Improving Research Through Advanced REDCap Interfaces

scott.s.burns@vanderbilt.edu
EBRL

We study reading disabilities in children using behavioral and MR imaging measures

- Very wide databases
- Very expensive datasets
- Novel tasks (in & out of magnet)
- Many projects
Before REDCap

- Members touched every piece of data
- Issues joining across paradigms
- Saved and shared data in spreadsheets
- Always behind in analyses
- No traceable analyses

Input » Output
After REDCap

- Analyze some data within milliseconds
- Automate everything possible
- Automate the automation
- Start analyses from a single source
Goals

Advocate for advanced data management workflows
Goals

Discuss problems easily solved using the REDCap Application Programming Interface
Goals

Explain how Data Entry Triggers can tie everything together
Ideally...

Machines perform all **definable** analyses:

- Perform reproducible work
- Operate deterministically
- Orders of magnitude faster and cheaper
REDCap

- Is:
  - A service for collecting and storing data
  - Secure for the storage of PHI
  - An online spreadsheet

- Is not:
  - A relational database
Better than...

- A real database:
  - No administration
  - Easy schema definition

- A spreadsheet:
  - GUI is browser-based
  - Client-Server architecture
  - Advanced web features
# Vocabulary

<table>
<thead>
<tr>
<th>REDCap</th>
<th>Excel/SQL/etc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
<td>Table</td>
</tr>
<tr>
<td>Data Dictionary</td>
<td>Schema</td>
</tr>
<tr>
<td>Record</td>
<td>Row</td>
</tr>
<tr>
<td>Field</td>
<td>Column</td>
</tr>
<tr>
<td>Form</td>
<td>Set of columns</td>
</tr>
</tbody>
</table>
Advanced Features

• Application Programming Interface (API)
• Programmatic access to REDCap
• Data Entry Triggers
• Automated notifications

All the building blocks we need
API

A method for software programs to ask for and push data to REDCap projects
Using the API

HTTP POST to API URL

Any programming environment with an HTTP library can use the API

(http://sburns.github.io/PyCap)
Major API Methods

• Metadata Export
• Data Export
• Data Import
• File Import, Export & Deletion

https://redcap.vanderbilt.edu/api/help
API: Possible Uses

• Advanced & automated field calculation
• REDCap as the input for external systems
• Shared Filesystem
• Across-project data movement
Problem: How to update (many) fields across (many) records?

Download, Implement, Upload

REDCap Calculated Fields

API
API: External Systems

• Hooks to external databases
• Reproducible cohort/group determination
• Automated database cleanup & backup
API: Shared Filesystem

How to insert or generate *intermediate* data to/from our analysis infrastructure?

- Secure
- Easy
- Automated
API: Shared Filesystem

File → fields:

- Member runs test, saves file in REDCap
- We write software to:
  - Download file locally
  - Analyze file
  - Upload results to REDCap
API: Shared Filesystem

Fields → file:

• Given a record in the database
• We write software to:
  • Download data for that record
  • Substitute into a predefined template
  • Upload new report to REDCap
  • Alert lab members through email
API: Shuttle Data

• Capture data in one project
• Put a copy and results in another
• Public-facing projects → private projects
API
API: Pitfall

API only serves external requests

- One-off scripts
- Scheduled programs

Better idea about *when* to run analyses?
Data Entry Triggers

- Independent of but complimentary to API
- Register a URL to your project
- Internet notification when data is saved
- Notification contains context of the save
Data Entry Triggers
Data Entry Triggers

Humans

Web-App

API

Lab Server

REDCap
(Super) Data Entry Triggers

Humans

Web-App

API

Lab Server

REDCap
Data Entry Triggers: Pitfalls

- Not every research group:
  - Can setup, maintain & secure a web server
  - Has the resources to write the web-app
- But every lab should have access to this infrastructure!
Switchboard

- I wrote a (tiny) web-app to:
  - Parse incoming REDCap requests
  - Execute functions that “match” the request
- In production for our lab

http://github.com/sburns/switchboard
Data Entry Triggers

In a perfect world, we all share a Vanderbilt-wide web-server

- Just one server to maintain & protect
- Sharing is good
- Remove excuses for buy-in
- Everyone benefits from optimization
Conclusions
Engineering Better
Science

• All the pieces exist to offload a massive amount of data-management work from humans to machines

• Cost-effective and improves work through improved accuracy and reproducibility

• Let machines do that which can be defined

• Let humans do the hard work
Automation improves research

Easier to automate machines than humans

- Humans
- Web-App
- API
- Lab Server
- REDCap

Friday, July 12, 13
Automate the automation

Machines don’t make excuses

Humans

Web-App

API

Lab Server

REDCap
Thank you

Laurie Cutting, Ph.D.  
Nikki Davis, Ph.D.  
Sheryl Rimrodt, M.D.  

REDCap Team (Paul Harris, Rob Taylor, etc)
Email: scott.s.burns@vanderbilt.edu

Github: http://github.com/sburns

Questions & Comments?