

Semi-Automatically Modeling Web APIs to Create Linked APIs

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USC Information Sciences Institute

About: Downtown Los Angeles [Sponge](#) [Permalink](#)

An Entity of Type : [Neighborhoods in Los Angeles, California](#), within Data Space : [dbpedia.org](#)

Type:

Downtown Los Angeles is the central business district of Los Angeles, California, United States, located close to the geographic center of the metropolitan area. The area features many of the city's major arts institutions and sports facilities, sightseeing opportunities, a variety of skyscrapers and associated large multinational corporations and an array of public art and unique shopping opportunities. Downtown is the hub of the city's freeway network and growing Metro rapid transit system.

<u>leader title</u>	City Council U.S. House State Senate State Assembly
<u>population total</u>	39537(xsd:integer)
<u>area total (km2)</u>	8.538 13.73988692533248
<u>foaf:homepage</u>	http://www.downtownla.com
<u>foaf:depiction</u>	



not

dbpedia.org

About: Downtown Los Angeles

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leader title City Council
U.S. House
State Senate
State Assembly

population total 39537(xsd:integer)

area total (km2) 8.538
13.73988692533246

The Weather Channel

Los Angel... 73°F

Los Angel... 70°F

Weather Lifestyle Social Maps Video News TV

Local National Forecast Severe Weather Alerts Hurricane Central

Los Angeles Weather

Local Pollen Alert

Right Now Updated: May 23, 2012, 3:45pm PDT

73°F Sunny

From 10 mph WIND

51% HUMIDITY

54° DEW POINT

9.0 mi VISIBILITY

29.74 in → PRESSURE

5 - Moderate UV INDEX

Feels like 73°F

Love! Ugh!

Live weather

Current temperature	73°F
Wind	10 mph SW
Humidity	51%
Dew Point	54°

not

dbpedia.org

About: Downtown Los Angeles [Sponge](#) [Permalink](#)

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Events for May. 2012



Film

Transparent Cities
5/1/2012
REDCAT Theater

Meeting

Saving Our Sons: A Community Conversation
5/2/2012
Los Angeles Trade Tech College

Special Event

Autumn Lights Night
5/3/2012
401 s Main Street

Concert

Martin Hasselbock Leads LACO's Baroque
Conversations
2012
Corn School of Performing Arts

Ongoing Events

Exhibit

A Nation Emerges: The Mexican Revolution Revealed
9/8/2011 - 6/3/2012
LA Public Library - Central

Museum

Justice, Balance and Achievement: African Americans in the California Courts
1/12/2012 - 5/27/2012
California African American Museum

Exhibit

Trouble In Paradise: Music and Los Angeles, 1945-1975
2/22/2012 - 6/3/2012
GRAMMY Museum

Exhibit

Xploration Lab 2012
3/17/2012 - 6/17/2012

Current temperature	73°F
Wind	10 mph SW
Humidity	51%
Dew Point	54°
Events	Transparent Cities 5/1/2012 REDCAT Theater Saving Our Sons : A Community Conversatio... ...



Events

not

dbpedia.org

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Events	Transparent Cities 5/1/2012 Saving Our Sons : A Community Conversation ...
--------	--

Twitter Feed	Los Angeles becomes the largest U.S. city to ban... Plastic grocery bags will now be banned in
--------------	--

Yale Environment 360 @YaleE360

Los Angeles becomes the largest U.S. city to ban **plastic bags**
bit.ly/JA0PdX #LosAngeles #plasticbagban

Expand

18m

DestinationTampaBay @DestTampaBay

Plastic grocery **bags** will now be banned in #LosAngeles. What do you think of that concept for #Florida?

Expand

48m

annmarie anderson @AnnmarieCloud

"@HuffingtonPost: The nation's second largest city has just banned **plastic bags** in grocery stores huff.to/Jygs5N" #LosAngeles #green

Expand

55m

gomaam @gomaam

#LosAngeles is now the largest U.S. city to #ban #**plastic bags**
dlvr.it/1cX0bW

Expand

1h

Ozzyopolis @Ozzyopolis

Los Angeles Becomes Largest U.S. City to Ban **Plastic Bags**:
bit.ly/Jpl9xw via @TreeHugger #LosAngeles #plasticbagban

Expand ← Reply ↻ Retweet ★ Favorite

3h



Live Twitter Feed

But, the Information is Available in Web APIs

About: Downtown Los Angeles
 An Entity of Type : [Neighborhoods in Los Angeles](#)
 Type: `yago:NeighborhoodsInLosAngeles`


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World Weather Online API

Summary Mashups (1) How-To (1) Developers (1) Comments




World Weather Online provides weather forecast and weather data for worldwide city and towns. The Developer Weather API allows developers and programmers to access free 5-day weather forecasts.

Current temperature	73°F
Wind	10 mph SW
Humidity	51%
Dew Point	54°
Events	Transparent Cities 5/1/2012 REDCAT Theater Saving Our Sons : A Community Conversatio... ...
Twitter Feed	Los Angeles becomes the largest U.S. city to ban plastic grocery bags will now be banned in

Eventful API


Summary Mashups (46) How-To Developers (30) Comments



Eventful is the world's largest collection of events, taking place in markets throughout the world, from concerts and sports events and political rallies. Eventful.com is built upon a...

Twitter API

Summary Mashups (709) How-To (34) Developers (432) API



The Twitter micro-blogging service includes two RESTful Twitter REST API methods allow developers to access...


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<u>population total</u>	395370
<u>area total (km2)</u>	8.538 13.739
Current temperature	73°F
Wind	10 mph
Humidity	51%
Dew Point	54°
Events	Trans Savig ...
Twitter Feed	Los A Plastic ...



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[Home](#) [API News](#) [API Directory](#) [Mashups](#) [Community](#) [How-to](#)

