A Case Study in Competing Risk

Reliability Analysis Using JMP Software

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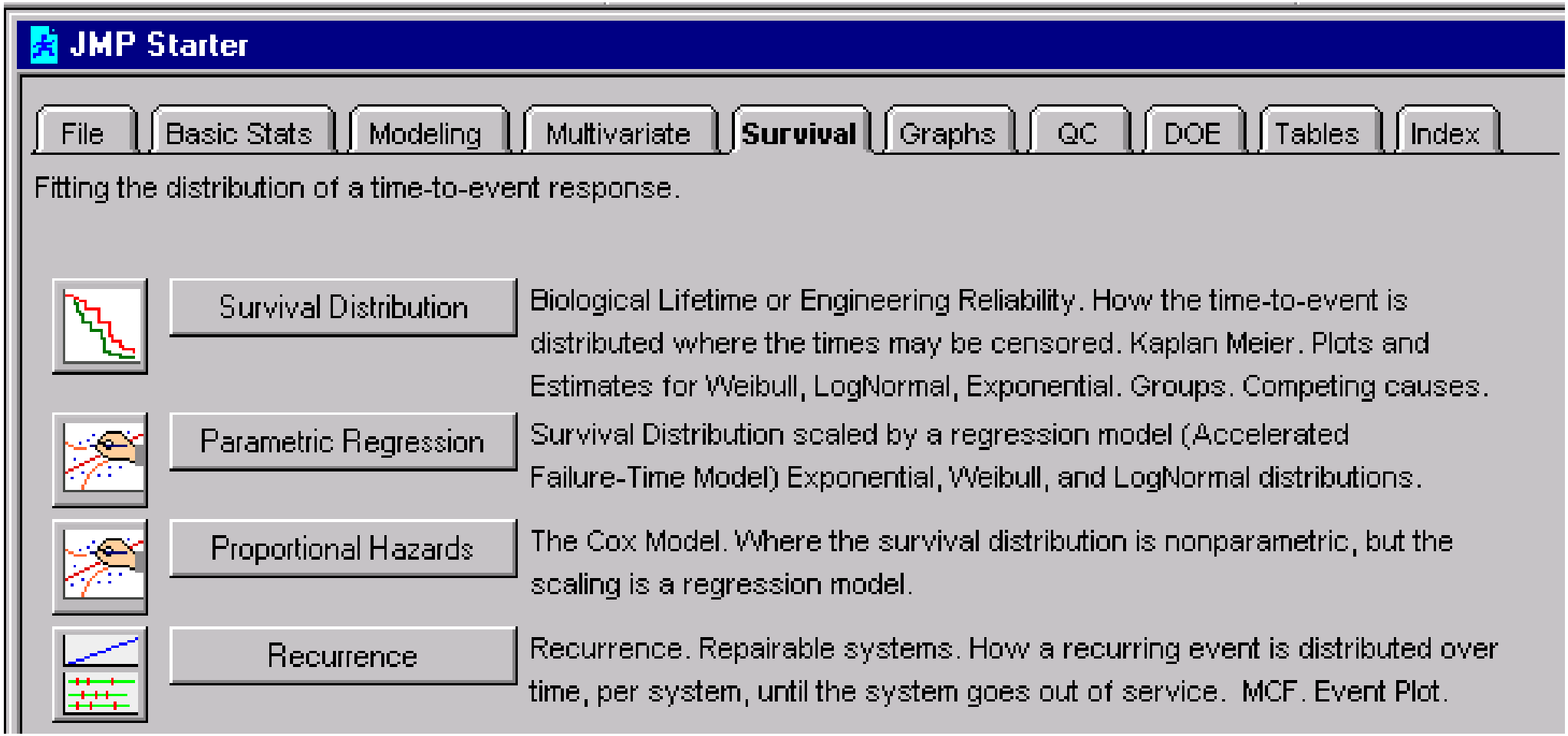
Outline

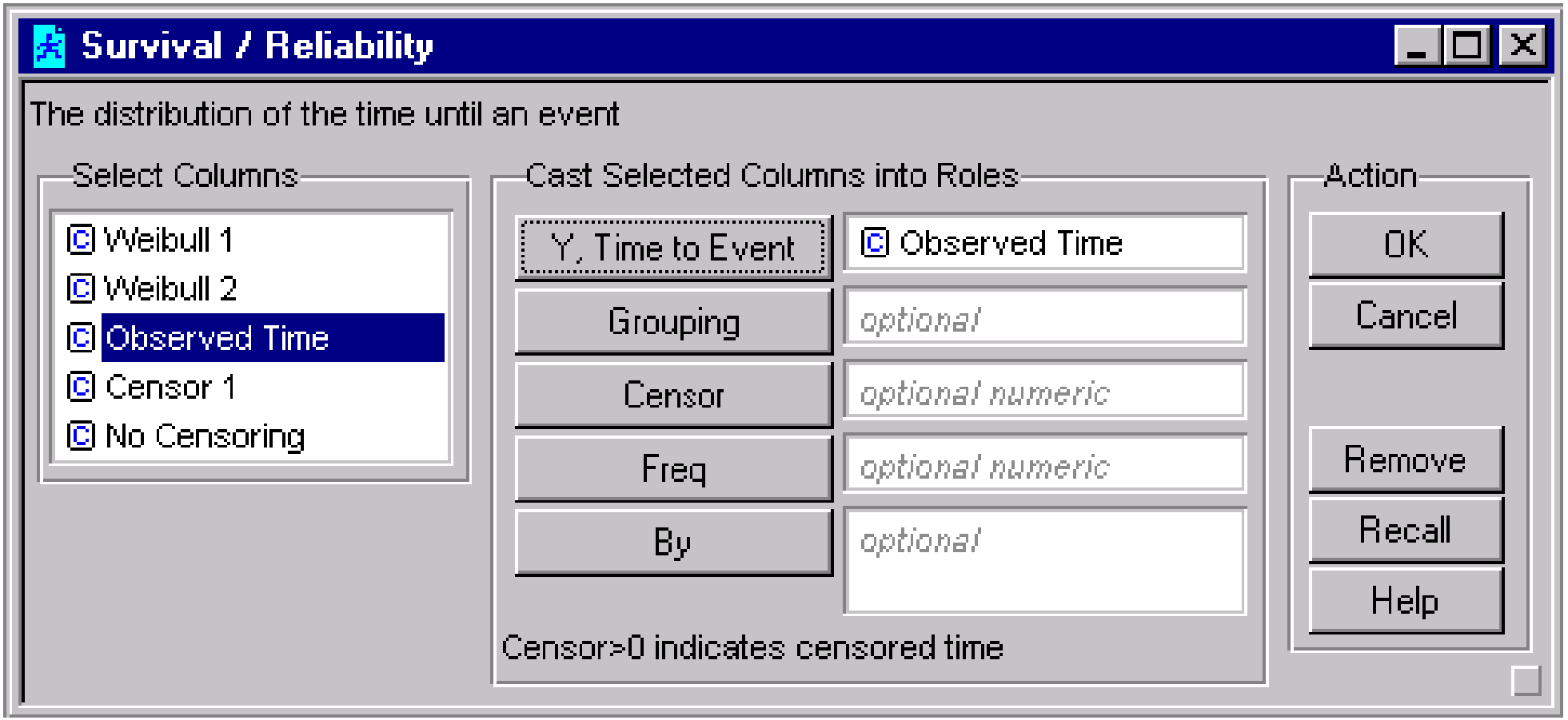
- Overview of Reliability (Survival) Analysis in JMP 4.0
- A JMP Script - Competing Causes GUI
- Analysis of some pseudo-data
- Analysis of Process data

