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Biostatistics

Doctor 2018 | Medicine | JU

◉ Sheet ○ Slides

Done By

Luna Hussein

Contributed in the Scientific Correction

Mohammad Aboshaban

Contributed in the Grammatical Correction

Mohammad Aboshaban

Doctor

Hamza Alduraidi

*In this lecture, we're going to discuss **the measures of dispersion***

Please refer back to the slides

***at the beginning, the doctor mentioned another way by which we can check our calculations of quartiles: (Quartiles are discussed in the previous sheet)**

- Always write the numbers in ascending order *-ترتيب تصاعدي*
- Calculate the median, the way we've learnt

Remember: 50% of data are larger and 50% are smaller than the median. Pretend that to the right of the median you've got a new sample, and to the left there's another sample.

-Now calculate the median for the sample that is to the **RIGHT** of the original median. **This is Q3**.

-Calculate the median for the sample that is to the **LEFT** of the original median. **This is Q1**.

*If you calculate **Q3-Q1**, you'll obtain a value that is called: **Interquartile Range (IQR).** This will move us to the topic of this lecture. ☺

REMEBER: In descriptive statistics, we have ***MEASURES OF LOCATION*** (central tendency and non-central tendency) & ***MEASURES OF DISPERSION.***

- **Measures of dispersion** try to assess sample members tendency to be located away from the center & away from each other. **مقاييس التشتّت**

*Regarding measures of dispersion, you'll read many terms that reflect the fact that the values are away from each other**.(Variance, Variability, dispersion, deviation, width, range)** or in Arabic **(تباعد- تشتّت – اتّساع – انحراف)**.

- **It is never enough in any research study to put only the mean of something without putting another value next to it. The value that is always accompanied with the mean is the standard deviation**.

****Now take this example that emphasizes why the mean isn't enough alone to represent a sample:**

we have two sections in the university. In their biostatistics exam that is out of 30, the average of the 1st section was 23. The average of the 2nd section was also 23.

When you hear this for a while, you may imagine that both samples are distributed similarly. Actually, this is not true because the mean alone isn't considered enough to give a full description of a sample.

Let's continue with our example- After checking the students' marks in both sections that have the same average, we observed that:

- In section one: The highest mark (MAX) was 30/30.The lowest one (MIN) was 5/30.
- In section two: The (MAX) was 27/30, THE(MIN) WAS 19/30.

****Notice the difference! Although the mean is the same for both sections, the values (marks) are more dispersed in section 1 ****

(العلامات متباعدة عن بعضها في الشّعبة الآولى بالمقارنة مع الشعبة الأخرى)

In our example regarding section, we can calculate the standard deviation for both sections and determine how wide the distribution was in both of them or how many students with marks away from the center we have. We'll be discussing the standard deviation very soon during the lecture.

Measures of Dispersion

Range | IQR | Variance

STDV | CV

Range vs. Interquartile Range (IQR)

***Range**: (THE UPPER LIMIT – THE LOWER LIMIT) الحد الأعلى ناقص الحد الأدني**

***Interquartile Range (IQR)**: Q3-Q1 , this will confine (يحصر) the middle 50%.**

Important: *The range is wider than the IQR.

***IQR is always within the range.**

***Standard deviation*: The most important, useful and meaningful measure of dispersion. In simple words, it is the average distance between every individual value and the mean.**

Note: Although the range gives us an indication of the width, it is similar to the mean by their sensitivity to extreme values. They're both influenced.

E.g.: If the marks of the majority of students in a class were between25-30 out of 30. Unfortunately, we have a student that was asleep during biostatistics lectures and got 5/30. Now if we calculate the range: MAX-MIN, it'll be 30-5=25! This gives an indication that the students' marks are so dispersed and away from each other but this is not the case. **We conclude from this example that the range was highly influenced only by a single extreme value. Thus, we calculate the standard deviation in order to solve this problem.**

<u>*In order to calculate the standard deviation,</u> we use a mathematical equation. The doctor said that we're not required to do the long calculations of STDV. during the exam, but for your own knowledge please refer back to the slides and take a look. **Dear students, please note that it is written in the beginning of this sheet that we have to refer to the slides since I am only writing what was explained and discussed by the doctor during the lecture.**

***we use n-1 in calculations regarding the sample, and N in the calculations of the population. This is explained briefly in one of the slides so refer to it!**

<u>*Very Important</u>: In statistics, we always prefer to have low variability among values or low dispersion because this implies that our calculated mean is a good representative of the sample. Moreover, the implications of this appear in inferential statistics by which it's very unlikely to find significance when the values are very far-away of each other. In contrast, it's very likely to find significance when the values are close to each other.

