

Biomedical Informatics

PHR design and implementation

PersonalHealthRecord

Προσωπικός Φάκελος Υγείας

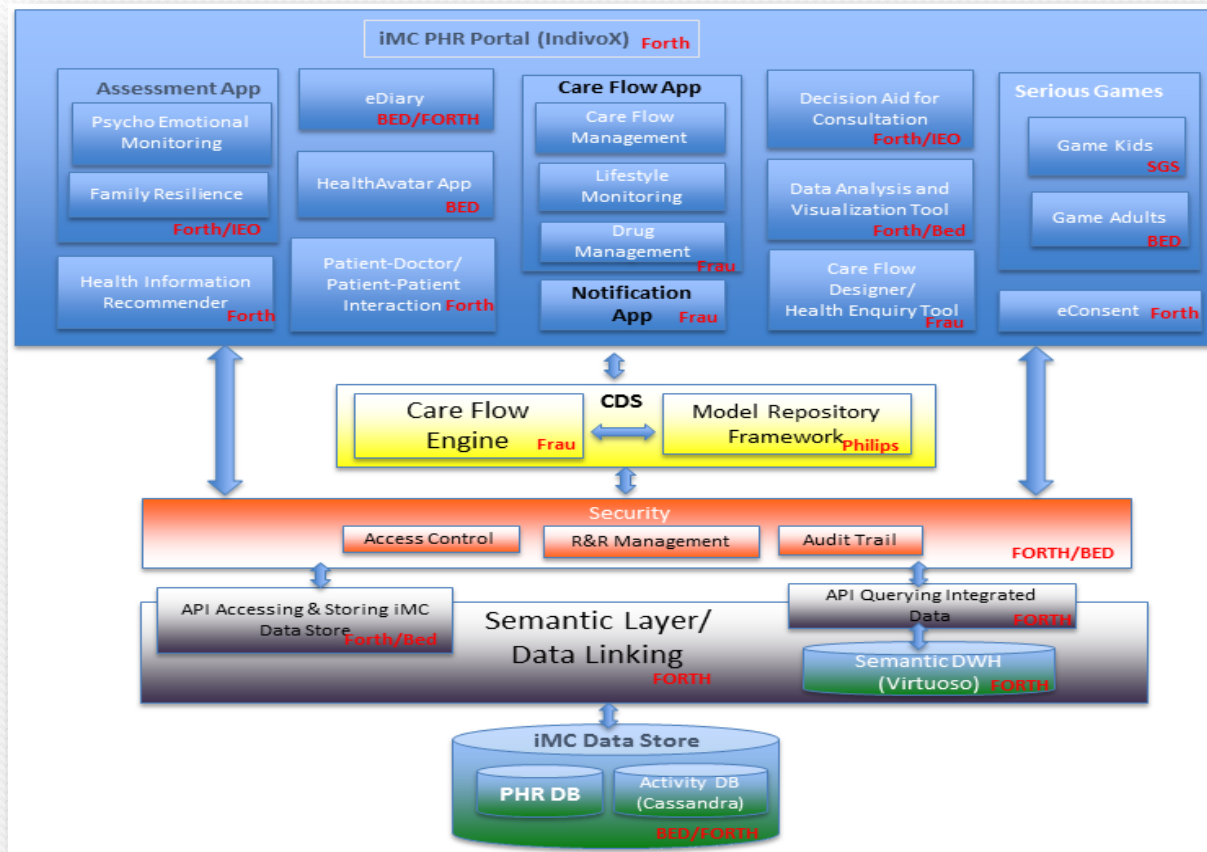
Motivation

- ❑ There is an increasing need for patients to manage their own healthcare.
- ❑ Trends: portable and wearable devices & health applications.
 - ❑ Information technologies as a means to transform the role of the patient from a passive recipient to an active participant in matters concerning their health.

Personal Health Record (PHR)

- **The Personal Health Record (PHR)** is a system in which medical data and information related to a patient's care are maintained and managed by the patient. In contrast, **Electronic Health Records (EHRs)** are maintained by institutions (such as hospitals) and contain data entered by clinical physicians or billing data for insurance claims.
- The purpose of a **Personal Health Record** is to provide a comprehensive and accurate summary of an individual's medical history that is available online. Medical data can be provided by the patient, such as laboratory test results, or can be supplied by a device or a smartphone application.

Indicative Architecture



PHR

- Empowering an individual to control and manage a comprehensive and secure digital copy of their health and quality-of-life information.
- The central access tool for:
 - Clinical physicians
 - Patients
 - Relatives / family members
 - Researchers
 - Administrators

PHR

- Common functionalities
 - ❑ Web based & Responsive
 - ❑ Multilingual
 - ❑ Help/manual
 - ❑ Autocomplete (using ontologies)
 - ❑ ICD
 - ❑ SNOMED
 - ❑ RxTerms
 - ❑ LOINC
 - ❑ Rest API
 - ❑ Security integration
 - ❑ OAuth 2.0 Provider
 - ❑ OAuth 2.0 API

PHR

- Roles
 - Patient
 - Healthcare professional
 - Administrator
 - Researcher

User - Patient

➤ Applications

- eDiary
- Problems
 - Time
 - Chronical problems
 - Primary/co-morbidities
- Demographics
 - Smoking
 - Pregnancy
 - Weight
- Allergies
- Medications
- Laboratories
- Procedures
- Upload Documents
- Other apps
 - Download iMC mobile apps
- myStatistics
- PHIR
- Measurements
- Appointments
 - Alerts
- Psycho-emotional questionnaires
- Export RDF/XML
- Bulk import

Patient view

The screenshot displays the iPHR patient view interface for Diana Allen. The main content area is titled "Measurements List" and includes "List View" and "Graph View" buttons. Below these are "add measurement" and "deleted measurements" buttons. A table lists various measurements with their values and units.

| Kind | Value/Unit |
|------------------|------------|
| body temperature | 36.7 °C |
| body temperature | 41 °C |
| body temperature | 36.4 °C |
| diastole | 68 mmHg |
| diastole | 70 mmHg |
| diastole | 60 mmHg |
| weight | 69 kg |
| weight | 69 kg |
| weight | 68 kg |
| body temperature | 39 °C |
| body temperature | 36.6 °C |
| body temperature | 36.6 °C |

Below the table is a "Sharing and Audit" section: "Shared with Physicians. [update]"

