Dictionary of Computers edited by Pankaj Dhaka and the Graphical Law

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Abstract

We study the entries in the Dictionary of Computers edited by Pankaj Dhaka. We draw the natural logarithm of the number of entries, normalised, starting with a letter vs the natural logarithm of the rank of the letter, normalised. We conclude that the Dictionary can be characterised by BP(4,$\beta H = 0.05$) i.e. a magnetisation curve in the Bethe-Peierls approximation of the Ising model with four nearest neighbours in the presence of external magnetic field, H, with $\beta H = 0.05$. β is $\frac{1}{k_B T}$ where, T is temperature and k_B is the tiny Boltzmann constant.

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I. INTRODUCTION

Starting from Charles Babbage to computers is an interesting piece of history in invention. A computer has hardware as well as softwares. This is like bones as well as electrochemical networks in a human body. In this paper we study a dictionary of computers. This is the Dictionary of Computers edited by Pankaj Dhaka, [1], published by Bulbul Books, Delhi, wayback in the year 2010. We count one by one all entries of this dictionary, looking for the graphical law. We have started considering magnetic field pattern in [2], in the languages we converse with. We have studied there, a set of natural languages, [2] and have found existence of a magnetisation curve under each language. We have termed this phenomenon as the Graphical Law. Then, we moved on to investigate, [3], into dictionaries of five disciplines of knowledge and found the existence of a curve of magnetisation under each discipline. This was followed by finding of the graphical law in references from [4] to [79].

We describe how the graphical law is hidden within the entries in the Dictionary of Computers edited by Pankaj Dhaka, [1], in this article. The planning of the paper is as follows. We give an introduction to the standard curves of magnetisation of Ising model in the section II. In the section III, we describe the analysis of the entries of the Dictionary of Computers by Pankaj Dhaka [1]. The section IV is Acknowledgment. The last section is Bibliography.

II. MAGNETISATION

A. Bragg-Williams approximation

Let us consider a coin. Let us toss it many times. Probability of getting head or, tale is half i.e. we will get head and tale equal number of times. If we attach value one to head, minus one to tale, the average value we obtain, after many tossing is zero. Instead let us consider a one-sided loaded coin, say on the head side. The probability of getting head is more than one half, getting tale is less than one-half. Average value, in this case, after many tossing we obtain is non-zero, the precise number depends on the loading. The loaded coin is like ferromagnet, the unloaded coin is like para magnet, at zero external magnetic field. Average value we obtain is like magnetisation, loading is like coupling among the spins of the ferromagnetic units. Outcome of single coin toss is random, but average value we get after long sequence of tossing is fixed. This is long-range order. But if we take a small sequence of tossing, say, three consecutive tossing, the average value we obtain is not fixed, can be anything. There is no short-range order.

Let us consider a row of spins, one can imagine them as spears which can be vertically up or, down. Assume there is a long-range order with probability to get a spin up is two third. That would mean when we consider a long sequence of spins, two third of those are with spin up. Moreover, assign with each up spin a value one and a down spin a value minus one. Then total spin we obtain is one third. This value is referred to as the value of long-range order parameter. Now consider a short-range order existing which is identical with the long-range order. That would mean if we pick up any three consecutive spins, two will be up, one down. Bragg-Williams approximation means short-range order is identical with long-range order, applied to a lattice of spins, in general. Row of spins is a lattice of one dimension.

