

And so??

- ◆ Think of other contexts...
- ◆ For instance, databases: **SQL** (!)
- ◆ In its base versions, like SQL-92, every SQL «query» (program...) terminates!
- ◆ So? Why?
- ◆ Well, SQL is not Turing-complete: so it has limited expressive power, but terminates!

SPARQL



◆ ***SPARQL Protocol and RDF
Query Language***

Structure of the basic query..

◆ Similar to SQL:

◆ **PREFIX ...**

SELECT ...

FROM ...

WHERE {

...

}

ORDER BY ...

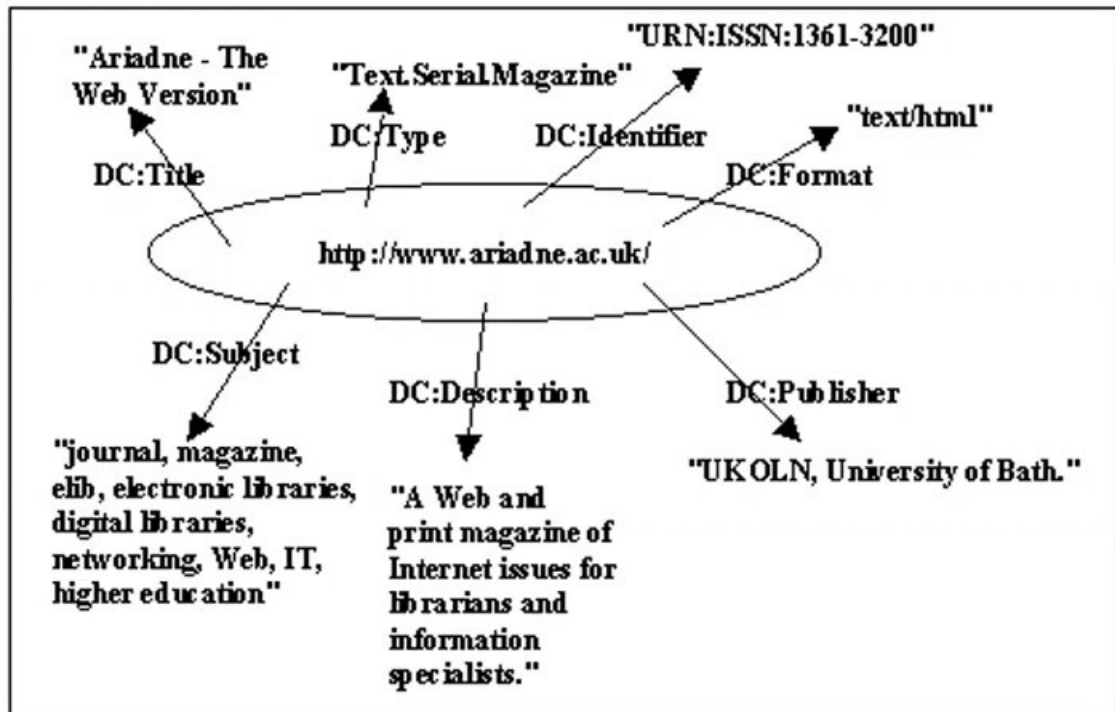




DC = Dublin Core

- ◆ The standard to describe the basic properties of documents
- ◆ 15 information elements:
- ◆ Title Creator / Subject / Description / Publisher
- ◆ Contributor / Date / Type / Format
- ◆ Identifier / Source / Language
- ◆ Relation / Coverage / Rights

Example



Example of embedding into HTML



```
◆ <meta name="DC.title"  
    content="What is OWL?" >  
<meta name="DC.subject"  
    content="Semantic Web" >  
<meta name="DC.author"  
    content="Massimo Marchiori" >
```

How to describe a person

- ◆ The class **Person**, with properties
Name / title / firstName / surname /
nick / schoolHomepage /
workplaceHomePage /
workInfoHomePage / myersBriggs /
phone / webpage / weblog

Social? Friends...

