Topics

- Data
  - JSON
  - XML, XPath
  - SQL and SELECT statement
- Analysis
  - Naïve Bayes
  - Bootstrap and Bagging
  - Cross-validation

Data Analysis Issues

- Model selection: How to choose the k in K-NN, the complexity parameter in recursive partitioning, the threshold in Naïve Bayes?
- Variability: How accurate is our predictor?
- Generalizability: What can our data and findings say about other situations?

Structured
Plain-text Data

Recall

- Delimited data, e.g.,
  - comma separated values
  - Tab-delimited
- Fixed-width format data
- Key:value pairs

Data Available on the Web

- HTML
  - HTML Table
  - plain text formats (e.g., delimited)
- Other Formats:
  - JSON
  - XML

JSON

JavaScript Object Notation

- Text format
- Lightweight data-interchange
- Easy for humans to read and write.
- Easy for machines to parse and generate

JSON Primitive Data Types

- Number
  - like numeric in R
  - no NaN, NA, Inf
- String (in double quotes)
- Boolean (true or false)
- These are scalars
- null – empty object (like NULL in R)

JSON Structures: Array

- Unnamed
- Ordered
- Comma-separated
- Square brackets
- Possibly heterogeneous

```
[value, value, value, …]
```

JSON Structures: Object

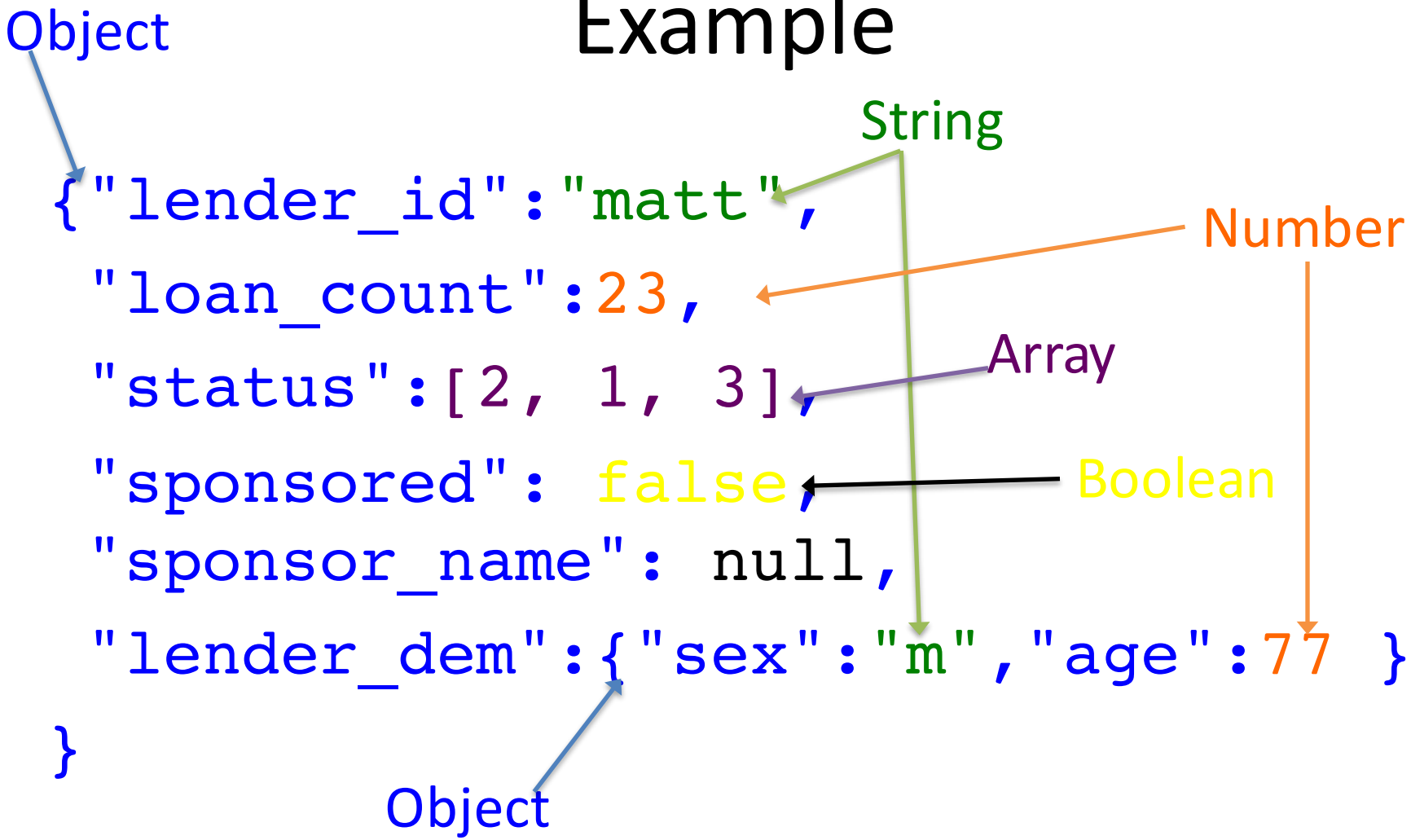
- Named
- Unordered
- Comma-separated
- Curly brackets
- Possibly heterogeneous
- AKA: Associative array

{"key": value, "key": value, "key": value, …}

Example


```
{"lender_id":"matt",
 "loan_count":23,
 "status":[2, 1, 3],
 "sponsored": false,
 "sponsor_name": null,
 "lender_dem":{"sex":"m","age":77 }
}
```

Example


Object
String
Number
Array
Boolean
Object
{"lender_id":"matt",
"loan_count":23,
"status":[2, 1, 3],
"sponsored": false,
"sponsor_name": null,
"lender_dem":{"sex":"m","age":77 }
}

Twitter

Donald J. Trump @realDonaldTrump · 48m

We are winning and the press is refusing to report it. Don't let them fool you- get out and vote! #DrainTheSwamp on November 8th!

4.8K 9.6K

Donald J. Trump @realDonaldTrump · 2h

Why has nobody asked Kaine about the horrible views emanated on WikiLeaks about Catholics? Media in the tank for Clinton but Trump will win!

6.1K 14K

Donald J. Trump @realDonaldTrump · 2h

Major story that the Dems are making up phony polls in order to suppress the the Trump . We are going to WIN!

