

# Fast Input-Response Space Filling (FIRSF) Designs Application User Guide

## Section 1: Data Preparation

### Section 1.1: Prepare Data

#### Section 1.1.1: Download Reference Materials

Download Demonstration Materials:

<a href="#">User Guide</a>	
<a href="#">Regression model</a>	<a href="#">Regression with saddle point</a>
<a href="#">Regression with irregular area</a>	<a href="#">Exponential function</a>
<a href="#">Grmacy and Lee function</a>	<a href="#">Two inputs and two responses</a>
<a href="#">Three inputs and one response</a>	

- You may download a sample data set by clicking buttons below the “*User Guide*” button such as “*Regression model*” button. The example data set consists of two groups of candidate data. Attached below is an image of the first few rows of the example data set. You may also download this guide by clicking the “*User Guide*” button

	A	B	C
1	x1	x2	y1
2	-1	-1	40
3	-1	-0.931	40.67334
4	-1	-0.862	41.31335
5	-1	-0.7932	41.91832
6	-1	-0.7242	42.49177
7	-1	-0.6552	43.0319
8	-1	-0.5862	43.53869
9	-1	-0.5172	44.01216
10	-1	-0.4482	44.45231
11	-1	-0.3794	44.85799
12	-1	-0.3104	45.23158
13	-1	-0.2414	45.57184
14	-1	-0.1724	45.87877
15	1	0.1024	46.15720

#### Section 1.1.2: Upload Data

Upload Data:

Upload data	No file selected
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- In *Upload Data* part, please click the *Upload File* button to upload a .csv file with your data. Please check that the data has the same format as the example data given above. The data set should contain two parts. The first part contains the *n*-dimensional input candidate set as *n* columns in the tables, and the second part contains the *m*-dimensional response candidate set as *m* columns in the tables. The order should be {*input set*, *response set*}.

Data Recognition:

Please enter the dimension of input space and response space

Input	Response
<input type="text"/>	<input type="text"/>

- After the data set is uploaded, please use the textboxes in *Data Recognition* section to enter the dimension of input space (*Input* textbox) and response space (*Response* textbox) to let this

application recognize input part and response part of candidate set. Then the application automatically populates the *Data Visualization* tab.

## Section 1.2: Validate Data

### Section 1.2.1: Instruction

**Step:**

1. Complete the Prepare Data section to generate the Data Visualization and Candidate Data tabs

2. Complete the IRSF-clustering section to generate ISF, RSF, or IRSF Pareto Front

For more detailed operations, please read the guidebook (File downloaded by the 'User Guide' button).

- In the *Instructions* tab, the page show the procedure of this application. For more information, please read this guidebook.

### Section 1.2.2: Data Visualization

Instructions

Data Visualization

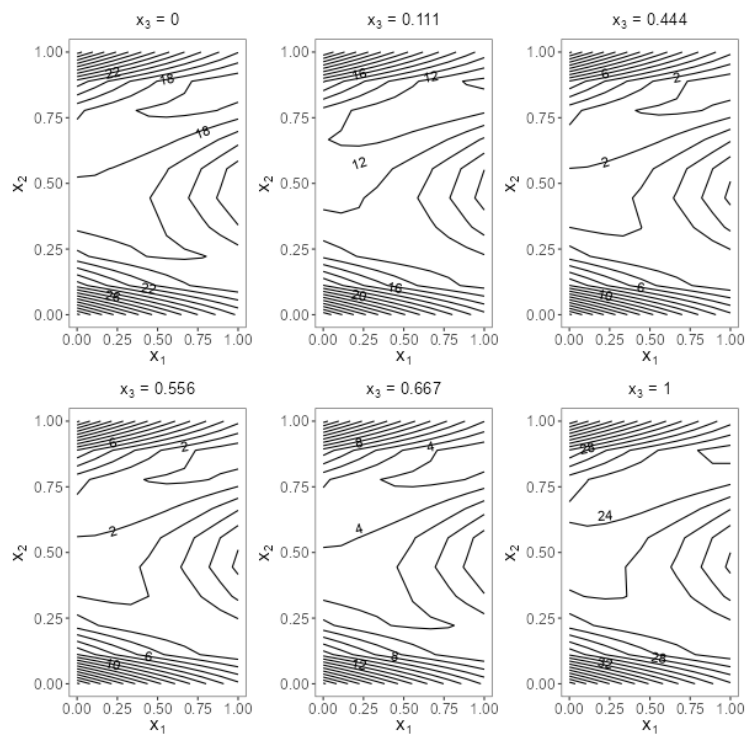
- After inputting the dimensions of input space and response space, you can click the *Data Visualization* tab to view the data structure. The plots are available for lower dimensional cases (1d input and 1d response; 2d input and 1d response; 3d input and 1d response; 2d input and 2d response).

