STAT3032 SURVIVAL MODELS

TUTORIAL WEEK TEN

Question One

A Mortality Committee has collected exposed to risk and death data for male annuitants for the period 1995-97. A research assistant has been hired to produce a graduation of the crude rates over the age range 65-89.

The formula below was used to perform the graduation.

$$-\ln\left(\frac{1-q_x}{1-q_x^s}\right) = Ax^2 + Bx + C,$$

where q_x^s are the mortality rates in the ALT90-92 table.

The exposed to risk and deaths data and the research assistant's graduated rates are shown below.

Age	ETR	Deaths	Crude Rates	Graduated Rates	Expected Deaths	Deviation	Variance	Cumulative Deviation	Cumulative Variance	Standardised Deviation	Chi Square
65	393	2	0.005089	0.013	5.015	-3.015	4.951	-3.015	4.951	-1.355	1.836
66	588.5	9	0.015293	0.014	8.168	0.832	8.055	-2.183	13.006	0.293	0.086
67	713	11	0.015428	0.015	10.688	0.312	10.528	-1.871	23.533	0.096	0.009
68	858.5	14	0.016308	0.016	13.865	0.135	13.641	-1.736	37.174	0.037	0.001
69	1069.5	24	0.02244	0.017	18.599	5.401	18.275	3.666	55.449	1.263	1.596
70	1181	28	0.023709	0.019	22.132	5.868	21.717	9.534	77.167	1.259	1.586
71	1067.5	22	0.020609	0.020	21.628	0.372	21.189	9.906	98.356	0.081	0.007
72	769	10	0.013004	0.022	16.910	-6.910	16.538	2.996	114.894	-1.699	2.887
73	569	13	0.022847	0.024	13.633	-0.633	13.307	2.363	128.201	-0.174	0.030
74	500	5	0.01	0.026	13.110	-8.110	12.766	-5.747	140.967	-2.270	5.152
75	424	9	0.021226	0.029	12.215	-3.215	11.864	-8.963	152.831	-0.934	0.872
76	351.5	13	0.036984	0.032	11.167	1.833	10.812	-7.130	163.643	0.557	0.311
77	277.5	14	0.05045	0.035	9.737	4.263	9.396	-2.867	173.039	1.391	1.934
78	217	11	0.050691	0.039	8.422	2.578	8.095	-0.289	181.134	0.906	0.821
79	192	6	0.03125	0.043	8.243	-2.243	7.889	-2.532	189.023	-0.798	0.638
80	177	11	0.062147	0.047	8.400	2.600	8.002	0.068	197.024	0.919	0.845
81	153.5	8	0.052117	0.052	8.043	-0.043	7.622	0.024	204.646	-0.016	0.000
82	119	7	0.058824	0.058	6.875	0.125	6.477	0.150	211.124	0.049	0.002
83	97	10	0.103093	0.064	6.165	3.835	5.773	3.984	216.897	1.596	2.547
84	98.5	7	0.071066	0.070	6.874	0.126	6.395	4.110	223.292	0.050	0.002
85	82	7	0.085366	0.076	6.270	0.730	5.790	4.840	229.082	0.303	0.092
86	67	7	0.104478	0.084	5.601	1.399	5.132	6.240	234.214	0.618	0.382
87	63	5	0.079365	0.091	5.742	-0.742	5.219	5.498	239.433	-0.325	0.105
88	57.5	4	0.069565	0.099	5.704	-1.704	5.138	3.794	244.571	-0.752	0.565
89	43.5	6	0.137931	0.108	4.680	1.320	4.177	5.114	248.748	0.646	0.417
Totals	**10129**	**263**			**257.886**	**5.114**	**248.748**				**22.723**

Test the fit of the graduation using the statistical tests we covered this week.

Question Two

The mortality rates for a particular population (age range 60 to 64) were "smoothed" by fitting the following model to the rates estimated from observed data: $\log(q_x / p_x) = \beta_0 + \beta_1 x$. The parameter estimates from fitting this model are: $b_0 = -10.9$ and $b_1 = 0.11$ The table below contains the number of deaths observed at each age. The exposed to risk at each age was 35,000.

Age x	60	61	62	63	64
deaths	450	550	525	700	650

Use a Chi-Square test to determine whether the model suggested above provides a good fit to the observed data.