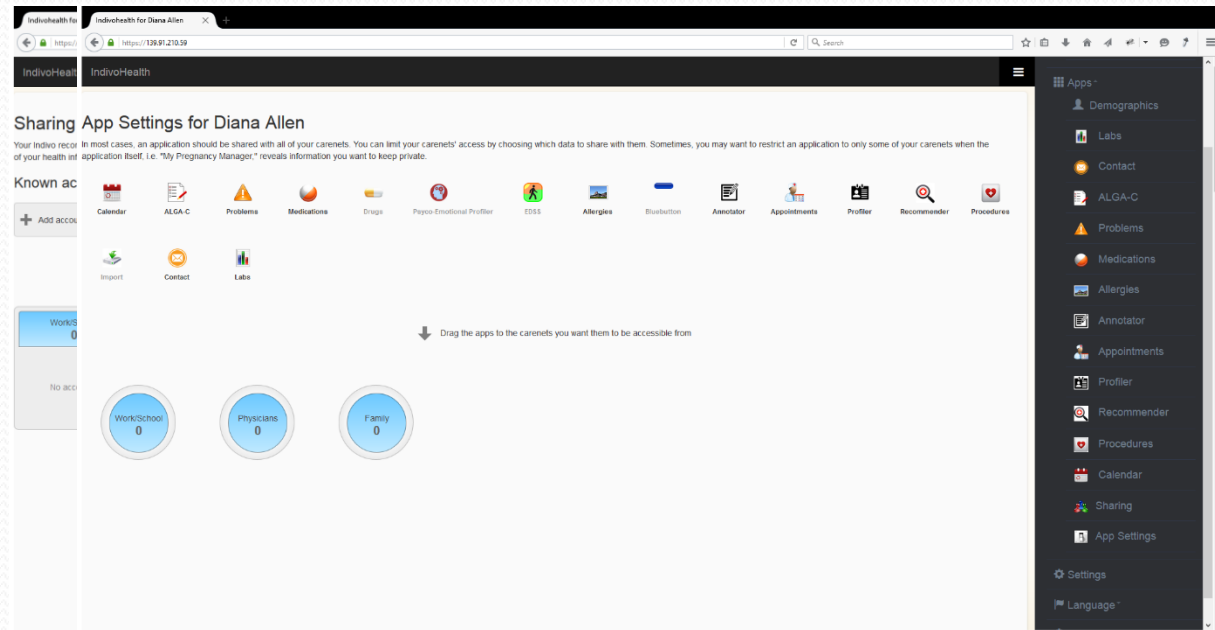
Two graphs are shown: "pulse graph" and "temperature graph". The pulse graph shows a sharp drop from 100 to approximately 65, followed by a gradual rise. The temperature graph shows a steady, slight increase from approximately 35 to 37.

The right sidebar contains navigation options: Patients (Diana Allen), Apps (Problems, Contact, Labs, Measurements, Recommender, Annotator, ALGA-C), Settings, Language, and Logout.

Patient view– Data Sharing

- Διαμοιρασμός πληροφοριών με :

- Κλινικούς ιατρούς
- Ασθενείς
- Συγγενείς
- Ερευνητές



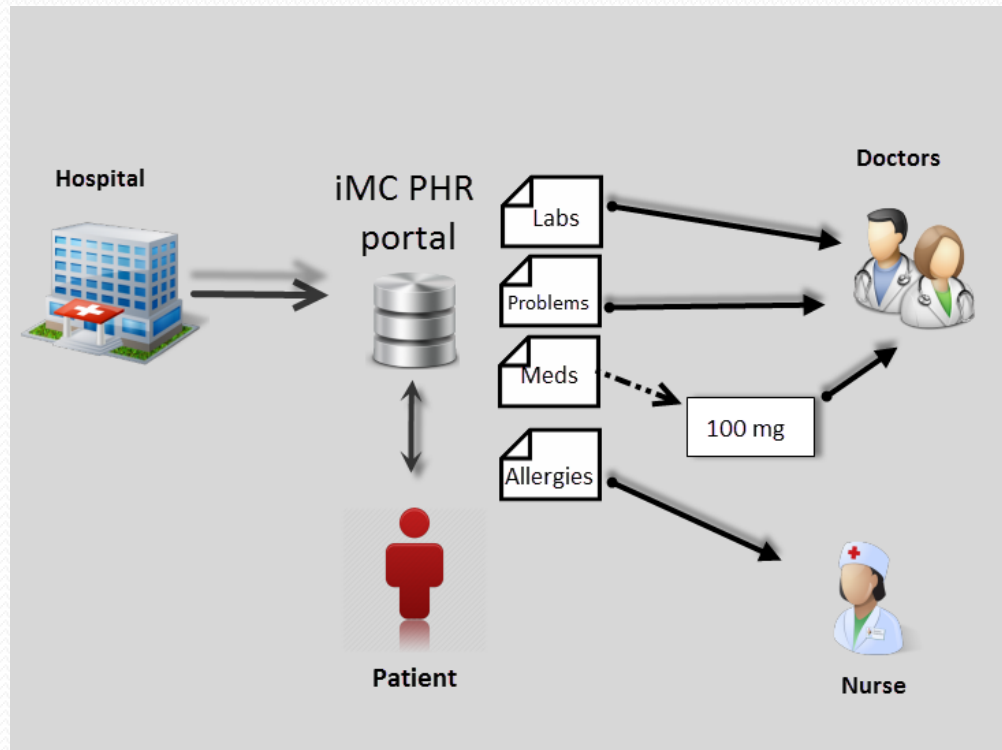
Indivo sharing models

- Full share
 - Sharing the entire patient health record with another system account (giving full control over a record to another account)
 - Goal: to allow multiple accounts to have access to — or “own” — the same patient record.
- Partly share
 - Give control over some parts of a record to another account

Architecture – Indivo Model: Share

- Carenet
 - A group created by a patient in order to share their medical information with the members of the group.
 - Each member of the group has full access to the information that has been shared with the group.

Sharing managements



Role healthcare professional

➤ Indicative applications

- Clinical assessment
- Questionnaires: Only for patients that provided sharing access
- Profiler
- Statistics
- Phyco-emotional questionnaires
 - ❑ ALGA-C
 - ❑ Family Resilience
 - ❑ Psycho-emotional
- Annotator

Role healthcare professional

The screenshot displays the IPHR interface for a healthcare professional. The main window is titled 'New Cancer Clinical Assessment Questionnaire' and shows a patient selection dropdown. Below it is an 'Annotator' section. A 'Questionnaire Results' pop-up window is open, displaying a table of results. The table has columns for 'Question', 'Answer', and 'Points'. The data is as follows:

| Question | Answer | Points |
|--|-----------|--------|
| GSRH Compared to others your age, would you say your health is... | Very poor | 1 |
| GSRH In general, would you say your health is... | Poor | 2 |
| undefined Section: Perceived physical health (in the last 4 weeks) | undefined | 3 |
| Perceived physical health Did you feel tired? | Often | 4 |
| Perceived physical health Did you feel weak? | Always | 5 |

The interface also shows a sidebar with 'Patients' and 'Apps' sections, and a bottom navigation bar with 'Clinical assessment', 'Annotator', 'Profiler', 'Sharing', 'App Settings', 'Settings', 'Inbox', 'Language', and 'IPHR Validation Questionnaire'.


