NUMERICAL COMPARISON IN INTERNET TRAFFIC SHARING

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ABSTRACT

In the globalized world computer networks have been playing a prominent role. In computer networks internet sharing poses crucial problems. Probability of traffic sharing between two operations in computer networks can be done through many derivations to overcome the problems. In this paper comparisons of the approximate bounded area and computation of probability using numerical techniques especially Weddle's and Romberg's rules are made.

Keywords: Probability Curve,Traffic Sharing, Weddle's Rule, Trapezoidal Rule, Romberg's Method.

INTRODUCTION

Numerical integration is the approximate computation of an Integral using numerical techniques. The numerical computation of an integral is sometimes called quadrature. Ueberhuber(1997,p.71) uses the word "quadrature" to mean numerical computation of a univariate integral and"cubature" to mean numerical computation of a multiple integral.There are a wide range of methods available for numerical integration. A good sourcefor such techniques is Press et al. (1992)

The most straightforward numerical integration technique uses the Newton-Cotes formulas(also called quadrature formulas), which approximate a function tabulated at a sequence of regularly spaced intervals by various degree of polynomials. If the endpoints are tabulated,then the 2- and 3-point formulas are called the Trapezoidal rule and Simpson's rule ,respectively. The 5-point formula is called booles rule a generalization of the trapezoidal rule is Romberg integration,which can yield accurate results for many few function evaluations.

If the functions are known analytically instead of being tabulated at equally spaced intervals,the best numerical method of integration is called Gaussian quadrature . By picking the abscissas at which to evaluate the function, Gaussian quadrature produces the most accurate approximations possible. However, given the speed of modern computers, the additional complication of the Gaussian quadrature formalism often makes it less desirable than simply brute-force calculating twice as many points on a regular grid (which also permits the already computed values of the function to be re-used). An excellent reference for Gaussian quadrature is Hildebrand (1956).

Modern numerical integration methods based on information theory have been developed to simulate information systems such as computer controlled systems, communication systems and control systems since in these cases, the classical methods (which are based on approximation theory) are not as efficient (smith 1974).

The Internet is a popular electronic tool to access information around the world. Billions of people around the world are in the club of internet users at present. This fact is leading to a high amount of traffic load on the network Services. These services are provided by operators (Internet Service Providers) by the help of wide area network in a region. Naldi[1] has opened up the problem of internet traffic sharing evaluation.[1]has suggested a relationship between traffic sharing and blocking probability in anetwork using Markov chain model under the assumption of two network operators. Markov Chain Model is a technique of exploring the transition behaviour of a system.[1] has expressed the following relation

$$\bar{P} = (1 - L_1)\frac{p + (1-p)(1-p_A)L_2}{1 - L_1 L_2 (1-p_A)^2}$$

Where $\bar{P}$ is the traffic share by first operato . O_1 , P is user preference, L_1 ,L_2 are the network blocking probabilities experienced by both the operators O_1 and O_2.

In the above equation L_1 is a variable but all the other parameters p , p_A and L_2 are constants.

[2]Shukla and Thakur have estimated the bounded area of the curve generated by above expression using trapezoidal rule. This paper presents the estimation of bounded area by Weddle's rule and a comparison between Weddle's and Romberg's methods.

METHODOLOGY

WEDDLE'S RULE:

Consider$I = \int_a^b f(x)dx$, where f(x) is the given function that can be integrated in the interval a to b.

Let us divide the interval $[a, b]$ in to 6 equal parts $x_0, x_1, x_2, \ldots, x_6$ each of length $h = x_i - x_{i-1}$;i= 1,2,3,. . . ,6.and $y_0 = f(x_0)$,$y_1 = f(x_1)$,. . . ,$y_6 = f(x_6)$

$$I = \int_a^b f(x)dx = \int_a^b y\,dx = \frac{3h}{10}[y_0 + 5y_1 + y_2 + 6y_3 + y_4 + 5y_5 + y_6]$$

ROMBERG'S RULE:

$$I = \int_a^b f(x)dx = I_2 + \frac{I_2 - I_1}{3}$$

Where I_1 , I_2 are the approximated values of I obtained by using the Trapezoidal rule with two different subintervals of width h_1 and h_2.

