## Rules

- The number of items in a group $\mathrm{k}=\mathrm{N} / \mathrm{n}$
- Range $=X_{\text {largest }}-X_{\text {smallest }}$
- Class interval (width) $=\frac{\text { Range }}{\text { class number }}$
- Relative Frequency = Frequency / Total
- Cumulative Frequency $=($ Frequency $/$ Total $) * 100$
- Cumulative Percentage $=$ Cumulative Frequency *100
- Median position $=\frac{n+1}{2}$ in the ordered data
- Median Value $=\left\{\begin{array}{c}\frac{n+1}{2} \text { in the odd } \\ \frac{n}{2}, \frac{n}{2}+1 \text { in the oven }\end{array}\right.$
- Sample Mean $\bar{X}=\frac{\sum_{i=1}^{n} X_{i}}{n}=\frac{X_{1}+X_{2}+\cdots+X_{n}}{n}$
- Population Mean, $\mu=\frac{\sum_{i=1}^{N} X_{i}}{N}=\frac{X_{1}+X_{2}+\cdots+X_{N}}{N}$
- Sample Variance $S^{2}=\frac{\sum_{i=1}^{n}\left(X_{i}-\bar{X}\right)^{2}}{n-1}$
- Sample Standard deviation, $S=\sqrt{\frac{\sum_{i=1}^{n}\left(X_{i}-\bar{X}\right)^{2}}{n-1}}$
- Population Variance, $\sigma^{2}=\frac{\sum_{i=1}^{N}\left(X_{i}-\mu\right)^{2}}{N}$
- Population Standard deviation, $\sigma=\sqrt{\frac{\sum_{i=1}^{N}\left(X_{i}-\mu\right)^{2}}{N}}$
- Coefficient of variation $\mathrm{CV}=\left(\frac{S}{\bar{X}}\right) \cdot 100 \%$
- Z-score, $Z=\frac{X-\bar{X}}{S}$
- First quartile position: $\mathbf{Q}_{\mathbf{1}}=(\mathbf{n}+\mathbf{1}) / \mathbf{4}$ ranked value.
- Second quartile position: $\mathbf{Q}_{2}=(\mathbf{n}+\mathbf{1}) / \mathbf{2}$ ranked value.
- Third quartile position: $\mathbf{Q}_{\mathbf{3}}=\mathbf{3}(\mathbf{n}+\mathbf{1}) / 4$ ranked value.
- $\quad$ QRR is Q3 -Q1


## - Empirical Rule

- One standard deviation $(\mu \pm \sigma)$
- Two standard deviations $(\mu \pm 2 \sigma)$
- Three standard deviations ( $\mu \pm 3 \sigma$ )
- The sample covariance, $\operatorname{cov}(X, Y)=\frac{\sum_{i=1}^{n}\left(X_{i}-\bar{X}\right)\left(Y_{i}-\bar{Y}\right)}{n-1}$
- Sample coefficient of correlation, $r=\frac{\operatorname{cov}(X, Y)}{s_{X} s_{Y}}$
where, $S_{X}=\sqrt{\frac{\sum_{i=1}^{n}\left(X_{i}-\bar{X}\right)^{2}}{n-1}}$ and $S_{Y}=\sqrt{\frac{\sum_{i=1}^{n}\left(Y_{i}-\bar{Y}\right)^{2}}{n-1}}$
- probability of occurrence $=\frac{X}{T} \quad=\frac{\text { number of ways in which the event occurs }}{\text { total number of possible outcomes }}$
$P(A$ and $B)=\frac{\text { number of outcomes satisfying } A \text { and } B}{\text { total number of outcomes }}$
- A marginal probability
$P(A)=P\left(A\right.$ and $\left.B_{1}\right)+P\left(A\right.$ and $\left.B_{2}\right)+\cdots+P\left(A\right.$ and $\left.B_{k}\right)$
- General addition rule $\mathbf{P}(\mathbf{A}$ or $\mathbf{B})=\mathbf{P}(\mathbf{A})+\mathbf{P}(\mathbf{B})-\mathbf{P}(\mathbf{A}$ and $\mathbf{B})$
- Addition rule for mutually exclusive events

$$
\circ \mathbf{P}(\mathbf{A} \text { or } \mathbf{B})=\mathbf{P}(\mathbf{A})+\mathbf{P}(\mathbf{B})
$$

