Report Survival Function

Data and Methodology

The dataset used in the study was obtained from CVE website (cve.org) for the year 2021, 2022 and 2023. For each vulnerability, the patch was released by the respective companies. The killed count here refers to the number of vulnerabilities whose patch was created/made where as the censored here refers to those vulnerabilities who are still alive and no patch was made for them.

The survival function was used to asses the lifetime of CVE's. Survival function graphs visually depict the estimated likelihood that a subject will survive beyond a specific time point in survival analysis. These graphs play a crucial role in comprehending the survival journey of a population or a studied group. Below is an explanation of the elements and the interpretation of survival function graphs.

Cumulative Hazard Function: The survival function provides the probability of surviving past a specific time point, while the cumulative hazard function indicates the cumulative risk or failure rate leading up to that time point. Both functions are crucial in survival analysis for understanding time-to-event data and evaluating associated risk factors.

Empirical Results (Year 2021)

The survival analysis comprises of 287 vulnerabilities, 248 of whom were killed as their patch was made available. The number of censored vulnerabilities were 32 as their patch was not available. Our analysis observed a total of 365 days. (Table 1)

Table: 1 Killed and censored counts

Time	First Seen	CVE	Release Date	Patch Details	Killed Count	Censored/Uncensored
1	26-Dec-20	CVE-2021-43220	Jan 12, 2021	CVE-2021-1716	17	0
2	19-Jan-21	CVE-2021-1636	Feb 9, 2021	CVE-2021-24092	21	0
3	3-Feb-21	CVE-2021-24075	Feb 4, 2021	CVE-2021-24113	1	0
4	23-Feb-21	CVE-2021-24082	Mar 2, 2021	CVE-2021-26857	7	0
5	23-Feb-21	CVE-2021-24085	Mar 9, 2021	CVE-2021-27055	14	0
6	31-Mar-21	CVE-2021-26427	Apr 13, 2021	CVE-2021-28317	13	0
7	19-Apr-21	CVE-2021-26436	May 11, 2021	CVE-2021-31936	22	0
8	25-May-21	CVE-2021-26439	May 27, 2021	CVE-2021-31982	2	0
9	21-May-21	CVE-2021-28450	Jun 8, 2021	CVE-2021-33739	18	0
10	3-Jun-21	CVE-2021-31174	Jun 4, 2021	CVE-2021-33741	1	0
11	19-Jun-21	CVE-2021-31175	Jul 13, 2021	CVE-2021-34464	24	0
12	22-Jun-21	CVE-2021-31176	Jun 24, 2021	CVE-2021-34475	2	0
13	14-Jul-21	CVE-2021-31181	Jul 15, 2021	CVE-2021-34481	1	0
14	30-Jun-21	CVE-2021-31206	Jul 1, 2021	CVE-2021-34527	1	0
15	19-Jul-21	CVE-2021-31936	Jul 22, 2021	CVE-2021-36931	3	0
16	19-Jul-21	CVE-2021-31937	Jul 20, 2021	CVE-2021-36934	1	0
17	2-Aug-21	CVE-2021-31938	Aug 10, 2021	CVE-2021-36949	8	0
18	28-Aug-21	CVE-2021-34453	Sep 2, 2021	CVE-2021-38642	5	0
19	29-Aug-21	CVE-2021-34464	Sep 14, 2021	CVE-2021-38657	16	0
20	8-Sep-21	CVE-2021-34468	Sep 9, 2021	CVE-2021-38669	1	0
21	6-Sep-21	CVE-2021-34524	Sep 7, 2021	CVE-2021-40444	1	0

