

Author Name(s) Biography

Dr. Danni Yu is a Sr. Research Scientist in Oncology at Eli Lilly and Company. She received her doctoral degree in Statistics from Purdue University, where she worked with several multidisciplinary experts to develop statistical methods for multi-omic datasets. After joining Lilly in 2013, Dr. Yu focused her research on statistical methodology and software implementation of biomarker-driven clinical trial analysis for target therapy development. She developed a shiny app named BEACH that provides a table/figure/listing (TFL) automation platform for R users. The package was published in GitHub and R CRAN in October 2016.

Michael Man received his doctorate in biochemistry and molecular biology from University of Minnesota. He completed postdoctoral training in biostatistics at University of North Carolina in 1998. Before joining Lilly in 2007, Dr. Man was a statistician at Pfizer Ann Arbor site. At Lilly, he has made significant contribution to PGx and biomarker area. He provided technical leadership in genomic submission and post marketing support for Prasugrel. More recently, his work has been focused on tailoring in oncology, covering early phase compounds. He has contributed to the scientific community with more than 20 publications.

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BEACH: an open platform for building interactive and automated analysis powered by R/Shiny

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PharmaSUG 2018
Paper #XXXX

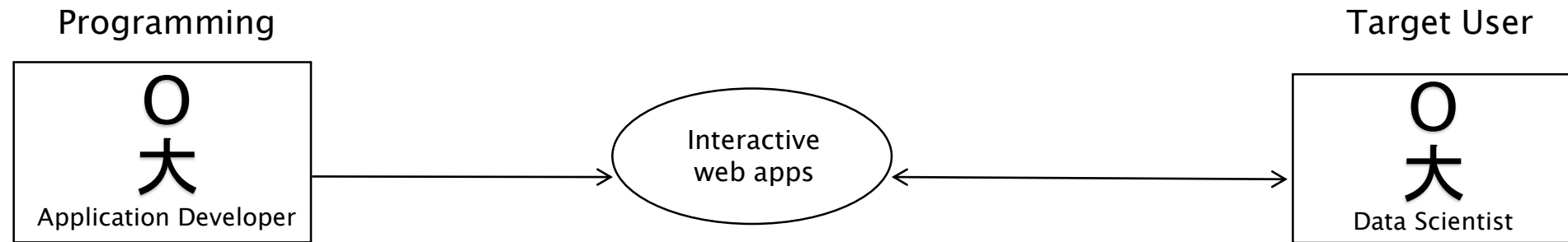


Outline

- ▶ Motivation
 - Typical use case of automated analysis
 - Introduction to R/Shiny
 - The challenge of managing code
- ▶ BEACH features
 - Built-in capability to import multiple types of datasets
 - Flexible in running different analysis
 - Easy to save output, LoA and code for traceability
 - Capable for generating animation file
 - Adjustable graph quality and table layout
- ▶ New BEACH analysis creation
- ▶ Summary and conclusion