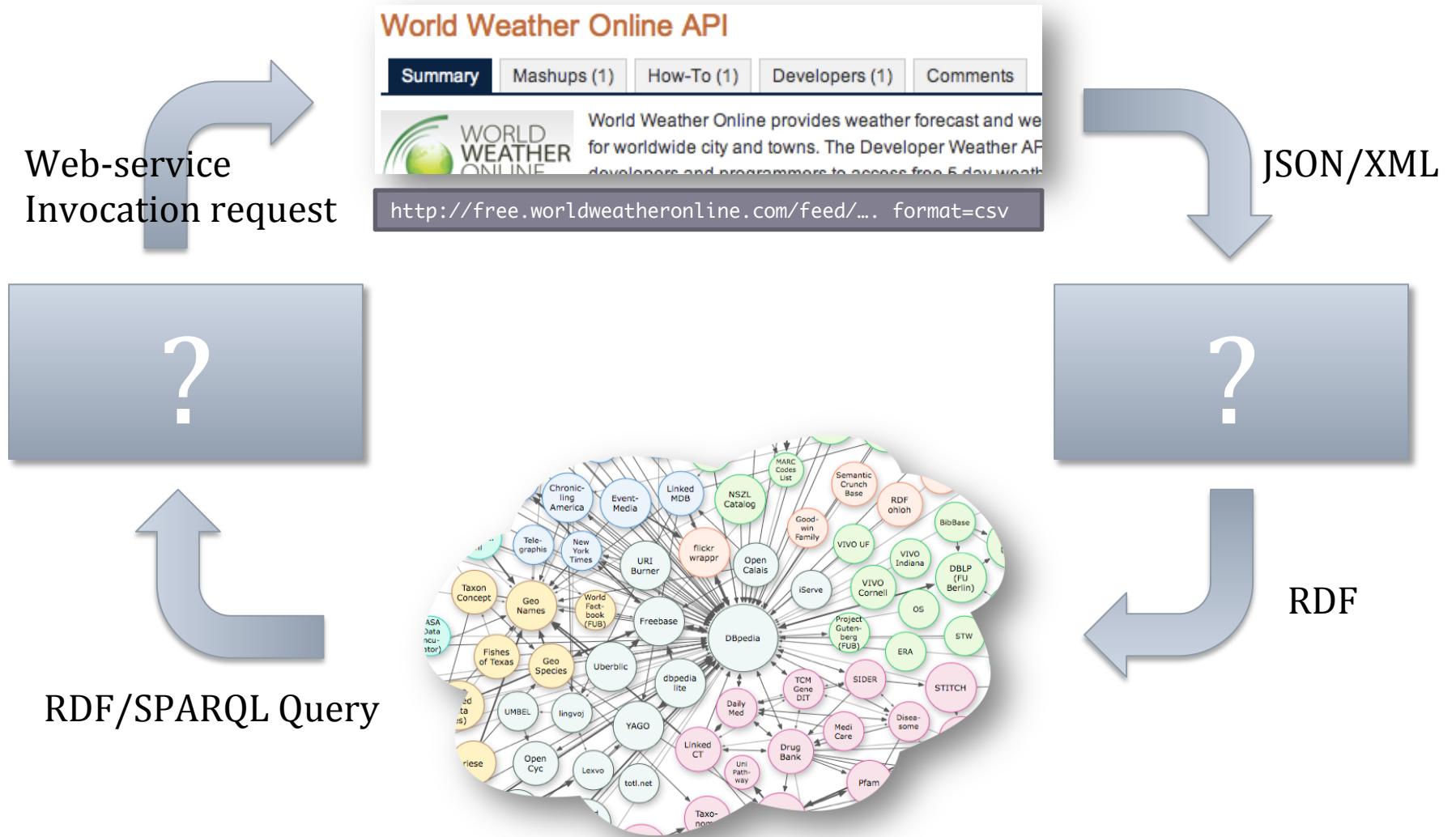
[Dashboard](#) [Tour](#)

Keeping you up to date with APIs, mashups and the Web as platform.

Popular searches: [photo](#) [google](#) [flash](#) [mapping](#) [enterprise](#) [sms](#)

6052
APIs

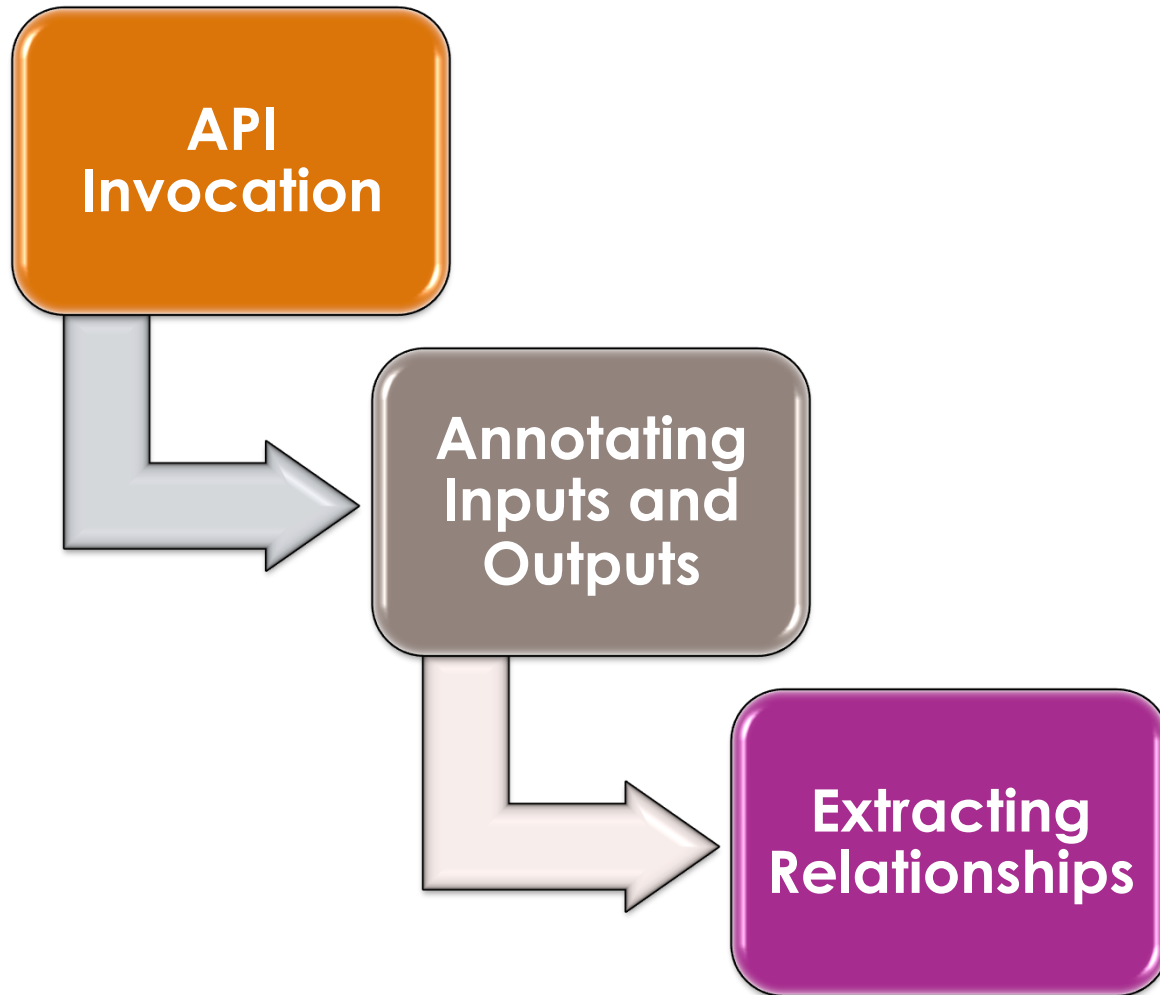
The Problem



Modeling APIs

- **Input**
 - Examples of the request URLs
 - Ontology
- **Output**
 - A semantic model of the API built interactively

Approach



Service Invocation

KARMA



Sample Request URLs

A screenshot of a web browser window titled "example-requests". The window displays a list of four URLs under the heading "URL". The URLs are: <http://example.com/weather?city=Irvine&state=CA>, <http://example.com/weather?city=Chicago&state=IL>, <http://example.com/weather?city=Miami&state=FL>, and <http://example.com/weather?city=New+York&state=NY>. At the bottom of the window, there is a pagination control showing "Show: 10 20 50 records" and "Previous Next" links.

