Biomedical Informatics

PHR design and implementation

PersonalHealthRecord

Προσωπικός Φάκελος Υγείας

Motivation

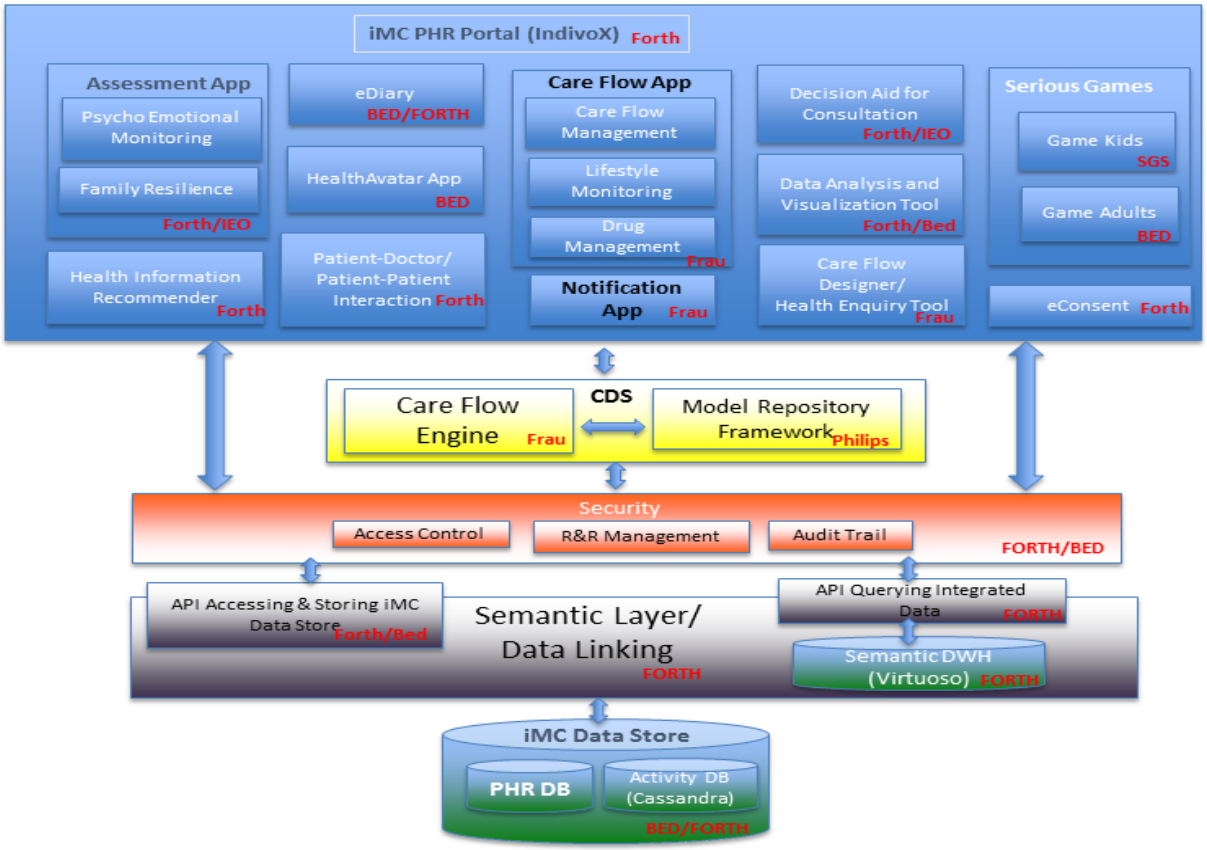
- There is an increasing need for patients to manage their own healthcare.

- 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

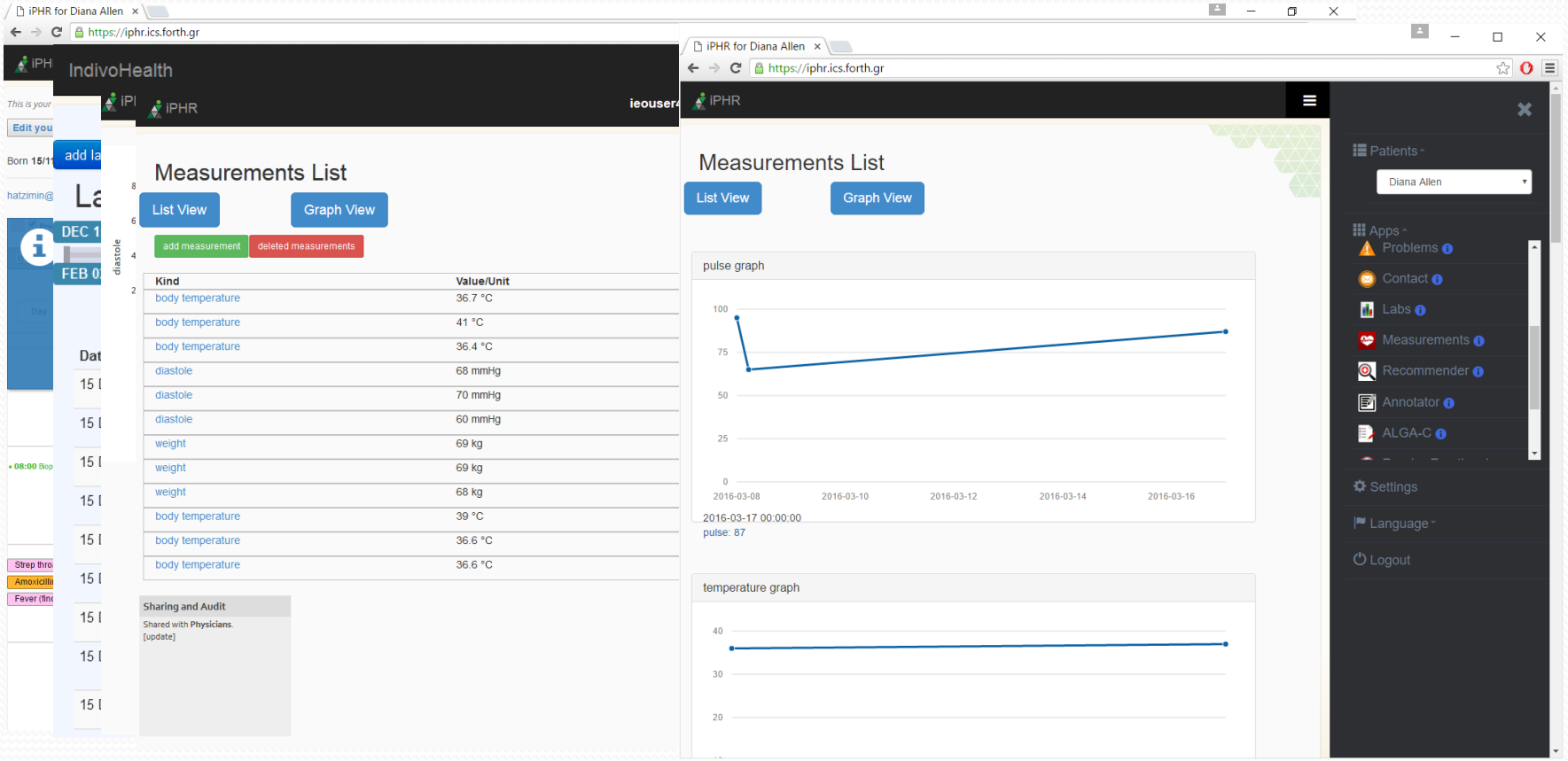
- Roles
  - Patient
  - Healthcare professional
  - Administrator
  - Researcher

User - Patient

- Applications
  - **eDiary**
  - **Problems**
    - **Time**
    - **Chronical problems**
    - **Primary/co-morbidities**
  - **Demographics**
    - **Smoking**
    - **Pregnancy**
    - **Weight**
  - **Allergies**
  - **Medications**
  - **Laboratories**
  - **Procedures**
  - **Upload Documents**