Typical use case for automated analyses



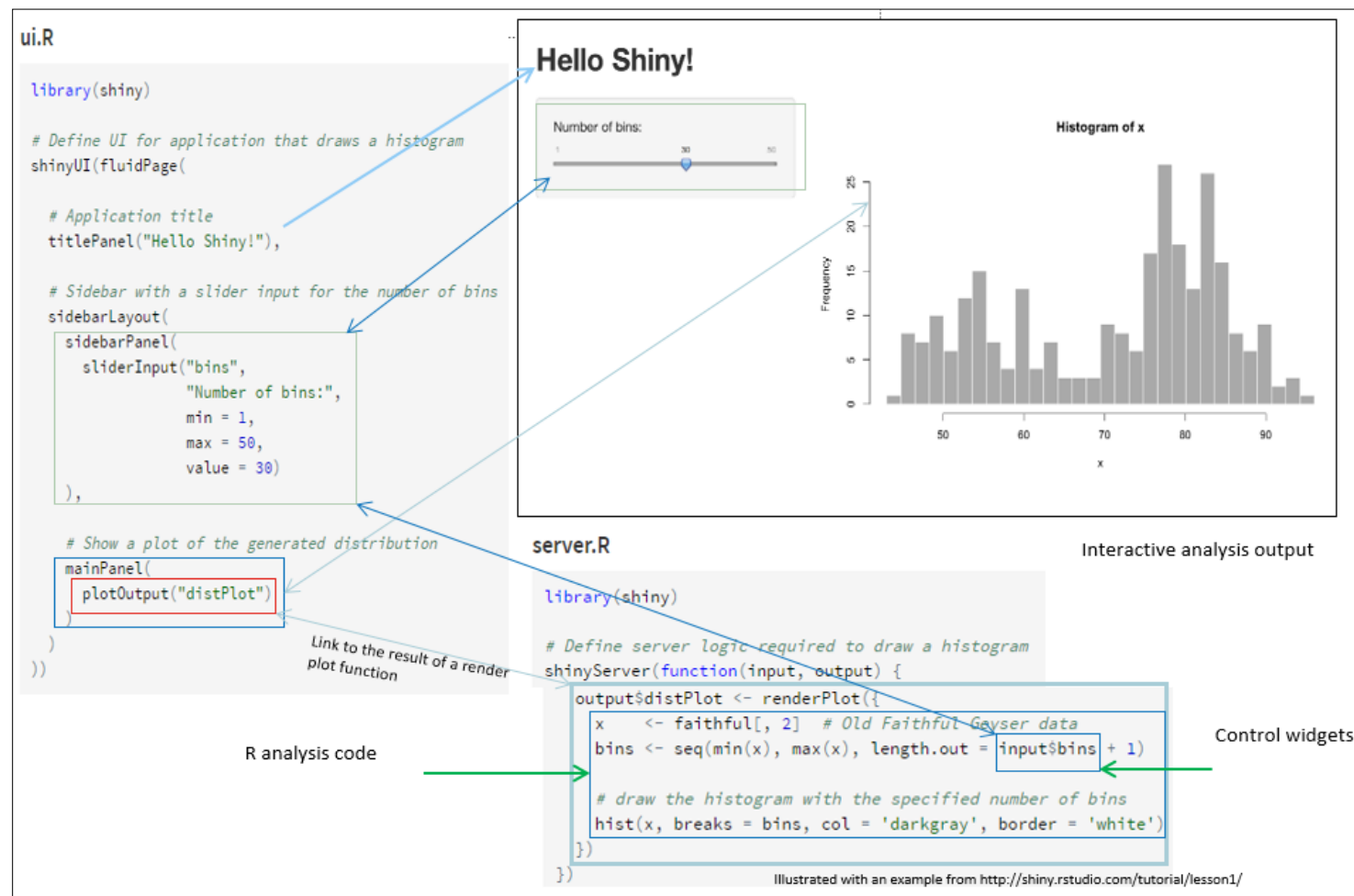
R/Shiny developed by RStudio

- is a powerful tool to build interactive web applications
- works in R environment
- enables web app development in R



Introduction to R/Shiny

- ▶ A Shiny app requires two parts: UI and server.
 - UI has the dynamic HTML code for user interface passed through the 'shinyUI' function.
 - Server has the R analysis function sent to the backend JavaScript through the 'shinyServer' function.



The challenge of managing code

- ▶ Users has to *repeatedly* embed R analysis code as an element of the 'output' object in the server file.
- ▶ Users has to define the widgets *redundantly* and *separately* in the ui file.
- ▶ Ok for simple analysis, but *headache for large numbers of analyses* with large numbers of widgets
- ▶ Time-consuming and difficult experience for code management and debugging



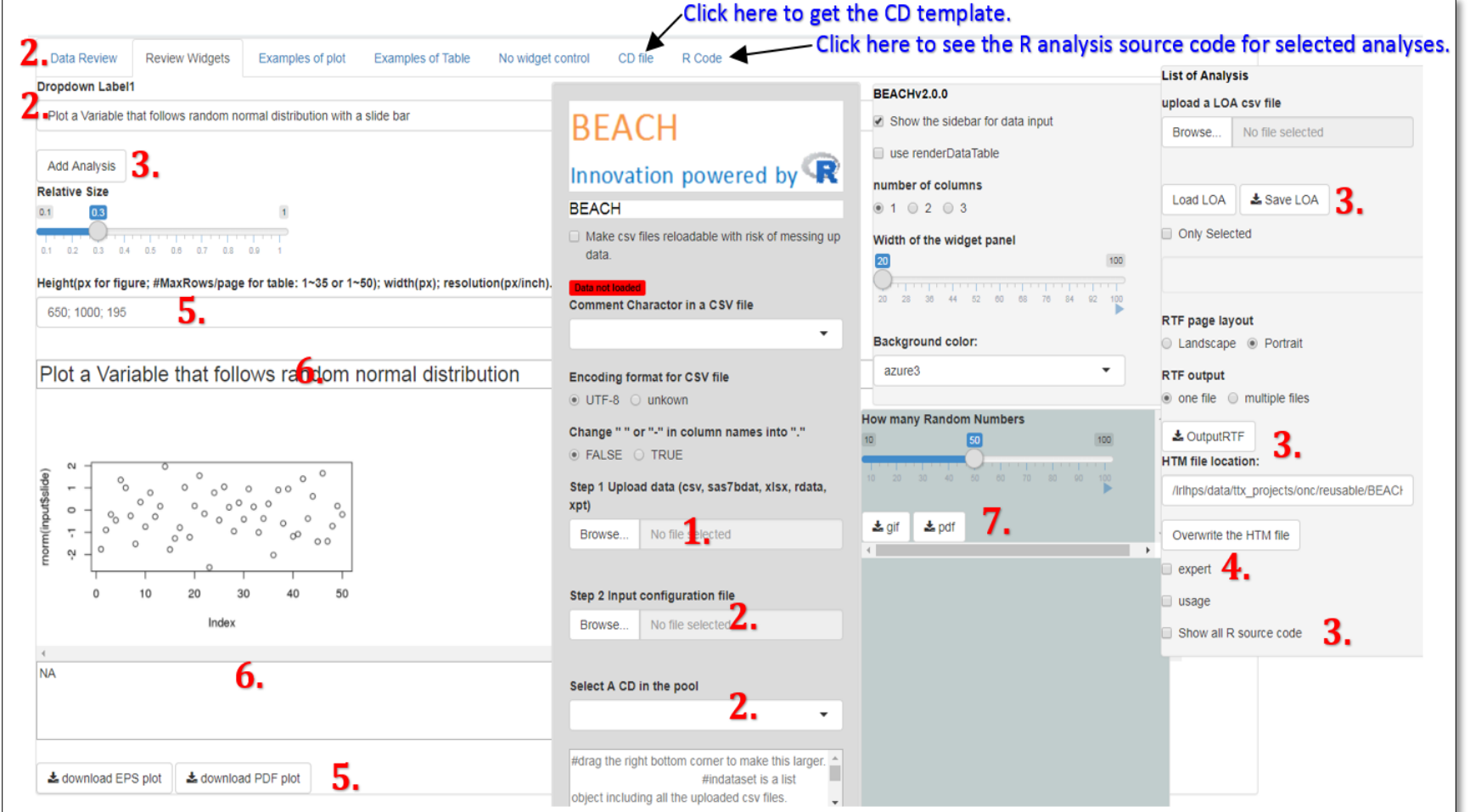
To meet the challenge

- ▶ BEACH was designed to
 - avoid of repeating blocks of shiny code
 - give up redundant programming for widget controls
 - enable app developers to focus on R coding only
 - remove the time and cost used for debugging in R/shiny code
 - manage large number of R chunk code and the interactive dashboard in only one configuration (CD) file
 - make the CD file user-friendly and editable in CSV format



