popHealth® code

Software Design Document

April 17, 2012

Introduction

Purpose of This Document

This document provides a high level description of the design and implementation of popHealth, an open source population health reporting reference implementation. popHealth is a software tool that automates the reporting of quality measures, from data extracted by continuity of care XML files.

This document has been written for software engineers, software architects, and technical program managers. The latest information about popHealth will be available at the project's open source website via http://projectpophealth.org

Overview

popHealth is a open source software tool that automates select clinical quality report measures. popHealth integrates with a healthcare provider's electronic health record (EHR) system to produce summary quality measures on the provider's patient population.

popHealth demonstrates how a provider can use quality measures to analyze the quality of care provided as part of their existing workflow. popHealth helps providers easily understand the logic behind clinical quality measures and identifies patients requiring follow-up care. The transmission of summary quality data is simple and scalable, representing an alternative to traditional methods of data analysis and reporting.

popHealth's design leverages the generation of Continuity of Care records from a provider's EHR to produce the clinical quality measure reports. Specifically, popHealth accepts patient data via either the Healthcare Information Technology Standards Panel (HITSP) C32 XML standard or American Society of Testing and Materials (ASTM) Continuity of Care Record (CCR) continuity of care XML standard. popHealth provides a streamlined mechanism to generate summary quality measure reports for individual providers using the Physician Quality Reporting Initiative (PQRI) reporting standard. These reports may be sent to public health organizations using existing mechanisms.

Concept of Operations

popHealth has been designed to be a software module that can integrate and interoperate with EHRs which can express its coded patient record data using either the ASTM CCR or HITSP C32 standards.

In order to integrate an EHR system with popHealth, patient data that has been captured in the EHR will need to be exported using either the CCR or C32. For each patient record in the EHR, a single CCR or C32 should be exported and then loaded into the popHealth web application via a RESTful web service. The popHealth

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software system then extracts the coded data associated with each of the patients and organizes it by section, such as medications, encounters, etc.

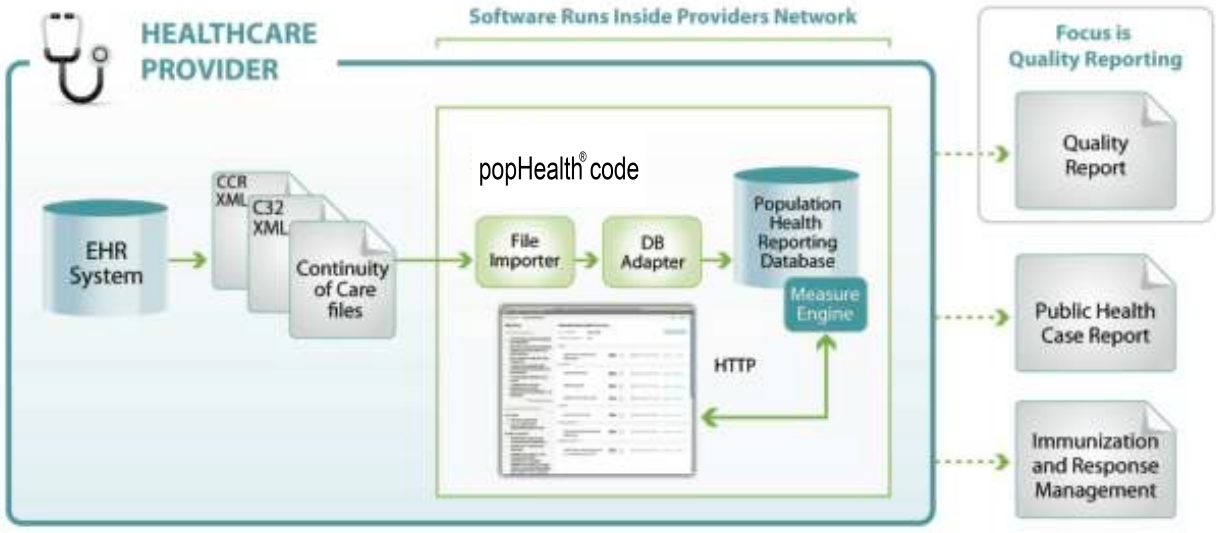
Once the coded information has been extracted and organized, it is compared to the quality measures loaded in popHealth. Coded information is then selected on a measure-by-measure basis, where coded values are stored in a patient document organized by the measure they are relevant to. When the data has been extracted and stored for the patients from the set of continuity of care records, the popHealth quality measure engine then uses Map-Reduce algorithms to generate the result of the set of quality measures. At the release of popHealth v1.0, this set of quality measures includes all 44 of the Meaningful Use Outpatient Quality Measures.

Finally, if an artifact is needed to represent the results of these quality measures, popHealth can automatically generate a PQRI XML document, which represents the summary results of all of the quality measures that the user has selected. The PQRI based quality report contains only aggregate data and does not expose any personally identifiable information, providing protection of a patient's privacy.

One of the advantages of popHealth is that it moves the production of quality measures to the place where the patient data is stored. Instead of collecting all of the necessary, detailed patient data in a central location, a distributed model collects only summarized data (counts, numerators and denominators, or key results). Personally identified information is held only at the source, and data are cleaned and analyzed in a common way at the source before being sent in a standardized format. Digitized data could be made accessible for analysis by different authorized entities across a network without requiring that each entity obtain a copy of all of the detailed underlying data. Trust across the network would be enabled by agreement on a key set of information policies and practices to protect data. This serves to minimize the exposure of underlying data, enables feedback loops to exist natively, and saves the original holders of the data from having to answer multiple separate requests for the same data sets. [1]

Extract Transform and Load Processing and Reporting

popHealth is meant to integrate with existing Health IT systems as an Extract Transform and Load (ETL) process. popHealth does not connect to the underlying data store of a Health IT system. Patient records loaded into popHealth are static. If a user wishes to generate a new set of results based on updated patient information, they should re-generate the patient records in the ASTM CCR or HITSP C32 standards, and load the data into popHealth again. This process, to re-import patient data, scales linearly with the number of patients.



popHealth Concept of Operations

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Software Architecture

popHealth is a Ruby on Rails 3 web application. It uses the open source MongoDB document-based database for data persistence. When deployed, the web application relies on a number of other modules to provide its full functionality. The project uses Bundler to manage its dependencies. The one exception to this being the popHealth CCR Importer module, which is written using the Java 1.6 programming language.