8.3K 18K

One Abbreviated Tweet

[
{
"favorite_count": 11495,
"favorited": false,
"user": {"verified": true, "profile_sidebar_fill_color": "C5CEC0", … }
"id_str": "786204978629185536",
"text": "Crooked Hillary Clinton likes to talk about the things she will do but she has been there for 30 years - why didn't she do them?”,
"id": 7.862e+17,
"source": "Twitter for iPhone",
"lang": "en",
"geo": null,
"created_at": "Wed Oct 12 14:00:48 +0000 2016",
"place":{"full_name": "Florida, USA", … }, …]

Translate into a Structure in R

```
> length(tweetList)
[1] 3243

> class(tweetList[[1]])
[1] "list”

> names(tweetList[[1]])
 [1] "favorite_count" "favorited"      "user"
 [4] "id_str"         "text"           "id"
 [7] "source"         "lang"           "geo"
[10] "created_at"     "place"
```

Translate into a Structure in R

```
> length(tweetList[[1]]$user)
[1] 41

> tweetList[[1]]$text
[1] "PAY TO PLAY POLITICS.
\n#CrookedHillary
https://t.co/wjsl8ITVvk"

> tweetList[[1]]$created_at
[1] "Wed Oct 12 14:00:48 +0000 2016"
```

Translate into a Structure in R

- Unnamed list of 3243 tweets
- Each tweet is a named list of 11 elements (this is an abbreviated file)
- Most of these elements are vectors of length 1 or NULL vectors
- Two are named lists with 41 (user) and 10 (place) elements. These elements are a mix of vectors and lists

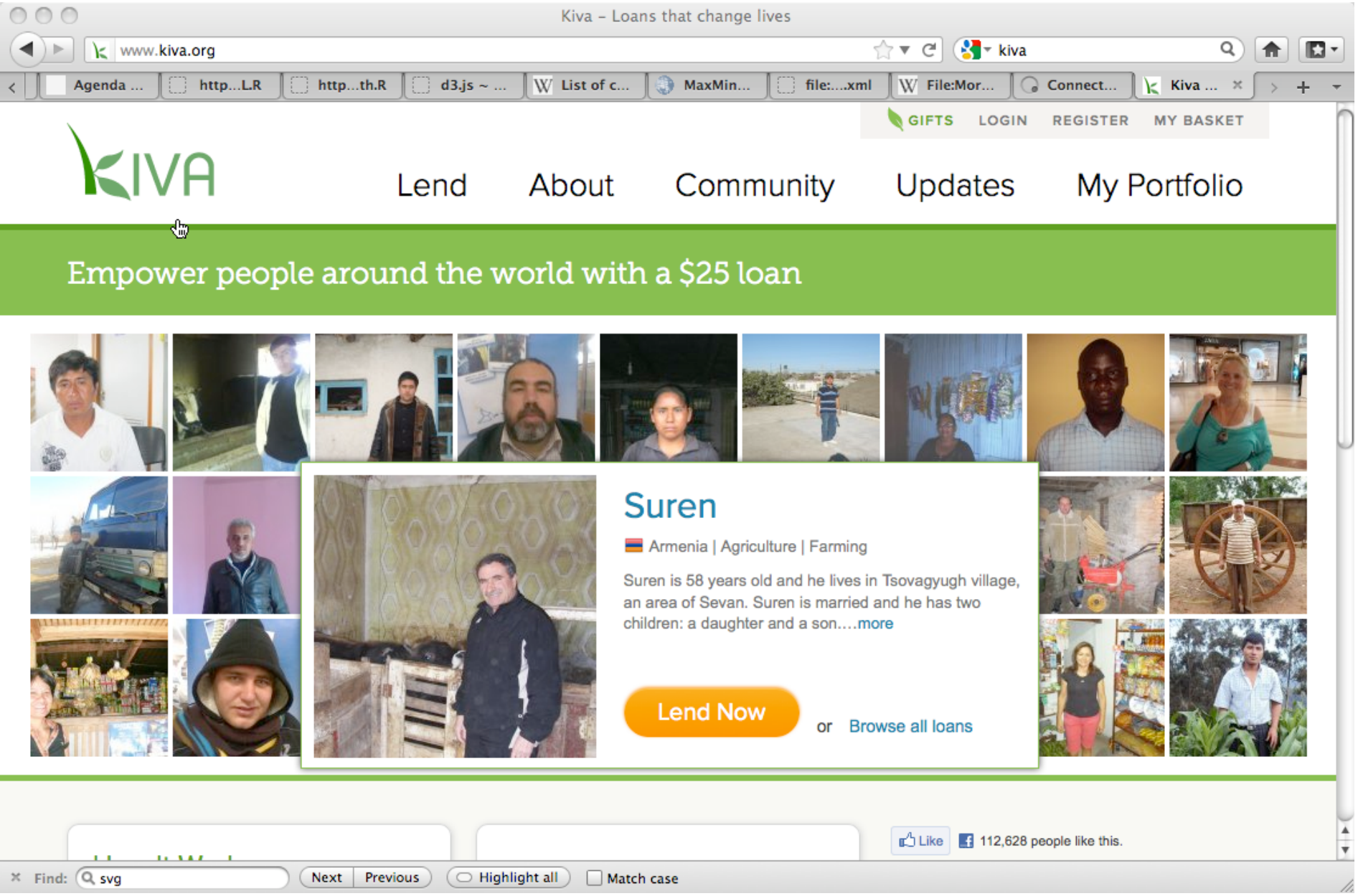
XML

eXtensible Markup Language

XML is a standard for *semantic*, *hierarchical* representation of data

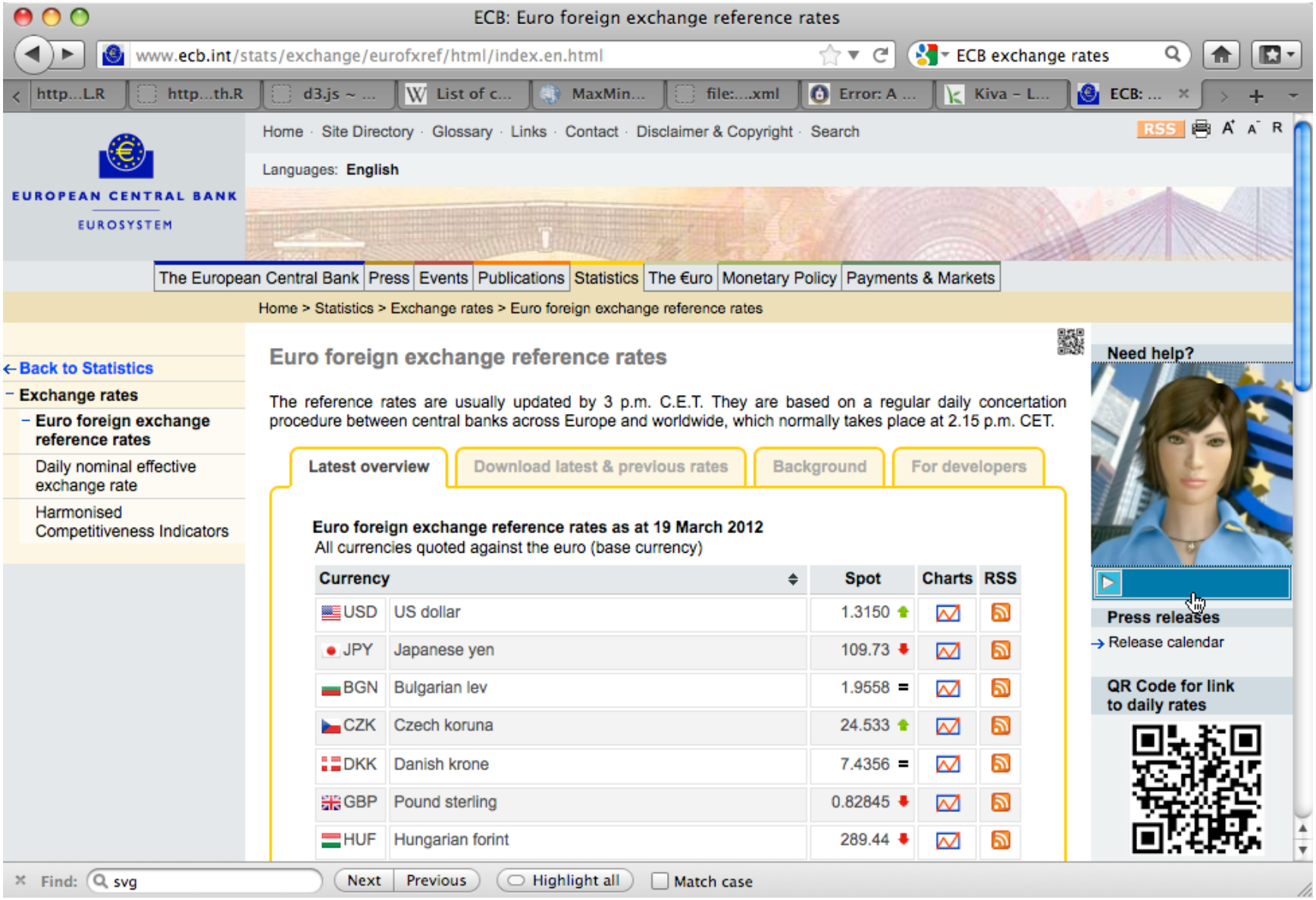
```
<catalog>
  <plant>
    <common>Bloodroot</common>
    <botanical>Sanguinaria canadensis</botanical>
    <zone>4</zone>
    <light>Mostly Shady</light>
    <price>2.44</price>
    <availability>03/15/2006</availability>
    <indoor>true</indoor>
  </plant>
…
</catalog>
```