22	19-Sep-21	CVE-2021-34527	Oct 12, 2021	CVE-2021-40474	23		0
23	27-Oct-21	CVE-2021-36929	Nov 9, 2021	CVE-2021-41351	13		0
24	17-Oct-21	CVE-2021-38658	Oct 18, 2021	CVE-2021-42299	1		0
25	16-Nov-21	CVE-2021-40479	Nov 17, 2021	CVE-2021-42306	1		0
26	20-Oct-21	CVE-2021-41350	Oct 21, 2021	CVE-2021-42307	1		0
27	16-Nov-21	CVE-2021-42276	Nov 19, 2021	CVE-2021-43220	3		0
28	17-Nov-21	CVE-2021-43216	Dec 14, 2021	CVE-2021-43896	27		0
29	12-Jan-21	CVE-2021-21470					1
30	05-Aug-21	CVE-2021-37614					1
31	07-Aug-21	CVE-2021-38159					1
32	03-Feb-21	CVE-2021-25274					1
33	09-Feb-21	CVE-2021-25139					1
34	09-Feb-21	CVE-2021-25140					1
35	14-Sep-21	CVE-2021-38175					1
36	17-Feb-21	CVE-2021-1372					1
37	27-Sep-21	CVE-2021-34410					1
38	27-Sep-21	CVE-2021-34413					1
39	02-Mar-21	CVE-2021-21513					1
40	11-Mar-21	CVE-2021-28141					1
41	16-Apr-21	CVE-2021-29443					1
42	06-May-21	CVE-2021-21505					1
43	29-Sep-21	CVE-2021-36745					1
44	11-May-21	CVE-2021-29508					1
45	29-Sep-21	CVE-2021-39855					1
46	30-Sep-21	CVE-2021-33583					1
47	04-Oct-21	CVE-2021-21706					1
48	18-May-21	CVE-2021-31827					1
49	12-Oct-21	CVE-2021-35494					1
50	12-Oct-21	CVE-2021-35495					1
51	12-Oct-21	CVE-2021-35496					1
52	17-Nov-21	CVE-2021-43551					1
53	19-Nov-21	CVE-2021-33850					1
54	09-Jun-21	CVE-2021-33894					1
55	22-Nov-21	CVE-2021-40828					1
56	08-Dec-21	CVE-2021-38505					1
57	14-Dec-21	CVE-2021-41065					1
58	30-Jun-21	CVE-2021-35971					1
59	22-Dec-21	CVE-2021-43853					1
60	14-Jul-21	CVE-2021-35211					1

The survival plots for the survivor, cumulative hazard and actual data are represent in the fig. 1, 2 and 3 respectively.
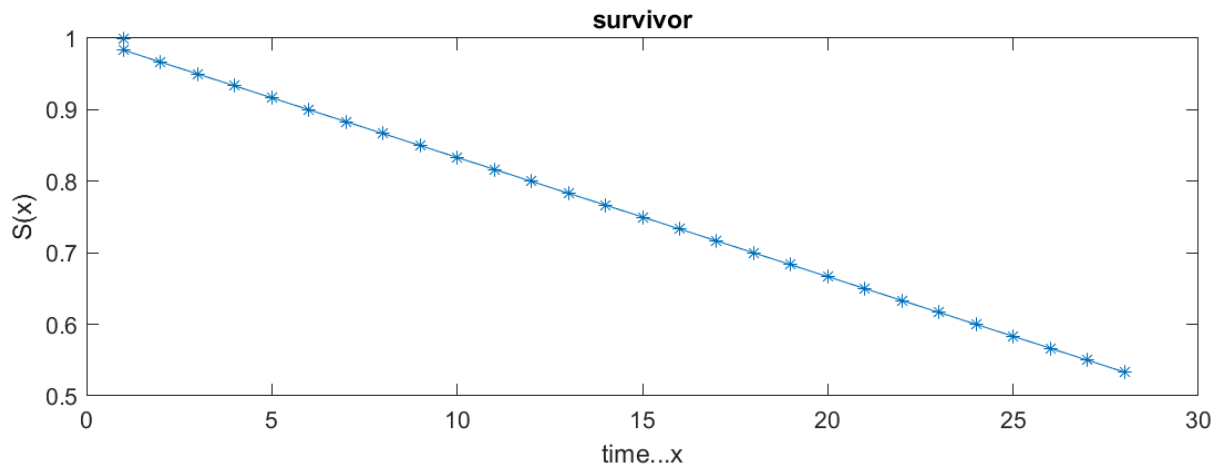
Fig. 1: Survivor Function

