



From Multi-Domain Statistical Data to Complex Decisions and Actions: A Linked Data Based Approach

Marta Sabou, Irem Önder, Adrian M.P. Brasoveanu



Does the GNI of Japan influence arrivals of Japanese tourists to Austria?

Complex Question

Multi-domain Indicators

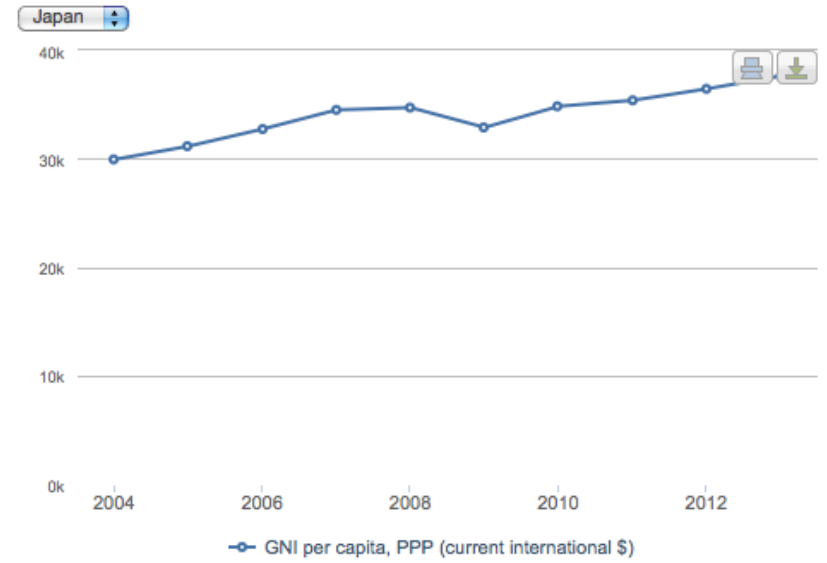
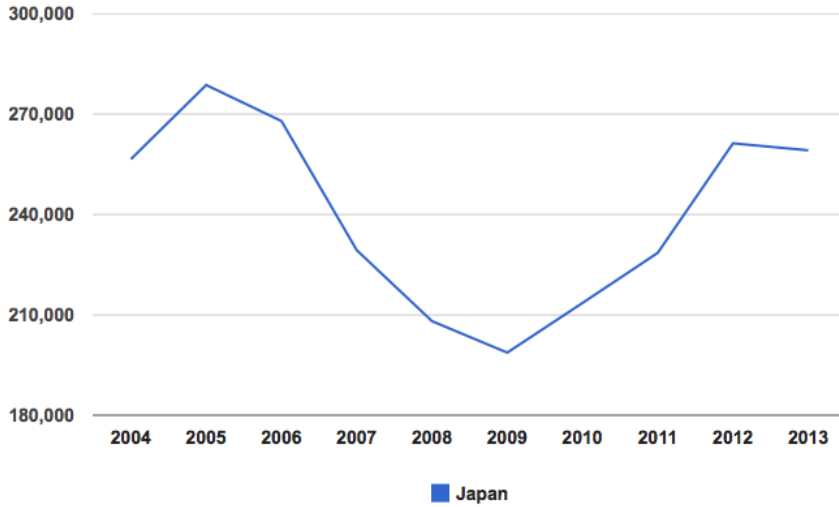


World DataBank | World Development Indicators

TABLE CHART MAP METADATA

Austria 2004 - 2013

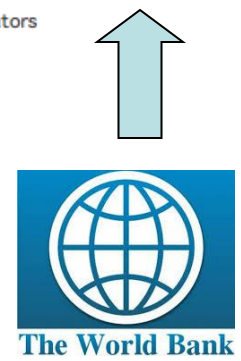
Arrivals in all forms of paid accommodation



Source: World Development Indicators

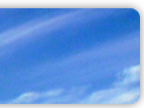
↑
TourMIS

**Manual data
collection and
integration/
interpretation**



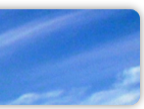


Why can't computer programs do this task for us?