Overview of Reliability Analysis in JMP 4.0

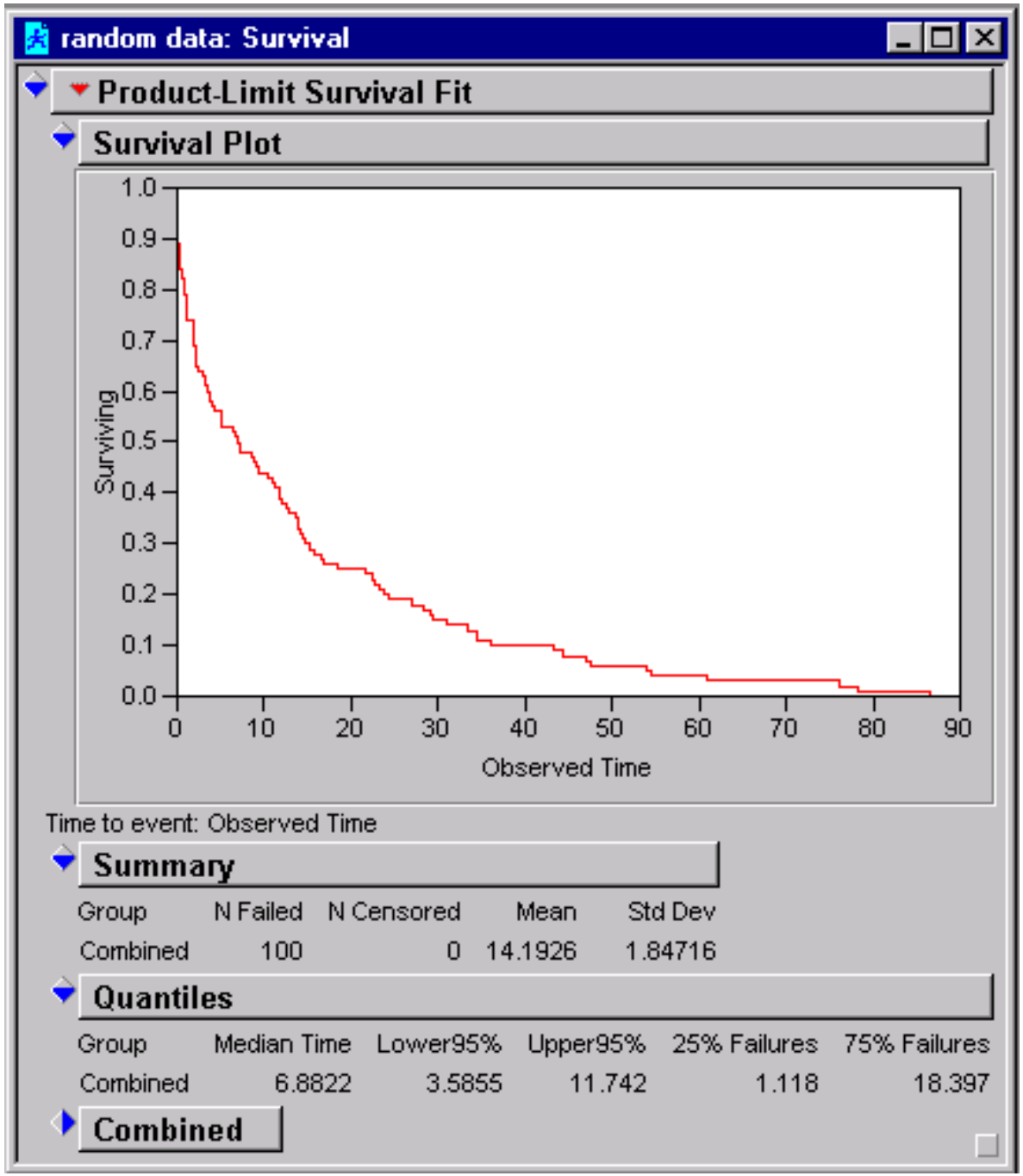


JMP Starter Window

Univariate Survival Launch Dialog



Default Analysis

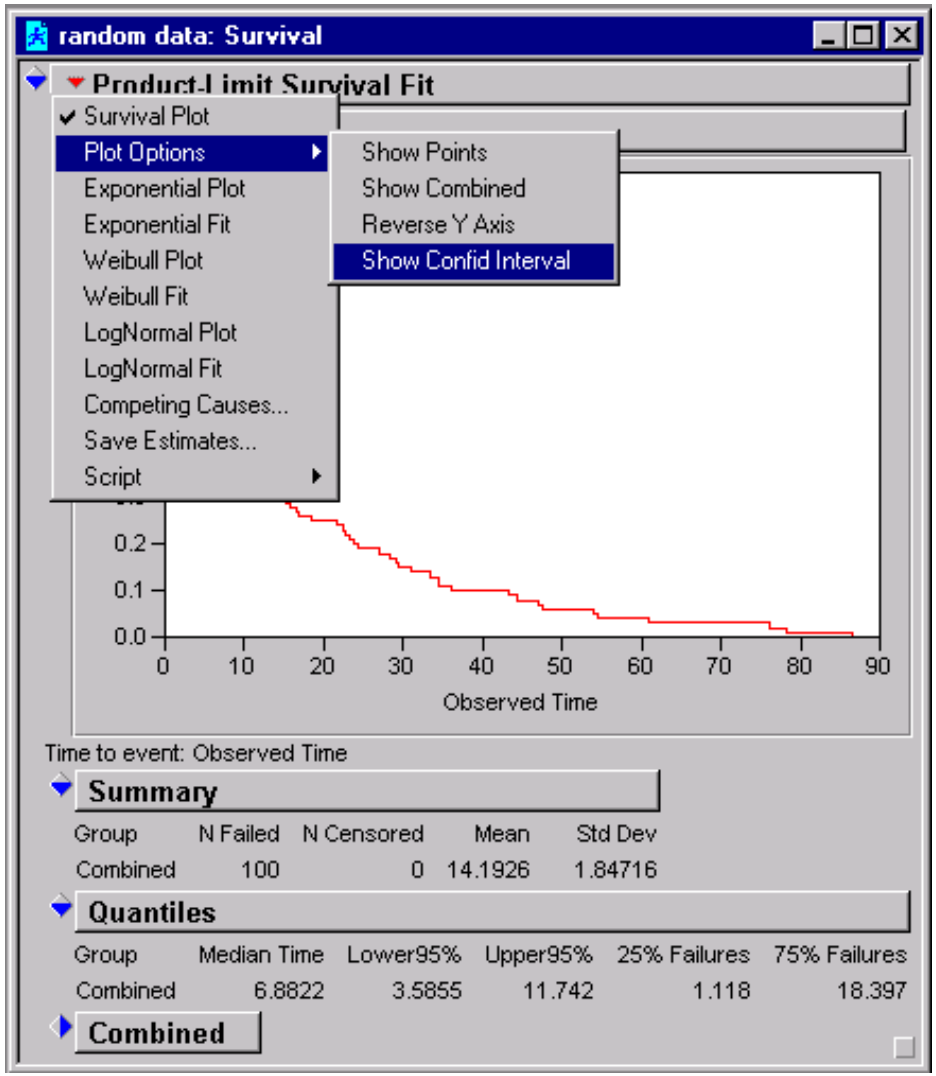


Default Analysis cont.