◆ The basic property is **foaf:knows**

◆ Example:

```
<foaf:Person>
```

```
<foaf:name>Massimo Marchiori
```

```
</foaf:name>
```

```
....
```

```
<foaf:knows>
```

```
  <foaf:Person>....</foaf:Person>
```

```
</foaf:knows>
```

```
...
```

```
</foaf:Person>
```


Let's see some example

- ◆ PlanetRDF has been one of the first «fully semantic» websites



Let's search for...

- ◆ The web address of «Mark Twain»'s blog:
- ◆ PREFIX foaf:<http://xmlns.com/foaf/0.1/>
SELECT ?url
FROM <http://planetrdf.com/bloggers.rdf>
WHERE {
 ?someone foaf:name "Mark Twain" .
 ?someone foaf:weblog ?url .
}



Optional data

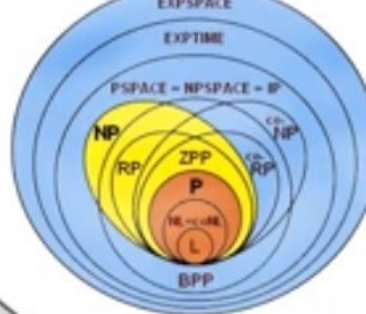
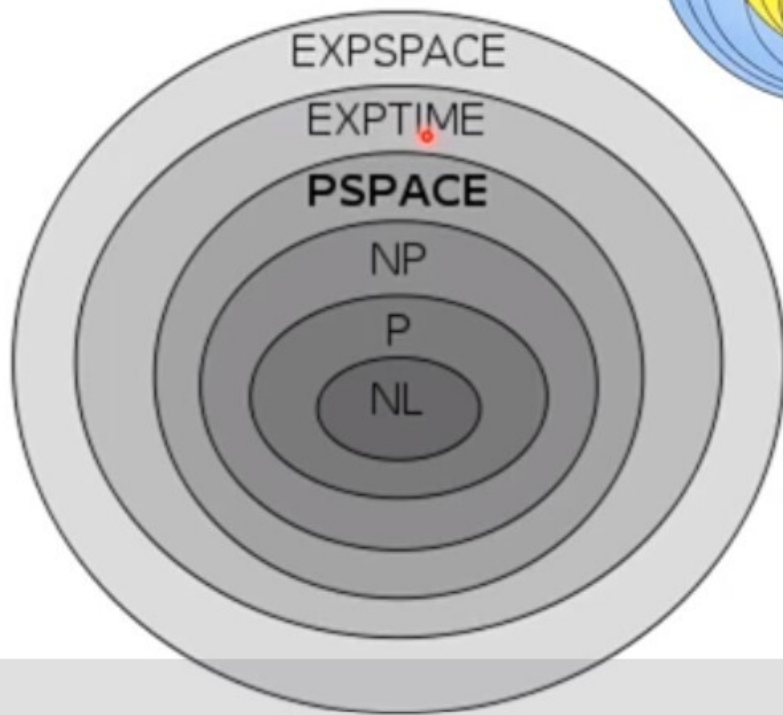
- ◆ In the Semantic Web, knowledge graphs come from multiple sources, and can be anyway contain *partial* information
- ◆ → SPARQL allows to deal with partial information, by using the **OPTIONAL** command



Example

```
◆ PREFIX foaf:<http://xmlns.com/foaf/0.1/>
  SELECT ?name ?picture
  WHERE {
    ?someone foaf:name ?name .
    OPTIONAL {
      ?someone foaf:depiction ?picture .
    }
  }
```

The base hierarchy



So OK for RDF...

and what about OWL?

- ◆ Do we restrict ourselves to a ***decidable*** logic and sacrifice ***expressive power***, or...
- ◆ Do we choose an ***expressive*** logic, but we give up ***computability*** (undecidable logic) ??

Solution?