- A conditional probability

$$
P(A \mid B)=\frac{P(A \text { and } B)}{P(B)}, P(B \mid A)=\frac{P(A \text { and } B)}{P(A)}
$$

- A conditional probability for independent events $P(A \mid B)=P(A)$
- The General Multiplication Rule $\mathbf{P ( A \text { and } B ) = \mathbf { P } ( \mathbf { A } | \mathbf { B } ) \mathbf { P } ( \mathbf { B } )}$
- Multiplication Rule for independent event

$$
\mathrm{P}(\mathrm{~A} \text { and } \mathrm{B})=\mathrm{P}(\mathrm{~A}) \mathrm{P}(\mathrm{~B})
$$

- Marginal probability for event A:

$$
\mathrm{P}(\mathrm{~A})=\mathrm{P}\left(\mathrm{~A} \mid \mathrm{B}_{1}\right) \mathrm{P}\left(\mathrm{~B}_{1}\right)+\mathrm{P}\left(\mathrm{~A} \mid \mathrm{B}_{2}\right) \mathrm{P}\left(\mathrm{~B}_{2}\right)+\cdots+\mathrm{P}\left(\mathrm{~A} \mid \mathrm{B}_{\mathrm{k}}\right) \mathrm{P}\left(\mathrm{~B}_{\mathrm{k}}\right)
$$

- Bayes' Theorem

$$
\mathrm{P}\left(\mathrm{~B}_{\mathrm{i}} \mid \mathrm{A}\right)=\frac{\mathrm{P}\left(\mathrm{~A} \mid \mathrm{B}_{i}\right) \mathrm{P}\left(\mathrm{~B}_{i}\right)}{\mathrm{P}\left(\mathrm{~A} \mid \mathrm{B}_{1}\right) \mathrm{P}\left(\mathrm{~B}_{1}\right)+\mathrm{P}\left(\mathrm{~A} \mid \mathrm{B}_{2}\right) \mathrm{P}\left(\mathrm{~B}_{2}\right)+\cdots+\mathrm{P}\left(\mathrm{~A} \mid \mathrm{B}_{\mathrm{k}}\right) \mathrm{P}\left(\mathrm{~B}_{\mathrm{k}}\right)}
$$

- Counting rule 1: -The number of possible outcomes is equal to $K^{n}$
- Counting Rule 2: -The number of possible outcomes is equal to $\left(k_{1}\right)\left(k_{2}\right)\left(k_{3}\right)$
- Counting Rule 3: -The number of possible outcomes is

$$
n!=(n)(n-1) \cdots(1)
$$

- Counting Rule 4 (Permutations): -The number of possible outcomes is $n P_{x}=\frac{\mathrm{n}!}{(n-X)!}$
- Counting Rule 5 (Combination): -The number of possible outcomes is $n C_{x}=\frac{\mathrm{n}!}{\mathrm{X}!(n-X)!}$
- Expected Value (or mean) of a discrete variable

$$
\mu=\mathrm{E}(X)=\sum_{i=1}^{N} x_{i} P\left(X=x_{i}\right)
$$

- Variance of a discrete variable, $\sigma^{2}=\sum_{i=1}^{N}\left[x_{i}-E(X)\right]^{2} P\left(X=x_{i}\right)$
- Standard Deviation of a discrete variable.

$$
\sigma=\sqrt{\sigma^{2}}=\sqrt{\sum_{i=1}^{N}\left[x_{i}-E(X)\right]^{2} P\left(X=x_{i}\right)}
$$

- Binomial Distribution Formula $\mathrm{P}(\mathrm{X}=\mathrm{x} \mid \mathrm{n}, \pi)=\frac{n!}{x!(n-x)!} \boldsymbol{\pi}^{x}(\mathbf{1}-\boldsymbol{\pi})^{\boldsymbol{n - x}}$
- Binomial Mean: $\mu=E(X)=n \pi$
- Binomial Variance and Standard Deviation: $\sigma^{2}=n \pi(1-\pi), \sigma=\sqrt{n \pi(1-\pi)}$
- Poisson Distribution Formula, $P(X=x \mid \lambda)=\frac{e^{-\lambda} \lambda^{x}}{x!}$
- Poisson Mean: $\mu=\lambda$
- Poisson Variance and Standard Deviation: $\sigma^{2}=\lambda, \sigma=\sqrt{\lambda}$
- Convert to X units to z, $\quad X=\mu+Z \sigma$

