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Rules of Probability

Independent

$P(A \cap B) = P(A)\,P(B)$ probability that both A & B occur

for mutually exclusive events $P(A \cap B) = \phi$

for mutually exclusive events $P(A \cup B) = P(A) + P(B)$ probability that A or B will occur

general form

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

Dependence - occurrence of 1 event does affect the probability of occurrence of another event.

Example: Pick a card, do not replace it, pick another card. What is the probability both cards were hearts?

$P(\text{1st heart}) = \frac{13}{52}$

$P(\text{2nd heart}) = \begin{cases} \frac{12}{51} & \text{if 1st heart} \\ \frac{13}{51} & \text{if 1st not heart} \end{cases}$

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Note: <u>Conditional Probability</u>

B depends on A

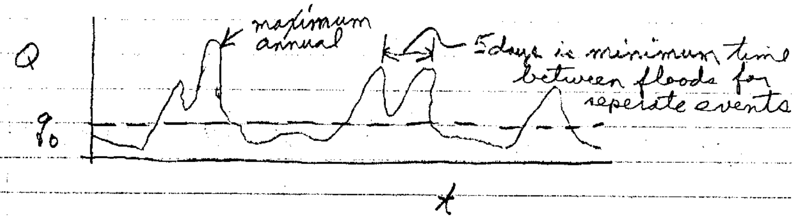
$P(A \cap B) = P(A)P(B|A)$

for card example

$P(A \cap B) = \frac{13}{52}\left(\frac{12}{51}\right) = \frac{3}{51}$

<u>APPLICATION TO FLOODS</u>

Floods are independent continuous Random events.



q_0 = base level

<u>Probability applied to Floods</u>

$P(Flood = n) = 0$ n any number

we talk about the probability of a flood being greater or less than n, not equal to n.

$P(Flood \geq x) =$ Exceedence Probability

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<u>Exceedence Probability</u> – Probability that a flood of a given magnitude will be exceeded in any given year.

$$\underline{\text{Return Period}} = \frac{1}{\text{Exceedence Probability}}$$

$P(F) = p$ (Probability that the flood will be exceeded)

$P(\text{not exceeded}) = 1 - p$

$P(\text{not having a flood for } n \text{ straight years}) = (1-p)^n$

$\text{Risk} = P(\text{having at least 1 flood during } n \text{ years}) = 1-(1-p$

<u>Example</u>:

$P(F) = .1, \; n = 10 \text{ years}$

$\text{Risk} = 1-(1-p)^n = 1-(1-.1)^{10} = .65 = 65\%$

$P(F) = .01, \; n = 100 \text{ years}$

$\text{Risk} = 1-(1-.01)^{100} = .63 = 63\%$

$P(F) = .01, \; n = 10 \text{ years}$

$\text{Risk} = 1-(1-.01)^{10} = .095 = 9.5\%$

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Example: Want a 5% chance that our project will fail in the next 10 years. What recurrence interval should we us.

$$Risk = 1 - (1-p)^n$$

$$.05 = 1 - (1-p)^{10}$$

$$p = .005$$

$$\text{Return period} = \frac{1}{p} = \frac{1}{.005} = 195 \text{ years}$$

	Vapor pressure		
	mb	psi	in. Hg
10^{-5}	6.11	0.09	0.18
10^{-5}	8.36	0.12	0.25
10^{-5}	12.19	0.18	0.36
10^{-5}	17.51	0.26	0.52
10^{-5}	24.79	0.36	0.74
10^{-5}	34.61	0.51	1.03
10^{-5}	47.68	0.70	1.42
10^{-5}	64.88	0.95	1.94