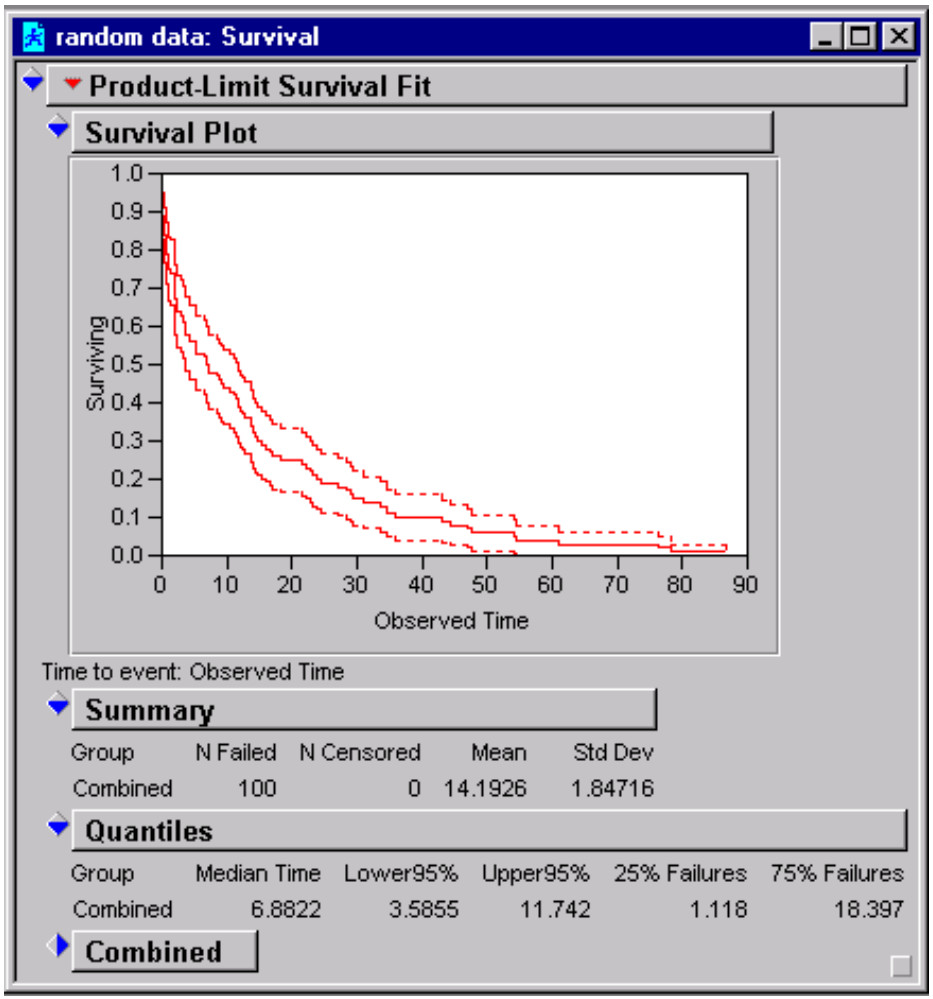
Combined

Observed Time	Survival	Failure	SurvStdErr	N Failed	N Censored	At Risk
0.0000	1.0000	0.0000	0.0000	0	0	100
0.0000	0.9900	0.0100	0.0099	1	0	100
0.0005	0.9800	0.0200	0.0140	1	0	99
0.0013	0.9700	0.0300	0.0171	1	0	98
0.0014	0.9600	0.0400	0.0196	1	0	97
0.0279	0.9500	0.0500	0.0218	1	0	96
0.0329	0.9400	0.0600	0.0237	1	0	95
0.0355	0.9300	0.0700	0.0255	1	0	94
0.0419	0.9200	0.0800	0.0271	1	0	93
0.0424	0.9100	0.0900	0.0286	1	0	92
0.0475	0.9000	0.1000	0.0300	1	0	91
0.0718	0.8900	0.1100	0.0313	1	0	90
0.2082	0.8800	0.1200	0.0325	1	0	89
0.2210	0.8700	0.1300	0.0336	1	0	88
0.2453	0.8600	0.1400	0.0347	1	0	87
0.2891	0.8500	0.1500	0.0357	1	0	86
0.3240	0.8400	0.1600	0.0367	1	0	85
0.6482	0.8300	0.1700	0.0376	1	0	84
0.6529	0.8200	0.1800	0.0384	1	0	83
0.6870	0.8100	0.1900	0.0392	1	0	82
0.7316	0.8000	0.2000	0.0400	1	0	81
0.7633	0.7900	0.2100	0.0407	1	0	80
1.0445	0.7800	0.2200	0.0414	1	0	79

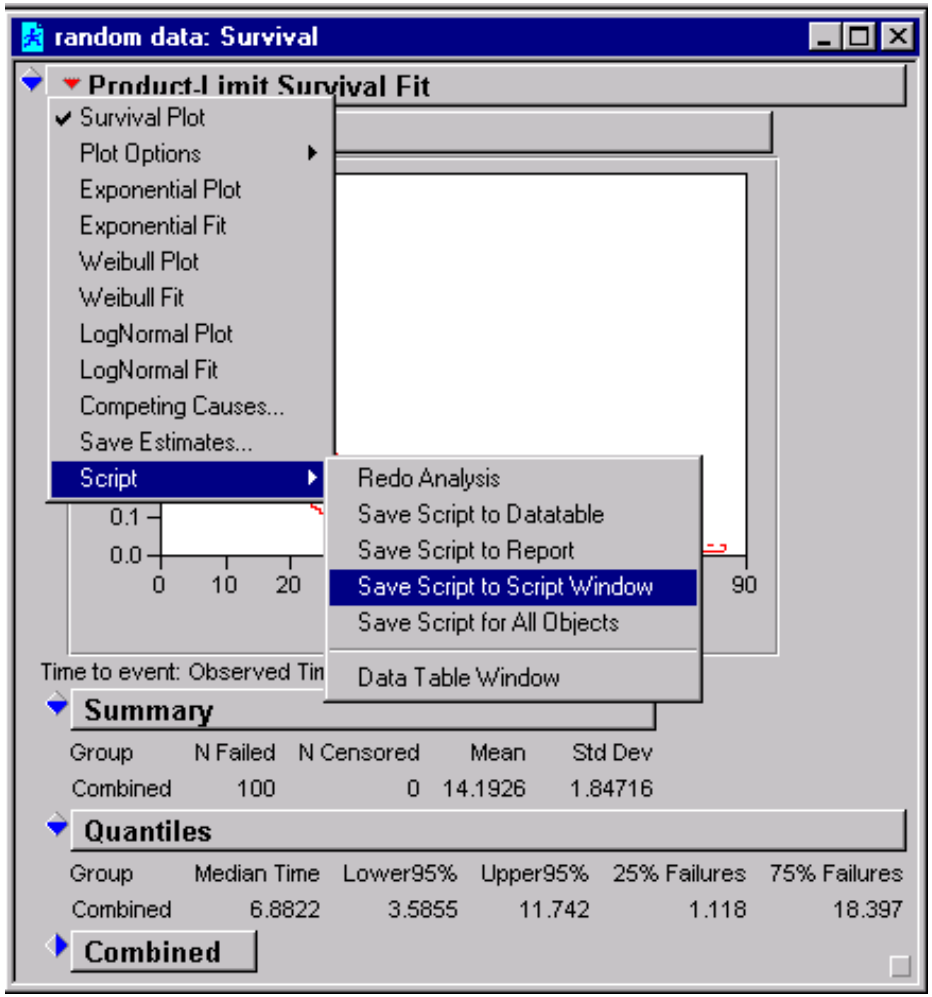
Options Menu Choice...



