Random numbers

9 marks

Random numbers. Computers generate pseudo-random numbers which, although entirely deterministic, are meant to emulate truly random sequences.

In this question, you will examine numbers generated by an early random number generator produced by IBM for their first mainframes.

These are arranged as triples and available in `R` as the data-frame `random3d` (available in as the file `random3d.Rda` in the assignment `R` directory; use 'load("random3d.Rda")). Each number is constructed in order so as to appear to be an independently drawn sample value from a uniform distribution. If so, then the triples should appear as a uniform sample in a three dimensional cube.

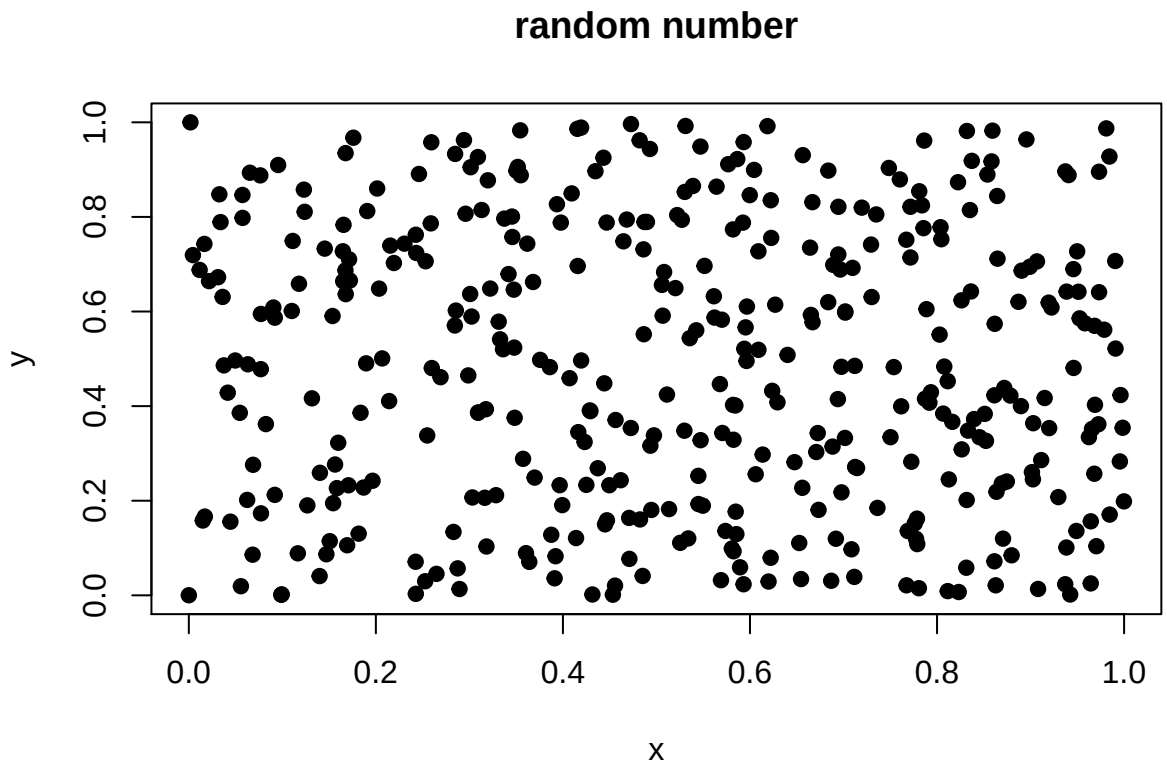
1200 of these random numbers have been created and saved in `R` as a 400 by 3 matrix whose rows are successive triples of the random numbers. The data matrix is in `R` as `random3d`.

Let $\mathbf{r}_i^T = (x_i, y_i, z_i)^T$ denote the ith row of `random3d`.

