

DESIGN AND ANALYSIS OF ALGORITHMS

EXPERIMENT 1A

Manav Bhanushali

CSE-DS D1

UID: 2021700008

AIM:

TO IMPLEMENT VARIOUS FUNCTIONS E.G. LINEAR, NON-LINEAR, QUADRATIC, EXPONENTIAL, ETC.

THEORY:

A function is a process or a relation that associates each element 'a' of a non-empty set A, at least to a single element 'b' of another non-empty set B.

A relation f from a set A (the domain of the function) to another set B (the co-domain of the function) is called a function in math. $f = \{(a,b) | \text{for all } a \in A, b \in B\}$

- A relation is said to be a function if every element of set A has one and only one image in set B.
- A function is a relation from a non-empty set B such that the domain of a function is A and no two distinct ordered pairs in f have the same first element.
- A function from $A \rightarrow B$ and $(a,b) \in f$, then $f(a) = b$, where 'b' is the image of 'a' under 'f' and 'a' is the preimage of 'b' under 'f'.
- If there exists a function $f: A \rightarrow B$, the set A is called the domain of the function f, and the set B is called its co-domain.

ALGORITHM:

STEP_1: Start.

STEP_2: Print the header row to make one column for input, ten columns for functions and last column for factorial of a number.

STEP_3: Start a for loop which will run from i=0 to 100 to find values of functions for all numbers from 0 to 100. In this loop:

- (1) First print the input.
- (2) Define function f1 as $(3/2)^n$. Print its value.
- (3) Define function f2 as n^3 . Print its value.
- (4) Define function f3 as $2^{(2^n)}$. Print its value.
- (5) Define function f4 as $\ln(\ln(n))$. Print its value.
- (6) Define function f5 as $n \cdot (2^n)$. Print its value.
- (7) Define function f6 as $\ln(n)$. Print its value.
- (8) Define function f7 as 2^n . Print its value.
- (9) Define function f8 as $2^{(2^{(n+1)})}$. Print its value.
- (10) Define function f9 as e^n . Print its value.
- (11) Define function f10 as $\lg(n)$. Print its value.
- (12) To print the factorial of first 20 numbers, put an if statement. Initialise fact=1, put fact=fact*i to calculate factorial and print its value.

STEP_4: Stop.

CODE:

```
#include <stdio.h>
#include <math.h>

int
main ()
{
    printf
    ("Input (3/2)^n      n^3      2^(2^n)      ln(ln(n))      n*(2^n)      ln(n)      2^n
      2^(2^(n+1))      e^n      lg(n)      Factorial\n");

    for (int i = 0; i <= 100; i++)
    {
        printf ("%d ", i);
        float f1 = pow ((float) 3 / 2, i);
        printf ("%f ", f1);
        float f2 = pow (i, 3);
        printf ("%f ", f2);
        float f3 = pow (2, pow (2, i));
        printf ("%f ", f3);
        float f4 = log (log (i));
        printf ("%f ", f4);
        float f5 = i * pow (2, i);
        printf ("%f ", f5);
        float f6 = log (i);
        printf ("%f ", f6);
        float f7 = pow (2, i);
        printf ("%f ", f7);
        float f8 = pow (2, pow (2, i + 1));
        printf ("%f ", f8);
        float f9 = pow (2.71, i);
        printf ("%f ", f9);
        float f10 = log (i) / log (2);
        printf ("%f ", f10);
        int fact = 1;
        if (i == 0)
            printf ("0 ");
        else if (i <= 20)
        {
            fact *= i;
            printf ("%d ", fact);
        }
        printf ("\n");
    }

    return 0;
}
```

