Software Design Document (SDD) v1.92

Technical Specifications & General Information for SOEN/CompSci Interns

February 5, 2014

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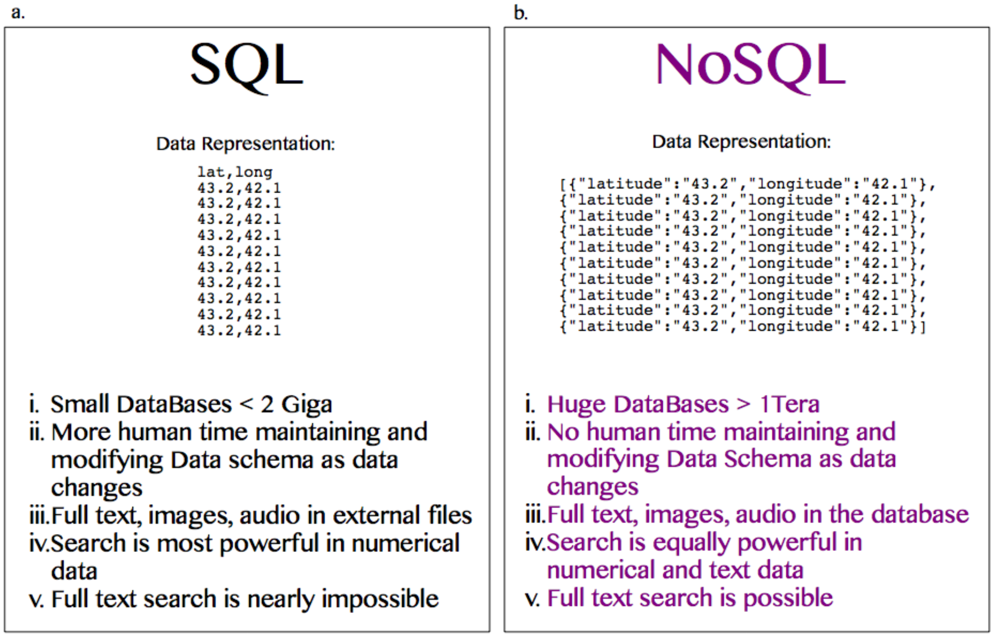
and document-like (1b) (commonly referenced in language documentation literature simply as *XML*, and in the software industry as *NoSQL*).[1] NoSQL data stores, including simple file based systems, have always existed and in fact pre-date SQL databases. Much like field linguists and language documentation standard bodies, companies who need scalable data management such as Google (**??**) Adobe (**?**) Facebook (**?**) and LinkedIn (**?**) actively resist SQL (frequently proprietary) data storage solutions (2a) and seek open source NoSQL solutions (2b).

By April 2012 when LingSync began, NoSQL databases had matured to the extent that they were well understood, and deployed at large scale. Using an existing mature NoSQL database solution has greatly reduced the novel code needed to build LingSync, meaning we were able to focus our efforts on building usable user interfaces, and integrating our favourite field linguistics tools as modules and plugins to help automate the data entry process.

(1) Illustration of the storage requirements vs self-documenting ability of NoSQL



a.

SQL

Data Representation:

```
lat,long
43.2,42.1
43.2,42.1
43.2,42.1
43.2,42.1
43.2,42.1
43.2,42.1
43.2,42.1
43.2,42.1
43.2,42.1
43.2,42.1
```

i. Small DataBases < 2 Giga
ii. More human time maintaining and modifying Data schema as data changes
iii. Full text, images, audio in external files
iv. Search is most powerful in numerical data
v. Full text search is nearly impossible

b.

