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# Using R and Shiny to Analyze National Assessment Data

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# Agenda

1. Context
2. Statement of problem
3. Demo R Package - EdSurvey
4. Demo Shiny App - interactive NCES Results Display (iNRD)

# Context - NCES and NAEP



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The *National Center for Education Statistics (NCES)* is the primary federal entity for collecting and analyzing data related to education in the U.S. and other nations.

The *National Assessment of Educational Progress (NAEP)* is the largest nationally representative and continuing assessment of what America's students know and can do in various subject areas.

Analyzing NAEP data for students achievement involves:

- Using plausible values to account for uncertainty in the estimates of student test scores; and
- Employing special methods (e.g., jackknife) that account for the NAEP complex sampling design.

# Statement of Problem



# Statement of Problem

1. Cost: requires specialized statistical software
2. Complexity:
  - survey data size can be unwieldy on some machines
  - custom code required to perform analyses
3. Access Limitations: impediments to downloading and reading-in data
4. Inefficiency: cognitive burden creating and reproducing analyses
5. Software Fatigue: data downloading, processing, manipulation and analysis all done in different software

# Statement of Problem

Analyzing NCES data is too costly, complex, inaccessible, and burdensome for researchers.

# EdSurvey





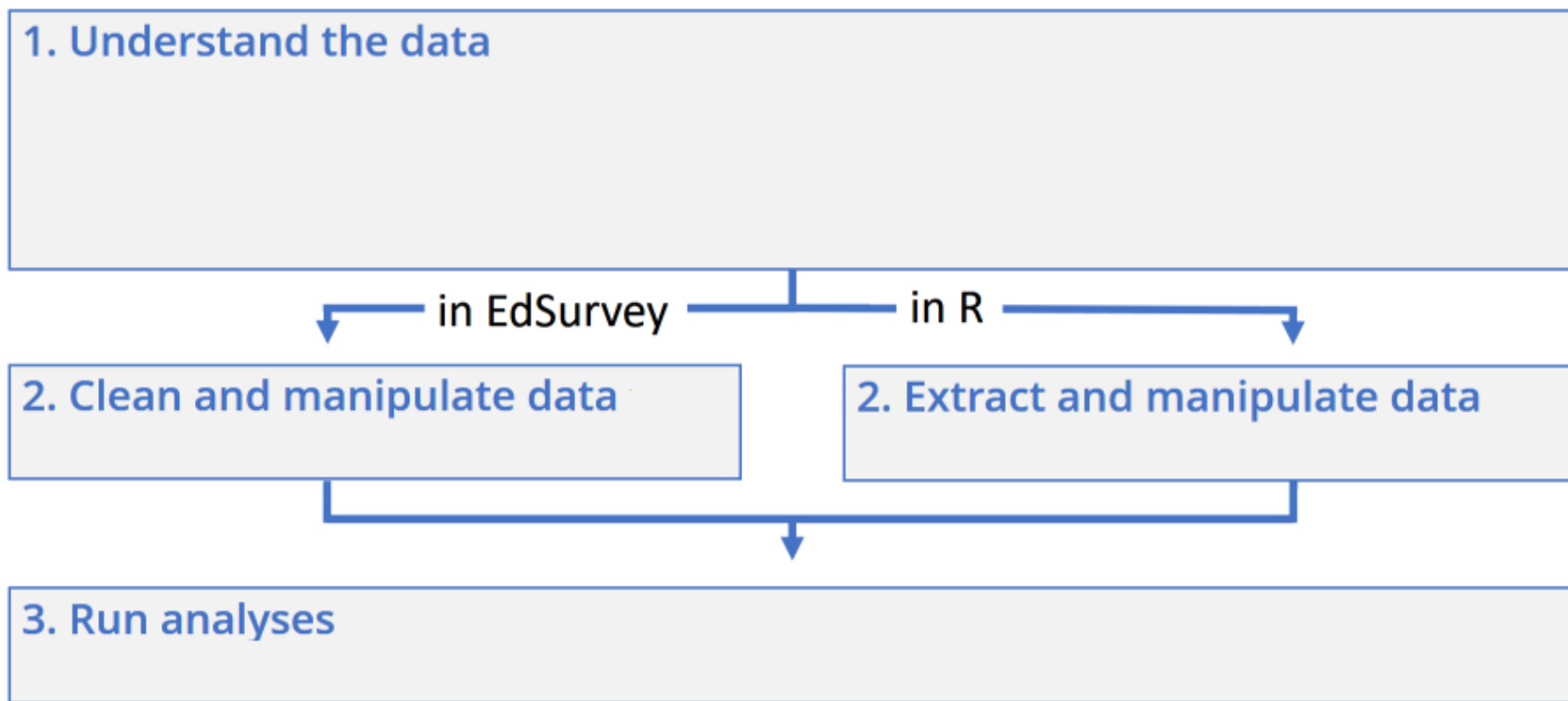
# What is EdSurvey?