OUTPUT:

```

Input (3/2)^n n^3 2^(2^n) ln(ln(n)) n*(2^n) ln(n) 2^n2^(2^(n+1)) e^n lg(n) Factorial
0 1.000000 0.000000 2.000000 -inf 0.000000 -inf 1.000000 4.000000 -inf 0
1 1.500000 1.000000 4.000000 -inf 2.000000 0.000000 2.000000 2.710000 0.000000 1
2 2.250000 8.000000 16.000000 -0.366513 8.000000 0.693147 4.000000 256.000000 7.344100 1.000000 2
3 3.375000 27.000000 256.000000 0.094048 24.000000 1.098612 8.000000 65536.000000 19.902512 1.584962 3
4 5.062500 64.000000 65536.000000 0.326634 64.000000 1.386294 16.000000 4294967296.000000 53.935806 2.000000 4
5 7.593750 125.000000 4294967296.000000 0.475885 160.000000 1.609438 32.000000 18446744073709551616.000000 146.166031 2.321928 5
6 11.390625 216.000000 18446744073709551616.000000 0.583198 384.000000 1.791759 64.000000 inf 396.109955 2.584963 6
7 17.085938 343.000000 inf 0.665730 896.000000 1.945910 128.000000 inf 1073.458008 2.807355 7
8 25.628906 512.000000 inf 0.732099 2048.000000 2.079442 256.000000 inf 2909.071045 3.000000 8
9 38.443359 729.000000 inf 0.787195 4608.000000 2.197225 512.000000 inf 7883.582520 3.169925 9
10 57.665039 1000.000000 inf 0.834032 10240.000000 2.302585 1024.000000 inf 21364.507812 3.321928 10
11 86.497559 1331.000000 inf 0.874591 22528.000000 2.397895 2048.000000 inf 57897.820312 3.459432 11
12 129.746338 1728.000000 inf 0.910235 49152.000000 2.484907 4096.000000 inf 156903.093750 3.584963 12
13 194.619507 2197.000000 inf 0.941939 106496.000000 2.564949 8192.000000 inf 425207.375000 3.700440 13
14 291.929260 2744.000000 inf 0.970422 229376.000000 2.639057 16384.000000 inf 1152312.000000 3.807355 14
15 437.893890 3375.000000 inf 0.996229 491520.000000 2.708050 32768.000000 inf 3122765.500000 3.906891 15
16 656.480820 4096.000000 inf 1.019781 1048576.000000 2.772589 65536.000000 inf 8462694.000000 4.000000 16
17 985.261220 4913.000000 inf 1.041412 2228224.000000 2.833213 131072.000000 inf 22833902.000000 4.087463 17
18 1477.891846 5832.000000 inf 1.061385 4718592.000000 2.890372 262144.000000 inf 62150872.000000 4.169925 18
19 2216.837891 6859.000000 inf 1.079918 9961472.000000 2.944439 524288.000000 inf 16842864.000000 4.247928 19
20 3325.256836 8000.000000 inf 1.097189 20971520.000000 2.995732 1048576.000000 inf 456442240.000000 4.321928 20
21 4987.885254 9261.000000 inf 1.113344 44040192.000000 3.044523 2097152.000000 inf 1236958464.000000 4.392317
22 7481.827637 10648.000000 inf 1.128508 92274688.000000 3.091043 4194304.000000 inf 3352157440.000000 4.459432
23 11222.741211 12167.000000 inf 1.142787 192937984.000000 3.135494 8388608.000000 inf 9084346368.000000 4.523562
24 16834.111328 13824.000000 inf 1.156269 402653184.000000 3.178054 16777216.000000 inf 24618579968.000000 4.584962
25 25251.167969 15625.000000 inf 1.169032 838860800.000000 3.218876 33554432.000000 inf 66716348416.000000 4.643856
26 37876.753906 17576.000000 inf 1.181143 1744830464.000000 3.258096 6710864.000000 inf 18080120624.000000 4.700440
27 56815.128906 19683.000000 inf 1.192660 362387856.000000 3.295837 13421728.000000 inf 48997154816.000000 4.754888
28 85222.695312 21952.000000 inf 1.203634 7516192768.000000 3.332205 268435456.000000 inf 132782292920.000000 4.807355
29 127834.039062 24389.000000 inf 1.214110 15569256448.000000 3.367296 536870912.000000 inf 3598400094208.000000 4.857981
30 191751.062500 27000.000000 inf 1.224128 32212254720.000000 3.401197 1073741824.000000 inf 9751663476736.000000 4.906890
31 287626.593750 29791.000000 inf 1.233722 66571993088.000000 3.433987 2147483648.000000 inf 26427009269760.000000 4.954196
32 431439.875000 32768.000000 inf 1.242925 137438953472.000000 3.465736 4294967296.000000 inf 71617195540480.000000 5.000000
33 647159.812500 35937.000000 inf 1.251765 283467841536.000000 3.496508 8589934592.000000 inf 194082552784384.000000 5.044394
34 970739.750000 39304.000000 inf 1.260266 584115552256.000000 3.526361 17179869184.000000 inf 525963842551808.000000 5.087463
35 1456109.625000 42875.000000 inf 1.268453 1202590842880.000000 3.555348 34359738368.000000 inf 1425362072371200.000000 5.129283
36 2184164.500000 46856.000000 inf 1.276345 2473901162496.000000 3.583519 68719476736.000000 inf 3862731102571520.000000 5.169925
37 3276246.500000 50653.000000 inf 1.283962 5085241278464.000000 3.610918 137438953472.000000 inf 10468001383972864.000000 5.209454
  