Now let us imagine an arbitrary lattice, with each up spin assigned a value one and a down spin a value minus one, with an unspecified long-range order parameter defined as above by $L = \frac{1}{N}\Sigma_i \sigma_i$, where σ_i is i-th spin, N being total number of spins. L can vary from minus one to one. $N = N_+ + N_-$, where N_+ is the number of up spins, N_- is the number of down spins. $L = \frac{1}{N}(N_+ - N_-)$. As a result, $N_+ = \frac{N}{2}(1+L)$ and $N_- = \frac{N}{2}(1-L)$. Magnetisation or, net magnetic moment , M is $\mu\Sigma_i\sigma_i$ or, $\mu(N_+ - N_-)$ or, $\mu N L$, $M_{max} = \mu N$. $\frac{M}{M_{max}} = L$. $\frac{M}{M_{max}}$ is referred to as reduced magnetisation. Moreover, the Ising Hamiltonian,[81], for the lattice of spins, setting μ to one, is $-\epsilon\Sigma_{n.n}\sigma_i\sigma_j - H\Sigma_i\sigma_i$, where n.n refers to nearest neighbour pairs. The difference $\triangle E$ of energy if we flip an up spin to down spin is, [82], $2\epsilon\gamma\bar{\sigma} + 2H$, where γ is the number of nearest neighbours of a spin. According to Boltzmann principle, $\frac{N_-}{N_+}$ equals $exp(-\frac{\triangle E}{k_B T})$, [83]. In the Bragg-Williams approximation,[84], $\bar{\sigma} = L$, considered in the thermal average sense. Consequently,

$$ln\frac{1+L}{1-L} = 2\frac{\gamma\epsilon L + H}{k_B T} = 2\frac{L + \frac{H}{\gamma\epsilon}}{\frac{T}{\gamma\epsilon/k_B}} = 2\frac{L + c}{\frac{T}{T_c}} \quad (1)$$

where, $c = \frac{H}{\gamma\epsilon}$, $T_c = \gamma\epsilon/k_B$, [85]. $\frac{T}{T_c}$ is referred to as reduced temperature.

Plot of L vs $\frac{T}{T_c}$ or, reduced magentisation vs. reduced temperature is used as reference curve. In the presence of magnetic field, $c \neq 0$, the curve bulges outward. Bragg-Williams is a Mean Field approximation. This approximation holds when number of neighbours interacting with a site is very large, reducing the importance of local fluctuation or, local order, making the long-range order or, average degree of freedom as the only degree of freedom of the lattice.

To have a feeling how this approximation leads to matching between experimental and Ising model prediction one can refer to FIG.12.12 of [82]. W. L. Bragg was a professor of Hans Bethe. Rudolf Peierls was a friend of Hans Bethe. At the suggestion of W. L. Bragg, Rudolf Peierls following Hans Bethe improved the approximation scheme, applying quasi-chemical method.

B. Bethe-peierls approximation in presence of four nearest neighbours, in absence of external magnetic field

In the approximation scheme which is improvement over the Bragg-Williams, [81],[82],[83],[84],[85], due to Bethe-Peierls, [86], reduced magnetisation varies with reduced temperature, for γ neighbours, in absence of external magnetic field, as

$$\frac{ln\frac{\gamma}{\gamma-2}}{ln\frac{factor-1}{factor^{\frac{\gamma-1}{\gamma}}-factor^{\frac{1}{\gamma}}}}=\frac{T}{T_c};factor=\frac{\frac{M}{M_{max}}+1}{1-\frac{M}{M_{max}}}. \quad (2)$$

$ln\frac{\gamma}{\gamma-2}$ for four nearest neighbours i.e. for $\gamma = 4$ is 0.693. For a snapshot of different kind of magnetisation curves for magnetic materials the reader is urged to give a google search "reduced magnetisation vs reduced temperature curve". In the following, we describe data s generated from the equation(1) and the equation(2) in the table, I, and curves of magnetisation plotted on the basis of those data s. BW stands for reduced temperature in Bragg-Williams approximation, calculated from the equation(1). BP(4) represents reduced temperature in the Bethe-Peierls approximation, for four nearest neighbours, computed from the equation(2). The data set is used to plot fig.1. Empty spaces in the table, I, mean corresponding point pairs were not used for plotting a line.