◆ ***Both (!)***



Three OWL layers

- ◆ In order of growing expressive power:
- ◆ **OWL Lite**
- ◆ **OWL DL**
- ◆ **OWL Full**



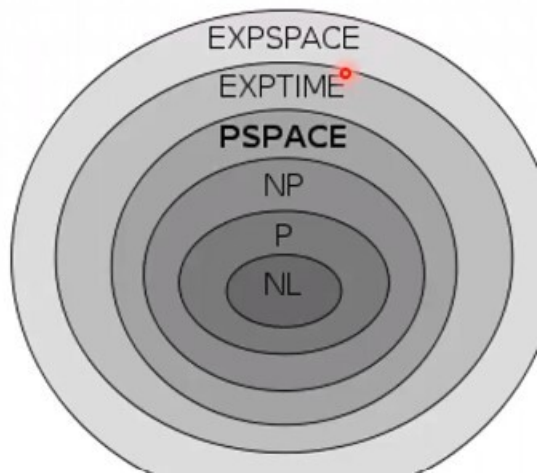
The three OWLs...



- ◆ OWL Lite is ***decidable***
(→ the so-called SHIF logic)
- ◆ OWL DL is ***decidable***
(→ the so-called SHOIN logic, a
descriptive logic (DL))
- ◆ OWL Full has no restrictions...
(and it is ***undecidable***)

Complexity?

- ◆ SHIF (OWL Lite) = EXPTIME
- ◆ SHOIN (OWL DL) = NEXPTIME



In reality...

- ◆ The complexity class of a problem is just the tip of the iceberg...



What really matters...

- ◆ Is the *average complexity* and the *context*



Example 0

- ◆ Computational cost of search engine queries...

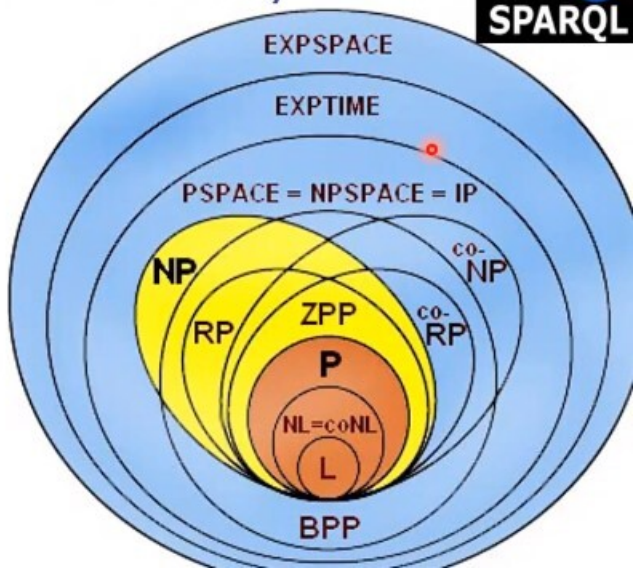
The Google logo, featuring the word "Google" in its characteristic multi-colored font (blue, red, yellow, green, red, blue).The Bing logo, featuring the word "bing" in a blue sans-serif font with a small orange dot above the 'i'. A small red dot is visible above the 'i' in the original image.



Example 1 (SPARQL)

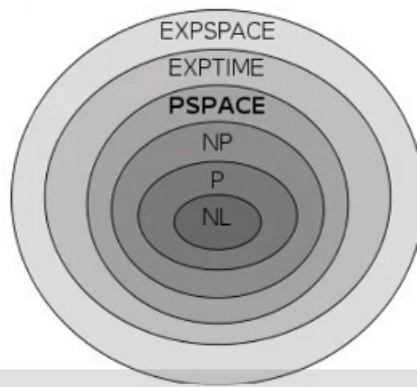
◆ SPARQL is in **PSPACE**

◆ But taking out just OPTIONAL, we fall back 100% into **co-NP**



Example 2 (OWL)

- ◆ **Indecidable** (OWL Full) / **NEXPTIME** (OWL DL) / **EXPTIME** (OWL Lite)
- ◆ But statistically, most of the knowledge we use and that is also on the web stays in sub-logics like AL and ALC
- ◆ ALC \rightarrow **PSPACE**
- ◆ AL \rightarrow **P**




So now, on to applications!