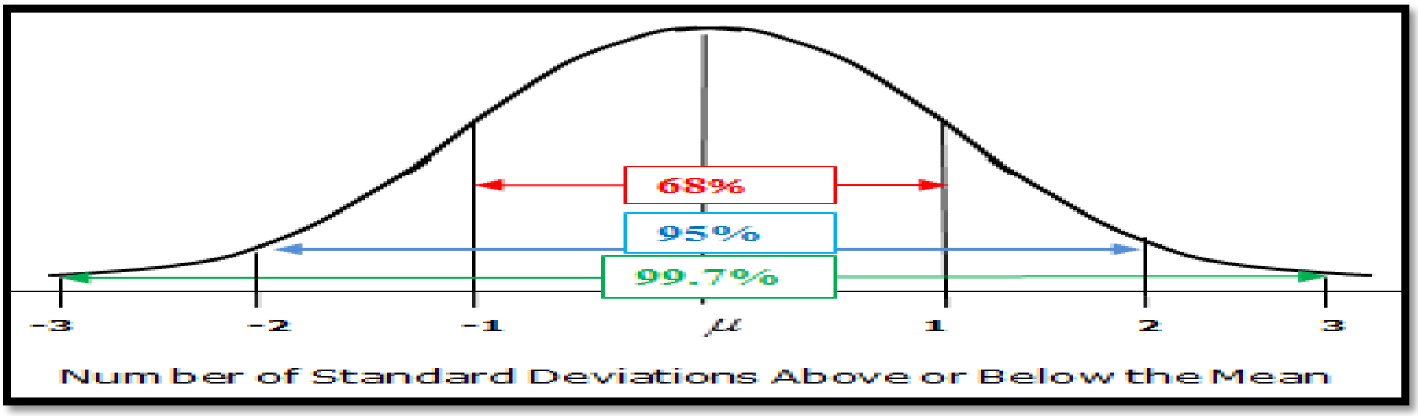
- Remember that the normal distribution is when we have the mean, median & mode all located at the same point in the center. There's a very useful implication for this:
  -When we say that a certain population is normally distributed, we conclude that most of the people in this population will be located around the center (the middle).
  -E.g.: Assuming that the height of Jordanian Males is normally distributed, what is the chance that you may find someone whose height is lower than 1 meter? <u>It's very little.</u> Also, the chance of finding another one whose height is more than 2 meter <u>is very little.</u> But the chance of finding someone whose height is 1.70 would be <u>very possible!</u> i.e. highly likely.

-Moreover, If we calculate the standard deviation of the people's heights, there's a beautiful fact that implies the following:

- Within **ONE** standard deviation to the right & 1 STDV to the left: **68% of the people will be contained/confined within this area.**

Regarding our heights example: Take the mean 170cm , Standard deviation (STDV)=10>>> we conclude that Jordanian Males whose heights are between 160 & 180 cm. who are one STDV Away from the mean are 68% of the population, i.e. of the Jordanian Males.

- Within **TWO** standard deviations to the right & 2 standard deviations to the left: **95% of Jordanian males whose heights are between 150 & 190 cm will be confined.**
- Within **2.5** standard deviations to the right & 2.5 standard deviations to the left: **99% of Jordanian Males whose heights are between 145 &195 cm will be confined.**
- Within **3** standard deviations to the right & **3** standard deviations to the left: **99.7% of people are confined.**
- Within **4** standard deviations to the right & **4** standard deviations to the left: **99.99%.**



- **let's discuss other measures of dispersion:**

***Variance**: **it's the square of the standard deviation.**

***Coefficient of Variation (CV):(Standard deviation ÷ Mean)× 100%.**

This percentage(CV) could be one of the following:

- Percentage <100% ** when the standard deviation is lower (which is good & preferred).
- =100%** when the standard deviation = the mean
- 100%< percentage** when the standard deviation is higher than the mean (there's a high dispersion and it's not desired in statistics).