Clinical
assessment
Annotator
Profiler

Role administrator

- Admin console
 - Add a new administrator
 - Send an email to all patients
 - New entries in the system
 - New users
 - Audit visualization
 - Problem reports (Bugs reported in the portal)

Role administrator

Total number of patients Application filter

stephan.kiefer@hotmail.de Stephan
Stephan Hello Fatima, This is a
test. Please let me
know whether you have  iManageMyHealth

Add new administrator Send a Message

Users New Users New Entries

Audit Visualization Problem Reports

Full name E-mail Status Role

 Select Select

Search Reset

| | | | | | | | | |
|-----------|---------------------|------------|---|---|--------|------------|---------|--------|
| ieouser26 | ieouser26@email.com | 2017-05-17 | 2 | 0 | active | 2017-05-09 | patient | Delete |
| ieouser36 | ieouser36@email.com | 2017-05-17 | 6 | 0 | active | 2017-05-09 | patient | Delete |
| ieouser24 | ieouser24@email.com | 2017-05-17 | 1 | 0 | active | 2017-05-09 | patient | Delete |
| ieouser5 | ieouser5@email.com | 2017-05-17 | 7 | 0 | active | 2017-05-09 | patient | Delete |
| ieouser22 | ieouser22@email.com | 2017-05-17 | 2 | 0 | active | 2017-05-09 | patient | Delete |
| ieouser29 | ieouser29@email.com | - | 0 | 0 | active | 2017-05-09 | patient | Delete |

Audit visualization

Problems report

Users

Deployment details

- PHR Server:
 - Ubuntu
 - PostgreSQL
 - MySQL
 - Python 2.6+
 - Django
 - Apache 2.4
- PHR Client:
 - Python 2.6+
 - Django
 - Html
 - Javascript

Security

- Indivo security breaks down in two steps:
 - Authentication
 - Ταυτοποίηση για σύνδεση στο σύστημα
 - Authorization
 - Εξουσιοδότηση για πρόσβαση σε δεδομένα ή εφαρμογές
 - Audit system
 - Καλείται μετά την ταυτοποίηση και την εξουσιοδότηση
- Στόχος: Κανένας να μην έχει πρόσβαση σε πληροφορίες που δεν είναι εξουσιοδοτημένος (είτε του ανήκουν είτε από διαμοιρασμό)

Security – OAuth 2.0

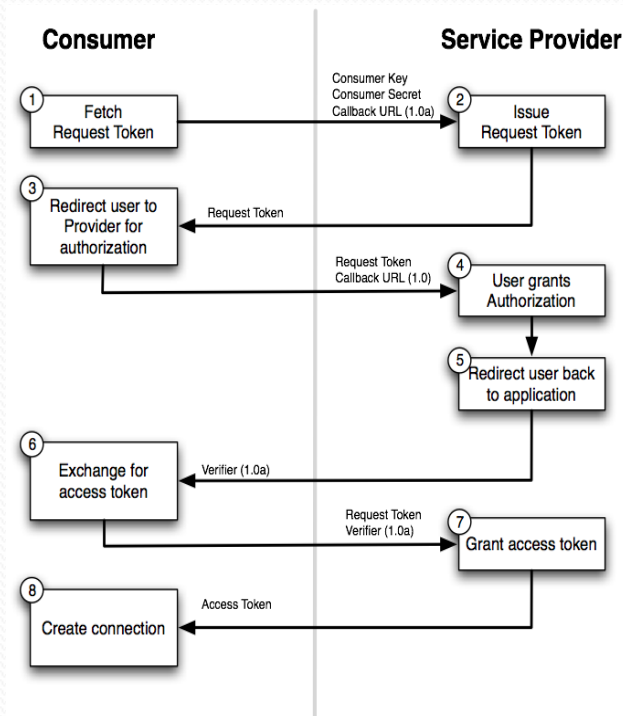
- Authorization framework enables a third-party application to obtain limited access to an HTTP service.
- OAuth works over HTTP and authorizes Devices, APIs, Servers and Applications with access tokens rather than credentials.

Security – Provider

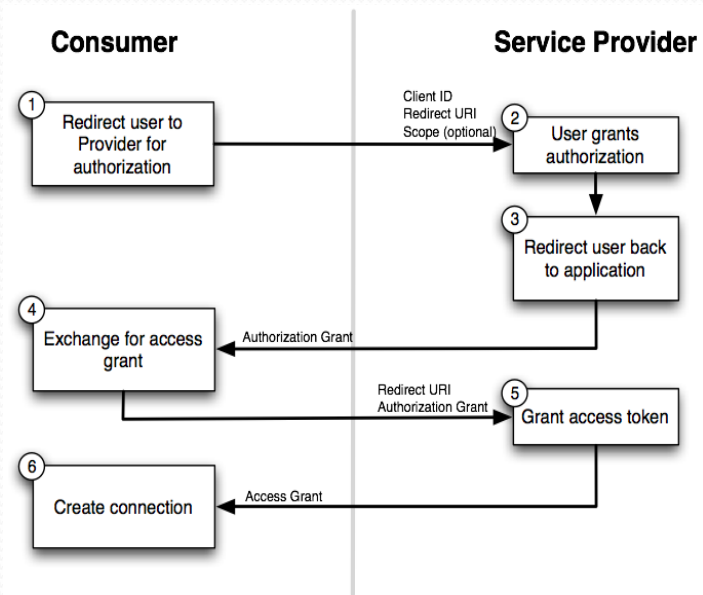
- OAuth Provider is the provider that supplies the OAuth service for instance google, twitter, yahoo, facebook or whoever you are asking to log in the user.
- Or in other words the provider that tells that the user logged in successfully.