```

TABLE:

Input	$(3/2)^n$	n^3	$2^{(2^n)}$	$\ln(\ln(n))$	$n \cdot (2^n)$	$\ln(n)$	$2^n 2^{(2^{(n+1)})}$	e^n	$\lg(n)$	Factorial
0	1	0	2	#NAME?	0	#NAME?	1	4	1	
1	1.5	1	4	#NAME?	2	0	2	16	2.71	0
2	2.25	8	16	-0.366513	8	0.693147	4	256	7.3441	1
3	3.375	27	256	0.094048	24	1.098612	8	65536	19.902512	
4	5.0625	64	65536	0.326634	64	1.386294	16	4294967296		
5	7.59375125	125	4294967296	0.475885	160	1.609438	32			
6	11.390625	216	1.84467E+19	0.583198	384	1.791759	64			
7	17.085938	343	inf	0.66573896	1.94591128	inf	1073.458008			
8	25.628906	512	inf	0.732099	2048	2.079442	256	inf		
9	38.443359	729	inf	0.787195	4608	2.197225	512	inf		

10	57.665039 21364.50781	1000 3.321928	inf	0.834032 10	10240	2.302585	1024	inf
11	86.497559 57897.82031	1331 3.459432	inf	0.874591 11	22528	2.397895	2048	inf
12	129.746338 156903.0938	1728 3.584963	inf	0.910235 12	49152	2.484907	4096	inf
13	194.619507 425207.375	2197 3.7004413	inf	0.941939	106496	2.564949	8192	inf
14	291.92926 1152312	2744 3.807355	inf	0.970422 14	229376	2.639057	16384	inf
15	437.89389 3.906891	3375 15	inf	0.996229	491520	2.7080532768	inf	3122765.5
16	656.84082 inf	4096 8462694	inf 4	1.019781 16	1048576	2.772589	65536	
17	985.26123 inf	4913 22933902	inf 4.087463	1.041412 17	2228224	2.833213	131072	
18	1477.891846 inf	5832 62150872	inf 4.169925	1.061385 18	4718592	2.890372	262144	
19	2216.837891 inf	6859 168428864	inf 4.247928	1.079918 19	9961472	2.944439	524288	
20	3325.256836 inf	8000 456442240	inf 4.321928	1.097189 20	20971520	2.995732	1048576	
21	4987.885254 inf	9261 1236958464	inf 4.392317	1.113344	44040192	3.044523	2097152	
22	7481.827637 inf	10648 3352157440	inf 4.459432	1.128508	92274688	3.091043	4194304	
23	11222.74121 inf	12167 9084346368	inf 4.523562	1.142787	192937984	3.135494	8388608	
24	16834.11133 inf	13824 24618579968	inf 4.584962	1.156269	402653184	3.178054	16777216	
25	25251.16797 inf	15625 66716348416	inf 4.643856	1.169032	838860800	3.218876	33554432	
26	37876.75391 inf	17576 1.80801E+11	inf 4.70044	1.181143	1744830464	3.258096	67108864	
27	56815.12891 inf	19683 4.89972E+11	inf 4.754888	1.192663623878656	3.295837	134217728		
28	85222.69531 268435456	21952 inf	inf 1.32782E+12	1.203634 4.807355	7516192768	3.332205		
29	127834.0391 inf	24389 3.5984E+12	inf 4.857981	1.2141115569256448	3.367296	536870912		
30	191751.0625	27000	inf	1.224128	32212254720	3.401197		