Overview of BEACH

- ▶ Biometrics
Exploratory
Analysis
Creation
House.
- ▶ Key features are illustrated in the following 7 slides



The screenshot displays the BEACH web application interface, which is used for biometrics exploratory analysis creation. The interface is divided into several sections:

- Top Navigation:** Includes tabs for "Data Review", "Review Widgets", "Examples of plot", "Examples of Table", "No widget control", "CD file", and "R Code".
- Left Panel (Data Review):**
 - Contains a "Dropdown Label1" and a "Plot a Variable that follows random normal distribution with a slide bar".
 - Includes a "Relative Size" slider (0.1 to 1.0) and a "Height(px for figure; #MaxRows/page for table: 1~35 or 1~50); width(px); resolution(px/inch)" input field.
 - Displays a scatter plot of "norm(input\$side)" vs "Index".
 - Includes a "download EPS plot" and "download PDF plot" button.
- Center Panel (BEACH):**
 - Contains the "BEACH" logo and the text "Innovation powered by R".
 - Includes a "Data not loaded" message and a "Comment Character in a CSV file" dropdown.
 - Includes an "Encoding format for CSV file" dropdown (UTF-8, unknown).
 - Includes a "Change ' ' or ' ' in column names into ' ' " dropdown (FALSE, TRUE).
 - Includes a "Step 1 Upload data (csv, sas7bdat, xlsx, rdata, xpt)" section with a "Browse..." button.
 - Includes a "Step 2 Input configuration file" section with a "Browse..." button.
 - Includes a "Select A CD in the pool" dropdown.
 - Includes a "#drag the right bottom corner to make this larger." instruction and a "#indataset is a list object including all the uploaded csv files." instruction.
- Right Panel (BEACHv2.0.0):**
 - Includes a "Show the sidebar for data input" checkbox and a "use renderDataTable" checkbox.
 - Includes a "number of columns" dropdown (1, 2, 3).
 - Includes a "Width of the widget panel" slider (20 to 100).
 - Includes a "Background color:" dropdown (azure3).
 - Includes a "How many Random Numbers" slider (10 to 100).
 - Includes a "List of Analysis" section with an "upload a LOA csv file" section (Browse..., No file selected) and a "Load LOA" button.
 - Includes an "RTF page layout" section (Landscape, Portrait) and an "RTF output" section (one file, multiple files).
 - Includes an "OutputRTF" button.
 - Includes an "HTM file location:" input field.
 - Includes an "Overwrite the HTM file" section (expert, usage) and a "Show all R source code" checkbox.

Numbered callouts (1-7) highlight specific features:

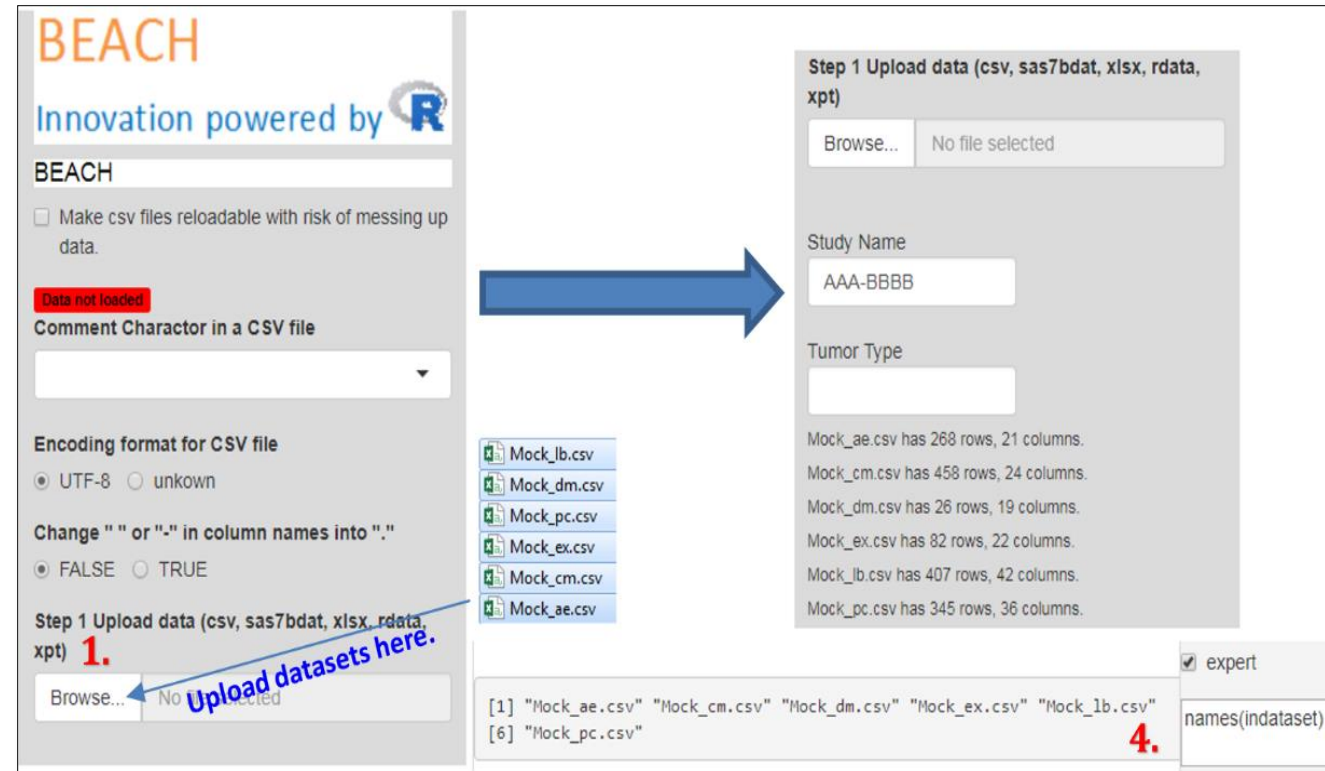
1. "Data not loaded" message
2. "Step 1 Upload data" and "Step 2 Input configuration file" buttons
3. "Load LOA" button
4. "expert" checkbox
5. "download EPS plot" and "download PDF plot" buttons
6. "Index" label on the plot
7. "How many Random Numbers" slider