C. Bethe-peierls approximation in presence of four nearest neighbours, in presence of external magnetic field

In the Bethe-Peierls approximation scheme , [86], reduced magnetisation varies with reduced temperature, for γ neighbours, in presence of external magnetic field, as

$$\frac{ln\frac{\gamma}{\gamma-2}}{ln\frac{factor-1}{e^{\frac{2\beta H}{\gamma}}factor^{\frac{\gamma-1}{\gamma}}-e^{-\frac{2\beta H}{\gamma}}factor^{\frac{1}{\gamma}}}}=\frac{T}{T_c};factor=\frac{\frac{M}{M_{max}}+1}{1-\frac{M}{M_{max}}}. \quad (3)$$

BW	BW(c=0.01)	BP(4,βH = 0)	reduced magnetisation
0	0	0	1
0.435	0.439	0.563	0.978
0.439	0.443	0.568	0.977
0.491	0.495	0.624	0.961
0.501	0.507	0.630	0.957
0.514	0.519	0.648	0.952
0.559	0.566	0.654	0.931
0.566	0.573	0.7	0.927
0.584	0.590	0.7	0.917
0.601	0.607	0.722	0.907
0.607	0.613	0.729	0.903
0.653	0.661	0.770	0.869
0.659	0.668	0.773	0.865
0.669	0.676	0.784	0.856
0.679	0.688	0.792	0.847
0.701	0.710	0.807	0.828
0.723	0.731	0.828	0.805
0.732	0.743	0.832	0.796
0.756	0.766	0.845	0.772
0.779	0.788	0.864	0.740
0.838	0.853	0.911	0.651
0.850	0.861	0.911	0.628
0.870	0.885	0.923	0.592
0.883	0.895	0.928	0.564
0.899	0.918		0.527
0.904	0.926	0.941	0.513
0.946	0.968	0.965	0.400
0.967	0.998	0.965	0.300
0.987		1	0.200
0.997		1	0.100
1	1	1	0

TABLE I. Reduced magnetisation vs reduced temperature data s for Bragg-Williams approximation, in absence of and in presence of magnetic field, $c = \frac{H}{\gamma\epsilon} = 0.01$, and Bethe-Peierls approximation in absence of magnetic field, for four nearest neighbours.

Derivation of this formula ala [86] is given in the appendix of [7].

$ln\frac{\gamma}{\gamma-2}$ for four nearest neighbours i.e. for $\gamma = 4$ is 0.693. For four neighbours,

$$\frac{0.693}{ln\frac{factor-1}{e^{\frac{2\beta H}{\gamma}}factor^{\frac{\gamma-1}{\gamma}}-e^{-\frac{2\beta H}{\gamma}}factor^{\frac{1}{\gamma}}}} = \frac{T}{T_c}; factor = \frac{\frac{M}{M_{max}}+1}{1-\frac{M}{M_{max}}}. \tag{4}$$

In the following, we describe data s in the table, II, generated from the equation(4) and curves of magnetisation plotted on the basis of those data s. BP(m=0.03) stands for reduced temperature in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H = 0.06$. calculated from the equation(4). BP(m=0.025) stands for reduced temperature in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H = 0.05$. calculated from the equation(4). BP(m=0.02) stands for reduced temperature

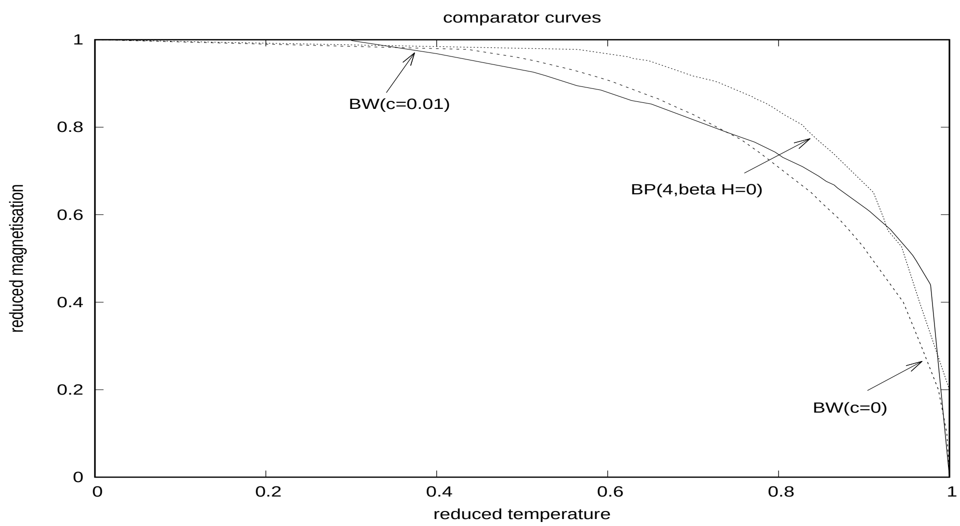

FIG. 1. Reduced magnetisation vs reduced temperature curves for Bragg-Williams approximation, in absence(dark) of and presence(inner in the top) of magnetic field, $c = \frac{H}{\gamma\epsilon} = 0.01$, and Bethe-Peierls approximation in absence of magnetic field, for four nearest neighbours (outer in the top).