TRAPEZOIDAL RULE:

$$I = \int_a^b f(x)dx = \int_a^b y\,dx = \frac{h}{2}[y_0 + 2(y_1 + y_2 + \cdots + y_{n-1}) + y_n]$$

APPLICATIONS:

In the formula

$$\bar{P} = (1 - L_1)\frac{p + (1-p)(1-p_A)L_2}{1 - L_1 L_2 (1-p_A)^2}$$

L_1 is a variable but all the other parameters p, p_A and L_2 are constants.

For the variation of L_1 we can find different values of $\bar{P}$ which are given in the tables 1 -6 . Then the total bounded area can be calculated by using Weddle's rule (tables 1 -3 ; graph 1-3) and Romberg's rule (tables 4 -6 ; graph 4-6) .

A linearly decreasing function of self network blocking probability is found in traffic share as per Table 1. Very small fluctuations is noticed as L_2 increases as the operator O_1 gains the traffic share. This is further supported by Graph 1 which displays the linearly increasing trend between $\bar{P}$ and L_2.

It is indicated that traffic share is function of p and L_2 as the bounded area level increases with the increase of probability P as shown in Table 2.Bounded area below the curve increases with increment of P from 18% to 49.6% which is represented as a straight line as shown in Graph 2.The bounded area reduces reflecting that the total bounded area is a function of P, $P_{A,}$and L_2, with the variation of P_A as shown in Table 3.Variation of the same from 27% to 13.8% represented in Graph3. The area observed by weddle's rule is found to be lower as the bounded area increases as shown in Table 4. Bounded area increases from 15% to 39.8% as represented in the Graph 4. The area of the Weddle's rule is lower as the bounded area increases as shown in Table 5. A straight line is observed from as the bounded area increases from 18% to 49.6% as shown in Graph 5.

Towards the end the area obtained from Table 6 is higher than the bounded area as it decreases as shown in Table 3. In Graph 6 the decreases area from 26.9% to 13.8% is reflected.

CONCLUSION

The bounded area is a function of many parameters under the probability curve. It depends on the variation of parameters. The bounded area increases as L_2 and P increases, where as the area decreases as P_A increases.

The maximum bounded area by Weddle's rule is 0.496845 at P = 0.9 and the maximum area by Romberg's rule is 0.496833 at P = 0.9. The values of both the methods are very closed to each other.

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TABLE 1: WEDDLE'S RULE

$P = 0.25, P_A = 0.35, h = 1/6$

L_2 / L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.2987	0.3475	0.3962	0.4450	0.4937	0.5425	0.5912	0.64	0.6887
1/6	0.2507	0.2937	0.3373	0.3815	0.4264	0.4720	0.5182	0.5651	0.6127
2/6	0.2020	0.2383	0.2758	0.3143	0.3541	0.3950	0.4372	0.4808	0.5258
3/6	0.1525	0.1814	0.2115	0.2430	0.2760	0.3106	0.3469	0.3850	0.4252
4/6	0.1024	0.1227	0.1442	0.1671	0.1915	0.2176	0.2454	0.2753	0.3075
5/6	0.0516	0.0623	0.0738	0.0863	0.0998	0.1146	0.1307	0.1484	0.1680
1	0	0	0	0	0	0	0	0	0
AREA	*0.1514*	*0.1788*	*0.0738*	*0.2361*	*0.2663*	*0.2975*	*0.3299*	*0.3636*	*0.3988*

TABLE 2 :WEDDLE'S RULE

$P_A = 0.25, L_2 = 0.35, h = 1/6$

P / L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.3362	0.41	0.4837	0.5575	0.6312	0.705	0.7787	0.8525	0.9262
1/6	0.2897	0.3532	0.4168	0.4803	0.5438	0.6074	0.6709	0.7345	0.7980
2/6	0.2399	0.2925	0.3451	0.3977	0.4503	0.5030	0.5556	0.6082	0.6608
3/6	0.1864	0.2273	0.2682	0.3091	0.3500	0.3909	0.4318	0.4727	0.5136
4/6	0.1290	0.1573	0.1856	0.2139	0.2422	0.2705	0.2988	0.3270	0.3553
5/6	0.0670	0.0817	0.0964	0.1111	0.1258	0.1405	0.1552	0.1699	0.1846
6/6	0	0	0	0	0	0	0	0	0
AREA	0.1803	0.2199	0.2594	0.2990	0.3385	0.3781	0.4177	0.4572	0.4968