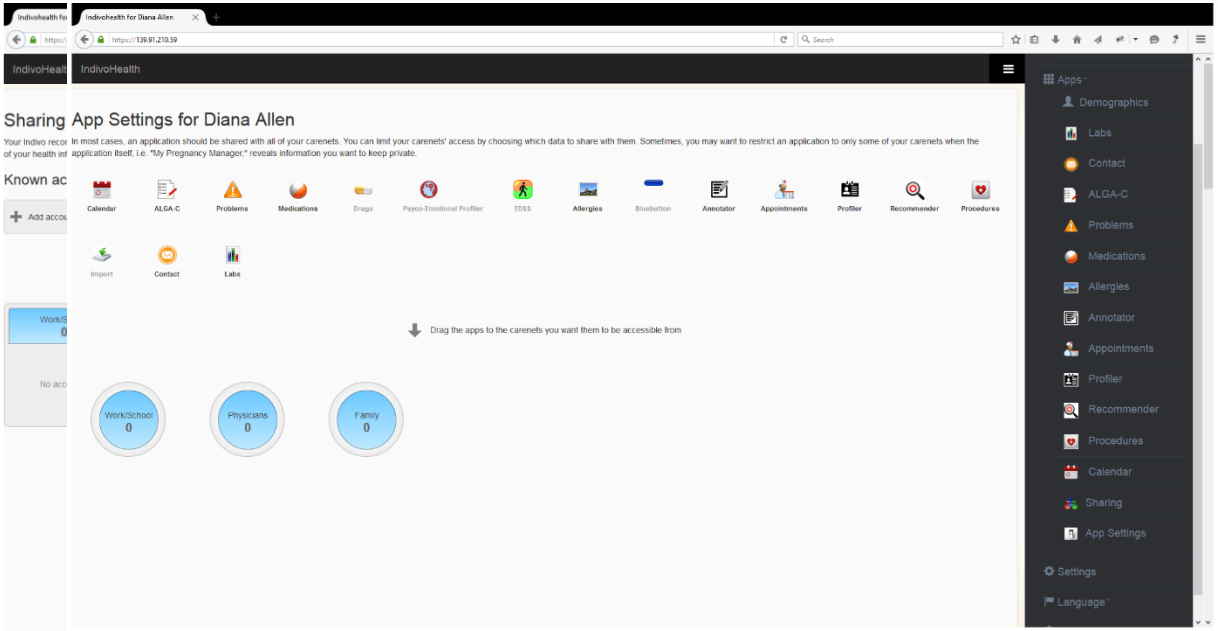
- **Other apps**
  - **Download iMC mobile apps**
- **myStatistics**
- **PHIR**
- **Measurements**
- **Appointments**
  - **Alerts**
- **Psycho-emotional questionnaires**
- **Export RDF/XML**
- **Bulk import**

Patient view



Patient view– Data Sharing

- Διαμοιρασμός πληροφοριών με :
  - Κλινικούς ιατρούς
  - Ασθενείς
  - Συγγενείς
  - Ερευνητές



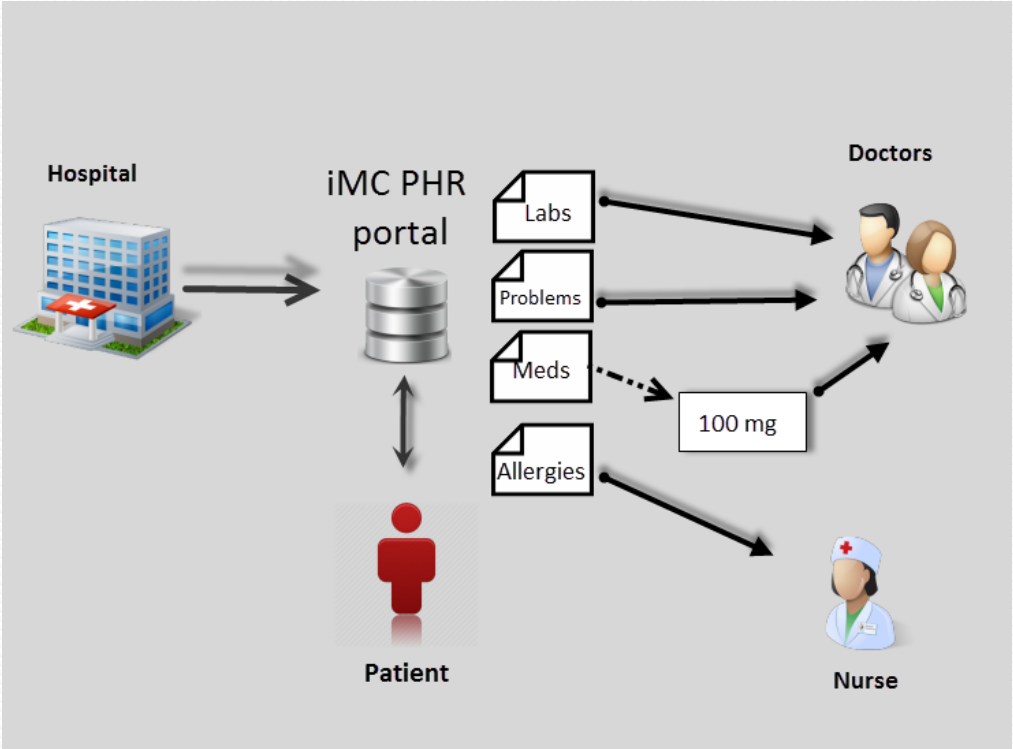
Indivo sharing models

- 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.