- **Syntactic:**
 - mostly open data, BUT
 - offered using different syntactic formats that require substantial effort for integration (e.g., especially when extracted from pdf files ..)
- **Semantic:**
 - Use different terms for the same entity: WB:Austria; TourMIS:AT
 - Different geographic granularity
 - Measurements at different time intervals
 - Different ways to measure the same indicator
 - None of these differences are explicit in a machine format

Need an analyst to understand and combine the data.

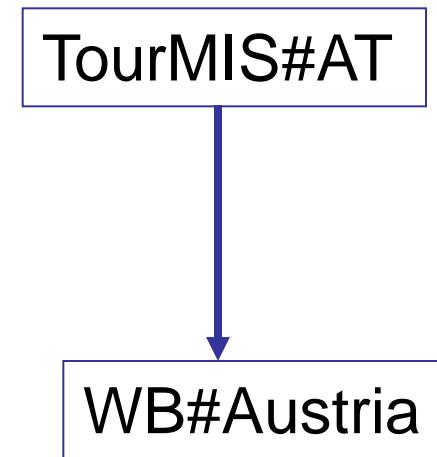


A set of technologies to explain domain knowledge formally and make links between entities in datasets:

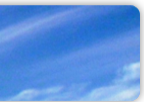
Entity in Database 1

“IS THE SAME AS”

Entity in Database 2



... so that machines can perform more intelligent tasks by THEMSELVES.



Austria at TourMISLOD

<http://tourmislod.modul.ac.at/tourmis/resource/Austria>

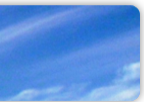
Property	Value
sesame:directType	<ul style="list-style-type: none"> ▪ to:Country
is to:forCountry of	<ul style="list-style-type: none"> ▪ tr:marketForAustria
rdfs:label	<ul style="list-style-type: none"> ▪ Austria
owl:sameAs	<ul style="list-style-type: none"> ▪ <http://dbpedia.org/resource/Austria>
rdf:type	<ul style="list-style-type: none"> ▪ to:Country ▪ rdfs:Resource ▪ owl:Thing

worldbank.270a.info/classification/country/AT.html

This page is about [Austria](#)

About [Austria](#)

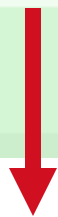
skos:prefLabel	Austria [en]
rdf:type	dbpo:Country skos:Concept
dct:creator	Sarven Capadisli
property:capital	Vienna [en]
dct:created	2012-02-29T00:00:00Z
dct:issued	2014-06-25T10:35:30Z
dct:license	CC0 1.0 Universal
dct:source	http://api.worldbank.org/countries/AUT
Income level	High income: OECD
Lending type	Not classified
Region	Europe & Central Asia (all income levels)
owl:sameAs	dbp:Austria



Austria at TourMISLOD

<http://tourmislod.modul.ac.at/tourmis/resource/Austria>


Property	Value
sesame:directType	<ul style="list-style-type: none"> to:Country
is to:forCountry of	<ul style="list-style-type: none"> tr:marketForAustria
rdfs:label	<ul style="list-style-type: none"> Austria
owl:sameAs	<ul style="list-style-type: none"> <http://dbpedia.org/resource/Austria>
rdf:type	<ul style="list-style-type: none"> to:Country rdfs:Resource owl:Thing



dbpedia.org/page/Austria

About: Austria

An Entity of Type : [place](#), from Named Graph : <http://dbpedia.org>, within Data Space : dbpedia.org



Austria (/ˈɔːstriə/ or /ɒstriə/; German: Österreich [ˈøːstɛˈʁɑ̃ç]), officially the Republic of Austria (German: Republik Österreich), is a federal republic and a landlocked country of roughly 8.5 million people in Central Europe. It is bordered by the Czech Republic and Germany to the north, Hungary and Slovakia to the east, Slovenia and Italy to the south, and Switzerland and Liechtenstein to the west.

