CSCE 590-1: From Data to Decisions with Open Data: A Practical Introduction to AI

Lecture 2: Data

PROF. BIPLAV SRIVASTAVA, AI INSTITUTE

14TH JAN 2021

Carolinian Creed: "I will practice personal and academic integrity."

Organization of Lecture 2

- Introduction Segment
  - Recap of Lecture 1
- Main Segment
  - Types
    - Structured,
    - Semi-structured,
    - Unstructured,
  - By media: text, audio, video, multi-media;
  - Open Data
- Concluding Segment
  - About Next Lecture – Lecture 3
  - Ask me anything

Introduction Segment

Recap of Lecture 1

- We did a quick overview of the course
- Looked at AI, Data and Decisions
- Course will focus on
  - Practical methods to derive insights from open data
  - Evaluation will be by via project, paper and quizzes
  - **Bring your ideas to your project**
- Exciting techniques to learn to impact the world around us

Questions from Lecture 1

- Math requirements
  - Linear Algebra, Differential Equations, Matrices, Discrete Mathematics
- Programming requirements
  - Data Structures, Software Engineering

Sub-areas of AI

- Representation: formal representation of knowledge.
  - Illustration: entities and their relationships, like last Russian Czar's family tree
  - Methods: Ontology, knowledge graph, word embedding, "Model"
- Reasoning: deriving conclusions from formally represented knowledge.
  - Illustration: Modus ponen – P implies Q. P is True. Hence Q must be true.
  - Methods: Deduction, Induction, Abduction, Proposition logic, First-order logic, Fuzzy logic
- Learning: drawing insights from data
  - Illustration: predict COVID cases in USA by end of the month
  - Methods: Machine Learning – Classification, Clustering, Association; Deep Neural Network

Example: Courses for a Student

- Decision: Student deciding which courses to take for their program
- Data
  - About courses
  - About faculties
  - About job opportunities
  - About research opportunities and industry trends
  - Private: what the student wants to do
- Analysis
  - **Descriptive**: Courses offered in different semesters; Teachers offering courses
  - **Predictive**: How fill will be a particular class next semester?
  - **Prescriptive**: Should a student a particular course?

Example: Health During a Pandemic

- Decision: Individual staying healthy during a pandemic like COVID19
- Data
  - About cases
  - About mitigation steps: e.g., mask wearing restrictions and practices, lockdowns, hospital conditions
  - Private: pre-existing health conditions
- Analysis
  - **Descriptive**: Regions with high and low cases
  - **Predictive**: Does wearing mask help reduce cases?
  - **Prescriptive**:
    - Whether to eat inside a restaurant?
    - How to make an urgent road trip ?
    - How to hold classes at a University?

Main Segment

Data – The Fuel for AI

Overview: Types of Data

- By content structure: Structured, unstructured and semi-structured
- By media: text, audio, visual, multi-media

- By source
  - Open data
  - Social data
  - Sensor data
  - Proprietary data

- Value is by fusing data across all types
  - sources, content structure and media

Types of Data - Structured

- The structure of data is fixed. Example: columns in a database
- Benefits
  - Can be stored and queried efficiently, e.g., by commercial databases
  - Easy to analyze, e.g., by SQL or programs – pandas in Python
- Disadvantage
  - Hard to handle data's structural changes. E.g., adding a new column. Complex data migration procedures

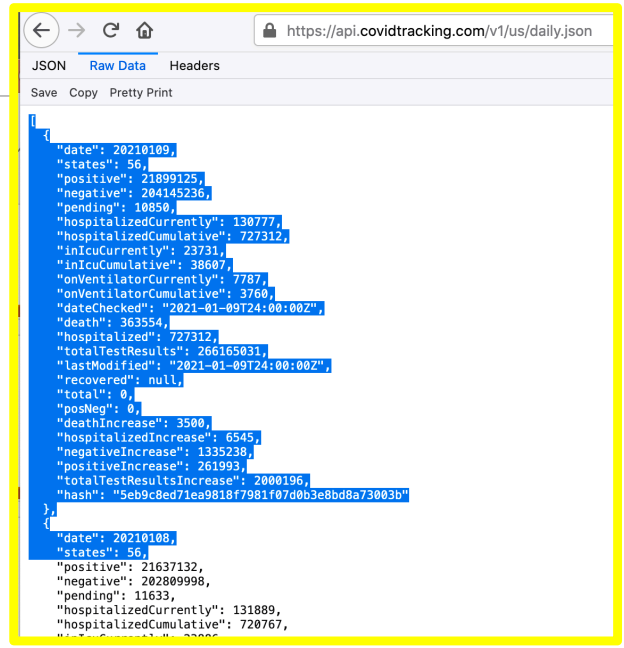
```
country,placename,frequency,start_date,end_date,year,month,week,deaths,expected_deaths,excess_deaths,baseline

...
France,,weekly,2020-04-27,2020-05-03,2020,4,18,10498,10357,141,2010-2018 weekly average
...
```