Examples of XML


Kiva – Loans that change lives
www.kiva.org
kiva
Agenda ...
http...L.R
http...th.R
d3.js ~ ...
List of c...
MaxMin...
file:....xml
File:Mor...
Connect...
Kiva ...
GIFTS
LOGIN
REGISTER
MY BASKET
KIVA
Lend
About
Community
Updates
My Portfolio
Empower people around the world with a $25 loan
Suren
Armenia | Agriculture | Farming
Suren is 58 years old and he lives in Tsovagyugh village, an area of Sevan. Suren is married and he has two children: a daughter and a son....more
Lend Now
or
Browse all loans
Like
112,628 people like this.
Find:
svg
Next
Previous
Highlight all
Match case

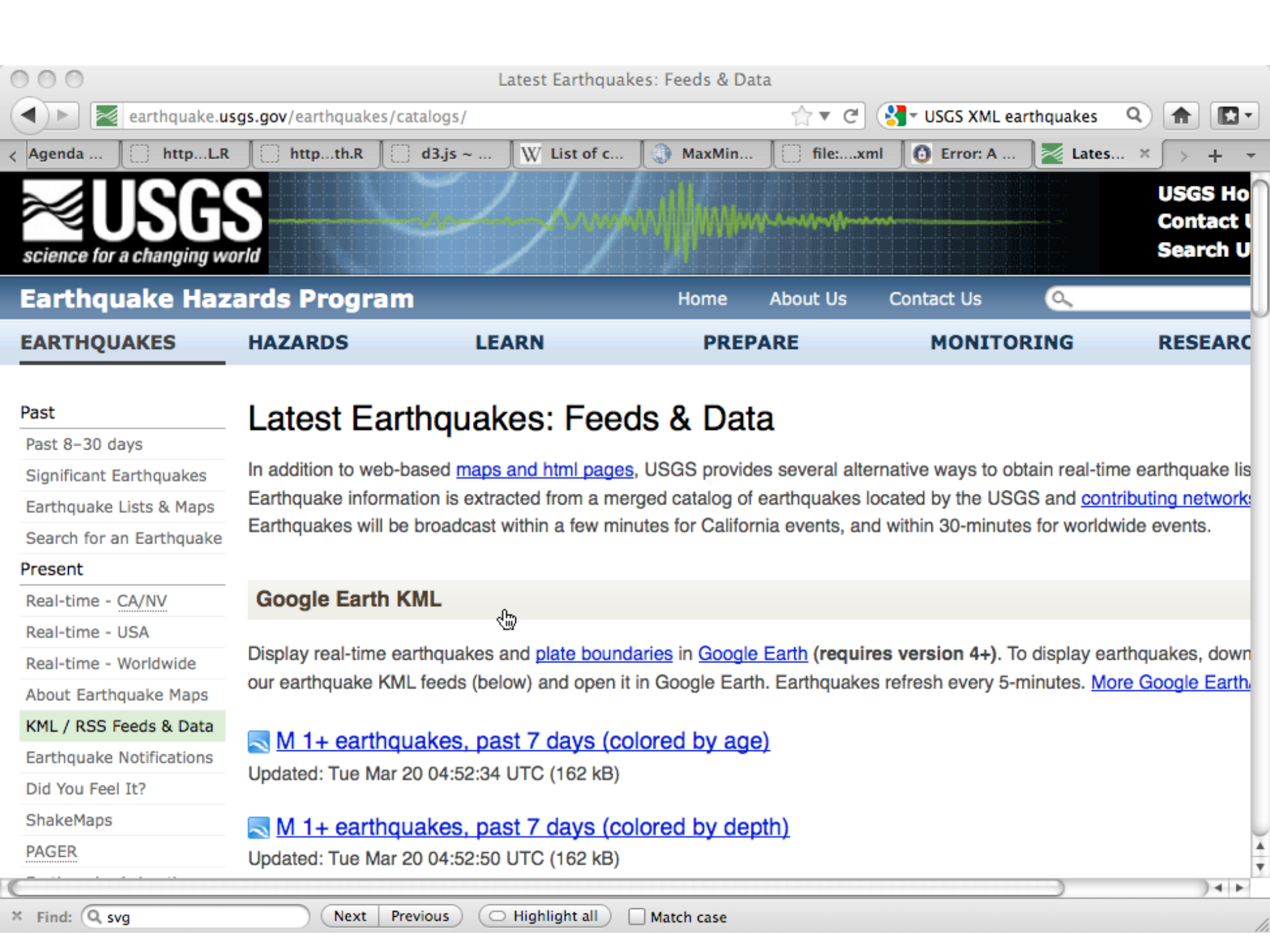
```
<lender>
    <lender_id>matt</lender_id>
    <name>Matt</name>
    <image>
     <id>12829</id>
     <template_id>1</template_id>
    </image>
    <whereabouts>San Francisco CA</whereabouts>
    <country_code>US</country_code>
    <uid>matt</uid>
    <member_since>2006-01-01T09:01:01Z</member_since>
    <personal_url>www.socialedge.org/blogs/kiva-chronicles
    </personal_url>
    <occupation>Entrepreneur</occupation>
    <loan_because>I love the stories. </loan_because>
    <occupational_info>I co-founded a startup nonprofit (this one!)
     and I work with an amazing group of people dreaming up ways to
     alleviate poverty through personal lending.
    </occupational_info>
    <loan_count>89</loan_count>
    <invitee_count>23</invitee_count>
  </lender>
```

