Chapter 1

Introduction

1.1 Problems

Problem 1.1 (Illuminated mouse) *You often power your laptop with the battery while you are traveling. You need to buy a new mouse, but want to maximize the battery life. Explain why buying the illuminated mouse is not a wise choice.*

(ans: An illuminated mouse contains an LED light source that requires power, which is supplied by the battery. Hence, battery life will be decreased with an illuminated mouse.
)

Problem 1.2 (Threshold detection) *Digital signals that occur within your computer are designed to be either 0 V or 5 V. Additive noise produced the following detected values:*

$$-0.1,\ 3.9,\ 0.9,\ 5.1,\ 0.7,\ 4.85$$

What threshold value would you use to restore the values? Explain why. Restore these detected values to their designed values.

(ans: The ideal threshold is mid-way between the two voltage extremes. Hence, with [0,5V], a 2.5V threshold does not favor either 0V or 5V signals. Restored values are

$$0,\ 5,\ 0,\ 5,\ 0,\ 5$$

)

Problem 1.3 (Error correction) *Threshold detection converted signal values 0 V and 5 V into binary logic values 1 and 0. For transmission over a noisy channel, each binary value is transmitted five times. A threshold detector produces the following binary sequence:*

$$00100\ 11001\ 01000\ 10110\ 10001$$

1. *Assuming at most 2 errors occur per 5-bit code word, estimate the probability of error in the channel as the number of errors in the sequence divided by the number of data bits transmissions.*

(ans: There are 25 data transmissions and there are 8 errors. This gives

$$\textit{Prob[error]} = \frac{8}{25} = 0.32$$

)

2. *What rule would you apply to try to correct the errors?*

   (ans: Count number of 1's in each code word, if count ≤ 2 then corrected codeword is 00000, otherwise 11111.
)

3. *Write your corrected binary sequence.*

   (ans:

   $$00000\ 11111\ 00000\ 11111\ 00000$$

)

Problem 1.4 (Prediction with Moore's law) *Using the current year's performance as the base, how much more powerful will your computer be in 6 years?*

(ans:

$$P(t_1) = P(t_o)e^{\frac{t_1 - t_o}{1.5}}$$

$t_1 = t_o + 6$ *gives*

$$P(t_o + 6) = P(t_o)e^{\frac{t_o + 6 - t_o}{1.5}} = P(t_o)e^{\frac{6}{1.5}}$$
$$\frac{P(t_o + 6)}{P(t_o)} = e^4 = 2.7183^4 = 54.6$$

)

Problem 1.5 (Prediction with Moore's law) *How long will you need to wait for your next computer to be 100 times more powerful than your current computer?*

(ans: In x years, we have an improvement of one hundred, or

$$\frac{P(t_o + x)}{P(t_o)} = e^{\frac{x}{1.5}} = 100$$

Taking the logarithm to the base e (natural logarithm) of the left side gives

$$\ln\left(e^{\frac{x}{1.5}}\right) = \frac{x}{1.5}$$

and equating to the logarithm of the right side

$$\frac{x}{1.5} = \ln(100) \quad \rightarrow \quad x = 1.5\ln(100) = 1.5(4.6) = 6.9 \textit{ years}$$

)

Problem 1.6 (Simultaneous users on a 4G LTE network) *How many digital speech signals can a 100 Mbps 4G LTE service simultaneously?*

(ans: Figure 1.12 and the Digital speech *section indicate that speech signals are transmitted at a 30 kbps rate. Hence, if n_{ss} denotes the number of speech signals that can be transmitted simultaneously, we find*

$$n_{ss} = \frac{100\,Mbps}{30\,kbps} = \frac{10^8\,bps}{3 \times 10^4\,bps} = 0.33 \times 10^4 = 3,300 \quad (or\ 3,333)$$

)

Problem 1.7 (Simultaneous TV channels on an optical fiber) *Assuming an HDTV program requires a data rate of 15 Mbps, how many channels can an optical fiber provide simultaneously.*

(ans: Figure 1.12 indicates that optical fiber can transmit data at rates up to 100 Gbps. Hence, if n_{tv} denotes the number of HDTV signals, we find

$$n_{tv} = \frac{100\,Gbps}{15\,Mbps} = \frac{10^{11}\,bps}{15 \times 10^6\,bps} = 0.067 \times 10^5 = 6,700 \quad (or\ 6,667)$$

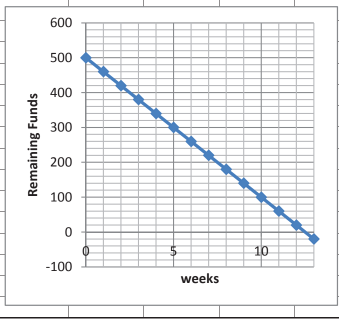
)

1.2 Excel Projects

Project 1.1 (Specifying input values and plotting a linear function) *Using Example 13.7 as a guide, plot a linear* funds depletion *curve. Assume you start the term,, time=0, with \$500 for expenses. You spend \$50 per week, producing slope of -\$50/week, making the curve intersect \$0 at week 10. You need the funds to last at least 12 weeks. Modify the slope value so that the funds are exhausted between weeks 12 and 13. What is the resulting slope value on your chart?*