Source: https://github.com/nytimes/covid-19-data/tree/master/excess-deaths

NYT COVID datasets: https://github.com/nytimes/covid-19-data/

Types of Data – Semi-Structured

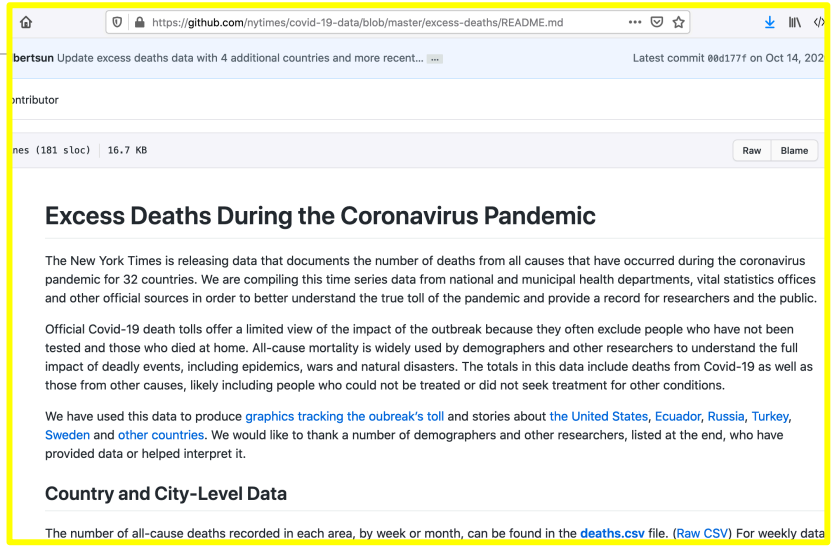
- The structure of meta-data is fixed, but the structure of data is allowed to change. Example: XML, JSON
- Benefits
  - Relatively easy to analyze, e.g., commands similar to SQL in langauges like OQL or Xquery
  - Structure of data easy to extend
- Disadvantage
  - Size of data is larger than structured representation as metadata is added with each record



Source: https://api.covidtracking.com/v1/us/daily.json

Types of Data – Unstructured

- The data has no structure.
  Example: text
- Benefits
  - Easy to change structure
  - Content can be compactly stored
- Disadvantage
  - Hard to analyze content. Example: word analysis, sentiments, topic, …



Source: https://github.com/nytimes/covid-19-data/blob/master/excess-deaths/README.md

NYT COVID datasets: https://github.com/nytimes/covid-19-data/

Textual Data

- Media: text
- Components: characters, words, paragraph
- Representation
  - Uncompressed / encoding – ASCII, UTF-8, UTF-16
  - Compressed - .zip
  - Lossy compression -
- Language: English, French, …
- Programming libraries: nltk, spacy

Filename extension	.txt
Internet media type	text/plain
Type code	TEXT
Uniform Type Identifier (UTI)	public.plain-text
UTI conformation	public.text
Type of format	Document file format, Generic container format

Details: https://en.wikipedia.org/wiki/List_of_file_formats

Sound

- Media: sound
- Components: phoneme
- Representation
  - Uncompressed - .wav, .aiff
  - Compressed lossless -
  - Lossy compression - .mp3, .aac (iTunes)
- Programming libraries: playsound, simpleaudio, winsound, python-sounddevice, pydub, pyaudio

Details: https://en.wikipedia.org/wiki/Audio_file_format

Filename extension	.wav .wave
Internet media type	audio/vnd.wave,[1] audio/wav, audio/wave, audio/x-wav[2]
Type code	WAVE
Uniform Type Identifier (UTI)	com.microsoft.waveform-audio
Developed by	IBM & Microsoft
Initial release	August 1991; 29 years ago[3]
Latest release	Multiple Channel Audio Data and WAVE Files (7 March 2007; 13 years ago (update)[4][5])
Type of format	audio file format, container format
Extended from	RIFF
Extended to	BWF, RF64

Visual

- Media: image, video
- Components: pixel, frame
- Representation
  - Uncompressed – bitmap
  - Compressed lossless - .gif
  - Lossy compression - .jpeg
  - Containers: AVI (.avi) and QuickTime (.mov)
- Programming libraries: PIL, OpenCV

Filename extension	.avi
Internet media type	video/vnd.avi[1] video/avi video/msvideo video/x-msvideo
Type code	'Vfw '
Uniform Type Identifier (UTI)	public.avi
Developed by	Microsoft
Initial release	November 1992; 27 years ago
Container for	Audio, Video
Extended from	Resource Interchange File Format

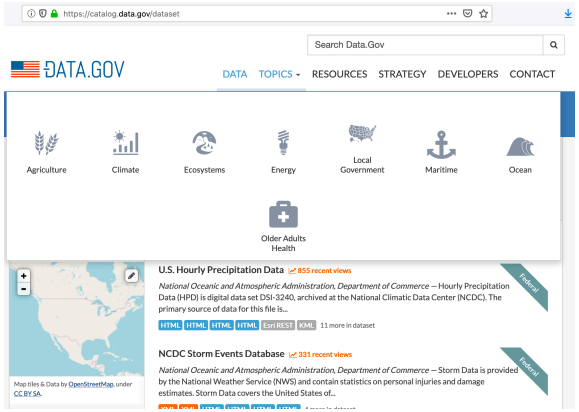
Open Data

"Open data and content can be **freely used, modified, and shared** by **anyone** for **any purpose**"

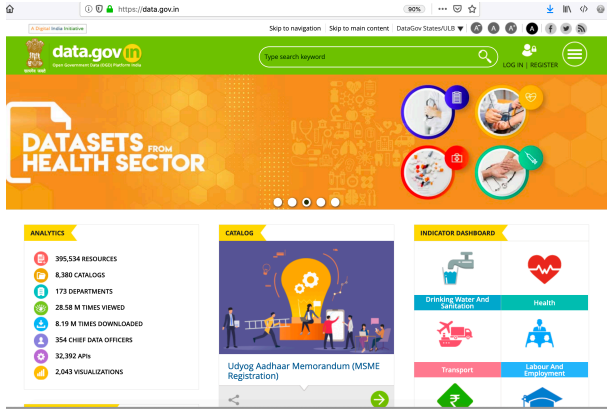
http://opendefinition.org/od/2.1/en/

Open Data is an Old Concept in a New Setting

- Open data is the notion that data should not be hidden, but made available to everyone to **reuse**. The idea is not new.
- Scientific publications follow this: “standing on the shoulders of giants”
- Data quality and open publishing process is critical