	1073741824	inf	9.75166E+12	4.90689		
31	287626.5938 2147483648	29791 inf	inf 2.6427E+13	1.233722 4.954196	66571993088	3.433987
32	431439.875 4294967296	32768 inf	inf 7.16172E+13	1.242925 5	1.37439E+11	3.465736
33	647159.8125 8589934592	35937 inf	inf 1.94083E+14	1.251765 5.044394	2.83468E+11	3.496508
34	970739.75 17179869184	39304 inf	inf 5.25964E+14	1.260266 5.087463	5.84116E+11	3.526361
35	1456109.625 34359738368	42875 inf	inf 1.42536E+15	1.268453 5.129283	1.20259E+12	3.555348
36	2184164.5 68719476736	46656 inf	inf 3.86273E+15	1.276345 5.169925	2.4739E+12	3.583519
37	3276246.5 1.37439E+11	50653 inf	inf 1.0468E+16	1.283962 5.209454	5.08524E+12	3.610918
38	4914370 inf	54872 2.83683E+16	inf 5.247928	1.291321.04454E+13	3.637586	2.74878E+11
39	7371555 5.49756E+11	59319 inf	inf 7.68781E+16	1.298436 5.285402	2.14405E+13	3.663562
40	11057332 1.09951E+12	64000 inf	inf 2.0834E+17	1.305323 5.321928	4.39805E+13	3.688879
41	16585998 2.19902E+12	68921 inf	inf 5.646E+17	1.311994 5.357552	9.016E+13	3.713572
42	24878998 inf	74088 1.53007E+18	inf 5.392317	1.318462	1.84718E+14	3.737674.39805E+12
43	37318496 inf	79507 4.14648E+18	inf 5.426265	1.324738	3.78232E+14	3.7612 8.79609E+12
44	55977744 inf	85184 1.1237E+19	inf 5.459432	1.330832	7.74056E+14	3.784191.75922E+13
45	83966616 3.51844E+13	91125 inf	inf 3.04522E+19	1.336753 5.491853	1.5833E+15	3.806663
46	125949928 inf	97336 8.25253E+19	inf 5.523562	1.342513.23696E+15	3.828641	7.03687E+13
47	188924896 1.40737E+14	103823 inf	inf 2.23644E+20	1.348112 5.554589	6.61466E+15	3.850147
48	283387328 2.81475E+14	110592 inf	inf 6.06074E+20	1.353565 5.584962	1.35108E+16	3.871201
49	425080992 inf	117649 1.64246E+21	inf 5.61471	1.358877	2.75845E+16	3.891825.6295E+14
50	637621504 1.1259E+15	125000 inf	inf 4.45107E+21	1.364055 5.643856	5.6295E+16	3.912023

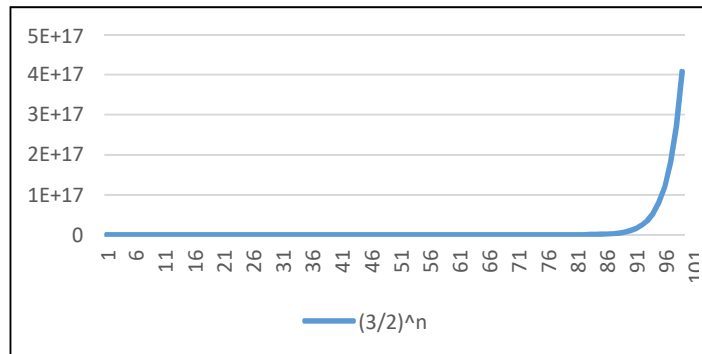
51	956432256 2.2518E+15	132651 inf inf	1.369104 1.20624E+22	1.14842E+17 5.672425	3.931826	
52	1434648320 inf	140608 inf 3.26891E+22	1.374032.34187E+17 5.70044	3.951244	4.5036E+15	
53	2151972608 inf	148877 inf 8.85875E+22	1.378844.77382E+17 5.727921	3.970292	9.0072E+15	
54	3227958784 1.80144E+16	157464 inf inf	1.383537 2.40072E+23	9.72778E+17 5.754888	3.988984	
55	4841938432 3.60288E+16	166375 inf inf	1.388126 6.50595E+23	1.98158E+18 5.78136	4.007333	
56	7262907392 7.20576E+16	175616 inf inf	1.392612 1.76311E+24	4.03523E+18 5.807355	4.025352	
57	10894361600 inf	185193 inf 4.77804E+24	1.397 5.83289	8.21457E+18 4.043051	1.44115E+17	
58	16341541888 2.8823E+17	195112 inf inf	1.401292 1.29485E+25	1.67174E+19 5.857981	4.060443	
59	24512313344 5.76461E+17	205379 inf inf	1.405493 3.50904E+25	3.40112E+19 5.882643	4.077538	
60	36768468992 1.15292E+18	216000 inf inf	1.409607 9.50949E+25	6.91753E+19 5.90689	4.094345	
61	55152701440 2.30584E+18	226981 inf inf	1.413636 2.57707E+26	1.40656E+20 5.930737	4.110874	
62	82729058304 4.61169E+18	238328 inf inf	1.417583 6.98387E+26	2.85925E+20 5.954196	4.127134	
63	1.24094E+11 9.22337E+18	250047 inf inf	1.421453 1.89263E+27	5.81072E+20 5.97728	4.143135	
64	1.8614E+11 1.84467E+19	262144 inf inf	1.425247 5.12902E+27	1.18059E+21 6	4.158883	
65	2.79211E+11 3.68935E+19	274625 inf inf	1.428968 1.38997E+28	2.39808E+21 6.022368	4.174387	
66	4.18816E+11 7.3787E+19	287496 inf inf	1.432618 3.76681E+28	4.86994E+21 6.044394	4.189655	
67	6.28224E+11 1.47574E+20	300763 inf inf	1.436201 1.0208E+29	9.88745E+21 6.066089	4.204693	
68	9.42336E+11 2.95148E+20	314432 inf inf	1.439718 2.76638E+29	2.00701E+22 6.087463	4.219508	
69	1.4135E+12 5.90296E+20	328509 inf inf	1.443172 7.49689E+29	4.07304E+22 6.108524	4.234107	
70	2.12026E+12 1.18059E+21	343000 inf inf	1.446565 2.03166E+30	8.26414E+22 6.129283	4.248495	
71	3.18038E+12	357911 inf	1.449898	1.67644E+23	4.262682.36118E+21	