Snippet of Kiva Data for one lender


ECB: Euro foreign exchange reference rates
www.ecb.int/stats/exchange/eurofxref/html/index.en.html
ECB exchange rates
EUROPEAN CENTRAL BANK
EUROSYSTEM
Home · Site Directory · Glossary · Links · Contact · Disclaimer & Copyright · Search
Languages: English
The European Central Bank | Press | Events | Publications | Statistics | The €uro | Monetary Policy | Payments & Markets
Home > Statistics > Exchange rates > Euro foreign exchange reference rates
← Back to Statistics
Exchange rates
Euro foreign exchange reference rates
Daily nominal effective exchange rate
Harmonised Competitiveness Indicators
Euro foreign exchange reference rates
The reference rates are usually updated by 3 p.m. C.E.T. They are based on a regular daily concertation procedure between central banks across Europe and worldwide, which normally takes place at 2.15 p.m. CET.
Latest overview
Download latest & previous rates
Background
For developers
Euro foreign exchange reference rates as at 19 March 2012
All currencies quoted against the euro (base currency)
Currency
Spot
Charts
RSS
USD US dollar 1.3150
JPY Japanese yen 109.73
BGN Bulgarian lev 1.9558
CZK Czech koruna 24.533
DKK Danish krone 7.4356
GBP Pound sterling 0.82845
HUF Hungarian forint 289.44
Need help?
Press releases
Release calendar
QR Code for link to daily rates
Find: svg
Next
Previous
Highlight all
Match case

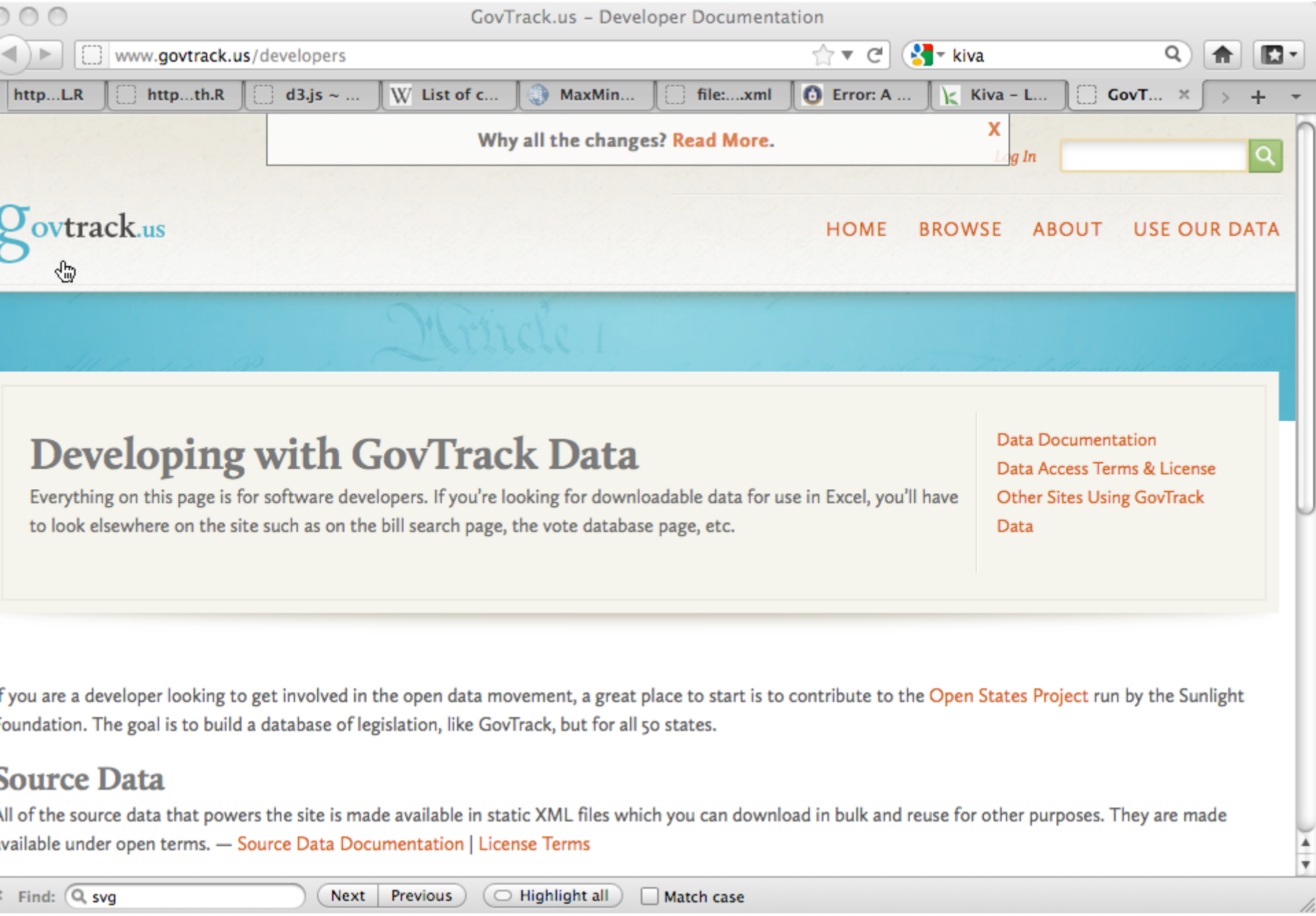
Snippet of exchange data

```
<Cube>
 <Cube time="2008-04-21">
 <Cube currency="USD" rate="1.5898"/>
  <Cube currency="JPY" rate="164.43"/>
  <Cube currency="BGN" rate="1.9558"/>
  <Cube currency="CZK" rate="25.091"/>
 </Cube>
 <Cube time="2008-04-17">
  <Cube currency="USD" rate="1.5872"/>
  <Cube currency="JPY" rate="162.74"/>
  <Cube currency="BGN" rate="1.9558"/>
  <Cube currency="CZK" rate="24.975"/>
 </Cube>
 </Cube>
```


