

White Wings sells flour for cooking in $2kg$ packs. If we accept the claim that the pack's weight is $\mu = 2kg$ and $\sigma = 35grams$, how large a sample is required if we want a 98% confidence interval for the mean μ to have a margin of error of $\pm 15grams$.

MJ has a small business selling packs of recycled origami paper. The label on the packs states that there are 200 sheets of paper in the pack and that the side length is 150mm.

Nina bought a pack of this paper and is now complaining that the paper is not as specified and she wants a refund. Nina claims she took a simple random sample of 7 sheets of paper and measured a single random side length from each piece of paper. The side length data (in millimetres) that Nina provided is:

$\{150.3, 152.0, 149.1, 148.2, 150.3, 151.5, 147.4\}$

Set up and test an appropriate hypothesis at the 1% significance level to determine if the sample provides sufficient evidence to support MJ's claim that the paper has side length of 150mm.

Ensure that you state and justify all assumptions, identify critical regions, determine the test statistic and provide a conclusion with reasoning.

According to Glamor Magazine in the UK, the most popular K-pop band in the world is BTS. In 2019 BTS held a concert in Seoul. BTS is very popular amongst teenagers so a significant number of attendees were the adult guardians of the teenage fans.

At the concert a simple random sample of attendees ($n=16$) were asked to provide proof of their age. No other data was collected.

Age data

95	14	13	15	15	39	17	47
20	12	42	21	10	35	44	12

- Determine the mean, mode and standard deviation of the sample.
 - Create a histogram of the sample data with interval widths of 10 years.
 - Determine the 5-number summary.
 - Determine any outliers and draw a box plot.
 - Discuss the following and justify your answers with reference to the information provided and/or your analysis:
 - Is standard deviation a useful statistic for this data?
 - Advertisers are wanting to use statistics to focus their marketing for the next BTS concert in New York. Which is the most informative statistic: mean or mode?
 - Should the outlier be excluded from the data set?
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According to "Psychology Today" numerous studies indicate that the prevalence of left-handedness lies somewhere between 9.3% and 18.1% with the best overall estimate being 10.6%. The percentage of left-handedness varies by country with some countries only having 3% of people being left-handed. It appears that the lower rates of left-handedness reflect social conventions on which hand is used for writing and eating.

According to Statistica.com (2020) 4.70% of people in Japan are left-handed.

- a) What sort of variable is 4.70%?
- b) You are visiting Tokyo for work. Determine the probability that:
 - I. none of the next 10 people you meet are left-handed.
 - II. At least some of the next 10 people you meet are left-handed
 - III. 9 of the next 10 people you meet are left-handed.

Nissan guarantees that the eNV200 Lithium-ion battery used in the Nissan Leaf will have a battery capacity of greater than 75% for the first 160,000 km of driving. Once the battery capacity is less than 75%, it is described as failed.

Assuming that the battery life follows a normal distribution, $\mu = 160,000$ km and $\sigma = 17,000$ km, determine:

- a) The probability that a battery will last
 - I. Exactly 160,000 km.
 - II. More than 185,000 km.
- b) The probability that a random sample of 10 batteries will last more than 185,000 km
- c) The km's by which 40% of batteries will have failed?

In the 19th century the Prussian military became concerned about the number of its cavalry officers killed by horse kick during peacetime. The Prussians had the foresight to collect hard data over 20 years on death by horse kick.

It would have been easy to blame these deaths on what are described as “never events”, which are adverse, serious and largely preventable events e.g. blaming the victims for being careless, horses for being vicious or poor leadership and systems. Instead, the Mathematician Ladislaus Bortkiewicz analyzed the data. In his book “The Law of Small Numbers” (1908) he showed that these fatalities were rare events (low frequency) in a large population and closely followed a Poisson distribution.

From historical data on 120 cavalry corps (a corps is a group of military personnel), MJ has estimated that the average death rate in the Prussian military over 20 years was 1.03 deaths per corps.

Determine the probability that over this time a corps had:

- a) No deaths.
- b) Some deaths.
- c) 2 deaths.

A recent newspaper article observed that seven out of the ten top government schools in England insist that students wear a uniform of school blazer and tie. A spokesman for the Department of Education stated that the newspaper article was proof that wearing a blazer and tie lead to improved academic success.

Use your knowledge of statistics and the scientific method to critique the “proof”.

Typical feedback comments

Formula missing or incorrect

Insufficient working

Not attempted.

BTS question

1a mean= 28.19, mode are 12 and 15 s=22.06. All notation must be correct and formula provided

1b graphs need working to support their construction and informative legends and titles. Data must be ordered to construct a histogram

1c 5 - number summary needs working to support answer. This includes demonstrating that the numbers have been ordered and all necessary calculations are provided.

1c quartiles are incorrect

1d box plot is incorrect. It is a linear graph, and there are rules about whiskers and outliers.

1e standard deviation is good for data that is symmetrically distributed but this sample is not symmetrical and we have no limited idea about the population distribution so it is probably ND. Given the target audience and that adults are going as guardians (under sufferance) the mode values are more indicative of market targets. you need to have very good reasons for excluding data. Being old is not a good reason.

Prussian military this is a Poisson distribution with $\lambda = 1.03$ deaths/corp.

You must always ensure that your working makes clear what formula is used and what problem is being solved. $P(x=0)=0.0357$, $P(X>0) = 1 - P(X=0)$ and $P(X=2)=0.1894$

left hand 4.7% is a probability or Bernoulli variable $p=0.047$, this is also a Binomial question.

Always make sure you provide the correct formula and make it clear what the key variables are so that other people can understand your working.

$P(x=0)=0.6179$, $P(X>0) = 1 - P(X=0)$ and $P(X=9)$ is so small it is effectively zero. 1.066×10^{-11}

Nissan 4 Normal distribution. It is important that you take care with notation. (a) 0 and 0.0708, (b) ~ 0 , (c) 155,750 km

this is a backwards problem where instead of determine a probability you are given a probability and have to work backwards to the original km.

Origami hypothesis we have done a lot of hypothesis questions.

Stating and justifying your assumptions is very important. whilst the sample needs to be srs it is even more important that for our result to be meaningful we want the sample to be representative of the population. We do not have any population data but hopefully it is ok to assume that the side lengths are normally distributed (or close to n). This is a t distribution. $T(\text{test}) = -0.266$, the limits on t are ± 3.707 .

Our test data lies within these limits so we have reason to be confident given all the limitations on data gathered and other assumptions that the paper does have a side length of 150mm at the given significance. Nina can stop complaining.

white wings this type of question is in the notes. Always take care with units, make sure you clearly state formula and n gets rounded up. $n=30$.

school uniform. Newspaper is not always a quality source and neither is someone's opinion.

There is no information on how the data is collected. Correlation is not causation.

There may be many other important variables, much more important than school uniform

e.g. schools might be selective, scholarships are offered to target high achievers, some schools might be in poorer areas, what sort of schools....