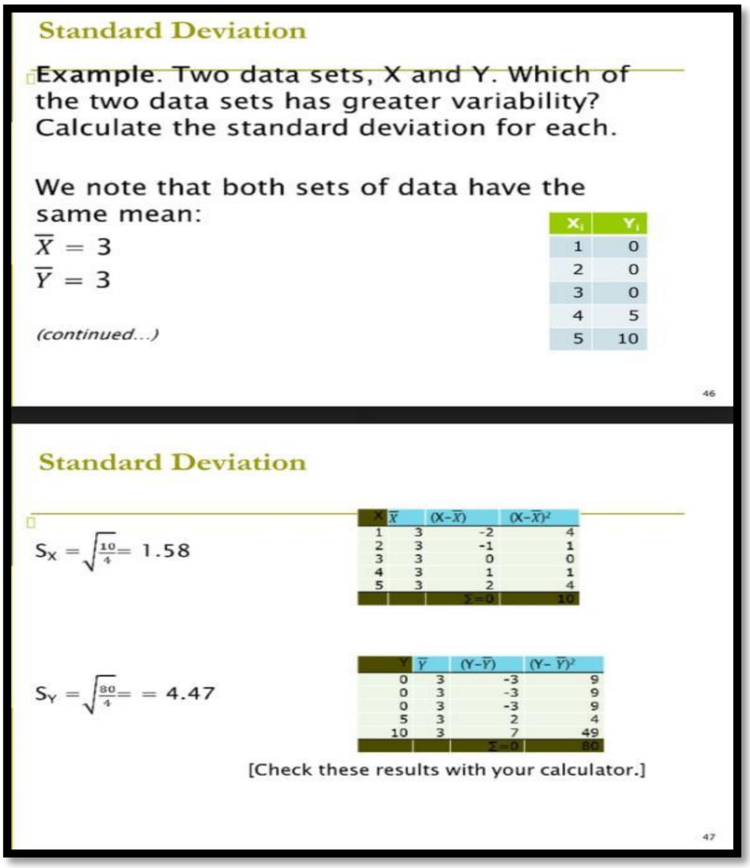
Sometimes, the CV Might be 200%! , i.e. the STDV is two times higher than the mean & this is even worse. (The higher the CV, The worst for our statistical implications)

More examples on the previous idea:

- CV FOR X: APPROXIMATELY 1.5/3*100%= 50%.

- FOR Y: APPROXIMATELY 4.5/3*100%= 150%

- ASSUME ANOTHER ONE Z WITH STDEV=6 AND MEAN =3. CV FOR Z= 6/3*100%= 200%! THIS IS THE WORST!



Standard Deviation

Example. Two data sets, X and Y. Which of the two data sets has greater variability? Calculate the standard deviation for each.

We note that both sets of data have the same mean:

$\overline{X} = 3$

$\overline{Y} = 3$

(continued...)

X_i	Y_i
1	0
2	0
3	0
4	5
5	10

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Standard Deviation

$S_X = \sqrt{\frac{10}{4}} = 1.58$

X	$\overline{X}$	$(X-\overline{X})$	$(X-\overline{X})^2$
1	3	-2	4
2	3	-1	1
3	3	0	0
4	3	1	1
5	3	2	4
		$\Sigma=0$	10

$S_Y = \sqrt{\frac{80}{4}} = = 4.47$

Y	$\overline{Y}$	$(Y-\overline{Y})$	$(Y-\overline{Y})^2$
0	3	-3	9
0	3	-3	9
0	3	-3	9
5	3	2	4
10	3	7	49
		$\Sigma=0$	80

[Check these results with your calculator.]