Calculation of quality measures is handled by the popHealth Quality Measure Engine. This is a separate Ruby Gem that is also maintained by the popHealth project. The Quality Measure Engine also provides code to preprocess HITSP C32 documents for measure calculation.

Definitions of quality measures are separated from the web application as well as the Quality Measure Engine. It is possible to create new measures in addition to those measures needed to meet meaningful use requirements.

Data Flow

Patient information is imported into popHealth via ASTM CCR or HITSP C32. Users load information into the application by performing an HTTP POST to the `/records` URL on the application. The web application will then examine the contents of the POST-ed document and determine how the patient should be imported.

The CCR or C32 will be parsed and measure-specific information will be extracted. Measure-specific information extracted from the patient summary C32 XML files or CCR XML files are parsed into a JSON document and stored in MongoDB in the records collection.

Users are then able to log into the web application a select quality measures. When this happens, the Quality Measure Engine will run the selected measure against the patient pool and report the results.

The popHealth web application does not use ActiveRecord for database interactions, but instead directly uses the MongoDB Ruby Driver.

Users are stored in the users collection. Passwords are hashed using bcrypt-ruby and never stored in plain text.

Web Interface

popHealth was built atop of the open source Laika software. Laika is an open source electronic health record (EHR) testing framework that was designed and developed by the MITRE Corporation. Laika analyzes and reports on the interoperability capabilities of EHR systems, and includes testing of EHR software products and networks. Included in Laika are the XPath expressions for extracting coded information from the HITSP C32, as well as a representation of patient records in a standards-agnostic form.

popHealth is a modern HTML5 based web application that leverages the jQuery JavaScript library with some plugins. The user interface has been tested on Firefox version 3.5 and higher, Microsoft Internet Explorer 8, Apple Safari 4, and Google Chrome 8 and higher.

There are several web pages in popHealth that display the information in the popHealth database, and allow for users to perform and export their own reports. These are detailed below.

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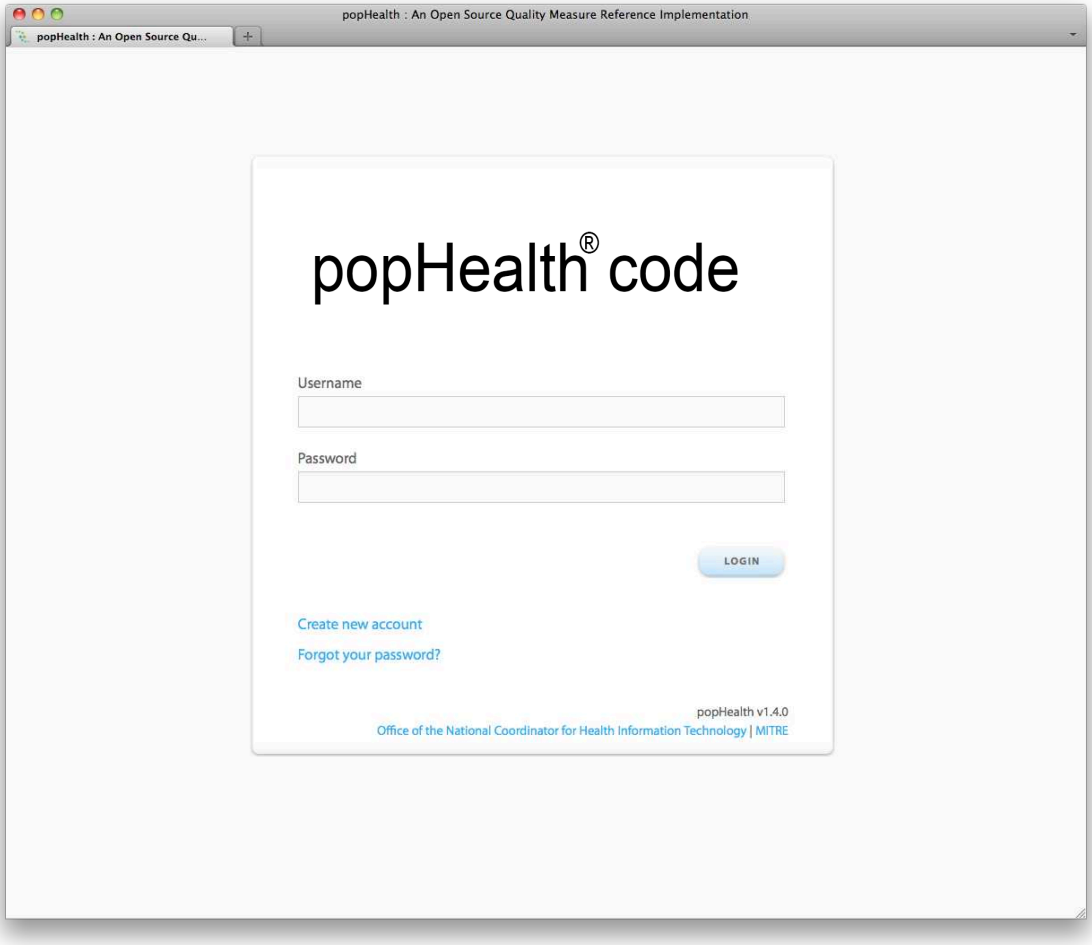
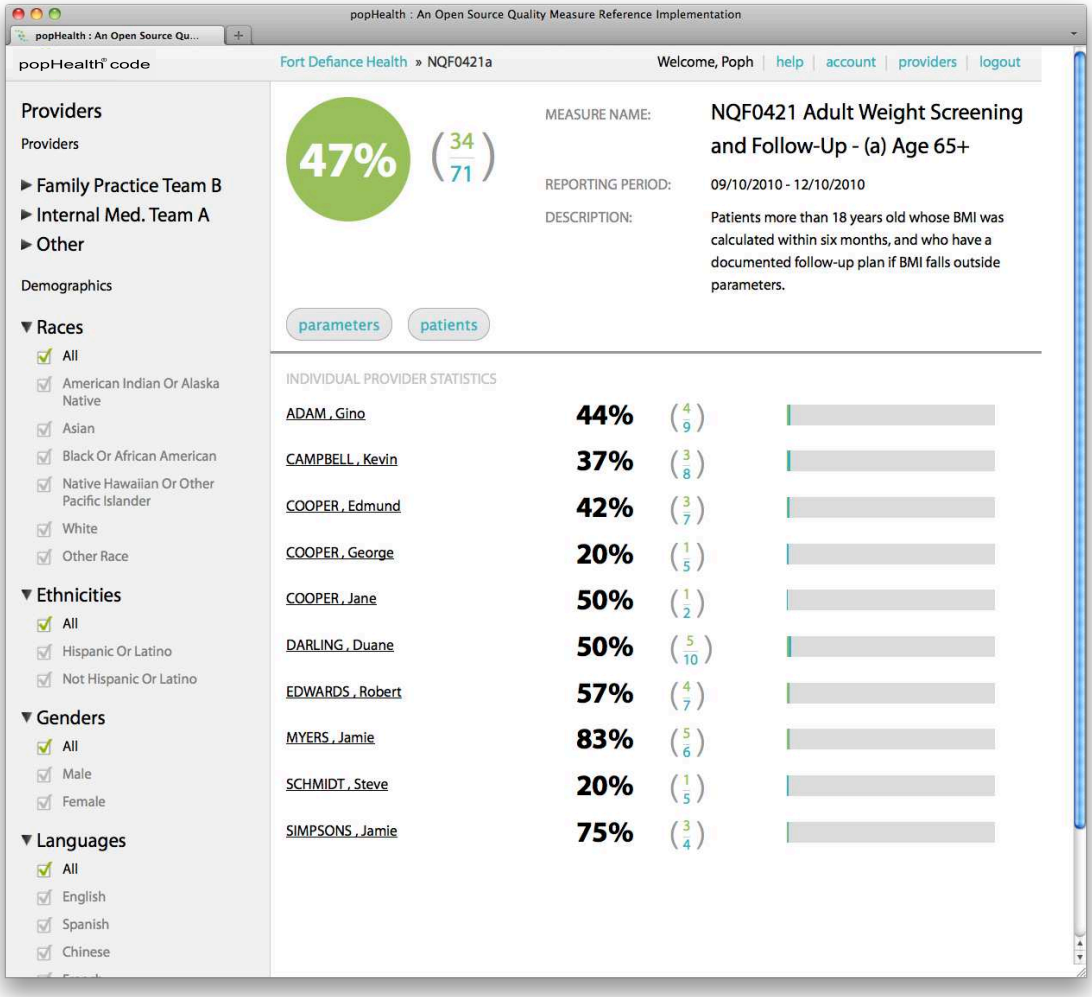