in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H = 0.04$. calculated from the equation(4). BP(m=0.01) stands for reduced temperature in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H = 0.02$. calculated from the equation(4). BP(m=0.005) stands for reduced temperature in Bethe-Peierls approximation, for four nearest neighbours, in presence of a variable external magnetic field, H, such that $\beta H = 0.01$. calculated from the equation(4). The data set in the table, II, is used to plot fig.2. Empty spaces in the table, II, mean corresponding point pairs were not used for plotting a line.

BP(m=0.03)	BP(m=0.025)	BP(m=0.02)	BP(m=0.01)	BP(m=0.005)	reduced magnetisation
0	0	0	0	0	1
0.583	0.580	0.577	0.572	0.569	0.978
0.587	0.584	0.581	0.575	0.572	0.977
0.647	0.643	0.639	0.632	0.628	0.961
0.657	0.653	0.649	0.641	0.637	0.957
0.671	0.667		0.654	0.650	0.952
	0.716			0.696	0.931
0.723	0.718	0.713	0.702	0.697	0.927
0.743	0.737	0.731	0.720	0.714	0.917
0.762	0.756	0.749	0.737	0.731	0.907
0.770	0.764	0.757	0.745	0.738	0.903
0.816	0.808	0.800	0.785	0.778	0.869
0.821	0.813	0.805	0.789	0.782	0.865
0.832	0.823	0.815	0.799	0.791	0.856
0.841	0.833	0.824	0.807	0.799	0.847
0.863	0.853	0.844	0.826	0.817	0.828
0.887	0.876	0.866	0.846	0.836	0.805
0.895	0.884	0.873	0.852	0.842	0.796
0.916	0.904	0.892	0.869	0.858	0.772
0.940	0.926	0.914	0.888	0.876	0.740
	0.929			0.877	0.735
	0.936			0.883	0.730
	0.944			0.889	0.720
	0.945				0.710
	0.955			0.897	0.700
	0.963			0.903	0.690
	0.973			0.910	0.680
				0.909	0.670
	0.993			0.925	0.650
		0.976	0.942		0.651
	1.00				0.640
		0.983	0.946	0.928	0.628
		1.00	0.963	0.943	0.592
			0.972	0.951	0.564
			0.990	0.967	0.527
				0.964	0.513
			1.00		0.500
				1.00	0.400
					0.300
					0.200
					0.100
					0