(ans:

	A	B	C	D	E	F	G	H	I
1	x_i	y_i							
2	0	500		m=					
3	1	460		-40					
4	2	420							
5	3	380							
6	4	340		b=					
7	5	300		500					
8	6	260							
9	7	220							
10	8	180							
11	9	140							
12	10	100							
13	11	60							
14	12	20							
15	13	-20							



	A	B	C	D
1	x_i	y_i		
2	0	=\$D\$3*A2 +\$D\$7		m=
3	=A2+1	=\$D\$3*A3 +\$D\$7		-40
4	=A3+1	=\$D\$3*A4 +\$D\$7		
5	=A4+1	=\$D\$3*A5 +\$D\$7		
6	=A5+1	=\$D\$3*A6 +\$D\$7		b=
7	=A6+1	=\$D\$3*A7 +\$D\$7		500
8	=A7+1	=\$D\$3*A8 +\$D\$7		
9	=A8+1	=\$D\$3*A9 +\$D\$7		
10	=A9+1	=\$D\$3*A10 +\$D\$7		
11	=A10+1	=\$D\$3*A11 +\$D\$7		
12	=A11+1	=\$D\$3*A12 +\$D\$7		
13	=A12+1	=\$D\$3*A13 +\$D\$7		
14	=A13+1	=\$D\$3*A14 +\$D\$7		
15	=A14+1	=\$D\$3*A15 +\$D\$7		

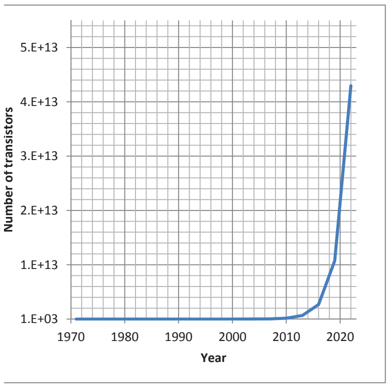
)

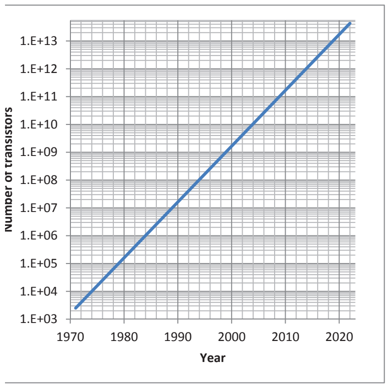
Project 1.2 (Moore's Law) *Extend Example 13.9 to plot Moore's Law from 1971 to 2020 in 3 year increments, and compare linear and logarithmic plots of the y values.*

(ans: The choice of linear and logarithmic units is found by formatting the y Axis and checking the Logarithmic scale box and specifying Base = 10.

	A	B	C	D
1	N_0=	2500	t_0=	1971
2				
3	t_i(year)	N(t_i)		
4	1971	2500		
5	1974	10000		
6	1977	40000		
7	1980	160000		
8	1983	640000		
9	1986	2560000		
10	1989	10240000		
11	1992	40960000		
12	1995	163840000		
13	1998	655360000		
14	2001	2621440000		
15	2004	10485760000		
16	2007	41943040000		
17	2010	167772160000		
18	2013	671088640000		
19	2016	2684354560000		
20	2019	10737418240000		
21	2022	42949672960000		

	A	B	C	D
1	N_0=	2500	t_0=	1971
2				
3	t_i(year)	N(t_i)		
4	1971	=$B$1*2^((A4-$D$1)/1.5)		
5	=A4+3	=$B$1*2^((A5-$A$4)/1.5)		
6	=A5+3	=$B$1*2^((A6-$A$4)/1.5)		
7	=A6+3	=$B$1*2^((A7-$A$4)/1.5)		
8	=A7+3	=$B$1*2^((A8-$A$4)/1.5)		
9	=A8+3	=$B$1*2^((A9-$A$4)/1.5)		
10	=A9+3	=$B$1*2^((A10-$A$4)/1.5)		
11	=A10+3	=$B$1*2^((A11-$A$4)/1.5)		
12	=A11+3	=$B$1*2^((A12-$A$4)/1.5)		
13	=A12+3	=$B$1*2^((A13-$A$4)/1.5)		
14	=A13+3	=$B$1*2^((A14-$A$4)/1.5)		
15	=A14+3	=$B$1*2^((A15-$A$4)/1.5)		
16	=A15+3	=$B$1*2^((A16-$A$4)/1.5)		
17	=A16+3	=$B$1*2^((A17-$A$4)/1.5)		
18	=A17+3	=$B$1*2^((A18-$A$4)/1.5)		
19	=A18+3	=$B$1*2^((A19-$A$4)/1.5)		
20	=A19+3	=$B$1*2^((A20-$A$4)/1.5)		
21	=A20+3	=$B$1*2^((A21-$A$4)/1.5)		





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