NoSQL

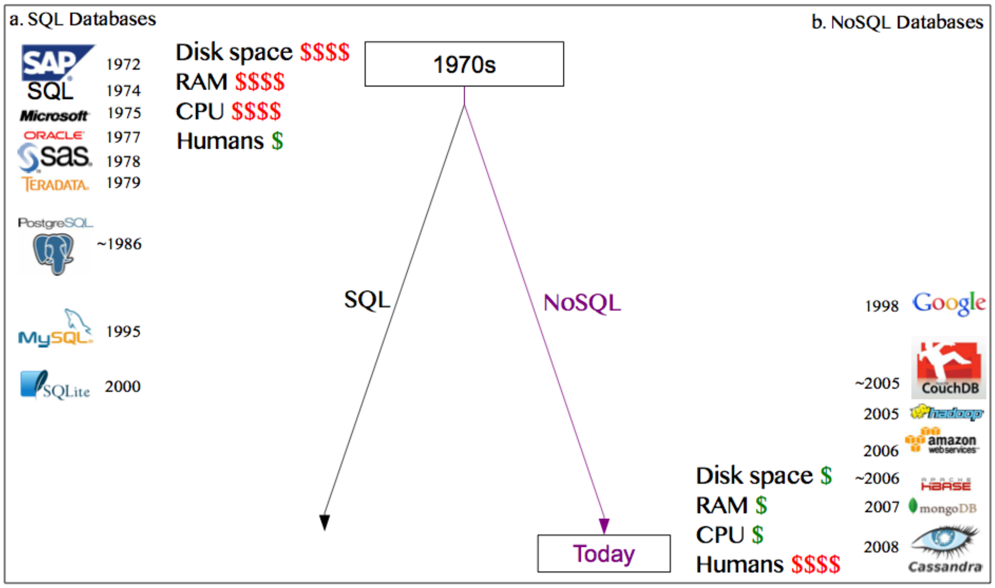
Data Representation:

```
[{"latitude":"43.2","longitude":"42.1"},
{"latitude":"43.2","longitude":"42.1"},
{"latitude":"43.2","longitude":"42.1"},
{"latitude":"43.2","longitude":"42.1"},
{"latitude":"43.2","longitude":"42.1"},
{"latitude":"43.2","longitude":"42.1"},
{"latitude":"43.2","longitude":"42.1"},
{"latitude":"43.2","longitude":"42.1"},
{"latitude":"43.2","longitude":"42.1"},
{"latitude":"43.2","longitude":"42.1"}]
```

i. Huge DataBases > 1Tera
ii. No human time maintaining and modifying Data Schema as data changes
iii. Full text, images, audio in the database
iv. Search is equally powerful in numerical and text data
v. Full text search is possible

(2) Currently human resources are very expensive while hardware is inexpensive, resulting in a growing popularity of NoSQL databases including what is under LingSync (CouchDB)

[1] NoSQL is actually a broad category encompasing anything which is not SQL, including documents but also interconnected web/neuron-like data strutures.



In June 2012, only one month before we launched the project at CAML, it became possible to build a web app which also worked offline. In April 2013 CouchDB added CORS (Cross-Origin Resource Sharing) support, permitting what are called 'mashups' essentially the ability for one to build independent apps which interfaces with LingSync data securely in realtime, with no additional infrastructure.

Prior to 2011 there is one other aspect of LingSync which was not possible: only one programming language is used throughout LingSync. The web services are written in JavaScript, the user interface is written in JavaScript, and even the database queries are written in JavaScript. JavaScript has a very simple yet consistent syntax, and only a handful of data types, meaning that research assistants can learn to script in less than one week, and even design and complete their own components in one semester. JavaScript has only recently become a popular programming language, and as such there are a wealth of beginner friendly video screencasts and tutorials which are targeted at non-programmers. Prior to 2011 research assistants frequently learned Python, Bash, and Unix utilities to help clean and transform data, in addition of course to LaTeXand/or Praat. Unlike professional fieldwork, research is unknown, no software can plan everything a research team might wish to do with their data. As most research budgets are dedicated to funding students, and a growing number of linguistics students come to a department with a basic knowledge of web programming, a viable solution is ask research assistants to manipulate data in batches via scripts. Without a bit of scripting, research assistance are relegated to tasks of monotonous repetition which must be performed in a consistent manner. Training research assistants to script data manipulation not only saves time, but also permits labs to pass on technical knowledge to future lab members, rather than outsourcing data management to external consultants or computer science students who have largely been trained on SQL best practices which contradict the best practices needed for smooth data management of the NoSQL data inherent in fieldwork. **?** also advocates in-house learning, “there is a need for data management skills to be developed among linguistic scholars so that our relatively small collections can be maintained.”

