STAEDTLER® No. 937 811E Engineer's Computation Pad

Problem 2.20

E ≡ excessive bacteria in the water supply.

$P(A) = \frac{1}{1+1+3} = \underline{\underline{0.2}}$

$P(B) = \frac{1}{5} = \underline{\underline{0.2}}$

$P(C) = \frac{3}{5} = \underline{\underline{0.6}}$

$P(E|A) = \underline{\underline{0.05}}$

$P(E|B) = \underline{\underline{0.1}}$

$P(E|C) = \underline{\underline{0.02}}$

a) $\underline{\underline{P(E)}} = P(E|A)P(A) + P(E|B)P(B) + P(E|C)P(C)$

$= (0.05)(0.2) + (0.1)(0.2) + 0.02(0.6)$

$= 0.01 + 0.02 + 0.012$

$= \boxed{0.042}$

b) $\underline{\underline{P(A|\bar{E})}} = \frac{P(\bar{E}|A)P(A)}{P(\bar{E})} = \frac{(1-P(E|A))P(A)}{1-P(E)}$

$= \frac{(1-0.05)(0.2)}{1-0.042}$

$= \frac{0.19}{0.958}$

$= \boxed{0.198}$

Problem 2.22

D = structural damage from tornadoes in next 50 years

T_i = i number of tornadoes in the next 50 years.

$P(T_1) = 0.2$

$P(T_2) = 0.03$

$P(T_3) = 0.001$

$P(T_4) = P(T_5) = \cdots P(T_n) = 0.0$

Thus, $P(T_0) = 1 - 0.2 - 0.03 - 0.001 = \underline{0.769}$

$P(D|T_1) = 0.7$

$P(\bar{D}|T_1) = 1 - 0.7 = 0.3$

$P(\bar{D}|T_2) = 0.3(0.3) = 0.09$

$P(\bar{D}|T_3) = (0.3)^3 = 0.027$

$P(\bar{D}|T_0) = 1.0$

P(no structural damage from tornadoes in next 50 years) = $P(\bar{D})$.

$$\underline{P(\bar{D})} = P(\bar{D}|T_0)P(T_0) + P(\bar{D}|T_1)P(T_1) + P(\bar{D}|T_2)P(T_2) + P(\bar{D}|T_3)P(T_3)$$

$$= 1(0.769) + 0.3(0.2) + 0.09(0.03) + 0.027(0.001)$$

$$= 0.769 + 0.06 + 0.0027 + 0.000027$$

$$= \boxed{0.832}$$

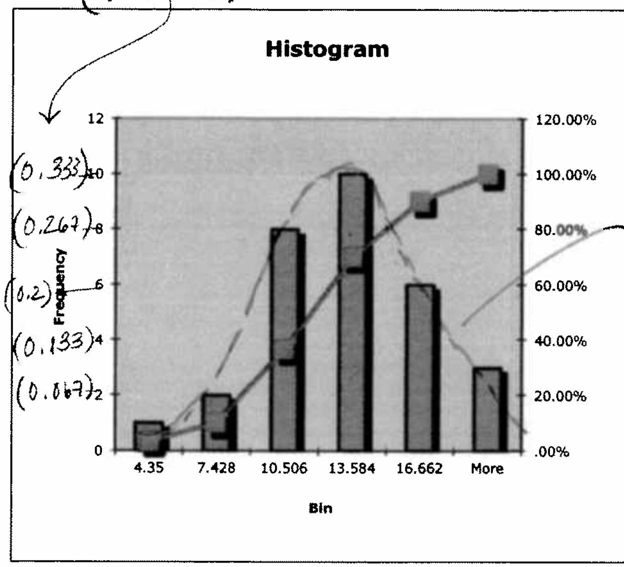
3/4

Annual Precip [in]	Skewness: top	freq for sorted	sorted data	Part (d)
11.6	-2.23E-03	0.01	4.35	
7.19	-9.36E+01	0.02	6.93	
12.69	8.83E-01	0.02	7.19	
11.86	2.16E-03	0.02	8	
14.81	2.92E+01	0.02	8.07	
8.07	-4.91E+01	0.02	8.53	
11.15	-1.96E-01	0.02	8.63	
8	-5.19E+01	0.02	8.68	
9.55	-1.04E+01	0.03	9.55	
11.02	-3.59E-01	0.03	9.62	
19.54	4.76E+02	0.03	9.68	
8.63	-2.98E+01	0.03	10.55	
12.33	2.15E-01	0.03	10.64	
8.53	-3.28E+01	0.03	11.02	
16.55	1.12E+02	0.03	11.13	
19.74	5.14E+02	0.03	11.15	
18.4	2.97E+02	0.03	11.37	
11.37	-4.69E-02	0.03	11.6	
10.55	-1.65E+00	0.03	11.86	**0.63**
8.68	-2.84E+01	0.04	12.33	
9.62	-9.40E+00	0.04	12.69	
6.93	-1.11E+02	0.04	14.56	
14.8	2.89E+01	0.04	14.76	
10.64	-1.30E+00	0.04	14.8	
14.76	2.78E+01	0.04	14.81	
15.19	4.14E+01	0.04	15.19	
14.56	2.26E+01	0.05	16.55	
9.68	-8.62E+00	0.05	18.4	
11.13	-2.17E-01	0.06	19.54	
4.35	-4.02E+02	0.06	19.74	
351.92	**7.19E+02**	**1**		**0.37**

Tools-> Data Analysis-> Histogram

Bin	Frequency		Cumulative %	
4.35	0.033	1	3.33%	
7.428	0.067	2	10.00%	
10.506	0.267	***8***	***36.67%***	part (d)
13.584	0.333	10	70.00%	
16.662	0.200	6	90.00%	
More	0.100	3	100.00%	

(÷ 30 ↑)



frequency diagram drawn by hand.