popHealth Login Page



popHealth Provider List Page

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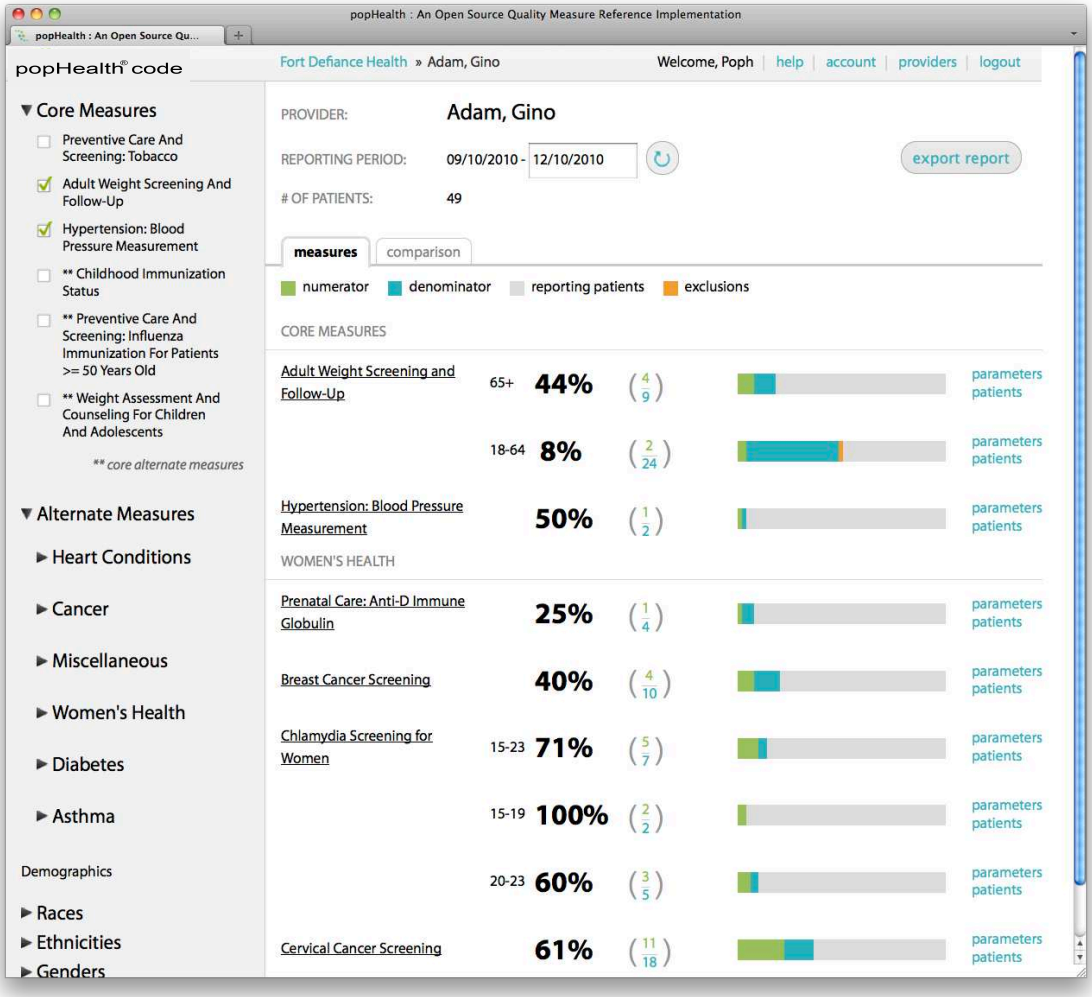
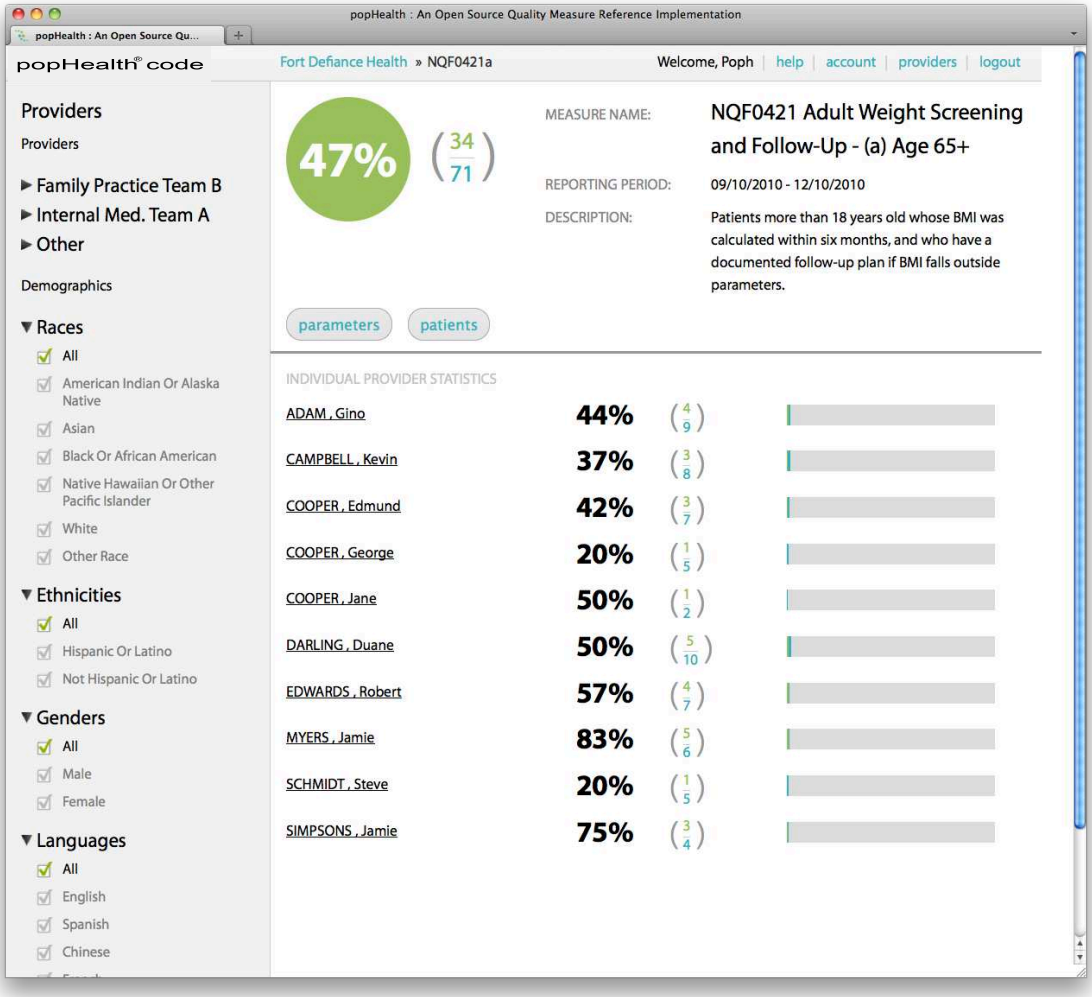