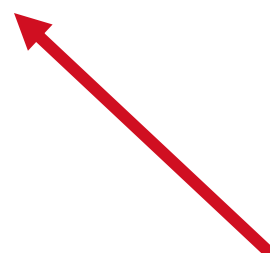
Property	Value
dbpedia-owl:PopulatedPlace/areaTotal	<ul style="list-style-type: none"> 83871.0 83871.58497701069
dbpedia-owl:PopulatedPlace/populationDensity	<ul style="list-style-type: none"> 101.3904268332463 101.4

worldbank.270a.info/classification/country/AT.html

This page is about [Austria](#)

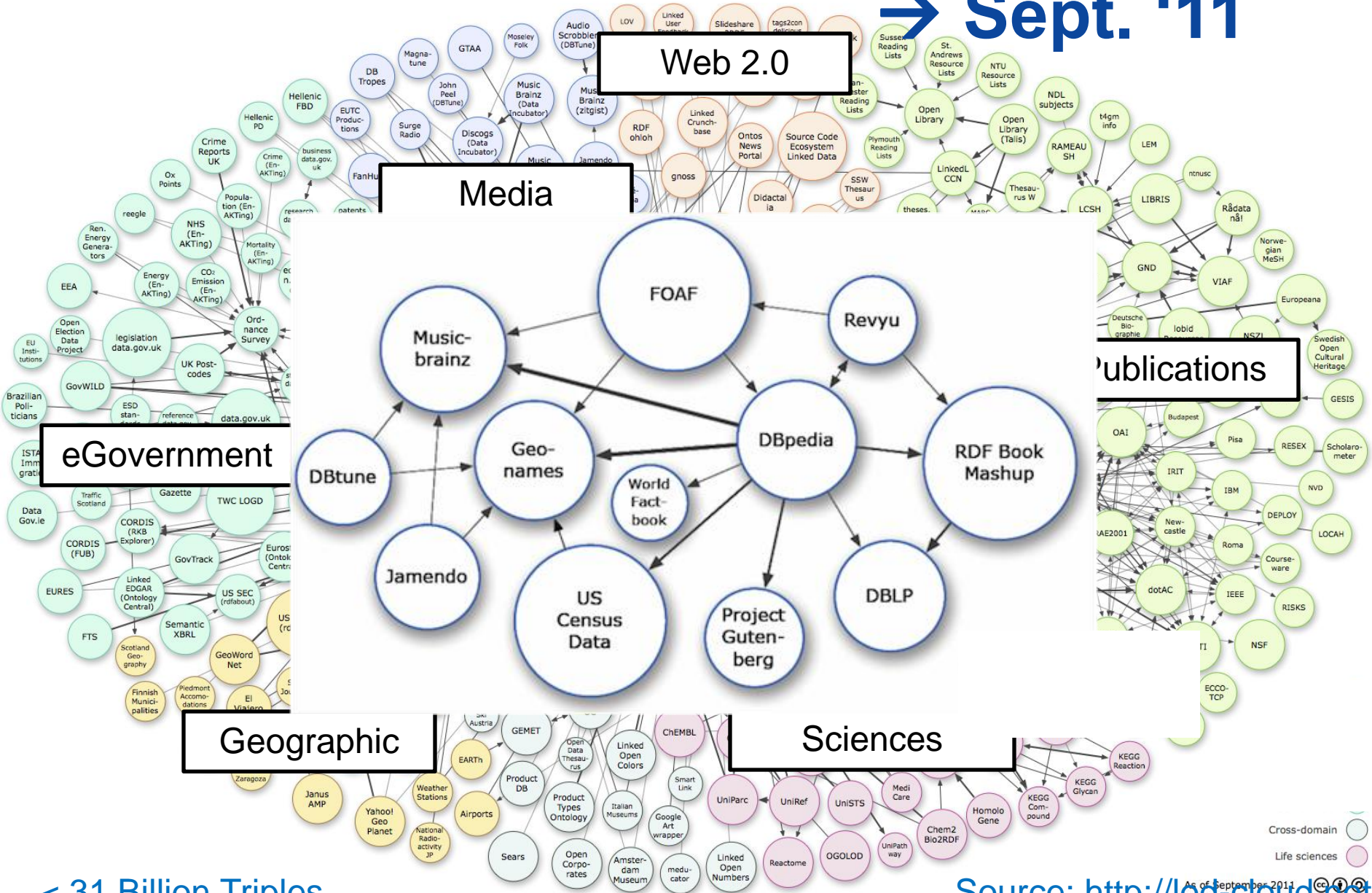
About [Austria](#)

skos:prefLabel	Austria [en]
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owl:sameAs	dbp:Austria