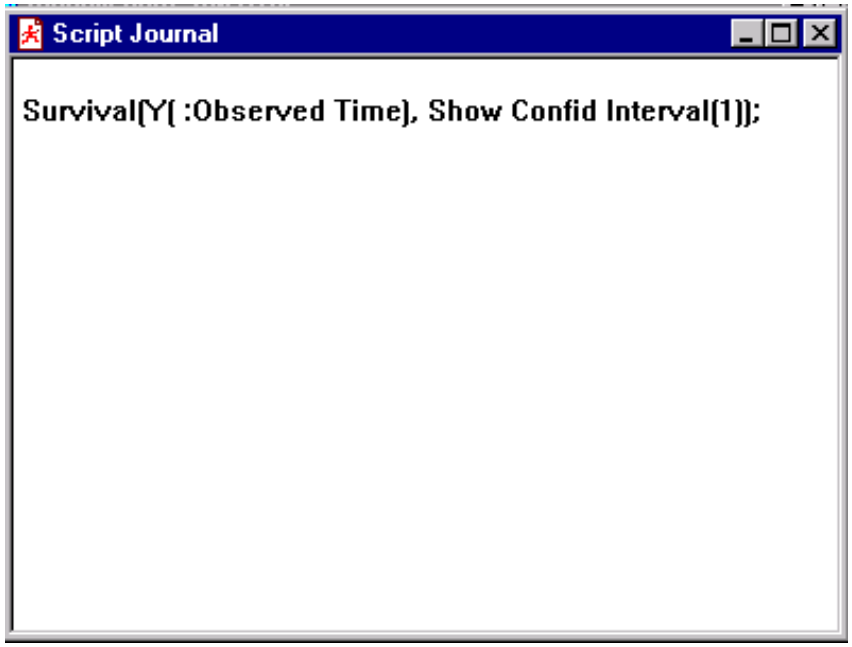
…and Results


random data: Survival
Product-Limit Survival Fit
Survival Plot
Surviving
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
10
20
30
40
50
60
70
80
90
Observed Time
Time to event: Observed Time
Summary
Group N Failed N Censored Mean Std Dev
Combined 100 0 14.1926 1.84716
Quantiles
Group Median Time Lower95% Upper95% 25% Failures 75% Failures
Combined 6.8822 3.5855 11.742 1.118 18.397
Combined

Scripting Options Choice...

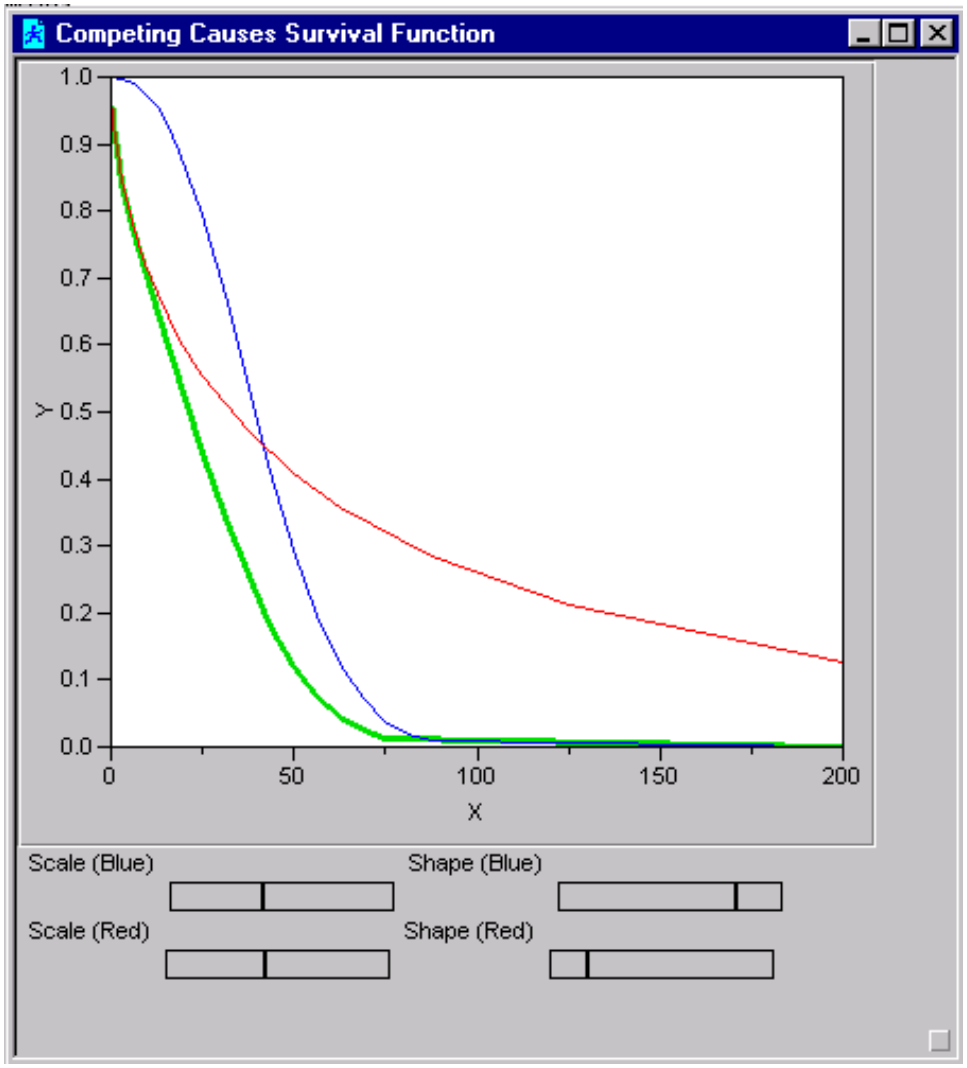


…and Results



Submitting the script above reproduces the analysis.