Rows

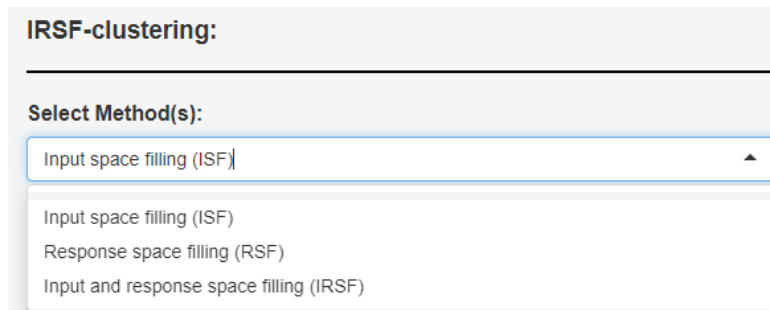
5

- Please enter the number of rows of candidate set in *Rows* textbox. The default number is “5”. After the number of “*Rows*” be entered, the table sample and plots (for special dimensional cases) would be shown in the page as below. Here the 3 dimensional input space and 1 dimensional response space would be utilized as an example.

x1	x2	x3	y1
0.00	0.00	0.00	35.00
0.11	0.00	0.00	33.27
0.22	0.00	0.00	31.64
0.33	0.00	0.00	30.11
0.44	0.00	0.00	28.68

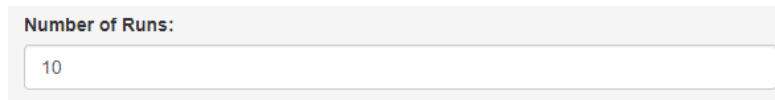


## Section 2: FIRSF Designs



The screenshot shows a web interface titled "IRSF-clustering:". Below the title is a section labeled "Select Method(s):" which contains a dropdown menu. The dropdown menu is currently open, showing three options: "Input space filling (ISF)", "Response space filling (RSF)", and "Input and response space filling (IRSF)". The first option, "Input space filling (ISF)", is selected and highlighted.

- After the candidate set is uploaded and the dimensions of input space and response space are entered, the method of space-filling designs needs to be selected with the *Select Method(s)* menu. There are three choices including input space-filling (ISF) designs, response space-filling (RSF) designs, and input-response space-filling (IRSF) designs.



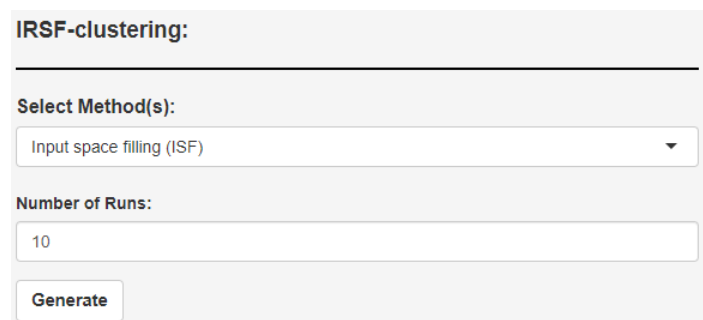
The screenshot shows a web interface titled "Number of Runs:". Below the title is a text input field containing the number "10".