→ Sept. '11



< 31 Billion Triples

Source: <http://lod-cloud.net>

Legend:
 ○ Cross-domain
 ● Life sciences



ETIHQ

Expose (ALL) TourMIS data as high quality Linked Data

Support tourism data owners to publish, connect and exploit their data sources for decision support by making use of Linked Data technologies



O1: Publish TI's as LD

Domain ontology
Provenance



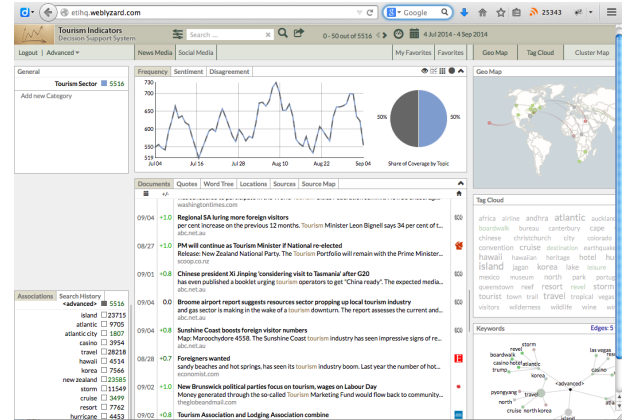
System Development



Triplification
Interlinking
Publishing

Raw Data

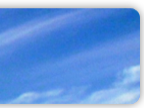