◆ **LINKED DATA**

- ◆ → The generalization of semantic web data: data that can be used to feed a Knowledge Graph

The LOD

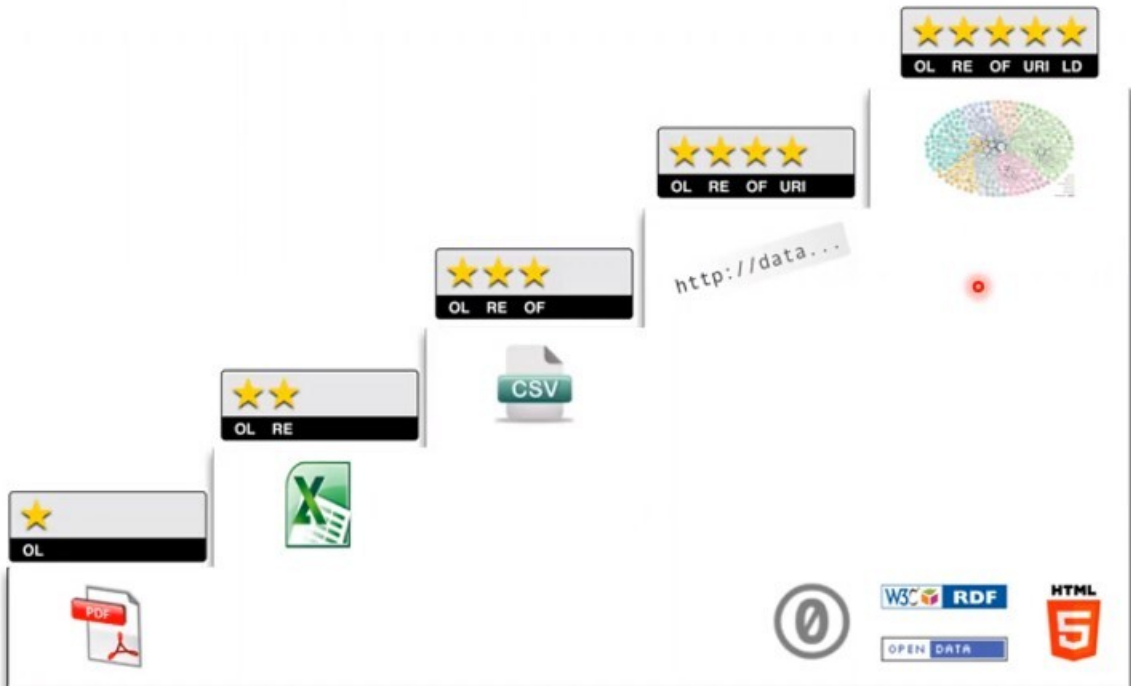
- ◆ LOD are a special kind Linked Data: the Linked **O**pen Data (!)
- ◆ They can be classified from one to five stars 



LOD classification

- ◆ ★: data available on the web but with an open license (open data)
- ◆ ★★: as above, with data in a machine-readable structured format
- ◆ ★★★: as above, using a non-proprietary data format
- ◆ ★★★★: as above, in Semantic Web format (RDF*,OWL)
- ◆ ★★★★★: as above, with data linked to other data sources to provide context

The Star Badges



LINKED **OPEN** DATA

- 
- On the web **OPEN LICENSE**
 - Machine-readable data
 - Non-proprietary format
 - RDF standards
 - Linked RDF

IS YOUR DATA 5 ★ ?

Note...

- ◆ There are interesting «middle zones» in LODs
- ◆ In particular, the ★★ layer (non-proprietary data), not necessarily in RDF*/OWL format



Up and down...