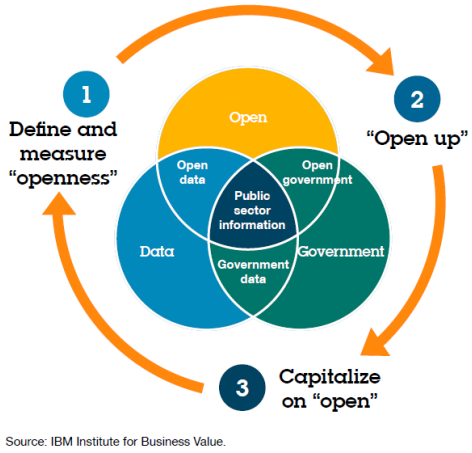


USA



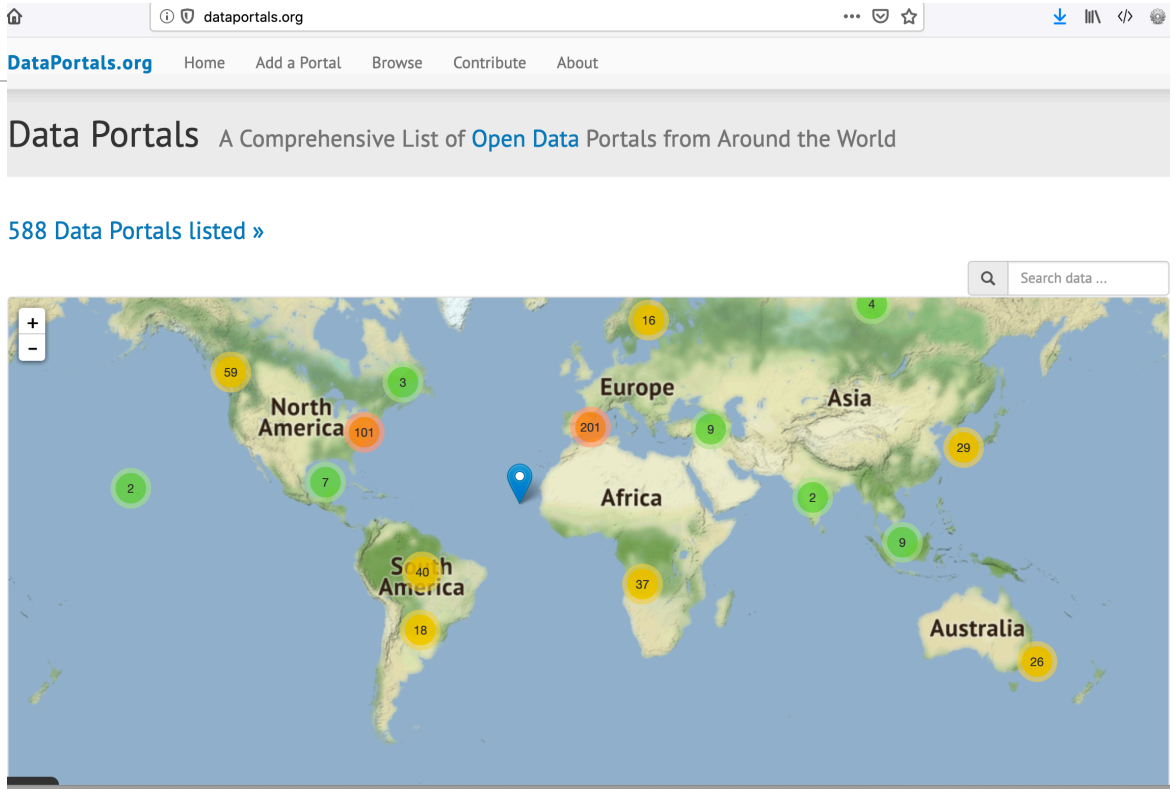
India

~600 Data Catalogs of Open Data



Source: IBM Institute for Business Value.

