

Random dots

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Introduction

We are not good at judging randomness. This document will compare two figures containing a selection of dots scattered on a grid. One of the grids will have a truly random scattering of dots. The other has a pattern of dots, but nevertheless, will look more random to the average observer.

Preliminaries

```
library(ggplot2)
set.seed(1234)
```

Functions

The `total_dots` argument is the total number of dots to plot in an `m` by `n` grid. The `random_dots` function will create exactly this many dots randomly distributed over the region, whereas `not_so_random_dots` will create `total_dots/(m * n)` dots in each of the `m * n` squares. (This number is rounded if `total_dots/(m * n)` is not a whole number.)¹

```
random_dots <- function(total_dots, m, n){
  x <- runif(total_dots)
  y <- runif(total_dots)
  xy <- data.frame(x, y)
  return(xy)
}

not_so_random_dots <- function(total_dots, m, n){
  # Fill each square randomly
  each_square <- function(x_shift, y_shift) {
    x <- x_shift + (1/m) * runif(round(total_dots/(m * n)))
    y <- y_shift + (1/n) * runif(round(total_dots/(m * n)))
    return(data.frame(x, y))
  }

  # Initialize empty data frame
  xy <- data.frame()
  # Glue all the squares together
  for(i in seq(0, (1 - 1/m), by = 1/m)){
    for(j in seq(0, (1 - 1/n), by = 1/n)){
      new_points <- each_square(x_shift = i, y_shift = j)
      xy <- rbind(xy, new_points)
    }
  }
  return(xy)
}
```

¹Rounded in R's weird "go to the even digit" way, though!

```

plot_dots <- function(xy, m, n) {
  ggplot(xy, aes(x = x, y = y)) +
    geom_point(size = rel(2)) +
    theme_minimal() +
    theme(panel.grid.major = element_line(size = rel(2))) +
    coord_fixed(ratio = n/m) +
    scale_x_continuous(name = NULL, labels = NULL,
                      breaks = seq(0, 1, by = 1/m),
                      minor_breaks = NULL,
                      limits = c(0, 1), expand = c(0, 0)) +
    scale_y_continuous(name = NULL, label = NULL,
                      breaks = seq(0, 1, by = 1/n),
                      minor_breaks = NULL,
                      limits = c(0, 1), expand = c(0, 0))
}

```

Set parameters

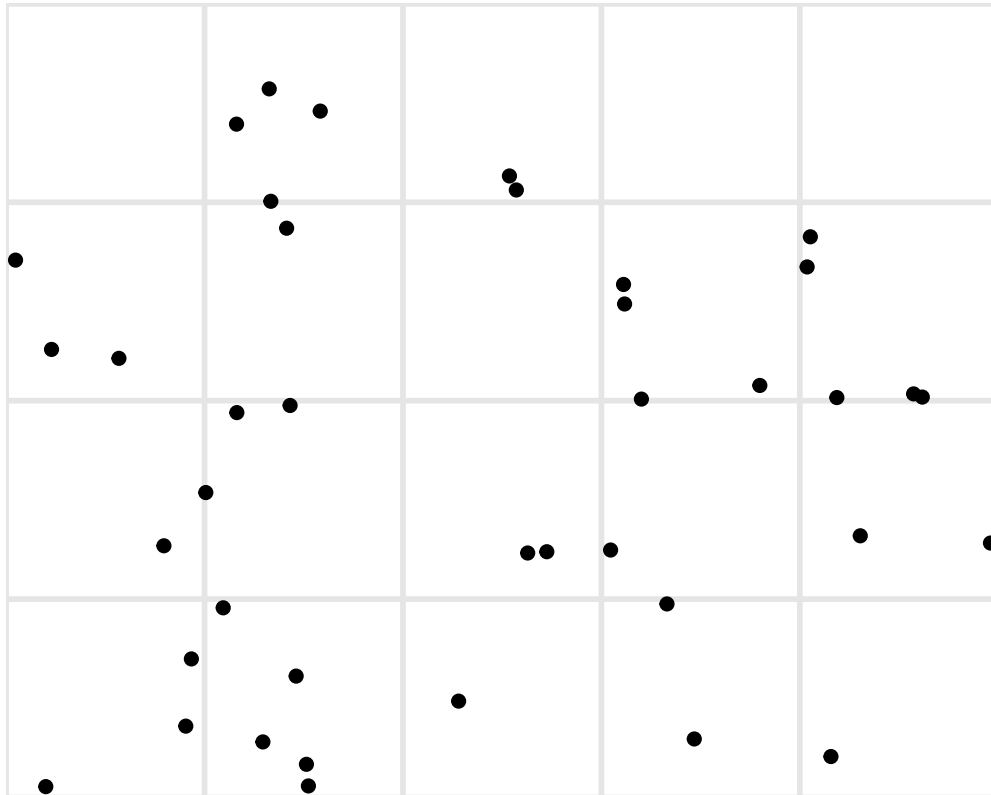
```

total_dots <- 40
m <- 5
n <- 4

```

Plot of random dots

```
xy <- random_dots(total_dots, m, n)  
plot_dots(xy, m, n)
```



Plot of not-so-random dots

```
xy <- not_so_random_dots(total_dots, m, n)  
plot_dots(xy, m, n)
```

