

REDCapSync: Encapsulated REDCap projects for pipelines, functions, and applications in R

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Abstract Many R packages exist for working with the various API endpoints but none have been established for an encapsulated “get-everything” work flow that produces a standardized R object. REDCapSync accomplishes this and can serve as a dynamic input object for downstream functions.

1 Abstract

- Brief description of REDCap as a dominant data capture platform in clinical research
- Limitations of existing R packages interfacing with the REDCap API
- Introduction of *REDCapSync* as an encapsulated, state-aware representation of REDCap projects in R
- Key contributions:
 - Project-level encapsulation of metadata and data
 - Incremental synchronization rather than full re-downloads
 - Export of structured, audit-friendly Excel workbooks with advanced features (e.g., deidentification)
 - Designed for pipelines, analysis functions, and Shiny applications
- Summary of current capabilities and future roadmap (bi-directional sync)

2 Introduction

Some REDCap API packages include [REDCapR](#), [redcapAPI](#), [tidyREDCap](#)...

One of the reasons people do not choose more complicated structures in REDCap, such as repeating instruments is the data exports require a manual or automated process to merge the data into a usable format. For example if you have non-repeating data in one form...

Enter REDCapSync ...



Figure 1: REDCapSync: Encapsulated REDCap projects for pipelines, functions, and applications in R

2.1 REDCap in Clinical and Translational Research

- Widespread use of REDCap for:
 - Clinical trials
 - Observational cohorts
 - Registries and quality improvement
- Strengths of REDCap (governance, compliance, structured metadata)
- Common downstream needs in R:
 - Analysis pipelines
 - Reporting
 - Visualization and applications

2.2 The Gap Between REDCap and R Pipelines

- Typical REDCap-to-R workflows:
 - Stateless API pulls
 - Flat data frames
 - Manual post-processing
- Consequences:
 - Redundant API calls
 - Loss of project structure
 - Fragile downstream code
 - Poor support for reproducibility and automation

3 Key Design Choices

- No API token stored anywhere except user-defined `r environ`, not in cache, project object, global environment, or code.
- deidentify Excel outputs by default

4 Hypothetical

You are working on a research project collecting surveys from hundreds of participants. You are writing code that makes a visual.

5 Who is REDCapSync for?

6 Related Work and Limitations of Existing Packages

6.1 Existing REDCap R Packages

- API wrappers

- Data-frame–oriented imports
- Metadata access utilities

6.2 Common Design Pattern: Stateless Data Access

- Existing tools primarily:
 - Fetch data on demand
 - Return tables or lists
 - Leave project structure implicit
- Lack of:
 - Encapsulation
 - Persistent project state
 - Awareness of prior syncs

6.3 Why Encapsulation Matters

- Contrast with object-oriented or stateful designs in:
 - Database interfaces
 - Data pipelines
 - ETL frameworks
- Motivation for a higher-level abstraction representing a **REDCap project as an object**

7 Design Philosophy of REDCapSync

7.1 Encapsulated REDCap Projects

- Core concept: a REDCap project is represented as a **single structured R object**
- Encapsulation of:
 - Project metadata
 - Instruments and fields
 - Records and events
 - Sync state and provenance

7.2 Separation of Concerns

- Clear distinction between:
 - Data retrieval
 - Transformation
 - Export and downstream usage

- Benefits for:
 - Reproducibility
 - Testing
 - Modularity

7.3 Designed for Pipelines, Not Just Data Access

- Object persists across:
 - Scripts
 - Functions
 - Shiny applications
- Enables consistent behavior across contexts

8 Incremental Synchronization

8.1 Motivation

- Large projects and frequent data updates
- Inefficiency of full data re-downloads

8.2 Selective Updating

- REDCapSync tracks:
 - What has already been retrieved
 - Which components need refreshing
- Supports:
 - Metadata-only updates
 - Data-only updates
 - Targeted form or event updates

8.3 Benefits

- Reduced API load
- Faster iteration
- Improved stability in automated workflows

9 Structured Excel Export as a First-Class Feature

9.1 Excel as an Interoperability Layer

- Excel remains a dominant format for:
 - Clinical teams
 - Data managers
 - Regulatory workflows

9.2 Custom Excel Workbooks

- REDCapSync exports:
 - Multiple sheets reflecting project structure
 - Consistent naming and formatting
- Preserves:
 - Metadata context
 - Variable labels
 - Choice mappings

9.3 Advanced Features

- Built-in support for:
 - Deidentification strategies
 - Derived fields
 - Project-specific annotations
- Designed for:
 - Review
 - Sharing
 - Archival

10 Applications

10.1 Clinical Trials

- Ongoing data monitoring
- Interim analyses
- Regulatory-compliant exports

10.2 Observational and Registry Studies

- Longitudinal data handling
- Incremental updates
- Consistent downstream datasets

10.3 Shiny Applications and Dashboards

- Live, synchronized project objects
- Reduced logic duplication
- Stable data interfaces

11 Implementation

11.1 Package Architecture

- Internal object structure
- Use of R lists / classes
- Dependency philosophy

11.2 Reproducibility and Transparency

- Explicit sync steps
- Inspectable internal state
- Alignment with reproducible research practices

12 Comparison with Existing Approaches

12.1 Feature Comparison

- Stateless API wrappers vs REDCapSync
- Encapsulation
- Incremental sync
- Structured Excel export
- Pipeline integration

12.2 When to Use REDCapSync

- Not a replacement for all REDCap tools
- Best suited for:

- Long-lived projects
- Repeated analyses
- Applications and automated pipelines

13 Future Directions

13.1 Bi-Directional Synchronization

- Uploading data from previously exported Excel workbooks
- Validation against metadata
- Controlled updates back to REDCap

13.2 Extended Deidentification and Governance Features

- Project-level policies
- Role-based exports

13.3 Ecosystem Integration

- Downstream analysis packages
- Shiny app wrappers
- File-system-based project organization

14 Conclusion

- REDCapSync introduces a new abstraction for working with REDCap in R
- Encapsulation enables:
 - More robust pipelines
 - Better reproducibility
 - Reduced cognitive and technical overhead
- Positions REDCap projects as durable, inspectable R objects rather than transient API responses

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