As on 20 June 2020



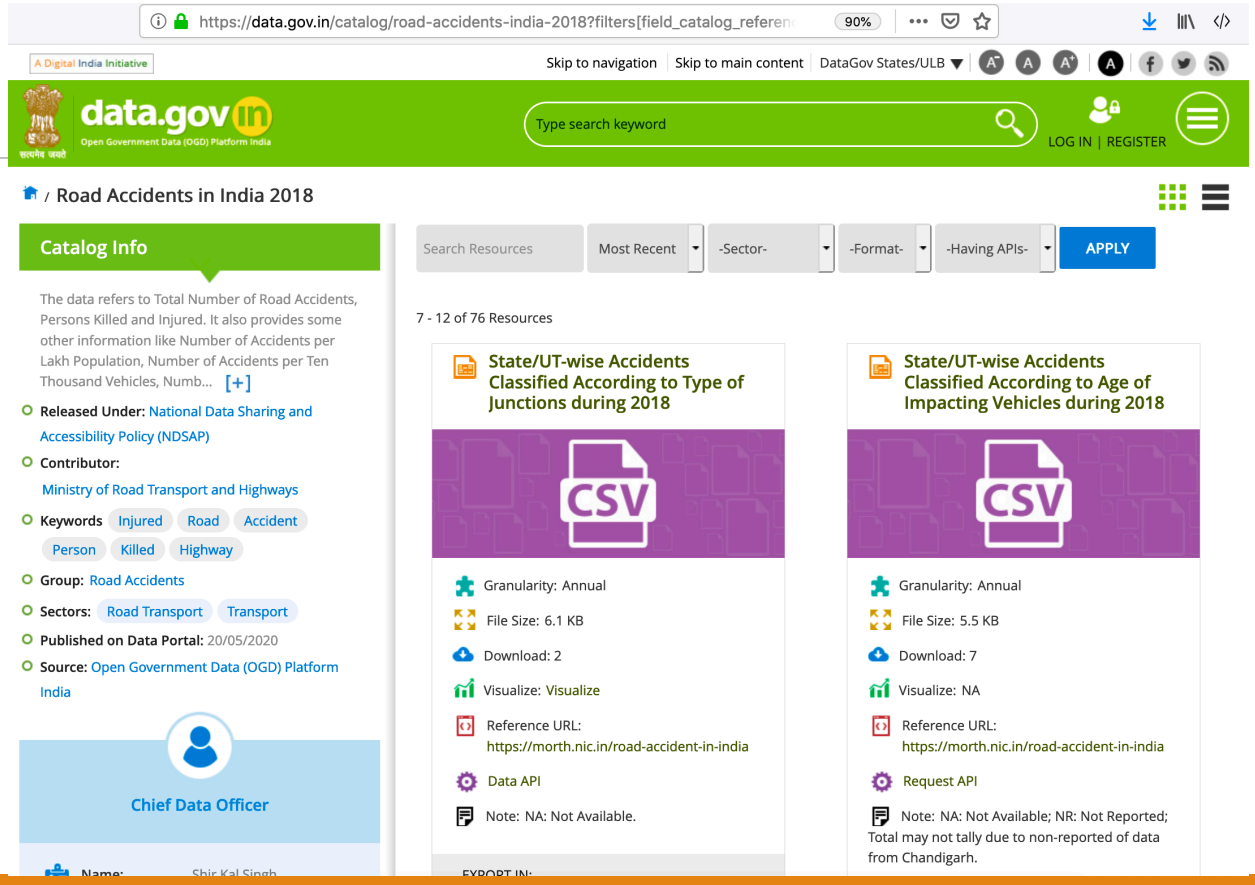
Demo: US Open Data

- Site: https://data.gov
-
- Tools: https://resources.data.gov/categories/data-tools/

Indian Open Data

Illustration: a catalog and resources (data sets) within them

- Road Accidents; 76 datasets



Open Data Should Not to Be Confused With Orthogonal Trend – Big Data

- Volume
- Variety
- Velocity
- Veracity
- …

"Your recent Amazon purchases, Tweet score and location history makes you 23.5% welcome here."

Cartoon critical of big data application, by T. Gregorius.

http://upload.wikimedia.org/wikipedia/commons/thumb/b/b3/Big_data_cartoon_t_gregorius.jpg/220px-Big_data_cartoon_t_gregorius.jpg

City Dashboard - London

CityDashboard aggregates simple spatial data for cities around the UK and displays the data on a dashboard and a map.

http://citydashboard.org/london/

http://citydashboard.org/about.php

Attempt for Dashboards - Amsterdam

[2016] http://citydashboard.waag.org/

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Exercise 1 - Explore

1. Google data search tool: https://datasetsearch.research.google.com/
2. US open data: https://www.data.gov/
3. Select a problem domain and search for data
4. Discuss your experience

Accessing Data

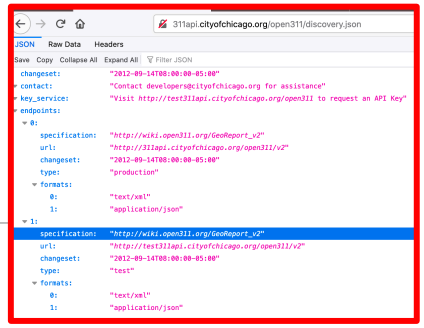
Example: Open 311 (http://open311.org/)

Refers to non-emergency events like graffiti, garbage, down trees, abandoned car, …

- Not human life threatening
- 60+ cities support it world-wide

Discovering Open 311 of a City

http://311api.cityofchicago.org/open311/discovery.json



changeset	"2012-09-14T08:00:00-05:00"
contact	"Contact developers@cityofchicago.org for assistance"
key_service	"Visit http://test311api.cityofchicago.org/open311 to request an API Key"
endpoints	
0	
specification	"http://wiki.open311.org/GeoReport_v2"
url	"http://311api.cityofchicago.org/open311/v2"
changeset	"2012-09-14T08:00:00-05:00"
type	"production"
formats	
0	"text/xml"
1	"application/json"
1	
specification	"http://wiki.open311.org/GeoReport_v2"
url	"http://test311api.cityofchicago.org/open311/v2"
changeset	"2012-09-14T08:00:00-05:00"
type	"test"
formats	
0	"text/xml"
1	"application/json"

Demonstration: Open 311

List of services

- http://311api.cityofchicago.org/open311/v2/services.json
- Result

[{"service_code":"4ffa4c69601827691b000018","service_name":"Abandoned Vehicle","description":"Abandoned vehicles are taken to auto pound 3S or 3N where they are -- if not redeemed by the owners -- sold for scrap.","metadata":true,"type":"batch","keywords":"code:SKA","group":"Streets & Sanitation"},

{"service_code":"4ffa9cad6018277d4000007b","service_name":"Alley Light Out","description":"One or more alley lights out, on a wooden pole in the alley itself, are reported under this service request type. Important information needed when reporting alley lights out includes: the exact address that the light/lights are behind, how many lights are out, and if the light(s) are completely out or if they blink on and off intermittently. Alley light repairs are done during the day when the lights are not on, so this information is essential to expedite the repair work.","metadata":true,"type":"batch","keywords":"code:SFA","group":"Transportation"},

…]

Details of a service

- http://311api.cityofchicago.org/open311/v2/services/4ffa4c69601827691b000018.json
- Result

{"service_code":"4ffa4c69601827691b000018",
"attributes":
[{"variable":true,"code":"FQSKA1",
"datatype":"singlevaluelist","required":false,"order":1,
"description":"Vehicle Make/Model",
"values":
[{"key":"ASVEAV","name":"(Assembled From Parts,Homemade)"},
{"key":"HOMDCYL","name":"(Homemade Motorcycle, Moped.Etc.)"},
{"key":"HMDETL","name":"(Homemade Trailer)"}, …]
…]}

