

Balloon Plot

Graphical tool for displaying tabular data

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Introduction

Numeric data is often summarized using rectangular tables. While these tables allow presentation of all of the relevant data, they do not lend themselves to rapid discovery of important patterns. The primary difficulty is that the visual impact of numeric values is not proportional to the scale of the numbers represented.

We have developed a new graphical tool, the `balloonplot`, which augments the numeric values in tables with colored circles with area proportional to the size of the corresponding table entry. This visually highlights the prominent features of data, while preserving the details conveyed by the numeric values themselves.

In this article, we describe the `balloonplot`, as implemented by the `balloonplot` function in the `gplots` package, and describe the features of our implementation.

Function description

The `balloonplot` function accepts a table (to be displayed as found) or lists of vectors for x (column category), y (row category) and z (data value) from which a table will be constructed.

The `balloonplot` function plots a graphical table, where each cell displays the appropriate numeric value plus a colored circle whose size reflects the relative magnitude of the corresponding component. The *area* of each circle is proportional to the frequency of data. (The circles are scaled so that the circle for largest value fills the available space in the cell.)

As a consequence, the largest values in the table are “spotlighted” by the biggest circles, while the smaller values are displayed with very small circles. Of course, circles can only have positive radius, so the radius of circles for cells with negative values are set to zero. (A warning is issued when this “truncation” occurs.)

Of course, when labels are present on the table or provided to the function, the graphical table is appropriately labeled. In addition, options are provided to allow control of various visual features of the plot:

- rotation of the row and column headers
- balloon color and shape (globally or individually)

- number of displayed digits
- display of entries with zero values
- display of marginal totals
- display of cumulative histograms
- x- and y-axes group sorting
- formatting of row and column labels
- as well as the traditional graphics parameters (title, background, etc.)

Example using the Titanic data set

For illustration purposes, we use the Titanic data set from the `datasets` package. Titanic provides survival status for passengers on the tragic maiden voyage of the ocean liner “Titanic”, summarized according to economic status (class), sex, and age.

Typically, the number of surviving passengers are shown in a tabular form, such as shown in Figure 1. (This was created by calling `balloonplot` with the `balloon` color set to match the background color and most options disabled.) Note that one must actively focus on the individual cell values in order to see any pattern in the data.

BalloonPlot : Surviving passengers

		Class				
		1st	2nd	3rd	Crew	
Age	Sex					
	Child	5	11	13	0	
Adult	Female	1	13	14	0	
	Male	57	14	75	192	
		Female	140	80	76	20

Figure 1: Tabular representation of survived population by gender and age

Now, we redraw the table with light-blue circles (‘balloons’) superimposed over the numerical values (figure 2). This is accomplished using the code:

```

data(Titanic)

# Convert to 1 entry per row format
dframe <- as.data.frame(Titanic)

# Select only surviving passengers
survived <- dframe[dframe$Survived=="Yes",]
attach(survived)

balloonplot(x=Class,
            y=list(Age, Sex),
            z=Freq,
            sort=TRUE,
            show.zeros=TRUE,
            dotcol='green',
            cum.margins=FALSE,
            main=
              "BalloonPlot : Surviving passengers"
            )

title(main=list("Circle area is proportional to\
              number of passengers",
              cex=0.9),
      line=0.5)

detach(survived)

```

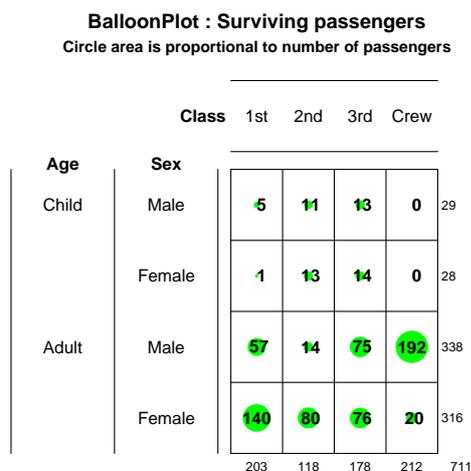


Figure 2: Balloon plot of surviving individuals by class, gender and age

With the addition of the blue “spotlights”, whose area is proportional to the magnitude of the data value, it is easy to see that only adult females and adult male crew members survived in large numbers. Note the addition of row and column marginal totals.