| 2 | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| -3.5 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 |
| -3.4 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0002 |
| -3.3 | 0.0005 | 0.0005 | 0.0005 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0003 |
| -3.2 | 0.0007 | 0.0007 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0005 | 0.0005 | 0.0005 |
| -3.1 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0007 | 0.0007 |
| -3.0 | 0.0013 | 0.0013 | 0.0013 | 0.0012 | 0.0012 | 0.0011 | 0.0011 | 0.0011 | 0.0010 | 0.0010 |
| -2.9 | 0.0019 | 0.0018 | 0.0018 | 0.0017 | 0.0016 | 0.0016 | 0.0015 | 0.0015 | 0.0014 | 0.0014 |
| -2.8 | 0.0026 | 0.0025 | 0.0024 | 0.0023 | 0.0023 | 0.0022 | 0.0021 | 0.0021 | 0.0020 | 0.0019 |
| -2.7 | 0.0035 | 0.0034 | 0.0033 | 0.0032 | 0.0031 | 0.0030 | 0.0029 | 0.0028 | 0.0027 | 0.0026 |
| -2.6 | 0.0047 | 0.0045 | 0.0044 | 0.0043 | 0.0041 | 0.0040 | 0.0039 | 0.0038 | 0.0037 | 0.0036 |
| -2.5 | 0.0062 | 0.0060 | 0.0059 | 0.0057 | 0.0055 | 0.0054 | 0.0052 | 0.0051 | 0.0049 | 0.0048 |
| -2.4 | 0.0082 | 0.0080 | 0.0078 | 0.0075 | 0.0073 | 0.0071 | 0.0069 | 0.0068 | 0.0066 | 0.0064 |
| $-2.3$ | 0.0107 | 0.0104 | 0.0102 | 0.0099 | 0.0096 | 0.0094 | 0.0091 | 0.0089 | 0.0087 | 0.0084 |
| -2.2 | 0.0139 | 0.0136 | 0.0132 | 0.0129 | 0.0125 | 0.0122 | 0.0119 | 0.0116 | 0.0113 | 0.0110 |
| -2.1 | 0.0179 | 0.0174 | 0.0170 | 0.0166 | 0.0162 | 0.0158 | 0.0154 | 0.0150 | 0.0146 | 0.0143 |
| -2.0 | 0.0228 | 0.0222 | 0.0217 | 0.0212 | 0.0207 | 0.0202 | 0.0197 | 0.0192 | 0.0188 | 0.0183 |
| -1.9 | 0.0287 | 0.0281 | 0.0274 | 0.0268 | 0.0262 | 0.0256 | 0.0250 | 0.0244 | 0.0239 | 0.0233 |
| -1.8 | 0.0359 | 0.0351 | 0.0344 | 0.0336 | 0.0329 | 0.0322 | 0.0314 | 0.0307 | 0.0301 | 0.0294 |
| -1.7 | 0.0446 | 0.0436 | 0.0427 | 0.0418 | 0.0409 | 0.0401 | 0.0392 | 0.0384 | 0.0375 | 0.0367 |
| -1.6 | 0.0548 | 0.0537 | 0.0526 | 0.0516 | 0.0505 | 0.0495 | 0.0485 | 0.0475 | 0.0465 | 0.0455 |
| -1.5 | 0.0668 | 0.0655 | 0.0643 | 0.0630 | 0.0618 | 0.0606 | 0.0594 | 0.0582 | 0.0571 | 0.0559 |
| -1.4 | 0.0808 | 0.0793 | 0.0778 | 0.0764 | 0.0749 | 0.0735 | 0.0721 | 0.0708 | 0.0694 | 0.0681 |
| -1.3 | 0.0968 | 0.0951 | 0.0934 | 0.0918 | 0.0901 | 0.0885 | 0.0869 | 0.0853 | 0.0838 | 0.0823 |
| -1.2 | 0.1151 | 0.1131 | 0.1112 | 0.1093 | 0.1075 | 0.1056 | 0.1038 | 0.1020 | 0.1003 | 0.0985 |
| -1.1 | 0.1357 | 0.1335 | 0.1314 | 0.1292 | 0.1271 | 0.1251 | 0.1230 | 0.1210 | 0.1190 | 0.1170 |
| -1.0 | 0.1587 | 0.1562 | 0.1539 | 0.1515 | 0.1492 | 0.1469 | 0.1446 | 0.1423 | 0.1401 | 0.1379 |
| -0.9 | 0.1841 | 0.1814 | 0.1788 | 0.1762 | 0.1736 | 0.1711 | 0.1685 | 0.1660 | 0.1635 | 0.1611 |
| -0.8 | 0.2119 | 0.2090 | 0.2061 | 0.2033 | 0.2005 | 0.1977 | 0.1949 | 0.1922 | 0.1894 | 0.1867 |
| -0.7 | 0.2420 | 0.2389 | 0.2358 | 0.2327 | 0.2296 | 0.2266 | 0.2236 | 0.2206 | 0.2177 | 0.2148 |
| -0.6 | 0.2743 | 0.2709 | 0.2676 | 0.2643 | 0.2611 | 0.2578 | 0.2546 | 0.2514 | 0.2483 | 0.2451 |
| -0.5 | 0.3085 | 0.3050 | 0.3015 | 0.2981 | 0.2946 | 0.2912 | 0.2877 | 0.2843 | 0.2810 | 0.2776 |
| -0.4 | 0.3446 | 0.3409 | 0.3372 | 0.3336 | 0.3300 | 0.3264 | 0.3228 | 0.3192 | 0.3156 | 0.3121 |
| -0.3 | 0.3821 | 0.3783 | 0.3745 | 0.3707 | 0.3669 | 0.3632 | 0.3594 | 0.3557 | 0.3520 | 0.3483 |
| -0.2 | 0.4207 | 0.4168 | 0.4129 | 0.4090 | 0.4052 | 0.4013 | 0.3974 | 0.3936 | 0.3897 | 0.3859 |
| 0.1 | 0.4602 | 0.4562 | 0.4522 | 0.4483 | 0.4443 | 0.4404 | 0.4364 | 0.4325 | 0.4286 | 0.4247 |
| -0.0 | 0.5000 | 0.4960 | 0.4920 | 0.4880 | 0.4840 | 0.4801 | 0.4761 | 0.4721 | 0.4681 | 0.4641 |