B Data Models

B.1 Datum

```
{
   "_id": "89bc4d7dcc2b1fc9a7bb0f4f474a7fb4",
   "_rev": "7-0d53714bc3b67681892fa0791cbebac3",
   "audioVideo": [],
   "comments": [
       {
           "text": "Hi\nJust a quick note to say that I automatically cleaned this datum
           "username": "quotecleaningbot",
           "timestamp": 1389642361952,
           "gravatar": "968b8e7fb72b5ffe2915256c28a9414c",
           "timestampModified": 1389642361952
       }
   ],
   "dateEntered": "\"2013-03-17T23:07:42.760Z\"",
   "dateModified": "\"2013-12-02T20:19:17.321Z\"",
   "datumFields": [
       {
           "label": "judgement",
           "value": "*",
           "mask": "*",
           "encrypted": "",
           "shouldBeEncrypted": "",
           "help": "Grammaticality/acceptability judgement (*,#,?, etc). Leaving it blan
           "size": "3",
           "showToUserTypes": "linguist",
           "userchooseable": "disabled"
       },
       {
           "label": "utterance",
           "value": "Erqekunata noqayku qaparinaywanku.",
           "mask": "Erqekunata noqayku qaparinaywanku.",
            "encrypted": "",
            "shouldBeEncrypted": "checked",
            "help": "Unparsed utterance in the language, in orthography or transcription.
            "showToUserTypes": "all",
            "userchooseable": "disabled"
        },
        {
            "label": "morphemes",
            "value": "Erqe-kuna-ta noqa-yku qapari-nay-wanku",
            "mask": "Erqe-kuna-ta noqa-yku qapari-nay-wanku",
            "encrypted": "",
            "shouldBeEncrypted": "checked",
            "help": "Morpheme-segmented utterance in the language. Used by the system to
            "showToUserTypes": "linguist",
            "userchooseable": "disabled",
            "alternates": [
                "Erqekuna-ta noqayku qapari-nay-wanku.",
                "Erqe-kuna-ta noqayku qapari-nay-wanku.",
                "Erqekunata noqayku qaparinaywanku."
            ]
        },
        {
            "label": "gloss",
            "value": "child-PL-ACC 1PL.ex yell-DES-3PL.1PLexOM",
            "mask": "child-PL-ACC 1PL.ex yell-DES-3PL.1PLexOM",
            "encrypted": "",
            "shouldBeEncrypted": "checked",
            "help": "Metalanguage glosses of each individual morpheme (above). Used by th
            "showToUserTypes": "linguist",
            "userchooseable": "disabled",
            "alternates": [
                "?-ACC ? yell-DES-?",
                "child-PL-ACC ? yell-DES-?",
                "Erqe-kuna-ta noqayku qapari-nay-wanku.",
                "Erqekuna-ta noqayku qapari-nay-wanku."
            ]
        },
        {
            "label": "syntacticCategory",
            "value": "",
        "mask": "",
        "encrypted": "",
        "shouldBeEncrypted": "checked",
        "help": "This optional field is used by the machine to help with search and d
        "showToUserTypes": "machine",
        "userchooseable": "disabled"
    },
    {
        "label": "translation",
        "value": "We feel like yelling at the children.",
        "mask": "We feel like yelling at the children.",
        "encrypted": "",
        "shouldBeEncrypted": "checked",
        "help": "Free translation into whichever language your team is comfortable wi
        "showToUserTypes": "all",
        "userchooseable": "disabled"
    },
    {
        "label": "tags",
        "value": "Impulsative, Person, Agreement",
        "mask": "Impulsative, Person, Agreement",
        "encrypted": "",
        "shouldBeEncrypted": "",
        "help": "Tags for constructions or other info that you might want to use to c
        "showToUserTypes": "all",
        "userchooseable": "disabled"
    },
    {
        "label": "validationStatus",
        "value": "CheckedWithSeberina",
        "mask": "CheckedWithSeberina",
        "encrypted": "",
        "shouldBeEncrypted": "",
        "help": "For example: To be checked with a language consultant, Checked with
        "showToUserTypes": "all",
        "userchooseable": "disabled"
    },
    {
        "label": "dateElicited",
        "value": "5/7/2010",
            "mask": "5/7/2010",
            "encrypted": "",
            "shouldBeEncrypted": "checked",
            "help": "This field came from file import ",
            "userchooseable": ""
        },
        {
            "label": "notesFromOldDB",
            "value": "backwards agreement",
            "mask": "backwards agreement",
            "encrypted": "",
            "shouldBeEncrypted": "checked",
            "help": "This field came from file import ",
            "userchooseable": ""
        },
        {
            "label": "dialect",