Example: $T = 50 \Rightarrow p = \frac{1}{50} = .02$

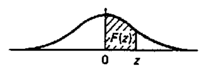
Then $1 - p = .98$

The table below show half of the curve, therefore must find

$.98 - .50 = .48$ ← closest

$\Rightarrow Z = 2.05$

TABLE C.1 AREAS UNDER THE NORMAL CURVE



$$F(z) = \int_0^z \frac{1}{\sqrt{2\pi}} e^{-z^2/2} dz$$

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0159	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2518	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4430	.4441
1.6	.4452	.4463	.4474	.4485	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4762	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4865	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4980	.4980	.4981
2.9	.4981	.4982	.4983	.4983	.4984	.4984	.4985	.4985	.4986	.4986

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Methods of Analysis

Non Parametric Methods: Plotting the data

Weibull plotting position formula

Rank Order Statistics - Calculate observed Probabilities.

$p = \frac{m}{n+1}$ where m = rank data point (largest to smallest)

n = total number of data points

p = observed probability

Parametric Methods: Analytical Frequency Curve.

* Normal - to use Standard Normal dist. ($\mu = 0, s = 1$)

then let

$Z = \frac{x - \bar{x}}{s}$ where Z = reducted variant (also called K)

x & $\bar{x}$ = data values or wanted values

$\Rightarrow x = \bar{x} + Zs$

Similar for other distributions.

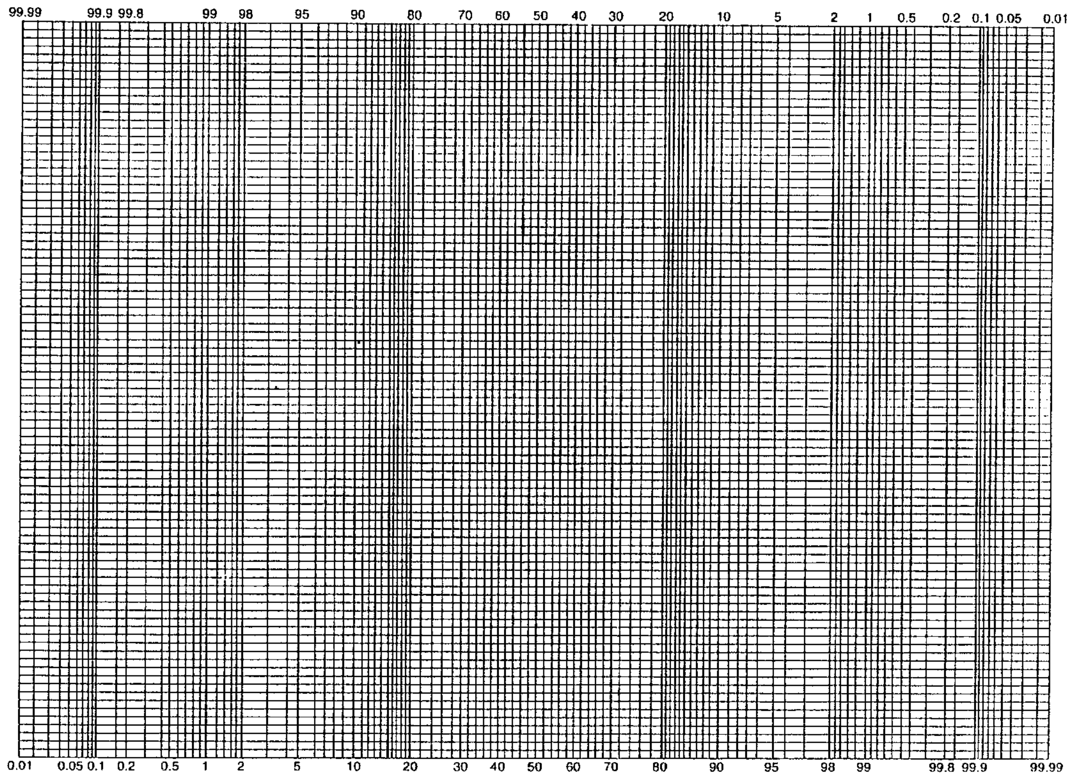

FIGURE 3.6 Normal probability paper