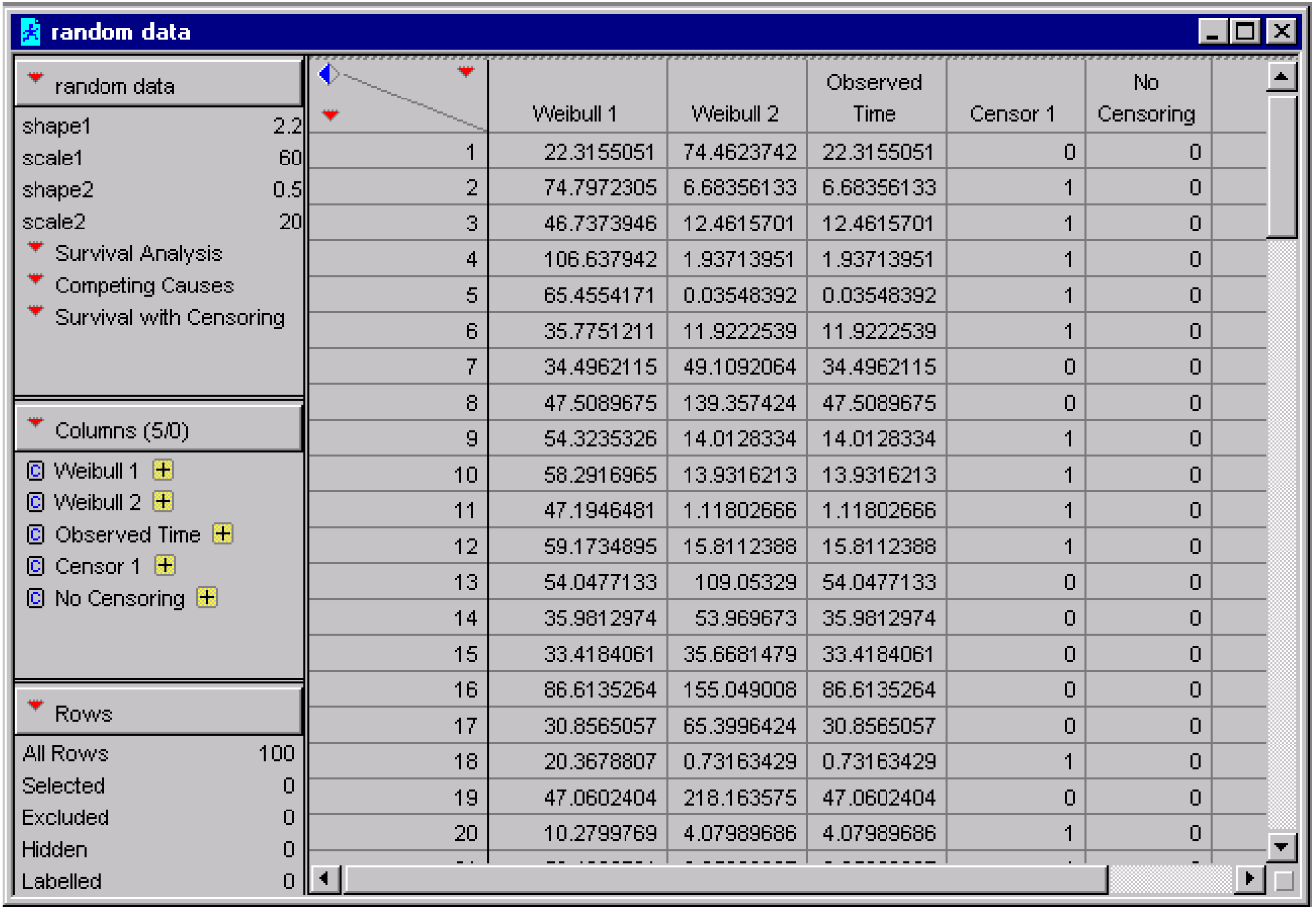
A JMP Script - Competing Causes GUI



Script

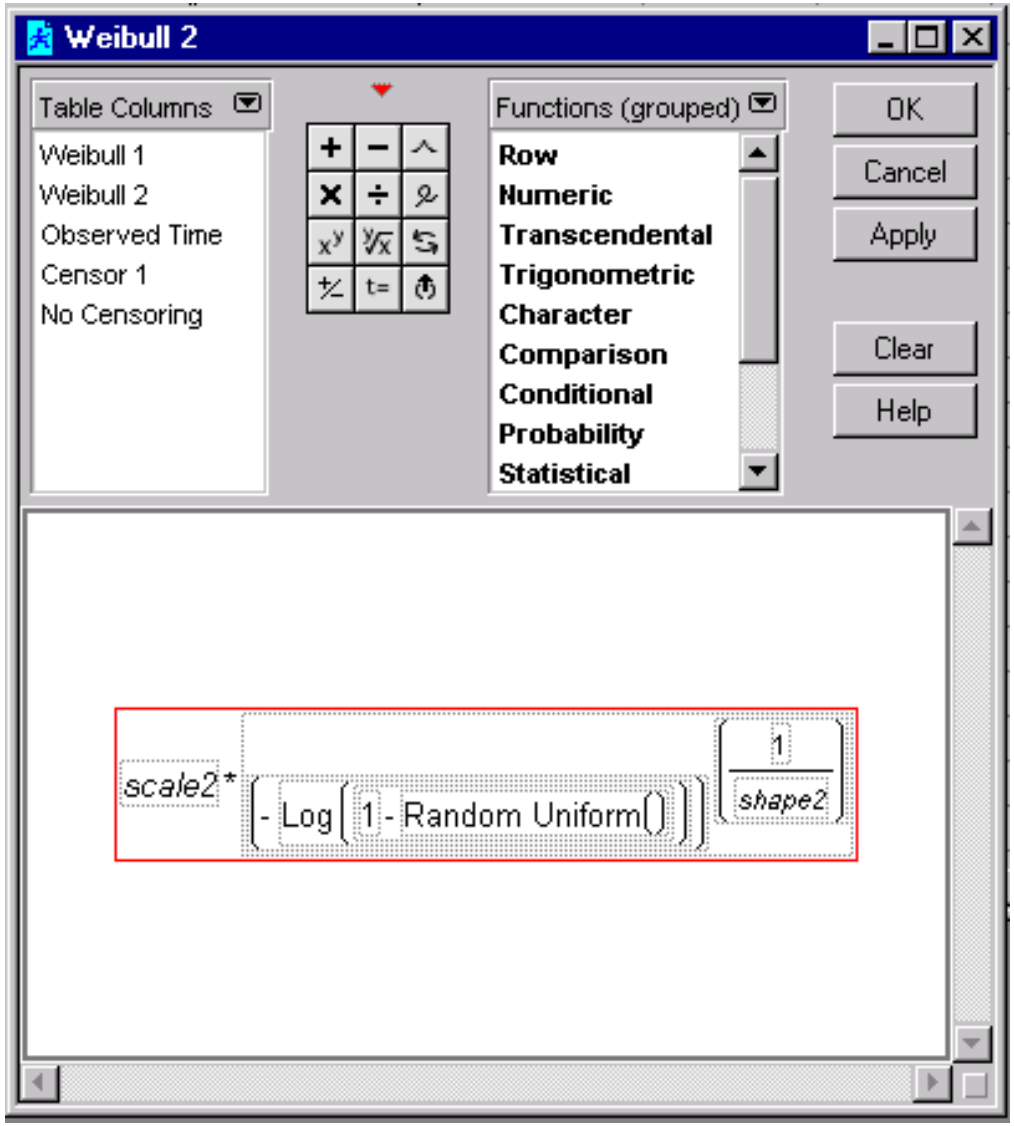
```
// Competing Causes Interactive Survival Plot
x=1; y=1;
shape1 = 2.4;                scale1 = log10(46);
shape2 = 0.6;                scale2 = log10(60);

survival = expr((1-Weibull Distribution(x, shape1, 10^scale1, 0))*(1-Weibull Distribution(x, shape2, 10^scale2, 0)));

gBox = Graph Box(FrameSize(500,300),Double Buffer,
                XScale(0,200),yScale(0,1),
                pen color("green");pen size(3);
                YFunction(survival,x),
                pen color("blue");pen size(1);
                YFunction(1-Weibull Distribution(x, shape1, 10^scale1, 0),x),
                pen color("red");pen size(1);
                YFunction(1-Weibull Distribution(x, shape2, 10^scale2, 0),x));

plot = gBox[FrameBox(1)];
NewWindow("Competing Causes Survival Function",
                v list box (gBox,
                                h list box (textbox("  Scale (Blue)  "),
                                                slider box (0,4, scale1,plot<<reshow()),
                                                textbox("  Shape (Blue)  "),
                                                slider box (0.1,3, shape1,plot<<reshow())),
                                h list box (textbox("  Scale (Red)  "),
                                                slider box (0,4, scale2,plot<<reshow()),
                                                textbox("  Shape (Red)  "),
                                                slider box (0.1,3, shape2,plot<<reshow()))
                                )
                );
```