            "value": "Cusco Quechua",
            "mask": "Cusco Quechua",
            "encrypted": "",
            "shouldBeEncrypted": "checked",
            "help": "This field came from file import ",
            "userchooseable": ""
        },
        {
            "label": "syntacticTreeLatex",
            "value": "",
            "mask": "",
            "encrypted": "",
            "shouldBeEncrypted": "",
            "help": "This optional field is used by the machine to make LaTeX trees and h
            "showToUserTypes": "machine",
            "userchooseable": "disabled"
        },
        {
            "label": "enteredByUser",
            "value": "",
            "mask": "",
            "encrypted": "",
            "shouldBeEncrypted": "",
            "help": "The user who originally entered the datum",
            "showToUserTypes": "all",
            "readonly": true,
            "userchooseable": "disabled"
        },
        {
            "label": "modifiedByUser",
            "value": "public",
            "mask": "public",
            "encrypted": "",
            "shouldBeEncrypted": "",
            "help": "An array of users who modified the datum",
            "showToUserTypes": "all",
            "readonly": true,
            "users": [
                {
                    "username": "public",
                    "gravatar": "968b8e7fb72b5ffe2915256c28a9414c",
                    "firstname": "",
                    "lastname": ""
                }
            ],
            "userchooseable": "disabled"
        }
    ],
    "pouchname": "lingllama-communitycorpus",
    "session": {
        "sessionFields": [
            {
                "label": "goal",
                "value": "This data was collected by ME Cathcart for her dissertation \"I
                "mask": "This data was collected by ME Cathcart for her dissertation \"Im
                "encrypted": "",
                "shouldBeEncrypted": "",
                "help": "This describes the goals of the session.",
                "userchooseable": "disabled"
            },
            {
                "label": "consultants",
                "value": "Lucia, Ricardo, Seberina",
            "mask": "Lucia, Ricardo, Seberina",
            "encrypted": "",
            "shouldBeEncrypted": "",
            "help": "Example from DataOne: Format conventions: use uppercase ,Codes f
            "userchooseable": "disabled"
        },
        {
            "label": "dialect",
            "value": "",
            "mask": "",
            "encrypted": "",
            "shouldBeEncrypted": "",
            "help": "You can use this field to be as precise as you would like about
            "userchooseable": "disabled"
        },
        {
            "label": "language",
            "value": "",
            "mask": "",
            "encrypted": "",
            "shouldBeEncrypted": "",
            "help": "This is the langauge (or language family) if you would like to u
            "userchooseable": "disabled"
        },
        {
            "label": "dateElicited",
            "value": "Summer 2010",
            "mask": "Summer 2010",
            "encrypted": "",
            "shouldBeEncrypted": "",
            "help": "This is the date in which the session took place.",
            "userchooseable": "disabled"
        },
        {
            "label": "user",
            "value": "",
            "mask": "",
            "encrypted": "",
            "shouldBeEncrypted": "",
            "help": "Example from DataOne: Format conventions: use uppercase ,Codes f
```

```
               "userchooseable": "disabled"
           },
           {
               "label": "dateSEntered",
               "value": "",
               "mask": "",
               "encrypted": "",
               "shouldBeEncrypted": "",
               "help": "This is the date in which the session was entered.",
               "userchooseable": "disabled"
           }
       ],
       "pouchname": "lingllama-communitycorpus",
       "comments": [
       ],
       "dateCreated": "\"2013-03-17T23:07:34.194Z\"",
       "dateModified": "\"2013-03-17T23:07:34.194Z\"",
       "timestamp": 1363561654194,
       "_id": "89bc4d7dcc2b1fc9a7bb0f4f474415e4",
       "_rev": "1-701f44686ae45a27d4e5a08ed6c26dc8"
   },
   "timestamp": 1386015557322,
   "jsonType": "Datum",
   "collection": "datums"
}
```

C Module Implementations

In this section we discuss in detail the timeline and budget for each of the modules that make up the LingSync application. The modules are grouped into core modules and dream modules which will be made when the budget becomes available.