TABLE 3:WEDDLE'S RULE

$P = 0.25, L_2 = 0.35, h = 1/6$

P_A / L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
L_2 / L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.4862	0.46	0.4337	0.4075	0.3812	0.355	0.3287	0.3025	0.2762
1/6	0.4253	0.3981	0.372	0.3468	0.3224	0.2986	0.2754	0.2526	0.2303
2/6	0.3579	0.3314	0.3066	0.2835	0.2618	0.2411	0.2214	0.2026	0.1843
3/6	0.2832	0.259	0.2372	0.2174	0.1993	0.1826	0.167	0.1523	0.1383
4/6	0.1998	0.1802	0.1632	0.1482	0.1349	0.1229	0.1119	0.1017	0.0922
5/6	0.1061	0.0942	0.0843	0.0758	0.0685	0.062	0.0562	0.0510	0.0461
6/6	0	0	0	0	0	0	0	0	0
AREA	0.27	0.2484	0.2304	0.2128	0.1964	0.1808	0/1661	0.1519	0.1382

TABLE 4 (a): TRAPEZOIDAL RULE

$P = 0.25, P_A = 0.35, h = 0.25$

L_2 \ L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.2987	0.3475	0.3962	0.445	0.4937	0.5425	0.5912	0.64	0.6887
0.25	0.2264	0.2662	0.3069	0.3484	0.3909	0.4344	0.4788	0.5243	0.5708
0.5	0.1525	0.1814	0.2115	0.2430	0.276	0.3106	0.3469	0.385	0.4252
0.75	0.0771	0.0927	0.1094	0.1273	0.1466	0.1674	0.1899	0.2143	0.2408
1	0	0	0	0	0	0	0	0	0
AREA (I_1)	0.1513	0.1785	0.2064	0.2353	0.265	0.2959	0.3278	0.3609	0.3952

TABLE 4 (b): TRAPEZOIDAL RULE

$P = 0.25, P_A = 0.35, h = 0.125$

L_2 \ L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.2987	0.3475	0.3962	0.445	0.4937	0.5425	0.5912	0.64	0.6887
0.125	0.2627	0.3073	0.3523	0.3977	0.4437	0.4902	0.5372	0.5847	0.6327
0.25	0.2264	0.2662	0.3069	0.3484	0.3909	0.4344	0.4788	0.5243	0.5708
0.375	0.1897	0.2242	0.26	0.2969	0.3351	0.3746	0.4156	0.4580	0.5020
0.5	0.1525	0.1814	0.2115	0.2430	0.276	0.3106	0.3469	0.385	0.4252
0.625	0.1150	0.1375	0.1613	01865	0.2133	0.2417	0.2719	0.3042	0.3387
0.75	0.0771	0.0927	0.1094	0.1273	0.1466	0.1674	0.1899	0.2143	0.2408
0.875	0.0387	0.0469	0.0557	0.0652	0.0757	0.0871	0.099	0.1135	0.129
1	0	0	0	0	0	0	0	0	0
AREA (I_2)	0.1513	0.1787	0.2069	0.2359	0.266	0.2971	0.3293	0.363	0.3979

TABLE 4: ROMBERG'S RULE

I_1	0.1513	0.1785	0.2064	0.2353	0.265	0.2959	0.3278	0.3609	0.3952
I_2	0.1513	0.1787	0.2069	0.2359	0.266	0.2971	0.3293	0.363	0.3979
I	0.1513	0.1787	0.2070	0.2361	0.2663	0.2975	O.3298	0.3637	0.3988

TABLE 5 (a): TRAPEZOIDAL RULE

$P_A = 0.25, L_2 = 0.35, h = 0.25$

P \ L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.3362	0.41	0.4837	0.5575	0.6312	0.705	0.7787	0.8525	0.9262
0.25	0.2652	0.3234	0.3815	0.4397	0.4979	0.5561	0.6142	0.6724	0.7306
0.5	0.1864	0.2273	0.2682	0.3091	0.35	0.3909	0.4318	0.4727	0.5136
0.75	0.0986	0.1202	0.1418	0.1635	0.1851	0.2067	0.2284	0.25	0.2716
1	0	0	0	0	0	0	0	0	0
AREA	0.1795	0.2189	0.2583	0.2977	0.3371	0.3765	0.4159	0.4553	0.4947