Additional annotations:

- "Click here to get the CD template." points to the "CD file" tab.
- "Click here to see the R analysis source code for selected analyses." points to the "R Code" tab.

Built-in capability to import data

- ▶ BEACH is flexible in reading different types of datasets directly, such as SDTM or ADaM SAS datasets, or data in the format of SAS7BDAT, XPT, CSV, EXCEL, and Rdata.



BEACH
Innovation powered by R

BEACH

☐ Make csv files reloadable with risk of messing up data.

Data not loaded

Comment Character in a CSV file

Encoding format for CSV file

☒ UTF-8 ☐ unknown

Change " " or "-" in column names into "."

☒ FALSE ☐ TRUE

Step 1 Upload data (csv, sas7bdat, xlsx, rdata, xpt) **1.**

Browse... No file selected

Upload datasets here.

Mock_lb.csv
Mock_dm.csv
Mock_pc.csv
Mock_ex.csv
Mock_cm.csv
Mock_ae.csv

Step 1 Upload data (csv, sas7bdat, xlsx, rdata, xpt)

Browse... No file selected

Study Name
AAA-BBBB

Tumor Type

Mock_ae.csv has 268 rows, 21 columns.
Mock_cm.csv has 458 rows, 24 columns.
Mock_dm.csv has 26 rows, 19 columns.
Mock_ex.csv has 82 rows, 22 columns.
Mock_lb.csv has 407 rows, 42 columns.
Mock_pc.csv has 345 rows, 36 columns.

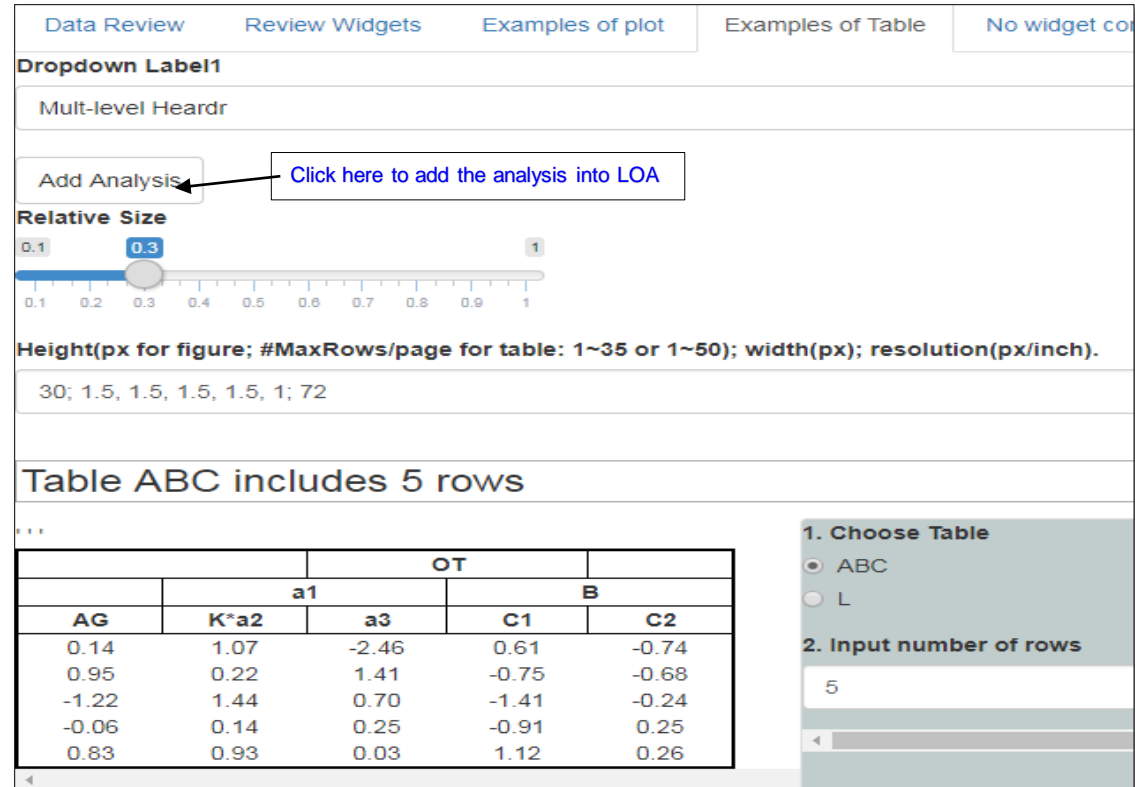
☒ expert

[1] "Mock_ae.csv" "Mock_cm.csv" "Mock_dm.csv" "Mock_ex.csv" "Mock_lb.csv"
[6] "Mock_pc.csv" **4.**

names(indataset)