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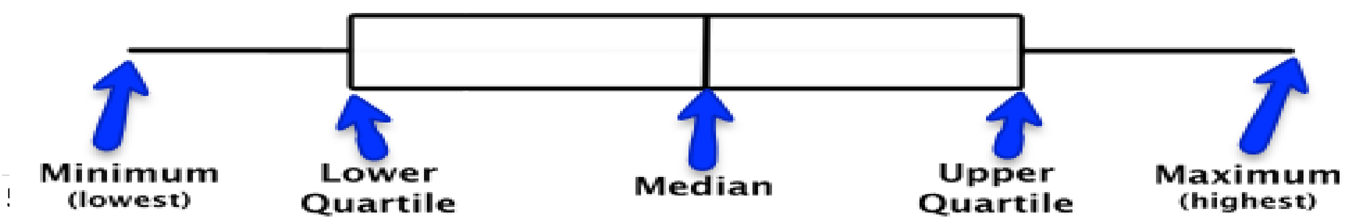
-The Five Number Summary: A useful way to represent (MIN, Q1, median, Q3, MAX).

*The five number summary is very important, and for exam purposes we may be asked various questions depending on it. E.g. we may be asked to calculate the IQR (we know the values of Q1 & Q3 from the summary).

Another very important thing we may be asked about is the symmetry of the distribution. How to answer this from the five number summary?

- If the distances between the values are approximately equal, it seems to be symmetric. But if we have a very long distance between the values due to a far-away value, it'll be skewed. To the right or to the left? It depends on the location of the value.
- Another way to assure that it's symmetric. Subtract the lower limit from the median. And substrate the median from the upper limit. If they're similar or identical (which is preferred), your answer will be certainly correct.



Now, we're going to discuss the z-score & this takes us to the next chapter (Probability).

We can convert any distribution into a normal one by standardization

***Standardization results in unit-less numbers, and speaks the language of standard deviation, i.e. how many standard deviations away from the mean. If we calculate the x for any distribution, standardization makes it normal! That's perfect!**

***E.g.>>** The salary of Jordanians isn't normally distributed, rather it's skewed for sure. But if we take the values and calculate the Z-scores for them, i.e., we standardize them, then plot them again, we'll find that the distribution becomes normal!

***Standardization makes any variable normal. This is proved by the central limit theorem. You may refer to the slides for this.**

*** REMEMBER:**

Note that the normal distribution is defined by two parameters, μ and σ . You can draw a normal distribution for any μ and σ combination. There is one normal distribution, Z, that is special. It has a μ = 0 and a σ = 1. This is the Z distribution, also called the *standard normal* distribution. It is one of trillions of normal distributions we could have selected.

*HOW TO COMPUTE Z-SCORE?

Z = Score of value – mean of scores divided by standard deviation.

*EXAMPLE: (IMPORTANT)

Standardizing Data: Z-Scores

- To compute the Z-scores:

$$Z = \frac{X - \bar{X}}{s}$$

Example.
Data: 0, 2, 4, 6, 8, 10
$\bar{X} = 30/6 = 5$; $s = 3.74$

X	→	Z
0	$\frac{0-5}{3.74}$	-1.34
2	$\frac{2-5}{3.74}$	-.80
4	$\frac{4-5}{3.74}$	-.27
6	$\frac{6-5}{3.74}$	.27
8	$\frac{8-5}{3.74}$	.80
10	$\frac{10-5}{3.74}$	1.34

We use the z-score for calculating probabilities

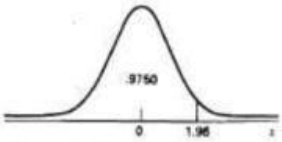
Given the values of μ and σ we can convert a value of x to a value of z and find its probability using the table of normal curve areas.

The table in the coming slide give the area under the curve (probabilities) between the mean and z.
The probabilities in the table refer to the likelihood that a randomly selected value Z is equal to or less than a given value of *z* and greater than 0 (the mean of the standard normal).