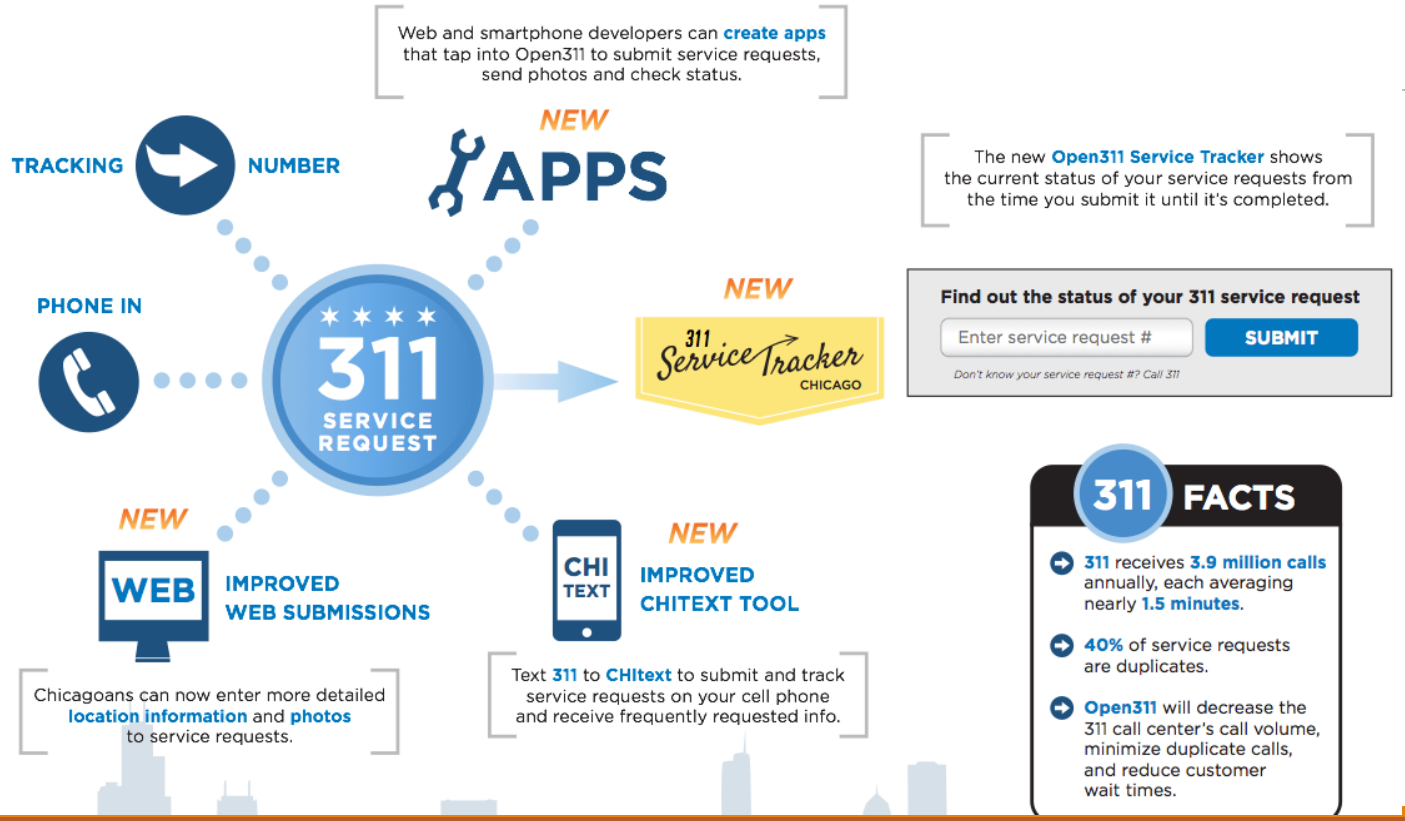
Demonstration: Open 311

http://311api.cityofchicago.org/open311/v2/services/4ffa9cad6018277d4000007b.json

