Probability
(Part 1)

Basics Concepts
Equation

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Probability

- **Probability** means possibility or Chance to happen
- It is a branch of mathematics that deals with the occurrence of a random event
- P = 0 to 1

Probability of event to happen P(E) = Number of favorable outcomes
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Total Number of outcomes

$$P(E) = A/S$$

$$P(\text{Head}) = 1\ (\text{head})/2 = \tfrac{1}{2} = 0.5$$

$$p + q = 1$$

P- Probability of Success

q – Probability of Failure


Probability

Example 2- calculate the probability head, if Two coin are tossed

H T x H T= HH, HT, TH, TT ------------ $(S)^n$ = 4 Possibility

P (0 head) = ¼ = 0.25

P(1 heads) = ½ = 0.5

P (2 heads) = ¼ = 0.25

P(head) = ¾ = 0.75

Example 3. A First aid box contains 10 tab of paracetamol and 20 tab of aspirin, what is the probability of paracetamol to picked from box?

P (pcm) = 10/30 = 1/3 = 0.33

Probability

P(E) = n(A)/S

Example 4. A First aid box contains 10 tab of paracetamol and 20 tab of aspirin,

1. what is the probability of paracetamol to picked from box in first event?

P (pcm) = 10/30 = 1/3 = 0.33

2. . what is the probability of aspirin to picked from box in second event

P = 20 /30-1 = 20/29

P_{Asp} = 19/29

Probability

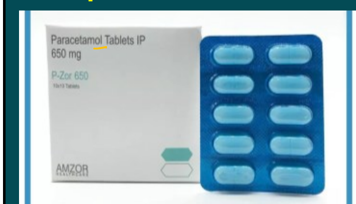
- **Theoretical**: It is Theoretical listing of outcomes and probabilities (Obtained from Mathematical model)


E.x.- Toss (probability of Head)- P = n(A)/n(S)

1/2 = 0.5

p + q = 1, (p = ½ and q = 1-1/2 = ½)

- **Experimental**: An empirical Listing of outcomes and their observed



10 $P_{pcm} = \frac{10}{30} = \frac{1}{3}$ 8/30

10 $P_{Atc} = \frac{1}{3}$ 2/30

10 $P_{Iby} = \frac{1}{3}$ 4/30

Probability

- Subjective listing of outcomes associated with their subjective or contrived probabilities representing the degree of conviction of the decision maker

Vs

0.5

½ ½

BJP Vs Cong

800 200

$\frac{800}{1000}$ p = 0.8 p = 0.2

sample size

Probability Distribution
(Part 2)

Binomial Disribution

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Probability Distribution

- Probability Distribution
  - 1 Binomial Distribution
  - Binomial Negative Distribution
  - Multinomial Distribution
  - 2 Poisson Distribution
  - 3 Normal Distribution
  - Hypergeometric Distribution

Binomial Distribution

- The binomial distribution is a "discrete probability distribution" that describe only two possible results (Fail or Success) in a fixed number of independent trials or experiments, where each trial has only two possible outcomes and the probability of success remains constant throughout all trials.
- For example, flipping a coin is a binomial experiment since there are only two possible outcomes (heads or tails) and the probability of getting heads (success) is always 0.5.

$p = \frac{1}{2}$

$p = \frac{1}{2}$

Binomial Distribution

- A single outcome (Success or Fail) test is also called a "Bernoulli trial" or Bernoulli experiments. And series of experiments is called "Bernoulli process"
- Some important properties of the binomial distribution include:
- Mean, $\overset{m}{\mu}$ = np

  n = no. of trials
  p = probability

  "$q = 1 - p$"
  "$p + q = 1$"

  $p = 0.1$
  $q = 0.9$
- Variance, σ^2 = npq
- Standard Deviation $\sigma = \sqrt{(npq)}$
- As the number of trials increases, the binomial distribution approaches a normal distribution.