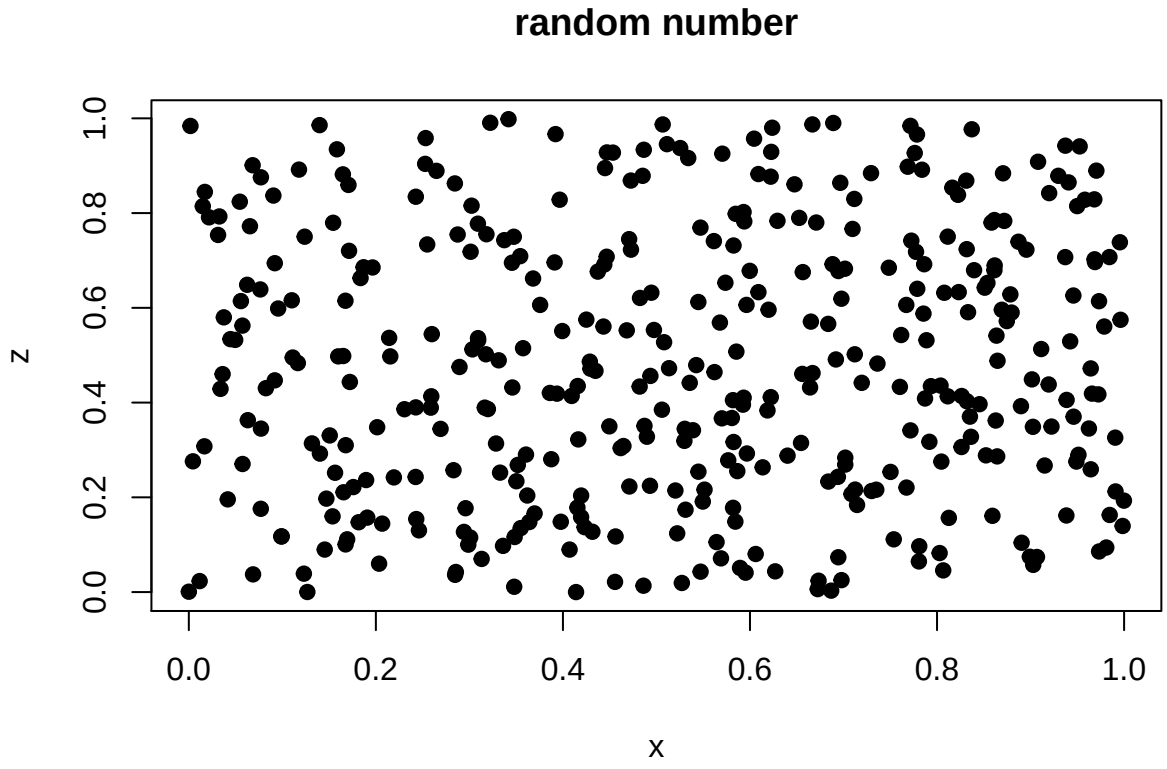
There are three separate sets of 2d points: (x_i, y_i), (x_i, z_i), and (y_i, z_i) for $i = 1, 2, \ldots, 400$.

a. **(6 marks)** Plot the data for each pair of variates (that is three different scatterplots). Comment on whether each pair of variates appear to come from independent marginal uniform distributions. Clearly explain your reasoning, using the displays as evidence.

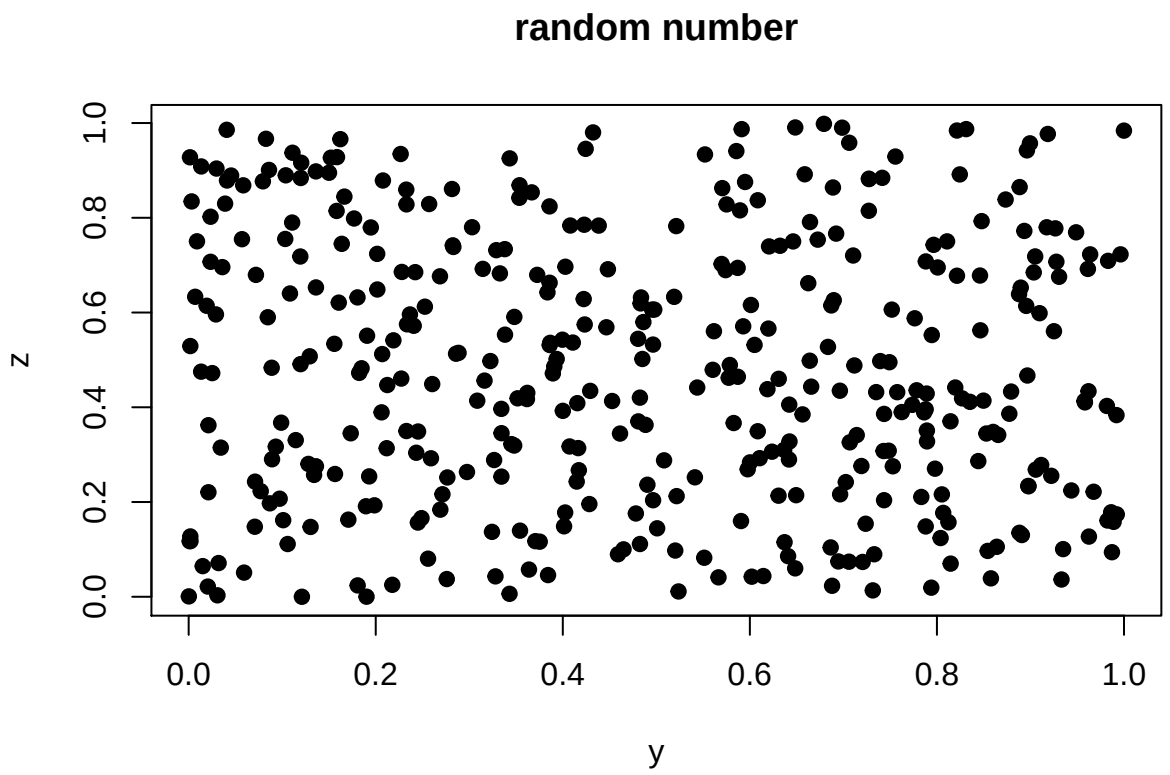
```
load("random3d.Rda")

x=random3d$x
y=random3d$y
z=random3d$z


plot(x,y,pch=19, main = "random number")
```




```
plot(x,z,pch=19, main = "random number")
```



```r
plot(y,z,pch=19, main = "random number")
```