OAuth 1.0 and 2.0

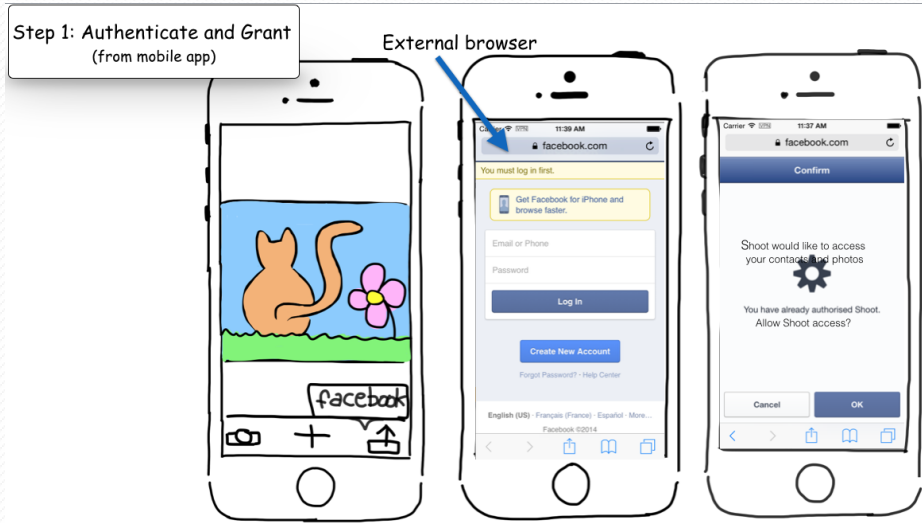
OAuth 1.0



OAuth 2.0



Security - Provider



Facebook example

```
root@ip-172-31-0-136:/home/ubuntu# curl -X POST -d "client_id=38525ae9102bb34a72ab&client_secret=c4ca8bd3eb7109718380104b1b5b
cab9fd45c267&grant_type=password&username=test&password=111111" https://www.iphr.care:8443/oauth2/access_token/ --insecure
{"access_token": "3de260c7d40cc624980f", "token_type": "Bearer", "expires_in": 1799, "refresh_token": "68c475b97fd1cb608450",
"scope": "read"}root@ip-172-31-0-136:/home/ubuntu#
```

Indivo Provider

API functionality

- Personal Health Applications (PHAs) make calls to the Indivo API Server using the REST convention
- Patient records and files:
 - Patient records and the applications that are authorized to access them
 - Create, read, and edit files
 - Display all files and deleted files
 - All files are centered around the patient's record (record-specific)

API – Functionality (example)

- Κλήση API : <https://www.iphr.care/api/records/1d7d4bc2-7cd7-4423-9217-62ab42d96892/reports/measurements/>

[-] Request

Method GET URL <https://www.iphr.care/api/records/1d7d4bc2-7cd7-4423-9217-62ab42d96892/reports/measurements/> SEND

Headers Remove All

MC-TOKEN: 3abc4d1bb79bd01ea768

Body

Request Body

[-] Response

Response Headers Response Body (Raw) Response Body (Highlight) Response Body (Preview)

1. Status Code : 200 OK ←

2. Connection : Keep-Alive

3. Content-Type : application/json

4. Date : Wed, 18 Oct 2017 10:01:33 GMT

5. Keep-Alive : timeout=5, max=100

6. Server : Apache/2.4.18 (Ubuntu)

7. Transfer-Encoding : chunked

[-] Request

Method GET URL <https://www.iphr.care/api/records/1d7d4bc2-7cd7-4423-9217-62ab42d96892/reports/measurements/> SEND

Headers Remove All

MC-TOKEN: 3abc4d1bb79bd01ea768

Body

Request Body

[-] Response

Response Headers Response Body (Raw) Response Body (Highlight) Response Body (Preview)

```
[[{"kind": "weight", "name": "-", "number": "None", "value": "68", "measurementDate": "2017-05-17T00:00:00Z", "name_value": "-", "__modelname__": "Measurements", "__documentid__": "d7a5d90c-5607-48bc-81d3-93f63df5fff6", "name_abbrev": "http://purl.bioontology.org/ontology/SNOMEDCT/", "unit": "kg", "comments": null}, {"kind": "pulse", "name": "-", "number": null, "value": "68", "measurementDate": "2017-07-07T01:10:00Z", "name_value": "-", "__modelname__": "Measurements", "__documentid__": "94788443-e807-4786-be2c-f102914a8622", "name_abbrev": "http://purl.bioontology.org/ontology/SNOMEDCT/", "unit": "bpm", "comments": null}, {"kind": "weight", "name": "-", "number": null, "value": "67", "measurementDate": "2017-05-06T00:00:00Z", "name_value": "-", "__modelname__": "Measurements", "__documentid__": "d78b0e44-82ed-4961-aeb2-b2a7d1387c91", "name_abbrev": "http://purl.bioontology.org/ontology/SNOMEDCT/", "unit": "kg", "comments": null}]]
```

PHR – Autocomplete

New Problem

Problem *

diso

I

- Closed traumatic dislocation of hip joint (disorder)
- Compound dental caries (disorder)
- Influenza due to Influenza virus, type A, human (disorder)
- Preinfarction angina (disorder)
- Fatty liver (disorder)
- Condylomata lata of perianal skin (disorder)
- Recurrent subluxation of the patella (disorder)
- Necrotizing vasculitis (disorder)
- Angle-closure glaucoma - borderline (disorder)
- Chronic urate nephropathy (disorder)
- Type I diabetes mellitus with ulcer (disorder)
- Oculoparesis (disorder)

* Mandatory Fields

Add New Problem

Cancel

PHR – Autocomplete

```
def code_lookup(request):
    client = get_indivo_client(request)

    query = request.GET['query']

    # reformat this for the jQuery autocomplete
    resp, content = client.coding_system_query(system_short_name='findings', body={'q':query})

#     resp, content = client.coding_system_query(system_short_name='snomed', body={'q':query})
if resp['status'] != '200':
    # TODO: handle errors
    # But this Indivo instance might not support codingsystem lookup, so let's pass
    pass
codes = simplejson.loads(content)
formatted_codes = {'query': query, 'suggestions': [c['consumer_value'] for c in codes], 'data': codes}

return HttpResponse(simplejson.dumps(formatted_codes), mimetype="text/plain")
```

Όνομα Αρχείου



PHR Client

findings.txt

```
SNOMED_CID|SNOMED_FSN|SNOMED_CONCEPT_STATUS|UMLS_CUI|OCCURRENCE|USAGE|FIRST_IN_SUBSET|IS_RETIRED_FROM_SUBSET|LAST_IN_SUBSET|REPLACED_BY_SNOEMED_CID
38341003|Hypertensive disorder, systemic arterial (disorder)|Current|C0020538|7|3.0824|200907|False||
55822004|Hyperlipidemia (disorder)|Current|C0020473|7|1.9094|200907|False||
35489007|Depressive disorder (disorder)|Current|C0011581|7|1.5214|200907|False||
235595009|Gastroesophageal reflux disease (disorder)|Current|C0017168|7|1.2295|200907|False||
44054006|Diabetes mellitus type 2 (disorder)|Current|C0011860|7|0.9864|200907|False||
195967001|Asthma (disorder)|Current|C0004096|7|0.9502|200907|False||
59621000|Essential hypertension (disorder)|Current|C0085580|6|0.9007|200907|False||
414916001|Obesity (disorder)|Current|C0028754|7|0.8746|200907|False||
73211009|Diabetes mellitus (disorder)|Current|C0011849|7|0.8591|200907|False||
61582004|Allergic rhinitis (disorder)|Current|C2607914|7|0.8303|200907|False||
40930008|Hypothyroidism (disorder)|Current|C0020676|6|0.8249|200907|False||
54150009|Upper respiratory infection (disorder)|Current|C0041912|7|0.7657|200907|False||
161891005|Backache (finding)|Current|C0004604|7|0.696|200907|False||
21522001|Abdominal pain (finding)|Current|C0000737|7|0.6917|200907|False||
```