	inf	5.50579E+30	6.149747		
72	4.77057E+12 4.72237E+21	373248 inf	1.453174 1.49207E+31	3.4001E+23 6.169925	4.276666
73	7.15586E+12 inf	389017 inf	1.456394 4.04351E+31	6.89466E+23 6.189825	4.290469.44473E+21
74	1.07338E+13 inf	405224 inf	1.459561.39782E+24 1.09579E+32	4.304065 6.209454	1.88895E+22
75	1.61007E+13 3.77789E+22	421875 inf	1.462674 2.96959E+32	2.83342E+24 6.228819	4.317488
76	2.4151E+13 7.55579E+22	438976 inf	1.465737 8.0476E+32	5.7424E+24 6.247928	4.330733
77	3.62265E+13 1.51116E+23	456533 inf	1.468751 2.1809E+33	1.16359E+25 6.266787	4.343805
78	5.43398E+13 3.02231E+23	474552 inf	1.471717 5.91023E+33	2.35741E+25 6.285402	4.356709
79	8.15097E+13 6.04463E+23	493039 inf	1.474637 1.60167E+34	4.77526E+25 6.303781	4.369448
80	1.22265E+14 1.20893E+24	512000 inf	1.477511 4.34054E+34	9.67141E+25 6.321928	4.382027
81	1.83397E+14 2.41785E+24	531441 inf	1.480342 1.17628E+35	1.95846E+26 6.33985	4.394449
82	2.75095E+14 inf	551368 inf	1.483133.96528E+26 3.18773E+35	4.406719 6.357552	4.8357E+24
83	4.12643E+14 inf	571787 inf	1.485877 8.63875E+35	8.02727E+26 6.37504	4.418849.67141E+24
84	6.18965E+14 1.93428E+25	592704 inf	1.488584 2.3411E+36	1.6248E+27 6.392317	4.430817
85	9.28447E+14 3.86856E+25	614125 inf	1.491251 6.34439E+36	3.28828E+27 6.409391	4.442651
86	1.39267E+15 7.73713E+25	636056 inf	1.493881 1.71933E+37	6.65393E+27 6.426265	4.454347
87	2.08901E+15 1.54743E+26	658503 inf	1.496473 4.65938E+37	1.34626E+28 6.442944	4.465908
88	3.13351E+15 3.09485E+26	681472 inf	1.499028 1.26269E+38	2.72347E+28 6.459432	4.477337
89	4.70026E+15 6.1897E+26	704969 inf	1.501549 inf	5.50883E+28 6.475733	4.488636
90	7.05039E+15 inf	729000 inf	1.504035 inf	1.11415E+29 6.491853	4.499811.23794E+27
91	1.05756E+16 2.47588E+27	753571 inf	1.506488 inf	2.25305E+29 6.507795	4.510859