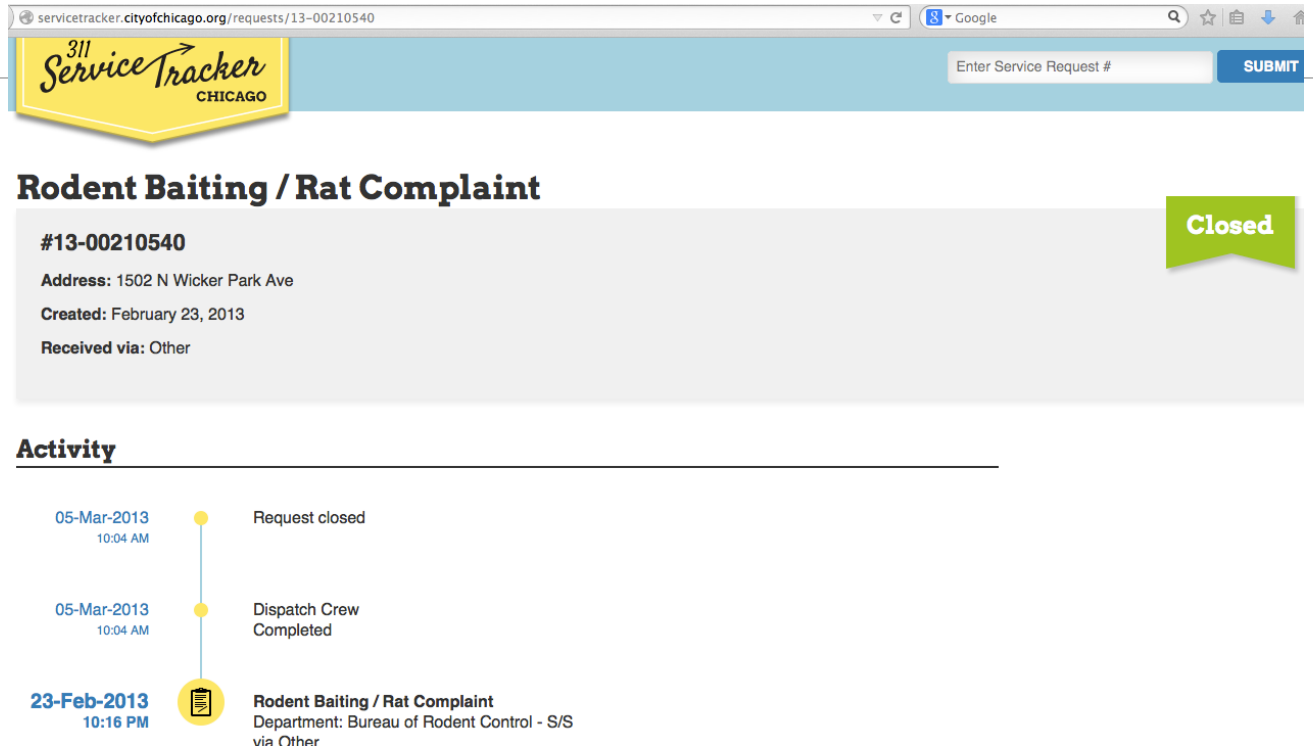
Result


```
{"service_code":"4ffa9cad6018277d4000007b",
  "attributes":
    [{"variable":true,"code":"ISTHELI2",
      "datatype":"singlevaluelist","required":true,"order":1,
      "description":"Is the light located in your alley or the street?",
      "values":[{"key":"ALLEY","name":"Alley"},
                {"key":"STREET","name":"Street"}]},


   {"variable":true,"code":"POLEWORM",
    "datatype":"singlevaluelist","required":true,"order":2,
    "description":"Is the pole wooden or metal?",
    "values":[{"key":"METAL","name":"Metal"},
              {"key":"WOODEN","name":"Wooden"}]},

  {"variable":true,"code":"ISTHELI3",
    "datatype":"singlevaluelist","required":true,"order":3,
    "description":"Is the light directly behind this address?",
    "values":[{"key":"NO","name":"No - Light Not Directly Behind Address"}
             ,{"key":"YES","name":"Yes - Light Directly Behind Address"}]},

 {"variable":true,"code":"A511OPTN",
   "datatype":"string","required":false,
   "datatype_description":"Enter number as 999-999-9999","order":4,
   "description":"Input mobile # to opt-in for text updates. If already opted-in, add mobile # to contact info."}]}
```

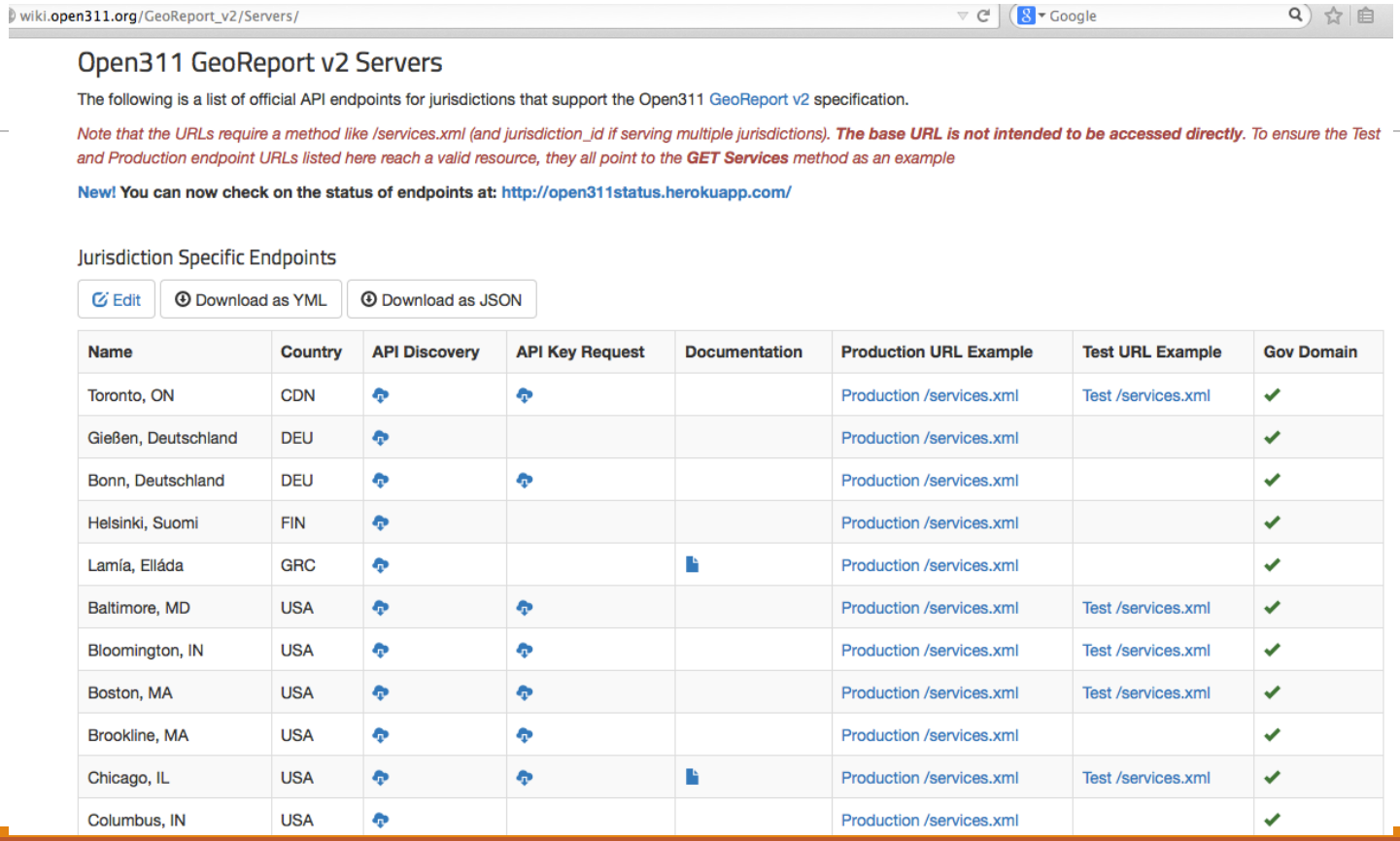
Chicago: Service Tracking



Example: Application over Open Data (Chicago)