TABLE 5 (b): TRAPEZOIDAL RULE

$P_A = 0.25, L_2 = 0.35, h = 0.125$

L_1 \ P	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.3362	0.41	0.4837	0.5575	0.6312	0.705	0.7787	0.8525	0.9262
0.125	0.3016	0.3678	0.4339	0.5001	0.5662	0.6324	0.6985	0.7647	0.8309
0.25	0.2652	0.3234	0.3815	0.4397	0.4979	0.5561	0.6142	0.6724	0.7306
0.375	0.2269	0.2766	0.3264	0.3762	0.4259	0.4757	0.5255	0.5752	0.6250
0.5	0.1864	0.2273	0.2682	0.3091	0.35	0.3909	0.4318	0.4727	0.5136
0.625	0.1437	0.1753	0.2068	0.2383	0.2699	0.3014	0.333	0.3645	0.396
0.75	0.0986	0.1202	0.1418	0.1635	0.1851	0.2067	0.2284	0.25	0.2716
0.875	0.0507	0.0619	0.073	0.0841	0.0953	0.1064	0.1176	0.1287	0,1398
1	0	0	0	0	0	0	0	0	0
AREA (I_2)	0.1805	0.2196	0.2591	0.2987	0.3382	0.3777	0.4172	0.4568	0.4963

TABLE 5: ROMBERG'S RULE

I_1	0.1795	0.2189	0.2583	0.2977	0.3371	0.3765	0.4159	0.4553	0.4947
I_2	0.1805	0.2196	0.2591	0.2987	0.3382	0.3777	0.4172	0.4568	0.4963
I	0.1808	0.2198	0.2593	0.299	0.3385	0.3781	0.4176	0.4573	0.4968

TABLE 6 (a): TRAPEZOIDAL RULE

= 0.35

L_1 \ P_A	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.4862	0.46	0.4337	0.4075	0.3812	0.355	0.3287	0.3025	0.2762
0.25	0.3925	0.3654	0.3398	0.3155	0.2923	0.27	0.2485	0.2276	0.2073
0.5	0.2832	0.259	0.2372	0.2174	0.1993	0.1826	0.167	0.1523	0.1383
0.75	0.1543	0.1382	0.1244	0.1125	0.1020	0.0926	0.0841	0.0764	0.0692
1	0	0	0	0	0	0	0	0	0
AREA	0.2682	0.2481	0.2295	0.2122	0.196	0.1806	0.1659	0.1518	0.1382

TABLE 6 (b): TRAPEZOIDAL RULE

$P = 0.25, L_2 = 0.35, h = 0.125$

L_1 \ P_A	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.4862	0.46	0.4337	0.4075	0.3812	0.355	0.3287	0.3025	0.2762
0.125	0.4411	0.414	0.3878	0.3622	0.3372	0.3128	0.2887	0.2651	0.2418
0.25	0.3925	0.3654	0.3398	0.3155	0.2923	0.27	0.2485	0.2276	0.2073
0.375	0.34	0.3138	0.2897	0.2673	0.2463	0.2266	0.2079	0.19	0.1728
0.5	0.2832	0.259	0.2372	0.2174	0.1993	0.1826	0.167	0.1523	0.1383
0.625	0.2216	0.2005	0.1821	0.1658	0.1512	0.1379	0.1257	0.1144	0.1038
0.75	0.1543	0.1382	0.1244	0.1125	0.1020	0.0926	0.0841	0.0764	0.0692
0.875	0.0808	0.0715	0.0637	0.0572	0.0516	0.0466	0.0422	0.03828	0.0346
1	0	0	0	0	0	0	0	0	0
AREA (I_2)	0.2695	0.2490	0.2301	0.2127	0.1963	0.1808	0.1660	0.1519	0.1382

TABLE 6: ROMBERG'S RULE

I_1	0.2682	0.2481	0.2295	0.2122	0.196	0.1806	0.1659	0.1518	0.1382
I_2	0.2695	0.2490	0.2301	0.2127	0.1963	0.1808	0.1660	0.1519	0.1382
I	0.2699	0.2493	0.2303	0.2128	0.1964	0.1808	0.1660	0.1519	0.1382