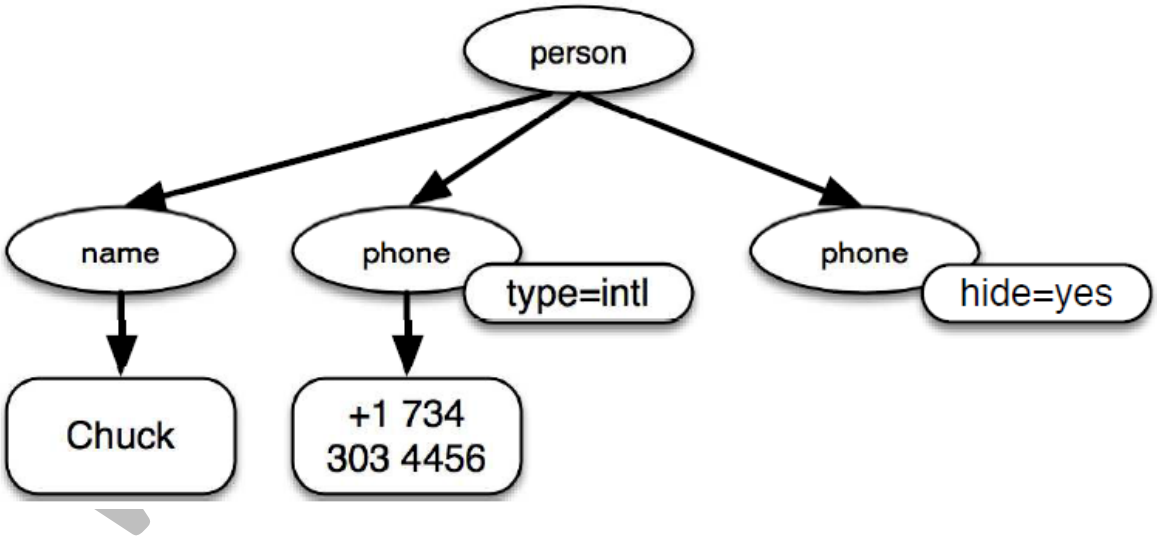
USING WEB SERVICES

eXtensible Markup Language – XML

XML looks very similar to HTML, but XML is more structured than HTML. Here is a sample of an XML document:

```
<person>
<name>Chuck</name>
<phone type="intl">
+1 734 303 4456
</phone>
<email hide="yes"/>
</person>
```

Often it is helpful to think of an XML document as a tree structure where there is a top tag person and other tags such as phone are drawn as *children* of their parent nodes.



Parsing XML

We will parse XML using a simple application and then extracts some data elements from it:

```
import xml.etree.ElementTree as ET
data = '''
<person>
<name>Chuck</name>
<phone type="intl">
+1 734 303 4456
</phone>
<email hide="yes"/>
</person>'''

tree = ET.fromstring(data)
print('Name:', tree.find('name').text)
print('Attr:', tree.find('email').get('hide'))
```

Calling fromstring converts the string representation of the XML into a "tree" ofXML nodes. When the XML is in a tree, we have a series of methods we can call to extract portions of data from the XML.The find function searches through the XML tree and retrieves a *node* that matches the specified tag. Each node can have some text, some attributes (like hide), and some "child" nodes. Each node can be the top of a tree of nodes.

Output:

```
Name: Chuck
Attr: yes
```

Using an XML parser such as ElementTree has the advantage that while the XML in this example is quite simple, it turns out there are many rules regarding valid XML and using ElementTree allows us to extract data from XML without worrying about the rules of XML syntax.

Looping through nodes

Often the XML has multiple nodes and we need to write a loop to process all of the nodes. In the following program, we loop through all of the user nodes:

```
import xml.etree.ElementTree as ET
input = '''
<stuff>
<users>
<user x="2">
```

```
<id>001</id>
<name>Chuck</name>
</user>
<user x="7">
<id>009</id>
<name>Brent</name>
</user>
</users>
</stuff>'''
stuff = ET.fromstring(input)
lst = stuff.findall('users/user')
print('User count:', len(lst))
for item in lst:
print('Name', item.find('name').text)
print('Id', item.find('id').text)
print('Attribute', item.get("x"))
```

The findall method retrieves a Python list of subtrees that represent the user structures in the XML tree. Then we can write a for loop that looks at each of the user nodes, and prints the name and id text elements as well as the x attribute from the user node.