Invoking API

A screenshot of a web browser window displaying a table of weather data. The table has the following columns: CITY, STATE, DATE, ICAO, TEMPERATURE, DEWPOINT, HUMIDITY, WINDSPEED, and SKYCONDITION. The data rows are: Irvine, CA, 1-Mar-12, KLOX, 61, 53, 67%, 07, Mainly clear; Chicago, IL, 1-Mar-12, KMDW, 54, 48, 45%, 11, Some sun with spotty showers; Miami, FL, 1-Mar-12, KMIA, 60, 57, 60%, 06, Turning cloudy; and New York, NY, 1-Mar-12, KJFK, 27, 26, 70%, 08, Mostly sunny. At the bottom right of the window, there is a "Previous Next" link.

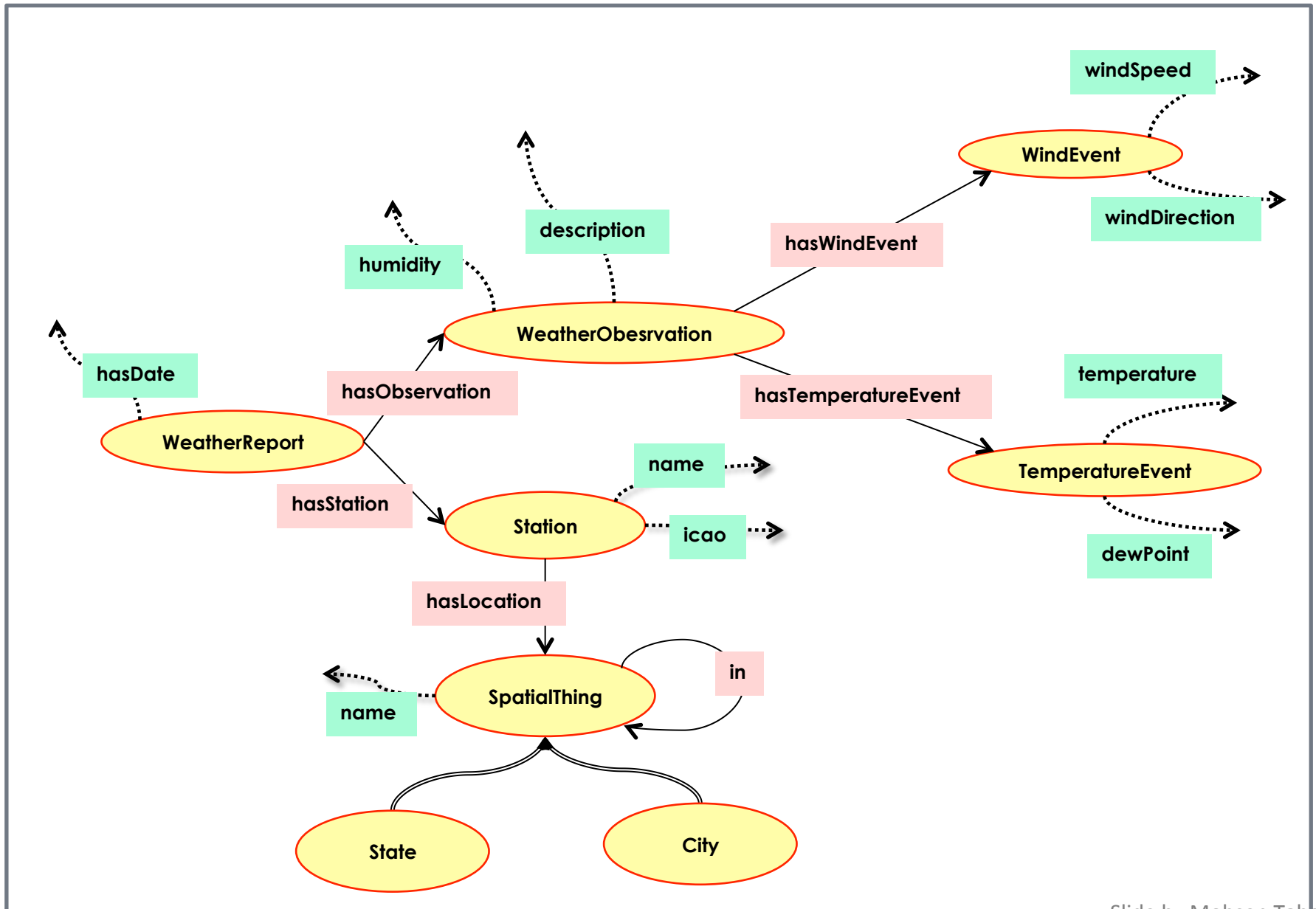
Inputs

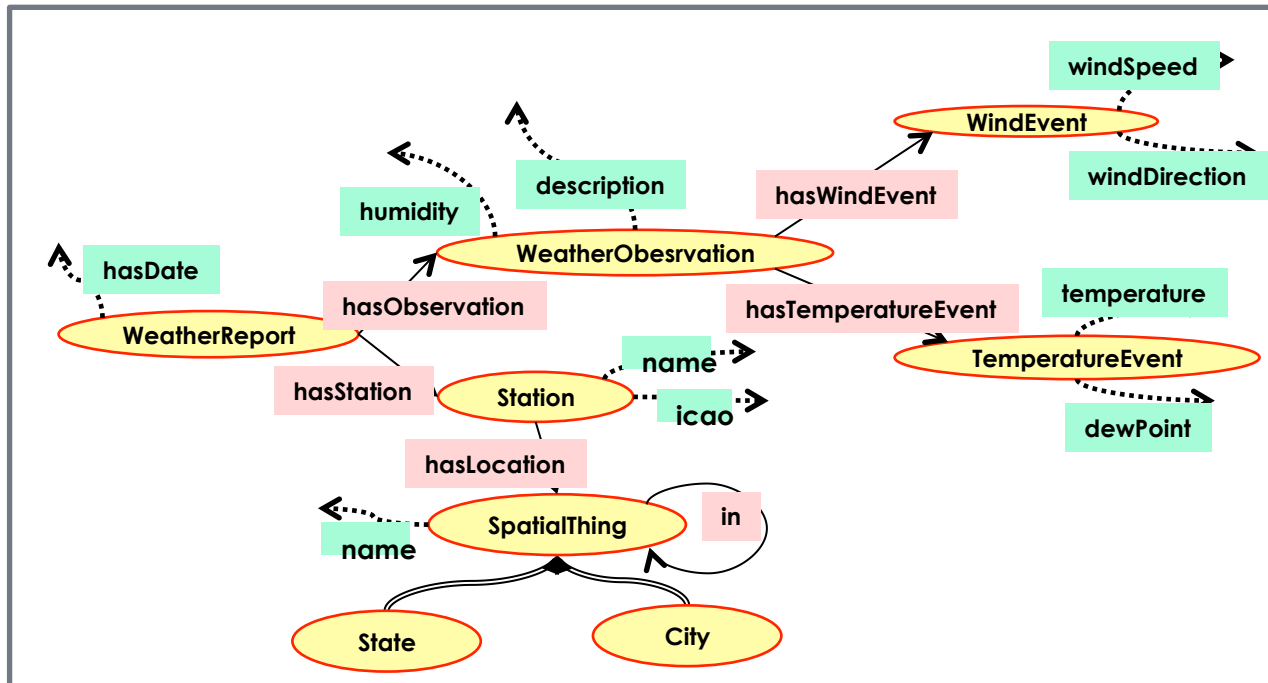
Outputs

Annotating Inputs and Outputs

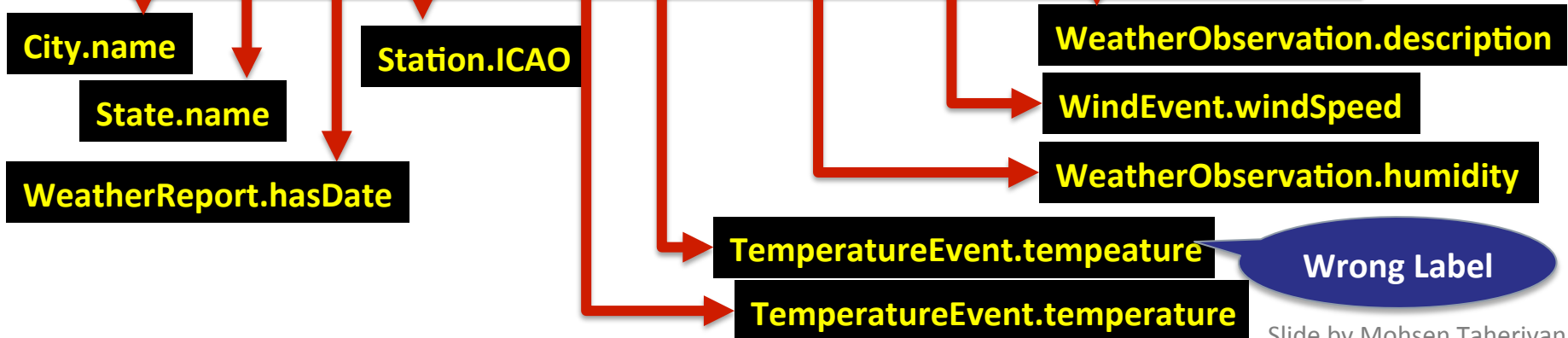
- Using Conditional Random Fields (CRF) to assign a *semantic type* to each column
- Semantic Types
 - Class
 - Data property and domain
- Example
 - OWL Class: **State**