C.1 Core Modules

The project has three core modules which must be developed prior to additional modules. These are the *collaboration, corpus* and *lexicon* modules, briefly outlined in terms of functionality and timeline in the following sections. Implementation of the three core modules began on April 20th 2012. The three core modules will be launched on August 1st at CAML in Patzun Guatemala. We estimate the three core modules and the software architecture to take 9.2 weeks to complete with three software developers, and cost roughly $23,800 before taxes. We will have its final time and costs on August 3rd 2012.

C.1.1 Collaboration Module

The collaboration module shown in Table 1 deals with users, teams, permissions, user authentication, as well as allowing users to see changes, modifications, and data verification in the form of an "Activity Feed." An activity feed is a common design pattern which allows users to learn form other users how to use the software, what are popular functions other users are completing in addition to being a central location to update oneself on the activity in the corpus. The system will have special users called "bot" which are scripts or programs which power users can write in Javascript which will crawl their corpus and clean/automate batch actions.

We estimate the total cost of the collaboration module to be around $5,700 before taxes. The implementation of the collaboration module was begun on April 20th 2012, and finished on August 1st 2012, with the exception of Team Feed and Team Preference Widgets.

Iteration	Hours	Technology
Software Architecture Design	20	Software Engineering
Collaboration API on central server	30	Software Engineering
Users Model	15	Javascript
consultant Model	15	Javascript
Team Model	15	Javascript
Bot Model	15	Javascript
User Activity Model	8	Javascript
Team Feed Widget	25	HTML5
User list item Widget	16	HTML5
Team Preferences Widget	8	HTML5
User Profile Widget	8	HTML5
User Tests	30	Javascript
Consultant Tests	30	Javascript
Team Tests	30	Javascript
Android Deployment	15	Java
Chrome Extension Deployment	20	Javascript
Heroku Deployment	5	Integration

Table 1: The Collaboration Module is used to permit collaboration with teams and users.

C.1.2 Corpus Module

The corpus module shown in Table 2 deals with storing confidential data in the AES US Federal encryption standard, replicating the corpus locally on the users' computers, as well as on a central server hosted either in the cloud, or on a linguistic department's server. The corpus module contains all of the core logic, including data fields, session fields, as well as data lists which are used to curate lists of data for handouts or publication either in linguistic articles or as web widgets embedded in external websites such as linguistic department blogs, or project pages. The corpus module is also where search of datum is implemented.

We estimate the total cost of the corpus module to be around $9,200 before taxes. The implementation of the corpus module was begun on April 20th 2012, and finished on August 1st 2012, with the exception of Corpus diff Widget.

Iteration	Hours	Technology
Software Architecture Design	20	Software Engineering
Corpus API on corpus server	20	Software Engineering
Corpus Model	8	Javascript
Session Model	8	Javascript
Datum Model	8	Javascript
Datum status model	8	Javascript
DataList Model	8	Javascript
Confidential datum encrypter	16	Javascript
Audio upload and play logic	8	Javascript
Corpus DB implementation on Android	20	Java
Corpus DB implementation on Chrome	20	Javascript
Corpus DB implementation on Node.js	20	Javascript
Corpus versioning Logic	25	Javascript
Corpus Preferences Widget	6	HTML5
Session Preferences Widget	6	HTML5
Datum Preferences Widget	20	HTML5
Datum Status Preferences Widget	16	HTML5
DataList Preferences Widget	6	HTML5
Corpus sync logic	10	Javascript
Corpus diff Widget (to show before sync)	10	HTML5
Insert Unicode Character Widget	10	HTML5
Corpus Details Widget	6	HTML5
Session Details Widget	6	HTML5
Datum Details Widget	20	Javascript
DataList Widget	30	Javascript
Global Search logic	30	Javascript
Power Search logic	80	Javascript
Corpus Tests	5	Javascript
Session Tests	10	Javascript
Datum Tests	10	Javascript
Datum Status Tests	10	Javascript
DataList Tests	20	Javascript
Heroku Deployment	5	Integration

Table 2: The Corpus Module is used to sync, share, edit, tag, categorize and open data.