- Please use the *Number of Runs* textbox to enter the number of runs in a design. The default number is “10”. The number requires that it is a positive integer number, and it cannot be over the candidate set size. If a number is not a positive integer number or over the candidate set size, a warning message would be given as below.



The first screenshot shows the "Number of Runs:" field with the value "10.3". Below the field, an orange warning message reads: "Please enter a positive integer number!". The second screenshot shows the "Number of Runs:" field with the value "2000". Below the field, an orange warning message reads: "The number of runs is over the candidate size!".

### Section 2.1: ISF



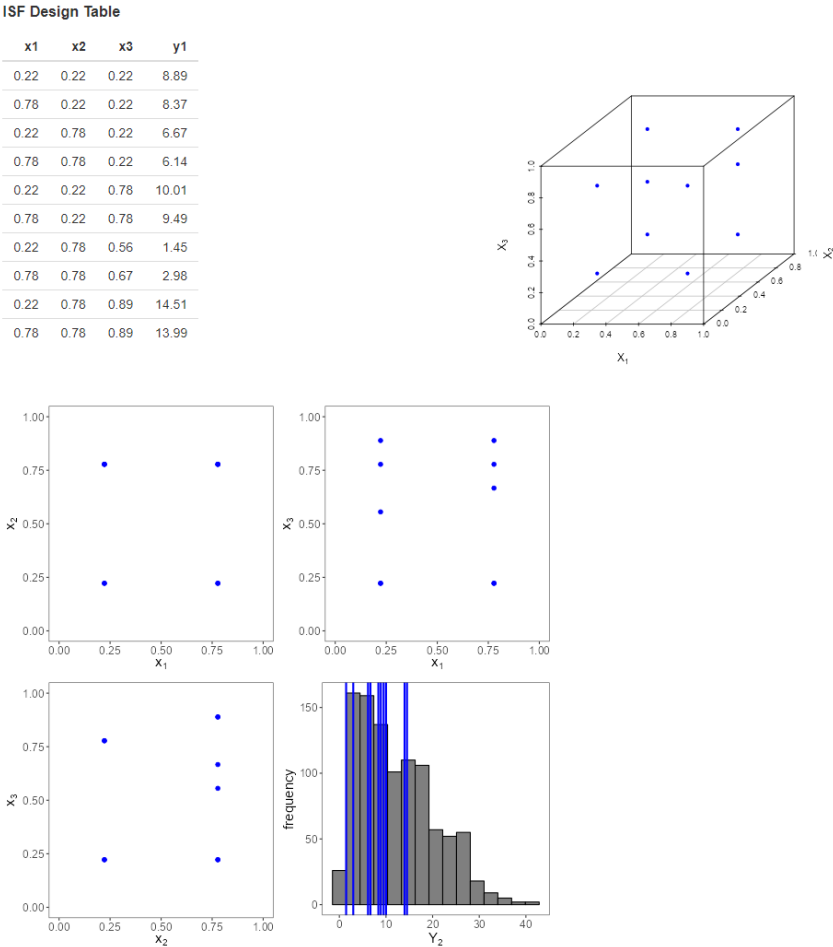
The screenshot shows a web interface titled "IRSF-clustering:". Below the title is a section labeled "Select Method(s):" which contains a dropdown menu with "Input space filling (ISF)" selected. Below this is a section labeled "Number of Runs:" which contains a text input field with the value "10". At the bottom of the interface is a button labeled "Generate".