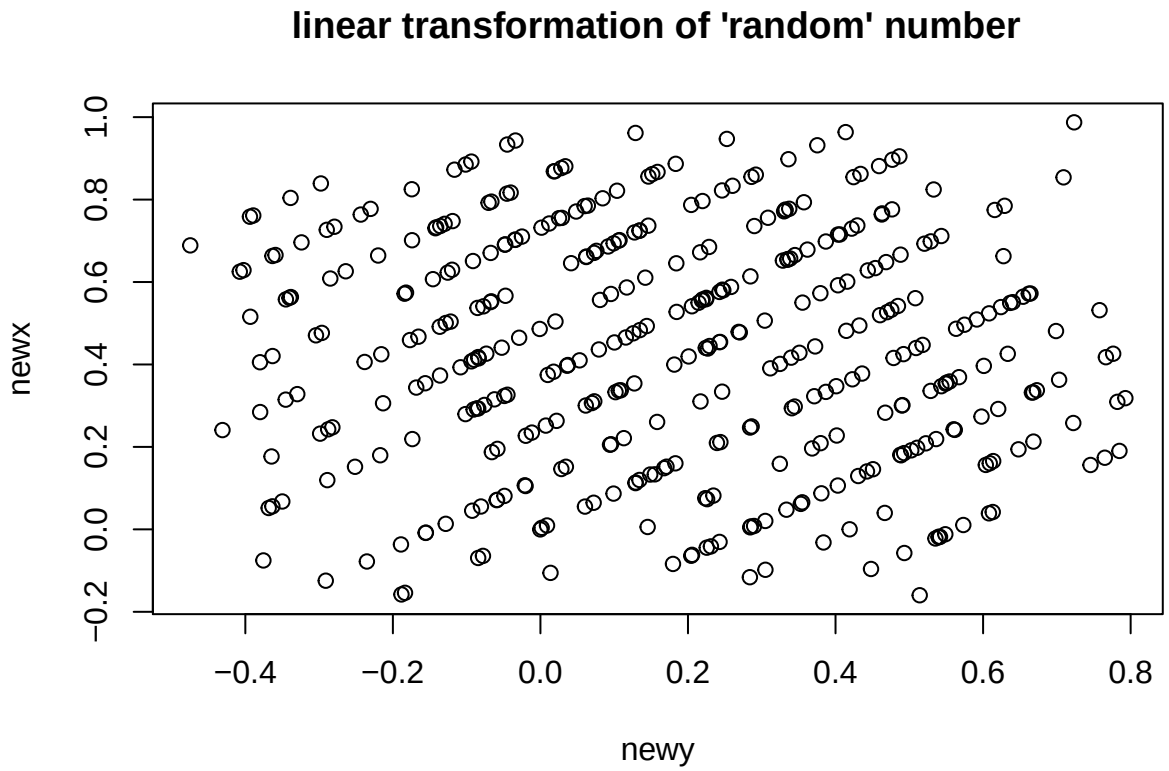


the data looks randomly uniform in all the two axis. there is no obvious pattern

b. **(3 marks)** Now use either `l_plot3D` or `l_navgraph` from `loon` to explore the joint three-dimensional structure of `random3d`.

   Comment on whether the three variates appear to have come from three independent uniform distributions. Explain your reasoning.

```r
#library("loon")
#l_plot3D(x,y,z)
newx = 0.975*x + 0.052*y -0.217*z
newy= y=-0.137*x+0.907*y-0.399*z
plot(newy, newx, main = "linear transformation of 'random' number")
```



we observe if we rotate to x = 0.975x + 0.052y -0.217z, y=-0.137x+0.907y-0.399z, all points are parallel to a line in 2d. And the parallel lines are equally separated. we conclude the points are not randomly generated, And there are values that the simulated random number cannot take.