



# Reconciliation with Elasticsearch

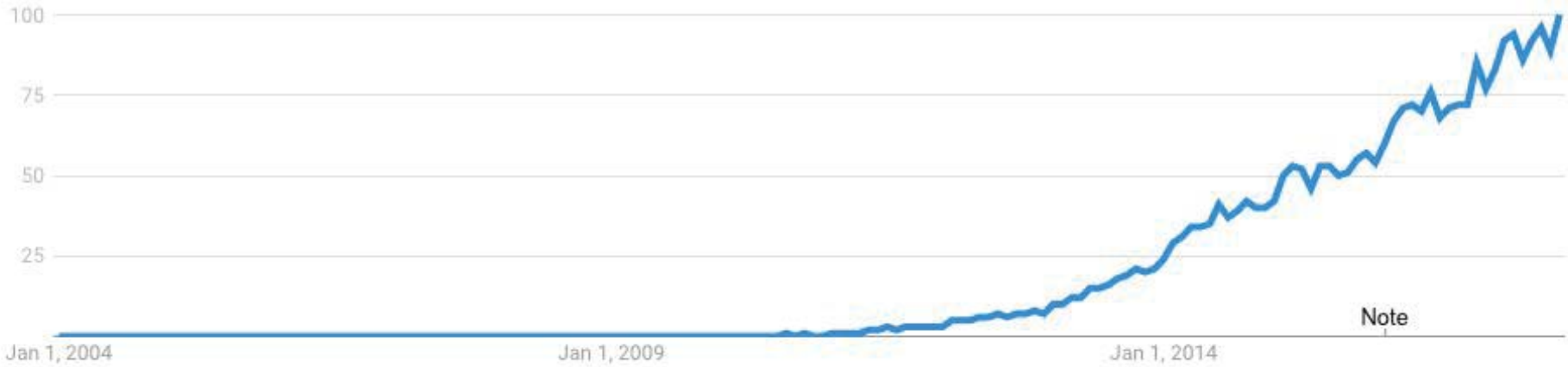
Nathan Lomeli

# What is Elasticsearch?

The screenshot shows the GitHub repository page for `elastic/elasticsearch`. At the top, there is a navigation bar with the GitHub logo, a search bar, and links for Pull requests, Issues, Marketplace, and Gist. On the right side of the navigation bar, there are notification and user profile icons. Below the navigation bar, the repository name `elastic / elasticsearch` is displayed, followed by statistics: 2,088 Watchers, 24,401 Stars, and 8,626 Forks. A secondary navigation bar includes links for Code, Issues (1,191), Pull requests (139), Projects (1), and Insights. The repository description is "Open Source, Distributed, RESTful Search Engine" with a link to <https://www.elastic.co/products/elast...>. Below the description are tags for `elasticsearch`, `java`, and `search-engine`. A horizontal bar displays repository statistics: 28,484 commits, 104 branches, 187 releases, 865 contributors, and Apache-2.0 license. Below this bar are buttons for "Branch: master", "New pull request", "Create new file", "Upload files", "Find file", and a prominent green "Clone or download" button. The commit history section shows a recent commit by `jasontedor` titled "Rename CONF\_DIR to ES\_PATH\_CONF" with a link to the commit details and the text "Latest commit e968762 2 hours ago". Below the commit history, a file entry for `.github` is shown with the title "Add version command to issue template" and the text "15 days ago".

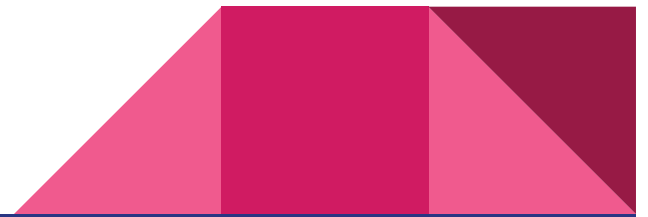
# Rising popularity

Interest over time ?