Of course, the number of surviving passengers is only half of the story. We could create a similar plot showing the number of passengers who did not survive. Alternatively, we can simply add survival status as another variable to the display, setting the

color of the circles to green for passengers who survived, and magenta for those who did not:

BalloonPlot : Passenger Class by Survival, Age and Sex
Circle area is proportional to number of passengers

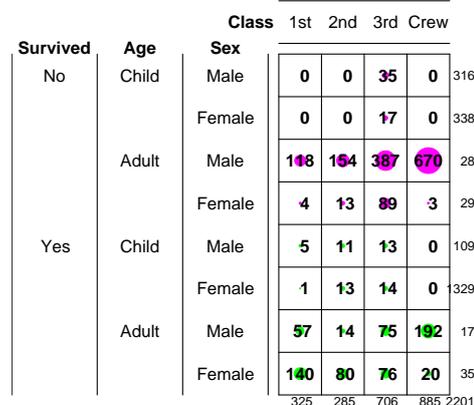


Figure 3: Balloon plot of Titanic passengers by gender, age and class. Green circles represent passengers who survived and magenta circles represent the passengers who did not survive.

Figure 3 conveys considerably more information than figures 1 and 2 without substantial loss of clarity. The large magenta circles make it clear that most passengers did not survive.

To further improve the display, we add a visual representation of the row and column sums using grey bars behind the row and column headers (figure 4). This is accomplished using the code:

```

attach(dframe)
colors <- ifelse( Survived=="Yes", "green",
                 "magenta")

balloonplot(x=Class,
            y=list(Survived, Age, Sex),
            z=Freq,
            sort=FALSE,
            dotcol=colors,
            show.zeros=TRUE,
            main="BalloonPlot : Passenger Class \
              by Survival, Age and Sex"
            )

points( x=1, y=8, pch=20, col="magenta")
points( x=1, y=4, pch=20, col="green")

title(main=list("Circle area is proportional to \
              number of passengers",
              cex=0.9),
      line=0.5)

detach(dframe)

```

BalloonPlot : Passenger Class by Survival, Age and Sex
Circle area is proportional to number of passengers

Survived		Age	Sex	Class				
No	Yes			1st	2nd	3rd	Crew	
No	Child	Male	0	0	35	0	316	
		Female	0	0	17	0	338	
	Adult	Male	118	154	387	670	28	
		Female	4	13	89	3	29	
	Child	Male	5	11	13	0	109	
		Female	1	13	14	0	329	
	Adult	Male	57	14	75	192	17	
		Female	140	80	76	20		
			325	285	706	885	2201	

Figure 4: Balloon plot of all the passengers of Titanic, stratified by survival, age, sex and class

It is now easy to see several facts:

- A surprisingly large fraction (885/2201) of passengers were crew members
- Most passengers and crew were adult males
- Most adult males perished
- Most women survived, except in 3rd class
- Only 3rd class children perished

Perhaps the most striking fact is that survival is lowest among 3rd class passengers for all age/gender groups. It turns out that there is a well known reason for this difference in survival. Passengers in 1st and 2nd class, as well as crew members, had better access to the lifeboats. Since there were too few lifeboats for the number of passengers and crew, most women and children among the 1st class, 2nd class and crew found space in a lifeboat, while many of the later arriving 3rd class women and children were too late: the lifeboats had already been filled and had moved away from the quickly sinking ship.

Conclusion

Using the well worn Titanic data, we have shown how balloonplots help to convey important aspects of tabular data, without obscuring the exact numeric values. We hope that this new approach to visualizing tabular data will assist other statisticians in more effectively understanding and presenting tabular data.

We wish to thank *Ramon Alonso-Allende* allende@cnb.uam.es for the discussion on R-help which lead to the development of *balloonplot*, as well as for the code for displaying the row and column sums.

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