Linked Data



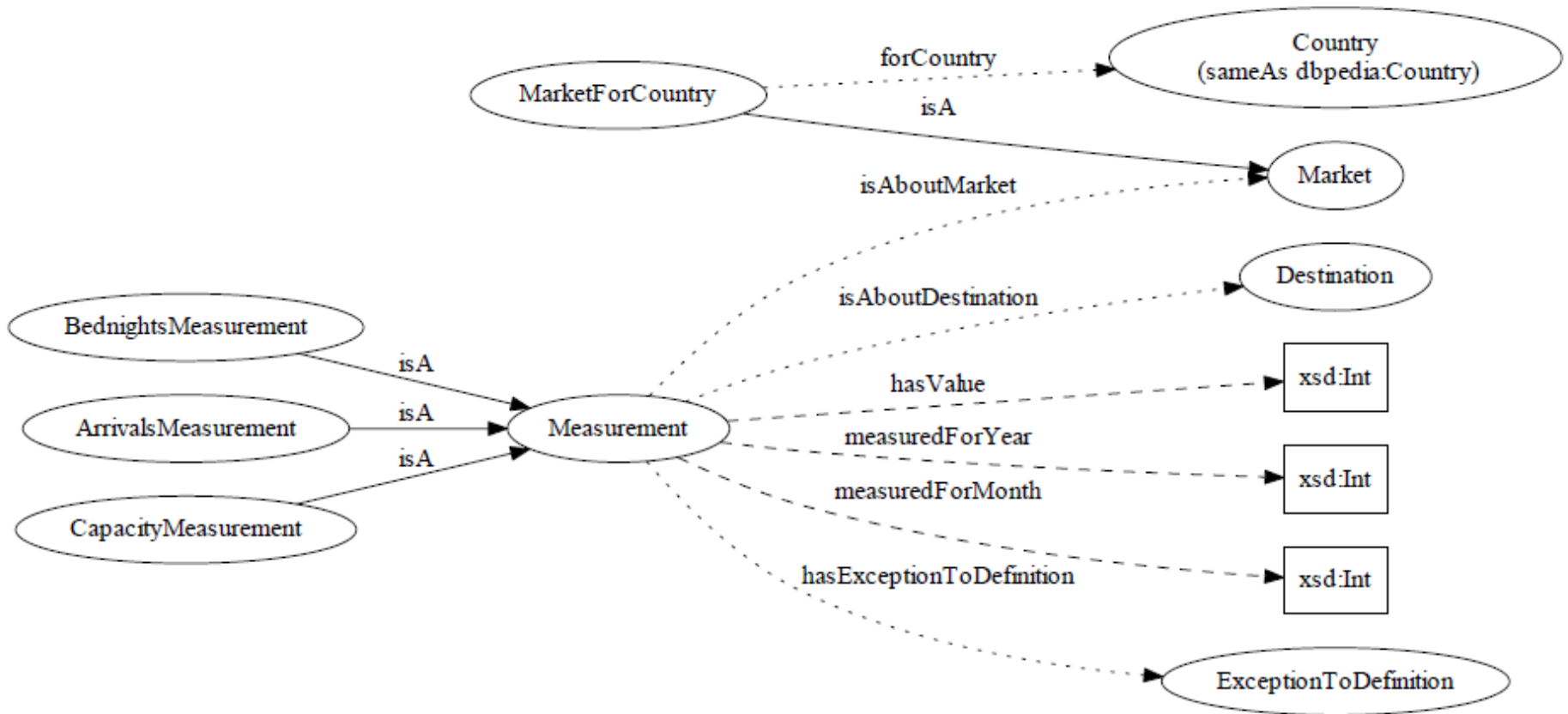
Application

O2: Link to external TI's

O3: Build a tourism DSS



```
<data>  
  <destination>BER</destination>  
  <market>AT</market>  
  <year>2005</year>  
  <month>8</month>  
  <value>13901</value>  
</data>
```





Browser window: aBednightsMeasurement_BER_2005_8_AT | TourMISLOD

Address bar: tourmislod.modul.ac.at/tourmis/page/resource/aBednightsMeasurement_BER_2005_8_AT

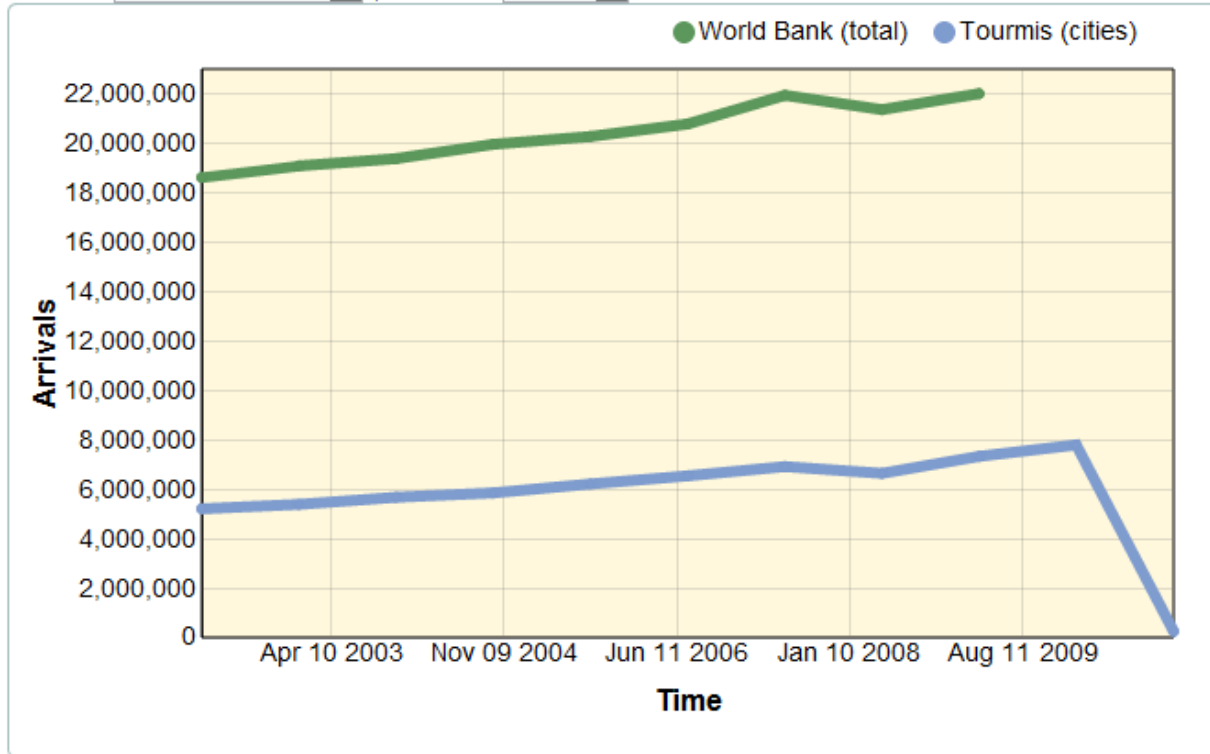
aBednightsMeasurement_BER_2005_8_AT at TourMISLOD