Flexible in running different analyses

- ▶ Incorporating both source and self-replication analysis codes
- ▶ Three hierarchical layers for users to change or switch analysis

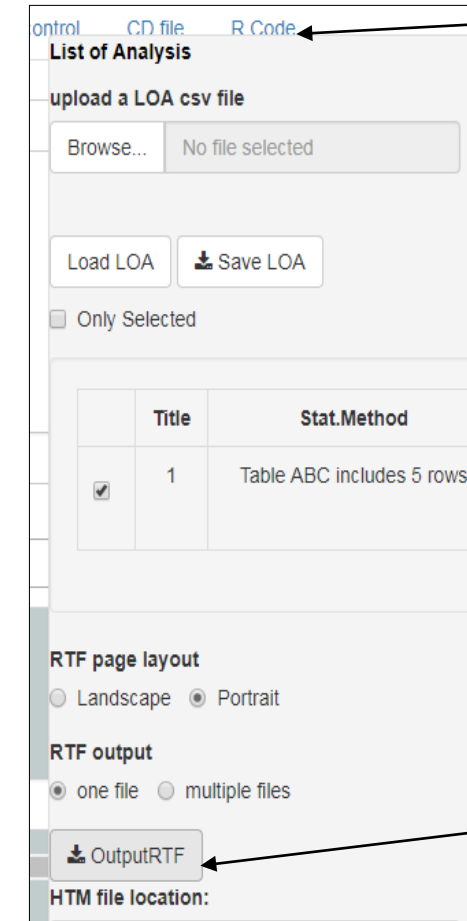


The screenshot displays a web interface for configuring analysis parameters. At the top, there are tabs: "Data Review", "Review Widgets", "Examples of plot", "Examples of Table", and "No widget co". Below the tabs, the "Dropdown Label1" section shows "Mult-level Heardr". An "Add Analysis" button is highlighted with a callout box that says "Click here to add the analysis into LOA". Below this is a "Relative Size" slider ranging from 0.1 to 1.0, with the current value set at 0.3. The "Height(px for figure; #MaxRows/page for table: 1~35 or 1~50); width(px); resolution(px/inch)." section shows the value "30; 1.5, 1.5, 1.5, 1.5, 1; 72". The "Table ABC includes 5 rows" section displays a table with 5 rows and 5 columns. To the right of the table, there are two sections: "1. Choose Table" with radio buttons for "ABC" (selected) and "L", and "2. Input number of rows" with a text input field containing the value "5".

a1			OT	
AG	K*a2	a3	C1	C2
0.14	1.07	-2.46	0.61	-0.74
0.95	0.22	1.41	-0.75	-0.68
-1.22	1.44	0.70	-1.41	-0.24
-0.06	0.14	0.25	-0.91	0.25
0.83	0.93	0.03	1.12	0.26

Easy to save output, LoA and code

- ▶ On the list-of-Analyses (LoA) panel, users can add analysis into the table, select or deselect the analysis, and then output the table or figure result into one or multiple RTF files.
- ▶ Under the 'Rcode' session, users can review or download the main R scripts and source functions of the selected analysis.



control CD file R Code

List of Analysis

upload a LOA csv file

Browse... No file selected

Load LOA Save LOA

☐ Only Selected

	Title	Stat.Method
<input checked="" type="checkbox"/>	1	Table ABC includes 5 rows

RTF page layout

☐ Landscape ☒ Portrait

RTF output

☒ one file ☐ multiple files

OutputRTF

HTM file location:

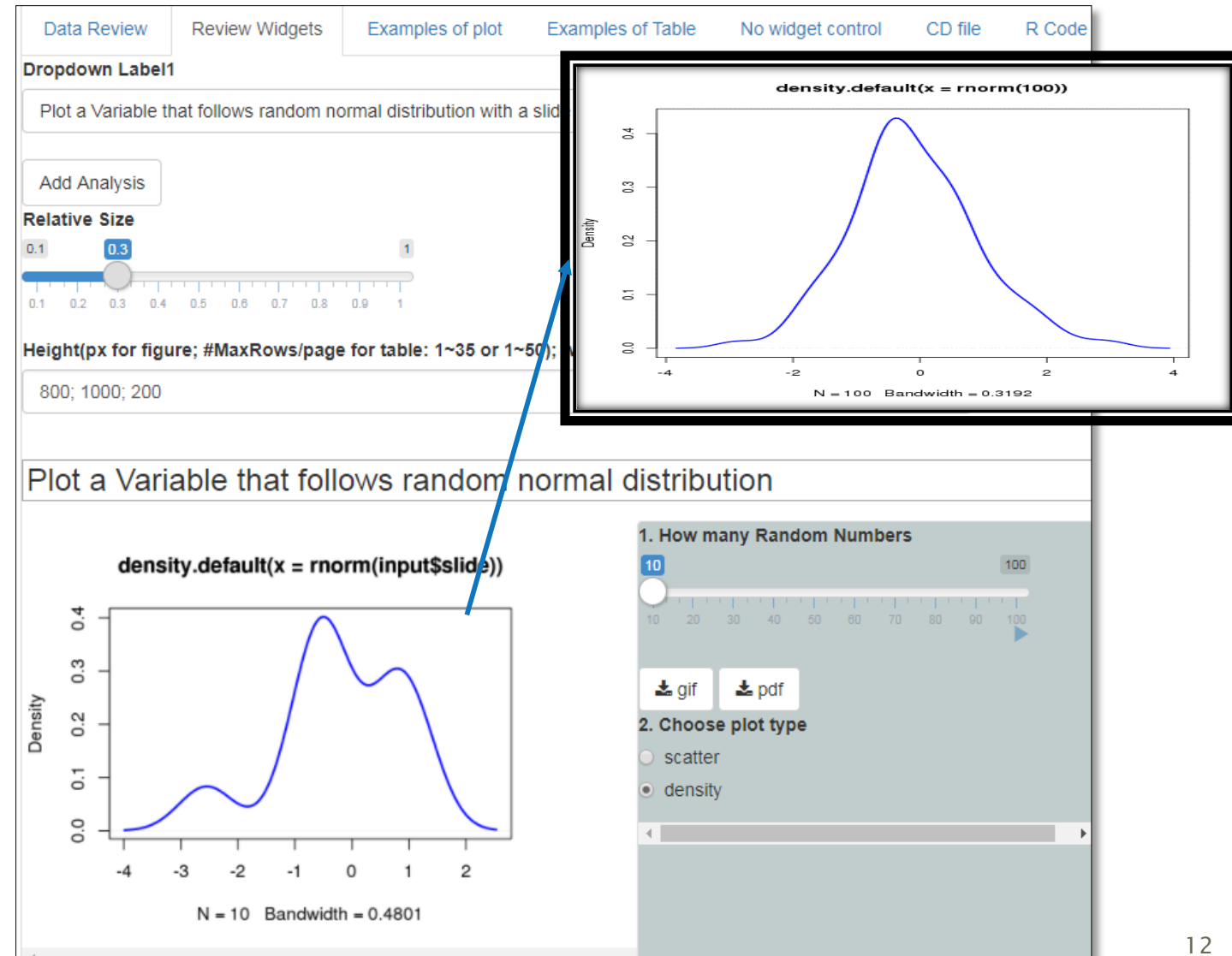
[Click here to obtain the main and source code](#)