# Data in, data out

```
PUT /megacorp/employee/1
{
  "first_name" : "John",
  "last_name"  : "Smith",
  "age"       : 25,
  "about"    : "I love to go rock climbing",
  "interests": [ "sports", "music" ]
}
```



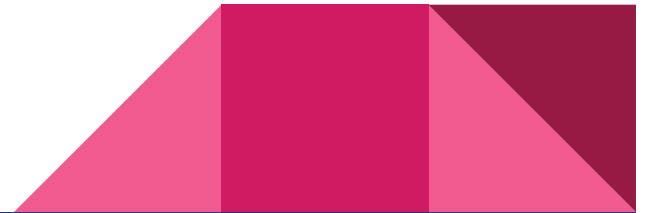
# Data in, data out

```
PUT /megacorp/employee/1
```

```
{  
  "first_name" : "John",  
  "last_name"  : "Smith",  
  "age"       : 25,  
  "about"     : "I love to go rock climbing",  
  "interests" : [ "sports", "music" ]  
}
```

```
PUT /megacorp/employee/2
```

```
{  
  "first_name" : "Jane",  
  "last_name"  : "Smith",  
  "age"       : 32,  
  "about"     : "I like to collect rock albums",  
  "interests" : [ "music" ]  
}
```



```
GET /megacorp/employee/_search?q=last_name:Smith
```

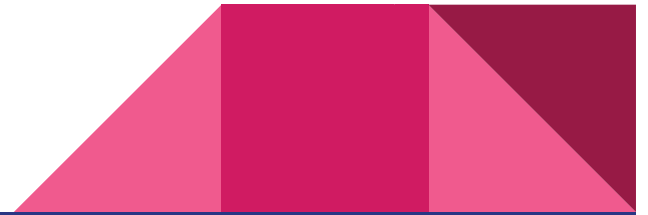
```
{
  "hits": {
    "total": 2,
    "max_score": 0.30685282,
    "hits": [
      {
        ...
        "_source": {
          "first_name": "John",
          "last_name": "Smith",
          "age": 25,
          "about": "I love to go rock climbing",
          "interests": [ "sports", "music" ]
        }
      },
      {
        ...
        "_source": {
          "first_name": "Jane",
          "last_name": "Smith",
          "age": 32,
          "about": "I like to collect rock albums",
          "interests": [ "music" ]
        }
      }
    ]
  }
}
```



# Multi-field search

GET /megacorp/employee/\_search

```
{
  "query" : {
    "bool" : {
      "must" : {
        "match" : {
          "last_name" : "smith"
        }
      },
      "filter" : {
        "range" : {
          "age" : { "gt" : 30 }
        }
      }
    }
  }
}
```



# When can Elasticsearch help with reconciliation?

- good when source data is labeled or structured
- good when multiple fields aid discrimination
- good when target vocabulary has relevant metadata fields
- good for providing ranked list of candidate matches
- good for labor saving compared to manual reconciliation