- ◆ Going from the non-Semantic Web world (e.g., XML/HTML/SQL etc) to the RDF world is called ***lifting***
- ◆ The other direction is instead called ***lowering***



Example

relations.xml

```
<relations>
  <person name="Alice">
    <knows>Bob</knows>
    <knows>Charles</knows>
  </person>
  <person name="Bob">
    <knows>Charles</knows>
  </person>
  <person name="Charles"/>
</relations>
```

Lowering

relations.rdf

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
_:b1 a foaf:Person;
     foaf:name "Alice";
     foaf:knows _:b2;
     foaf:knows _:b3.
_:b2 a foaf:Person; foaf:name "Bob";
     foaf:knows _:b3.
_:b3 a foaf:Person; foaf:name "Charles".
```

Lifting

Mashup

- ◆ Lowering and lifting are important to do the so-called ***mashup*** : join the XML/XHTML/HTML world (and all its huge amount of information) with the RDF/Semantic Web world, and vice versa

Examples of Lifting

◆ From SQL / relational data



D2RQ



- ◆ **D2RQ** (d2rq.org) allows to automatically pass data from SQL to RDF
- ◆ (high-level: JDBC database connections)
- ◆ Can work also as a server, giving immediate web access to data as RDF

Openlink Virtuoso



- ◆ Virtuoso is a “universal server”, implementing many protocols to handle information
- ◆ It allows interaction at various levels among SQL, XML, RDF, web services

And what about the other data?

- ◆ For instance ***web pages***, ***text***, pdf, word etc?



NLP tools



- ◆ NLP (= Natural Language Processing) tools analyze textual/hypertextual information and allow automatic lifting

Examples



- ◆ Open Calais (developed by Thomson Reuters)



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Accetta



Offering the data?

- ◆ To have at least 1 LOD star data must be on the Web, but how?
- ◆ We could just make the data available as a file in a certain URL address: in case of 3 LOD stars this is called an ***RDF dump***
- ◆ Problem: «dumping» data is just not very practical (think of Big Data etc)

Example: SPARQL

- ◆ Instead of providing a raw file, we could offer a SPARQL ***web service***: much more powerful and flexible
- ◆ In this case we talk about ***SPARQL endpoints***

Endpoints access

- ◆ Varios ways, the easiest is via GET
- ◆ → we can do an HTTP GET to the SPARQL endpoint, passing various parameters in the query part of the URL

GET parameters

- ◆ **query** : the SPARQL query to execute (modified via the classic %-encoding ("urlencoding") for URLs)
- ◆ **default-graph-uri** (optional): the URI of the default knowledge graph

Example

◆ Query SPARQL:

PREFIX dc:

<http://purl.org/dc/elements/1.1/>

SELECT ?book ?who

WHERE { ?book dc:creator ?who }

Example (cont.)

◆ GET call:

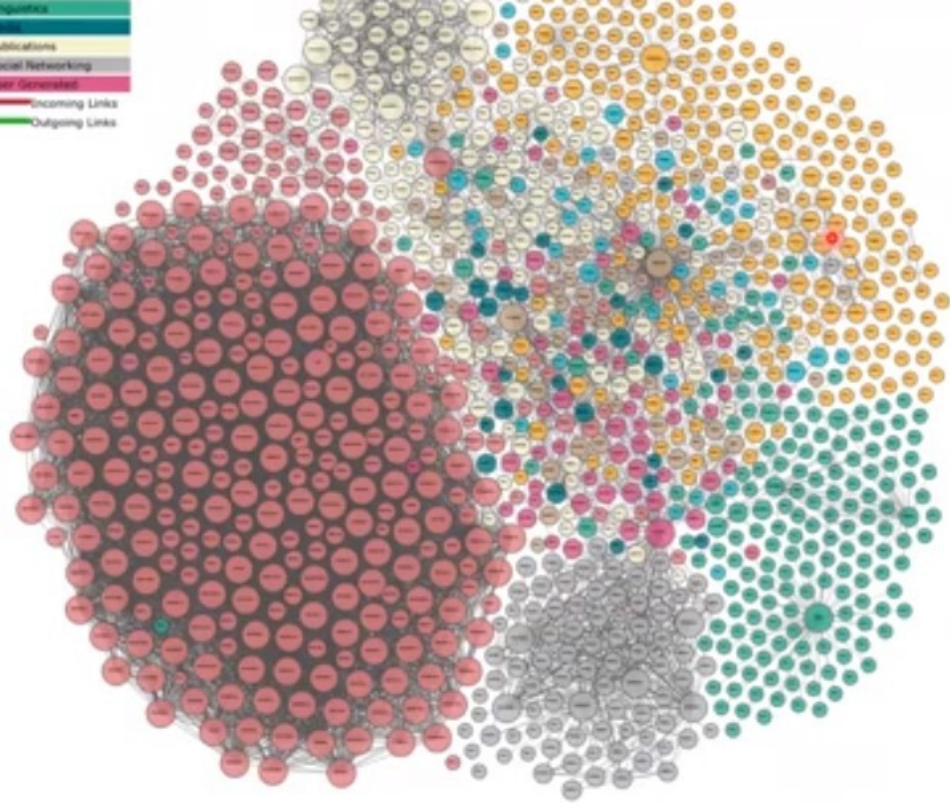
`http://www.endpoint.com/?query=PREFIX%20dc%3A%20%3Chttp%3A%2F%2Fpurl.org%2Fdc%2Felements%2F1.1%2F%3E%20%0ASELECT%20%3Fbook%20%3Fwho%20%0AWHERE%20%7B%20%3Fbook%20dc%3Acreator%20%3Fwho%20%7D%0A`

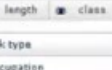
(%20=" ", %3A=":", %3C="<" etc...)

- ◆ Essentially, the ***semantic version of Wikipedia***
- ◆ <http://en.wikipedia.org/wiki/Italy> →
<http://dbpedia.org/resource/Italy> →
dbpedia:Italy

Schema.org