[Click here to download the table in RTF](#)



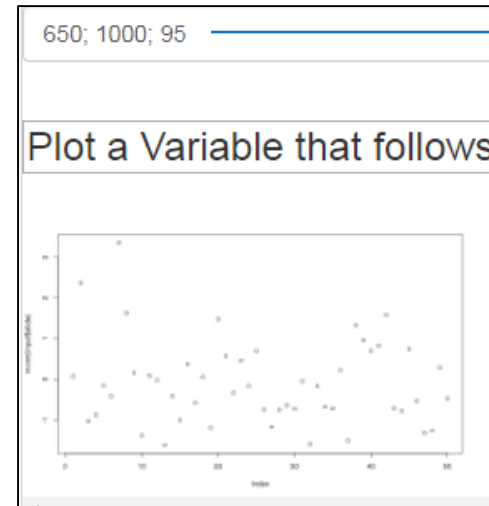
Capable for generating animation files

- ▶ Innovatively, BEACH provides an auto-sequent-downloading button
- ▶ It creates an animation file in a GIF file or a library file in a PDF file.

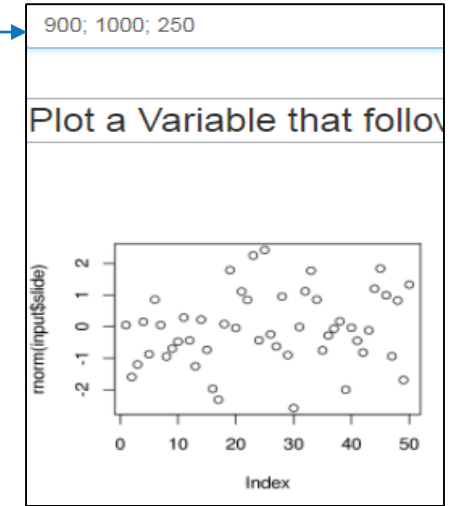


Adjustable graph quality and table layout

- ▶ Immediately adjusting figure resolution



Change the height (px), width (px), resolution (px/inch) to increase the quality of figure.



- ▶ Available for creating multi-level header table

Height(px for figure; #MaxRows/page for table: 1~35 or 1~50); width(px); resolution(px/inch).

30; 1.5, 1.5, 1.5, 1.5, 1; 72

Table ABC includes 5 rows

OT				
	a1		B	
AG	K*a2	a3	C1	C2
1.12	0.88	1.59	1.45	0.19
2.43	-0.59	0.06	1.35	0.12
0.41	-1.10	-0.84	1.63	-0.80
0.64	-1.82	0.33	0.77	-1.47
-0.69	0.03	-0.39	0.20	-0.82

*a Table ABC.5.
Total values of each column are 1.

Table ABC includes 5 rows

Study:
21:00 30Mar2018

Page 1

	a1		B	
	K*a2	a3	C1	C2
AG				
-0.32781206121434	0.643406561943446	-0.824535318347388	-0.29836882844405	0.4833090436
0.821785824671225	-0.026824897422162	0.939232711540138	-0.155672819777883	1.3394403762
0.317349275673816	0.404342461008576	-2.3219978468198	0.755965449746731	-0.306563125
0.183865903274687	-0.695283827559111	1.00012384707319	-0.551327889049908	935223
-0.663504207709725	-0.270170712781845	0.0984506166093572	-1.42997971847979	-0.432800155
				823015
				20011

Page 1 of 1 54 words English (United States)