# Application: The Provenance Project

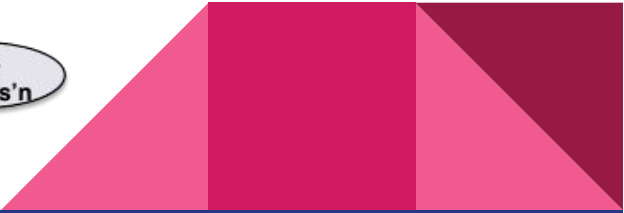
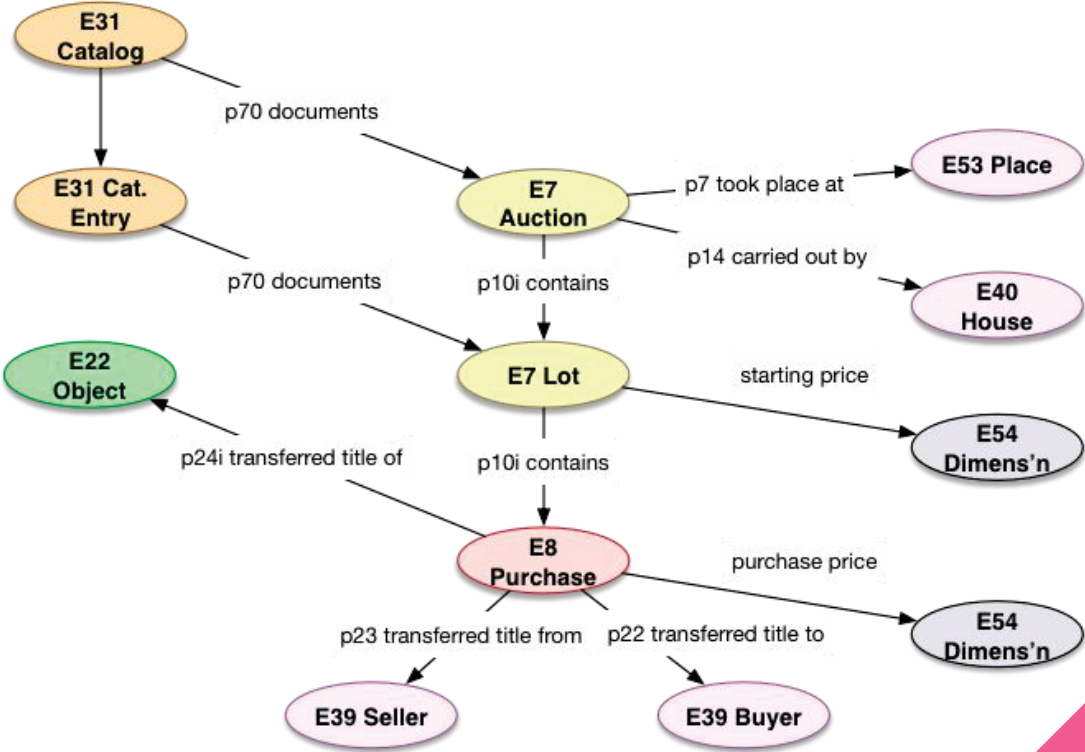


# Goal: structure written records

Date	Description	Name	Value	Other	Notes
1751	Jan 10 <sup>th</sup> 1751	John Brown	100	100	1751
1752	Feb 10 <sup>th</sup> 1752	Jacques	100	100	1752
1753	Mar 10 <sup>th</sup> 1753	J. L. Brown	100	100	1753
1754	Apr 10 <sup>th</sup> 1754	T. L. Brown	100	100	1754
1755	May 10 <sup>th</sup> 1755	J. L. Brown	100	100	1755
1756	Jun 10 <sup>th</sup> 1756	J. L. Brown	100	100	1756
1757	Jul 10 <sup>th</sup> 1757	J. L. Brown	100	100	1757
1758	Aug 10 <sup>th</sup> 1758	J. L. Brown	100	100	1758
1759	Sep 10 <sup>th</sup> 1759	J. L. Brown	100	100	1759
1760	Oct 10 <sup>th</sup> 1760	J. L. Brown	100	100	1760




# The semantic model



# Purpose: to explore provenance by entity

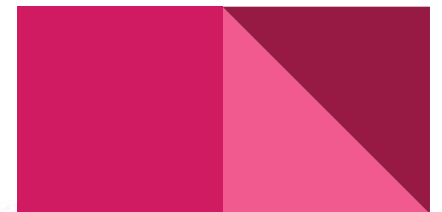
**Search our Database**

Enter Keyword

  
[Advanced Search](#)

## **Browse an Entity**

			
<b>Event</b> 100, 019	<b>Person / Institution</b> 75, 042	<b>Object</b> 80, 012	<b>Location</b> 50, 077
<a href="#">What's an Event?</a>	<a href="#">What's a Person/Institution?</a>	<a href="#">What's an Object?</a>	<a href="#">What's a Location?</a>



Enter Keyword

**Filter Results** [Clear All](#) 305,150 Search results [Advanced Search](#) Sort by: Relevance ▼

**Entity Type**

- Events (100, 019)
- Person / Institution (75, 042)
- Object (80, 012)
- Location (50, 077)

**Date range**

From:  To:

**Lorem**

- Lorem ipsum
- Lorem dolor
- Lorem sit
- Lorem amet
- Lorem consectetur

[See All](#)