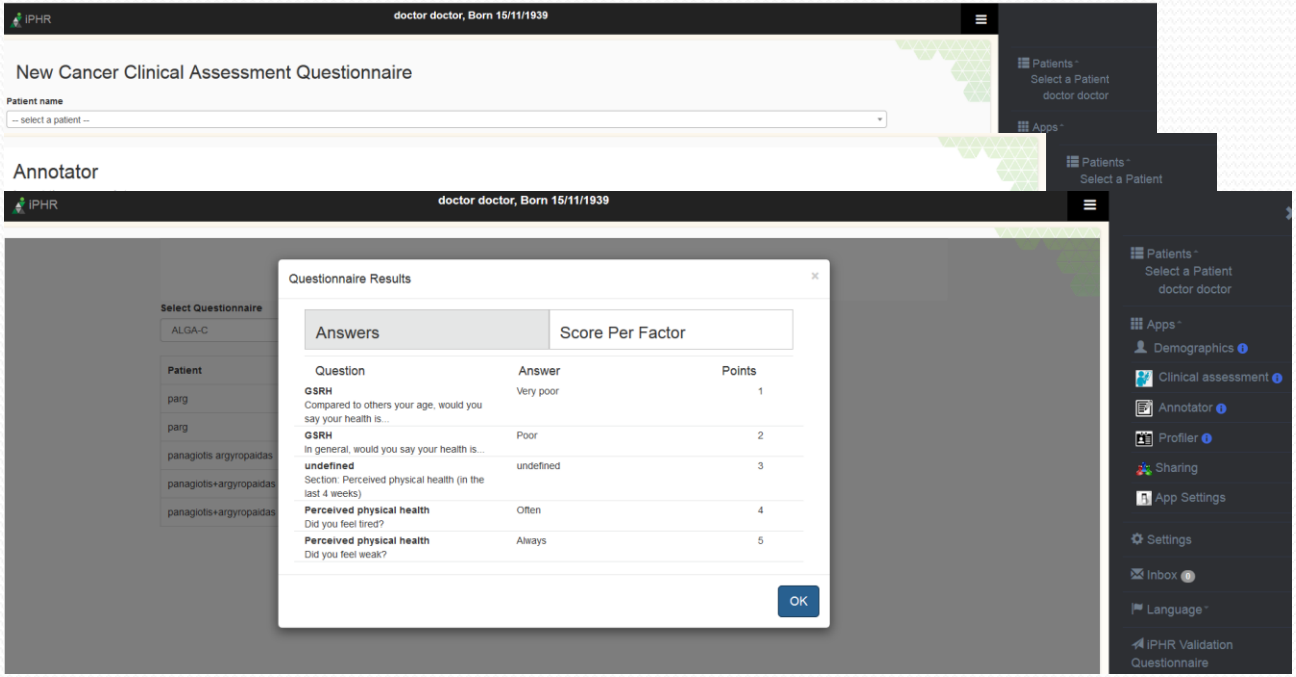
Sharing managements



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



Clinical assessment

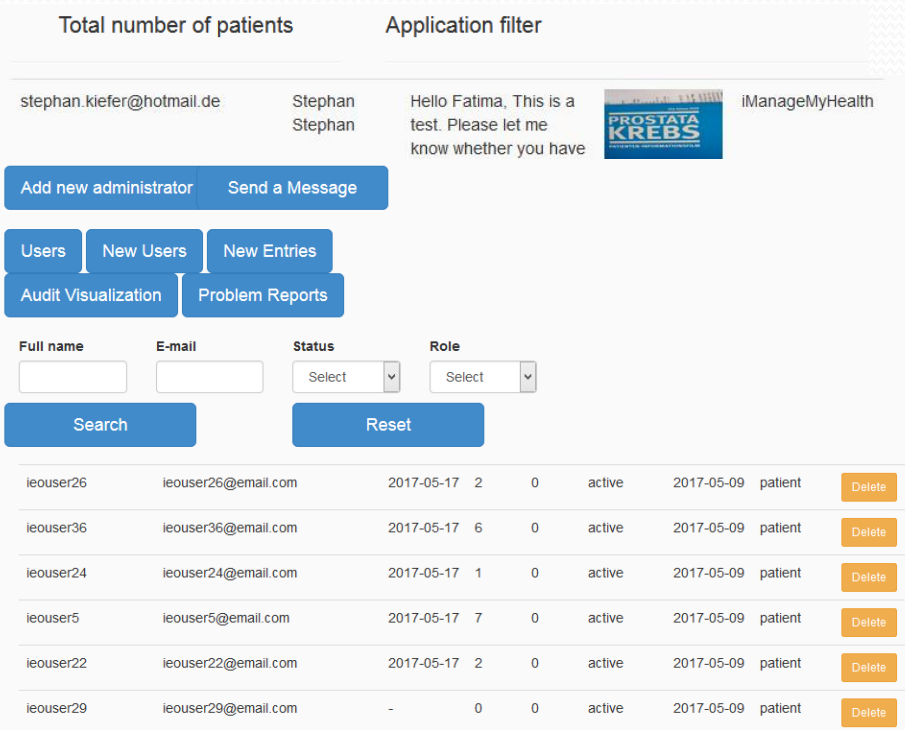
Annotator

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



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

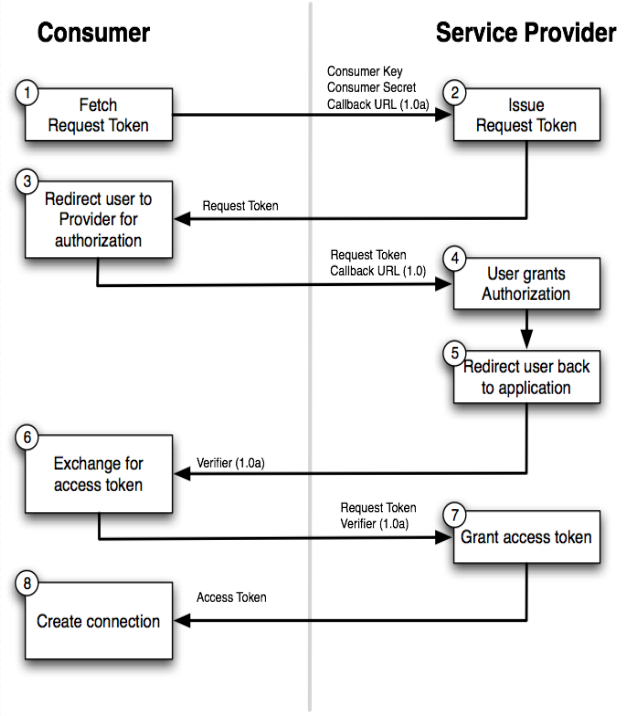
- Authorization framework enables a third-party application to obtain limited access to an HTTP service.
- OAuth works over HTTP and authorizes Devices, APIs, Servers and Applications with access tokens rather than credentials.

Security – Provider

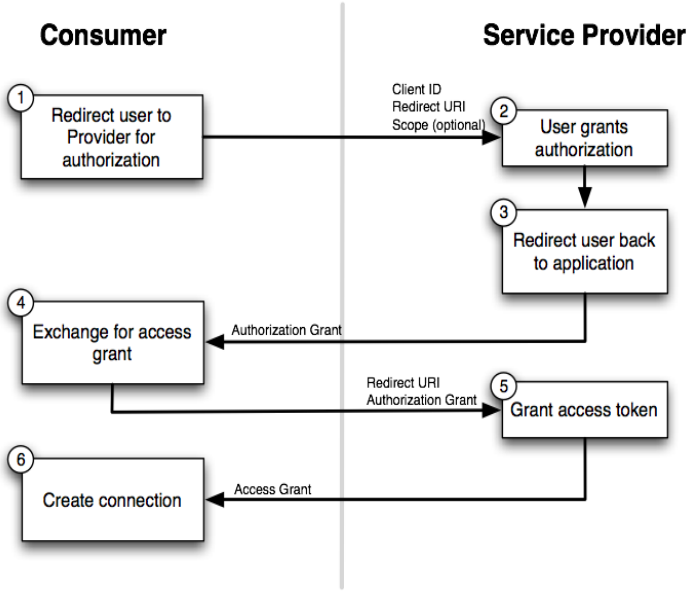
- OAuth Provider is the provider that supplies the OAuth service for instance google, twitter, yahoo, facebook or whoever you are asking to log in the user.
- Or in other words the provider that tells that the user logged in successfully.