Latest Earthquakes: Feeds & Data
earthquake.usgs.gov/earthquakes/catalogs/
USGS XML earthquakes
Agenda ...
http...L.R
http...th.R
d3.js ~ ...
List of c...
MaxMin...
file:....xml
Error: A ...
Lates...
USGS
science for a changing world
USGS Ho
Contact U
Search U
Earthquake Hazards Program
Home
About Us
Contact Us
EARTHQUAKES
HAZARDS
LEARN
PREPARE
MONITORING
RESEARC
Past
Past 8–30 days
Significant Earthquakes
Earthquake Lists & Maps
Search for an Earthquake
Present
Real-time - CA/NV
Real-time - USA
Real-time - Worldwide
About Earthquake Maps
KML / RSS Feeds & Data
Earthquake Notifications
Did You Feel It?
ShakeMaps
PAGER
Latest Earthquakes: Feeds & Data
In addition to web-based maps and html pages, USGS provides several alternative ways to obtain real-time earthquake lis
Earthquake information is extracted from a merged catalog of earthquakes located by the USGS and contributing network
Earthquakes will be broadcast within a few minutes for California events, and within 30-minutes for worldwide events.
Google Earth KML
Display real-time earthquakes and plate boundaries in Google Earth (requires version 4+). To display earthquakes, down
our earthquake KML feeds (below) and open it in Google Earth. Earthquakes refresh every 5-minutes. More Google Earth
M 1+ earthquakes, past 7 days (colored by age)
Updated: Tue Mar 20 04:52:34 UTC (162 kB)
M 1+ earthquakes, past 7 days (colored by depth)
Updated: Tue Mar 20 04:52:50 UTC (162 kB)
Find: svg
Next
Previous
Highlight all
Match case

```
<event id="00068404" network-code="ak"
    time-stamp="2008/09/16_22:17:31 " version="2">
    <param name="year" value="2008"/>
    <param name="month" value="09"/>
    <param name="day" value="14"/>
    <param name="hour" value="00"/>
    <param name="minute" value="59"/>
    <param name="second" value="04.0"/>
    <param name="latitude" value="51.8106"/>
    <param name="longitude" value="-175.9250"/>
    <param name="depth" value="146.0"/>
    <param name="magnitude" value="3.8"/>
    <param name="num-stations" value="10"/>
    <param name="num-phases" value="15"/>
    <param name="dist-first-station" value="126.1"/>
    <param name="azimuthal-gap" value="53"/>
    <param name="magnitude-type" value="L"/>
    <param name="magnitude-type-ext"
        value="Ml = local magnitude (synthetic Wood-Anderson)"/>
    <param name="location-method" value="a"/>
    <param name="location-method-ext"
        value="Auryn (Confirmed by human review)"/>
  </event>
  <event>
```

Snippet of USGS earthquake catalog data (quakeml)


GovTrack.us – Developer Documentation
www.govtrack.us/developers
kiva
http...L.R
http...th.R
d3.js ~ ...
List of c...
MaxMin...
file:....xml
Error: A ...
Kiva – L...
GovT...
Why all the changes? Read More.
X
Log In
govtrack.us
HOME
BROWSE
ABOUT
USE OUR DATA
Developing with GovTrack Data
Everything on this page is for software developers. If you're looking for downloadable data for use in Excel, you'll have to look elsewhere on the site such as on the bill search page, the vote database page, etc.
Data Documentation
Data Access Terms & License
Other Sites Using GovTrack Data
f you are a developer looking to get involved in the open data movement, a great place to start is to contribute to the Open States Project run by the Sunlight oundation. The goal is to build a database of legislation, like GovTrack, but for all 50 states.
Source Data
ll of the source data that powers the site is made available in static XML files which you can download in bulk and reuse for other purposes. They are made vailable under open terms. — Source Data Documentation | License Terms
Find: svg
Next
Previous
Highlight all
Match case

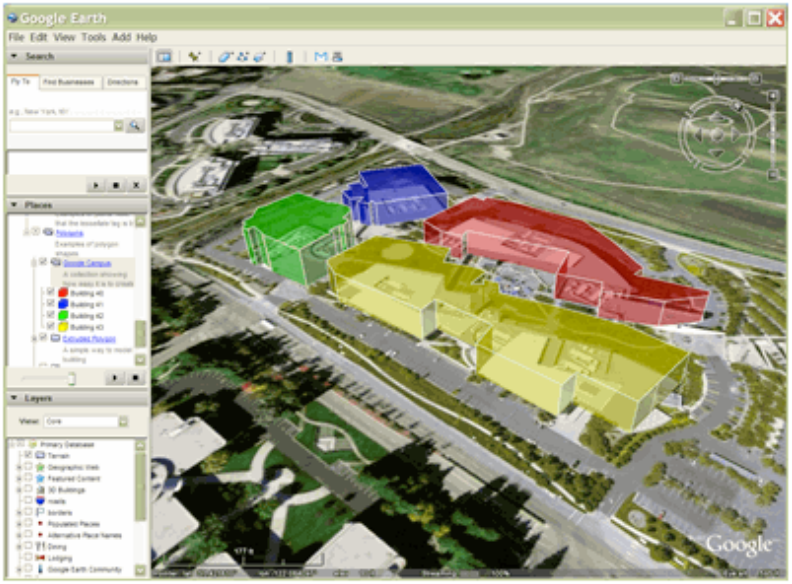
```
<actions>
  <action datetime="2009-01-26">
    <text>Referred to the Committee on Appropriations, and in addition
        to the Committee on the Budget, for a period to be
        subsequently determined by the Speaker, in each case for
        consideration of such provisions as fall within the
        jurisdiction of the committee concerned.
    </text>
  </action>
  <action datetime="2009-01-26">
    <text>Referred to House Appropriations</text>
  </action>
</actions>
..
<relatedbills>
  <bill relation="rule" session="111" type="hr" number="88" />
</relatedbills>
```

Snippet of US Congress data

Keyhole Markup Language

KML Tutorial

KML is a file format used to display geographic data in an Earth browser such as Google Earth, Google Maps, and Google Maps for mobile. KML uses a tag-based structure with nested elements and attributes and is based on the XML standard. All tags are case-sensitive and must be appear exactly as they are listed in the KML Reference. The Reference indicates which tags are optional. Within a given element, tags must appear in the order shown in the Reference.



If you're new to KML, explore this document and the accompanying samples files (*SamplesInEarth* and *SamplesInMaps*) to begin learning about the basic structure of a KML file and the most commonly used tags. The first section describes

```
<Placemark id="217">
    <name>8.2</name>
    <description>
Date: 2008-9-15
Magnitude: 1.5
Depth: 8.2 km
    </description>
    <styleUrl>#ball1-2</styleUrl>
    <Point>
      <coordinates>-147.426, 60.929,
0</coordinates>
    </Point>
</Placemark>
```

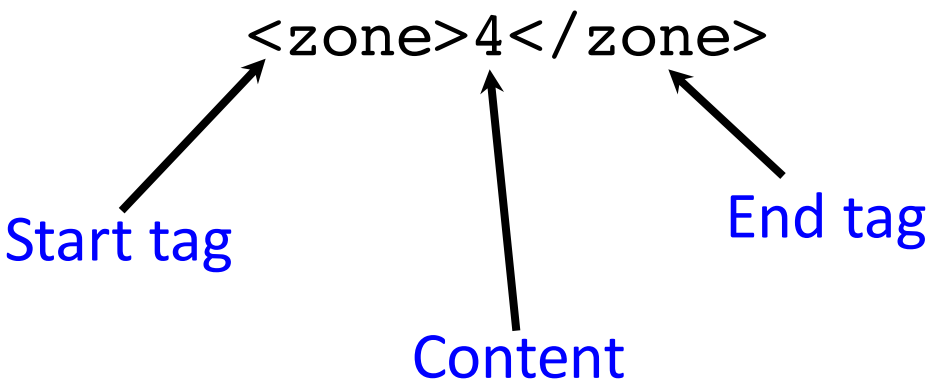
Snippet of KML for one earthquake placemark