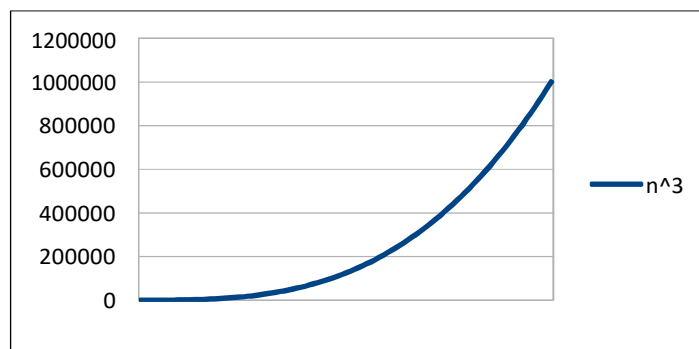
92	1.58634E+16 4.95176E+27	778688 inf inf inf	1.508908 6.523562	4.55562E+29	4.521789
93	2.37951E+16 9.90352E+27	804357 inf inf inf	1.511296 6.539159	9.21027E+29	4.532599
94	3.56926E+16 1.9807E+28	830584 inf inf inf	1.513652 6.554589	1.86186E+30	4.543295
95	5.35389E+16 3.96141E+28	857375 inf inf inf	1.515979 6.569856	3.76334E+30	4.553877
96	8.03084E+16 7.92282E+28	884736 inf inf inf	1.518276 6.584962	7.6059E+30	4.564348
97	1.20463E+17 1.58456E+29	912673 inf inf inf	1.520544 6.599913	1.53703E+31	4.574711
98	1.80694E+17 3.16913E+29	941192 inf inf inf	1.522783 6.61471	3.10574E+31	4.584968
99	2.71041E+17 inf inf	970299 inf 6.629356	1.524995	6.27487E+31	4.595126.33825E+29
100	4.06561E+17 inf inf	1000000 6.643856	inf	1.527181.26765E+32	4.605171.26765E+30

GRAPHS:

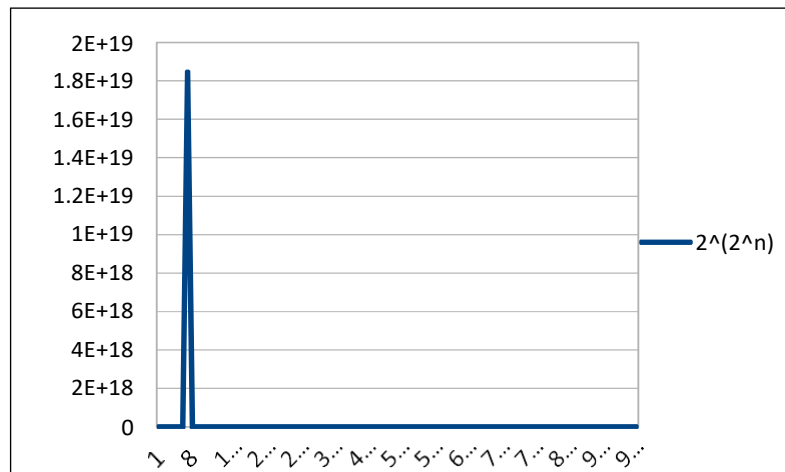
OBSERVATION_(1) $(3/2)^n$: The values of the function are gradually increasing.
At $n=83$ there is a sudden rise in value after which the result tends to infinity.



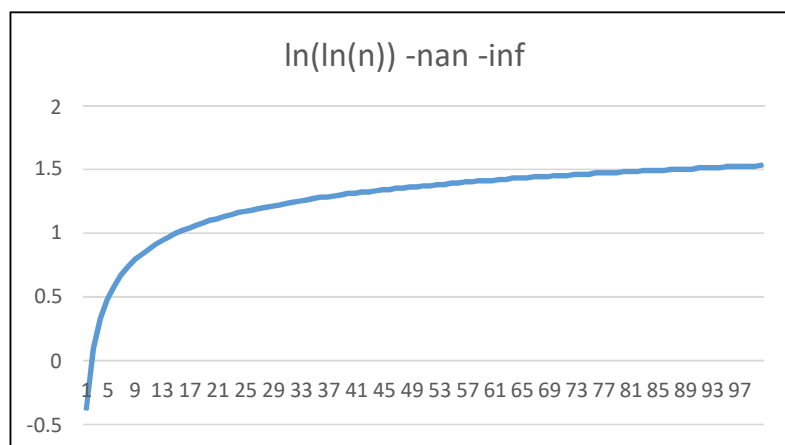
OBSERVATION_(2) n^3 : This function has a U shaped graph which starts from 0 and gradually increases to infinity.



