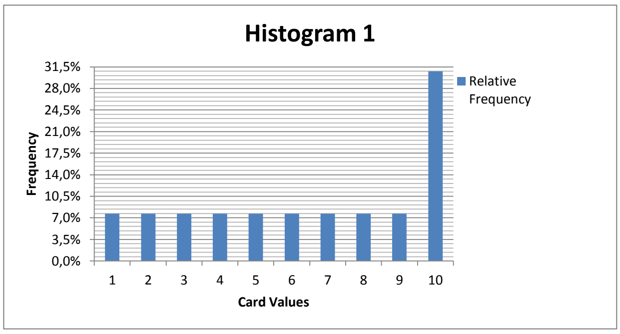
This experiment will require the use of a standard deck of playing cards.
This is a deck of fifty-two cards divided into four suits (spades (♠), hearts (♥), diamonds (♦), and clubs (♣)),
each suit containing thirteen cards (Ace, numbers 2-10, and face cards Jack, Queen, and King)

1. First, create a histogram depicting the relative frequencies of the card values.

			Relative Frequency		Squared
Card	Value	Cards Num	Proportion	Percentage	Deviation
Ace	1	4	0,077	7,69%	30,67
2	2	4	0,077	7,69%	20,60
3	3	4	0,077	7,69%	12,52
4	4	4	0,077	7,69%	6,44
5	5	4	0,077	7,69%	2,37
6	6	4	0,077	7,69%	0,29
7	7	4	0,077	7,69%	0,21
8	8	4	0,077	7,69%	2,14
9	9	4	0,077	7,69%	6,06
10	10	16	0,308	30,77%	11,98
Jack	10				11,98
Queen	10				11,98
King	10				11,98
Total		52	1	100	129,23



	Population		
Mean	6,54		
Median	7,00		
Mode	10,00	TRUE	

Comment : The histogram 1 of card values is negatively skewed.
We have a much higher proportion of frequencies to the max value of 10.
Mode is higher than the Median, which is also higher than the Mean.
If value 10 could be considered as an outlier, then the shape is uniform.

2. Now, we will get samples for a new distribution. To obtain a single sample, shuffle your deck of cards and draw three cards from it.
(You will be sampling from the deck without replacement.) Record the cards that you have drawn and the sum of the three cards' values.
Replace the drawn cards back into the deck and repeat this sampling procedure a total of at least thirty times.

Data can be found below on PDF format at Page 4 and/or on the xlsx file attached at SampleData Sheet.

3. Let's take a look at the distribution of the card sums. Report descriptive statistics for the samples you have drawn.
Include at least two measures of central tendency and two measures of variability.

Measure of central tendency:

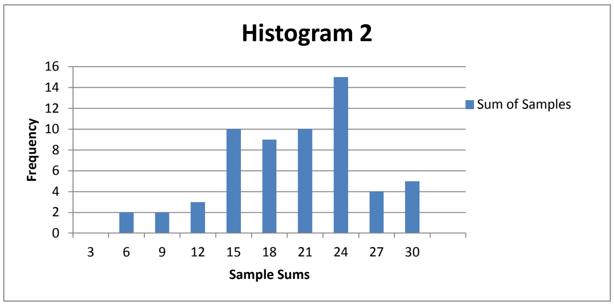
	Population	Sample Sums	Sample Means
Mean	6,54	19,13	6,38
Median	7,00	20,00	6,67
Mode	10,00	22,00	7,33

Measures of variability

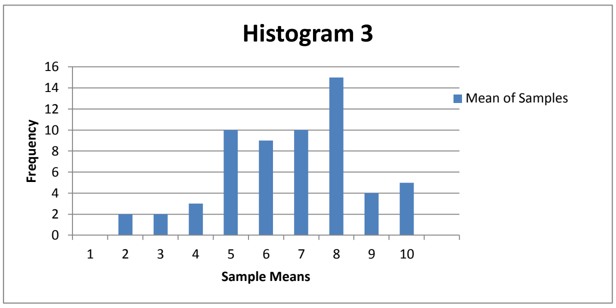
	Population	Sample Sums	Sample Means
Max	10,00	30,00	10,00
Q4	10,00	30,00	10,00
Q3	10,00	23,00	7,67
Q2	7,00	20,00	6,67
Q1	4,00	15,00	5,00
Min	1,00	5,00	1,67
Range	9,00	25,00	8,33
IQR	6,00	8,00	2,67
Variance	9,94	34,08	3,79
Standard deviation	3,15	5,84	1,95
Bessel's correction			
Variance	10,77	34,66	3,85
Standard deviation	3,28	5,89	1,96

4. Create a histogram of the sampled card sums you have recorded.
Compare its shape to that of the original distribution. How are they different, and can you explain why this is the case?