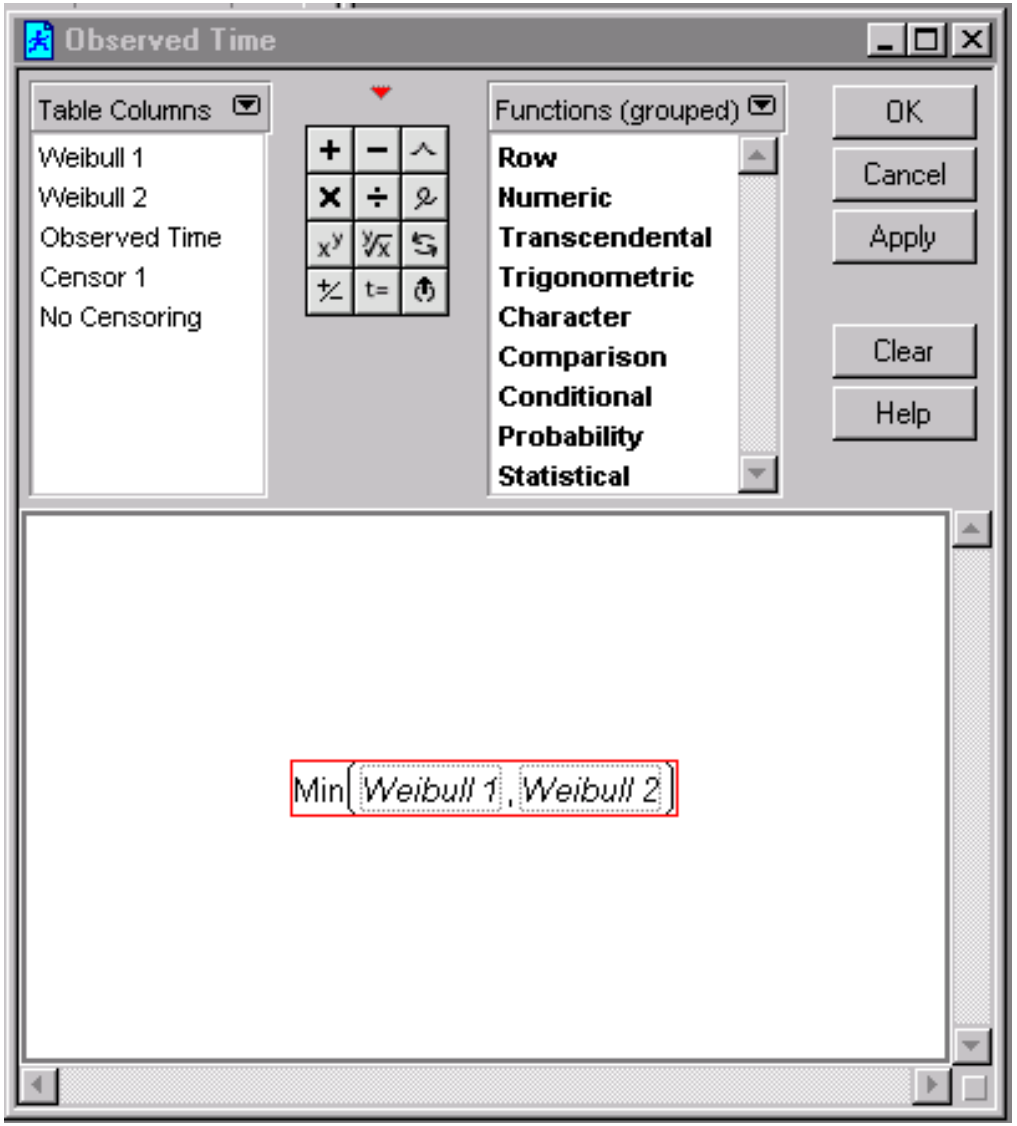
Analysis of some pseudo-data



	Weibull 1	Weibull 2	Observed Time	Censor 1	No Censoring
1	22.3155051	74.4623742	22.3155051	0	0
2	74.7972305	6.68356133	6.68356133	1	0
3	46.7373946	12.4615701	12.4615701	1	0
4	106.637942	1.93713951	1.93713951	1	0
5	65.4554171	0.03548392	0.03548392	1	0
6	35.7751211	11.9222539	11.9222539	1	0
7	34.4962115	49.1092064	34.4962115	0	0
8	47.5089675	139.357424	47.5089675	0	0
9	54.3235326	14.0128334	14.0128334	1	0
10	58.2916965	13.9316213	13.9316213	1	0
11	47.1946481	1.11802666	1.11802666	1	0
12	59.1734895	15.8112388	15.8112388	1	0
13	54.0477133	109.05329	54.0477133	0	0
14	35.9812974	53.969673	35.9812974	0	0
15	33.4184061	35.6681479	33.4184061	0	0
16	86.6135264	155.049008	86.6135264	0	0
17	30.8565057	65.3996424	30.8565057	0	0
18	20.3678807	0.73163429	0.73163429	1	0
19	47.0602404	218.163575	47.0602404	0	0
20	10.2799769	4.07989686	4.07989686	1	0

Column Formulae





random data

random data

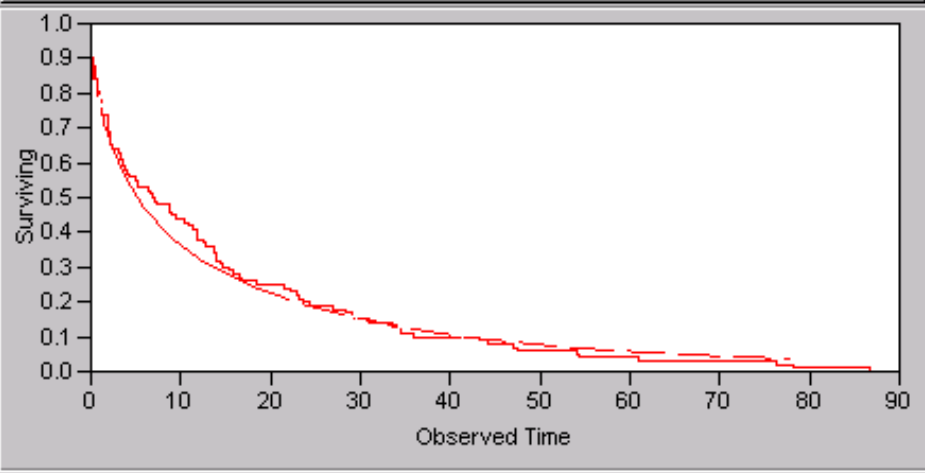
shape1	2.2
scale1	60
shape2	0.5
scale2	20