---

**Ipsum**

---

**Dolor**

---

**Sit**

---

**Amet**

---

<p><b>IMG</b> Bassano, Jacopa Birth date: 1510 Death date: February 14, 1592 Artworks: The Way to Calvary, Mad...</p> <p><b>Relationships</b> <input type="checkbox"/> 125 <input type="checkbox"/> 15 <input type="checkbox"/> 5 <input type="checkbox"/> 10</p> <p><b>Person (artist)</b></p>	<p><b>IMG</b> National Gallery Founded 1824 Location: London, England Artworks: A Young Woman standing at...</p> <p><b>Relationships</b> <input type="checkbox"/> 50 <input type="checkbox"/> 100 <input type="checkbox"/> 5 <input type="checkbox"/> 1</p> <p><b>Institution (owner)</b></p>
<p><b>IMG</b> The Departure of Abraham Artist Unknown Owner: National Gallery Location: London, England</p> <p><b>Relationships</b> <input type="checkbox"/> 125 <input type="checkbox"/> 15 <input type="checkbox"/> 5 <input type="checkbox"/> 10</p> <p><b>Object (painting)</b></p>	<p><b>IMG</b> London, England Lorem ipsum dolor sit amet, consectetur adipiscing elit. Maecenas libero quam.</p> <p><b>Relationships</b> <input type="checkbox"/> 125 <input type="checkbox"/> 15 <input type="checkbox"/> 5 <input type="checkbox"/> 0</p> <p><b>Location (city)</b></p>
<p><b>IMG</b> February 23, 1801 Event: Sale Location London, England Seller Lorem Ipsum</p> <p><b>Relationships</b> <input type="checkbox"/> 30 <input type="checkbox"/> 15 <input type="checkbox"/> 5 <input type="checkbox"/> 10</p> <p><b>Event (sale)</b></p>	<p><b>IMG</b> The Good Samaritan Artist van Rijn, Rembrandt Owner: The Met Location: New York, NY</p> <p><b>Relationships</b> <input type="checkbox"/> 125 <input type="checkbox"/> 15 <input type="checkbox"/> 5 <input type="checkbox"/> 10</p> <p><b>Object (painting)</b></p>
<p><b>IMG</b> Asselijn, Jan Birth date: 1610 Death date: 1652 Artworks: The Threatened Swan, St. An...</p> <p><b>Relationships</b> <input type="checkbox"/> 125 <input type="checkbox"/> 15 <input type="checkbox"/> 5 <input type="checkbox"/> 10</p> <p><b>Person (artist)</b></p>	<p><b>IMG</b> February 24, 1801 Event: Inventory Location London, England Seller Lorem Ipsum</p> <p><b>Relationships</b> <input type="checkbox"/> 5 <input type="checkbox"/> 15 <input type="checkbox"/> 5 <input type="checkbox"/> 10</p> <p><b>Event (inventory)</b></p>
<p><b>IMG</b> February 25, 1801 Event: Inventory Location London, England Seller Lorem Ipsum</p> <p><b>Relationships</b> <input type="checkbox"/> 50 <input type="checkbox"/> 15 <input type="checkbox"/> 5 <input type="checkbox"/> 10</p> <p><b>Event (inventory)</b></p>	<p><b>IMG</b> Paris, France Lorem ipsum dolor sit amet, consectetur adipiscing elit. Maecenas libero quam.</p> <p><b>Relationships</b> <input type="checkbox"/> 125 <input type="checkbox"/> 15 <input type="checkbox"/> 5 <input type="checkbox"/> 0</p> <p><b>Location (city)</b></p>