popHealth Provider Dashboard Page



popHealth Provider Dashboard Page

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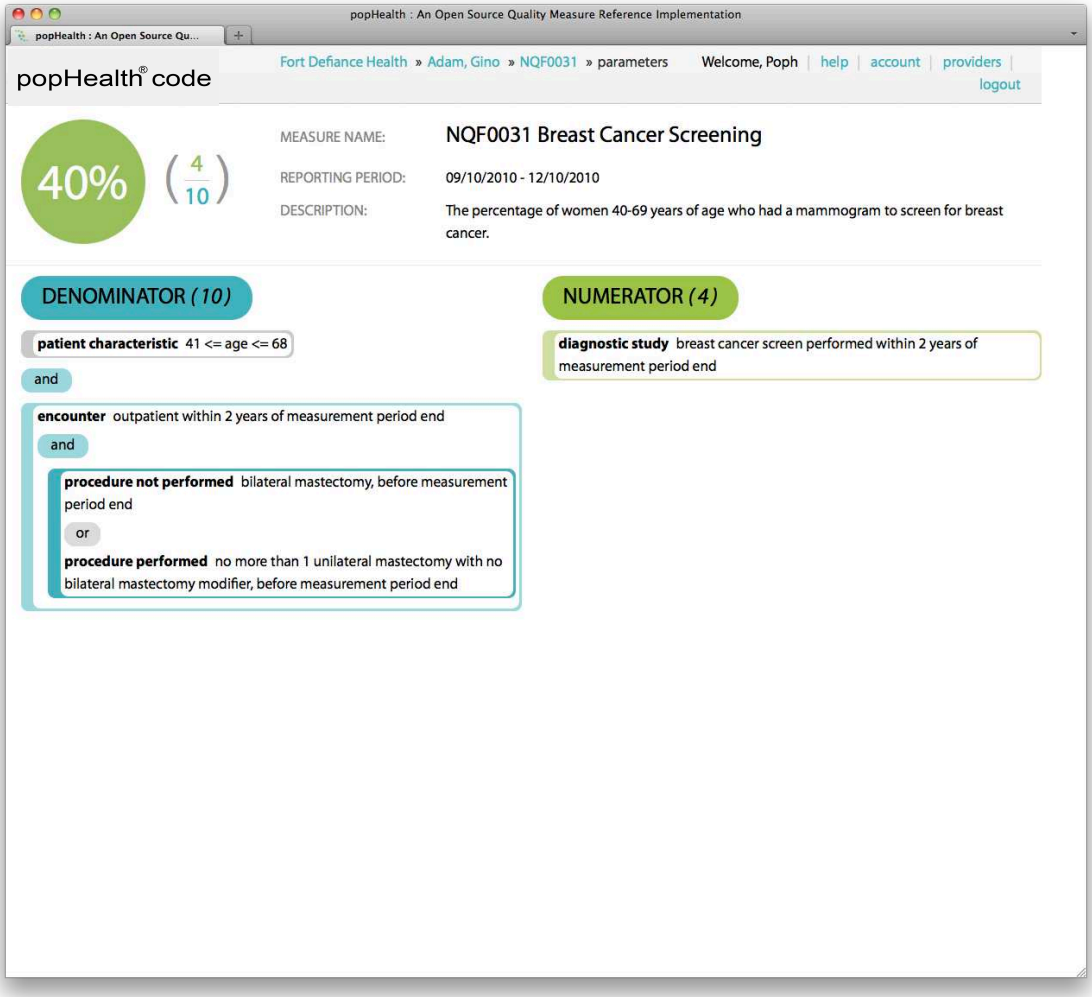
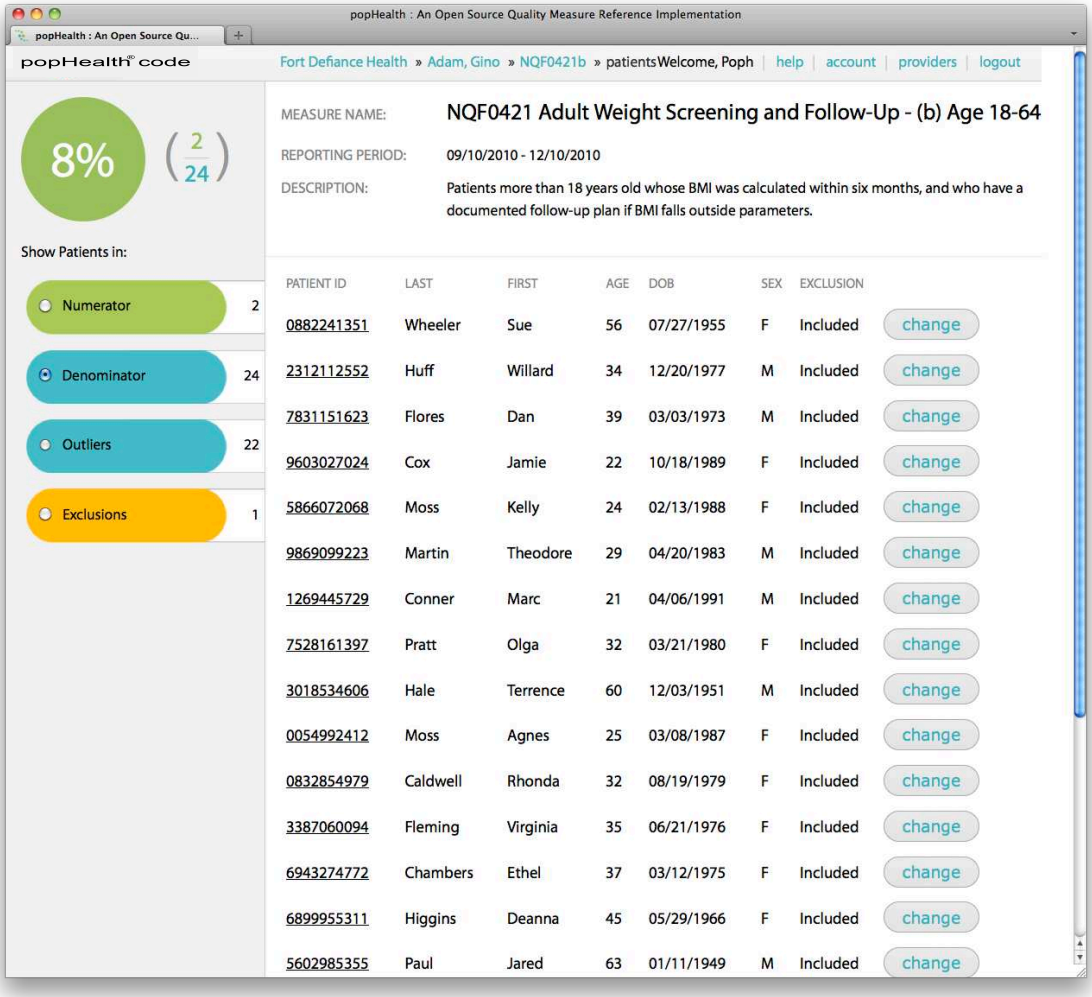