THE TABLE OF THE NORMAL CURVE IS DIVIDED INTO POSITIVE & NEGATIVE SECTIONS. IT'LL BE GIVEN IN THE EXAM BUT WE HAVE TO KNOW HOW TO USE IT

Table of Normal Curve Areas

TABLE D Normal Curve Areas $P(z \le z_o)$. Entries in the Body of the Table Are Areas Between $-\infty$ and z



z	−0.09	−0.08	−0.07	−0.06	−0.05	−0.04	−0.03	−0.02	−0.01	0.00	z
−3.80	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	−3.80
−3.70	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	−3.70
−3.60	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0002	.0002	−3.60
−3.50	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	−3.50
−3.40	.0002	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	−3.40
−3.30	.0003	.0004	.0004	.0004	.0004	.0004	.0004	.0005	.0005	.0005	−3.30
−3.20	.0005	.0005	.0005	.0006	.0006	.0006	.0006	.0006	.0007	.0007	−3.20
−3.10	.0007	.0007	.0008	.0008	.0008	.0008	.0009	.0009	.0009	.0010	−3.10
−3.00	.0010	.0010	.0011	.0011	.0011	.0012	.0012	.0013	.0013	.0013	−3.00
−2.90	.0014	.0014	.0015	.0015	.0016	.0016	.0017	.0018	.0018	.0019	−2.90
−2.80	.0019	.0020	.0021	.0021	.0022	.0023	.0023	.0024	.0025	.0026	−2.80
−2.70	.0026	.0027	.0028	.0029	.0030	.0031	.0032	.0033	.0034	.0035	−2.70
−2.60	.0036	.0037	.0038	.0039	.0040	.0041	.0043	.0044	.0045	.0047	−2.60
−2.50	.0048	.0049	.0051	.0052	.0054	.0055	.0057	.0059	.0060	.0062	−2.50
−2.40	.0064	.0066	.0068	.0069	.0071	.0073	.0075	.0078	.0080	.0082	−2.40
−2.30	.0084	.0087	.0089	.0091	.0094	.0096	.0099	.0102	.0104	.0107	−2.30
−2.20	.0110	.0113	.0116	.0119	.0122	.0125	.0129	.0132	.0136	.0139	−2.20
−2.10	.0143	.0146	.0150	.0154	.0158	.0162	.0166	.0170	.0174	.0179	−2.10
−2.00	.0183	.0188	.0192	.0197	.0202	.0207	.0212	.0217	.0222	.0228	−2.00
−1.90	.0233	.0239	.0244	.0250	.0256	.0262	.0268	.0274	.0281	.0287	−1.90
−1.80	.0294	.0301	.0307	.0314	.0322	.0329	.0336	.0344	.0351	.0359	−1.80
−1.70	.0367	.0375	.0384	.0392	.0401	.0409	.0418	.0427	.0436	.0446	−1.70
−1.60	.0455	.0465	.0475	.0485	.0495	.0505	.0516	.0526	.0537	.0548	−1.60
−1.50	.0559	.0571	.0582	.0594	.0606	.0618	.0630	.0643	.0655	.0668	−1.50
−1.40	.0681	.0694	.0708	.0721	.0735	.0749	.0764	.0778	.0793	.0808	−1.40
−1.30	.0823	.0838	.0853	.0869	.0885	.0901	.0918	.0934	.0951	.0968	−1.30
−1.20	.0985	.1003	.1020	.1038	.1056	.1075	.1093	.1112	.1131	.1151	−1.20
−1.10	.1170	.1190	.1210	.1230	.1251	.1271	.1292	.1314	.1335	.1357	−1.10
−1.00	.1379	.1401	.1423	.1446	.1469	.1492	.1515	.1539	.1562	.1587	−1.00
−0.90	.1611	.1635	.1660	.1685	.1711	.1736	.1762	.1788	.1814	.1841	−0.90
−0.80	.1867	.1894	.1922	.1949	.1977	.2005	.2033	.2061	.2090	.2119	−0.80
−0.70	.2148	.2177	.2206	.2236	.2266	.2296	.2327	.2358	.2389	.2420	−0.70
−0.60	.2451	.2483	.2514	.2546	.2578	.2611	.2643	.2676	.2709	.2743	−0.60
−0.50	.2776	.2810	.2843	.2877	.2912	.2946	.2981	.3015	.3050	.3085	−0.50
−0.40	.3121	.3156	.3192	.3228	.3264	.3300	.3336	.3372	.3409	.3446	−0.40
−0.30	.3483	.3520	.3557	.3594	.3632	.3669	.3707	.3745	.3783	.3821	−0.30
−0.20	.3859	.3897	.3936	.3974	.4013	.4052	.4090	.4129	.4168	.4207	−0.20
−0.10	.4247	.4286	.4325	.4364	.4404	.4443	.4483	.4522	.4562	.4602	−0.10
0.00	.4641	.4681	.4721	.4761	.4801	.4840	.4880	.4920	.4960	.5000	0.00