- ◆ It defines the most important/used ontologies for Web data





Filter by:

length class link **connect**

link type	num	vi
occupation	3/3	1
parentsCompany	1/2	1
product	3/3	1
products	2/2	1
redirect	0/1	1
relatedAutomobile	1/1	1
significantProjects	0/1	1
similar	5/5	1
subsid	0/2	1
subsidiary	1/3	1
team	1/1	1



First...

- ◆ Google has full support for the semantic web
- ◆ It understands all schema.org and beyond
- ◆ All the semantics is used internally
- ◆ Externally only some properties are visible to the users

National data

- ◆ Please note that every state usually makes open data available
- ◆ For instance in Italy: dati.gov.it
- ◆ (actually by European Law it's mandatory for every public data...!!
Public data = public access without restrictions!)

And Google?



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apple pie



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[allrecipes.com/recipe/apple-pie-by-grandma-ople/](#)

★★★★★ Rating: 4.8 - 5223 reviews - 1 hr 30 mins - 512 cal

A unique and popular recipe. Sliced **apples** under a lattice crust get bathed with a sweet buttery sauce before baking.

[Apple Pie by Grandma Ople - Apple Pie I - Grandma Ople's Apple Pie - Reviewer](#)

2

[Apple pie - Wikipedia, the free encyclopedia](#)

[en.wikipedia.org/wiki/Apple_pie](#)

An **apple pie** is a fruit pie (or tart) in which the principal filling ingredient is apples. It is sometimes served with whipped cream or ice cream on top, or alongside ...

Rich Snippets

◆ Many kinds of items supported, for instance...

[Battlestar Galactica \(TV Series 2004–2009\) - IMDb](#)

[www.imdb.com/title/tt0407362/](#)

★★★★★ Rating: 8.8/10 - 71506 votes

The second war against the Cylons is over and The Twelve Colonies have been destroyed. Now Commander Adama of the **Battlestar** Galactica and President Laura...
Starring Jamie Bamber, Edward James Olmos, Mary McDonnell.

Full cast and crew - Episodes - Tricia Helfer - Episodes cast

Rocky Pardjo shared this on Google+

[Battlestar Galactica.com Leading the BSG Universe](#)

[www.battlestargalactica.com/](#)

Battlestar Galactica.com, Richard Hatch inspired site dedicated to showcasing the BSG Universe and Promoting **Battlestar Galactica**. GSP NETWORK.

Google search results for "apple pie". The search bar shows "apple pie" and the Google logo. Below the search bar are tabs for Web, Images, Maps, Shopping, Recipes, More, and Search tools. The results show "About 71,000,000 results (0.20 seconds)".

1 [Apple Pie by Grandma Ople Recipe - Allrecipes.com](#)
[allrecipes.com/recipe/apple-pie-by-grandma-ople/](#)
★★★★★ Rating: 4.6 - 5223 reviews - 1 hr 30 mins - 512 cal
A unique and popular recipe. Sliced apples under a lattice crust get bathed with a sweet buttery sauce before baking.
Apple Pie by Grandma Ople - Apple Pie I - Grandma Ople's Apple Pie - Reviewer

2 [Apple pie - Wikipedia, the free encyclopedia](#)
[en.wikipedia.org/wiki/Apple_pie](#)
An **apple pie** is a fruit pie (or tart) in which the principal filling ingredient is apples. It is sometimes served with whipped cream or ice cream on top, or alongside ...

Authors (Google was the «bad guy»...)