An **R** statistical package that gives users functions to connect seamlessly with NCES data to *perform analyses that take into account complex sample survey design and the use of plausible values.*

# Why EdSurvey?

1. **One-stop shop** for data downloading, processing, manipulation and analysis of survey data.
2. **Automated**: Weights and complex sampling design calculations are automated following standard NCES methodology.
3. **Simple**: e.g., a regression with 90 replicate weights requires only a few lines of code.
4. **Flexible**: You can use functions that rely on EdSurvey methods or get the data and use traditional R.
5. **Minimizes memory footprint** by only reading in required data.

# One-stop Shop for NCEES Survey Analysis



# One-stop Shop for NCEs Survey Analysis

## 1. Understand the data

- Explore: explore the codebook, see the variables with plausible values, see weights.
- Search: search variables.
- Expand: see variable levels, tabulate response percentages, see assessment scores by response category, summarize continuous variables.



## 2. Clean and manipulate data

## 2. Extract and manipulate data

## 3. Run analyses

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2. Extract and manipulate data as a data frame (for experienced R users.)

## 3. Run analyses

# One-stop Shop for NCEs Survey Analysis

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2. Clean and manipulate data with built-in subset and recode features.

2. Extract and manipulate data as a data frame (for experienced R users.)

3. Run analyses such as regression analysis, logit analysis, mixed models, show gaps, calculate achievement levels, correlate variables, calculate percentiles.

# Demo - EdSurvey



# Installing the EdSurvey Package

```
# to install the package  
install.packages("EdSurvey")  
  
# to load the package  
library(EdSurvey)
```

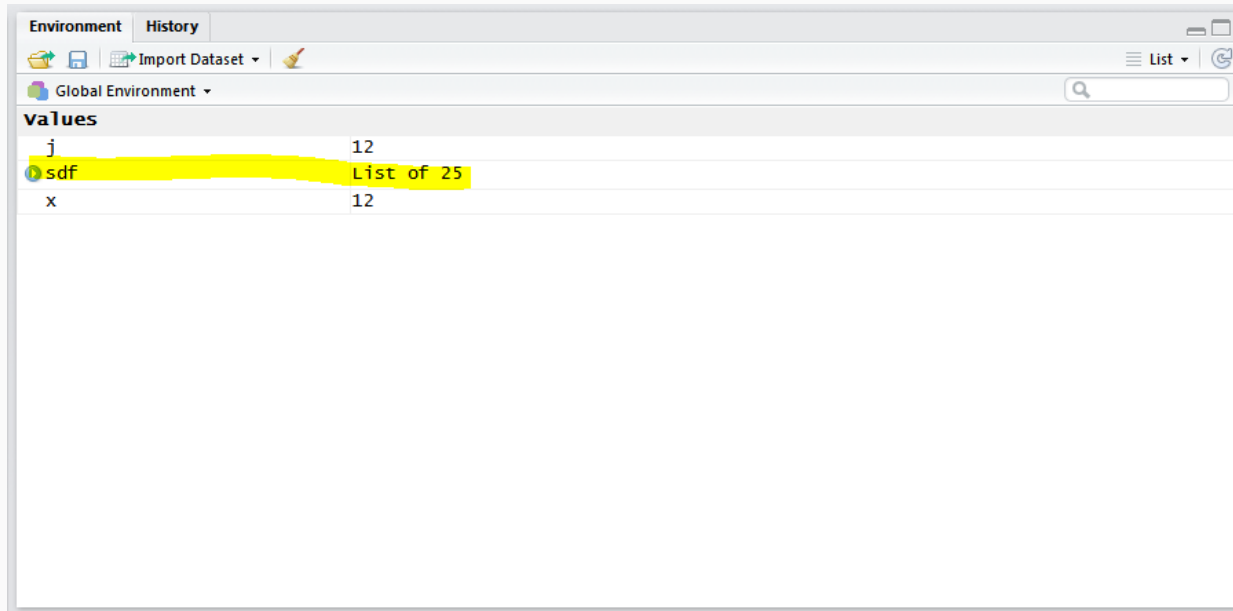


# Data Processing

# Data Processing

- First, read in the data

```
sdf <- readNAEP(system.file("extdata/data", "M36NT2PM.dat", package = "NAEP
```