 - <http://dbpedia.org/page/California>
 - OWL Data Property, Domain class: **State.name**
 - California

Weather Ontology





CITY	STATE	DATE	ICAO	TEMPERATURE	DEWPOINT	HUMIDITY	WINDSPEED	SKYCONDITION
Irvine	CA	1-Mar-12	KLOX	61	53	67%	07	Mainly clear
Chicago	IL	1-Mar-12	KMDW	54	48	45%	11	Some sun with spotty showers
Miami	FL	1-Mar-12	KMIA	60	57	60%	06	Turning cloudy
New York	NY	1-Mar-12	KJFK	27	26	70%	08	Mostly sunny



Extracting the Relationships

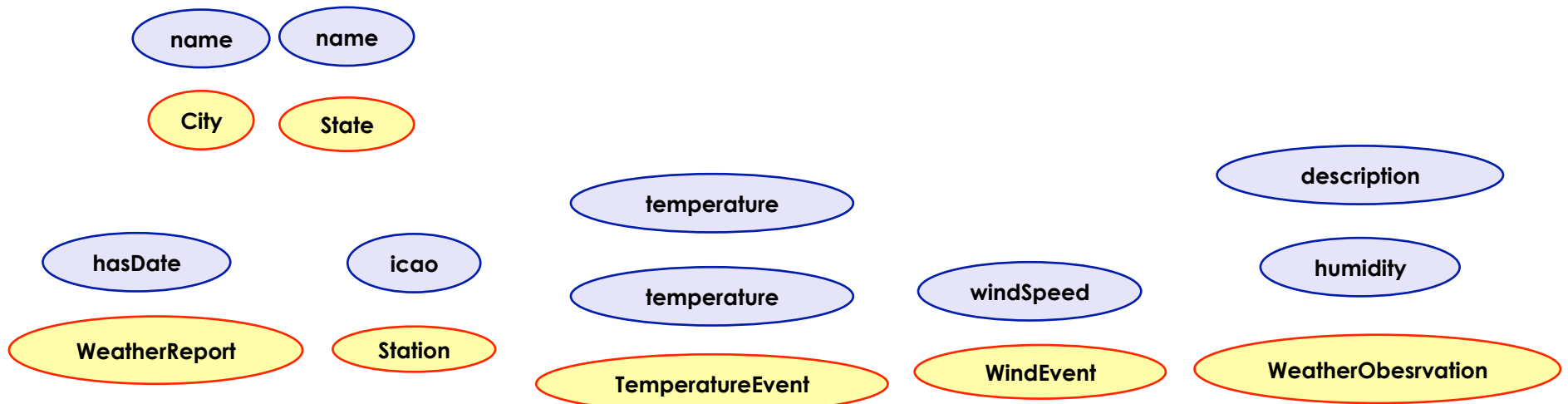
- Construct a graph from
 - Assigned Semantic Types
 - Ontology Graph
- Select minimal tree that connects all semantic types
 - A customized Steiner tree algorithm
- Steiner minimal tree (SMT)
 - $G=(V,E)$, $S \subset V$, $c: E \rightarrow \mathfrak{R}$ (S: Steiner Nodes)
 - Shortest network connecting vertices of T
 - Approximation Alg. [Kou & Markowsky, 1981]
 - $O(|V|^2|S|)$, Approximation Ratio: less than 2