Output:

```
User count: 2
Name Chuck
Id 001
Attribute 2
Name Brent
Id 009
Attribute 7
```

JavaScript Object Notation – JSON

The JSON format was inspired by the object and array format used in the JavaScript language. But since Python was invented before JavaScript, Python's syntax for dictionaries and lists influenced the syntax of JSON. So the format of JSON is nearly identical to a combination of Python lists and dictionaries. Here is a JSON encoding that is roughly equivalent to the simple XML from above:

```
{
"name" : "Chuck",
"phone" : {
```

```
"type" : "intl",
"number" : "+1 734 303 4456"
},
"email" : {
"hide" : "yes"
}
}
```

Differences noticed b/w XML and JSON

First, in XML, we can add attributes like “intl” to the “phone” tag. In JSON, we simply have key-value pairs. Also the XML “person” tag is gone, replaced by a set of outer curly braces.

JSON structures are simpler than XML because JSON has fewer capabilities than XML. But JSON has the advantage that it maps *directly* to some combination of dictionaries and lists. And since nearly all programming languages have something equivalent to Python’s dictionaries and lists, JSON is a very natural format to have two cooperating programs exchange data.

JSON is quickly becoming the format of choice for nearly all data exchange between applications because of its relative simplicity compared to XML.

Parsing JSON

We construct our JSON by nesting dictionaries (objects) and lists as needed. In this example, we present a list of users where each user is a set of key-value pairs (i.e., a dictionary). So we have a list of dictionaries .In the following program, we use the built-in *json* library to parse the JSON and read through the data. The JSON has less detail, so we must know in advance that we are getting a list and that the list is of users and each user is a set of key-value pairs. The JSON is more succinct (an advantage) but also is less self-describing (a disadvantage).

```
import json
data = '''
[
{ "id" : "001",
"x" : "2",
"name" : "Chuck"
} ,
{ "id" : "009",
"x" : "7",
"name" : "Chuck"
}
```

```
]'''
info = json.loads(data)
print('User count:', len(info))
for item in info:
print('Name', item['name'])
print('Id', item['id'])
print('Attribute', item['x'])
```

Explanation

If you compare the code to extract data from the parsed JSON and XML we will see that what we get from *json.loads()* is a Python list which we traverse with a for loop, and each item within that list is a Python dictionary. Once the JSON has been parsed, we can use the Python index operator to extract the various bits of data for each user.

Output

User count: 2
Name Chuck
Id 001
Attribute 2
Name Brent
Id 009
Attribute 7

Application Programming Interfaces

Defining and documenting "contracts" between applications using various techniques. The general name for these application-to-application contracts is *Application Program Interfaces* or APIs. When we use an API, generally one program makes a set of *services* available for use by other applications and publishes the APIs (i.e., the "rules") that must be followed to access the services provided by the program.

Service oriented architecture(SOA) and Non Service oriented architecture(SOA)

A SOA approach is one where our overall application makes use of the services of other applications. A non-SOA approach is where the application is a single standalone application which contains all of the
code necessary to implement the application.

Example

We see many examples of SOA when we use the web. We can go to a single web site and book air travel, hotels, and automobiles all from a single site. The data for hotels is not stored on the airline computers. Instead, the airline computers contact the services on the hotel computers and retrieve the hotel data and present it to the user. When the user agrees to make a hotel reservation using the airline site, the airline site uses another web service on the hotel systems to actually make the reservation.

Advantages of SOA

- We always maintain only one copy of data.
- The owners of the data can set the rules about the use of their data.

Google geocoding web service

Google has an excellent web service that allows us to make use of their large database of geographic information. We can submit a geographical search string like "Ann Arbor, MI" or any other place to their geocoding API and have Google return its best guess as to where on a map we might find our search string and tell us about the landmarks nearby.

Python program to prompt the user for a search string, call the Google geocoding API, and extract information from the returned JSON.

```
import urllib.request, urllib.parse, urllib.error
import json
# Note that Google is increasingly requiring keys
# for this API
serviceurl = 'http://maps.googleapis.com/maps/api/geocode/json?'
while True:
address = input('Enter location: ')
if len(address) < 1: break
url = serviceurl + urllib.parse.urlencode(
{'address': address})
print('Retrieving', url)
uh = urllib.request.urlopen(url)
data = uh.read().decode()
print('Retrieved', len(data), 'characters')
try:
js = json.loads(data)
except:
```

```
js = None
if not js or 'status' not in js or js['status'] != 'OK':
print('==== Failure To Retrieve ====')
print(data)
continue
print(json.dumps(js, indent=4))
lat = js["results"][0]["geometry"]["location"]["lat"]
lng = js["results"][0]["geometry"]["location"]["lng"]
print('lat', lat, 'lng', lng)
location = js['results'][0]['formatted_address']
print(location)
```

Explanation

The program takes the search string and constructs a URL with the search string as a properly encoded parameter and then uses *urllib* to retrieve the text from the Google geocoding API. Unlike a fixed web page, the data we get depends on theparameters we send and the geographical data stored in Google's servers.