Binomial Distribution

- Example: roll the coin 3 time, so possible combinations:

(HT x HT x HT

(HH HT TH TT) x HT

$(S)^n$ $(2)^3 = 8$

HHH	HHT	HTH	HTT	THH	THT	TTH	TTT
3	2	2	1	2	1	1	0

Heads

- 0 heads – 1/8 $= 0.125$
- 1 heads – 3/8
- 2 heads – 3/8
- 3 heads- 1/8

$\geq 2 = \frac{3}{8} + \frac{1}{8} = \frac{4}{8} = \frac{1}{2} = 0.5$

$P_{(r)} = {}^nC_r \times q^{(n-r)} \times p^r$

${}^nC_r = n!/\ r! \times (n-r)!$

* roll the coin 10 times $n = 10$

$(S)^n = (2)^{10}$
$= 1024$

- P(r) = probability of defined r success in n trial (probability in binomial distribution)
- p = probability of success in single trail
- q = probability of failure in single trial (q = 1-p)
- n = no. of trial
- r = no. of success in n trial

$n = 3$

$n! = 3!$
$= 3 \times 2 \times 1$

$n! = 4!$
$= 4 \times 3 \times 2 \times 1$

" $n! = 0! = 1$ "

Binomial Distribution

- Example 1: roll the coin 3 time, so find out the possibilities of
- a) exactly 1 heads
- b) at least 2 heads:

$P_{(r)} = {}^nC_r \times q^{(n-r)} \times p^r$

${}^nC_r = n!/\ r! \times (n-r)$

$n = 3$ $q = 1-p = 1-\frac{1}{2} = \frac{1}{2}$
$r = 1$
$p = 1/2$ $n-r = 3-1 = 2$

$P_r = {}^nC_r \times q^{(n-r)} \times p^r$

$= \frac{n!}{r! \times (n-r)!} \times q^{n-r} \times p^r$

$= \frac{3 \times \cancel{2} \times \cancel{1}}{1 \times \cancel{2} \times \cancel{1}} \times \left(\frac{1}{2}\right)^2 \times \left(\frac{1}{2}\right)^1$

$= 3 \times \frac{1}{4} \times \frac{1}{2}$

$P_{(1)} = \frac{3}{8}$

Binomial Distribution

- Example 1: roll the coin 3 time, so find out the possibilities of
- a) exactly 1 heads $n=3 \quad p=\frac{1}{2} \quad q=\frac{1}{2}$
- b) at least 2 heads: $r \geq 2 \quad r=2 \quad r=3$

$n-r=1 \qquad n-r=0$

$P_{(r)} = {}^nC_r \times q^{(n-r)} \times p^r$

${}^nC_r = n!/ r! \times (n-r)$

$$P_{(2)} = \frac{3!}{2! \times 1!} \times \left(\frac{1}{2}\right)^1 \times \left(\frac{1}{2}\right)^2 = \frac{3 \times \cancel{2} \times 1}{\cancel{2} \times 1 \times 1} \times \frac{1}{2} \times \frac{1}{4} = \frac{3}{1} \times \frac{1}{2} \times \frac{1}{4}$$

$$P_{(2)} = 3/8$$

$$P_3 = \frac{3!}{3! \times 0!} \times \left(\frac{1}{2}\right)^0 \times \left(\frac{1}{2}\right)^3 = \frac{\cancel{3 \times 2 \times 1}}{\cancel{3 \times 2 \times 1} \times 1} \times 1 \times \frac{1}{8} = \frac{1}{1} \times \frac{1}{1} \times \frac{1}{8} =$$

$$P_{(3)} = \frac{1}{8}$$

$$P_{(\geq 2)} = P_{(2)} + P_{(3)} = \frac{3}{8} + \frac{1}{8} = \frac{4}{8} = 0.5$$

Probability Distribution (Part 3)

Poisson's Distribution

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Poisson Distribution

- In Statistics, a Poisson distribution is a probability distribution that is used to show how many times an event is likely to occur over a specific period.
- In other words, it is a "count distribution."
- A state has 1000 pharma companies and average 1 factory has closed during 1 year. If their will be 2000 pharma companies then what will be the probability of 5 company will be closed.

$$P_{(r)} = \frac{e^{-m} m^r}{r!}$$

- e = 2.7183
- m = np   n = no. of trial, p = probability
- r = expected success in n trial
- n = no. of trials

