MA323 Lab-4
C. Akshay
200123013

Q1. The following are the mean and variance of the sample

Mean of Z1 generated from Box-Muller method: -0.004219702547243169
Variance of Z1 generated from Box-Muller method: 1.0184240605062744

Mean of Z2 generated from Box-Muller method: -0.015206417146939821
Variance of Z2 generated from Box-Muller method: 1.0137866348035094

Mean of Z1 generated from Marsaglia and Bray method: 0.00022750252123027615
Variance of Z1 generated from Marsaglia and Bray method: 0.9692759936649232

Mean of Z2 generated from Marsaglia and Bray method: -0.00615034520526329
Variance of Z2 generated from Marsaglia and Bray method: 1.0079154155731564

The actual mean and variance for N(0,1) is 0 and 1. The experimental values are very close to the actual value

The following is the 2d histogram plot for the sample generated by both the methods:
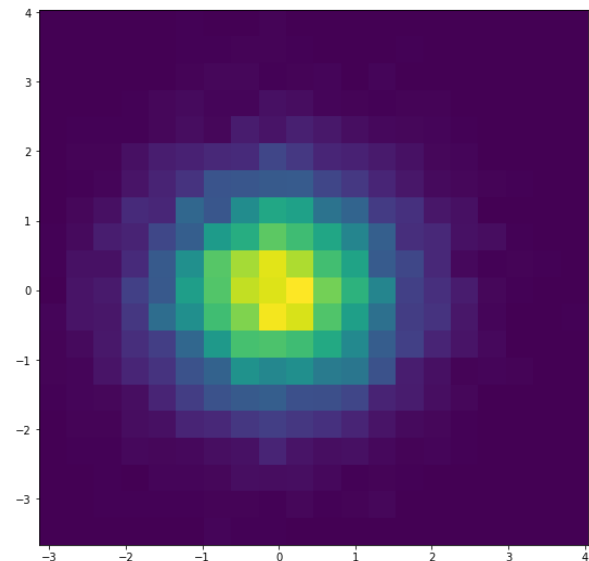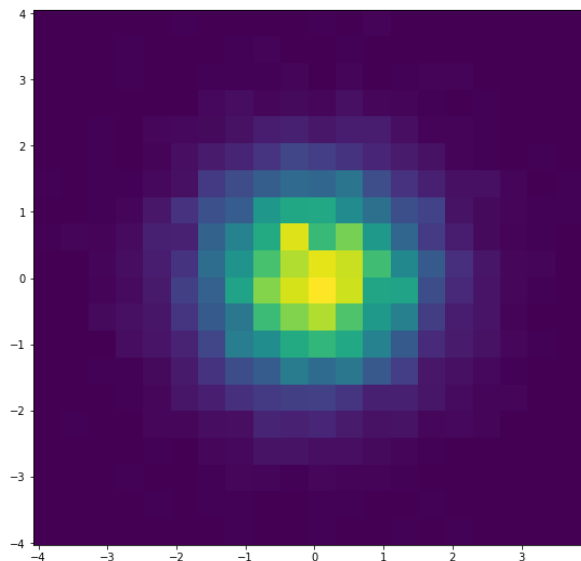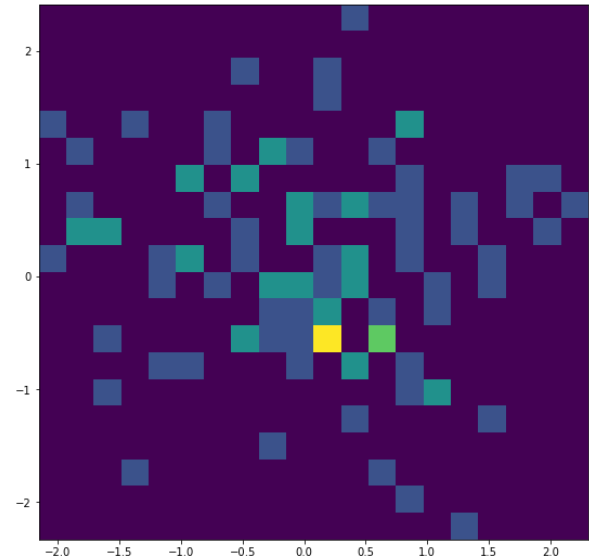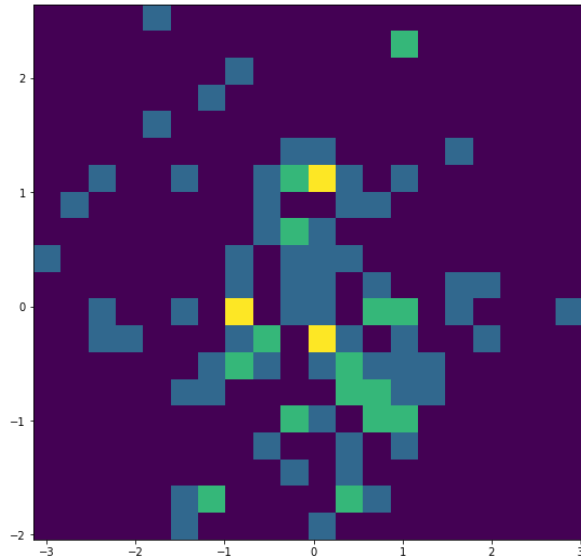
The first row represents the plot for N = 100 and Second row
represents the plot for N = 10000.
The first column is the sample generated by Box Muller method
The second column is the sample generated by Marsaglia and
Bray method.