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[drivinginertia.com/.../what-is-the-best-laptop-for-travel-hint-its-under...](#)

Jan 10, 2013 – One of the most-read posts on our site is about **laptops**. Travel **laptops**, specifically, and which one to buy. It's about a year old, so here's an ...

[Laptop buying guide - CNET Reviews](#)
[reviews.cnet.com > Reviews > Laptops](#)



by Dan Ackerman - in 3,598 Google+ circles - More by Dan Ackerman
Oct 4, 2012 – Want to skip all the details and research and just buy a great **laptop**? ... consumer **laptop** you can buy; the Lenovo IdeaPad 13, the **best** example of the above on choosing a **laptop** based on how often it will **travel** with you.

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120 personal results. 1,180,000,000 other results.

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US Route 101, Length

[U.S. Route 101 - Wikipedia, the free encyclopedia](#)
[en.wikipedia.org/wiki/U.S._Route_101](#) -
The old road is known as County Road S-21 or Historic Route 101 in northern San Diego County. The nearly 2,500 km (1,550 mi)-long highway's "northern" ...

[US Route 101 in Washington](#)
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[www.yelp.com/.../san-francisco-driving-from-sf-to-la-on-101-how-long](#) -
Aug 17, 2009 - Hi yelpers, I need some advice about driving from SF to LA. This will be my first visit to California and I'm trying to squeeze in as many touristy ...

US Route 101

Road

U.S. Route 101, or U.S. Highway 101, is a north-south U.S. highway that runs through the states of California, Oregon, and Washington, on the West Coast of the United States. Wikipedia

Length: 1,540 miles (2,478 km)

Constructed: 1926

Highway system: US Numbered Highways

Major cities: Los Angeles, San Francisco, San Jose, Newport, Olympia

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Today, 4:07 PM (PT)



San Francisco
Giants
(23-15)



Toronto
Blue Jays
(15-24)



Preview - Tickets

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The Official Site of The San Francisco Giants | SFGiants.com

sanfrancisco.giants.mlb.com/

Headlines, statistics, photograph galleries and general team information.

Schedule

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Scoreboard. Current day's games are shown starting at 11am ET ...

MLB News

The Giants rewarded Brett Pill for his torrid hitting by recalling the ...

News for sf giants



[Giants demote one, promote one](#)

[San Francisco Chronicle \(blog\)](#) • 1 day ago

The **Giants** have optioned outfielder Francisco Peguero to Triple-A Fresno and recalled first baseman Brett Pill, who has wielded a hot bat ...

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Lincozum leads [SFGiants.com](#) Atlanta



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Manager: [Bruce Bochy](#)

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Lincozum fans 7, allows only 2 hits over 7 shutout innings in 5-1 win over Braves.

RECAP: <http://sfbay.mlb.com/163uJ40>

May 12, 2013

Roster

Player	Num	Position
Buster Posey	28	Catcher
Tim Lincecum	55	Pitcher
Pablo Sandoval	48	Infielder
Matt Cain	18	Pitcher
Berry Zo	75	Pitcher