## Means: digitizing records ...

artist_authority_artist_1	variant_names_artist_1	birth_date_artist_1	death_date_artist_1	period_activ	century_activ	active_city_date_artist_1	nationality_artist_1
ALLORI, ALESSANDRO	Allori, Alessandro; Alessandro Allori;	1535	1607	x	16th		Italian
ALLORI, ALESSANDRO	Allori, Alessandro; Alessandro Allori;	1535	1607	x	16th		Italian
MAILLOL, ARISTIDE	Maillol, Aristide; Aristide Maillol; Ma	1861	1944	x	19th-20th		French
COROT, JEAN BAPTISTE CAMILLE	Corot, Jean Baptiste Camille; jean-ba	1796	1875	x	19th		French
CHELMINSKI, JAN	Chelminski, Jan; chelminski j.v.; chelr	1851	1925	x	19th		Polish
PEALE, CHARLES WILLSON	Peale, Charles Willson; Peale; peale c	1741	1827	x	18th		American
PEALE, CHARLES WILLSON	Peale, Charles Willson; Peale; peale c	1741	1827	x	18th		American
BENBRIDGE, HENRY	Benbridge, Henry; Henry Benbridge;	1743	1812	x	18th		American
SULLY, THOMAS	Sully, Thomas; Thomas Sully; Sully; th	1783	1872	x	19th	Richmond; Philadelphia; C	American
CHASE, WILLIAM MERRITT	Chase, William Merritt; William Merr	1849	1916	x	19th		American
REMBRANDT HARMENSZ. VAN RIJN	Rembrandt Harmensz. van Rijn; Rem	1606	1669	x	17th	Amsterdam (1630-1669)	Dutch
BERTZIG, ANTON	Bertzig, Anton; Anton Bertzik; bertsic	1856	1912	x	19th-20th	Wien	Austrian
TOMSON, CLIFTON	Tomson, Clifton; clifton tomson; c. th	ca.1775	1831	x	18th-19th		British
DANCE-HOLLAND, NATHANIEL	Dance-Holland, Nathaniel; Nathaniel	1735	1811	x	18th	London; Rome	British



# and aligning to the Getty Vocabularies



Research Home ▶ Tools ▶ Union List of Artist Names ▶ Full Record Display




## Union List of Artist Names® Online Full Record Display

[New Search](#)

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Click the  icon to view the hierarchy.

[Semantic View \(JSON, JSONLD, RDF, N3/Turtle, N-Triples\)](#)

▪ [Representative Images: 1 2 3 4 5](#)

**ID: 500011051**

**Record Type: Person**

 **Rembrandt van Rijn** (Dutch painter, printmaker, 1606-1669)

**Note:** Noted as one of the most popular and influential artists of his period. His work is characterized by the Baroque interest in dramatic scenes and strong contrasts of light on a dark stage. The subjects of his works include paintings, etchings, and drawings of subjects including portraits, landscapes, figures, animals, biblical and secular history and mythology.

### Names:

**Rembrandt van Rijn** ([preferred](#),[V](#),[display](#),[LC](#)) .... "Rijn" refers to a geographic place, the site of the mill owned by his father in Leyden

**Rijn, Rembrandt van** ([V](#))

**Rembrandt Harmensz. van Rijn** ([V](#))

**Rembrandt Harmensz van Rijn** ([V](#))

**Rijn, Rembrandt Harmensz. van** ([V](#))

**Van Rijn, Rembrandt** ([V](#))

**Rembrandt** ([V](#),[CN](#))

.... from 1632 onwards he signed his works with only the forename "Rembrandt"; in documents, however, he continued to sign "Rembrandt van Rijn"



# and aligning to the Getty Vocabularies



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**Rijn, Rembrandt Harmensz. van** ([V](#))

**Van Rijn, Rembrandt** ([V](#))

**Rembrandt** ([V](#),[CN](#))

.... from 1632 onwards he signed his works with only the forename "Rembrandt"; in documents, however, he continued to sign "Rembrandt van Rijn"

### Nationalities:

Dutch ([preferred](#))  
undetermined

### Roles:

artist ([preferred](#))  
draftsman  
printmaker  
etcher  
painter  
teacher  
miscellaneous  
portraitist

**Gender:** male

### Birth and Death Places:

Born: [Leyden \(South Holland, Netherlands\)](#) ([inhabited place](#))  
Died: [Amsterdam \(North Holland, Netherlands\)](#) ([inhabited place](#))

### Events:

active: 1631-1669 [Amsterdam \(North Holland, Netherlands\)](#) ([inhabited place](#))