oAuth 1.0 and 2.0

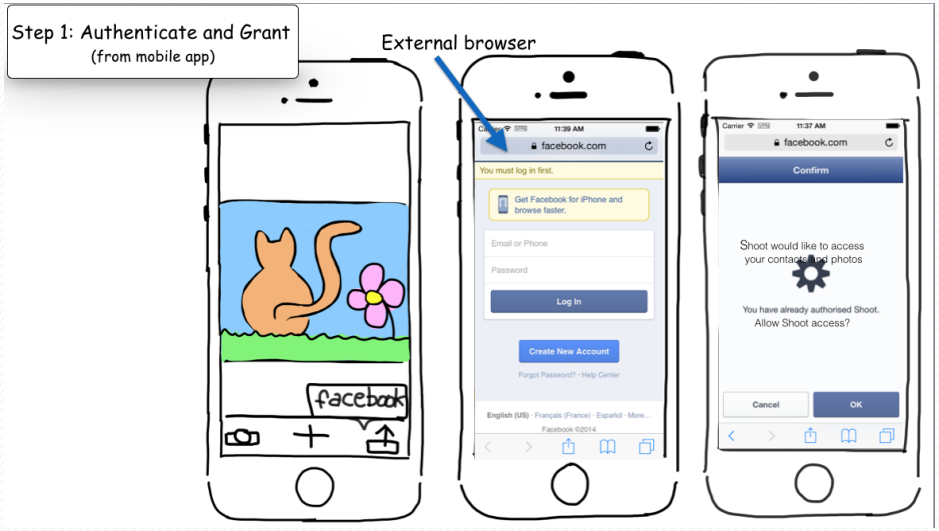
oAuth 1.0



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#
```

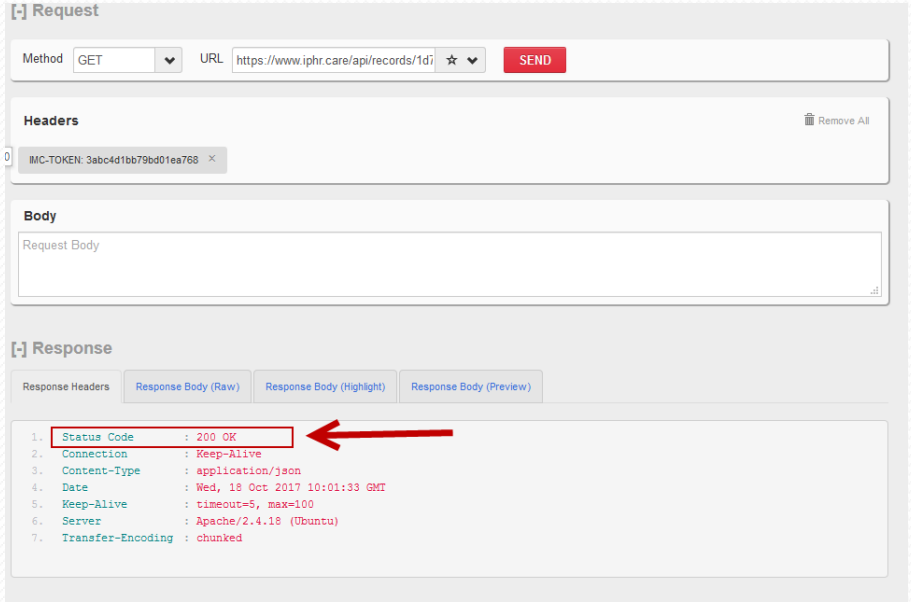
Indivo Provider

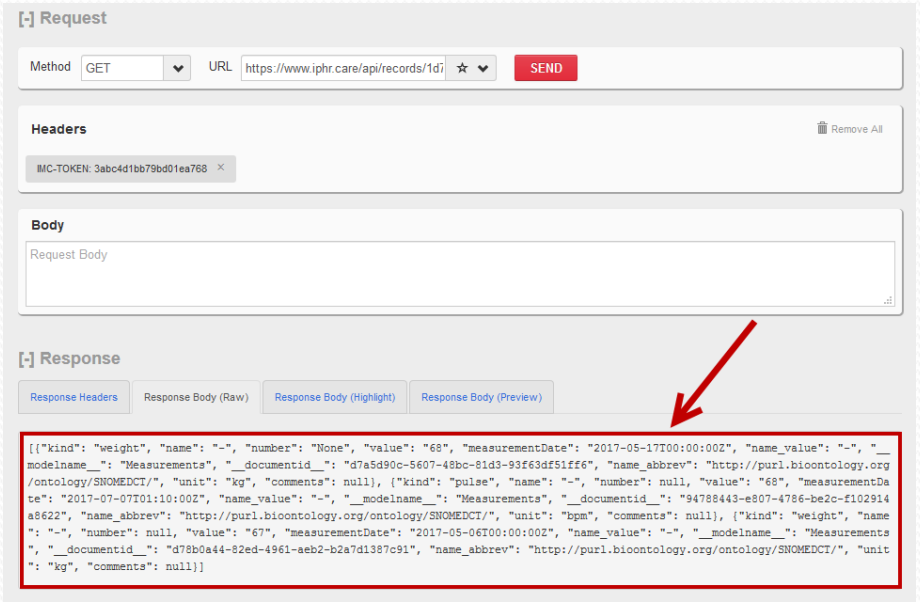
API functionality

- 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)

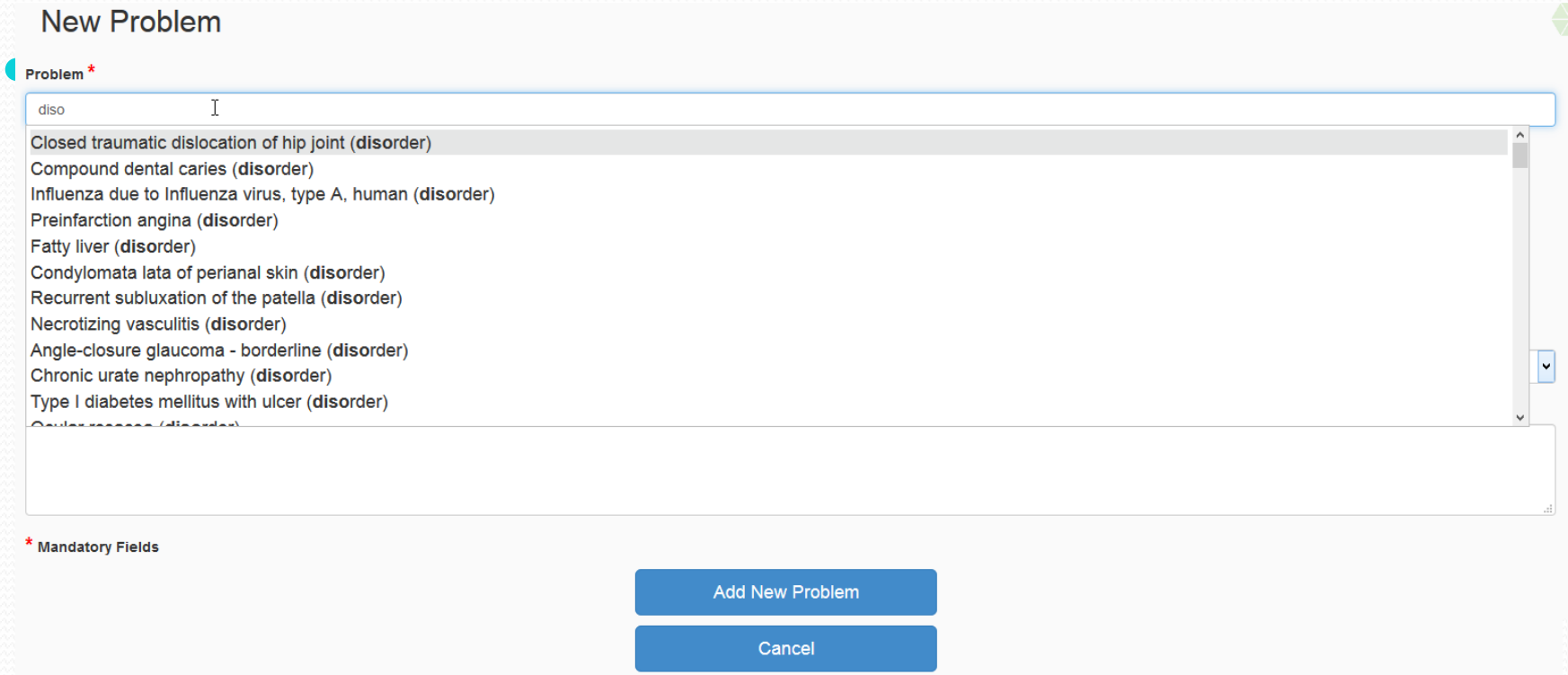
API – Functionality (example)

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





PHR – Autocomplete



PHR – Autocomplete

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

    query = request.GET['query']

    # reformat this for the jQuery autocompleter
    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_SNOMED_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