http://tourmislod.modul.ac.at/tourmis/resource/aBednightsMeasurement_BER_2005_8_AT

Property	Value
sesame:directType	<ul style="list-style-type: none"> to:BednightsMeasurement
to:hasValue	<ul style="list-style-type: none"> 13901
to:isAboutDestination	<ul style="list-style-type: none"> tr:Berlin
to:isAboutMarket	<ul style="list-style-type: none"> tr:marketForAustria
to:measuredForMonth	<ul style="list-style-type: none"> 8
to:measuredForYear	<ul style="list-style-type: none"> 2005
rdf:type	<ul style="list-style-type: none"> to:BednightsMeasurement to:Measurement rdfs:Resource owl:Thing

This page shows information obtained from the SPARQL endpoint at <http://tourmislod.modul.ac.at/openrdf-sesame/repositories/tester4>.
[As Turtle](#) | [As RDF/XML](#) | [Browse in Disco](#) | [Browse in Tabulator](#) | [Browse in OpenLink Browser](#)

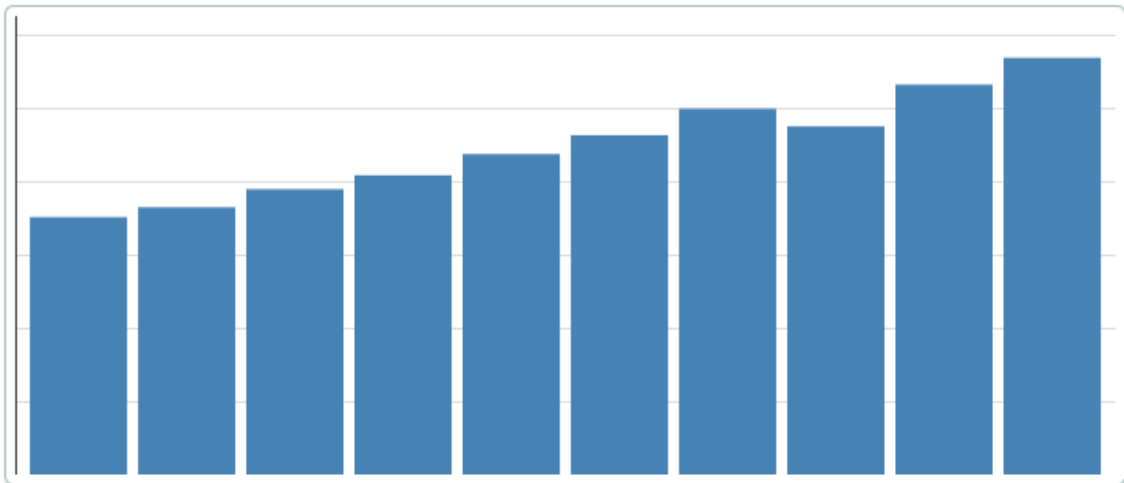
Country: Austria | Indicator: Arrivals



AUSTRIA
 URI: <http://dbpedia.org/resource/Austria>
 code: http://dbpedia.org/resource/ISO_3166-1:AT
 population: 8414638
 area: 83855