- Survival Analysis
- Competing Causes
- Survival with Censoring

random data: Survival

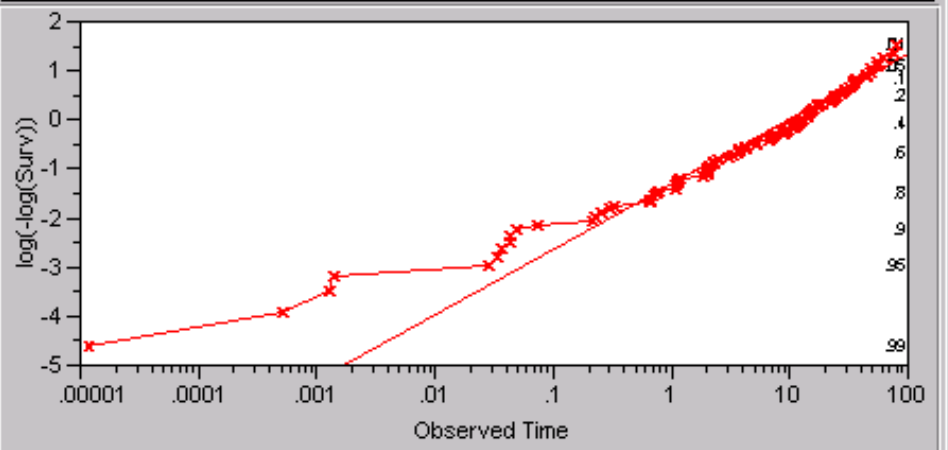
Product-Limit Survival Fit

Survival Plot



Time to event: Observed Time

Weibull Plot



Summary

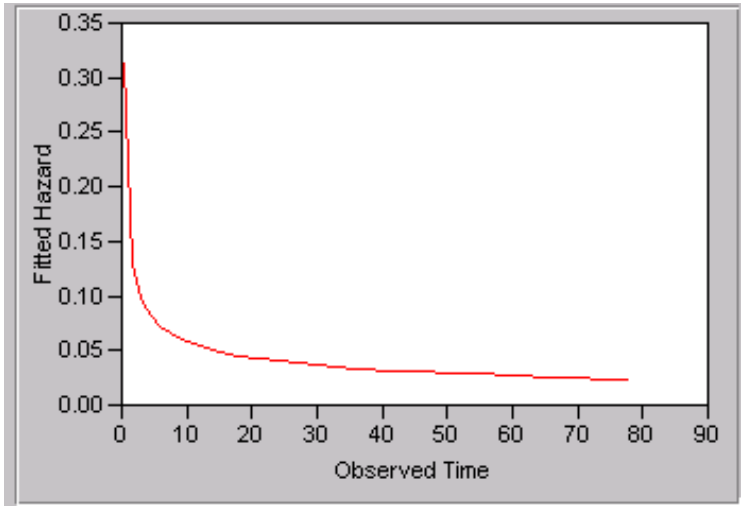
Quantiles

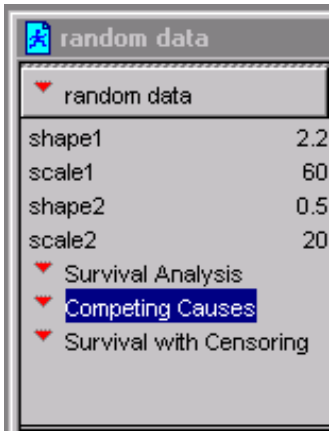
Combined

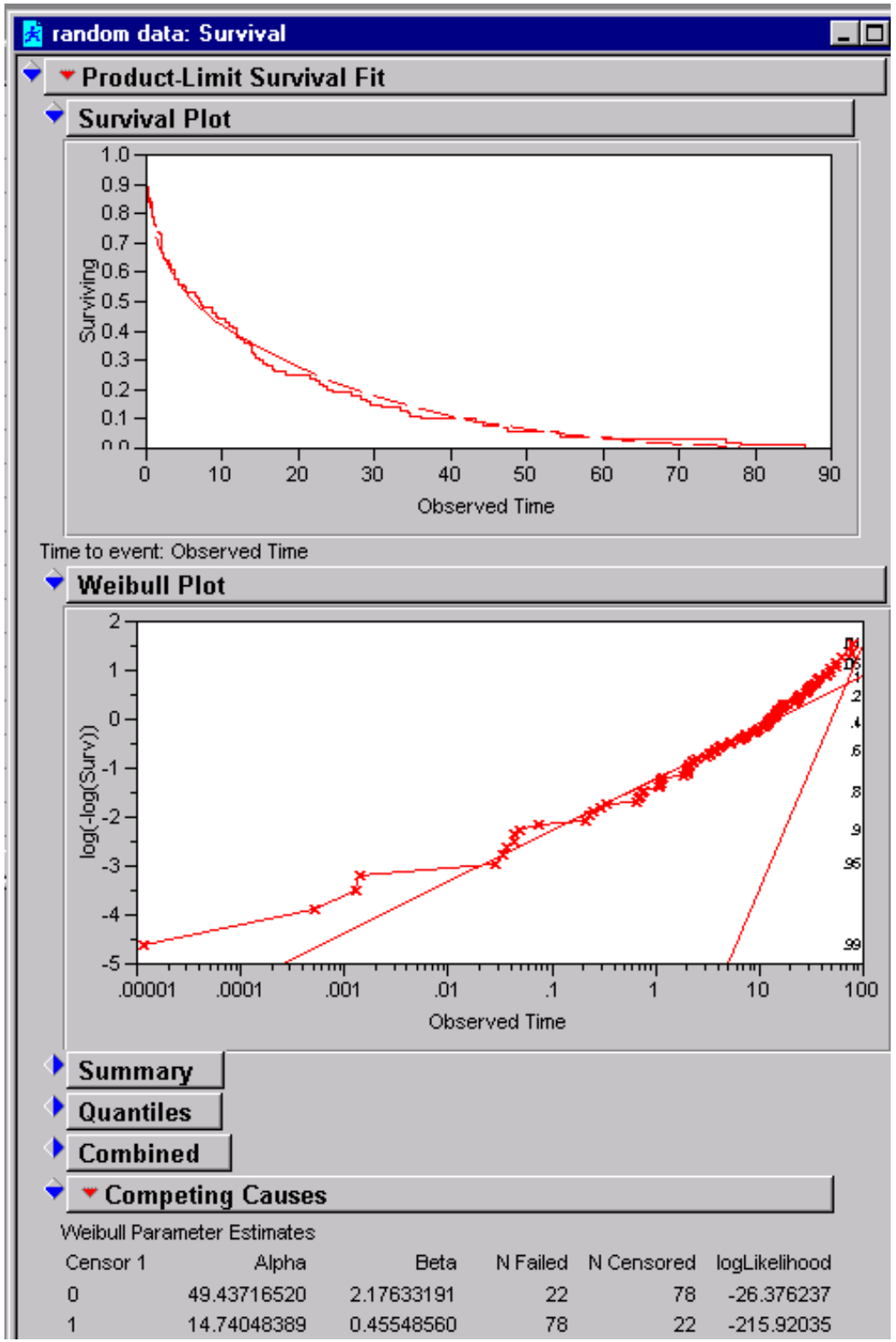
Competing Causes

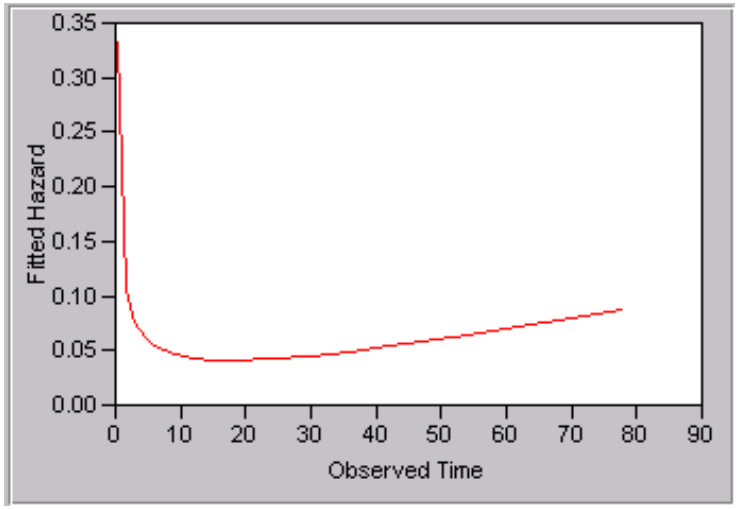
Weibull Parameter Estimates

No Censoring	Alpha	Beta	N Failed	N Censored	logLikelihood
0	9.849671791	0.5761583490	100	0	-219.12917