Biomedical Informatics

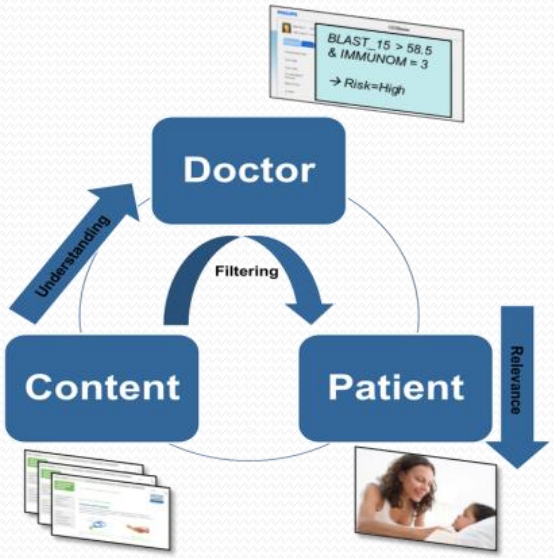
Introduction: patient empowerment

- 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

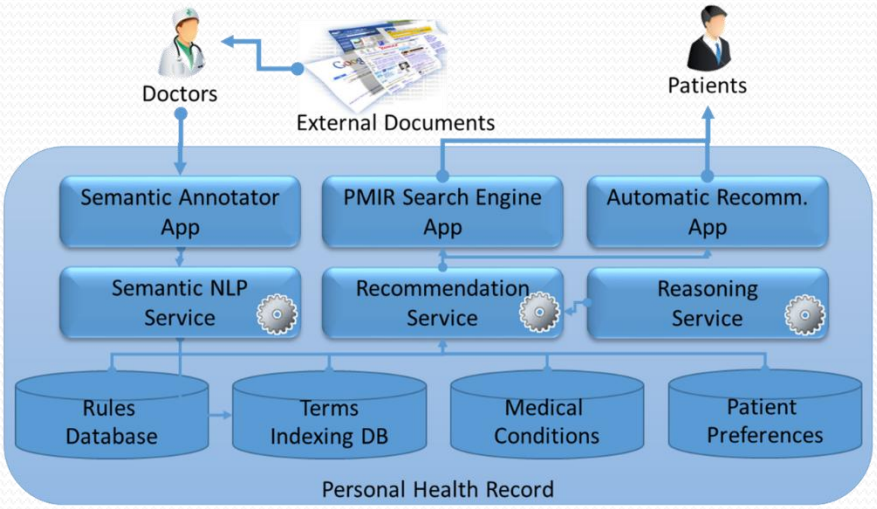
… the quality of information that can be found on online is very diverse

Introduction: patient empowerment



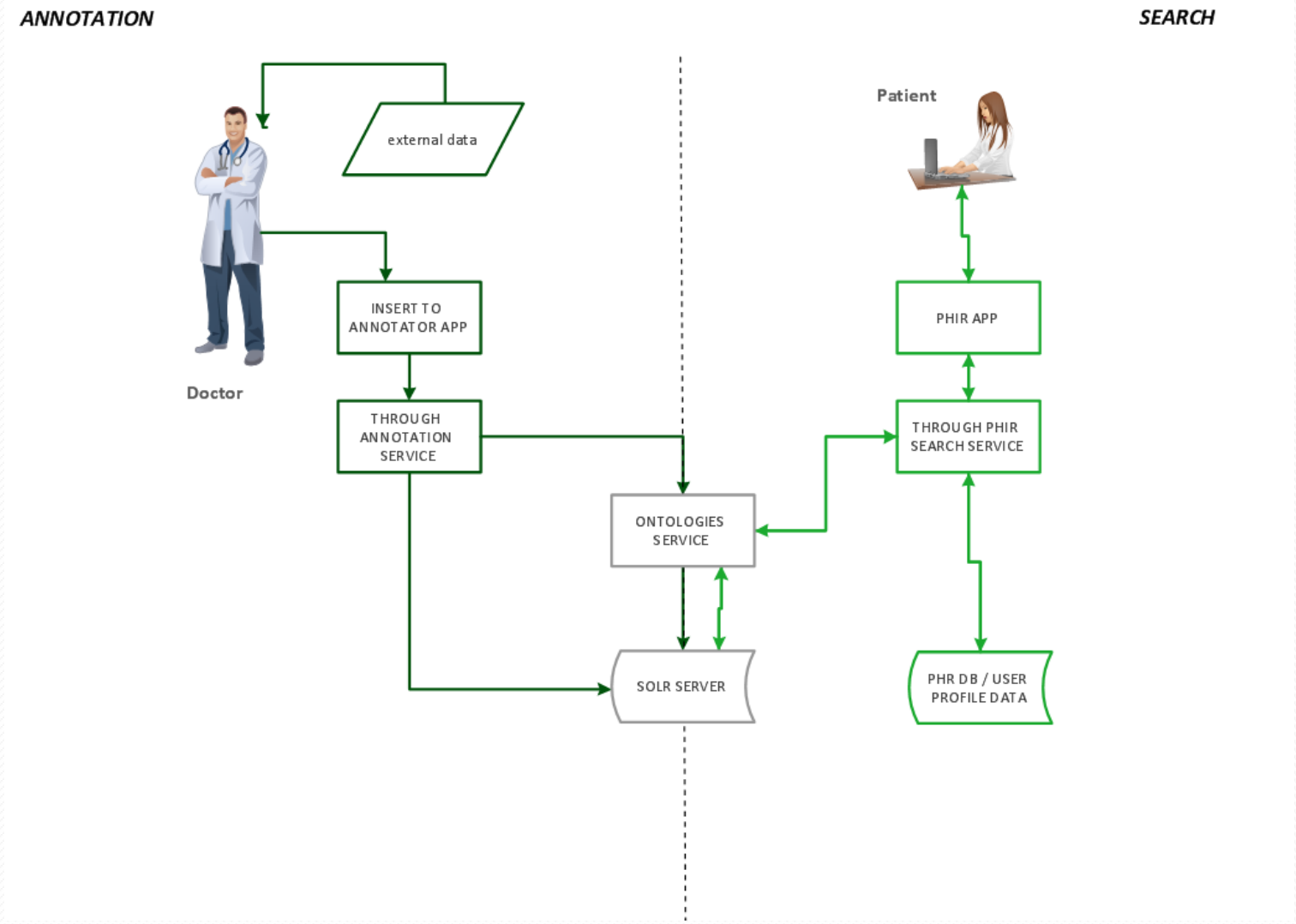
Personal Health Information Recommender (PHIR)

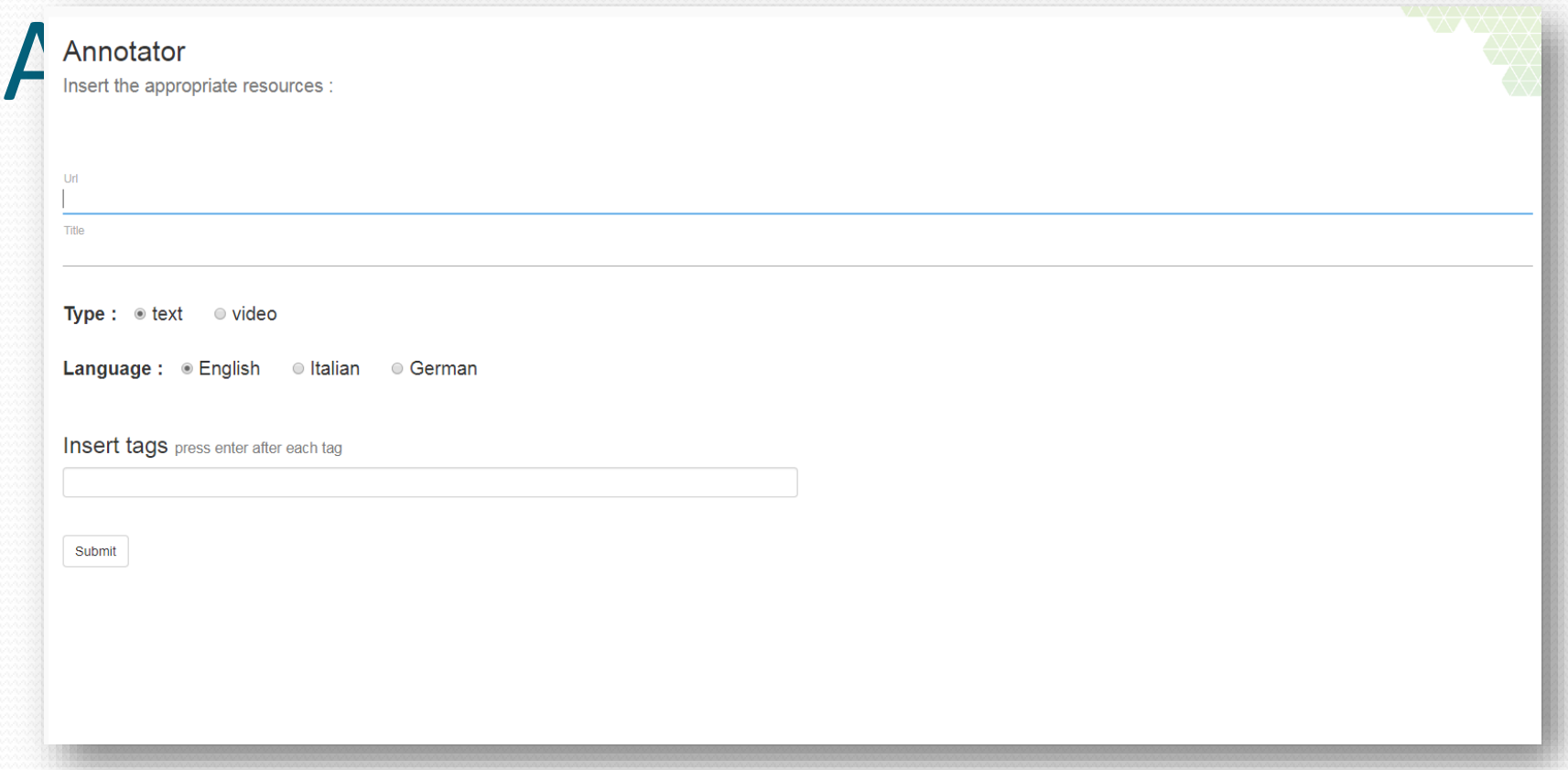
- ✓ allows searching in a high quality document repository
- ✓ automatically provides intelligent and personalized recommendations, according to the individual preferences and medical conditions

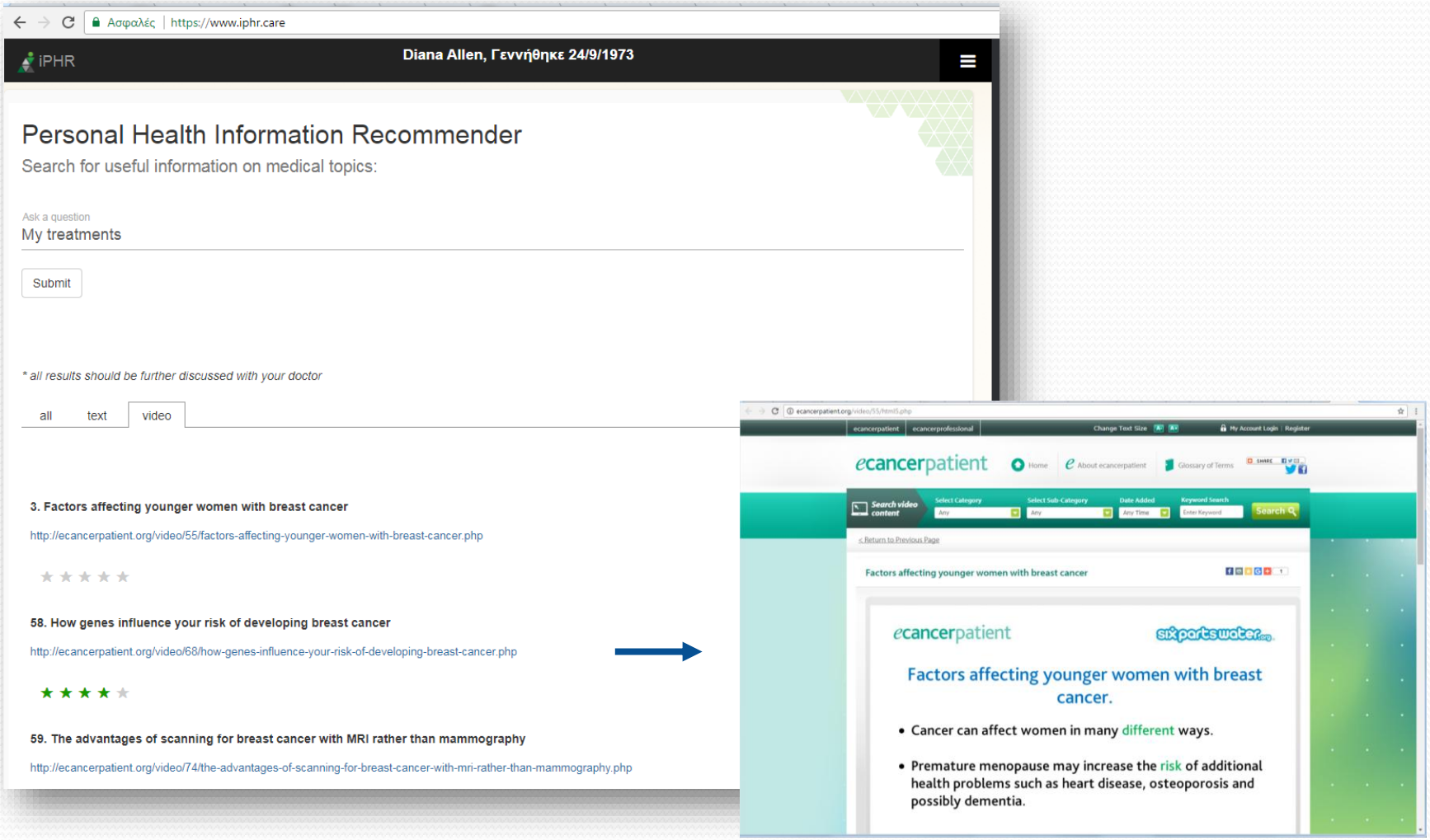


Integrated into a PHR as a set of individual apps

P

