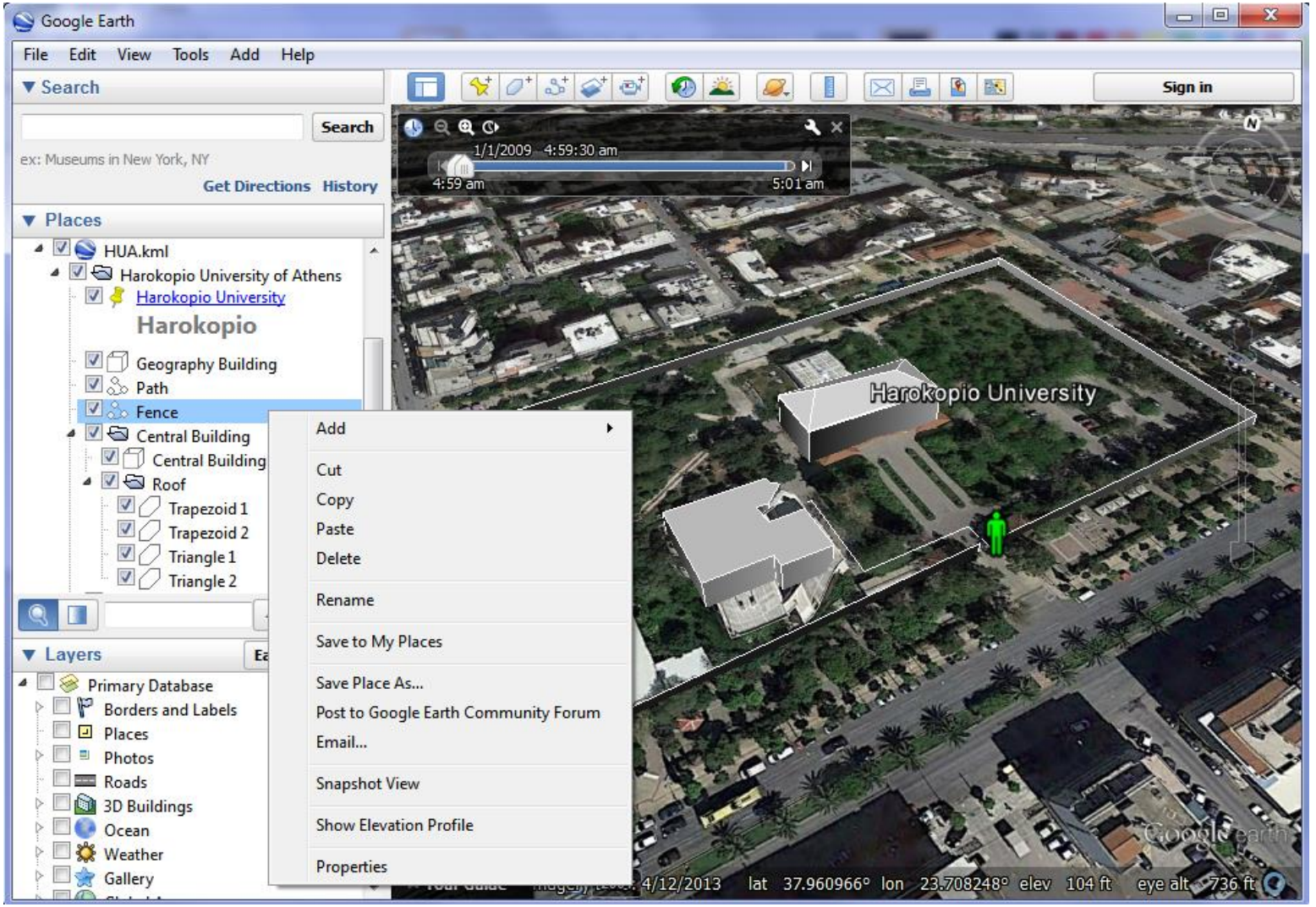


Keyhole Markup Language (KML)