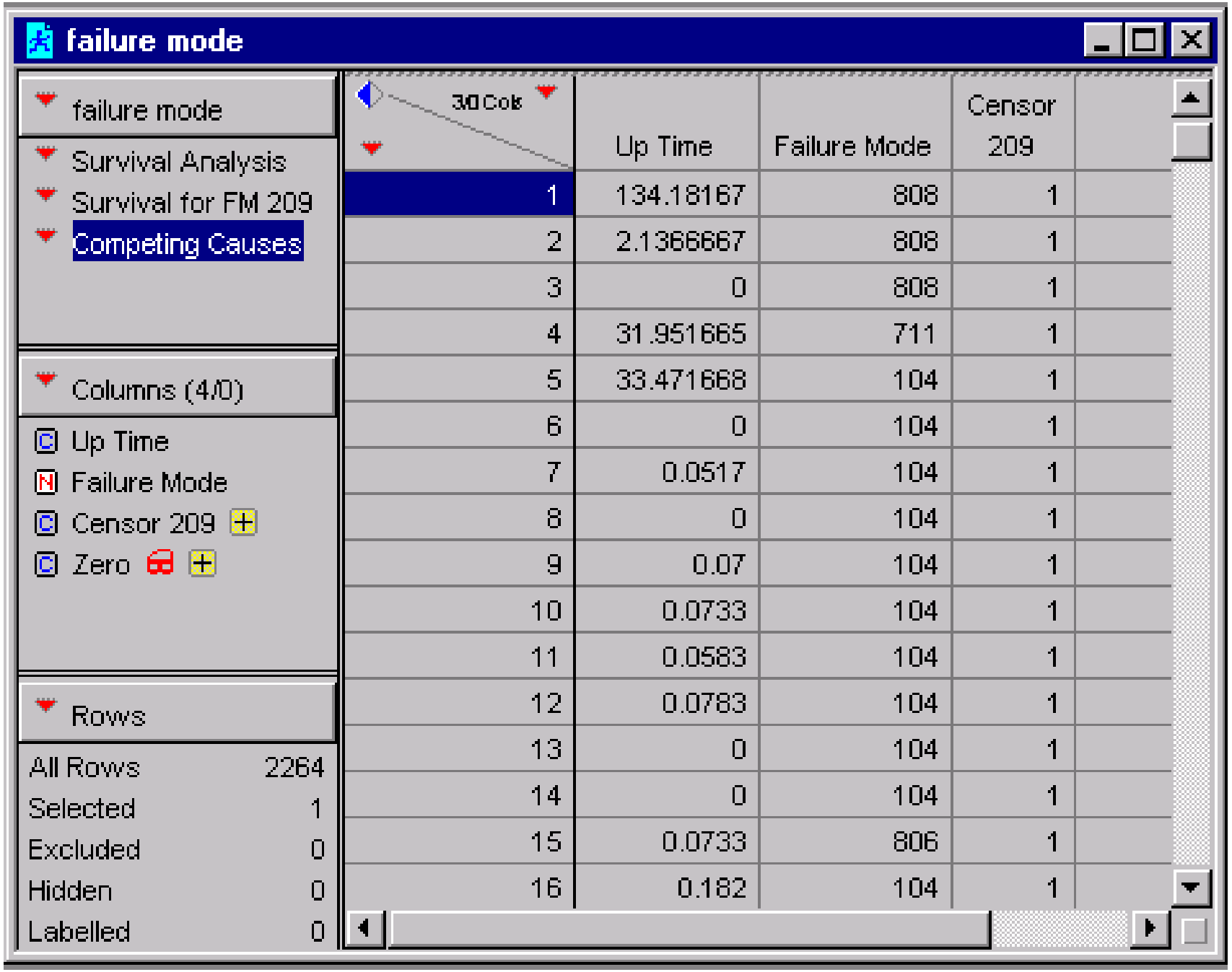



random data
random data
shape1 2.2
scale1 60
shape2 0.5
scale2 20
Survival Analysis
Competing Causes
Survival with Censoring


random data: Survival
Product-Limit Survival Fit
Survival Plot
Surviving
Observed Time
Time to event: Observed Time
Weibull Plot
log(-log(Surv))
Observed Time
Summary
Quantiles
Combined
Competing Causes
Weibull Parameter Estimates
Censor 1 Alpha Beta N Failed N Censored logLikelihood
0 49.43716520 2.17633191 22 78 -26.376237
1 14.74048389 0.45548560 78 22 -215.92035


Fitted Hazard
Observed Time

Analysis of Process data



Top Failure Modes

cause model

cause model

Columns (4/0)

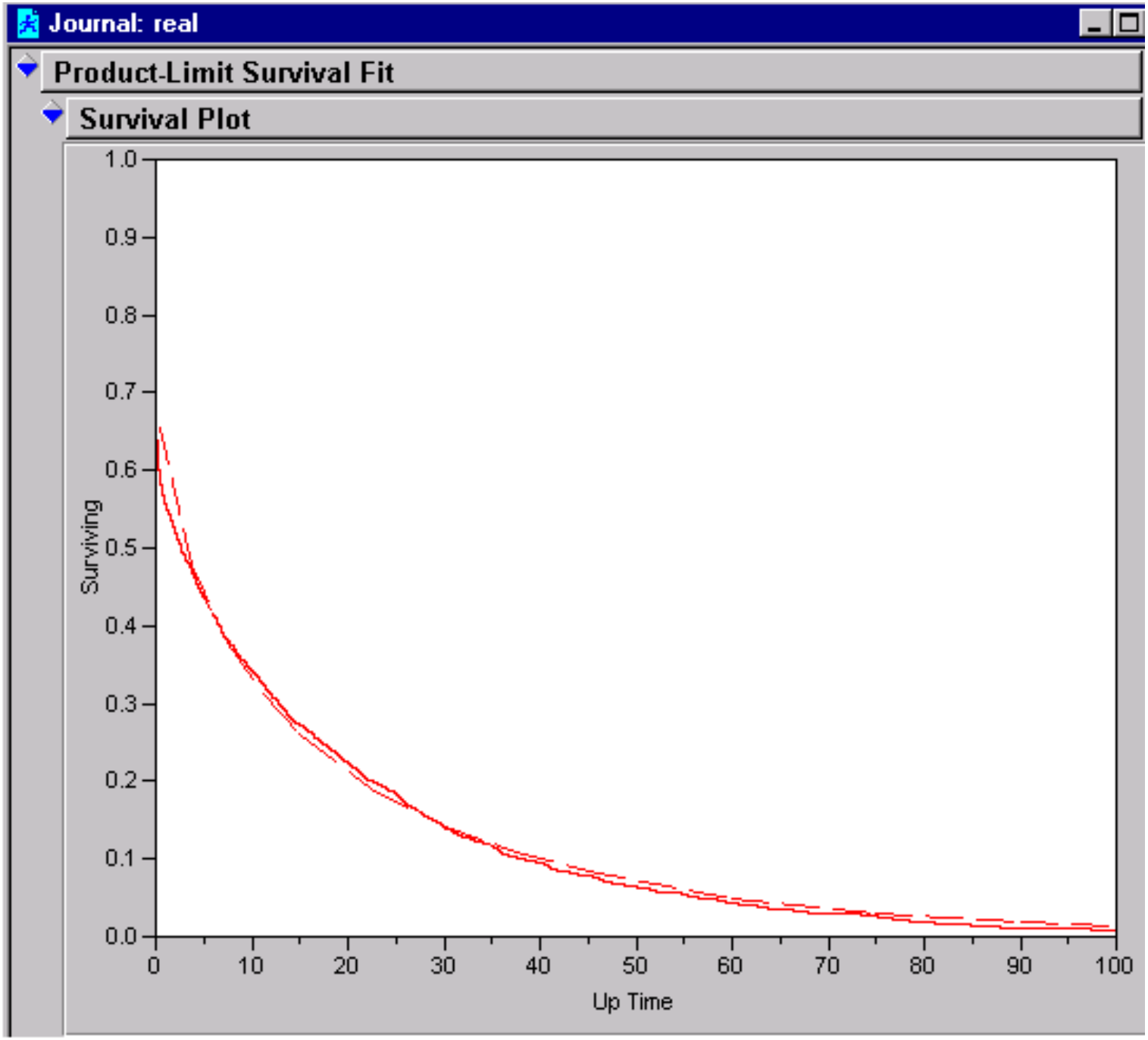
- N Failure Mode
- C Alpha
- C Beta
- C N Failed

Rows

All Rows	77
Selected	0
Excluded	0
Hidden	0
Labelled	0

	Failure Mode	Alpha	Beta	N Failed
1	305	2095.58539	0.41802564	184
2	804	1672.63641	0.58103421	159
3	209	840.662431	0.61528138	150
4	605	257.659589	1.05085605	107
5	406	6050.50221	0.69328967	93
6	304	777.941571	0.81241961	68
7	302	3385390.49	0.3135513	67
8	412	536139.398	0.31297188	64
9	706	695.017697	0.89973746	61
10	210	14264.7619	0.48370601	57
11	808	6479.30876	0.55011778	54
12	408	16575014.6	0.28865867	48

Competing Causes Fitted Survival



Omitting Causes