# Getting the vocabulary data

```
@prefix ulan_scopeNote: <http://vocab.getty.edu/ulan/scopeNote/> .
@prefix ulan_source: <http://vocab.getty.edu/ulan/source/> .
@prefix ulan_source_rev: <http://vocab.getty.edu/ulan/source/rev/> .
@prefix ulan_term: <http://vocab.getty.edu/ulan/term/> .
@prefix vaem: <http://www.linkedmodel.org/schema/vaem#> .
@prefix vann: <http://purl.org/vocab/vann/> .
@prefix vcard: <http://www.w3.org/2006/vcard/ns#> .
@prefix vdpp: <http://data.lirmm.fr/ontologies/vdpp#> .
@prefix voaf: <http://purl.org/vocommons/voaf#> .
@prefix voag: <http://voag.linkedmodel.org/voag#> .
@prefix void: <http://rdfs.org/ns/void#> .
@prefix wdrs: <http://www.w3.org/2007/05/powder-s#> .
@prefix wgs: <http://www.w3.org/2003/01/geo/wgs84_pos#> .
@prefix ww: <http://vocab.org/waiver/terms/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

ulan:500011051 a gvp:Subject , skos:Concept , gvp:PersonConcept ;
    rdfs:label "Rembrandt" , "Rhyn" , "Rembrandt van Rijn" , "Rijn, Rembrandt van" , "Rembrandt Harmensz. van Rijn" , "Rembrandt Harmensz van Rijn" , "Rijn, Rembrandt Harmensz. van" , "Van Rijn, Rembrandt" , "Rembrandt van Rhyn" , "Rembrandt van Ryn" , "Rembrandt van Rhijn" , "Rembrandt Harmensz. van Rhyn" , "Rembrandt Harmensz. van Rhijn" , "Rembrandt Hermansz van Rijn" , "Rembrandt Harmenszoon van Rijn" , "Rembrandt Hermanszoon van Rijn" , "Rembrandt Harmensz Van Rijn" , "Van Rhyn Rhembrandt" , "Rembrandt Van Rhyn" , "Rembrant van Rhijn" , "Rembrant van Rijn" , "Rembrant Van Rin" , "Rembrand van Rijn" , "Reimbrant van Rijn" , "Rambrandt van Rijn" , "Rembrandt Olandese" , "Van Ryn, Paul Rembrandt" , "Rembrandt, Harmensz. Van Rijn" , "Harmensz. Van Rijn Rembrandt" , "Rembrandt, Rhijn" , "Rijn, Rembrandt Harmenszoon van" , "Van Rijn, Rembrandt Harmenszoon" , "Rāmbirānt" , "Rembrandt Garmens van Reīn" , "Rembrandt van Reīn" , "Lun-po-lang" , "Reimbrandt" , "رامبرانت" , "רמברנדט הרמנסון וארדיין" , "רמברנדט" ;|
    gvp:broader ulan:500000002 ;
    gvp:broaderInstantialExtended ulan:500000002 ;
    gvp:broaderExtended ulan:500000002 ;
    gvp:broaderPreferredExtended ulan:500000002 ;
    gvp:parentString "Persons, Artists" ;
    gvp:agentType aat:300025174 , aat:300025529 , aat:300025103 , aat:300386698 , aat:300112172 , aat:300025136 , aat:300025164 ;
    skos:exactMatch ulan:500011051 , <http://id.loc.gov/authorities/names/n79142935> ;
    skosxl:prefLabel ulan_term:1500030898 ;
    skos:prefLabel "Rembrandt van Rijn" ;
    gvp:ulan1102 student of ulan:500022804 .
```

# Turning it into JSON

- ensure that your target resource representations are consistent (e.g. no mixed types for a given field)
- include and dereference fields that will be most useful for matching (may require building dereferencing dictionaries to go from vocab IDs to string literals)
- ensure JSON is ES compatible (e.g. no blank node " " keys)



```
"personDescription": "Dutch painter, printmaker, 1606-1669",
"birthPlace": {
  "id": "tgn:7006809-place",
  "label": {
    "nl": [
      "Leiden",
      "Leyden"
    ],
    "en": [
      "Leyden"
    ]
  }
},
"deathPlace": {
  "id": "tgn:7006952-place",
  "label": {
    "nl": [
      "Amsterdam"
    ],
    "en": [
      "Amsterdam"
    ]
  }
},
"estStart": {
  "type": "xsd:gYear",
  "@value": "1606-01-01"
},
"estEnd": {
  "type": "xsd:gYear",
  "@value": "1669-01-01"
}
}
```



