TABLE 2.1

Survival Functions of U.S. Population By Race and Sex in 1989

Age	White Male	White Female	Black Male	Black Female	Age	White Male	White Female	Black Male	Black Female
0	1.00000	1.00000	1.00000	1.00000	43	0.93771	0.97016	0.85917	0.93361
1	0.99092	0.99285	0.97996	0.98283	44	0.93477	0.96862	0.85163	0.92998
2	0.99024	0.99232	0.97881	0.98193	45	0.93161	0.96694	0.84377	0.92612
3	0.98975	0.99192	0.97792	0.98119	46	0.92820	0.96511	0.83559	0.92202
4	0.98937	0.99160	0.97722	0.98059	47	0.92450	0.96311	0.82707	0.91765
5	0.98905	0.99134	0.97664	0.98011	48	0.92050	0.96091	0.81814	0.91300
6	0.98877	0.99111	0.97615	0.97972	49	0.91617	0.95847	0.80871	0.90804
7	0.98850	0.99091	0.97571	0.97941	50	0.91148	0.95575	0.79870	0.90275
8	0.98825	0.99073	0.97532	0.97915	51	0.90639	0.95273	0.78808	0.89709
9	0.98802	0.99056	0.97499	0.97892	52	0.90086	0.94938	0.77685	0.89103
10	0.98782	0.99041	0.97472	0.97870	53	0.89480	0.94568	0.76503	0.88453
11	0.98765	0.99028	0.97449	0.97847	54	0.88810	0.94161	0.75268	0.87754
12	0.98748	0.99015	0.97425	0.97823	55	0.88068	0.93713	0.73983	0.87000
13	0.98724	0.98999	0.97392	0.97796	56	0.87250	0.93222	0.72649	0.86190
14	0.98686	0.98977	0.97339	0.97767	57	0.86352	0.92684	0.71262	0.85321
15	0.98628	0.98948	0.97258	0.97735	58	0.85370	0.92096	0.69817	0.84381
16	0.98547	0.98909	0.97145	0.97699	59	0.84299	0.91455	0.68308	0.83358
17	0.98445	0.98862	0.97002	0.97658	60	0.83135	0.90756	0.66730	0.82243
18	0.98326	0.98809	0.96829	0.97612	61	0.81873	0.89995	0.65083	0.81029
19	0.98197	0.98755	0.96628	0.97559	62	0.80511	0.89169	0.63368	0.79719
20	0.98063	0.98703	0.96403	0.97498	63	0.79052	0.88275	0.61584	0.78323
21	0.97924	0.98654	0.96151	0.97429	64	0.77501	0.87312	0.59732	0.76858
22	0.97780	0.98607	0.95873	0.97352	65	0.75860	0.86278	0.57813	0.75330
23	0.97633	0.98561	0.95575	0.97267	66	0.74131	0.85169	0.55829	0.73748
24	0.97483	0.98514	0.95267	0.97174	67	0.72309	0.83980	0.53783	0.72104
25	0.97332	0.98466	0.94954	0.97074	68	0.70383	0.82702	0.51679	0.70393
26	0.97181	0.98416	0.94639	0.96967	69	0.68339	0.81324	0.49520	0.68604
27	0.97029	0.98365	0.94319	0.96852	70	0.66166	0.79839	0.47312	0.66730
28	0.96876	0.98312	0.93989	0.96728	71	0.63865	0.78420	0.45058	0.64769
29	0.96719	0.98257	0.93642	0.96594	72	0.61441	0.76522	0.42765	0.62723
30	0.96557	0.98199	0.93273	0.96448	73	0.58897	0.74682	0.40442	0.60591
31	0.96390	0.98138	0.92881	0.96289	74	0.56238	0.72716	0.38100	0.58375
32	0.96217	0.98073	0.92466	0.96118	75	0.53470	0.70619	0.35749	0.56074
33	0.96038	0.98005	0.92024	0.95934	76	0.50601	0.68387	0.33397	0.53689
34	0.95852	0.97933	0.91551	0.95740	77	0.47641	0.66014	0.31050	0.51219
35	0.95659	0.97858	0.91044	0.95336	78	0.44604	0.63494	0.28713	0.48663
36	0.95457	0.97779	0.90501	0.95321	79	0.41503	0.60822	0.26391	0.46020
37	0.95245	0.97696	0.89922	0.95095	80	0.38355	0.57991	0.24091	0.43291
38	0.95024	0.97607	0.89312	0.94855	81	0.35178	0.54997	0.21819	0.40475
39	0.94794	0.97510	0.88677	0.94598	82	0.31991	0.51835	0.19583	0.37573
40	0.94555	0.97404	0.88021	0.94321	83	0.28816	0.48502	0.17392	0.34588
41	0.94307	0.97287	0.87344	0.94023	84	0.25677	0.44993	0.15257	0.31522
42	0.94047	0.97158	0.86643	0.93703	85	0.22599	0.41306	0.13191	0.28378