TourMIS data - click on city to see arrivals

- Vienna**
 short code: VIE
 Linz
 Bregenz
 Innsbruck
 Graz

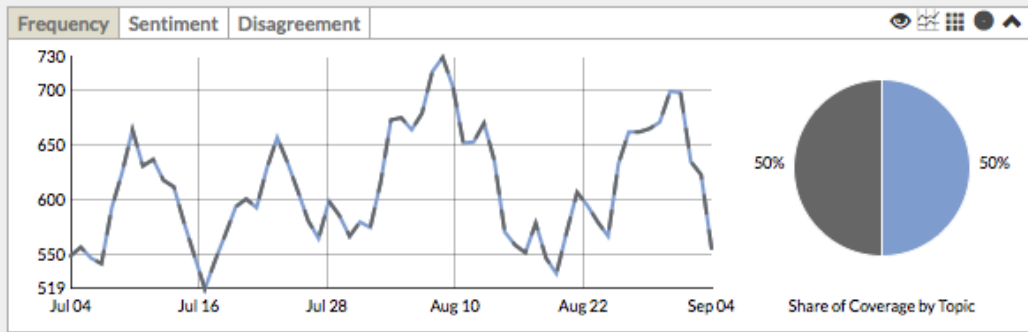




General

Tourism Sector ■ 5516

Add new Category



Associations | Search History <advanced> ■ 5516

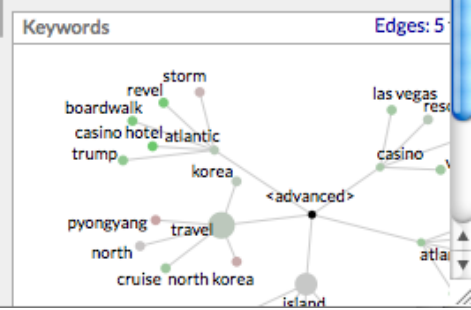
island	<input type="checkbox"/>	23715
atlantic	<input type="checkbox"/>	9705
atlantic city	<input type="checkbox"/>	1807
casino	<input type="checkbox"/>	3954
travel	<input type="checkbox"/>	28218
hawaii	<input type="checkbox"/>	4514
korea	<input type="checkbox"/>	7566
new zealand	<input type="checkbox"/>	23585
storm	<input type="checkbox"/>	11549
cruise	<input type="checkbox"/>	3499
resort	<input type="checkbox"/>	7762
hurricane	<input type="checkbox"/>	4453

Documents | Quotes | Word Tree | Locations | Sources | Source Map

Date	Sentiment	Title	Source
09/04	+1.0	Regional SA luring more foreign visitors per cent increase on the previous 12 months. Tourism Minister Leon Bignell says 34 per cent of t...	washingtontimes.com
08/27	+1.0	PM will continue as Tourism Minister if National re-elected Release: New Zealand National Party. The Tourism Portfolio will remain with the Prime Minister...	abc.net.au
09/01	+0.8	Chinese president Xi Jinping 'considering visit to Tasmania' after G20 has even published a booklet urging tourism operators to get "China ready". The expected media...	abc.net.au
09/04	0.0	Broome airport report suggests resources sector propping up local tourism industry and gas sector is making in the wake of a tourism downturn. The report assesses the current and...	abc.net.au
09/04	+0.8	Sunshine Coast boosts foreign visitor numbers Map: Maroochydore 4558. The Sunshine Coast tourism industry has seen impressive signs of re...	abc.net.au
08/28	+0.7	Foreigners wanted sandy beaches and hot springs, has seen its tourism industry boom. Last year the number of hot...	economist.com
09/02	+1.0	New Brunswick political parties focus on tourism, wages on Labour Day Money generated through the so-called Tourism Marketing Fund would flow back to community...	theglobeandmail.com
09/02	+0.8	Tourism Association and Lodging Association combine	

Tag Cloud

africa airline andhra atlantic auckland boardwalk bureau canterbury cape chinese christchurch city colorado convention cruise destination earthquake hawaii hawaiian heritage hotel hu island jagan korea lake leisure mexico museum north park portug queenstown reef resort revel storm tourist town trail travel tropical vegas visitors wilderness wildlife wine wir





From Data

To Action

Linked Data



Multi-domain
statistical data

DSS Dashboard



THANK YOU!





	UNWTO	Eurostat	WorldBank	TourMIS
Country	Y	Y	Y	N
Destination	N	N	N	Y
Year	Y	Y	Y	Y
Month	N	Y	N	Y
Access	xls/pdf	Xls/csv/pdf/ spss	Xml/xls/API	API

Open (but not yet Linked) Data