popHealth Measure Parameter Page



popHealth Patient List Page

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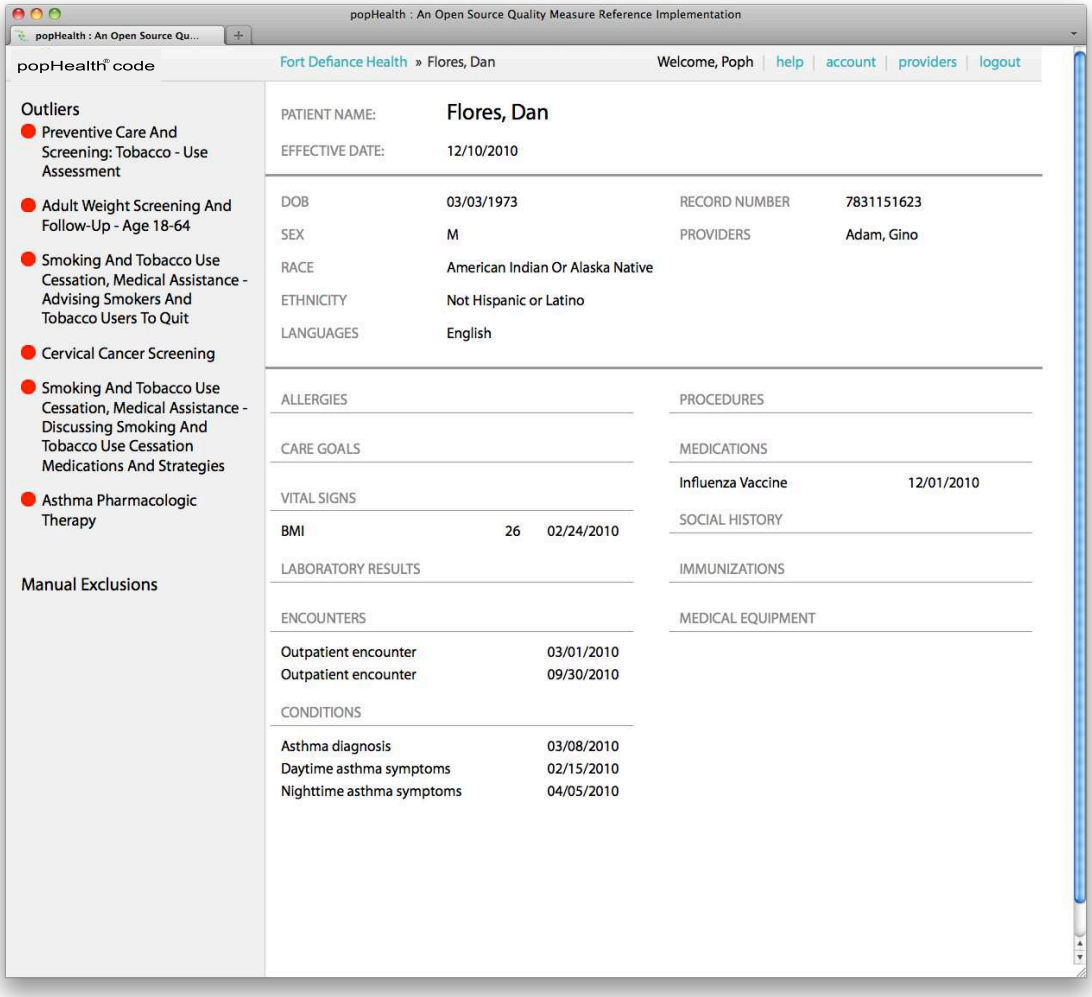

Individual Patient Page

Quality Measures

When a user logs into popHealth, they are presented with a list of available measures on the left side of the application. Selecting a measure adds it to the dashboard on the right hand side of the application and calculates the result. The user's selections are retained in the "selected_measures" collection inside of MongoDB. Documents in this collection contain the id of the measure as well as the name of the user. Some metadata about the measure is also copied into the document. This sort of de-normalization is a standard practice in document databases, as opposed to relational databases, where this is considered a poor practice.