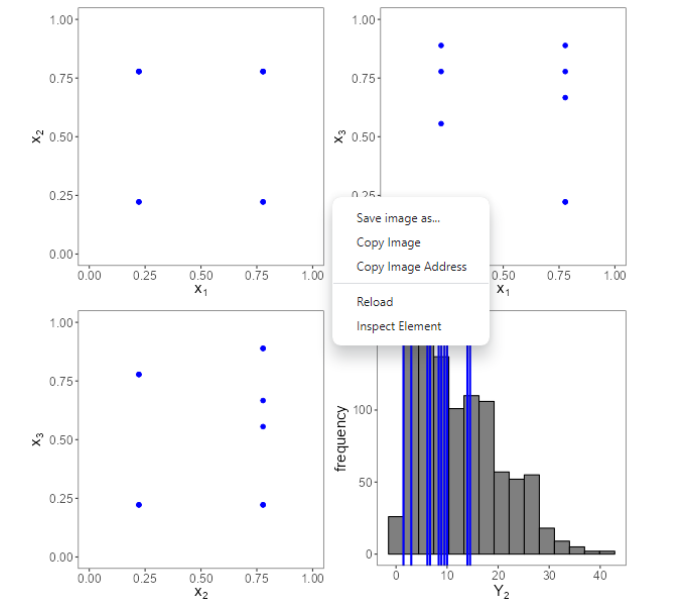
- If you select *Input space filling (ISF)* from the *Select Method(s)* menu and enter a number in the *Number of Runs* textbox, click the *Generate* button to process input space-filling (ISF) design.

ISF Design Table

x1	x2	x3	y1
0.22	0.22	0.22	8.89
0.78	0.22	0.22	8.37
0.22	0.78	0.22	6.67
0.78	0.78	0.22	6.14
0.22	0.22	0.78	10.01
0.78	0.22	0.78	9.49
0.22	0.78	0.56	1.45
0.78	0.78	0.67	2.98
0.22	0.78	0.89	14.51
0.78	0.78	0.89	13.99

- After you click the *Generate* button, please click *ISF* tab to check the result. In *ISF* tab page, there is a *ISF Design Table* given here. If your data satisfy the plot condition (1d input and 1d response; 2d input and 1d response; 3d input and 1d response; 2d input and 2d response), you will also get the related design plot. The following figure shows a result for a 3-dimensional input space and 1-dimensional response space case. You can also right-click the plot to save or copy the image.





## Section 2.2: RSF

**IRSF-clustering:**

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**Select Method(s):**

Response space filling (RSF) ▼

**Number of Runs:**

10

**Generate**

- If you select **Response space filling (ISF)** from the **Select Method(s)** menu and enter a number in the **Number of Runs** textbox, click the **Generate** button to process input space-filling (ISF) design.

**Instructions** **Data Visualization** **RSF**

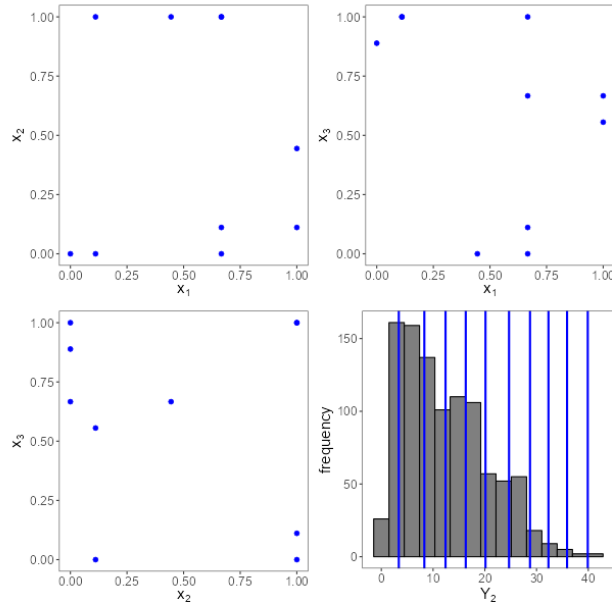
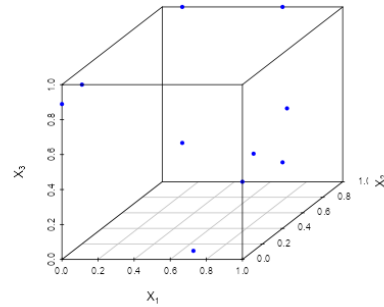
**RSF Design Table**