C.1.3 Lexicon Module

The lexicon module show in Table 3 is used for search. It is loosely modeled after a mental lexicon, in a network of morphemes, allomorphs, orthographie(s), glosses and translations. It is not a dictionary but rather a connected graph similar to theoretical models of mental lexicons (for a dictionary see the Dictionary Module in § C.2.4). As a connected graph it is the most useful structure to index datum and search for datum real time while data entry is happening.

We estimate the total cost of the lexicon module to be around $7,300 before taxes. The implementation of the lexicon module was begun on April 20th 2012. We will know its final costs on August 3rd 2012.

Iteration	Hours	Technology
Software Architecture Design	20	Software Engineering
Lexicon API on Lexicon server	20	Software Engineering
Lexicon Model	6	Javascript
Morpheme Model	6	Javascript
Allomorph Model	6	Javascript
Gloss Model	6	Javascript
Orthography Model	16	Javascript
Lexicon DB implementation on Android	20	Java
Lexicon DB implementation on Chrome	20	Javascript
Lexicon DB implementation on Node.js	20	Javascript
Lexicon versioning Logic	10	Javascript
Lexicon Preferences Widget	6	HTML5
Morpheme Tests	6	Javascript
Allomorph Tests	6	Javascript
Gloss Tests	6	Javascript
Orthography Tests	8	Javascript
Lexicon Analysis Widget	10	HTML5
Lexicon sync logic	10	Javascript
Lexicon diff Widget (to show before sync)	10	HTML5
Lexicon Details Widget	6	HTML5
Lexicon Tests	12	Javascript
Heroku Deployment	5	Integration

Table 3: The Lexicon Module is used to house, and read lexicon entries to be used for the glosser.

C.2 “Dream” Modules

The "dream" modules allow for more features that will save researchers time in their data entry and data analysis, but which are not necessary for simply entering and transcribing data. These modules are on hold until budget becomes available.

C.2.1 Language Learning Module

The language learning module shown in Table 4 enables researchers and language teachers to create language learning aids from the data in existing corpora and from the data newly collected for the purpose of language learning. The learning aids aim to help language learners improve their listening and speaking skills. The orthographic lines (i.e. utterance and morpheme lines) and the attached audio or video recordings of a datum are taken as materials to create a lesson.

The prototype of the language learning module was begun on September 13th 2012.

C.2.2 Phonological Search Module

The phonological search module shown in Table 5 is used to search for phonological features in context. It consists of a phonology ontology (a general purpose feature geometry/articulatory feature ontology, or a customized ontology created by the users for their language of interest) which lets the user search for potential minimal pairs or phonological features in context to verify with consultants or to prepare psycholinguistic experiments. The phonological search module is used by the *phonetic aligner* module to generate a “dictionary.txt” file containing orthography and phones which is used by the phonetic aligner module.

We estimate the cost of the phonological search module to be roughly $2,200 before taxes. The Phonological search, or the phonetic aligner module is currently schedule to begin in September 2012, we haven’t yet decided which is a priority.