Create new BEACH analysis in CD

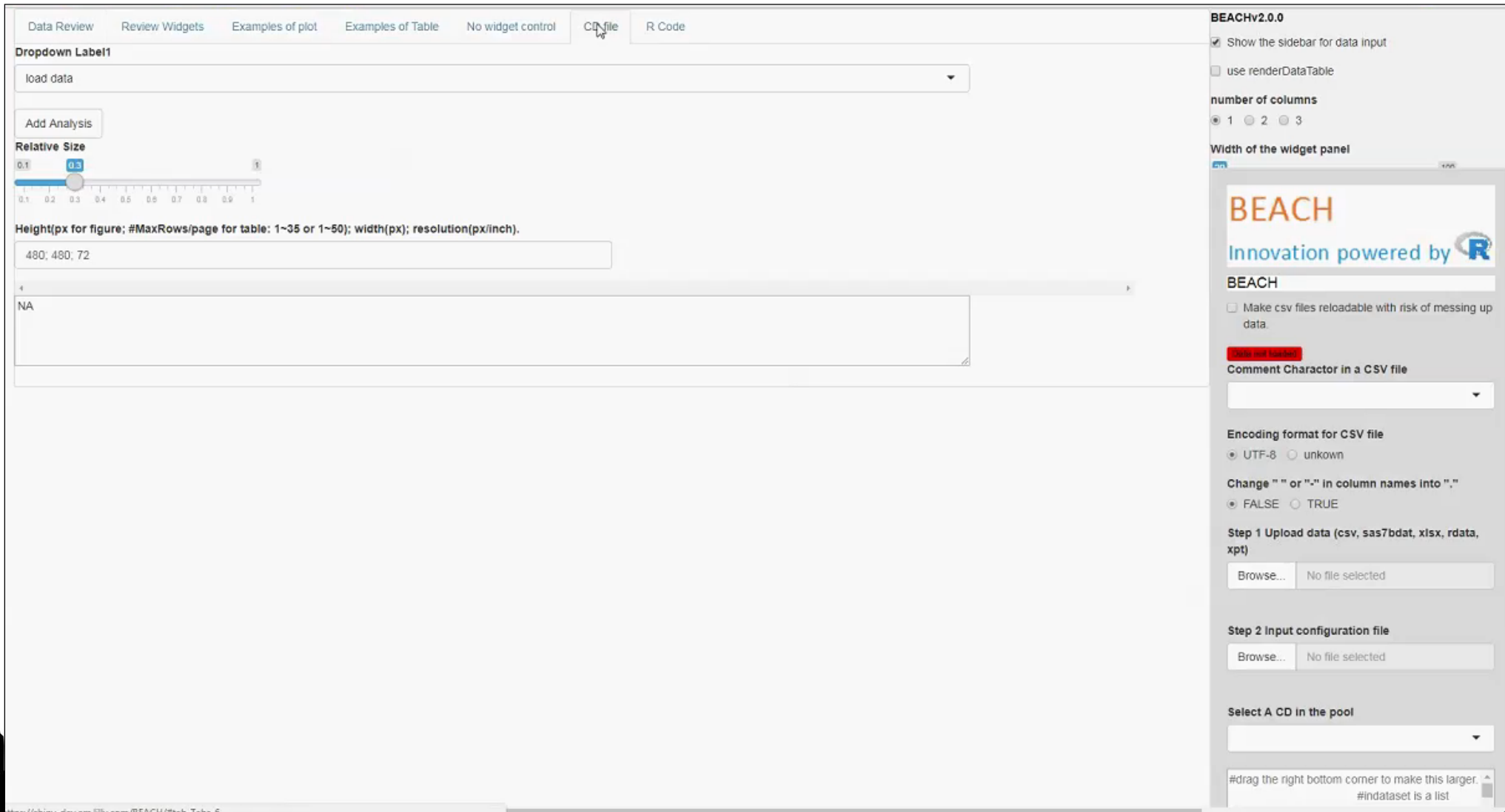
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Num	Add	Tab.value	Tab.label	select.label	Type	Source	Request.Name	Condition	Layout	Title	height	width	res	tmp	PlotCode	FootCode
0	TRUE	NA	NA	NA	title_image	NA	NA	NA	NA	logo.png	NA	NA	NA	NA	NA	
0	TRUE	NA	NA	NA	title_text	NA	NA	NA	NA	Add my Bi	NA		NA	NA		
1	TRUE	Tab0	Data Review	Dropdown Label	--	empty.r	load data	FALSE	1		0	0	NA		0 indataset.names <- names(indataset)tab	NA
3	TRUE	Tab1	Review W	Dropdown Label	Figure	NA	Plot a Variable tha	FALSE	1	Plot a Vari	650	1000	95		0 if(is.null(input\$slide)){ plot.new()}else{	NA
4	TRUE	cd	CD file	Dropdown Label	Table	NA	Show the current	FALSE	1	Configura	0	0	NA		0 Vdic0	
5	TRUE	rcode	R Code	NA	--	rcode.r	NA	NA	NA	NA	0	0	NA		0 return(NULL)	NA

T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
uiInput1	uilab1	uiInput2	uilab2	uiInput3	uilab3	uiInput4	uilab4	uiInput5	uilab5	uiInput6	uilab6	slide.min	slide.max	slide.by	slide.valu	slide.labe	slide.alert	radio.labe	radio.choi
						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		
						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
input\$slid	Random N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10	100	5	50	How many	NA	NA	NA
input\$rad	any label	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	no widget c	'at least N
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

- ▶ Managing code through configuration (CD) file
- ▶ The CD includes the layout, control widgets and R code