The screenshot shows the R Studio Environment pane. The 'Global Environment' is selected. Under the 'values' section, three variables are listed: 'j' with a value of 12, 'sdf' with a value of 'List of 25', and 'x' with a value of 12. The 'sdf' variable and its value are highlighted in yellow.

Variable	Value
j	12
sdf	List of 25
x	12

# Meet Your Data - print

## print()

- Print returns detailed data file information:

### print(sdf)

```
## edsurvey.data.frame for 2005 NAEP (Mathematics) in USA
##
## Dimensions: 17606 rows and 302 columns.
##
## There are 1 full sample weight(s) in this edsurvey.data.frame
## 'origwt' with 62 JK replicate weights (the default).
##
## There are 6 subject scale(s) or subscale(s) in this edsurvey.data.frame
## 'num_oper' subject scale or subscale with 5 plausible values.
## 'measurement' subject scale or subscale with 5 plausible values.
## 'geometry' subject scale or subscale with 5 plausible values.
## 'data_anal_prob' subject scale or subscale with 5 plausible values.
## 'algebra' subject scale or subscale with 5 plausible values.
## 'composite' subject scale or subscale with 5 plausible values (the default).
##
## Omitted Levels: 'Multiple', 'NA', 'Omitted'
##
```

# Data Exploration and Cross Tabulation

- Summary table of NAEP composite mathematics performance scale scores (**composite**) of 8th grade students by two student factors:
  - **dsex**: gender
  - **b017451**: frequency of talk about studies at home

```
es1 <- edsurveyTable(composite ~ dsex + b017451, data = sdf)
```

<b>dsex</b>	<b>b017451</b>	<b>N</b>	<b>WTD_N</b>	<b>PCT</b>	<b>SE(PCT)</b>	<b>MEAN</b>	<b>SE(MEAN)</b>
Male	Never or hardly ever	2350	2434.844	29.00978	0.6959418	270.8243	1.057078
Male	Once every few weeks	1603	1638.745	19.52472	0.5020657	275.0807	1.305922
Male	About once a week	1384	1423.312	16.95795	0.5057265	281.5612	1.409587
Male	2 or 3 times a week	1535	1563.393	18.62694	0.4811497	284.9066	1.546072
Male	Every day	1291	1332.890	15.88062	0.5872731	277.2597	1.795784
Female	Never or hardly ever	1487	1517.609	18.20203	0.5078805	266.7897	1.519020