Αρχείο που περιέχει
ιατρικούς όρους

Personal Health Information Recommender

Introduction: patient empowerment

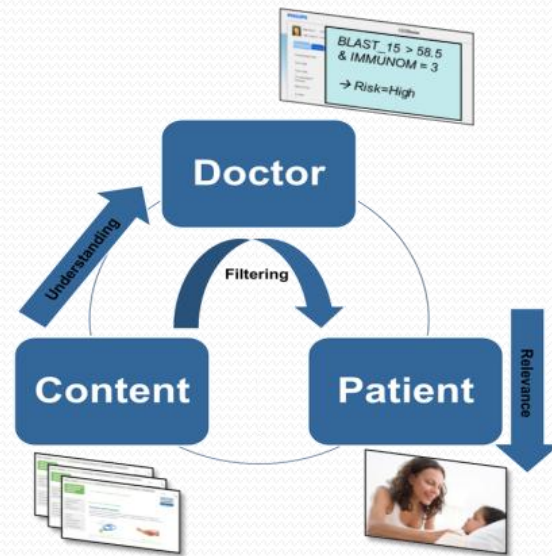
- Patients have the opportunity to inform themselves in the internet about their disease and possible treatments.



It is widely regarded as having a positive influence on the treatment

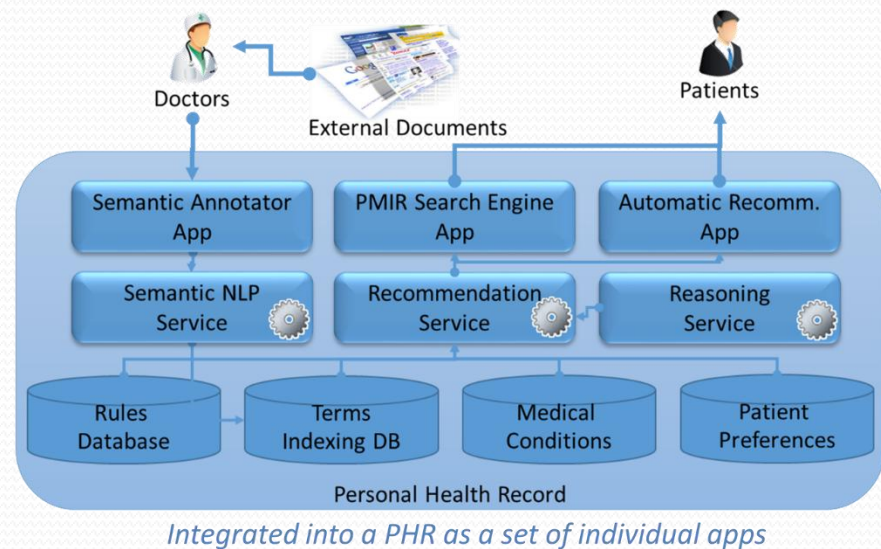
... the quality of information that can be found on online is very diverse

Introduction: patient empowerment



Personal Health Information Recommender (PHIR)

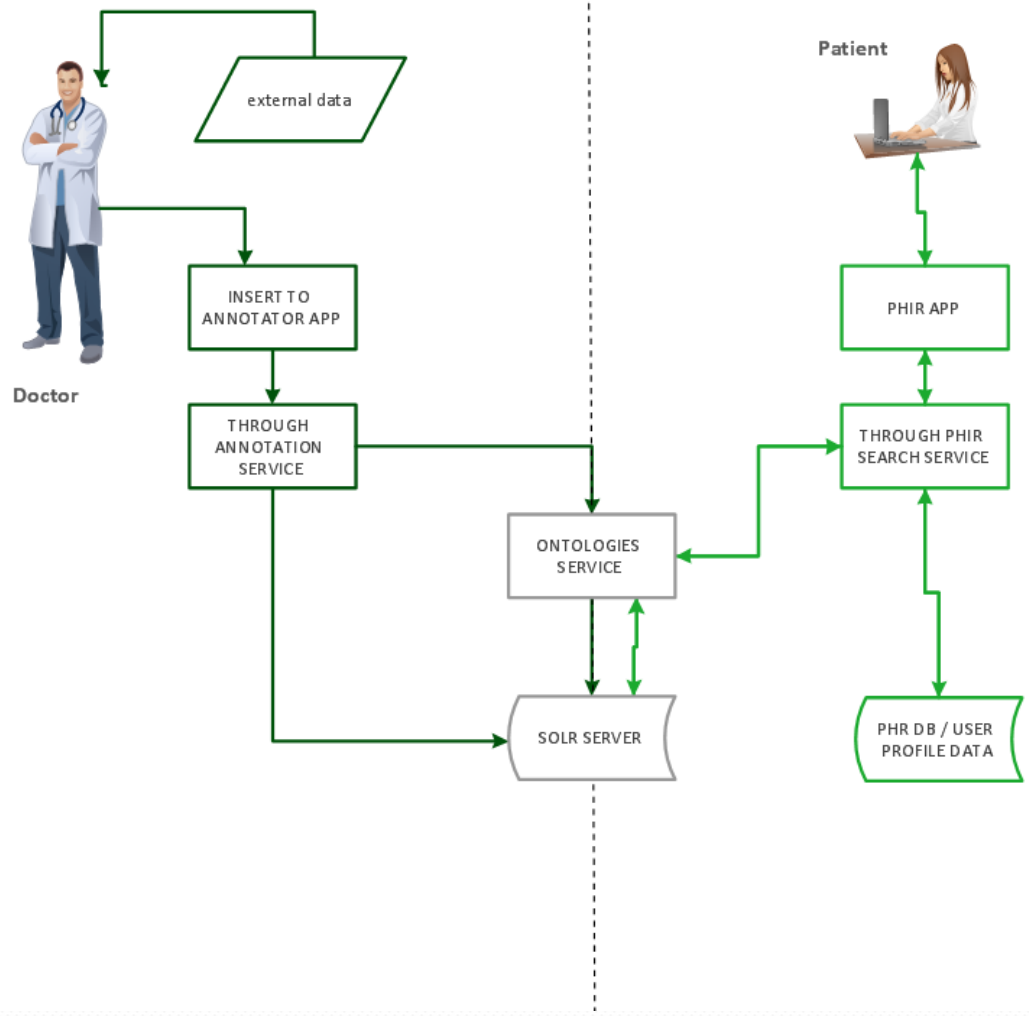
- ✓ allows searching in a high quality document repository
- ✓ automatically provides intelligent and personalized recommendations, according to the individual preferences and medical conditions