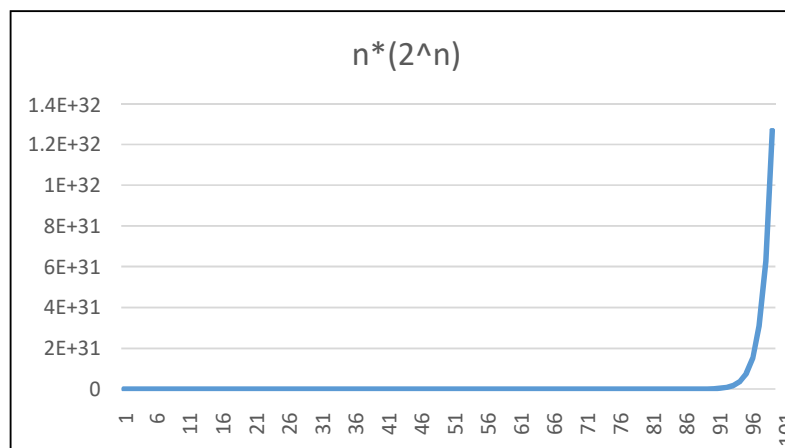
OBSERVATION_(3) $2^{(2^n)}$: After $n=8$, the graph of this functions tends to infinity.



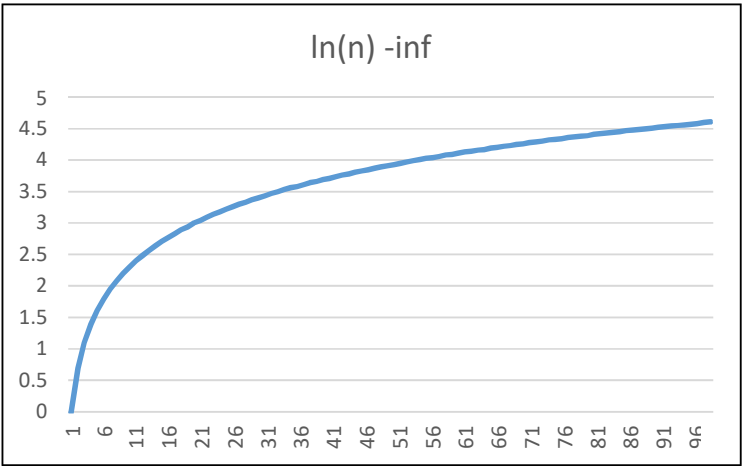
OBSERVATION_(4) $\ln(\ln(n))$: This function has a negative value at $n=2$. The graph has sudden increase at first but then gradually acquires a lesser slope.



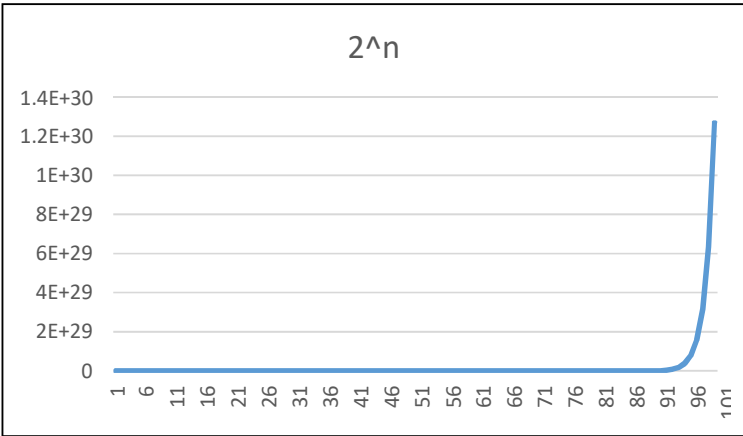
OBSERVATION_(5) $n \cdot (2^n)$: This function has a sudden rise in value at $n=92$ after which it tends to infinity.



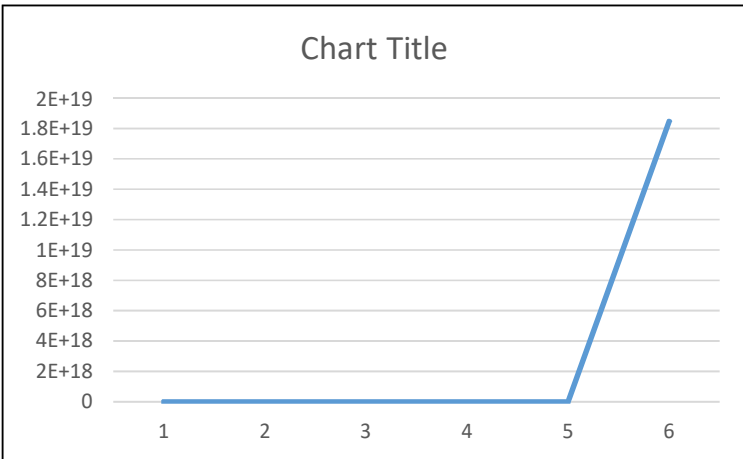
OBSERVATION_(6) $\ln(n)$: The graph starts from $\ln(1)=0$. It first increases steeply and then becomes gradual for higher values of n .