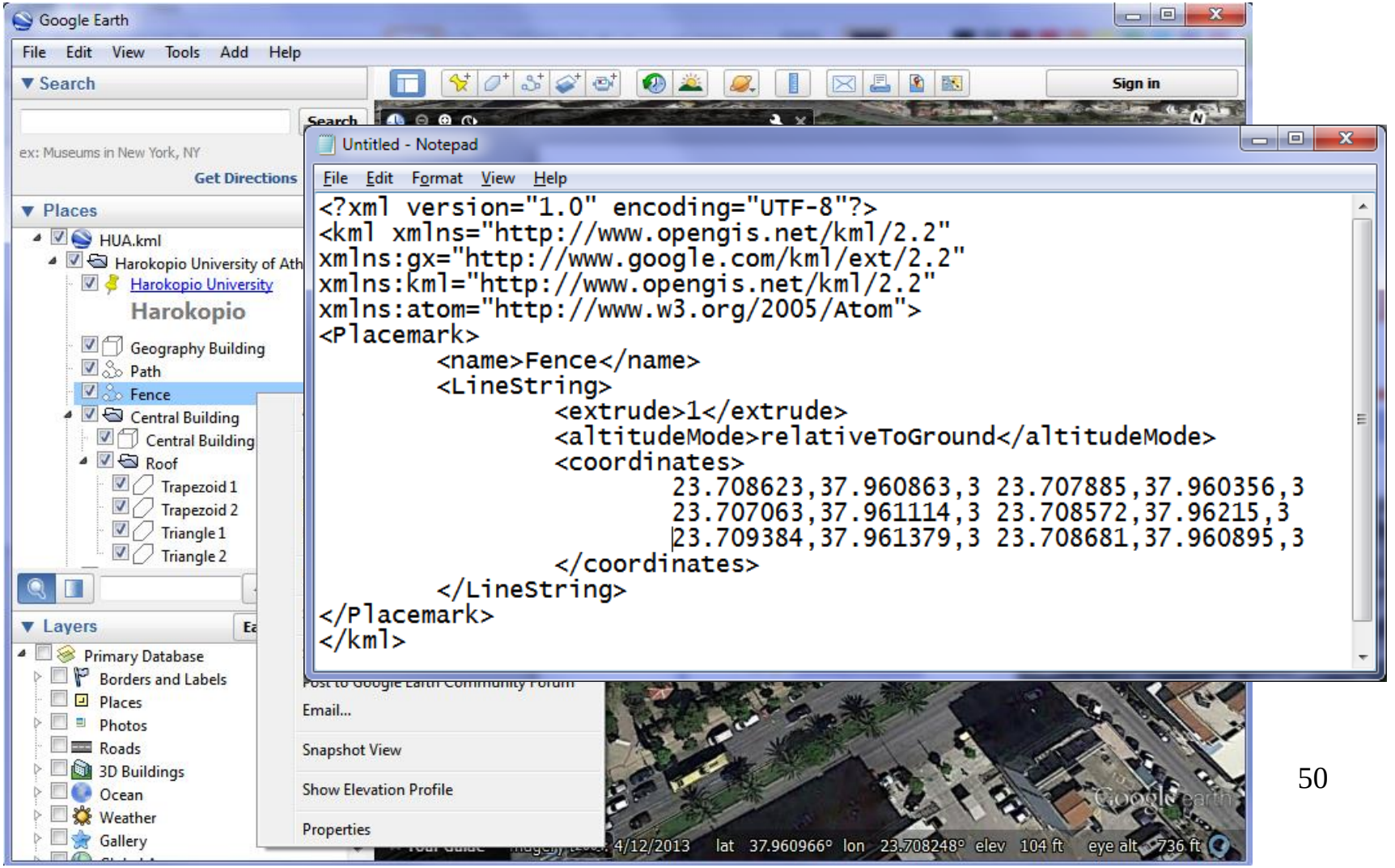
- Example…



Keyhole Markup Language (KML)



Keyhole Markup Language (KML)