P

ANNOTATION

SEARCH





Annotator

Insert the appropriate resources :

Uri

Title

Type : text video

Language : English Italian German

Insert tags press enter after each tag

Submit

← → ↻ Ασφαλές | https://www.iphr.care

IPHR Diana Allen, Γεννήθηκε 24/9/1973

Personal Health Information Recommender

Search for useful information on medical topics:

Ask a question
My treatments

Submit

** all results should be further discussed with your doctor*

all text video

3. Factors affecting younger women with breast cancer
<http://ecancerpatient.org/video/55/factors-affecting-younger-women-with-breast-cancer.php>
★ ★ ★ ★ ★

58. How genes influence your risk of developing breast cancer
<http://ecancerpatient.org/video/68/how-genes-influence-your-risk-of-developing-breast-cancer.php>
★ ★ ★ ★ ★

59. The advantages of scanning for breast cancer with MRI rather than mammography
<http://ecancerpatient.org/video/74/the-advantages-of-scanning-for-breast-cancer-with-mri-rather-than-mammography.php>



ecancerpatient.org/video/55/factors.php

ecancerpatient ecancerprofessional Change Text Size My Account Login Register

ecancerpatient Home About ecancerpatient Glossary of Terms

Search video content Select Category Select Sub-Category Date Added Keyword Search

Return to Previous Page

Factors affecting younger women with breast cancer

ecancerpatient six parts water.com

Factors affecting younger women with breast cancer.

- Cancer can affect women in many **different** ways.
- Premature menopause may increase the **risk** of additional health problems such as heart disease, osteoporosis and possibly dementia.

Search Engine App & Service

The user can search for high quality information.

The

IPHR diana Changed surname, Born 24/9/1973

Problems List

[add a problem](#) [deleted problems](#)

| Name | Onset | Resolution | Modify / Delete |
|---------------|-----------------------------|------------|--|
| breast cancer | 31/10/2016 11:00:00 μ.μ. | | edit delete |

1 p

Sharing and Audit
Shared with only your guardians.
[update]

IPHR diana Changed surname, Born 24/9/1973

Personal Health Information Recommender

Search for useful information on medical topics:

Ask a question
What is the best treatment for me?

*all results should be further discussed with your doctor

all text video

- 1. What Is Breast Cancer?**
<http://www.macmillan.org.uk/information-and-support/breast-cancer/what-is-breast-cancer.html#258895>
★ ★ ★ ★ ★
- 2. Breast cancer (female) - NHS Choices**
<http://www.nhs.uk/Conditions/Cancer-of-the-breast-female/Pages/Introduction.aspx>
★ ★ ★ ★ ★
- 3. What is breast cancer**
<http://www.cancerresearchuk.org/about-cancer/type/breast-cancer/about/the-breasts-and-lymphatic-system>
★ ★ ★ ★ ★

Results based on profile

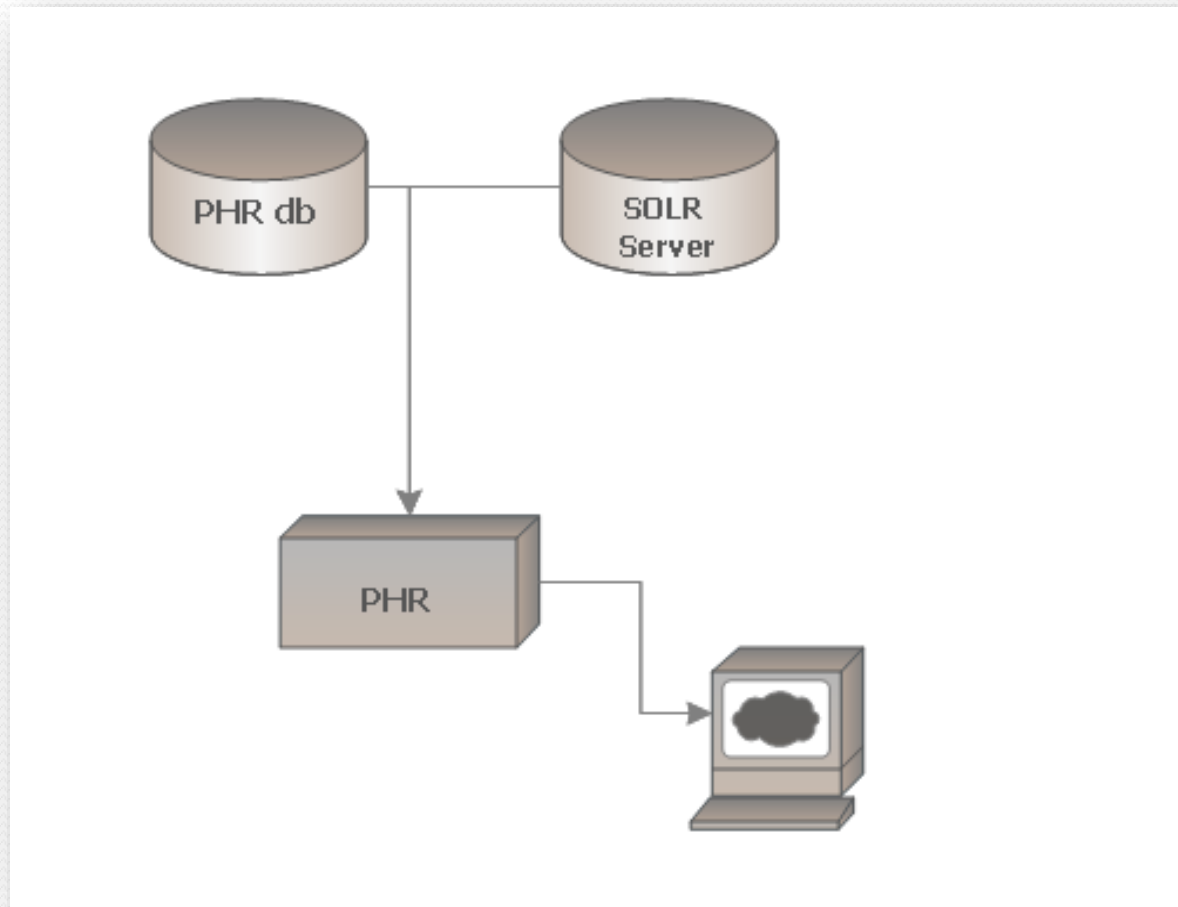
Search Engine App & Service

- Request to web rest service which can be used from other applications



```
1. [  
2.   {  
3.     "url": "https://www.kinderkrebsinfo.de/patienten/fragen_zu_krebs/index_ger.html",  
4.     "title": "Krebs bei Kindern: Fragen zu Krebs",  
5.     "type": "text",  
6.     "lang": "ger"  
7.   },  
8.   {  
9.     "url": "http://www.krebs-kompass.de/",  
10.    "title": "krebs forum",  
11.    "type": "text",  
12.    "lang": "ger"  
13.  },  
14.  {  
15.    "url": "https://www.youtube.com/watch?v=v4KFwiFrmOI",  
16.    "title": "Bewegung gegen Krebs",  
17.    "type": "video",  
18.    "lang": "ger"  
19.  },  
20.  {
```