Live demo for adding a new analysis



The screenshot displays the BEACHv2.0.0 web application interface. The main panel on the left contains a 'Dropdown Label1' with a 'load data' button, an 'Add Analysis' button, a 'Relative Size' slider (set to 0.3), and a 'Height(px for figure; #MaxRows/page for table: 1~35 or 1~50); width(px); resolution(px/inch)' field set to '480; 480; 72'. Below this is a table with one row containing 'NA'. The right sidebar, titled 'BEACHv2.0.0', includes several configuration options: 'Show the sidebar for data input' (checked), 'use renderDataTable' (unchecked), 'number of columns' (set to 1), and 'Width of the widget panel' (set to 600). The sidebar also features the BEACH logo, a checkbox for 'Make csv files reloadable with risk of messing up data' (unchecked), a 'Comment Character in a CSV file' dropdown, 'Encoding format for CSV file' (set to UTF-8), and a checkbox for 'Change " " or "-" in column names into "."' (set to FALSE). The sidebar is divided into two steps: 'Step 1 Upload data (csv, sas7bdat, xlsx, rdata, xpt)' with a 'Browse...' button and 'No file selected' status, and 'Step 2 Input configuration file' with a 'Browse...' button and 'No file selected' status. At the bottom, there is a 'Select A CD in the pool' dropdown and a note about dragging the right bottom corner to make the panel larger.

Data Review Review Widgets Examples of plot Examples of Table No widget control **CD file** R Code

Dropdown Label1

load data

Add Analysis

Relative Size

0.1 0.3 1

0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Height(px for figure; #MaxRows/page for table: 1~35 or 1~50); width(px); resolution(px/inch).

480; 480; 72

NA

BEACHv2.0.0

☒ Show the sidebar for data input

☐ use renderDataTable

number of columns

☒ 1 ☐ 2 ☐ 3

Width of the widget panel

600

BEACH

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BEACH

☐ Make csv files reloadable with risk of messing up data.

Make csv files reloadable

Comment Character in a CSV file

Encoding format for CSV file

☒ UTF-8 ☐ unknown

Change " " or "-" in column names into "."

☒ FALSE ☐ TRUE

Step 1 Upload data (csv, sas7bdat, xlsx, rdata, xpt)

Browse... No file selected

Step 2 Input configuration file

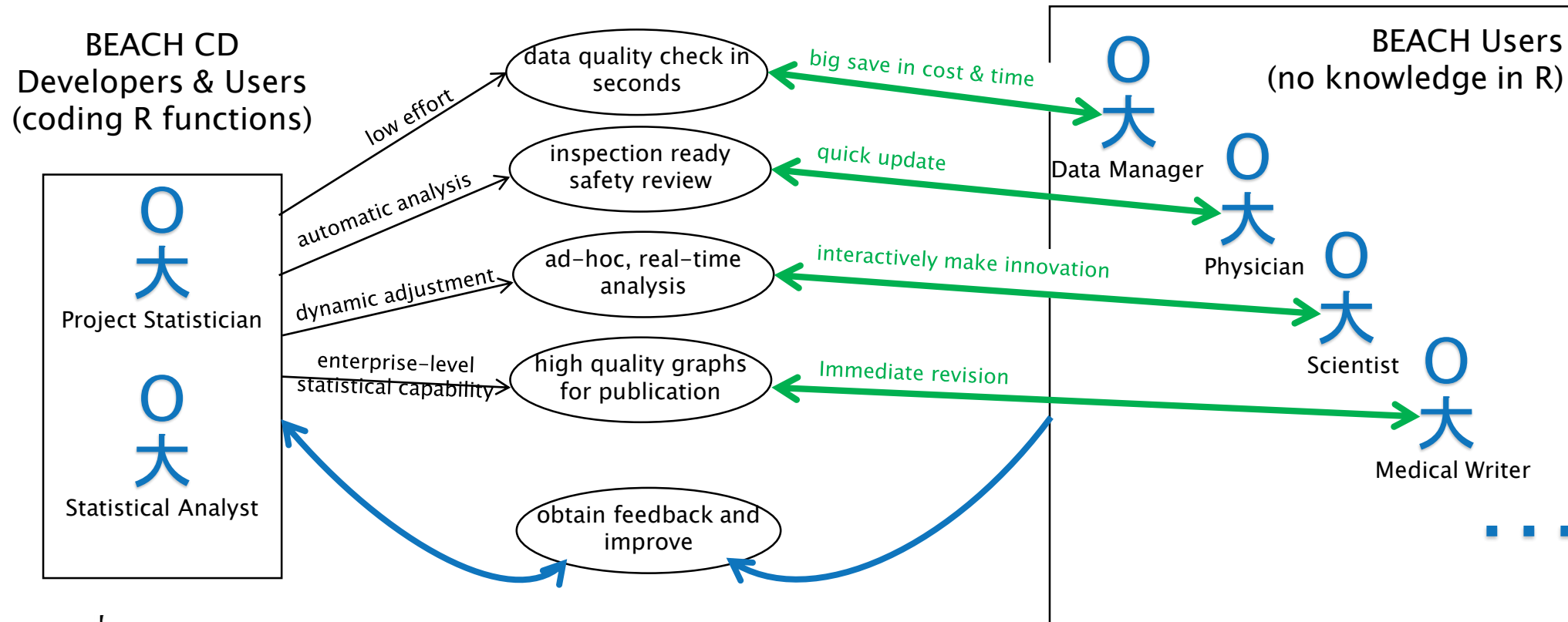
Browse... No file selected

Select A CD in the pool

#drag the right bottom corner to make this larger.

#indataset is a list

Summarizing use cases of BEACH



BEACH is a systematic tool that

- helps statisticians reduce redundant work
- enhances communication efficiency
- improves cross-disciplinary collaboration

Conclusion

- ▶ R/Shiny is a powerful tool for creating interactive analysis but hard for code management with unnecessary redundancy.
- ▶ BEACH is an innovative platform that
 - enables interactive and automatic study having large numbers of analyses,
 - combines the sophisticated backend R/Shiny and HTML code,
 - helps users build web GUI quickly for comprehensive statistical analysis.



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