TABLE D *(continued)*

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	z
0.00	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359	0.00
0.10	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753	0.10
0.20	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141	0.20
0.30	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517	0.30
0.40	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879	0.40
0.50	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224	0.50
0.60	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549	0.60
0.70	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852	0.70
0.80	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133	0.80
0.90	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389	0.90
1.00	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621	1.00
1.10	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830	1.10
1.20	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015	1.20
1.30	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177	1.30
1.40	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319	1.40
1.50	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441	1.50
1.60	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545	1.60
1.70	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633	1.70
1.80	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706	1.80
1.90	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767	1.90
2.00	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817	2.00
2.10	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857	2.10
2.20	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890	2.20
2.30	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916	2.30
2.40	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936	2.40
2.50	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952	2.50
2.60	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964	2.60
2.70	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974	2.70
2.80	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981	2.80
2.90	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986	2.90
3.00	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990	3.00
3.10	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993	3.10
3.20	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995	3.20
3.30	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997	3.30
3.40	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998	3.40
3.50	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	3.50
3.60	.9998	.9998	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	3.60
3.70	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	3.70
3.80	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	3.80

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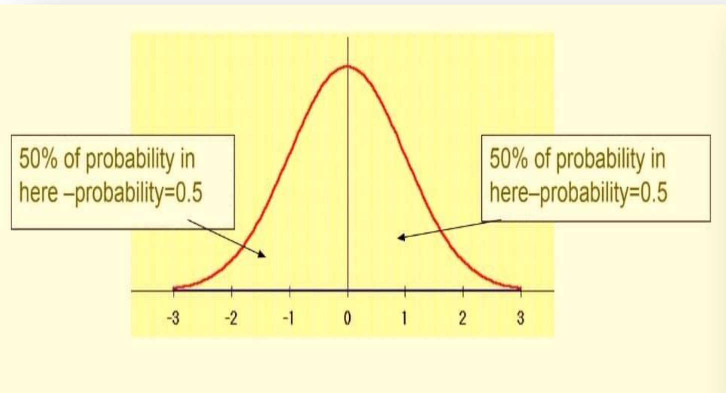
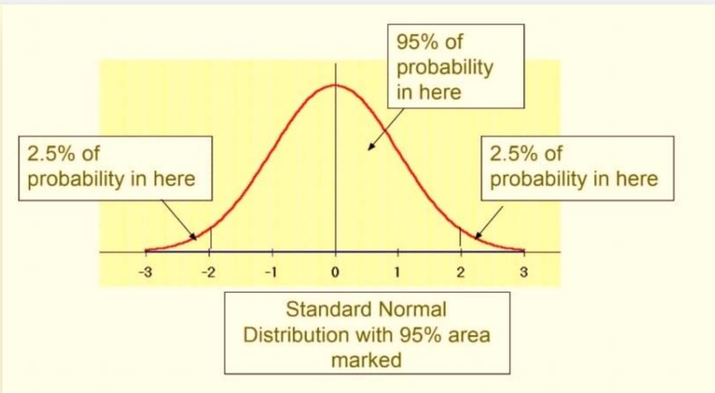




*EXAMPLES ON CALCULATIONS (VERY IMPORTANT):