# Linear Regression

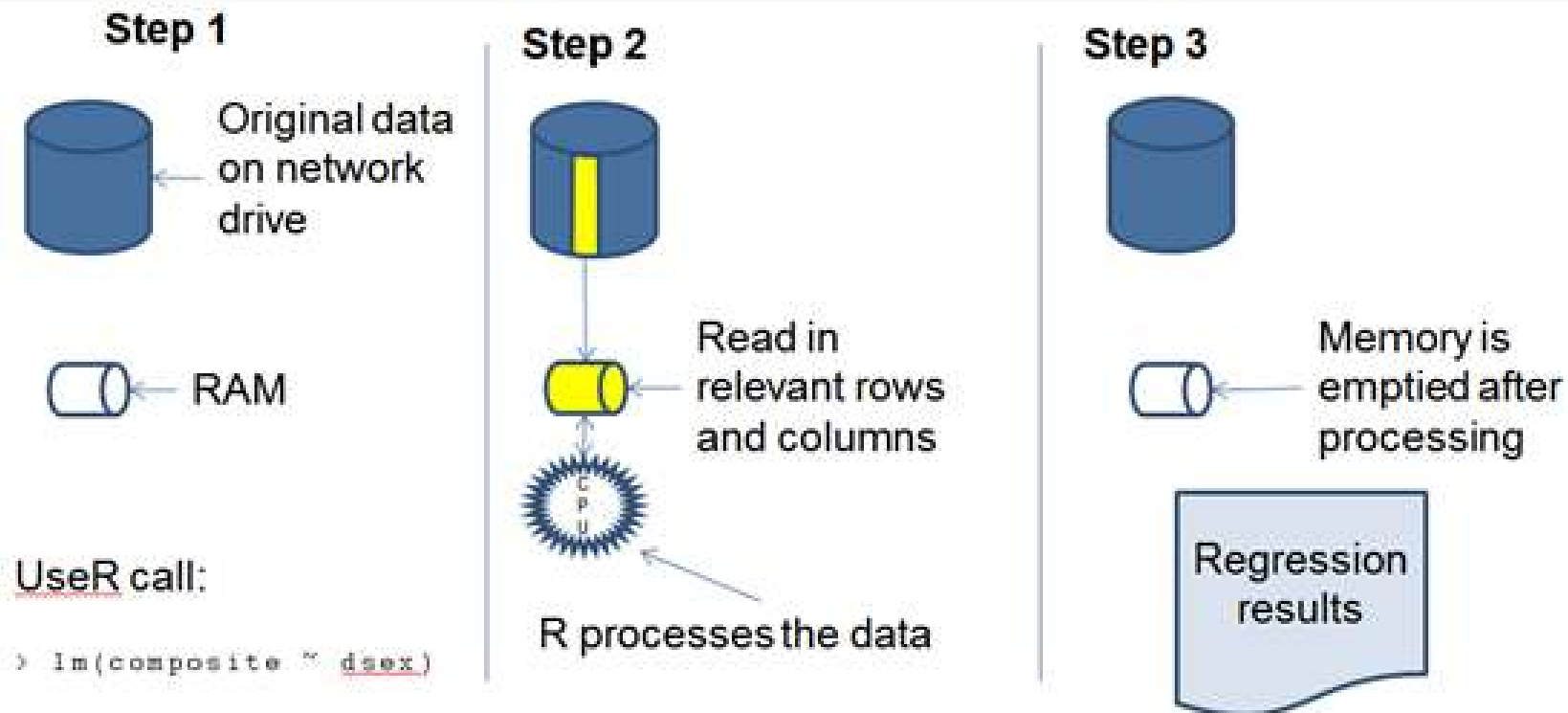
- fits a linear model formula using sampling weights and variance estimates:
  - **dsex**: gender
  - **b017451**: frequency of talk about studies at home

```
lm1 <- lm.sdf(composite ~ dsex + b017451,  
              weightVar = 'origwt', data = sdf)  
  
summary(lm1)
```

```
##  
## Formula: composite ~ dsex + b017451  
##  
## jrrIMax: 1  
## Weight variable: 'origwt'  
## Variance method: jackknife  
## JK replicates: 62  
## full data n: 17606  
## n used: 16331  
##  
## Coefficients:  
##  
##           coef           se           t    dof           Pr(>|t|)  
## (Intercept) 270.41112    1.02443 263.96149 54.670 < 0.0000000000000022 ***
```

# EdSurvey Calls Network Connection

## Small Memory Footprint



# Extensive Function Library

- Correlations
- Proportion meeting expectations
- Regression
- Logit/probit
- Quantile regression
- Percentiles
- Mixed models
- Gap trend analysis

# Learning EdSurvey

There are many ways to learn about how to use EdSurvey:

- Frequently offered workshops
- Reading vignettes on the EdSurvey Website (<https://www.air.org/page/edsurvey-installation-and-use>)
- Accessing vignettes via the package (requires internet)

```
vignette("introduction", package="EdSurvey")
```

- R help

```
help(package = "EdSurvey")
```



# iNRD



# iNRD

- A Shiny exploratory tool that visualizes results from one of the NCES data -National Assessment of Educational Progress (NAEP)- across year
- The iNRD is built using the R statistical software and it features an interactive interface with dropdowns, checkboxes and slider bars for ease of use
- Users can explore NAEP results and create customized plots including charts and maps that display NAEP national, state, and TUDA performances across multiple years, and broken down across a variety of student groups. Users can also download and save their plots to the png, pdf, or svg format.