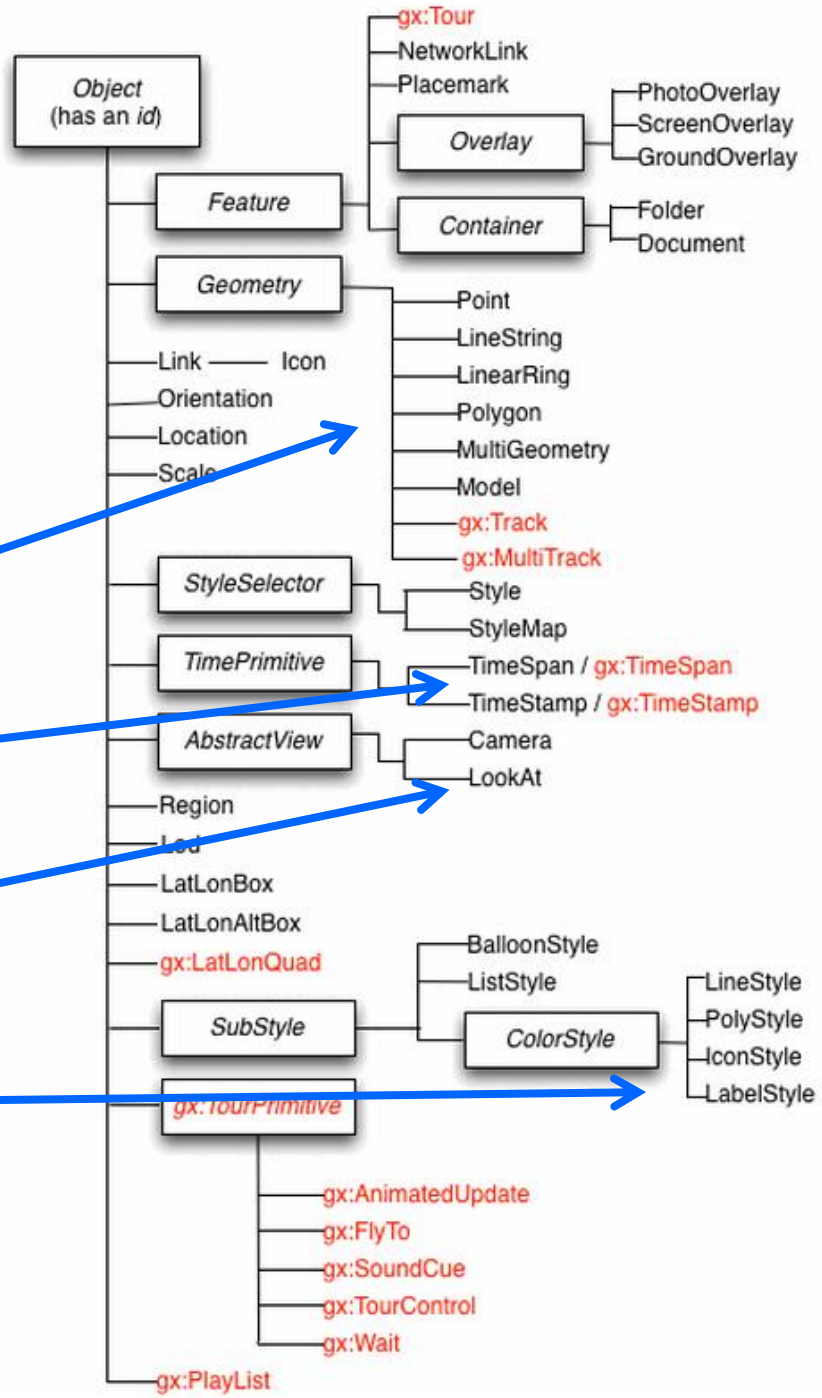
KML abstract elements