Scaling with Open 311



wiki.open311.org/GeoReport_v2/Servers/

Open311 GeoReport v2 Servers

The following is a list of official API endpoints for jurisdictions that support the Open311 GeoReport v2 specification.

Note that the URLs require a method like /services.xml (and jurisdiction_id if serving multiple jurisdictions). ***The base URL is not intended to be accessed directly****. To ensure the Test and Production endpoint URLs listed here reach a valid resource, they all point to the* ***GET Services*** *method as an example*

New! You can now check on the status of endpoints at: http://open311status.herokuapp.com/

Jurisdiction Specific Endpoints

Edit | Download as YML | Download as JSON

Name	Country	API Discovery	API Key Request	Documentation	Production URL Example	Test URL Example	Gov Domain
Toronto, ON	CDN				Production /services.xml	Test /services.xml	✔
Gießen, Deutschland	DEU				Production /services.xml		✔
Bonn, Deutschland	DEU				Production /services.xml		✔
Helsinki, Suomi	FIN				Production /services.xml		✔
Lamía, Elláda	GRC				Production /services.xml		✔
Baltimore, MD	USA				Production /services.xml	Test /services.xml	✔
Bloomington, IN	USA				Production /services.xml	Test /services.xml	✔
Boston, MA	USA				Production /services.xml	Test /services.xml	✔
Brookline, MA	USA				Production /services.xml		✔
Chicago, IL	USA				Production /services.xml	Test /services.xml	✔
Columbus, IN	USA				Production /services.xml		✔

Exercise 2 – Programmatically Access Data

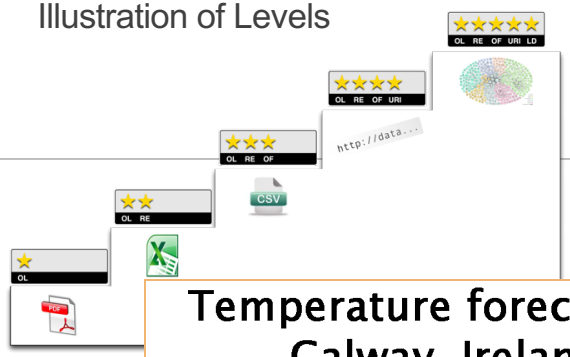
1. See sample code on GitHub:
   - https://github.com/biplav-s/course-d2d-ai/blob/main/sample-code/l1-intro/Explore%20OpenData.ipynb

2. Explore APIs of another city of your choice

Quality of Data

Does Opening Data Make It Reusable? No

Illustration of Levels



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Temperature forecast for Galway, Ireland

Day	Lowest Temperature (°C)
Saturday, 13 November 2010	2
Sunday, 14 November 2010	4
Monday, 15 November 2010	7

Temperature forecast for Galway, Ireland

Day	Lowest Temperature (°C)
Saturday, 13 November 2010	2
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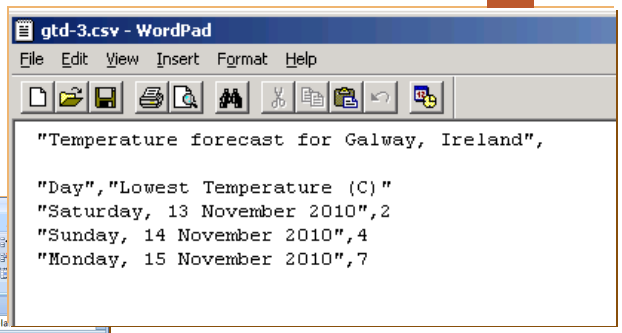
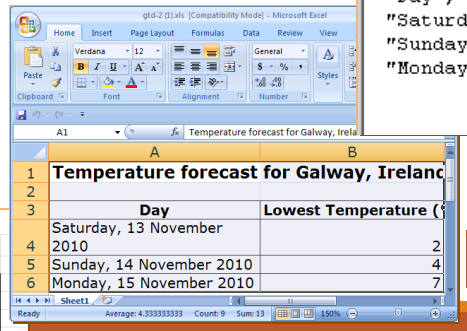
4