Iteration	Hours	Technology
– Prototype		
Software Architecture Design	55	Software Engineering
Lesson Datum Model	15	Javascript
Lesson Datum Listen and Repeat View	20	Javascript
XML import logic	6	Javascript
Datum to Lesson logic	6	Map Reduce
DataList to Unit logic	6	Map Reduce
Corpus to Language Learning logic	10	Map Reduce
Main Manu Dashboard	6	HTML
Student LIsten and Repeat Dashboard	10	HTML
Student Instructions View	6	Javascript
Audio Visualization View	30	Javascript
Audio Play/Record View	10	Javascript
Audio Text Time Alignment logic	20	Javascript
Audio Record Android logic	6	Java
Android Packaging	15	Java
Software Architecture Design	40	Software Engineering
Teacher User Model	10	Javascript
Teacher User View	40	Javascript
Language Learning Corpus	10	Javascript
Language Learning Corpus View	40	Javascript
Language Learning Corpus Dashboard	10	HTML
Student User Model	30	Javascript
Student User View	60	Javascript
Datum Shadowing Lesson Model	10	Javascript
Datum Shadowing Lesson View	10	Javascript
Student Shadowing Lesson Dashboard	40	HTML
Datum Quiz Multiple Choice Model	20	Javascript
Datum Quiz Multiple Choice View	20	Javascript
Student Quiz Dashboard	120	HTML
Datum Prompted Production Model	20	Javascript
Datum Prompted Production View	20	Javascript
Student Prompted Productions Dashboard	40	HTML
Feedback Comment Model	10	Javascript
Feedback Comment View	40	Javascript
Comment Teacher Feedback logic	6	Map Reduce
Audio import to Multiple Utterances logic	60	Praat & Javascript
Audio File Server	140	Node

Table 4: The Language Learning Module enables to use data in the database to create lessons for language learners.

Iteration	Hours	Technology
Phonology Ontology for phonological search	60	Java
Lexicon Visualization Widget	40	Javascript
Lexicon Editing Widget	20	Javascript

Table 5: This module is a subportion of the Lexicon Module.

C.2.3 Phonetic Aligner Module

The phonetic aligner module show in Table 6 makes it possible to use attached audio recordings and the orthographic/utterance lines of datum to create a dictionary unique to the corpus' language, and to run the ProsodyLab Aligner, a machine learning algorithm which uses Hidden Markov Models to predict boundaries between phones and creates a Praat TextGrid with estimated phone boundaries, saving hours of boundary tagging. We also have factored in a bit of sound editing to facilitate the process of creating audio files which correspond closely to the utterance line in the datum's fields.

We estimate the cost of the phonetic aligner module to be roughly $9,800 before taxes. The phonetic aligner or the phonological search module is currently scheduled to begin in September 2012, we haven't yet decided which is a priority.

Iteration	Hours	Technology
Software Architecture Design	10	Software Engineering
Aligner API on Lexicon server	10	Software Engineering
Dictionary Model	15	Javascript
Aligner DB implementation	80	Integration
Aligner Machine Learning Integration	80	Java
Aligner Preferences Widget	8	HTML5
Audio Waveform Visualization logic	30	Javascript
Audio Spectrogram Visualization logic	?	Javascript
Transcription User Interface	80	HTML5
TextGrid export	20	Javascript
Dialect Profile Widget	8	HTML5
Orthography Tests	30	Javascript
Training Tests	30	Java
Heroku Deployment	5	Integration

Table 6: The Aligner Module is used to create TextGrids from the orthography and the audio files, used for prosody and phonetic analysis.

C.2.4 Dictionary Module

The dictionary module shown in Table 7is used to crawl the corpus to gather citations and examples to build a Wiktionary dictionary for the corpus' language, as required by some grants which focus on endangered/minority languages. The dictionary module is quite complex and the central component of many online fieldlinguistics databases.

We estimate the dictionary module to cost roughly $ 18,800 before taxes. The dictionary module is not currently scheduled until we have more users who require its functionality.

Iteration	Hours	Technology
Software Architecture Design	40	Software Engineering
Dictionary API on Lexicon server	30	Software Engineering
Semantic Model	60	Javascript
Syntactic Model	60	Javascript
Citation Model	60	Javascript
Synonyms Model	60	Javascript
Dictionary DB implementation	80	Integration
Dictionary Training Logic	80	Java
Web Spider Training Logic	100	Java
Dictionary Preferences Widget	8	HTML5
Dictionary WordNet Analysis Widget	120	HTML6
Dialect Profile Widget	8	HTML5
Semantic Tests	30	Javascript
Syntactic Tests	30	Javascript
Citation Tests	30	Javascript
Synonyms Tests	30	Javascript
Spider Tests	30	Java
Training Tests	30	Java
Heroku Deployment	5	Integration

Table 7: The Dictionary Module is used to share the lexicon in the form of a WordNet/Wiktionary dictionary with the language community as required by some grants.