| 6 | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 06 | 0.0 | . 08 | . 09 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.0 | 0.5000 | 0.5040 | 0.5080 | 0.5120 | 0.5160 | 0.5199 | 0.5239 | 0.5279 | 0.5319 | 0.5359 |
| 0.1 | 0.5398 | 0.5438 | 0.5478 | 0.5517 | 0.5557 | 0.5596 | 0.5636 | 0.5675 | 0.5714 | 0.5753 |
| 0.2 | 0.5793 | 0.5832 | 0.5871 | 0.5910 | 0.5948 | 0.5987 | 0.6026 | 0.6064 | 0.6103 | 0.6 |
| 0.3 | 0.6179 | 0.6217 | 0.6255 | 0.6293 | 0.6331 | 0.6368 | 0.6406 | 0.6443 | 0.6480 | 0.6517 |
| 0.4 | 0.6554 | 0.6591 | 0.6628 | 0.6664 | 0.6700 | 0.6736 | 0.6772 | 0.68 | 44 | 0.6879 |
| 0.5 | 0.6915 | 0.6950 | 0.6985 | 0.7019 | 0.70 | 0.7088 | 723 | 57 | 0.7190 | 0.7224 |
| 0.6 | 7257 | 0.7 | 0.7324 | 0.7 | 0.7389 | 0.7422 | 0.7454 | 0.7486 | 0.7517 | 0.7549 |
| 0.7 | 0.7580 | 0.761 | 0.7642 | 0.7673 | 0.7704 | 0.7734 | 0.7764 | 0.7794 | 0.7823 | 52 |
| 0.8 | 0.7881 | 0.7910 | 0.7939 | 0.7967 | 0.7995 | 0.8023 | 0.8051 | 0.8078 | 0.8106 | 0.8133 |
| 0.9 | 0.8159 | 0.8186 | 0.8212 | 0.8238 | 0.826 | 0.8289 | 0.8315 | 0.8340 | 0.8365 | 0.8389 |
| 1.0 | 0.8413 | 0.8438 | 0.8461 | 0.84 | 0.85 | 0.8531 | 0.8554 | 0.8577 | 0.8599 | 0.8621 |
| 1.1 | 0.8643 | 0.8665 | 0.8686 | 0.8708 | 0.8729 | 0.8749 | 0.8770 | 0.8790 | 0.8810 | 0.8830 |
| 1.2 | 0.8849 | 0.8869 | 0.8888 | 0.8907 | 0.8925 | 0.8944 | 0.8962 | 0.8980 | 0.8997 | 0.9015 |
| 1.3 | 0.9032 | 0.9049 | 0.9066 | 0.9082 | 0.9099 | 0.9115 | 0.9131 | 0.9147 | 0.9162 | 77 |
| 1.4 | 0.9192 | 0.9207 | 0.9222 | 0.923 | 0.92 | 0.92 | 0.9279 | 0.9292 | 0.9306 | 0.9319 |
| 1.5 | 0.9332 | 0.9345 | 0.9357 | 0.9370 | 0.9382 | 0.9394 | 0.9406 | 0.9418 | 0.9429 | 0.9441 |
| 1.6 | 0.9452 | 0.9463 | 0.9474 | 0.9484 | 0.9495 | 0.9505 | 0.9515 | 0.9525 | 0.9535 | 0.9545 |