## A few more steps

- load JSON into your ES instance
- optionally create a web service that can relay queries to the ES instance
- consider how to validate reconciliation service



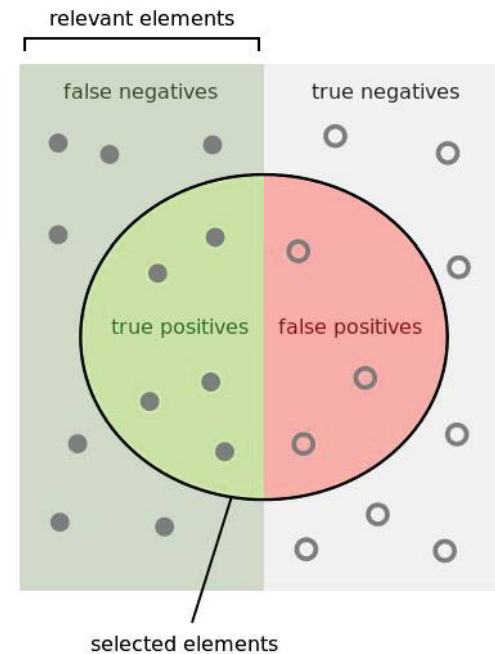
## Querying the service

```
GT27255:vocabs-autosuggest nloveli$ http 'http://0.0.0.0:5000/service/autosuggest/ulan?index=ulan&label=John%20Smith&nationality=British&cutoff=1.1'
HTTP/1.0 200 OK
Access-Control-Allow-Headers: Content-Type,Authorization
Access-Control-Allow-Methods: HEAD,GET,PUT,POST,DELETE,OPTIONS
Access-Control-Allow-Origin: *
Content-Length: 23035
Content-Type: application/json
Date: Tue, 15 Aug 2017 00:38:27 GMT
Server: Werkzeug/0.11.11 Python/3.6.1

[
  {
    "_id": "500095103",
    "_index": "ulan",
    "_score": 6.190874,
    "_source": {
      "agentType": [
        {
          "id": "aat:300024987",
          "label": {
            "en": [
              "architects",
              "architect"
            ]
          }
        }
      ]
    }
  }
]
```

# Validity: precision and recall

- precision is your signal-to-noise ratio
  - dense namespaces will reduce it
- recall is the sensitivity to make matches
  - ES is very sensitive by default
- external validation will require labor
  - known matches compared with results

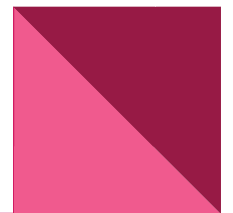


How many selected items are relevant?

$$\text{Precision} = \frac{\text{true positives}}{\text{true positives} + \text{false positives}}$$

How many relevant items are selected?

$$\text{Recall} = \frac{\text{true positives}}{\text{true positives} + \text{false negatives}}$$