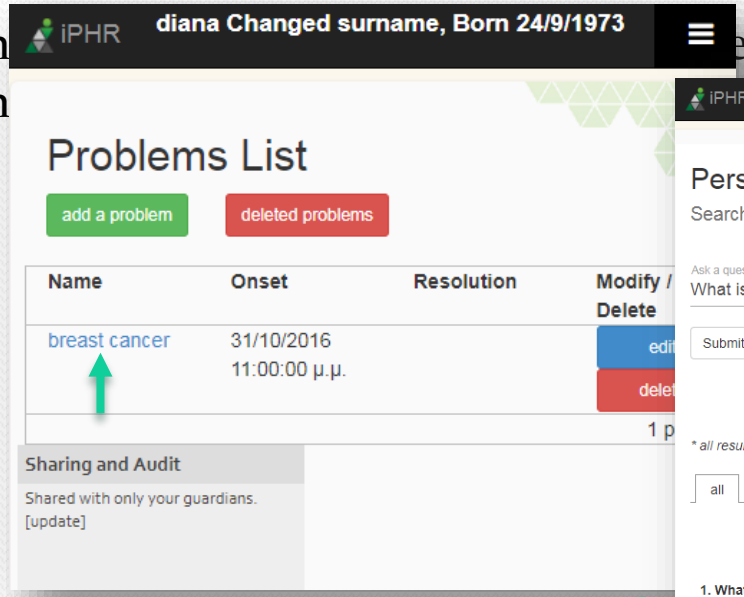

ANNOTATION
SEARCH
external data
Doctor
INSERT TO ANNOTATOR APP
THROUGH ANNOTATION SERVICE
Patient
PHIR APP
THROUGH PHIR SEARCH SERVICE
ONTOLOGIES SERVICE
SOLR SERVER
PHR DB / USER PROFILE DATA

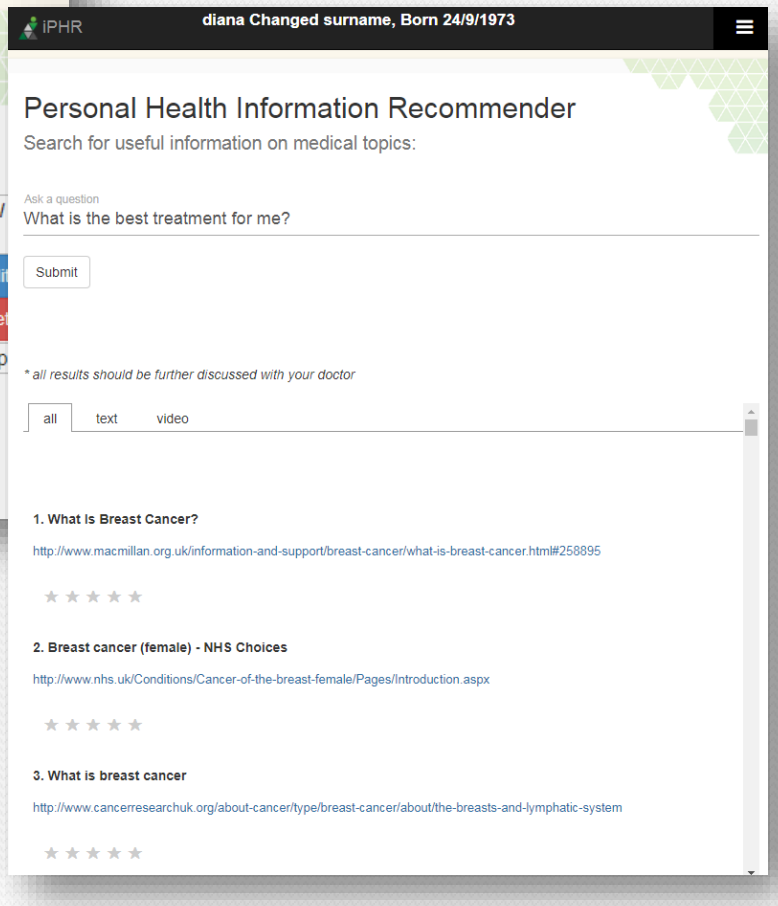

Annotator
Insert the appropriate resources :
Url
Title
Type : text video
Language : English Italian German
Insert tags press enter after each tag
Submit


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
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

Th er can search for high quality information.
Th





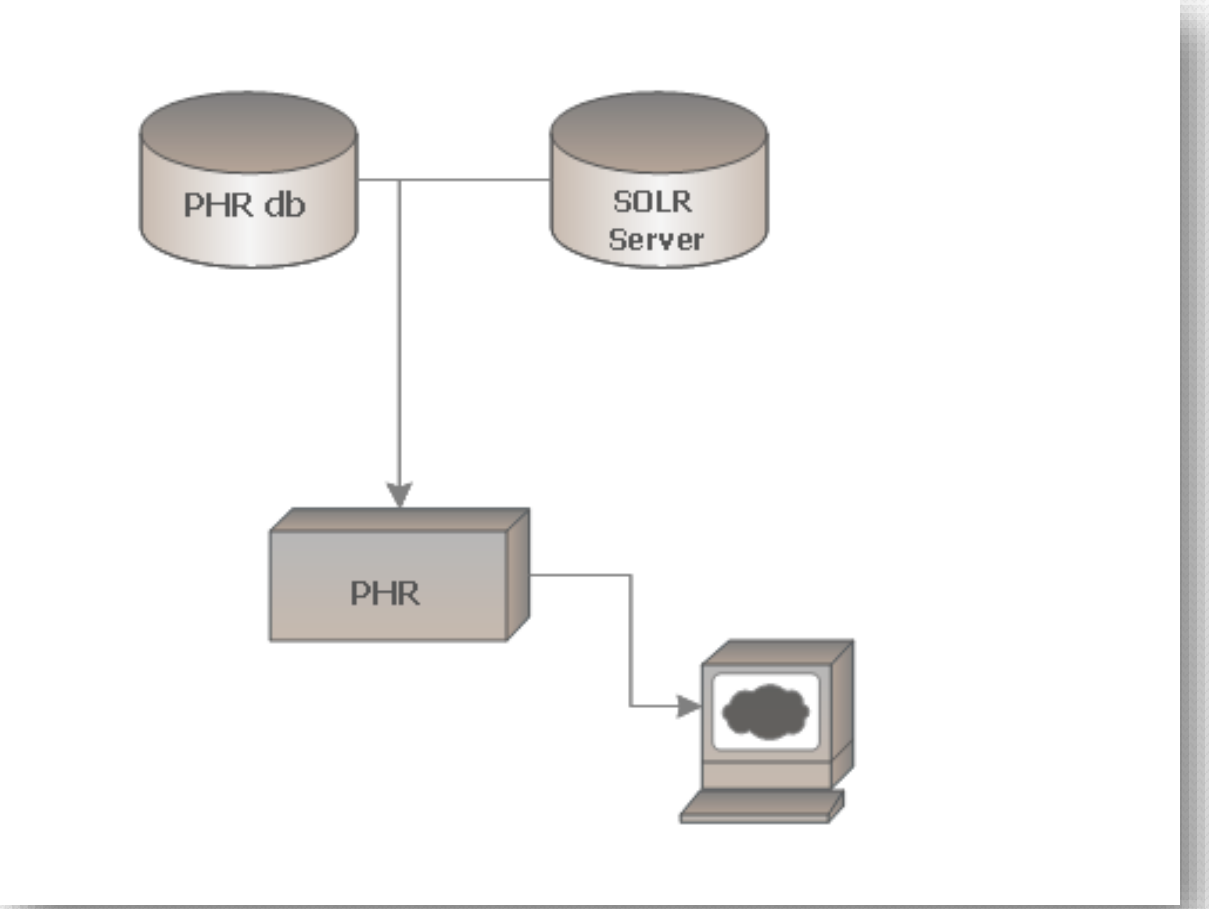
Results based on profile

Search Engine App & Service

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