C.2.5 Glosser Module

The glosser module show in Table 8 is designed to make the app "smarter" and to reduce the amount of time spent entering predictable information such as glosses. The glosser can use any existing morphological analysis tool to break down the utterance/orthography line into a probable morphological segmentation using known morphemes in the lexicon, and enters a probable gloss for the morphemes in the glossing line. The glosser module is designed to reduce redundant data entry, not to provide accurate glosses. It is of course crucial that predicted morpheme segmentation and glosses be corrected by users, particularly in languages where morphemes are ambiguous, or where morphemes are short and hence there are more ambiguous morpheme segmentations for words.

We estimate the glosser module to cost roughly $17,800. The glosser module is not currently scheduled until we have more users who require its functionality.

Iteration	Hours	Technology
Software Architecture Design	40	Software Engineering
Glosser API on Lexicon server	30	Software Engineering
Morpheme Model	15	Javascript
Allomorph Model	15	Javascript
Gloss Model	15	Javascript
Orthography Model	30	Javascript
Glosser DB implementation	80	Integration
Glosser Prediction Logic	80	Java
Glosser Machine Learning Logic	80	Java
Glosser Training Logic	80	Java
Web Spider Training Logic	80	Java
Glosser Preferences Widget	8	HTML5
Morphological Analysis Widget	40	HTML6
Dialect Profile Widget	8	HTML5
Morpheme Tests	30	Javascript
Allomorph Tests	30	Javascript
Gloss Tests	30	Javascript
Orthography Tests	30	Javascript
Spider Tests	30	Java
Training Tests	30	Java
Heroku Deployment	5	Integration

Table 8: The Glosser Module is used to automatically gloss datum, smarter than the standard lexicon.

C.2.6 Web Spider Module

The Web Spider module shown in Table 9 is a non-crucial module which allows researchers with limited access to consultants to gather data using blogs or forums. The web spider also provides an additional source of context to assist consultants in providing grammaticality judgements, as well as additional contexts where morphemes appear. For example, "ke" is largely considered a postposition by Urdu-consultants with explicit knowledge, however it is often produced as other functional morphemes in everyday spoken contexts. Blog/forum data can be used to discover these additional contexts.

The Web Spider module is currently not a scheduled module. It will not become a priority until we have more users who require its functionality.

Iteration	Hours	Technology
Corpus Visualization Widget	40	HTML5
Web Spider Training Logic	60	Java

Table 9: The Spider module allows for collection and annotation of E-Language data.

C.2.7 User Support & Maintenance

The user support & maintenance module shown in Table 10 includes general support, new features, upgrades, and maintenance. User support includes answering user's emails, helping system administrators install the app and its various server apps on their department server, creating video tutorials, screen casts and sample data to help users figure out the application and begin using it immediately, as well as discover some of its advanced/unexpected features.

We estimate the user support & maintenance module to cost roughly $30,200 if we include unlimited support, or $13,000 if we do not include email and tech support but only new features, maintenance, video tutorials and user guides.

Iteration	Hours	Technology
Sample data	30	Linguistics
Integrate software with sample data	30	Javascript
Screencasts on how to use the app(s)	24	Quicktime/YouTube
Screencasts on how to modify the code	40	Quicktime/YouTube
Server maintenance	20	Integration
Monitor server costs and develop pricing plan	100	Business
Answer user emails	250	Support
Read twitter feeds and facebook channels	100	Support
Help IT/developers install and set up the server on their department servers	50	Support
Upgrade javascript/android libraries	40	Javascript
Amazon EC2 server CPU+Memory+Bandwidth		Server
Release new versions	160	Javascript

Table 10: User Support includes 1 year of product support and project growth. It is needed to make a longterm viable and useful tool that field linguists can adopt for their labs or for their field methods courses.