| 1.7 | 0.9554 | 0.9564 | 0.9573 | 0.9582 | 0.9591 | 0.9599 | 0.9608 | 0.9616 | 0.9625 | 0.9633 |
| 1.8 | 0.9641 | 0.9649 | 0.9656 | 0.9664 | 0.967 | 0.9678 | 0.9686 | 0.9693 | 0.9699 | 706 |
| 1.9 | 0.9713 | 0.9719 | 0.9726 | 0.973 | 0.973 | 0.974 | 0.9750 | 0.9756 | 0.9761 | 0.9767 |
| 2.0 | 0.9772 | 0.9778 | 0.9783 | 0.9788 | 0.9793 | 0.9798 | 0.9803 | 0.9808 | 0.9812 | 0.9817 |
| 2.1 | 0.9821 | 0.9826 | 0.9830 | 0.9834 | 0.9838 | 0.9842 | 0.9846 | 0.9850 | 0.9854 | . 9857 |
| 2.2 | 0.9861 | 0.9864 | 0.9868 | 0.9871 | 0.9875 | 0.9878 | 0.9881 | 0.9884 | 0.9887 | 0.9890 |
| 2.3 | 0.9893 | 0.9896 | 0.9898 | 0.9901 | 0.9904 | 0.9906 | 0.9909 | 0.9911 | 0.9913 | 0.9916 |
| 2.4 | 0.9918 | 0.9920 | 0.9922 | 0.9925 | 0.9927 | 0.9929 | 0.9931 | 0.9932 | 0.9934 | 0.9936 |
| 2.5 | 0.9938 | 0.9940 | 0.9941 | 0.9943 | 0.9945 | 0.9946 | 0.9948 | 0.9949 | 0.9951 | 0.9952 |
| 2.6 | 0.9953 | 0.9955 | 0.9956 | 0.9957 | 0.9959 | 0.9960 | 0.9961 | 0.9962 | 0.9963 | 0.9964 |
| 2.7 | 0.9965 | 0.9966 | 0.9967 | 0.9968 | 0.9969 | 0.9970 | 0.9971 | 0.9972 | 0.9973 | 0.9974 |
| 2.8 | 0.9974 | 0.9975 | 0.9976 | 0.9977 | 0.9977 | 0.9978 | 0.9979 | 0.9979 | 0.9980 | 0.9981 |
| 2.9 | 0.9981 | 0.9982 | 0.9982 | 0.9983 | 0.9984 | 0.9984 | 0.9985 | 0.9985 | 0.9986 | 0.9986 |
| 3.0 | 0.9987 | 0.9987 | 0.9987 | 0.9988 | 0.9988 | 0.9989 | 0.9989 | 0.9989 | 0.9990 | 0.9990 |
| 3.1 | 0.9990 | 0.9991 | 0.9991 | 0.999 | 0.9992 | 0.9992 | 0.9992 | 0.9992 | 0.9993 | 0.9993 |
| 3.2 | 0.9993 | 0.9993 | 0.9994 | 0.9994 | 0.9994 | 0.9994 | 0.9994 | 0.9995 | 0.9995 | 0.9995 |
| 3.3 | 0.9995 | 0.9995 | 0.9995 | 0.9996 | 0.9996 | 0.9996 | 0.9996 | 0.9996 | 0.9996 | 0.9997 |
| 3.4 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9998 |
| 3.5 | 0.9998 | 0.9998 | 0.9998 | 0.9998 | 0.9998 | 0.9998 | 0.9998 | 0.9998 | 0.9998 | 0.9998 |