XML Syntax

Syntax

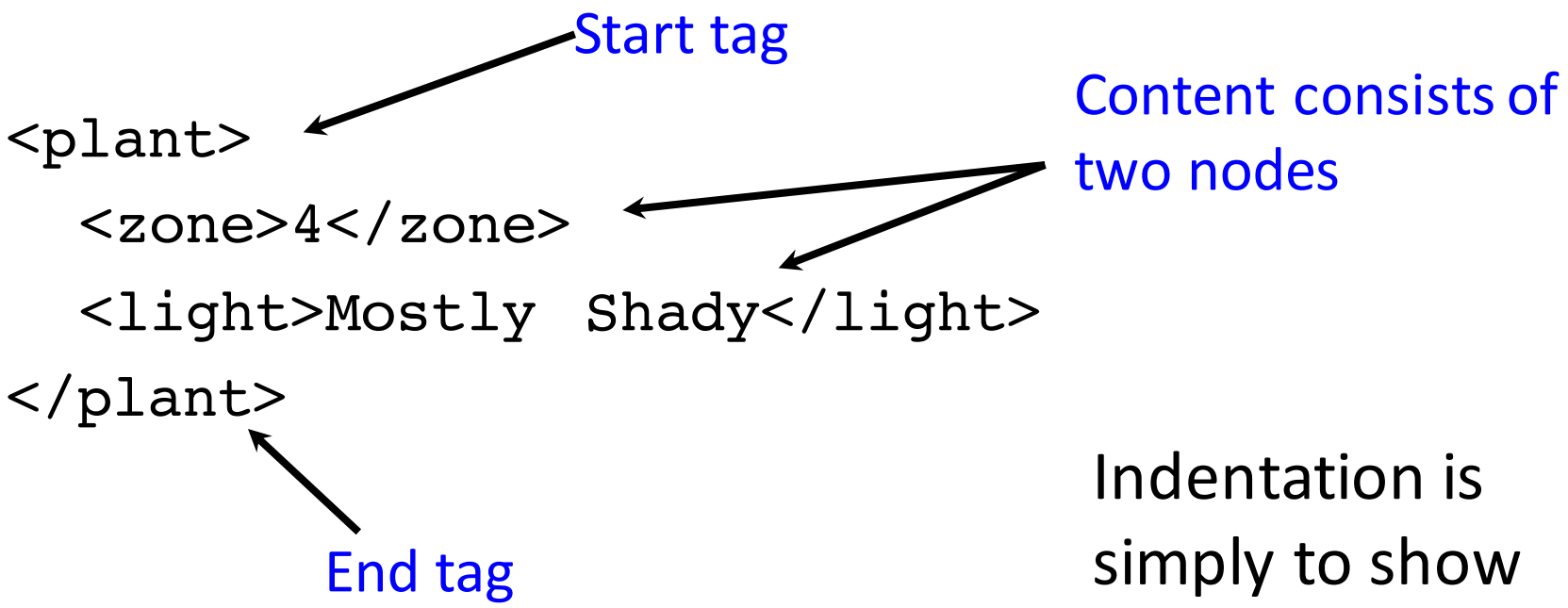
The basic unit of XML code is called an "element" or "node"

Each Node has a start tag and end tag



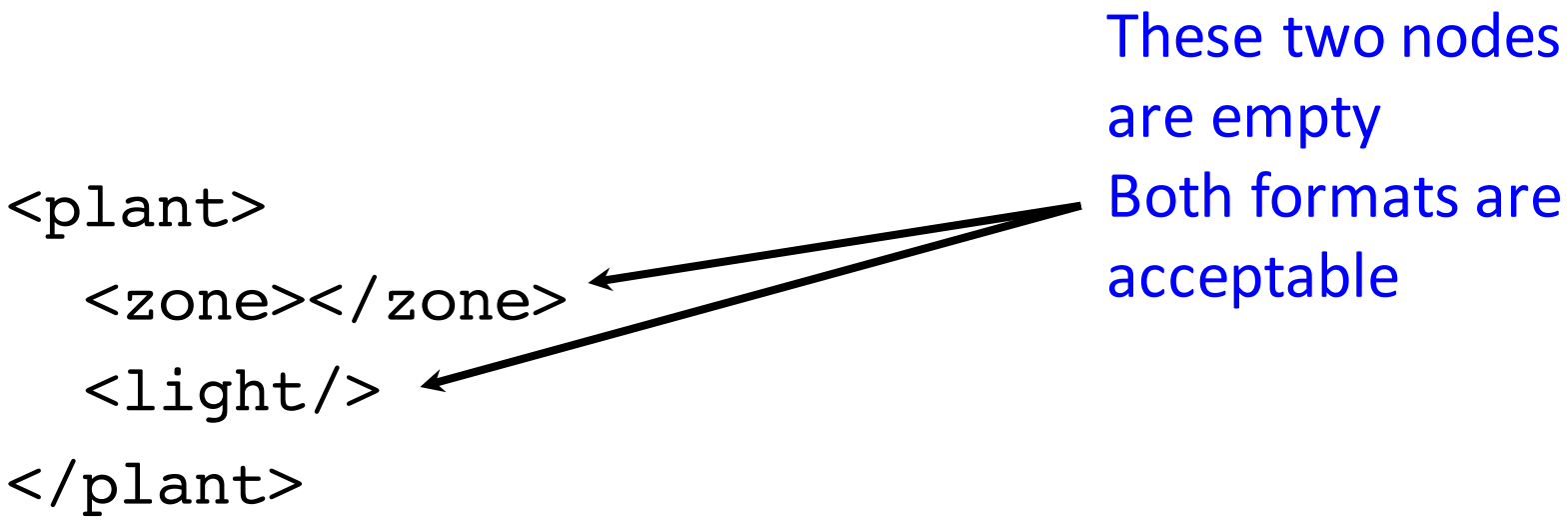
Syntax

A node may have other other nodes (children) in it in addition to plain text content.



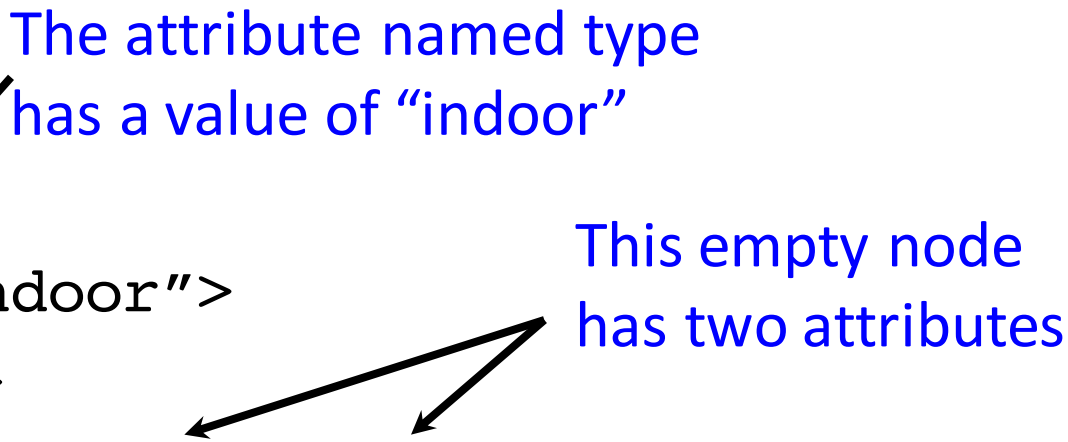
Syntax

Nodes may be empty



Syntax

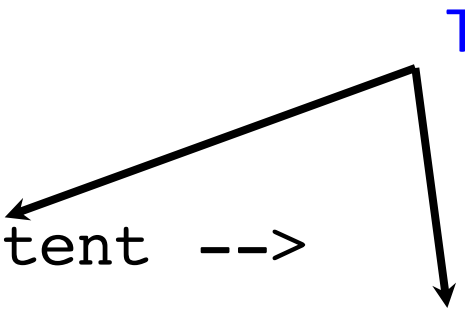
Nodes may have attributes (and attribute values)




```
<plant type="indoor">
  <zone></zone>
  <light source="2" class="new"/>
</plant>
```

