



M4-07: Normal Distribution

Part of the "Simulation and Distributions" Learning Badge

Video Walkthrough: <https://discovery.cs.illinois.edu/m4-07/>

The Normal Distribution

The normal curve is a bell-shaped histogram that many histograms resemble.

The standard normal curve is a special normal curve that has an average of 0 and an SD of 1. Here are some facts about the standard normal curve:

- It is bell-shaped.
- It is centered at 0.
- Both the average and the median are 0 and the SD is 1.
- The x-axis is measured in standard units (also called Z scores).
- The area under the curve is 100%.

Many histograms are close to the normal curve.

For these histograms, you can use the standard normal curve to estimate percentages for the data. But first you have to scale the data values to those of the standard normal curve. In other words, you have to change the horizontal scale to have an average of 0 and an SD =1. We do this by converting to standard units.

STANDARD UNITS or Z SCORES

Standard Units (also known as z scores) indicate how many SDs above or below the average a value is. To use the standard normal curve all data values must be converted to standard units by the following:

$$\text{Standard Units} = Z = (\text{value} - \text{average}) / SD = (x - \mu) / \sigma$$

NOTE: WHEN HISTOGRAMS DON'T LOOK CLOSE TO THE NORMAL CURVE, DON'T USE THE STANDARD NORMAL APPROXIMATION!

The standard normal curve has a nice table attached to it that we can use to answer questions about the data after we convert to z scores. Use the table shown on the next page to answer the questions for Puzzle #1.



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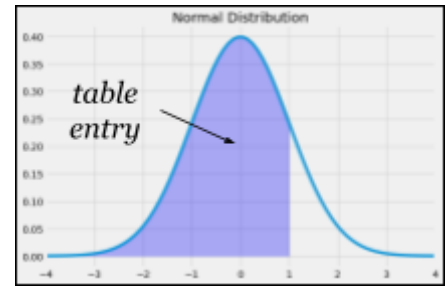
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Table of Standard Normal Percentiles

Table entry provides the area under a standard normal curve to the left of a z value, also known as the cumulative distribution function (cdf).

Standard Normal Distribution:
Normal distribution with mean=0, SD=1



Z=	+ .00	+ .01	+ .02	+ .03	+ .04	+ .05	+ .06	+ .07	+ .08	+ .09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952

There are many different normal tables that give different areas under the normal curve. This normal table gives the area to the left of the z -score (also known as the percentile, or the CDF).



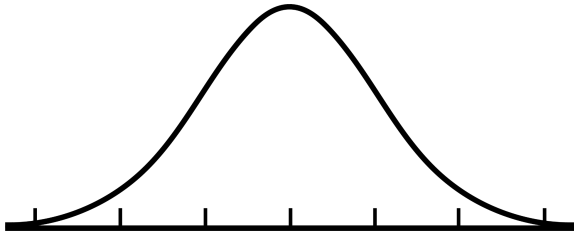
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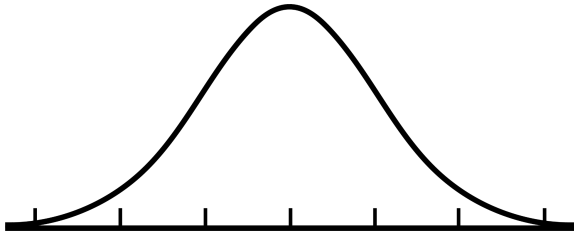
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Puzzle #1: Finding areas under the standard normal curve.

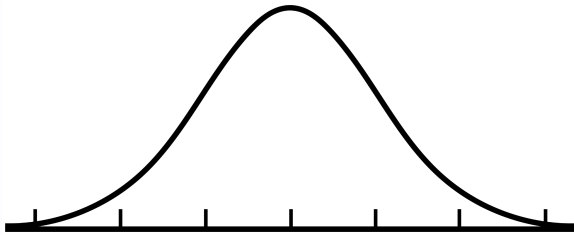
Find the area between 0 and 1.



Find the area below 1.



Find the area below -1.



Find the area between 1 and 2.