Constructing Graph

- Graph Initialization

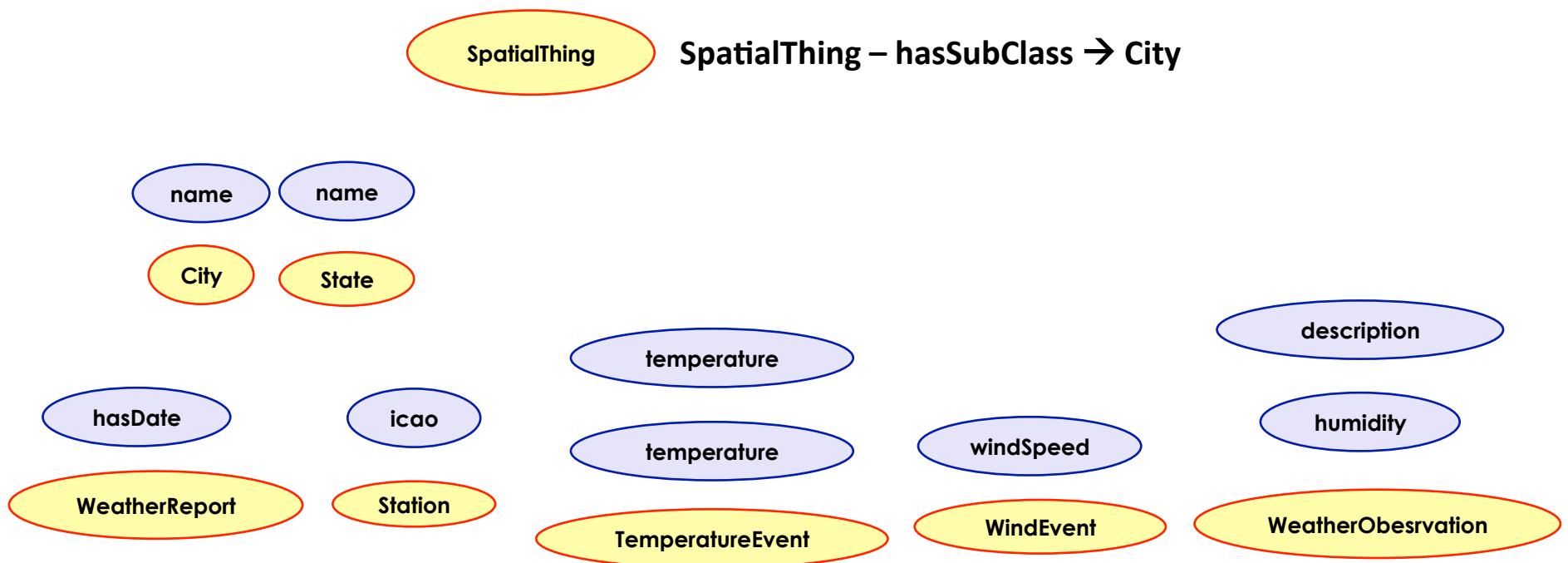
- Add one node for each semantic type
- For data property types, also add the domain (if not added before)

CITY	STATE	DATE	ICAO	TEMPERATURE	DEWPOINT	HUMIDITY	WINDSPEED	SKYCONDITION
Irvine	CA	1-Mar-12	KLOX	61	53	67%	07	Mainly clear
Chicago	IL	1-Mar-12	KMDW	54	48	45%	11	Some sun with spotty showers
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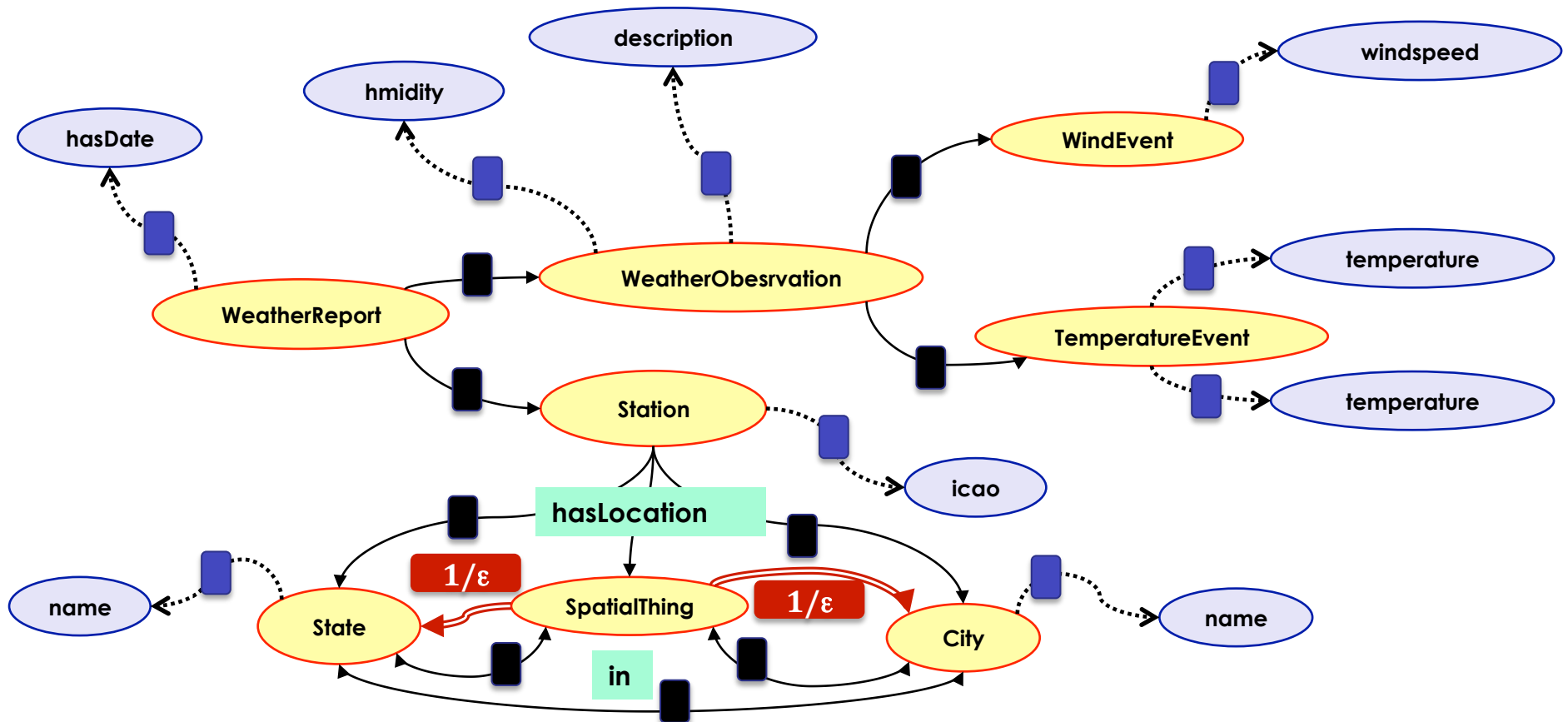
Constructing Graph