x1	x2	x3	y1
0.11	1.00	1.00	35.90
0.00	0.00	0.89	32.30
0.67	1.00	1.00	28.74
0.44	1.00	0.00	24.68
0.67	0.11	0.00	20.13
0.67	1.00	0.11	16.31
0.67	0.00	0.67	12.41
1.00	0.44	0.67	8.31
1.00	0.11	0.56	3.37
0.11	0.00	1.00	39.90

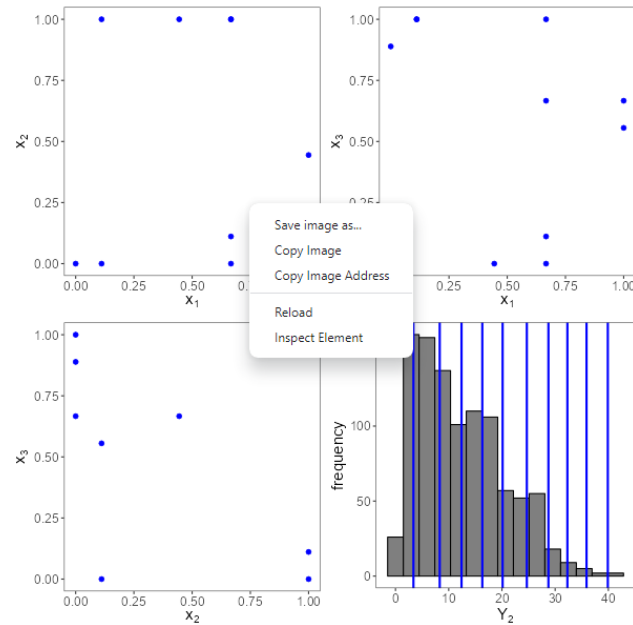
- After you click the **Generate** button, please click **RSF** tab to check the result. In **RSF** tab page, there is a **RSF Design Table** given here. If your data satisfy the plot condition (1d input and 1d response; 2d input and 1d response; 3d input and 1d response; 2d input and 2d response), you will also get the related design plot. The following figure shows a result for a 3-dimensional input space and 1-dimensional response space case. You can also right-click the plot to save or copy the image.

RSF Design Table

x1	x2	x3	y1
0.11	1.00	1.00	35.90
0.00	0.00	0.89	32.30
0.67	1.00	1.00	28.74
0.44	1.00	0.00	24.68
0.67	0.11	0.00	20.13
0.67	1.00	0.11	16.31
0.67	0.00	0.67	12.41
1.00	0.44	0.67	8.31
1.00	0.11	0.56	3.37
0.11	0.00	1.00	39.90







## Section 2.3: IRSF

**IRSF-clustering:**

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**Select Method(s):**

Input and response space filling (IRSF) ▼

**Number of weights:**

50

**Attention :** This value heavily affects the running time and memory usage.

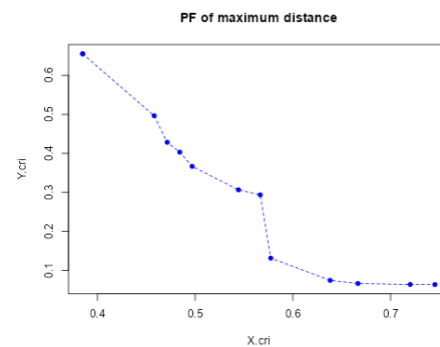
**Number of Runs:**

10

**Generate**

- If you select **Input and Response space filling (IRSF)** from the **Select Method(s)** menu, there is a new textbox shown in **IRSF-clustering** section, named **Number of weights**. The value in the **Number of weights** textbox decides how many weights systematically chosen from 0 to 1 are selected to run the FIRSF function. The default value is “50”. Please be careful to enter the number of weights since “This value heavily affects the running time and memory usage” as **Attention** shown. Same as the above, please use the **Number of Runs** textbox to enter the number of runs in a design. After you finish the above inputs, please click the **Generate** button to process the FIRSF procedure.