Once we retrieve the JSON data, we parse it with the *json* library and do a few checks to make sure that we received good data, then extract the information that we are looking for.

Output

```
Enter location: Ann Arbor, MI
Retrieving http://maps.googleapis.com/maps/api/
geocode/json?address=Ann+Arbor%2C+MI
Retrieved 1669 characters
{
"status": "OK",
"results": [
{
"geometry": {
"location_type": "APPROXIMATE",
"location": {
"lat": 42.2808256,
"lng": -83.7430378
}
},
"address_components": [
{
"long_name": "Ann Arbor",
```

"types": [
"locality",
"political"
],
"short_name": "Ann Arbor"
}
],
"formatted_address": "Ann Arbor, MI, USA",
"types": [
"locality",
"political"
]
}
]
}

lat 42.2808256 lng -83.7430378
Ann Arbor, MI, USA

Security and API usage

It is quite common that you need some kind of "API key" to make use of a vendor's API. The general idea is that they want to know who is using their services and how much each user is using. Perhaps they have free and pay tiers of their services or have a policy that limits the number of requests that a single individual can make during a particular time period. Sometimes once you get your API key, you simply include the key as part of POST data or perhaps as a parameter on the URL when calling the API.Other times, the vendor wants increased assurance of the source of the requestsand so they add expect you to send cryptographically signed messages using shared keys and secrets. A very common technology that is used to sign requests over the Internet is called *OAuth*.

Explanation and program taking Twitter API as example
As the Twitter API became increasingly valuable, Twitter went from an open and public API to an API that required the use of OAuth signatures on each API request. Thankfully there are still a number of convenient and free OAuth libraries so we can avoid writing an OAuth implementation from scratch by reading the specification.

Program specific explanation

For this next sample program we will download the files *twurl.py*, *hidden.py*, *oauth.py*, and *twitter1.py* from www.py4e.com/code and put them all in a folder on our computer.

To make use of these programs we will need to have a Twitter account, and authorize our Python code as an application, set up a key, secret, token and token secret. We will edit the file *hidden.py* and put these four strings into the appropriate variables in the file:

```
# Keep this file separate
# https://apps.twitter.com/
# Create new App and get the four strings
def oauth():
return {"consumer_key": "h7Lu...Ng",
"consumer_secret" : "dNKenAC3New...mmn7Q",
"token_key" : "10185562-eibxCp9n2...P4GEQQOSGI",
"token_secret" : "H0ycCFemmC4wyf1...qoIpBo"}
# Code: http://www.py4e.com/code3/hidden.py
```

The Twitter web service are accessed using a URL like this:

https://api.twitter.com/1.1/statuses/user_timeline.json

But once all of the security information has been added, the URL will look more like:

```
https://api.twitter.com/1.1/statuses/user_timeline.json?count=2
&oauth_version=1.0&oauth_token=101...SGI&screen_name=drchuck
&oauth_nonce=09239679&oauth_timestamp=1380395644
&oauth_signature=rLK...BoD&oauth_consumer_key=h7Lu...GNg
&oauth_signature_method=HMAC-SHA1
```

we can read the OAuth specification if you want to know more about the meaning of the various parameters that are added to meet the security requirements of OAuth. For the programs we run with Twitter, we hide all the complexity in the files *oauth.py* and *twurl.py*. We simply set the secrets in *hidden.py* and then send the desired URL to the *twurl.augment()* function and the library code adds all the necessary parameters to the URL for us.