[You could have plotted the frequency values between 0 and 1 vs. bin values (precip in inches) separately for the (b) part.]

Tools->Data Analysis->Descriptive Statistics

Column1	
Mean	11.73
Standard Error	0.69
Median	11.14
Mode	#N/A
Standard Deviation	3.78
Sample Variance	14.28
Kurtosis	-0.12
Skewness	0.49
Range	15.39
Minimum	4.35
Maximum	19.74
Sum	351.92
Count	30.00

COV	0.32	
skewness coef-ficient	0.48	used N=28

3.3 The traveling time from the office to the nearest airport may be 0.5, 1.0, 1.5, 2.0, 2.5, or 3.0 hours depending upon the time of travel. The corresponding PMFs are shown in Figure P3.3. Calculate the following information on the travel time:

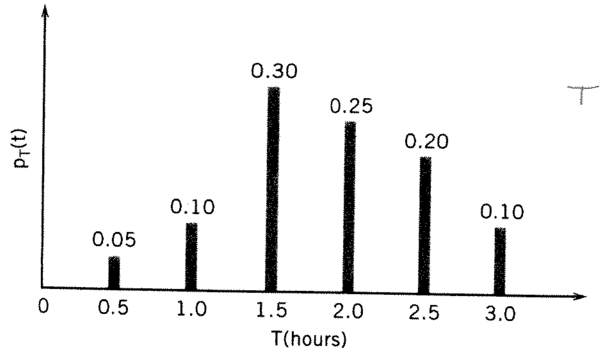


Figure P3.3 PMFs of Travel Time

T = time in hours

(a) The mean.
(b) The variance, standard deviation, and coefficient of variation.
(c) The skewness and skewness coefficient.

a) Mean $= E(T)$

$$= \sum_{i=1}^{n} t_i p_T(t_i) = 0.5(0.05) + 1.0(0.10) + 1.5(0.30) + 2.0(0.25) + 3.0(0.10) = \boxed{1.875 \text{ hours}}$$

b) Variance (T) = Var(T) = $\sum_{i=1}^{n} (t_i - 1.875)^2 p_T(t_i)$

$$= (0.5-1.875)^2(0.05) + (1.0-1.875)^2(0.10) + (1.5-1.875)^2(0.30) + (2.0-1.875)^2(0.25) + (2.5-1.875)^2(0.20) + (3.0-1.875)^2(0.10)$$

$$= \boxed{0.422\ (hr)^2}$$

$$\sigma_T = \sqrt{0.422} = \boxed{0.6496 \text{ hrs}}$$

$$\delta_T = COV(T) = 0.6496/1.875 = \boxed{0.347}$$

c) Skewness $= \sum_{i=1}^{n} (t_i - 1.875)^3 p_T(t_i)$

$$= (0.5-1.875)^3(0.05) + (1.0-1.875)^3(0.10) + (1.5-1.875)^3(0.30) + (2.0-1.875)^3(0.25) + (2.5-1.875)^3(0.20) + (3.0-1.875)^3(0.10)$$

$$= \boxed{-0.021}$$

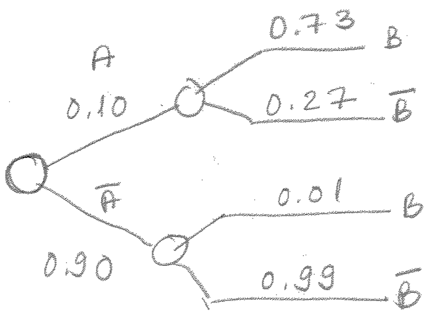
Skewness Coefficient $= \dfrac{-0.021}{(0.6496)^3} = \boxed{-0.077}$

CEE518 Types of uncertainty

Uncertainty in engineering decision-making cannot be avoided. There are two types of uncertainty encountered in practice. The first is the uncertainty associated with the data collected. For example, in structural engineering, capacity and demand variables are random in nature. Because they are not deterministic, the best one can characterize them is through statistical measures such as the mean and variance. That is, any data collected will display variability. This type of uncertainty is called *aleatoric.* Engineers typically describe this type of uncertainty through the coefficient of variation, or the standard deviation divided by the mean. In addition, the sample size affects the outcome of the data collection process.

The second type of uncertainty encountered is due to the imperfect knowledge of the physical phenomenon being examined. It is called *epistemic* uncertainty. The best way to reduce this type of uncertainty is to possess a better understanding of the phenomenon through enhanced prediction models. *Epistemic uncertainty* is uncertainty of the probability or risk calculated through imperfect models of the real world.

In summary, *aleatoric uncertainty* is data-based whereas *epistemic uncertainty* is knowledge-based. Both are important in the assessment of probability and risk in engineering.

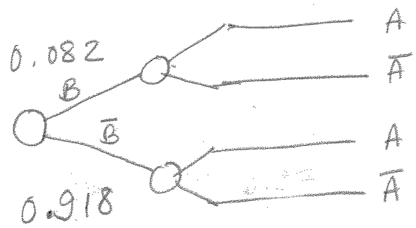


0.073	AB
0.027	$A\bar{B}$
0.009	$\bar{A}B$
0.891	$\bar{A}\bar{B}$

$P(\bar{B}) = 0.918$

$P(B) = 0.082$

1.00



0.073	AB	$\rightarrow \frac{0.073}{0.082} = 0.89$
0.009	$\bar{A}B$	$\rightarrow 0.11$
0.027	$A\bar{B}$	$\rightarrow 0.03$
0.891	$\bar{A}\bar{B}$	$\rightarrow 0.97$

∴ final flipped ~~tree~~ is