- Some current NCES data visualization tools are cumbersome
  - In NAEP Data Explorer and International Data Explorer, a user has to follow certain procedure to achieve a goal. Any mistake in a intermediate step will mess up the whole process, and the user has to go back to the beginning and restart the analysis.
  - Does not support sophisticated data exploration

## Trend in fourth-grade NAEP mathematics average scores by Gender

Interactive NAEP Results Display Home National - States - TUDA -

### Interactive NAEP Results Display Tool

#### About Interactive NAEP Results Display

The Interactive NAEP Results Display (iNRD) is an exploratory tool that visualizes NAEP mathematics and reading results from 1990 to 2017. The tool is built using the R statistical software and it features an interactive interface with dropdowns, checkboxes and slider bars for ease of use. Users can explore NAEP results and create customized plots including charts and maps that display NAEP national, state, and TUDA performances across multiple years, and broken down across a variety of student groups. Users can also download and save their plots to the png, pdf, or svg format.

#### Please cite all iNRD plots as:

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1990 - 2017 Mathematics and Reading Assessments, Interactive NAEP Results Display.

#### Difference Between EdSurvey

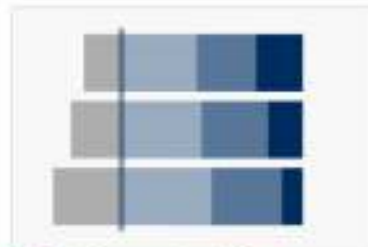
Another tool for research involving NAEP data is the [EdSurvey R package](#), which gives users functions to connect seamlessly with NAEP data sets and to perform analyses that account for both complex sample survey design and the use of plausible values. Although the focus of the EdSurvey R package is for in-depth analyses of full NAEP data sets, iNRD features critical demographic variables and groups in visual displays accessible to a wide audience - with or without statistical expertise.

**NOTE:** This version of iNRD is a preliminary version, and is still undergoing active development. We welcome your feedback! Please contact us at [EdSurvey.help@ed.gov](mailto:EdSurvey.help@ed.gov) with questions, comments, and other inquiries.

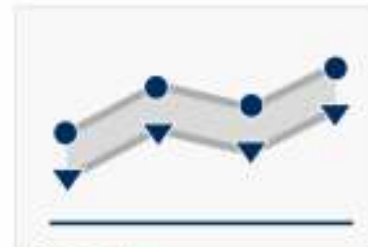
#### Explore Plot Options



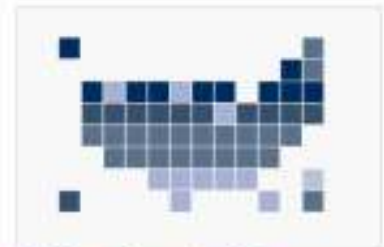
NAEP Line Plots



NAEP Achievement Level Plots



NAEP Gap Plots



NAEP State Comparison Plots

## Virginia fourth-grade NAEP mathematics achievement levels by race (black)

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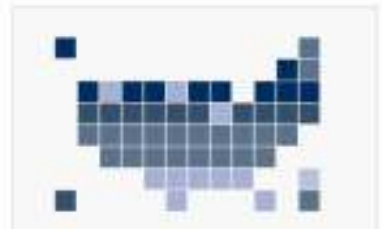
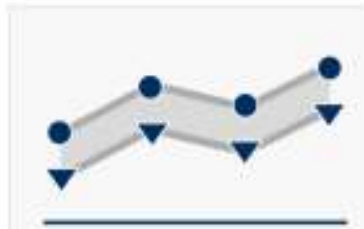
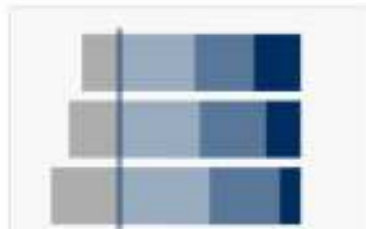
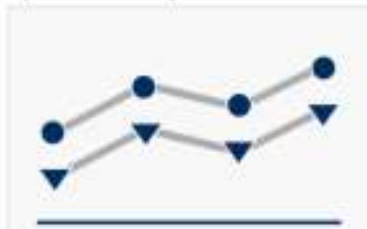
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**NOTE:** This version of iNRD is a preliminary version, and is still undergoing active development. We welcome your feedback! Please contact us at [EdSurvey.help@ed.gov](mailto:EdSurvey.help@ed.gov) with questions, comments, and other inquiries.

#### Explore Plot Options



Percent of Fourth-grade students at or above Proficient in Reading by IEP status (Y)