Syntax

Comments can appear anywhere




```
<plant>
<!-- elem with content -->
  <zone>4 <!-- a second comment --></zone>
  <light>Mostly Shady</light>
</plant>
```

Well-formed XML

- An element must have both an open and closing tag unless it is empty. If empty, it can be of the form `<tagname/>`.
- Tags must nest properly. (Inner tags must close before outer ones.)
- Tag names are case-sensitive; start and end tags must match exactly.
- No spaces are allowed between `<` and tag name.
- Tag names must begin with a letter and contain only alphanumeric characters.

Well-formed XML ctd.:

- All attributes must appear in quotes in the format:

```
name = "value"
```

- Isolated markup characters must be specified via entity references. `<` is specified by `<` and `>` is specified by `>`.
- All XML documents must have *one root node* that contains all the other nodes.

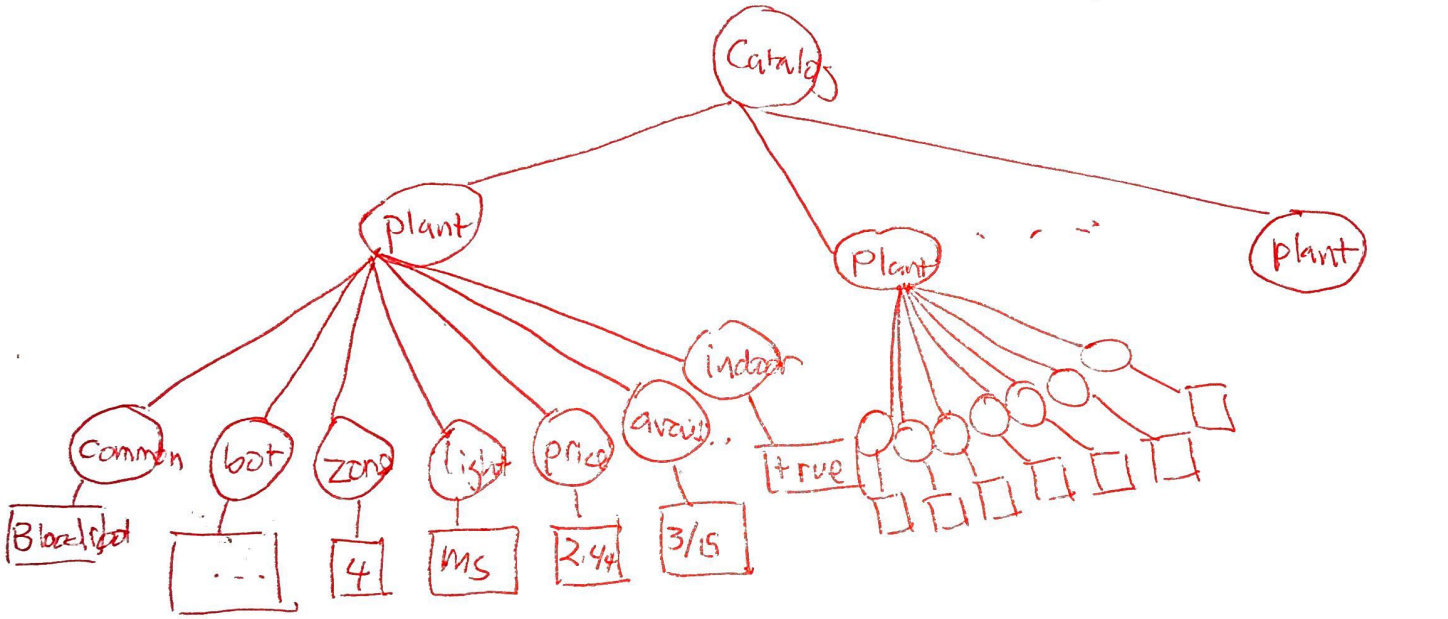
```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!-- Edited with XML Spy v2006 (http://www.altova.com) -->
<catalog>
 <plant>
   <common>Bloodroot</common>
   <botanical>Sanguinaria canadensis</botanical>
   <zone>4</zone>
   <light>Mostly Shady</light>
   <price>$2.44</price>
   <availability>031599</availability>
 </plant>
 <plant>
       <common>Columbine</common>
       <botanical>Aquilegia canadensis</botanical>
       <zone>3</zone>
       <light>Mostly Shady</light>
       <price>$9.37</PRICE>
       <availability>030699</availability>
   </plant>
…</catalog>
```

XML declaration and processing instructions

Note how indentation makes it easier to check that the tags are correctly nested.

Tree Representation

```
<catalog>
 <plant>
   <common>Bloodroot</common>
   <botanical>Sanguinaria canadensis</botanical>
   <zone>4</zone>
   <light>Mostly Shady</light>
   <price>$2.44</price>
   <availability>031599</availability>
 </plant>
   …
</catalog>
```