From the above figure it can be said that the overall trend of vulnerabilities is decreasing with respect to time. We can see that 91% of the vulnerabilities are alive for about 5 days, 83% of the vulnerabilities live for about 10 days. As the period of time increases, the number of vulnerabilities decreases as the patch was made available for them.
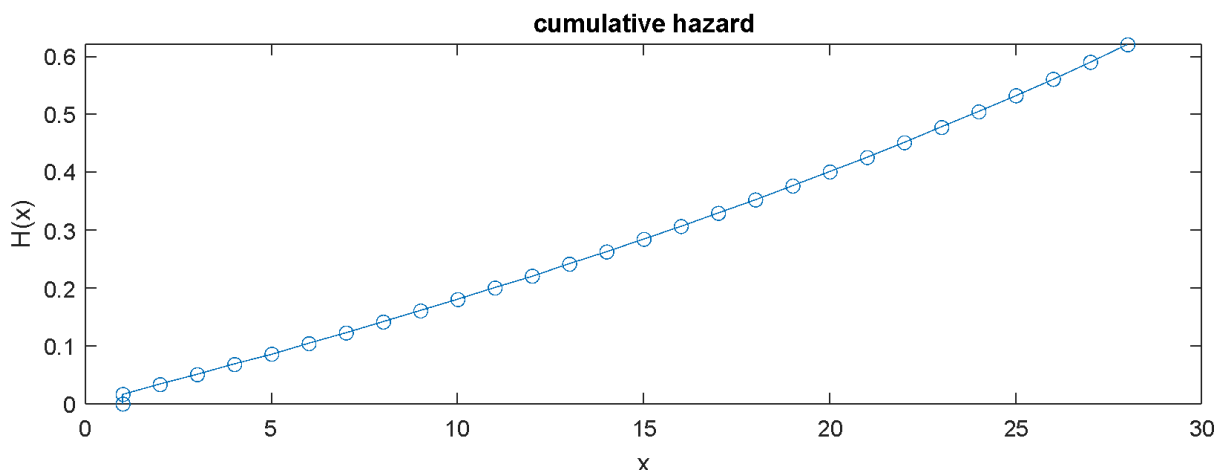

Fig. 2: Cumulative Hazard Function

From the above figure, it can be said that, at any given time, t, the value of H(x) signifies the cumulative risk of experiencing the vulnerability up to that particular date. A higher H(x) value indicates a greater cumulative risk or failure rate up to time t.
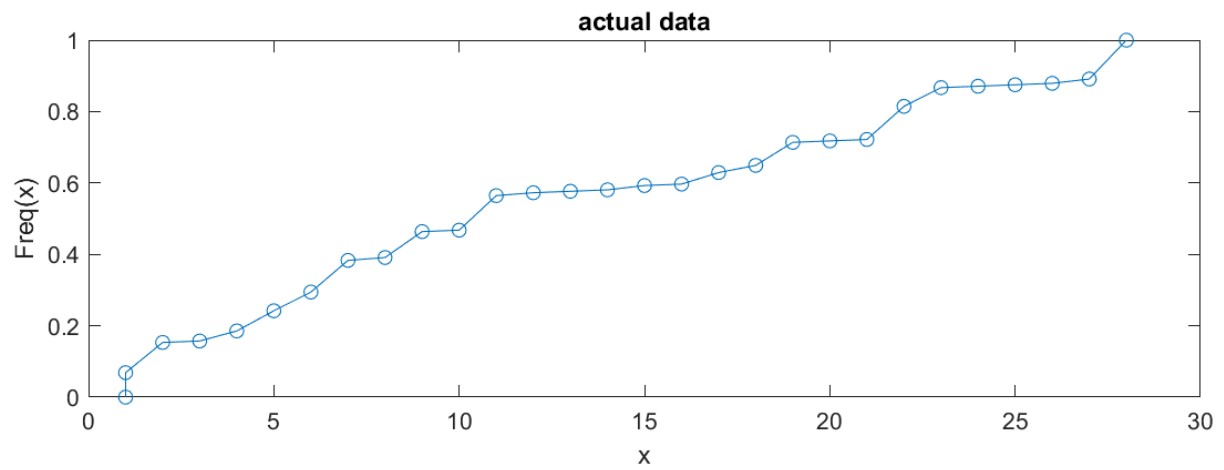
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Fig. 3: Actual Data

From the above figure, the overall trend of vulnerabilities is increasing day by day. The increasing trend in the curve can be seen from the actual data.