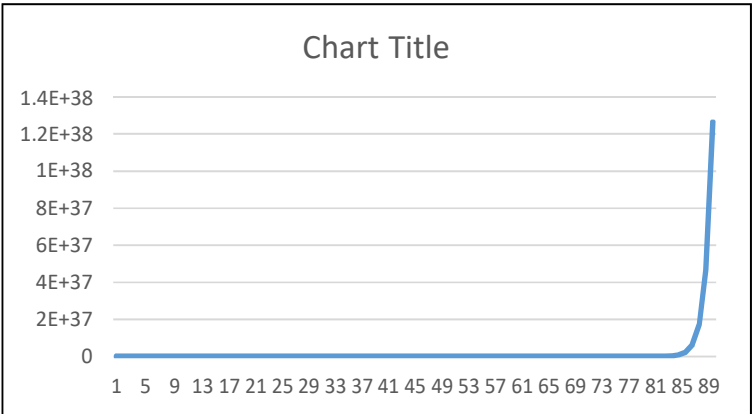
OBSERVATION_(7) 2^n : This function has a sudden rise in value at $n=92$ after which it tends to infinity.



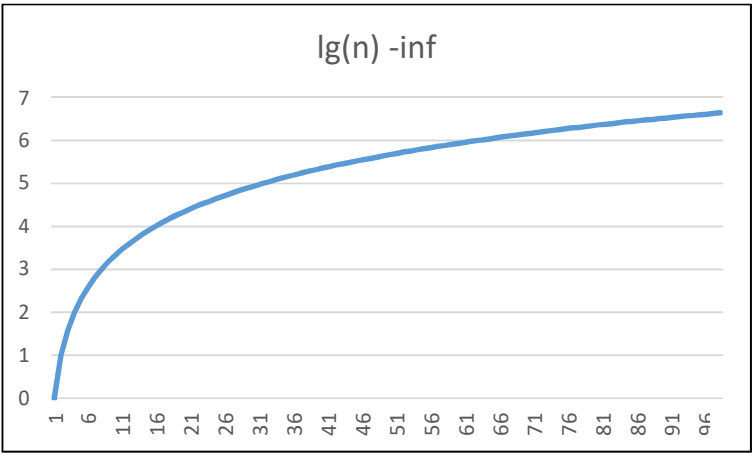
OBSERVATION_(8) $2^{(2^{(n+1)})}$: The graph has gradual increase in its values from $n=0$ to 5, at $n=5$ there is a sudden increase and the function gradually tends to infinity.



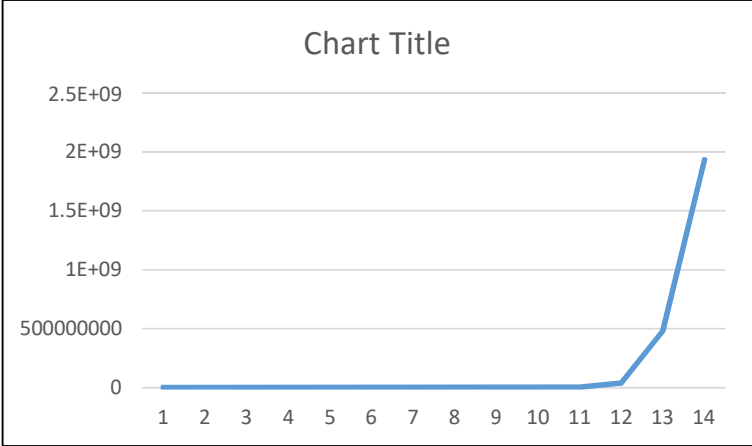
OBSERVATION_(9) e^n : The values of the function are gradually increasing. At $n=83$ there is a sudden rise in value after which the result tends to infinity.



OBSERVATION_(10) $\lg(n)$: The graph starts from $\lg(1)=0$. It first increases steeply and then becomes gradual for higher values of n .



OBSERVATION_(11) Factorial: The value of factorial keeps on increasing as n increases. There is a sudden rise in value at $n=13$.



CONCLUSION:

From this experiment I learnt how to implement various functions in C Programming language for values of n varying from 0 to 100, and also understood how the graph of each function is affected as value of n changes.