- Compute Nodes Closure
 - Object Property or hasSubClass relations

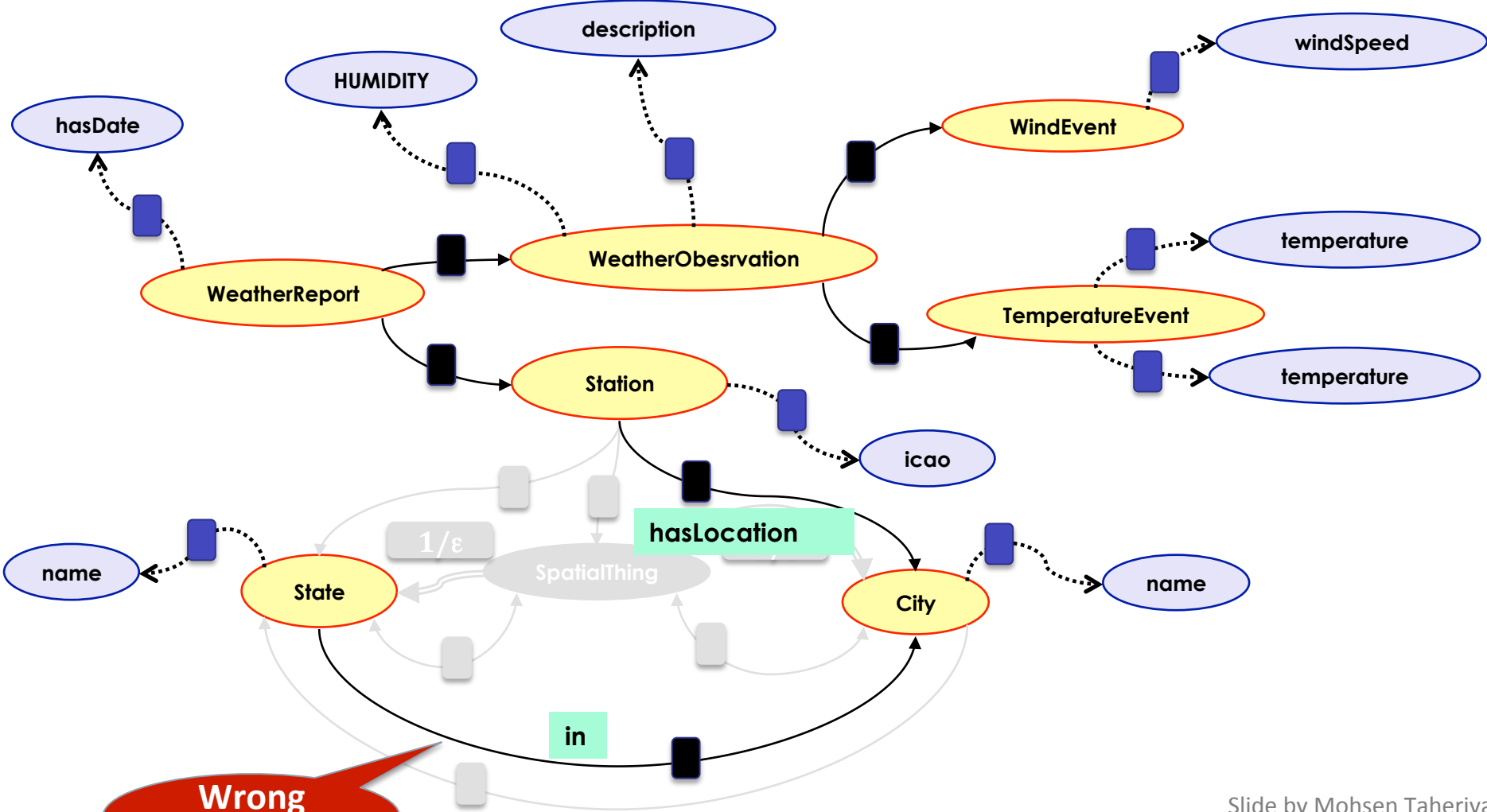


Constructing Graph

- Adding the Links
 - Put a link with $w=1$ from the domains to data property nodes
 - For every pair of class nodes like A and B:
 - Put a link with $w=1$ from A to B if there is a direct or inferred object property in the ontology
 - If B is a direct or inferred subclass of A, put a link with $w=1/\epsilon$ from A to B