The following is the density plot for the generated sample along
with its actual density function for both the cases:
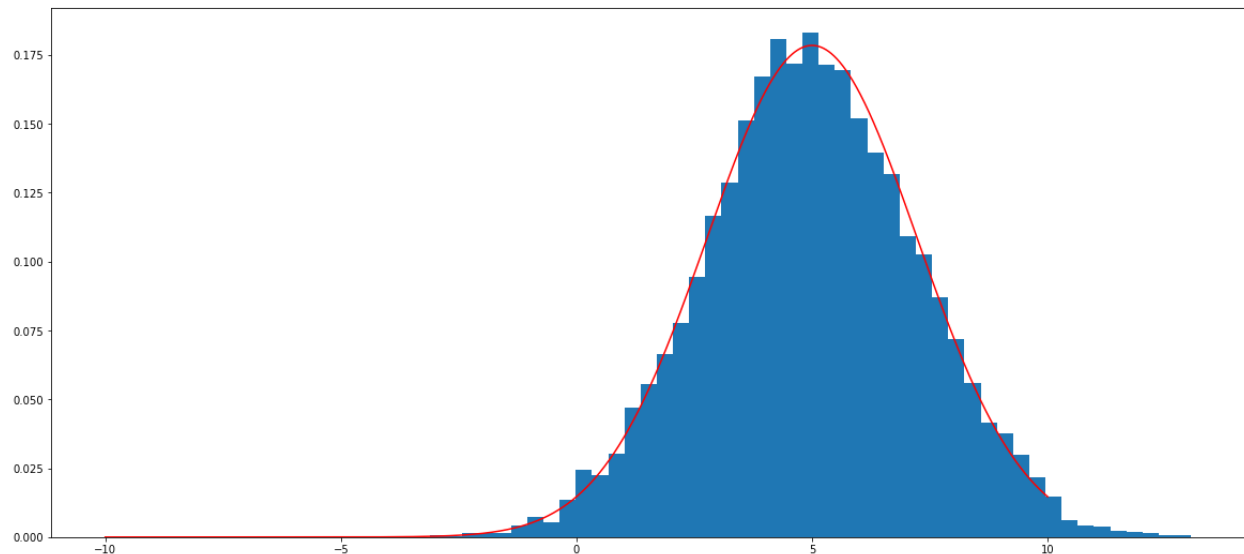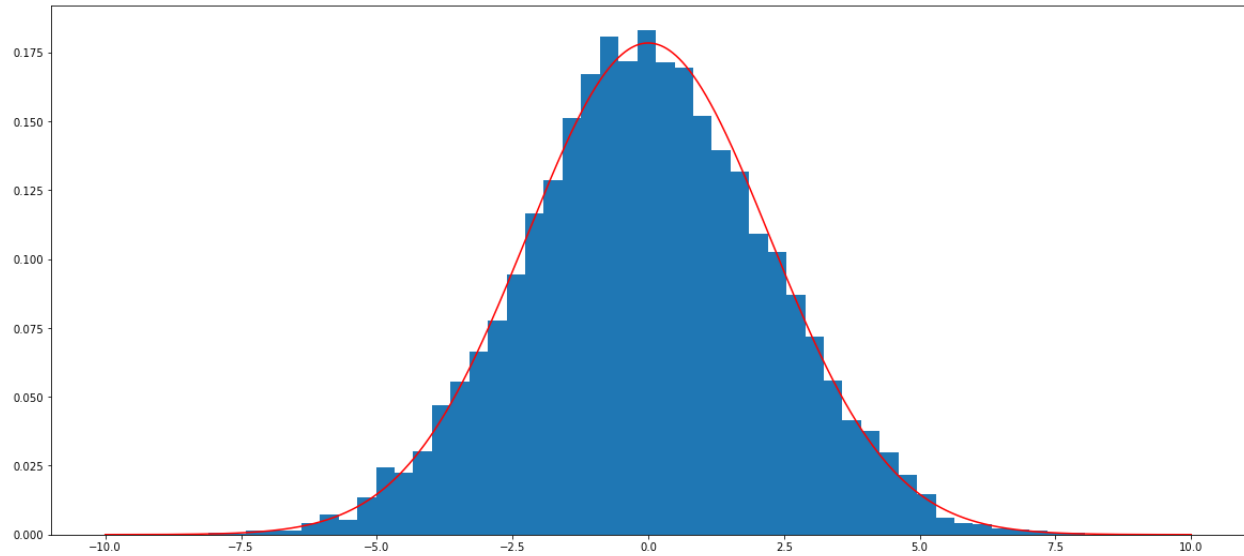
It can be seen that even though the mean and variance is changed, the distribution is approximately the actual distribution of the N(0,5) and N(5,5). The distribution of the generated sample will approach to the actual distribution as N tends to infinity.

Q2. The computation times for the 2 methods are as follows:
```
The time taken for Box-Muller method = 0.20975661277770996 sec
The time taken for Marsaglia and Bray method = 0.41982221603393555 sec
```

It can be seen that even though Marsaglia and Bray method is supposed to be faster, this does not happen practically as in the Acceptance Rejection technique (which is used in Marsaglia and Bray Method), we are looping through to accept only the suitable values and rejecting the undesired ones. As the sample size increases, this leads to significant overhead, as a result of which Marsaglia method becomes slightly slower than the Box-Muller method.

Q3. Portion of values rejected = 0.21630094043887146
    The value of $1-\pi/4$ = 0.21460183660255172

These values are approximately the same as theoretically, the proportion of values rejected should be almost equal to the quantity $1 - \pi/4$. This is because this is the area of the discarded region from a box of unit area. We are choosing only those random numbers s.t, they lie inside a circle which is inscribed in a square of unit area. As a result, the area of the remaining square turns out to be $1 - \pi/4$, which measures the proportion of the values rejected.