3





2

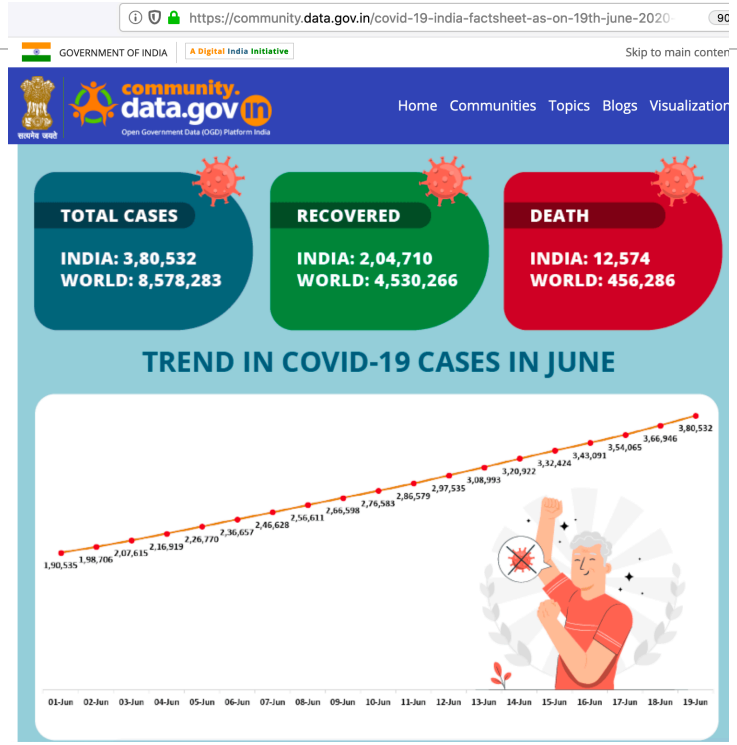
Source: http://5stardata.info/

Temperature forecast for Galway, Ireland

Day	Lowest Temperature (°C)
Saturday, 13 November 2010	2
Sunday, 14 November 2010	4
Monday, 15 November 2010	

1

Data Quality of Public Data in India



Right to Information

- Not even 1*
- Information available to requester, but no one else

Data.gov.in

- 2-3*
- Available in CSV, etc but not uniquely referenceable

Open data movements are moving to linked data form for semantics

Annotated – Indian Open Data

Vocabulary services: http://vocab.nic.in/index.php

- Authoritative
- Standardized codes

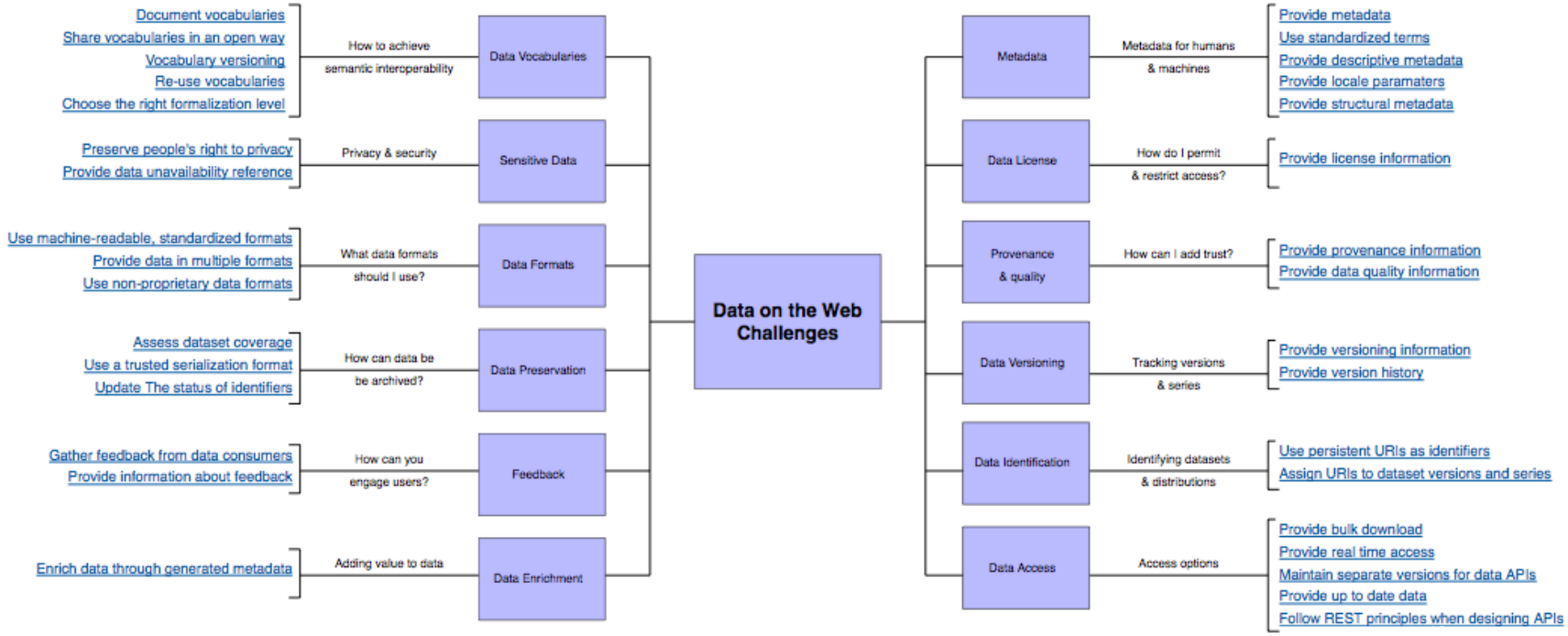
Examples

- States in the Union: http://vocab.nic.in/rest.php/states/json
- Districts in a state ("UP"): http://vocab.nic.in/rest.php/district/up/json
- State legislatures: http://vocab.nic.in/rest.php/orgn/sg/legislature/json
- Union government offices in a state ("TN"): http://vocab.nic.in/rest.php/orgn/ug/state/tn/json

Helping Publish Good Quality Open Data is Key

Have data policy in place
Publish with best practices, have semantics, promote reuse

Figure courtesy: http://www.w3.org/TR/2015/WD-dwbp-20150625/



Lecture 2: Concluding Comments

- We looked at data of different types: by structure, content type and source
- Open data is useful
- Accessing open data is quite easy, Open 311 helps
- Annotations are important for discovery
- Publishing good data is important for useful AI

Concluding Segment

About Next Lecture – Lecture 3

Lecture 3: A Systematic Approach

- Real-World Problems
- A Systematic Approach
  - Value of decision: before and after
  - Data-needed
  - Method
  - Evaluation
  - Integrating with overall process