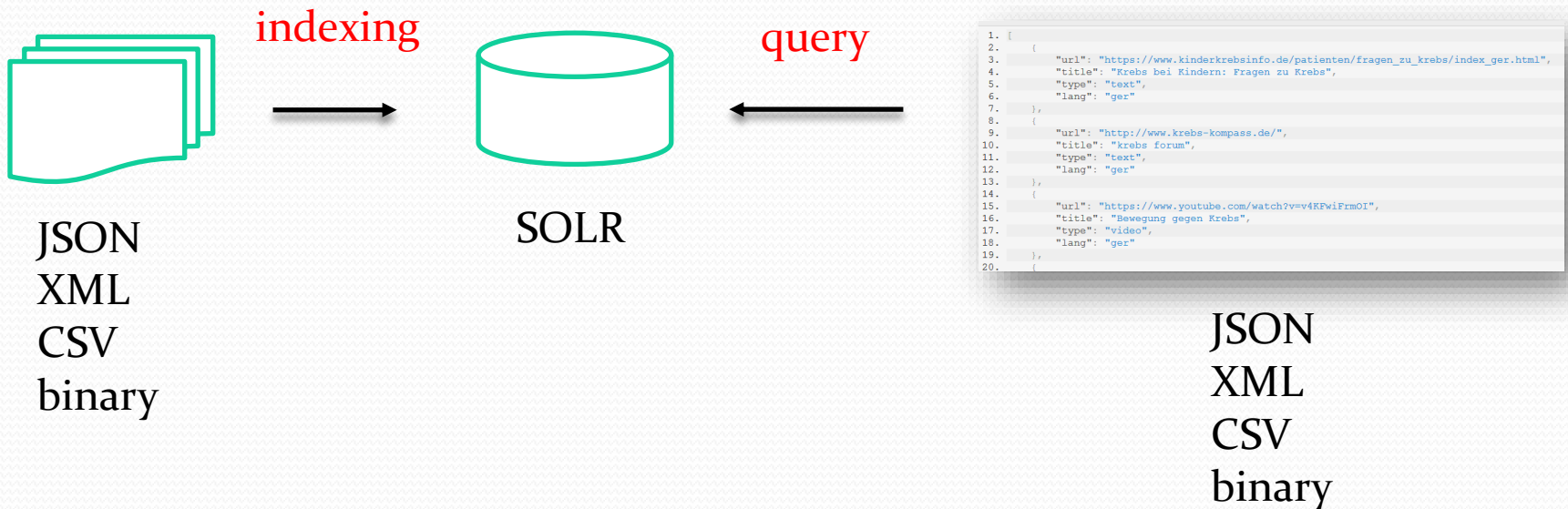
Data Servers



Solr Server

Solr is a standalone enterprise search server with a REST-like API.

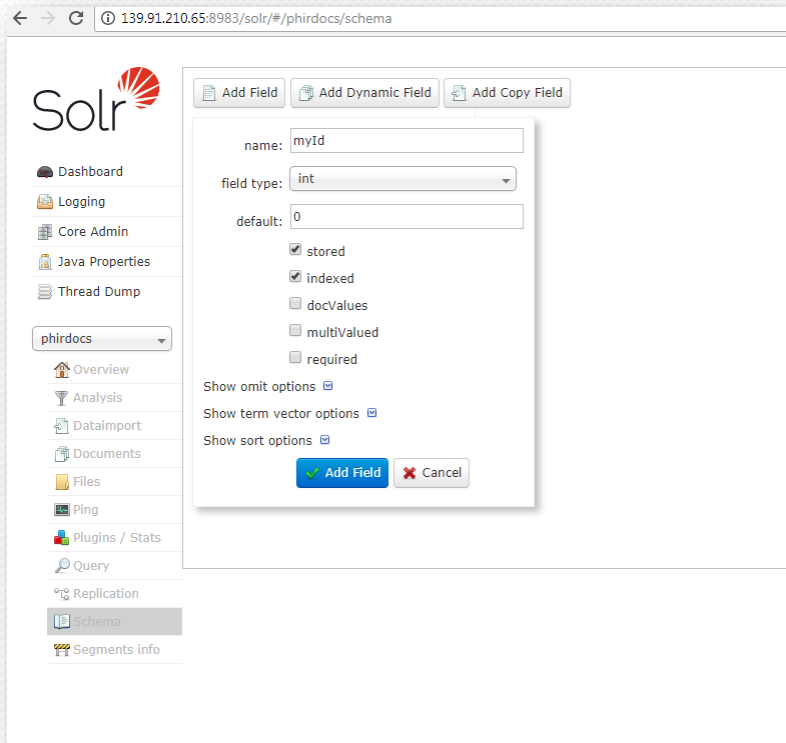
You put documents in it (called "indexing") via JSON, XML, CSV or binary over HTTP. You query it via HTTP GET and receive JSON, XML, CSV or binary results.



Solr : Data Representation

- **Document** is the unit of search and index.
- **An index consists of one or more Documents, and a Document consists of one or more Fields.**
- *In database terminology, a Document corresponds to a table row, and a Field corresponds to a table*

Solr : Schema



Solr Admin UI showing the 'Add Field' dialog box. The dialog is open for a field named 'myId' with a type of 'int' and a default value of '0'. The 'stored' and 'indexed' checkboxes are checked, while 'docValues', 'multiValued', and 'required' are unchecked. There are also options to show omit, term vector, and sort options, all of which are currently hidden. The 'Add Field' button is highlighted in blue.

```
{  
  "doc_id": [15],  
  "doc_url": ["http://www.cancerhelp.org.uk"],  
  "doc_ontology": ["UMLS"],  
  "doc_category": ["UMLS"],  
  "doc_title": [" Cancer Research UK\""],  
  "doc_type": ["text"],  
  "doc_lang": ["eng"],  
  "doc_content": ["HOMEABOUT..."],  
  "id": "bb907170-d4fb-4681-8b1d-",  
  "_version_": 1552430920949039104  
}
```