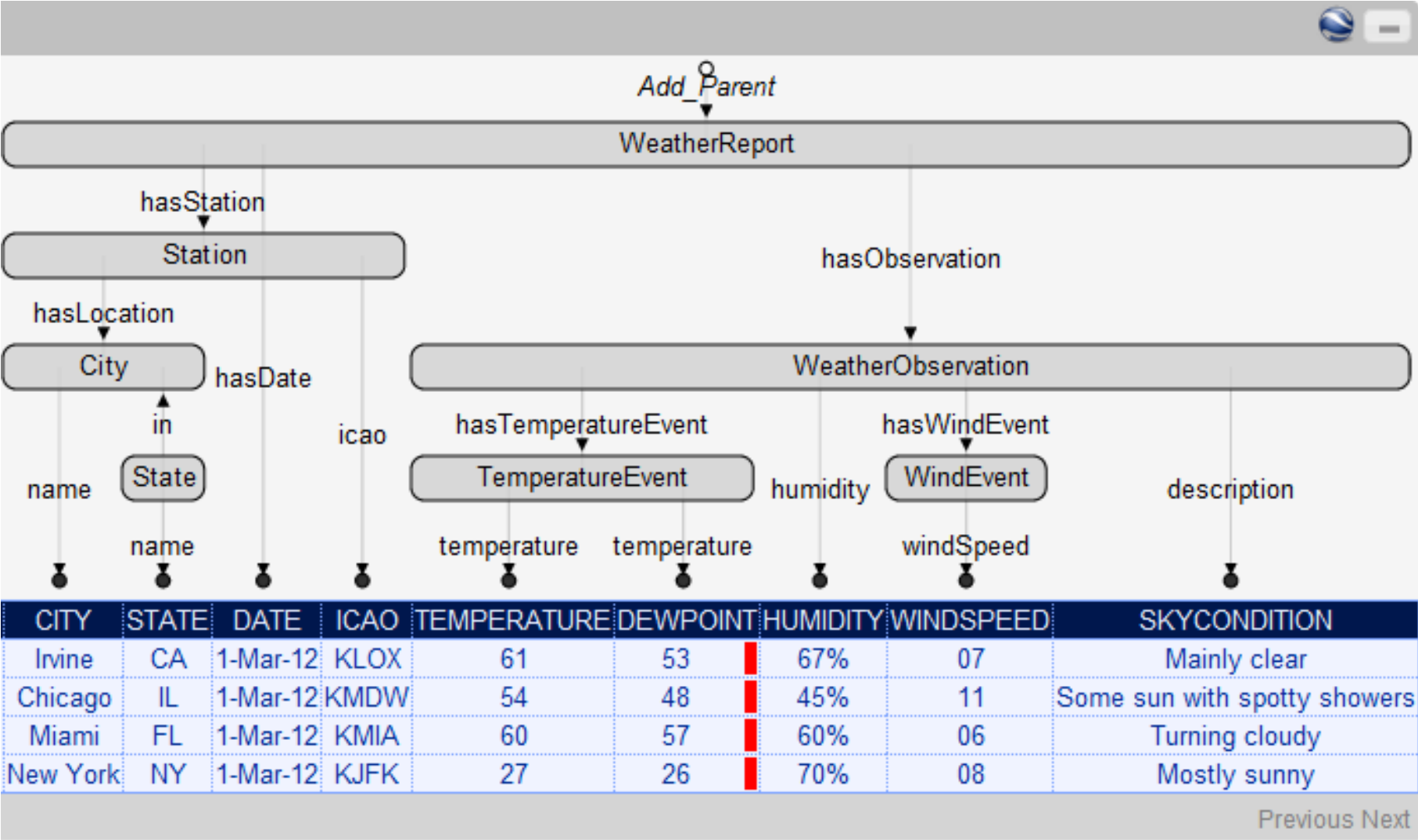


Steiner Tree



Wrong Link

Visualizing Model in Karma



Refinement – Change Semantic Types

The screenshot shows a software interface for refining semantic types. At the top, a window titled "Add Parent" shows a class hierarchy:

- WeatherReport** (parent class)
- Station** (child of WeatherReport, connected via `hasStation`)
- City** (child of Station, connected via `hasLocation`)
- TemperatureEvent** (child of WeatherReport, connected via `hasTemperatureEvent`)

The **City** class has properties: `name`, `State` (with `in` relationship), `hasDate`, and `icao`. The **TemperatureEvent** class has a property `temperature`, which is highlighted with a red circle. Below the class hierarchy is a table with columns: CITY, STATE, DATE, ICAO, TEMPERATURE, DEWPOINT, and a red vertical bar. The data rows are:

CITY	STATE	DATE	ICAO	TEMPERATURE	DEWPOINT	
Irvine	CA	1-Mar-12	KLOX	61	53	
Chicago	IL	1-Mar-12	KMDW	54	48	
Miami	FL	1-Mar-12	KMIA	60	57	60% 06 Turning cloudy
New York	NY	1-Mar-12	KJFK	27	26	70% 08 Mostly sunny

A dialog box titled "Semantic types:" is open over the `temperature` property. It lists several semantic types with radio buttons and "Edit" buttons:

- temperature of TemperatureEvent* (Primary)
- humidity of WeatherObservation* (CRF Suggested)
- windSpeed of WindEvent* (CRF Suggested)
- dewPoint of TemperatureEvent* (CRF Suggested)

Buttons at the bottom of the dialog include "Add synonym semantic type", "Mark as key for the class.", "Cancel", and "Submit".

Refinement – Adjust the links

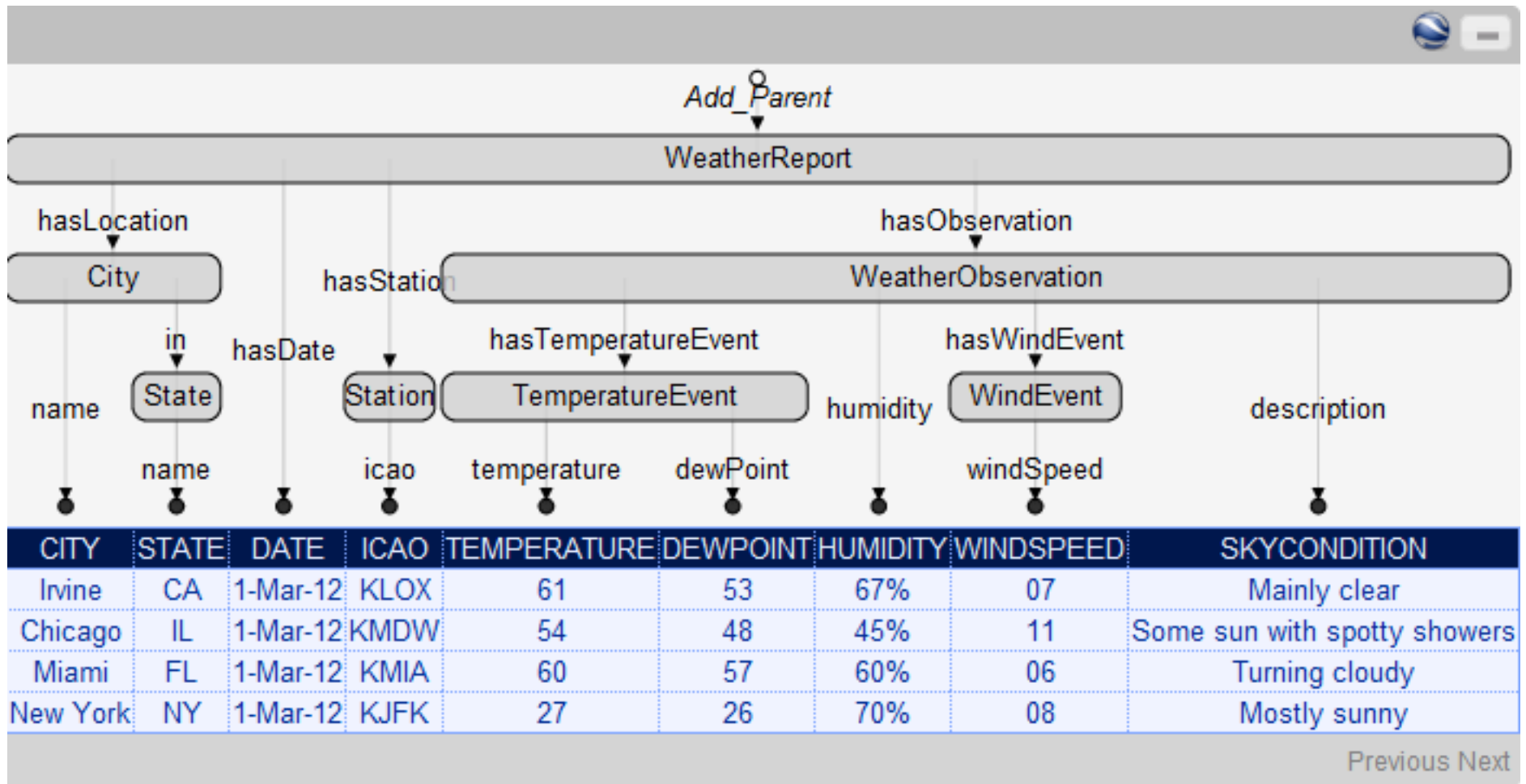
Click on State

Choose parent relationship:

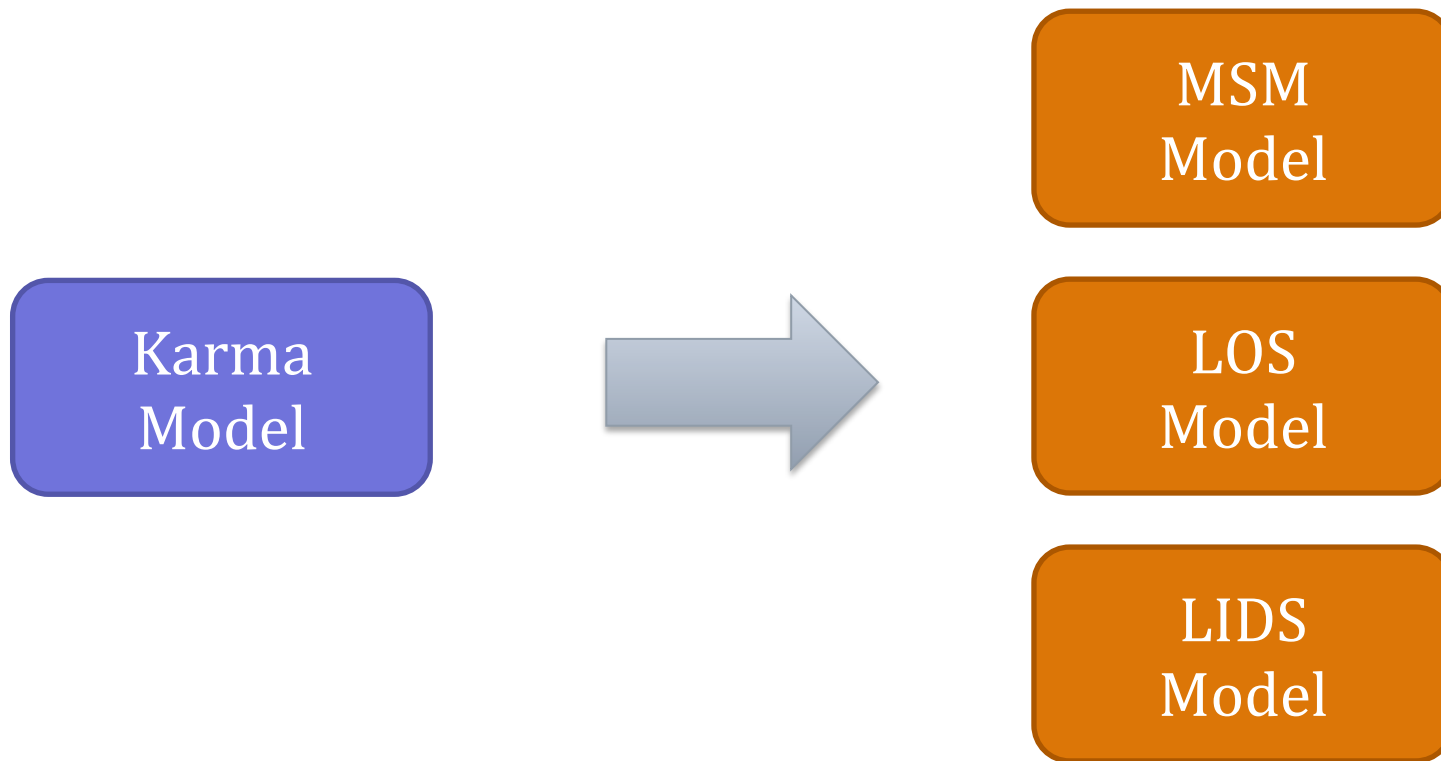
- City *in*
- Organization *hasLocation*
- Person *bornIn*
- Point *in*
- SpatialThing *hasSubClass*
- SpatialThing *in*
- Station *hasLocation*

CITY	STATE	DATE	ICAO	TEMPERATURE	SKYCONDITION
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Final Model in Karma



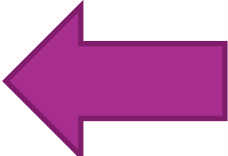
Generate Other Models?



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Challenge 1: Live Weather in DBPedia (For Every City)

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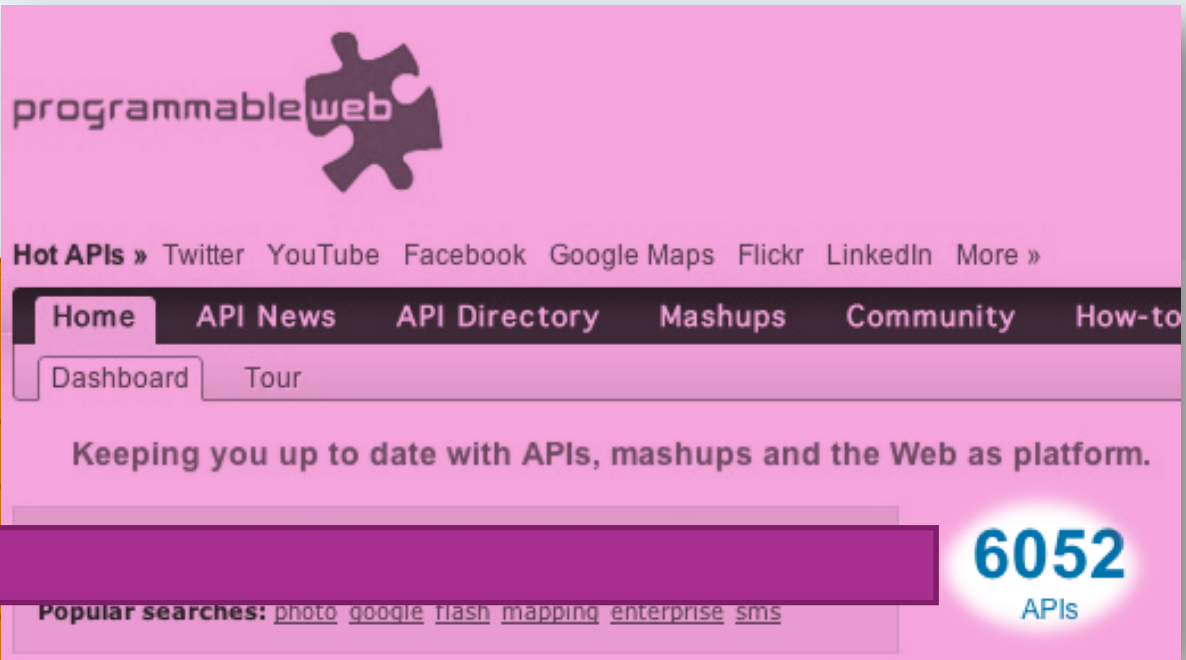

The Weather Channel
 Los Angel... 73°F
 Los Angel... 70°F
 Weather Lifestyle Social Maps Video News TV
 Local National Forecast Severe Weather Alerts Hurricane Central
 Los Angeles Weather ☆
 Local Pollen Alert
 Right Now Updated: May 23, 2012, 3:45pm PDT
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Challenge 2: Scale-Up

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Keeping you up to date with APIs, mashups and the Web as platform.

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APIs

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