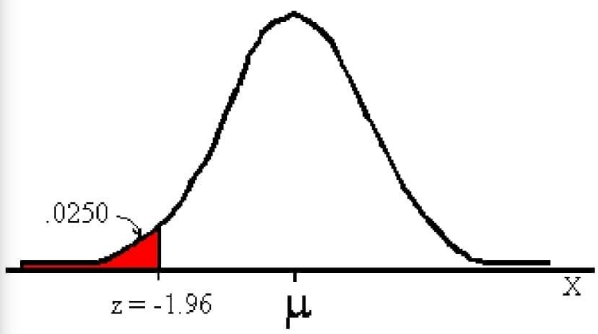
(a) What is the probability that z < -1.96?

(1) Sketch a normal curve

(2) Draw a line for z = -1.96

(3) Find the area in the table

(4) The answer is the area to the left of the line P(z < -1.96) = .0250



z	−0.09	−0.08	−0.07	−0.06	−0.05	−0.04	−0.03	−0.02	−0.01	0.00	z
−3.80	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	−3.80
−3.70	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	−3.70
−3.60	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0002	.0002	−3.60
−3.50	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	−3.50
−3.40	.0002	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	−3.40
−3.30	.0003	.0004	.0004	.0004	.0004	.0004	.0004	.0005	.0005	.0005	−3.30
−3.20	.0005	.0005	.0005	.0006	.0006	.0006	.0006	.0006	.0007	.0007	−3.20
−3.10	.0007	.0007	.0008	.0008	.0008	.0008	.0009	.0009	.0009	.0010	−3.10
−3.00	.0010	.0010	.0011	.0011	.0011	.0012	.0012	.0013	.0013	.0013	−3.00
−2.90	.0014	.0014	.0015	.0015	.0016	.0016	.0017	.0018	.0018	.0019	−2.90
−2.80	.0019	.0020	.0021	.0021	.0022	.0023	.0023	.0024	.0025	.0026	−2.80
−2.70	.0026	.0027	.0028	.0029	.0030	.0031	.0032	.0033	.0034	.0035	−2.70
−2.60	.0036	.0037	.0038	.0039	.0040	.0041	.0043	.0044	.0045	.0047	−2.60
−2.50	.0048	.0049	.0051	.0052	.0054	.0055	.0057	.0059	.0060	.0062	−2.50
−2.40	.0064	.0066	.0068	.0069	.0071	.0073	.0075	.0078	.0080	.0082	−2.40
−2.30	.0084	.0087	.0089	.0091	.0094	.0096	.0099	.0102	.0104	.0107	−2.30
−2.20	.0110	.0113	.0116	.0119	.0122	.0125	.0129	.0132	.0136	.0139	−2.20
−2.10	.0143	.0146	.0150	.0154	.0158	.0162	.0166	.0170	.0174	.0179	−2.10
−2.00	.0183	.0188	.0192	.0197	.0202	.0207	.0212	.0217	.0222	.0228	−2.00
−1.90	.0233	.0239	.0244	.0250	.0256	.0262	.0268	.0274	.0281	.0287	−1.90
−1.80	.0294	.0301	.0307	.0314	.0322	.0329	.0336	.0344	.0351	.0359	−1.80
−1.70	.0367	.0375	.0384	.0392	.0401	.0409	.0418	.0427	.0436	.0446	−1.70
−1.60	.0455	.0465	.0475	.0485	.0495	.0505	.0516	.0526	.0537	.0548	−1.60

(b) What is the probability that -1.96 < z < 1.96?