```
[
    {
        "url": "https://www.kinderkrebsinfo.de/patienten/fragen_zu_krebs/index_ger.html",
        "title": "Krebs bei Kindern: Fragen zu Krebs",
        "type": "text",
        "lang": "ger"
    },
    {
        "url": "http://www.krebs-kompass.de/",
        "title": "krebs forum",
        "type": "text",
        "lang": "ger"
    },
    {
        "url": "https://www.youtube.com/watch?v=v4KFwiFrmOI",
        "title": "Bewegung gegen Krebs",
        "type": "video",
        "lang": "ger"
    },
    {
```

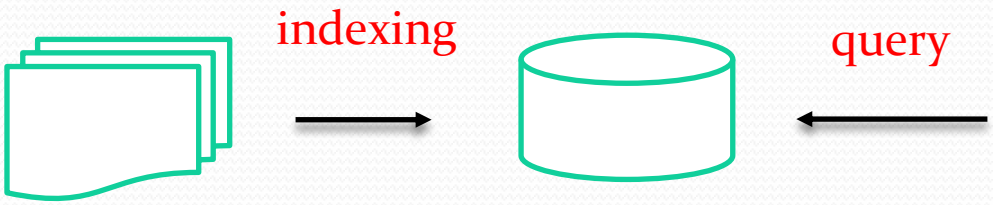
Data Servers



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.



JSON
XML
CSV
binary