partment of Health and Human Services, 1990). Figure 2.2 shows the survival curves and allows a visual comparison of the curves. We can see that white females have the best survival probability, white males and black females are comparable in their survival probabilities, and black males have the worst survival.
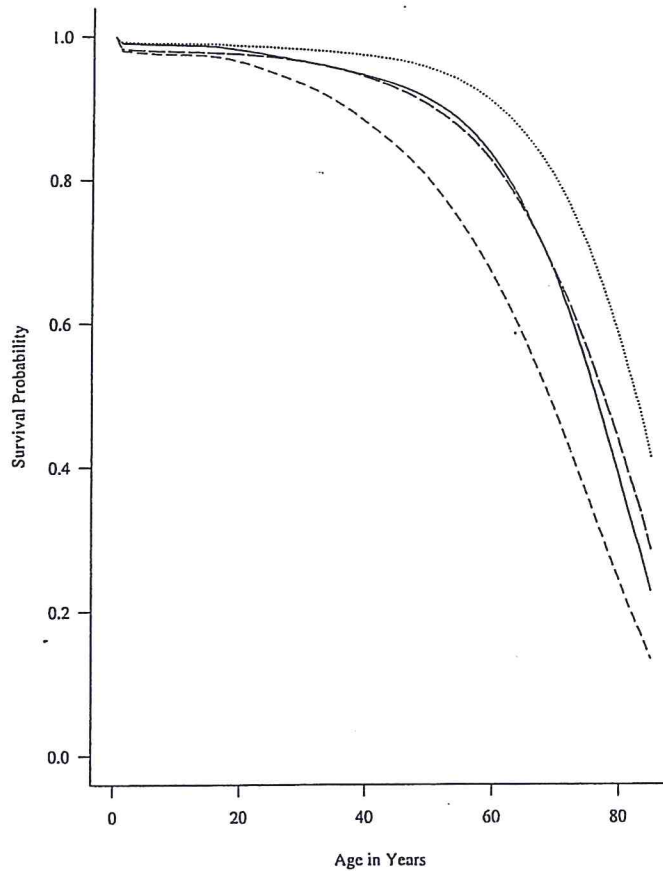

Figure 2.2   *Survival Functions for all cause mortality for the US population in 1989. White males (————); white females (······); black males (-------); black females (—— ——).*

. When X is a discrete random variable, different techniques are required. Discrete, random variables in survival analyses arise due to rounding off measurements, grouping of failure times into intervals, or when lifetimes refer to an integral number of units. Suppose that X can take on values x_j, $j = 1, 2, \ldots$ with probability mass function (p.m.f.) $p(x_j) = Pr(X = x_j)$, $j = 1, 2, \ldots$, where $x_1 < x_2 < \cdots$.

5) Figure 2.1 in Collett is a graph of the estimated survival function for patients being treated for pulmonary metastasis arising from osteosarcoma (a malignant bone tumour that has spread to the lungs). Graphically, after how many months have about 50% of the patients died?
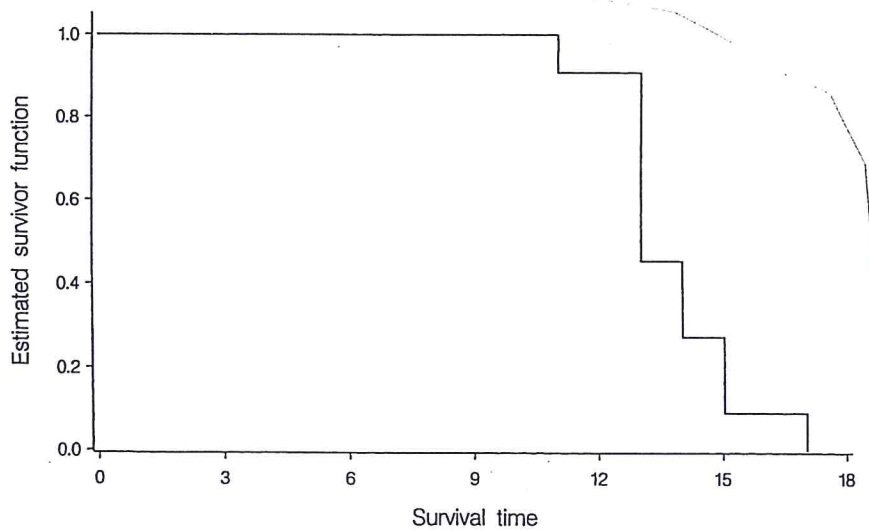

Figure 2.1 *Estimated survivor function for the data from Example 2.1.*

Collett for problem 5

1