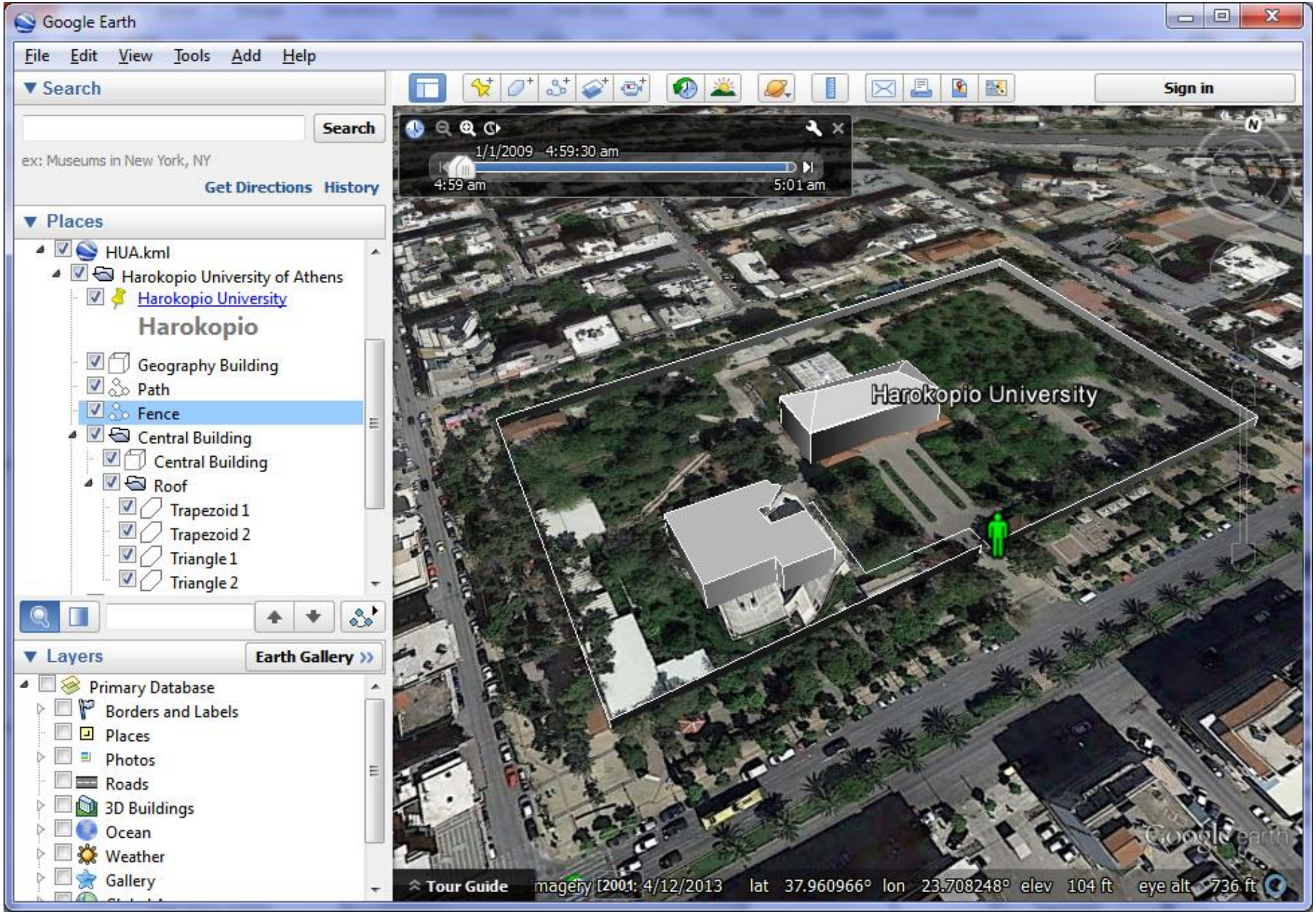
Space (Geometry)

Time

View (look At)