Data Import

Calculation of quality measures in popHealth proceeds in two stages. In the first stage patient records are imported from their native format (CCR or C32) and measure-specific properties are extracted to build a de-normalized record optimized for the second stage of calculation.

Transformation to Internal Normalized Record

Patient summaries (CCRs and C32s) are imported into popHealth by using HTTP to POST the XML documents to a specific URL in the web application. popHealth will then examine the contents of the file and determine whether to use the CCR or C32 normalization logic.

While the implementations for these routines are different, conceptually they are the same. Each section of a patient summary, such as medications or vital signs, is reduced to a set of "entries." An entry represents a single point of data in a patient summary and the term is borrowed from HL7 CDA parlance.

Entries contain the following data fields:

- Times - such as start, end or point in time values
- Codes - including the vocabulary used - if multiple codes are provided, they are all retained
- Status (optional) - appears in certain sections, such as conditions
- Value (optional) - sometimes required for vital signs or results

popHealth's C32 normalizer uses XPath expressions to search the XML and create entries. An XPath expression is created for each section. The CCR normalizer uses Java code that has been generated from the CCR XML Schema. These codes are then used to create entries, which are then grouped by the section that they correspond to.

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Measure-Specific De-Normalization

Each quality measure has a JSON definition, where each piece of data needed for the measure is defined in a "property". Measure properties contain the following information:

- Name - a name for the property, such as "outpatient encounter"
- Standard category - These categories are obtained from the measure definition spreadsheets. It is a description of where the information may be found, such as "medications" or "condition / diagnosis / problem"
- Schema - The structure of the information needed for the property. This may be a point in time value, such as an outpatient encounter. It may be a time and a value, such as a blood pressure reading. Finally, it can be a date range, such as the duration of a condition
- Codes - Lists of codes that are relevant for this property, grouped by code set

The standard categories and codes can be used to examine the normalized record to extract measure specific information.

Measure Definition Driven Code Matching

Each measure property has a standard category. Based on this standard category, popHealth will examine groups of entries in an attempt to find data points of interest. For instance, a measure property may check to see if a patient is a tobacco user. This property would fall into the "characteristic" standard category and entries in the conditions and social history groups will be examined.

popHealth will check codes in entries to see if they match codes for the property. Going back to the tobacco user example, there will be a list of codes that are associated with tobacco use. popHealth will check entries in conditions and social history to see if any of them have codes that match. If codes match a value will be generated according to the property schema.

Measure Definition Driven Output Format

All of the measure properties are grouped together and output as part of a JSON patient record. At the top level, the patient record contains basic demographic information: name, date of birth and gender. Then de-normalized measure information grouped by measure. Each measure group has its set of properties with values extracted from the patient summary document.

A resulting record will have the following form:

```
{
  "first": "Irma",
  "last": "Bloggs",
  "gender": "F",
  "birthdate": -290390400,
  "measures": {
    "0018": {
      "encounter_outpatient": [1266537600, 1277856000],
      "hypertension": 1266537600,
      "systolic_blood_pressure": [
        {
          "date": 1266537600,
          "value": 180
        },
        {
          "date": 1277856000,
          "value": 138
        }
      ],
      "diastolic_blood_pressure": [
        {
          "date": 1266537600,
          "value": 100
        },
        {
          "date": 1277856000,
          "value": 85
        }
      ]
    }
  }
}
```

In this example, we are showing a patient with a single measure. Dates and times in the measures are represented in seconds since the epoch. This is a female patient born on October 18, 1960. Her record lists two outpatient encounters (February 19, 2010 and June 30, 2010). This means that her patient summary document had two encounter entries with codes that matched codes listed for outpatient encounters for the measure. Her patient summary had a condition of hypertension and two blood pressure readings taken at her outpatient encounters.

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Measure Calculation

In the second stage of quality measure calculation in popHealth, each de-normalised patient record is compared against the measure criteria for the population, denominator, numerator and exclusions using a runtime-supplied measurement period end date. popHealth uses the popular map-reduce approach when calculating quality measure results for a set of patient records.

Map Reduce Introduction

Map-reduce is an algorithmic framework that can be used to calculate summary results over a large set of input data. It is widely used in "big data" problems, most notably by Google as the foundation of their Web search engine.

As its name suggests, map-reduce proceeds in two distinct steps, in popHealth the first 'map' step takes as input a single item of raw data and maps it to a summary data format. The second 'reduce' step takes a set of summary data produced by the 'map' step and outputs a summary of that set. This is perhaps best explained by a simple example: consider a set of patients that we need to summarize based on eye color, the input to the map function would be a single native patient record, the output of the map function would be a data structure containing a map of eye-color to count of patients with that color.

Since the map function only 'sees' a single patient record at a time, typically only one color value would be non-zero and that value would be one. The reduce function would take as input a list of map function output data structures and simply sum the values for each eye-color over the list, producing the same data structure but now with summary data for a set of patients. The reduce operation can be applied iteratively since its output format is the same as its input. E.g. you could evaluate the reduce function on groups of 100 results of the map function and then evaluate the reduce function a second time on the outputs of the first set of reduce functions to summarize over all groups.

Map-reduce has some important properties that make it suitable for large-scale calculations:

(i) Each map function evaluation is isolated and only requires access to a single input record to proceed. This allows many map functions to be run in parallel, either using separate threads within a process or distributing the work amongst a set of processes on a server farm.

(ii) Reduce functions can be applied iteratively allowing the work of reducing the output of map functions to be split amongst a set of workers and easily combined by a coordinator using a final reduce function execution.