Program below retrieves the timeline for a particular Twitter user and returns it to us in JSON format in a string. We simply print the first 250 characters of the string:

```
import urllib.request, urllib.parse, urllib.error
import twurl
import ssl
# https://apps.twitter.com/
```

```
# Create App and get the four strings, put them in hidden.py
TWITTER_URL = 'https://api.twitter.com/1.1/statuses/user_timeline.json'
# Ignore SSL certificate errors
ctx = ssl.create_default_context()
ctx.check_hostname = False
ctx.verify_mode = ssl.CERT_NONE
while True:
print('')
acct = input('Enter Twitter Account:')
if (len(acct) < 1): break
url = twurl.augment(TWITTER_URL,
{'screen_name': acct, 'count': '2'})
print('Retrieving', url)
connection = urllib.request.urlopen(url, context=ctx)
data = connection.read().decode()
print(data[:250])
headers = dict(connection.getheaders())
# print headers
print('Remaining', headers['x-rate-limit-remaining'])
# Code: http://www.py4e.com/code3/twitter1.py
```

When the program runs it produces the following output:

```
Enter Twitter Account:drchuck
Retrieving https://api.twitter.com/1.1/ ...
[{"created_at":"Sat Sep 28 17:30:25 +0000 2013","
id":384007200990982144,"id_str":"384007200990982144",
"text":"RT @fixpert: See how the Dutch handle traffic
intersections: http:\/\/t.co\/tIiVWtEhj4\n#brilliant",
"source":"web","truncated":false,"in_rep
Remaining 178

Enter Twitter Account:
```

Explanation

Along with the returned timeline data, Twitter also returns metadata about the request in the HTTP response headers. One header in particular, *x-rate-limit-remaining*, informs us how many more requests we can make before we will be shut off for a short time period.

In the following example, we retrieve a user's Twitter friends, parse the returned JSON, and extract some of the information about the friends. We also dump the JSON after parsing and "pretty-print" it with an indent of four characters to allow us to pore through the data when we want to extract more fields.

```
import urllib.request, urllib.parse, urllib.error
import twurl
import json
import ssl
# https://apps.twitter.com/
# Create App and get the four strings, put them in hidden.py
TWITTER_URL = 'https://api.twitter.com/1.1/friends/list.json'
# Ignore SSL certificate errors
ctx = ssl.create_default_context()
ctx.check_hostname = False
ctx.verify_mode = ssl.CERT_NONE
while True:
print('')
acct = input('Enter Twitter Account:')
if (len(acct) < 1): break
url = twurl.augment(TWITTER_URL,
{'screen_name': acct, 'count': '5'})
print('Retrieving', url)
connection = urllib.request.urlopen(url, context=ctx)
data = connection.read().decode()
js = json.loads(data)
print(json.dumps(js, indent=2))
headers = dict(connection.getheaders())
print('Remaining', headers['x-rate-limit-remaining'])
for u in js['users']:
print(u['screen_name'])
if 'status' not in u:
print(' * No status found')
continue
s = u['status']['text']
print(' ', s[:50])
# Code: http://www.py4e.com/code3/twitter2.py
```

Since the JSON becomes a set of nested Python lists and dictionaries, we can use a combination of the index operation and for loops to wander through the returned data structures with very little Python code.

The output of the program looks as follows (some of the data items are shortened to fit on the page):

Output:

```
Enter Twitter Account:drchuck
Retrieving https://api.twitter.com/1.1/friends ...
Remaining 14
{
"next_cursor": 1444171224491980205,
"users": [
{
"id": 662433,
"followers_count": 28725,
"status": {
"text": "@jazzychad I just bought one .__.",
"created_at": "Fri Sep 20 08:36:34 +0000 2013",
"retweeted": false,
},
"location": "San Francisco, California",
"screen_name": "leahculver",
"name": "Leah Culver",
},
{
"id": 40426722,
"followers_count": 2635,
"status": {
"text": "RT @WSJ: Big employers like Google ...",
"created_at": "Sat Sep 28 19:36:37 +0000 2013",
},
"location": "Victoria Canada",
"screen_name": "_valeriei",
"name": "Valerie Irvine",
],
"next_cursor_str": "1444171224491980205"
}
leahculver
@jazzychad I just bought one .__.
_valeriei
RT @WSJ: Big employers like Google, AT&amp;amp;T are h
ericbollens
RT @lukew: sneak peek: my LONG take on the good &a
```

halherzog
Learning Objects is 10. We had a cake with the LO,
scweeker
@DeviceLabDC love it! Now where so I get that "etc
Enter Twitter Account:
The last bit of the output is where we see the for loop reading the five most recent "friends" of the *drchuck* Twitter account and printing the most recent status foreach friend. There is a great deal more data available in the returned JSON. Ifwe look in the output of the program, you can also see that the "find the friends" of a particular account has a different rate limitation than the number of timeline queries we are allowed to run per time period.