Poisson Distribution

- Example: 10% tablet will be defective produced by dry granulation method. Find out the probability that in a 20 tablet chosen at random, exactly 6 will be defective by using Poisson distribution

$$P_{(r)} = \frac{e^{-m} m^r}{r!}$$

- e = 2.7183
- m = np
- r = expected success in n trial
- n = no. of trials

$n = 20$

$p = \frac{10}{100} = \frac{1}{10}$

$r = 6$

$m = np = 20 \cdot \frac{1}{10} = 2$

$$P_{(6)} = \frac{(2.7183)^{-2} \times (2)^6}{6 \times 5 \times 4 \times 3 \times 2 \times 1}$$

$$= \frac{0.13 \times 64}{720}$$

$$= \frac{8.67}{720}$$

$$\boxed{P_{(6)} = 0.012}$$

Poisson Distribution

- Example: A state has 1000 pharma companies and average 1 factory has closed during 1 year. If their will be 2000 pharma companies then what will be the probability of 5 company will be closed.

$$P_{(r)} = \frac{e^{-m} m^{r}}{r!}$$

$n = 2000$, $r = 5$

$p = \frac{1}{1000}$

$m = np = 2000 \times \frac{1}{1000} = 2$

$$P_{(5)} = \frac{(2.7183)^{-2} \times (2)^5}{5\times4\times3\times2\times1}$$

$= \frac{0.13 \times 32}{120}$

$= \frac{4.33}{120}$

$= 0.036$

$\boxed{P_{(5)} = 0.036}$

$(2.7183)^{-2} = \frac{1}{(2.7183)^2}$

$= \frac{1}{\text{antilog}(2 \times \log 2.71)}$

$= \frac{1}{\text{antilog}(2 \times 0.43)}$

$= \frac{1}{\text{antilog}(0.86)} = \frac{1}{10^{0.86}}$

$= \frac{1}{7.38} = 0.13$

- e = 2.7183
- m = np
- r = expected success in n trial
- n = no. of trials

Probability Distribution
(Part 4)

Normal Distribution

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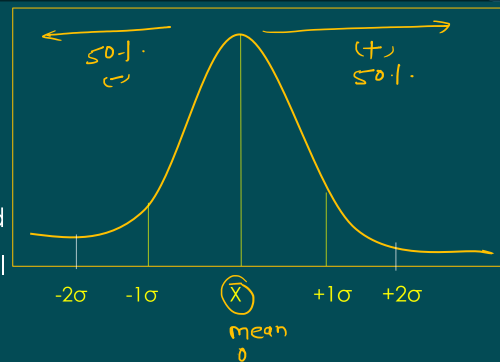
Normal Distribution

- The Normal distribution curve is Bell Shaped
- It is also called Gaussian distribution

- Symmetrical
- Central Tendency located at the center of graph
- a normal distribution with a mean 0 and standard deviation of 1 is called the standard normal distribution
- Mean = Mode = Median
- Two Tails of the distribution extended indefinitely but never touch the X axis



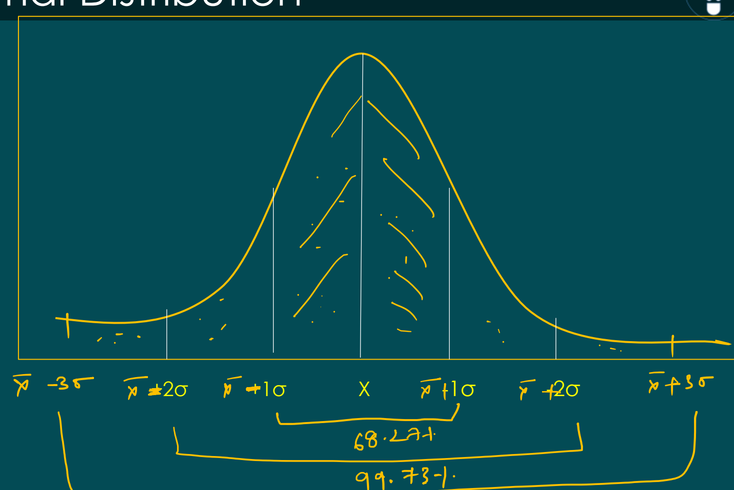
Normal Distribution

- The % distribution of area under standard normal curve is broadly as follow:
- ±1σ – 68.27%
- ±2σ – 95.44%
- ±3σ – 99.73%

This is observed by Z score

x = exp. data
x̄ = mean
σ = S.D.