Styles

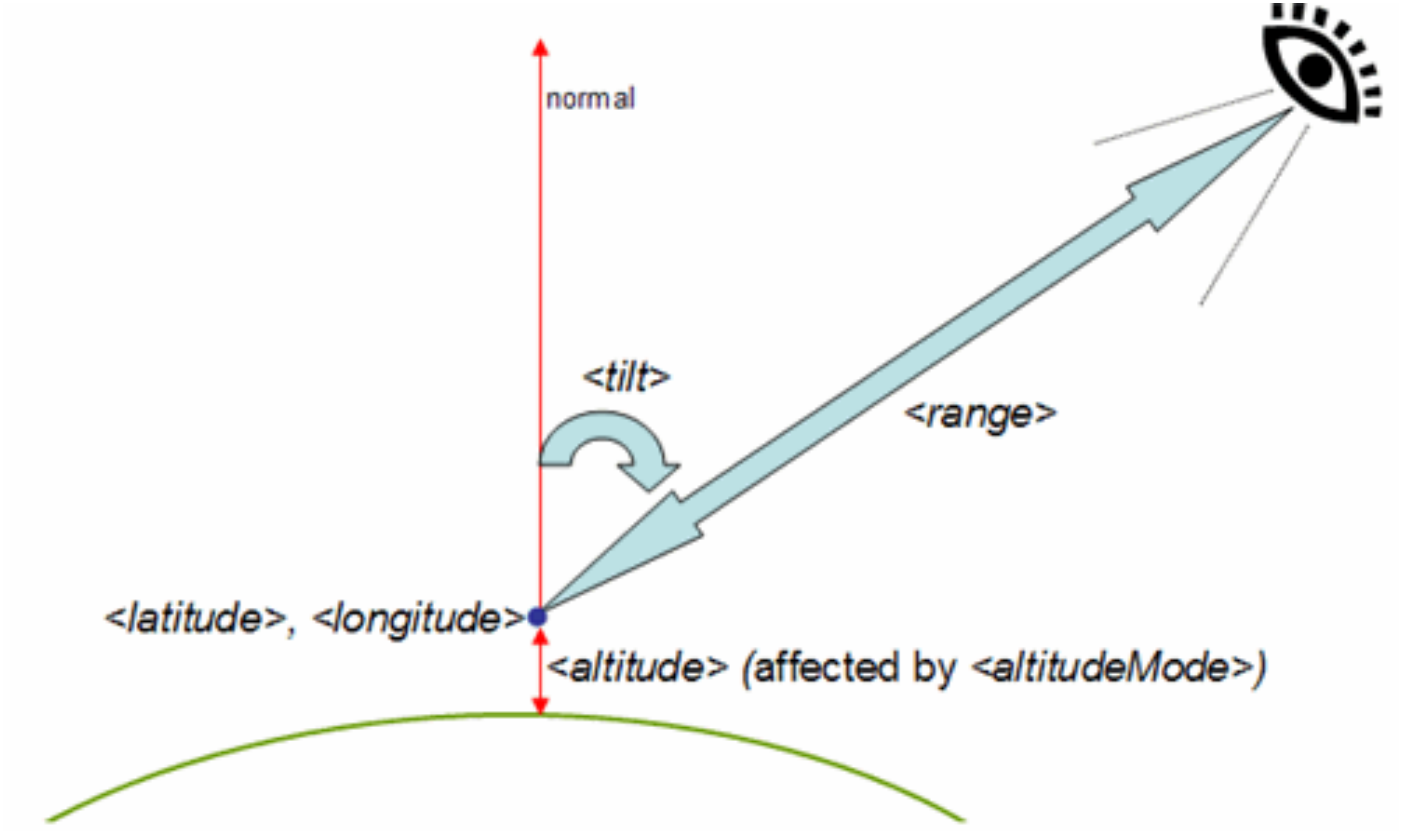



Google Earth
File Edit View Tools Add Help
Search
Search
ex: Museums in New York, NY
Get Directions History
Places
HUA.kml
Harokopio University of Athens
Harokopio University
Harokopio
Geography Building
Path
Fence
Central Building
Central Building
Roof
Trapezoid 1
Trapezoid 2
Triangle 1
Triangle 2
Layers
Earth Gallery
Primary Database
Borders and Labels
Places
Photos
Roads
3D Buildings
Ocean
Weather
Gallery
Sign in
1/1/2009 4:59:30 am
4:59 am
5:01 am
Harokopio University
Tour Guide
lat 37.960966° lon 23.708248° elev 104 ft eye alt 736 ft

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://earth.google.com/kml/2.2">
<Document>
    <name>HUA.kml</name>
    <open>1</open>
    <Folder>
        <name>Harokopio University of Athens</name>
        <open>1</open>
        <LookAt>
            <longitude>23.70824758819832</longitude>
            <latitude>37.96096628151464</latitude>
            <altitude>0</altitude>
            <range>192.2089882256726</range>
            <tilt>47.6770540588911</tilt>
            <heading>-11.65093403216848</heading>
            <altitudeMode>relativeToGround</altitudeMode>
        </LookAt>
        <Placemark>
            <name>Harokopio University</name>
            <description><![CDATA[<h2>Harokopio University of Athens</h2>
                <img src="photos/central_building.jpg" width="230" height="172"><br>
                <a href="http://www.hua.gr">http://www.hua.gr</a>]]></description>
            <Point>
                <extrude>1</extrude>
                <coordinates>23.7082,37.961285,15</coordinates>
            </Point>
        </Placemark>
```

Keyhole Markup Language (KML)

Content + Map Symbols + View point + …



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Obasanjo, D., 2001. An Exploration of XML in Database Management Systems. http://www.25hoursaday.com/StoringAndQueryingXML.html

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World Wide Web Consortium (W3C), http://www.w3c.org/

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