One more idea



Google  
Sheets



# Google Sheets

Knodler Reconciliation ☆

nathan.lomeli@gmail.com

File Edit View Insert Format Data Tools Add-ons Help All changes saved in Drive

Comments Share

123% Arial 10

	A	B	C	D	E	F	G	H
	artist_authority_artist_1	variant_names_artist_1	birth_date_artist_1	death_date_artist_1	period_active	century_active	active_city_date	nationality_artist_1
2	ALLORI, ALESSANDRO	Allori, Alessandro; Alessandro Allori; ales	1535	1607	x	16th		Italian
3	ALLORI, ALESSANDRO	Allori, Alessandro; Alessandro Allori; ales	1535	1607	x	16th		Italian
4	MAILLOL, ARISTIDE	Maillol, Aristide; Aristide Maillol; Maillol	1861	1944	x	19th-20th		French
5	COROT, JEAN BAPTISTE CAMILLE	Corot, Jean Baptiste Camille; jean-bapt. c	1796	1875	x	19th		French
6	CHELMINSKI, JAN	Chelminski, Jan; chelminski j.v.; chelmins	1851	1925	x	19th		Polish
7	PEALE, CHARLES WILLSON	Peale, Charles Willson; Peale; peale c.w.	1741	1827	x	18th		American
8	PEALE, CHARLES WILLSON	Peale, Charles Willson; Peale; peale c.w.	1741	1827	x	18th		American
9	BENBRIDGE, HENRY	Benbridge, Henry; Henry Benbridge; Ben	1743	1812	x	18th		American
10	SULLY, THOMAS	Sully, Thomas; Thomas Sully; Sully; thos.	1783	1872	x	19th	Richmond, Philade	American
11	CHASE, WILLIAM MERRITT	Chase, William Merritt; William Merritt C	1849	1916	x	19th		American
12	REMBRANDT HARMENSZ. VAN RIJN	Rembrandt Harmensz. van Rijn; Rembra	1606	1669	x	17th	Amsterdam (1630	Dutch
13	BERTZIG, ANTON	Bertzig, Anton; Anton Bertzik; bertsic; be	1856	1912	x	19th-20th	Wien	Austrian
14	TOMSON, CLIFTON	Tomson, Clifton; clifton tomson; c. thom ca.1775		1831	x	18th-19th		British
15	DANCE-HOLLAND, NATHANIEL	Dance-Holland, Nathaniel; Nathaniel Dan	1735	1811	x	18th	London; Rome	British
16	SCOTT, SAMUEL	Scott, Samuel; Scott; Samuel Scott; Scot;	1702/10	1772	x	18th		British
17	[ANONYMOUS - 18TH C.]	[Anonymous - 18th c.]; Anonymous - 18t	x		x	18th		Unknown
18	[ANONYMOUS - 18TH C.]	[Anonymous - 18th c.]; Anonymous - 18t	x		x	18th		Unknown
19	[ANONYMOUS - 18TH C.]	[Anonymous - 18th c.]; Anonymous - 18t	x		x	18th		Unknown
20	STEVENS, ALFRED EMILE LEOPOLD JOSEPH VICT	Stevens, Alfred Emile Leopold Joseph Vic	1823	1906	x	19th		Belgian
21	MURPHY, JOHN FRANCIS	Murphy, John Francis; John Francis Murp	1853	1921	x	19th		American
22	WHISTLER, JAMES ABBOTT MCNEILL	Whistler, James Abbott McNeill; James A	1834	1903	x	19th		American
23	SÁNCHEZ PERRIER, EMILIO	Sánchez Perrier, Emilio; Emilio Sanchez	1855	1907	x	19th		Spanish
24	CHADWICK, LYNN RUSSELL	Chadwick, Lynn; lynn chadwick	1914	2003	x	20th-21st	London	British
25	CHADWICK, LYNN RUSSELL	Chadwick, Lynn; lynn chadwick	1914	2003	x	20th-21st	London	British
26	CHADWICK, LYNN RUSSELL	Chadwick, Lynn; lynn chadwick	1914	2003	x	20th-21st	London	British
27	HAJDU, ETIENNE	Hajdu, Etienne; hajdu	1907	1996	x	20th	Paris; Switzerland;	French
28	HAJDU, ETIENNE	Hajdu, Etienne; hajdu	1907	1996	x	20th	Paris; Switzerland;	French
29	BRAQUE, GEORGES	Braque, Georges; Georges Braque; Braqu	1882	1963	x	20th		French
30	POUGNY, JEAN	Pougny, Jean; Jean Pougny; Pougny	1894	1956	x	20th		French



# A review of the pieces

- vocabulary data represented in stand-alone JSON documents
- a loaded Elasticsearch instance
- a web service layer to relay queries to the ES instance (optional)
- source records to be reconciled
- a script for sending records to the reconciliation service
- a Google Drive account for storing and editing results





# Reconciliation with Elasticsearch

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