The net result of (i) and (ii) is that native input data can easily be sharded across a set of servers and a map-reduce calculation made across all shards with minimal coordination. Each shard can work in isolation and the results for each shard are easily combined.

Measure Logic as a Map Function

In popHealth each measure is expressed as a map function whose output indicates whether a particular patient met the population, denominator, numerator and exclusion criteria for that measure.

popHealth is built on MongoDB, a document oriented database which has a native map-reduce capability based on JavaScript. Each measure is expressed as an anonymous JavaScript function template. popHealth also supplies a set of JavaScript library functions that ensure consistency of output and simplify working with the de-normalized patient data.

Function templates are converted into actual JavaScript functions at runtime by substituting a value for the effective date and inserting the popHealth-supplied library function definitions.

Generic Reduce Function

popHealth uses the same reduce function for all measures, it simply sums the patients that meet each of the population, denominator, numerator and exclusion criteria.

Result Cache

For performance reasons, measure results are cached after calculation in the MongoDB database using the measure number and effective date as keys. If new patient records are added the results are recalculated on demand.

HQMF Integration

For streamlining the import of new Meaningful Use Clinical Quality Measures, popHealth supports the ability to import a new CQM in the HQMF XML data format. Due to limitations associated with the HQMF standard, popHealth also supports a user interface to allow for human/manual refinements of the CQM definitions when the HQMF standard cannot adequately express the definition of the CQM logic.

Production Configuration

The popHealth software is available both as a binary distribution, and via the underlying software source code. Binary distributions of popHealth are setup to use Hypertext Transfer Protocol Secure (HTTPS). This is important to ensure that the communications between the client web browser and server are encrypted. This encryption is not enabled by default when downloading the software source code.

When setting up popHealth in a production environment from source code, and not from the popHealth binary distribution, it is the responsibility of the popHealth steward to ensure that all data stored on the system is encrypted, and all communications use HTTPS. Options for supporting this include the use of a self-

signed certificate by the popHealth steward, or by working with an authentication service to purchase a digital certificate.

Note that when using self-signed certificates, most browsers display a warning if they receive a certificate that is not from a recognized source. Most modern web browsers display a warning across the entire window when viewing resources from a source that is not recognized. Most modern browsers also prominently display the site's security information in the address bar.

popHealth and Open Source

As an open source software project, popHealth endeavors to create a community dedicated to addressing the need of automated calculation of clinical quality measures.

All activities on the popHealth project are open. Not only does this include access to the underlying source code, but also planned features, forums, and all email discussions. Embracing an open source model allows us to build trust with a community of users, collaborators, and contributors. With many eyes on all aspects of the popHealth project, we also hope to increase the reliability, accuracy, stability, and auditability of the software.

Examples of some of the successful open source software projects embracing these tenets include GNU/LINUX: a free open source operating system, Apache: the most popular web server used on the internet, and Firefox: the second most popular web browser used on the internet. Through this open source model, we hope to establish a level of trust among all members of the project's community.

It is our intention that popHealth will demonstrate how open source software can support a community and software that has a positive impact in the healthcare clinical quality measure domain.

Project Website

The popHealth project website is http://projectpophealth.org. This project site will include information about the latest version of the software, plans/schedule for new features, bug/issues around the software, and access to the free open source code.

Distribution License Associated with Quality Measures

The definition of the measure algorithms and associated code sets are the intellectual property of three different measure stewards, the American Medical Association, the National Committee for Quality Assurance, and the Quality Institute of Pennsylvania. To address requests by the measure stewards who view the JSON definition files of each measure as their intellectual property, the JSON and JavaScript files associated with each of the measures encoded in popHealth will not be distributed using the Apache 2.0 Open Source license. The license and language associated with the measure definition source code files is presented as follows:

Performance measures and related data specifications (the "Measures") are copyrighted by the noted quality measure providers as indicated in the applicable Measure. Coding vocabularies are owned by their copyright owners. By using the Measures, a user ("User") agrees to these Terms of Use. Measures are not clinical guidelines and do not establish a standard of medical care and quality measure providers are not responsible for any use of or reliance on the Measures.

THE MEASURES AND SPECIFICATIONS ARE PROVIDED "AS IS" WITHOUT ANY WARRANTY OF ANY KIND, AND ANY AND ALL IMPLIED WARRANTIES ARE HEREBY DISCLAIMED, INCLUDING ANY WARRANTY OF NON-INFRINGEMENT, ACCURACY, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. NO QUALITY MEASURE PROVIDER, NOR ANY OF THEIR TRUSTEES, DIRECTORS, MEMBERS, AFFILIATES, OFFICERS, EMPLOYEES, SUCCESSORS AND/OR ASSIGNS WILL BE LIABLE TO YOU FOR ANY DIRECT, INDIRECT, SPECIAL, EXEMPLARY, INCIDENTAL, PUNITIVE, AND/OR CONSEQUENTIAL DAMAGE OF ANY KIND, IN CONTRACT, TORT OR OTHERWISE, IN CONNECTION WITH THE USE OF THE POPHEALTH TOOL OR THE MEASURES, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH LOSS OR DAMAGE. The

Measures are licensed to a User for the limited purpose of using, reproducing and distributing the Measures with the popHealth Tool as delivered to User, without any modification, for commercial and noncommercial uses, but such uses are only permitted if the copies of the Measures contain this complete Copyright, Disclaimer and Terms of Use. Users of the Measures may not alter, enhance, or otherwise modify the Measures.

NOT A CONTRIBUTION - The Measures, including specifications and coding, as used in the popHealth Tool, are not a contribution under the Apache license. Coding in the Measures is provided for convenience only and necessary licenses for use should be obtained from the copyright owners. Current Procedural Terminology (CPT®) © 2004-2010 American Medical Association. LOINC® © 2004 Regenstrief Institute, Inc. SNOMED Clinical Terms® (SNOMED CT®) © 2004-2010 International Health Terminology Standards Development Organization.

Appendix

Acronyms and Terms

ASTM – The American Society for Testing and Materials is an international standards organization that develops and publishes voluntary technical standards for a wide range of materials, products, systems, and services.

C32 – A HITSP specification to constrain a Continuity of Care Document and require data elements for patient registration, medications, allergies and conditions.

CCD – Continuity of Care Document. An XML document detailing a snapshot of part of a patient's electronic health record. The HL7 Continuity of Care Document is the result of a collaborative effort between the Health Level Seven and ASTM organizations to "harmonize" the data format between ASTM's Continuity of Care Record and HL7's Clinical Document Architecture specifications.