```
[
    {
        "url": "https://www.kinderkrebsinfo.de/patienten/fragen_zu_krebs/index_ger.html",
        "title": "Krebs bei Kindern: Fragen zu Krebs",
        "type": "text",
        "lang": "ger"
    },
    {
        "url": "http://www.krebs-kompass.de/",
        "title": "krebs forum",
        "type": "text",
        "lang": "ger"
    },
    {
        "url": "https://www.youtube.com/watch?v=v4KFwiFrmOI",
        "title": "Bewegung gegen Krebs",
        "type": "video",
        "lang": "ger"
    },
    {
```

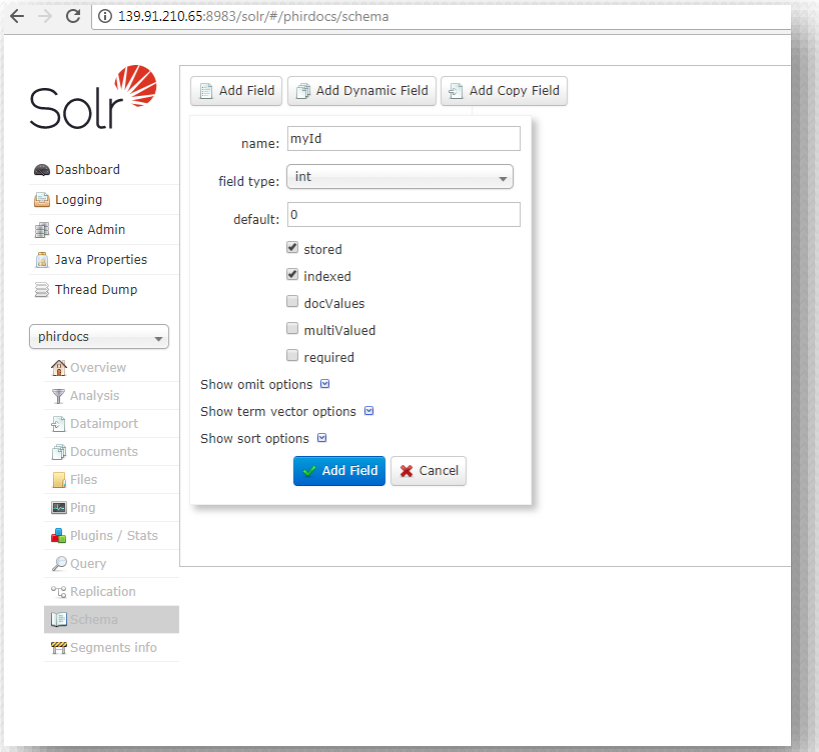
JSON
XML
CSV
binary

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.**

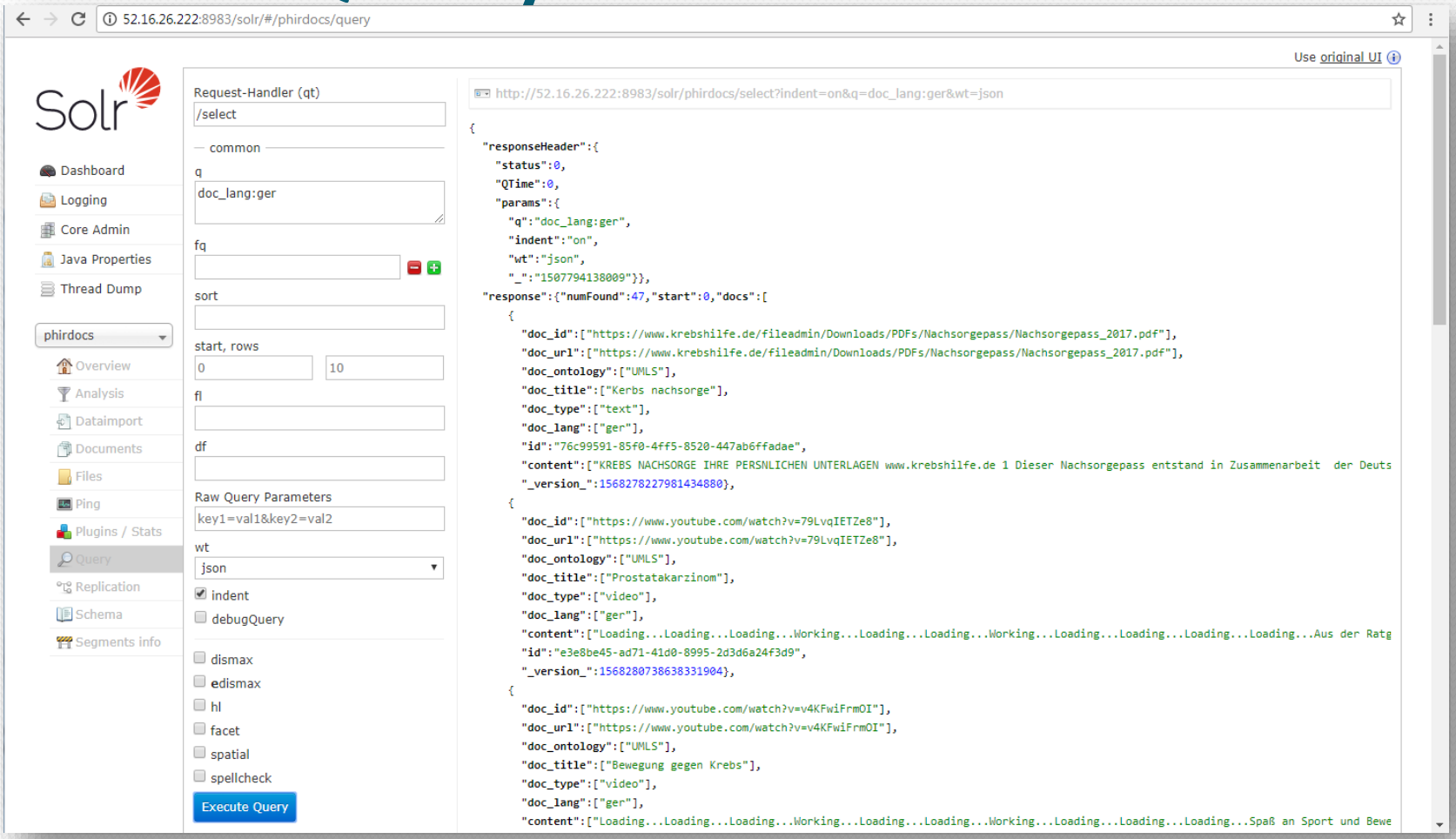
- *In database terminology, a Document corresponds to a table row, and a Field corresponds to a table*

Solr : Schema



{
"**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

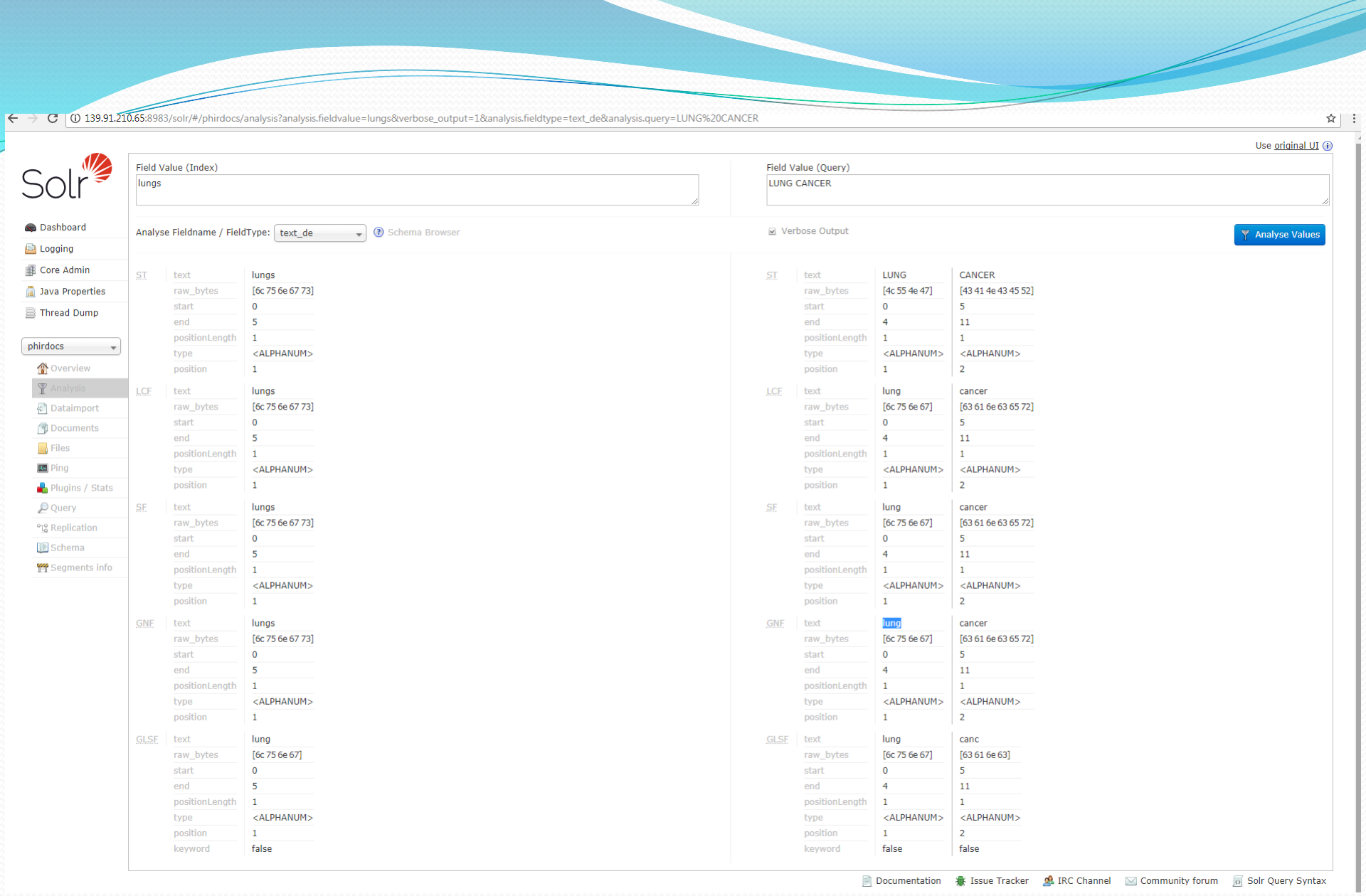

52.16.26.222:8983/solr/#/phirdocs/query
Use original UI
Solr
Dashboard
Logging
Core Admin
Java Properties
Thread Dump
phirdocs
Overview
Analysis
Dataimport
Documents
Files
Ping
Plugins / Stats
Query
Replication
Schema
Segments info
Request-Handler (qt)
/select
common
q
doc_lang:ger
fq
sort
start, rows
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...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.


139.91.210.65:8983/solr/#/phirdocs/analysis?analysis.fieldvalue=lungs&verbose_output=1&analysis.fieldtype=text_de&analysis.query=LUNG%20CANCER
Use original UI
Solr
Dashboard
Logging
Core Admin
Java Properties
Thread Dump
phirdocs
Overview
Analysis
Dataimport
Documents
Files
Ping
Plugins / Stats
Query
Replication
Schema
Segments info
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
SF 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
SF 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
Documentation
Issue Tracker
IRC Channel
Community forum
Solr Query Syntax

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);
```