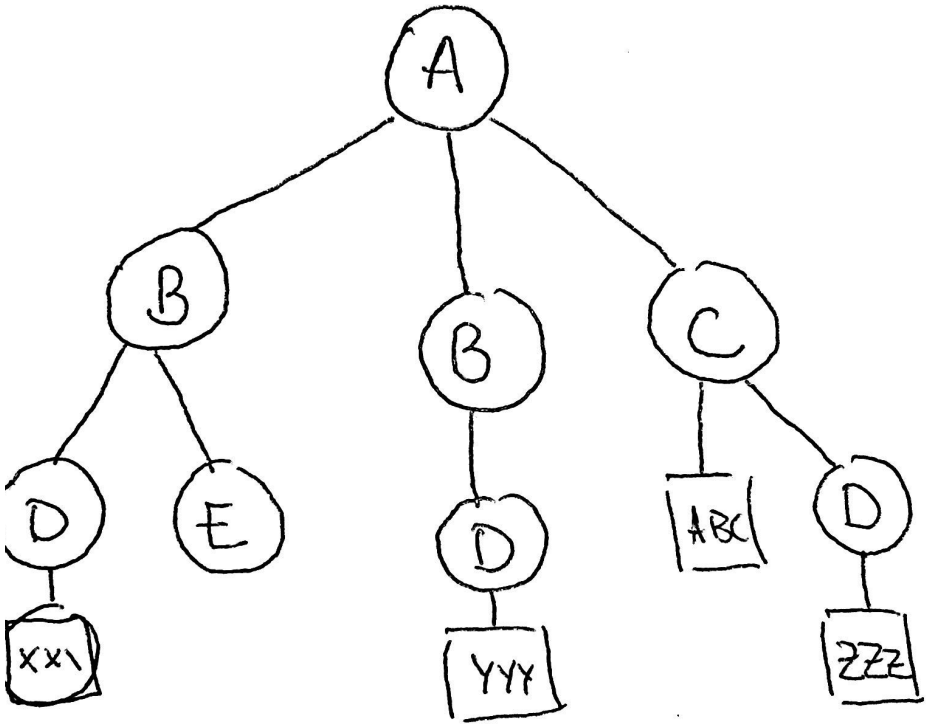
Tree terminology

- There is only one *root or document node* in the tree, and all the other nodes are contained within it.
- We think of these other nodes as being *descendants* of the root node.
- We use the language of a family tree to refer to relationships between nodes. *Parents, children, siblings, ancestors, descendants*
- The *terminal nodes* in a tree are also known as *leaf nodes*. Content always falls in a leaf node.

```
<A>
 <B>
    <D>xxx</D>
    <E/>
 </B>
 <B>
    <D> yyy </D>
 </B>
 <C>
    ABC
    <D> ZZZZ </D>
 </C>
</A>
```

Which statement is TRUE?

A. All B nodes are siblings
B. E's parent is a B node
C. All D nodes are siblings
D. A and B
E. A, B, and C




```
<A>
 <B>
   <D>xxx</D>
   <E/>
 </B>
 <B>
   <D> yyy </D>
 </B>
 <C>
   ABC
   <D> ZZZZ </D>
 </C>
</A>
```

Which statement is TRUE?

A. All B nodes are siblings

B. E's parent is a B node

C. All D nodes are siblings

D. A and B

E. A, B, and C

Working with XML in R

XML package

- Handy functions for parsing XML
  - **xmlParse**: read an XML file into R
  - **xmlValue**: retrieve text content of a node (including content of all child nodes)
  - **xmlSize**: return the number of child nodes
  - **xmlName**: return the tag name of a node
  - **xmlGetAttr**: return the attribute value of the specified attribute

To read an XML file into R, use `xmlParse`

```
doc = xmlParse("plant.xml")
```

and extract the root node using `xmlRoot`.

```
catalog = xmlRoot(doc)
class(catalog)
[1] "XMLNode"
```

To illustrate how we manipulate an XML object in R, we take this data and reformat it into a data frame with one row for each plant.

The XML document is a special object in R.

It is similar to a list, but we need special functions to extract content

`xmlParse` implements what is called the DOM (Document Object Model) parser.

We don't have time to cover it, but you should be aware of another parsing model called SAX (Simple API for XML). It reads the document incrementally and is more memory efficient, but it is trickier to use.

The tree structure is represented in R as a list of lists.

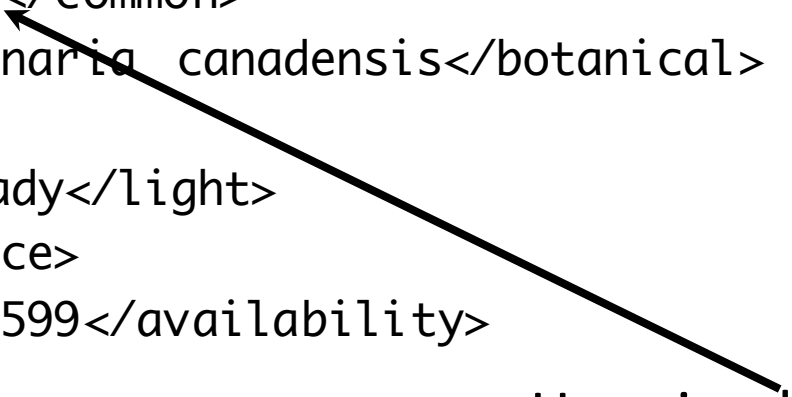
We can access an element within a node (i.e., a child), using the usual `[[ ]]` indexing for lists.

- XML versions of `lapply` and `sapply`, named `xmlApply` `xmlSApply`. Each takes an XMLNode object as its primary argument. They iterate over the node's children nodes, invoking the given function.

- Like `lapply`, `xmlApply` returns a list. Like `sapply`, `xmlSApply` returns a simpler data structure if possible.

Look at the first plant node

```
> oneplant = catalog[[1]]
> class(oneplant)
[1] "XMLNode"
> oneplant
<plant>
 <common>Bloodroot</common>
 <botanical>Sanguinaria  canadensis</botanical>
 <zone>4</zone>
 <light>Mostly  Shady</light>
 <price>$2.44</price>
 <availability>031599</availability>
</plant>
```



Here is a leaf node
It contains the content
"Bloodroot"

We can drill down further into the list:

```
> oneplant[['common']]
<common>Bloodroot</common>
```

Note that this doesn't remove the markup.

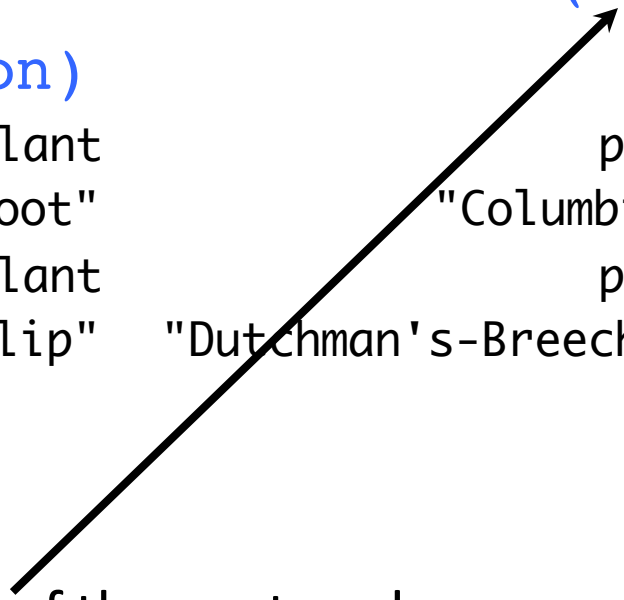
To do this, use the function `xmlValue`

```
> xmlValue(oneplant[['common']])
[1] "Bloodroot"
> xmlValue(oneplant[['botanical']])
[1] "Sanguinaria canadensis"
```

TASK: Create a vector of common names:

```
common = xmlSApply(catalog, function(el){
                   xmlValue(el[['common']])})
head(common)
```

```
            plant                     plant                     plant
"Bloodroot"                "Columbine"   "Marsh Marigold"
            plant                     plant                     plant
  "Cowslip"   "Dutchman's-Breeches"     "Ginger, Wild"
```



The elements of the root node
are all plant nodes,
like `oneplant`.

Pros

- data is self-describing
- format separates content from structure
- data can be easily merged and exchanged
- file is human-readable
- file is also easily machine-generated
- standards are widely adopted

Cons

- XML documents can be very verbose
- It’s so general that it can be difficult to develop tools for all cases
- Files can be quite large due to high amount of redundancy

Comparison JSON & XML

- JSON is simpler
- JSON is not as rich – no attributes, no schema for describing acceptable format
- Compressed JSON and XML not much different in size