Pareto Front Plot:



Criterion Table:

X.max	Y.max	weight.x	Method
0.38	0.66	1.00	complete
0.38	0.66	1.00	average
0.46	0.50	0.90	average
0.47	0.43	0.80	mcquitty
0.48	0.40	0.96	average
0.50	0.37	0.78	complete
0.54	0.31	0.82	mcquitty
0.57	0.29	0.62	average
0.58	0.13	0.72	average
0.64	0.07	0.02	average
0.67	0.07	0.06	complete
0.72	0.06	0.10	average
0.75	0.06	0.06	average

- After you click the **Generate** button, please click the **IRSF** tab to check the result. There are two parts showing at the top of this page, the **Pareto Front Plot** (left) and the **Criterion Table** (right). In the **Pareto Front Plot** part, you can click the points in the plot to get the specific design table as following.

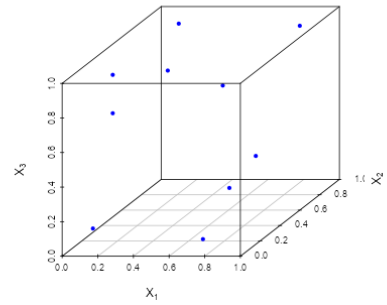
Design table

x1	x2	x3	y1
0.11	0.11	0.11	17.98
0.67	0.22	0.00	18.81
0.44	0.89	0.00	18.18
0.78	0.56	0.33	6.09
0.22	0.67	0.78	7.81
0.22	0.11	0.78	13.44
0.78	0.22	0.89	16.21
0.22	0.11	1.00	29.48
0.78	1.00	0.89	18.28
0.22	0.78	1.00	23.83

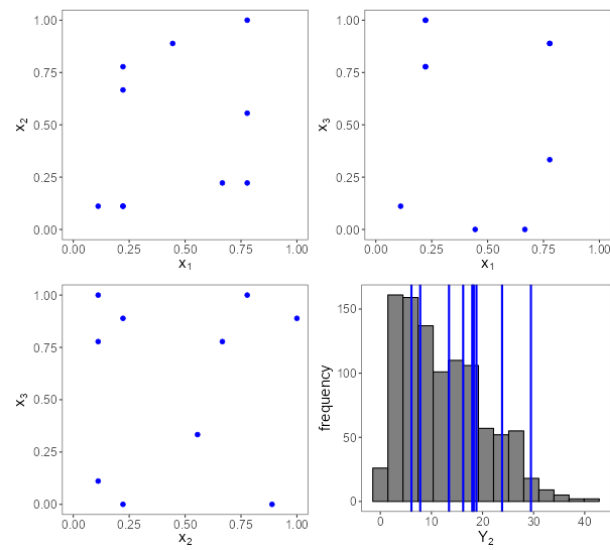
- For some special cases (1d input and 1d response; 2d input and 1d response; 3d input and 1d response; 2d input and 2d response), you can also get the related plot at the bottom of this page. Here we give an example for a 3-dimensional input space and 1-dimensional response space case as following. You can also right-click the plot to save or copy the image.

Design table

x1	x2	x3	y1
0.11	0.11	0.11	17.98
0.67	0.22	0.00	18.81
0.44	0.89	0.00	18.18
0.78	0.56	0.33	6.09
0.22	0.67	0.78	7.81
0.22	0.11	0.78	13.44
0.78	0.22	0.89	16.21
0.22	0.11	1.00	29.48
0.78	1.00	0.89	18.28
0.22	0.78	1.00	23.83



The 8 design on PF with average method



The 8 design on PF with average method