(1) Sketch a normal curve

(2) Draw lines for lower z = -1.96, and upper z = 1.96

(3) Find the area in the table corresponding to each value

(4) The answer is the area between the values. Subtract lower from upper:

P(-1.96 < z < 1.96) = .9750 - .0250 = .9500

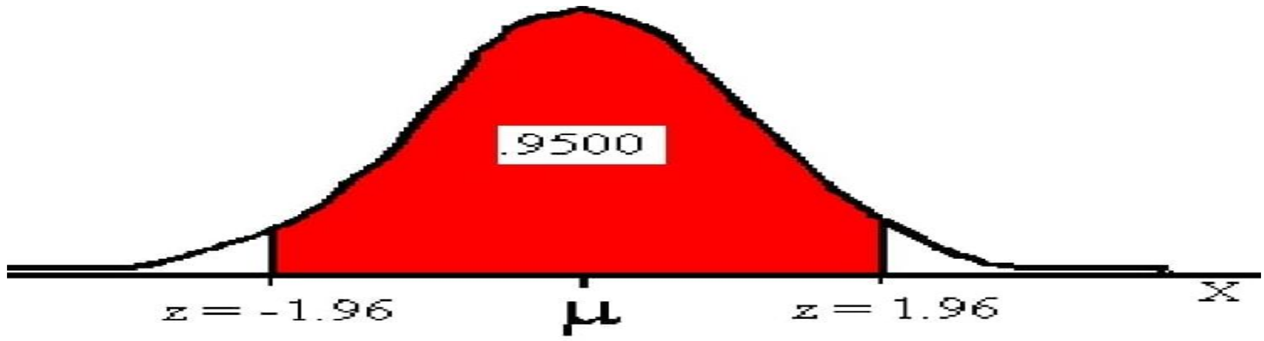


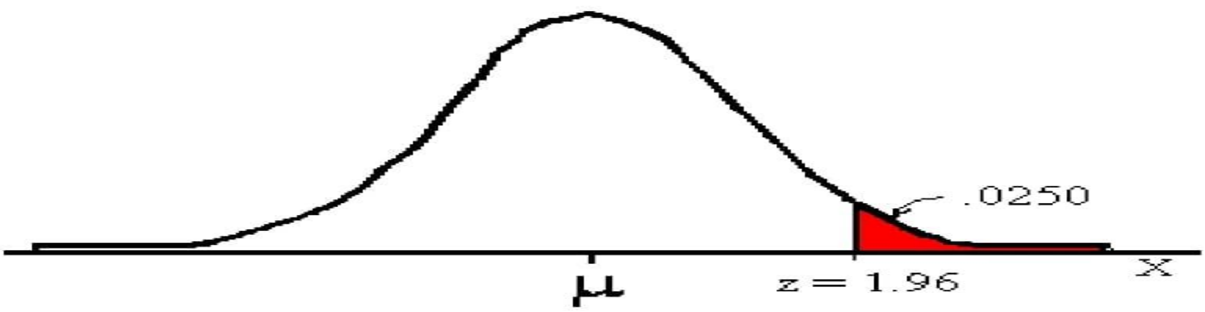
TABLE D *(continued)*

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	z
0.00	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359	0.00
0.10	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753	0.10
0.20	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141	0.20
0.30	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517	0.30
0.40	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879	0.40
0.50	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224	0.50
0.60	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549	0.60
0.70	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852	0.70
0.80	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133	0.80
0.90	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389	0.90
1.00	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621	1.00
1.10	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830	1.10
1.20	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015	1.20
1.30	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177	1.30
1.40	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319	1.40
1.50	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441	1.50
1.60	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545	1.60
1.70	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633	1.70
1.80	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706	1.80
1.90	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767	1.90
2.00	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817	2.00
2.10	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857	2.10
2.20	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890	2.20
2.30	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916	2.30
2.40	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936	2.40

(c) What is the probability that $z > 1.96$?

(1) Sketch a normal curve
(2) Draw a line for $z = 1.96$
(3) Find the area in the table
(4) The answer is the area to the right of the line. It is found by subtracting the table value from 1.0000:

$P(z > 1.96) = 1.0000 - .9750 = .0250$



- **The only problem is that the z-table works only on continuous variables.**

- **When we have a discrete variable, taking into consideration that discrete variables are either 2 categories (dichotomous) or more than 2 categories, we have these tables or distributions:**

- For discrete variables **with 2 categories**: we use the **binomial table**
- For discrete variables with **3 or more categories**: we use the **Poisson table**

The Binomial and the Poisson tables aren't required in this course.

****

THE END

MAY GOD BLESS YOU ALL