Bin	*Sum of Samples*
0	0
3	0
6	2
9	2
12	3
15	10
18	9
21	10
24	15
27	4
30	5



Bin	*Mean of Samples*
0	0
1	0
2	2
3	2
4	3
5	10
6	9
7	10
8	15
9	4
10	5

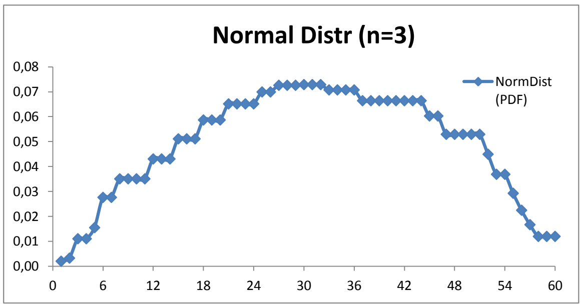


Comment : I have placed my notes for histogram 1 above on the first question.
Regarding histogram 2 and 3, their shape are appraching a normal distribution with respect to histogram 1.
Our sample size is 3 (n=3). Central limit theorem states that the larger the sample size,
the closer you will get to the normal distribution (regardless of the shape of the population distribution).
If we repeat the experiment many times, we could expect to see a distribution even closer to normal.
The Central Limit Theorem would have still been applied by taking either the Sample Sums or Sample Means.

Sampling Distribution

The mean of the sampling distribution is the same as the population mean (μ).
The Standard Error (SE) of the sampling distribution is equal to the population standard deviation (σ) / square root of the sample size n (n=3).
As the exercise is about the Sum rather than the Average of Values, we multiply the values by n (n=3).
Probability density function (PDF) calcs can be found on the xlsx file attached at SampleData Sheet on column AL.

	Population	Sampling Distribution of Sums		
Mean	6,54	Mean	19,62	
Variance	9,94	Variance	29,82	
Standard Deviation	3,15	Standard Error	5,46	3



Comment : The chart above shows the normal distribution for our sampling distribution of sums with N=3, Mean=6,54 and SE=1,82.
A dataset of 60 samples represents a small proportion (approx. 0,4%) of the total number of samples we can get for a card game.
If we choose a larger sample size (i.e. n=5), the peak of the graph distribution increases and the standard deviation is more likely to decrease.
The lower the standard deviation, the more probable to lie on this area away from the mean.

5. Make some estimates about values you will get on future draws. Within what range will you expect approximately 90% of your draw values to fall? What is the approximate probability that you will get a draw value of at least 20? Make sure you justify how you obtained your values.

5.1. Within what range will you expect approximately 90% of your draw values to fall?

Mean (µ)	19,62	*taken from Q4*
Standard Error (SE)	5,46	*taken from Q4. We chose the SE assuming that we plot on sampling distribution other samples of same size (future draws)*

Range of 90% induce 5% on the left of the curve and 5% on the right of the curve. 90% is on the middle area centered around the mean

Z-Table	Z	
Left side 5%	-1,645	*midpoint of -1,64 and -1,65*
Right side 5%	1,645	*midpoint of 1,64 and 1,65*
Z-Score	Z = (x-µ) / σ	*formula for calculating the Z-score, on x-axis how many standard deviations you are away from the mean*
Based on X	X = (z*σ) + µ	*σ we would use is the SE*
	X	
Left side 5%	10,63	
Right side 5%	28,60	

Thus 90% of our values will fall approx between 10,63 and 28,60.
On my Sample of 60 draws, 51 out of 60 values lie in this range. Calcs can be seen on the xlsx file attached at SampleData Sheet on Column AN.
If it would have been 54 out of 60 samples that fall within the X range, it would have been exactly 90%.

5.2. What is the approximate probability that you will get a draw value of at least 20?

X	20
Mean (µ)	19,62
Standard Error (SE)	5,46
Z-Score	Z = (x-µ) / σ
	0,07

Two calc options :

a) Looking at the z-table, the probability of z = 0,07 is correct if you will get a draw value less than 20.
A draw value of at least 20 is the negative z-score (z = -0,07) probability.
Looking at the z-table, the probability of z = -0,07 is 0,4721.
The answer is 47,21%

b) Looking at the z-table, the probability of z = 0,07 is correct if you will get a draw value less than 20.
Looking at the z-table, the probability of z = 0,07 is 0,5279.
This is the correct probability if you will get a draw value less than 20.
Thus the probability of a greater value than 20 is (1-0,5279)
The answer is 47,21%