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



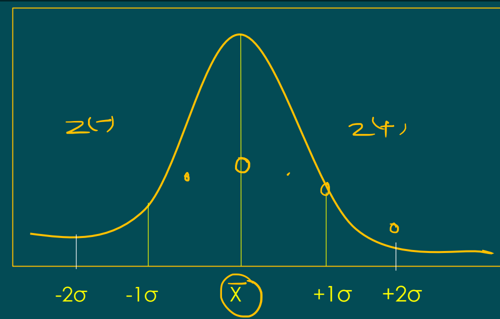
Normal Distribution

This is observed by Z score

z-ve

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

- Z<0 , data < mean or Z>0 , data > mean.
- Z = 0, data = mean
- Z = 1, represents an element or data, which is 1 standard deviation greater than the mean; a z-score equal to 2 signifies 2 standard deviations greater than the mean; etc



Normal Distribution

Q. Avg % of the class (n =100) is 55% with variance of 16%, calculate the probability that how many students have > 60%

$x = 60$
$\bar{x} = 55$
SD $\sigma = \sqrt{16} = 4$

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

$= \frac{60-55}{4} = \frac{5}{4}$

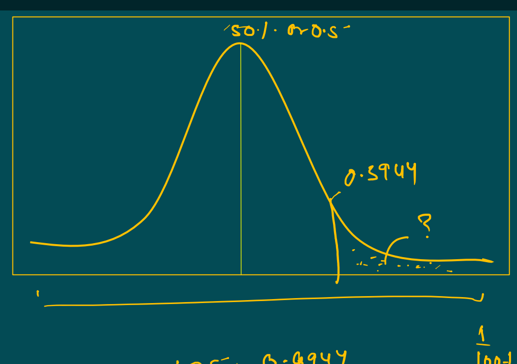
$Z = +1.25$

$$\begin{array}{r} 0.5000 \\ 0.3944 \\ \hline 0.1056 \end{array}$$

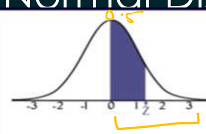
$P_{(>60)} = 100 \times 0.1056$

$\boxed{P = 10.56}$

10 to 11 students have > 60%



Normal Distribution



STANDARD NORMAL TABLE (Z)

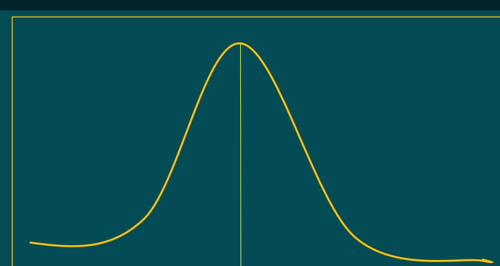
Entries in the table give the area under the curve between the mean and z standard deviations above the mean. For example, for $z = 1.25$ the area under the curve between the mean (0) and z is 0.3944.

0.3944

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0190	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2969	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3513	0.3554	0.3577	0.3529	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	$\boxed{0.3944}$	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

Normal Distribution

Q. Avg Weight of the College (n = 500) is 65 kg with ~~variance~~ SD of 2, calculate the probability that how many students have < 60 kg



$\bar{x} = 65$
$\sigma = 2$
$\bar{x} = 60$

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

$$= \frac{60 - 65}{2} = \frac{-5}{2}$$

$$Z = -2.5$$

$$\begin{array}{r} 0.5000 \\ -\ 0.0062 \\ \hline 0.4938 \end{array}$$

$$P_{(<60)} = 500 \times 0.4938$$

$$= 246.9$$

$$P \approx 247$$

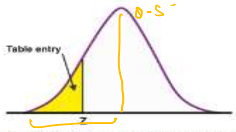


Table entry for z is the area under the standard normal curve to theleft of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

PC
Pharmacology Concepts
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