CCR – The Continuity of Care Record is a health record standard specification developed jointly by ASTM International, the Massachusetts Medical Society, HIMSS, the American Academy of Family Physicians, the American Academy of Pediatrics, and other health informatics vendors.

CDA – The HL7 Clinical Document Architecture is an XML-based markup standard intended to specify the encoding, structure and semantics of clinical documents for exchange.

CSS – Cascading Style Sheets s a style sheet language used to describe the presentation of a document written in a markup language. It is most common application is to style web pages written in HTML and XHTML, but the language can be applied to any kind of XML document, including SVG and XUL.

EC2 – Amazon Elastic Compute Cloud allows users to rent computers on which to run their own computer applications. EC2 allows scalable deployment of applications by providing a web service through which a user can boot an Amazon Machine Image to create a virtual machine, which Amazon calls an "instance", containing any software desired.

EHR – Electronic Health Record. An EHR refers to an individual patient's health record in digital format. Electronic health record systems co-ordinate the storage and retrieval of individual records with the aid of computers.

FFRDC – Federally Funded Research and Development Center.

HHS – The United States Department of Health and Human Services. This is a Cabinet department of the United States government with the goal of protecting the health of all Americans and providing essential human services.

HL7 – Health Level Seven is an all-volunteer, not-for-profit organization involved in development of international healthcare standards.

HITSP – Healthcare Information Technology Standards Panel. The American National Standards Institute Healthcare Information Technology Standards Panel was created in 2005 as part of efforts by the Office of the National Coordinator for Health Information Technology to promote interoperability in healthcare by harmonizing health information technology standards.

HIT – Healthcare Information Technology or Health Informatics. This is the intersection of information science, computer science and health care. It deals with the resources, devices and methods required to optimize the acquisition, storage, retrieval and use of information in health and biomedicine.

HQMF – The Health Quality Measures Format is an HL7 XML standard for expressing Clinical Quality Measure logic, and the associated clinical codes.

jQuery – A cross-browser JavaScript library designed to simplify the client-side scripting of HTML. jQuery was released in January 2006 at BarCamp NYC. jQuery is free, open source software, dual-licensed under the MIT License and the GNU General Public License, Version 2. jQuery's syntax is designed to make it easier to navigate a document, select DOM elements, create animations, handle events, and develop Ajax applications. jQuery also provides capabilities for developers to create plugins on top of the JavaScript library. Additional information about the jQuery JavaScript framework is available at http://jquery.com

JSON – JavaScript Object Notation is a lightweight data-interchange format. It is easy for humans to read and write. It is easy for machines to parse and generate. It is based on a subset of the JavaScript Programming Language. JSON is a text format that is completely language independent but uses conventions that are familiar to programmers of the C-family of languages, which includes C, C++, C#, Java, JavaScript, Perl, Python, and others.

Laika - Laika is an open source electronic health record (EHR) testing framework that was designed and developed by the MITRE Corporation. Laika analyzes and reports on the interoperability capabilities of EHR systems. This includes the testing for certification of EHR software products and networks. To support EHR data interoperability testing, Laika is designed to verify the input and output of EHR data against nationally recognized data and transport standards. For more information about Laika, visit http://projectlaika.org

Map Reduce – A framework for processing large datasets on certain kinds of distributable problems using a large number of computers referred to as nodes. The framework supports two steps, a "*Map*" step where the master node takes the input, partitions it up into smaller sub-problems, and distributes those to worker nodes. A worker node may do this again in turn, leading to a multi-level tree structure. The

worker node processes that smaller problem, and passes the answer back to its master node. There is also a "*Reduce*" step in this framework, where the master node then takes the answers to all the sub-problems and combines them in some way to get the output, the answer to the problem it was originally trying to solve. http://en.wikipedia.org/wiki/MapReduce

MITRE – The MITRE Corporation is a not-for-profit organization chartered to work in the public interest. As a national resource, MITRE applies expertise in systems engineering, information technology, operational concepts, and enterprise modernization to address their sponsors' critical needs.

NIST – The National Institute of Standards and Technology is a non-regulatory agency of the United States Department of Commerce. The institute's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve quality of life.

NHIN – The Nationwide Health Information Network (NHIN) is a collection of standards, protocols, legal agreements, specifications, and services that enables the secure exchange of health information over the internet.

ONC – The Office of the National Coordinator for Healthcare Information Technology (ONC) is at the forefront of the administration's health IT efforts and is a resource to the entire health system to support the adoption of health information technology and the promotion of nationwide health information exchange to improve health care. ONC is organizationally located within the Office of the Secretary for the U.S. Department of Health and Human Services (HHS).

Open Source – Open source is a set of principles and practices that promote access to the design and production of goods and knowledge. This allows users to create software content through incremental individual effort or through collaboration.

PQRI – Physician Quality Reporting Initiative. The 2006 Tax Relief and Health Care Act required the establishment of a physician quality reporting system, including an incentive payment for eligible professionals (EPs) who satisfactorily report data on quality measures for covered professional services furnished to Medicare beneficiaries during the second half of 2007. CMS named this program the Physician Quality Reporting Initiative (PQRI). The PQRI was further modified as a result of the Medicare, Medicaid, and SCHIP Extension Act of 2007 and the Medicare Improvements for Patients and Providers Act of 2008.

Ruby – Ruby is a reflective, dynamic, object-oriented programming language. It combines syntax inspired by Perl with Smalltalk-like object-oriented features, and also shares some features with Python, Lisp, Dylan, and CLU. Ruby is a single-pass interpreted language.

Ruby on Rails – Ruby on Rails is a free web application framework. It aims to increase the speed and ease with which database-driven web sites can be created, and offers skeleton code frameworks (scaffolding) from the outset. Often shortened to Rails, or RoR. Ruby on Rails is an open source project written in the Ruby programming language.

REST – Representational State Transfer is a style of software architecture for distributed hypermedia systems such as the World Wide Web.

SOAP – SOAP refers to both Simple Object Access Protocol, and also lately Service Oriented Architecture Protocol. SOAP is a protocol for exchanging XML-based messages over computer networks.

Wiki – A type of computer software that allows users to easily create, edit and link web pages. Wikis are often used to create collaborative websites and power community websites.

XML – The Extensible Markup Language is a general-purpose markup language. It is classified as an extensible language because it allows its users to define their own tags. Its primary purpose is to facilitate the sharing of structured data across different information systems, particularly via the Internet.

References

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