Question 2 - SampleData

Card 1	Card 2	Card 3	Value 1	Value 2	Value 3	Sample Sums	Sample Means
Hearts 5	Diamond 7	Space 6	5	7	6	18	6,00
Space 10	Space 6	Space 10	10	6	10	26	8,67
Diamond 7	Diamond 7	Space 10	7	7	10	24	8,00
Space 10	Diamond 3	Space 10	10	3	10	23	7,67
Space 10	Hearts 4	Space 10	10	4	10	24	8,00
Hearts 8	Hearts 9	Space 10	8	9	10	27	9,00
Diamond 7	Diamond 7	Space 10	7	7	10	24	8,00
Space 10	Space 2	Space 10	10	2	10	22	7,33
Space 10	Space 10	Space 10	10	10	10	30	10,00
Hearts 1	Diamond 3	Hearts 5	1	3	5	9	3,00
Hearts 5	Hearts 8	Hearts 8	5	8	8	21	7,00
Diamond 7	Space 6	Hearts 4	7	6	4	17	5,67
Diamond 3	Hearts 9	Diamond 7	3	9	7	19	6,33
Space 10	Hearts 8	Diamond 7	10	8	7	25	8,33
Hearts 5	Diamond 7	Space 10	5	7	10	22	7,33
Space 10	Hearts 5	Hearts 5	10	5	5	20	6,67
Space 2	Hearts 8	Diamond 3	2	8	3	13	4,33
Space 10	Space 10	Space 2	10	10	2	22	7,33
Space 6	Hearts 9	Hearts 1	6	9	1	16	5,33
Space 6	Hearts 4	Space 2	6	4	2	12	4,00
Hearts 8	Space 2	Hearts 9	8	2	9	19	6,33
Space 10	Hearts 4	Space 10	10	4	10	24	8,00
Hearts 1	Space 10	Space 10	1	10	10	21	7,00
Space 10	Hearts 8	Hearts 8	10	8	8	26	8,67
Hearts 5	Hearts 1	Space 10	5	1	10	16	5,33
Hearts 8	Diamond 3	Hearts 1	8	3	1	12	4,00
Space 2	Diamond 7	Hearts 4	2	7	4	13	4,33
Diamond 7	Space 2	Hearts 5	7	2	5	14	4,67
Space 10	Hearts 8	Diamond 3	10	8	3	21	7,00
Diamond 7	Hearts 4	Space 10	7	4	10	21	7,00
Space 10	Hearts 4	Hearts 1	10	4	1	15	5,00
Diamond 7	Hearts 1	Space 2	7	1	2	10	3,33
Space 10	Diamond 7	Diamond 3	10	7	3	20	6,67
Space 10	Space 10	Hearts 8	10	10	8	28	9,33
Diamond 3	Diamond 3	Diamond 7	3	3	7	13	4,33
Space 10	Space 10	Space 10	10	10	10	30	10,00
Space 2	Space 2	Hearts 5	2	2	5	9	3,00
Diamond 7	Space 6	Hearts 4	7	6	4	17	5,67
Hearts 4	Hearts 1	Space 10	4	1	10	15	5,00
Space 10	Space 10	Space 10	10	10	10	30	10,00
Space 10	Space 2	Space 10	10	2	10	22	7,33
Diamond 7	Space 6	Space 10	7	6	10	23	7,67
Space 10	Diamond 7	Hearts 5	10	7	5	22	7,33
Hearts 9	Diamond 3	Diamond 3	9	3	3	15	5,00
Space 10	Space 2	Space 2	10	2	2	14	4,67
Hearts 9	Diamond 3	Space 10	9	3	10	22	7,33
Hearts 4	Hearts 8	Space 10	4	8	10	22	7,33
Hearts 1	Hearts 1	Hearts 4	1	1	4	6	2,00
Hearts 5	Space 10	Hearts 5	5	10	5	20	6,67
Space 6	Space 10	Diamond 3	6	10	3	19	6,33
Hearts 8	Hearts 5	Hearts 1	8	5	1	14	4,67
Space 10	Hearts 9	Diamond 3	10	9	3	22	7,33
Space 6	Diamond 3	Hearts 4	6	3	4	13	4,33
Space 10	Diamond 7	Diamond 7	10	7	7	24	8,00
Space 2	Space 10	Hearts 4	2	10	4	16	5,33
Diamond 3	Space 10	Hearts 5	3	10	5	18	6,00
Hearts 5	Space 10	Space 2	5	10	2	17	5,67
Hearts 1	Space 10	Space 6	1	10	6	17	5,67
Hearts 1	Hearts 1	Diamond 3	1	1	3	5	1,67
Space 10	Space 10	Hearts 9	10	10	9	29	9,67