Solr : Query

Request-Handler (qt) /select

— common

q doc_lang:ger

fq

sort

start, rows 0 10

fl

df

Raw Query Parameters key1=val1&key2=val2

wt json

indent

debugQuery

dismax

edismax

hl

facet

spatial

spellcheck

Execute Query

http://52.16.26.222:8983/solr/phirdocs/select?indent=on&q=doc_lang:ger&wt=json

```
{
  "responseHeader": {
    "status": 0,
    "QTime": 0,
    "params": {
      "q": "doc_lang:ger",
      "indent": "on",
      "wt": "json",
      "_: "1507794138009"}},
  "response": {"numFound": 47, "start": 0, "docs": [
    {
      "doc_id": ["https://www.krebshilfe.de/fileadmin/Downloads/PDFs/Nachsorgepass/Nachsorgepass_2017.pdf"],
      "doc_url": ["https://www.krebshilfe.de/fileadmin/Downloads/PDFs/Nachsorgepass/Nachsorgepass_2017.pdf"],
      "doc_ontology": ["UMLS"],
      "doc_title": ["Kerbs nachsorge"],
      "doc_type": ["text"],
      "doc_lang": ["ger"],
      "id": "76c99591-85f0-4ff5-8520-447ab6ffadae",
      "content": ["KREBS NACHSORGE IHRE PERSNLICHEN UNTERLAGEN www.krebshilfe.de 1 Dieser Nachsorgepass entstand in Zusammenarbeit der Deuts
        "_version_": 1568278227981434880},
    {
      "doc_id": ["https://www.youtube.com/watch?v=79LvqIETZe8"],
      "doc_url": ["https://www.youtube.com/watch?v=79LvqIETZe8"],
      "doc_ontology": ["UMLS"],
      "doc_title": ["Prostatakarzinom"],
      "doc_type": ["video"],
      "doc_lang": ["ger"],
      "content": ["Loading...Loading...Loading...Working...Loading...Loading...Working...Loading...Loading...Loading...Aus der Ratg
        "id": "e3e8be45-ad71-41d0-8995-2d3d6a24f3d9",
        "_version_": 1568280738638331904},
    {
      "doc_id": ["https://www.youtube.com/watch?v=v4KFwiFrmOI"],
      "doc_url": ["https://www.youtube.com/watch?v=v4KFwiFrmOI"],
      "doc_ontology": ["UMLS"],
      "doc_title": ["Bewegung gegen Krebs"],
      "doc_type": ["video"],
      "doc_lang": ["ger"],
      "content": ["Loading...Loading...Loading...Working...Loading...Loading...Working...Loading...Loading...Loading...Spaß an Sport und Bewe
```

Solr : Analysis

- Analysis Phases:
 - Index time
 - Query time

Analyzers may be a single class or they may be composed of a series of *tokenizer* and *filter* classes.

- Tokenizers break field data into lexical units, or tokens.
- Filters examine a stream of tokens and keep them, transform or discard them, or create new ones.



- Dashboard
- Logging
- Core Admin
- Java Properties
- Thread Dump
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Field Value (Index)
lungs

Field Value (Query)
LUNG CANCER

Analyse Fieldname / FieldType: text_de Schema Browser

Verbose Output

Analyse Values

| | | |
|------|----------------|------------------|
| ST | text | lungs |
| | raw_bytes | [6c 75 6e 67 73] |
| | start | 0 |
| | end | 5 |
| | positionLength | 1 |
| | type | <ALPHANUM> |
| | position | 1 |
| LCF | text | lungs |
| | raw_bytes | [6c 75 6e 67 73] |
| | start | 0 |
| | end | 5 |
| | positionLength | 1 |
| | type | <ALPHANUM> |
| | position | 1 |
| SE | text | lungs |
| | raw_bytes | [6c 75 6e 67 73] |
| | start | 0 |
| | end | 5 |
| | positionLength | 1 |
| | type | <ALPHANUM> |
| | position | 1 |
| GNF | text | lungs |
| | raw_bytes | [6c 75 6e 67 73] |
| | start | 0 |
| | end | 5 |
| | positionLength | 1 |
| | type | <ALPHANUM> |
| | position | 1 |
| GLSF | text | lung |
| | raw_bytes | [6c 75 6e 67] |
| | start | 0 |
| | end | 5 |
| | positionLength | 1 |
| | type | <ALPHANUM> |
| | position | 1 |
| | keyword | false |

| | | | |
|------|----------------|---------------|---------------------|
| ST | text | LUNG | CANCER |
| | raw_bytes | [4c 55 4e 47] | [43 41 4e 43 45 52] |
| | start | 0 | 5 |
| | end | 4 | 11 |
| | positionLength | 1 | 1 |
| | type | <ALPHANUM> | <ALPHANUM> |
| | position | 1 | 2 |
| LCF | text | lung | cancer |
| | raw_bytes | [6c 75 6e 67] | [63 61 6e 63 65 72] |
| | start | 0 | 5 |
| | end | 4 | 11 |
| | positionLength | 1 | 1 |
| | type | <ALPHANUM> | <ALPHANUM> |
| | position | 1 | 2 |
| SE | text | lung | cancer |
| | raw_bytes | [6c 75 6e 67] | [63 61 6e 63 65 72] |
| | start | 0 | 5 |
| | end | 4 | 11 |
| | positionLength | 1 | 1 |
| | type | <ALPHANUM> | <ALPHANUM> |
| | position | 1 | 2 |
| GNF | text | lung | cancer |
| | raw_bytes | [6c 75 6e 67] | [63 61 6e 63 65 72] |
| | start | 0 | 5 |
| | end | 4 | 11 |
| | positionLength | 1 | 1 |
| | type | <ALPHANUM> | <ALPHANUM> |
| | position | 1 | 2 |
| GLSF | text | lung | canc |
| | raw_bytes | [6c 75 6e 67] | [63 61 6e 63] |
| | start | 0 | 5 |
| | end | 4 | 11 |
| | positionLength | 1 | 1 |
| | type | <ALPHANUM> | <ALPHANUM> |
| | position | 1 | 2 |
| | keyword | false | false |

Solr : Integration

- **SolrJ** is an API that makes it easy for Java applications to talk to Solr. SolrJ hides a lot of the details of connecting to Solr and allows your application to interact with Solr with simple high-level methods.

Solr : Query with solrj

```
SolrServer server = new HttpSolrServer("http://localhost:8080/apache-solr-1.4.0");
SolrQuery query = new SolrQuery();

query.setQuery("*:*");
query.setFacet(true);
query.set("wt", "json");
query.setRows(5);
query.setStart(0);

QueryResponse response = server.query(query);

System.out.println(response);
```