TABLE II. Bethe-Peierls approx. in presence of little external magnetic fields

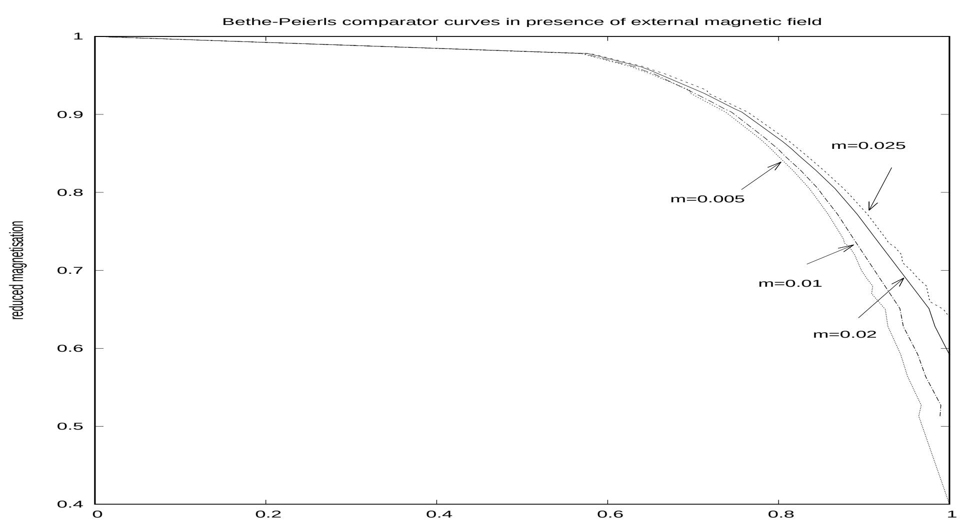

FIG. 2. Reduced magnetisation vs reduced temperature curves for Bethe-Peierls approximation in presence of little external magnetic fields, for four nearest neighbours, with $\beta H = 2m$.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
365	104	248	255	182	165	110	121	201	76	58	125	247	80	107	270	24	172	203	112	39	79	47	0	0	0

TABLE III. Entries of Dictionary of Computers edited by Pankaj Dhaka, [1]

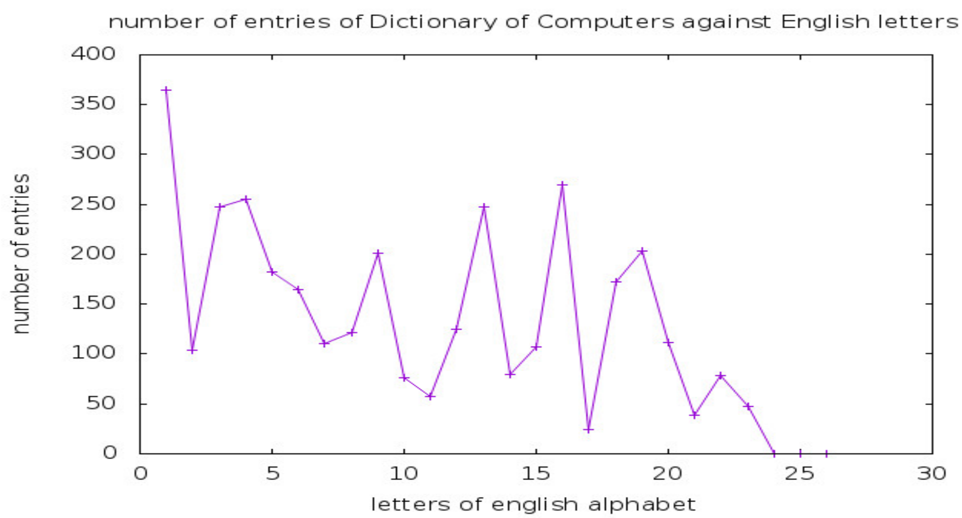

FIG. 3. The vertical axis is number of entries in Dictionary of Computers,[1]. The horizontal axis is the letters of the English alphabet. Letters are represented by the sequence number in the alphabet.

III. ANALYSIS OF ENTRIES OF DICTIONARY OF COMPUTERS

In the Dictionary of Computers edited by Pankaj Dhaka, [1], we have counted the entries, one by one from the beginning to the end, starting with different letters. The result is the table, III. Largest number of entries, three hundred sixty five, start with the letter A followed by entries numbering two hundred seventy beginning with P, two hundred fifty five with the letter D etc. To visualise we plot the number of entries again respective letters in the dictionary sequence,[1] in the adjoining figure, fig.3.

For the purpose of exploring graphical law, we assort the letters according to the number of entries, in the descending order, denoted by f and the respective rank, denoted by k. k is a positive integer starting from one. The lowest value of f is twenty four. Hence we attach a limiting number of words one. The corresponding rank, k, denoted as k_{lim} is twenty four.

As a result both $\frac{lnf}{lnf_{max}}$ and $\frac{lnk}{lnk_{lim}}$ varies from zero to one. Then we tabulate in the adjoining table, IV and plot $\frac{lnf}{lnf_{max}}$ against $\frac{lnk}{lnk_{lim}}$ in the figure fig.4. We then ignore the largest number entries, tabulate in the adjoining table, IV and redo the plot, normalising the lnfs with next-to-maximum lnf_{n-max}, and starting from $k = 2$ in the figure fig.5. This program then we repeat up to $k = 6$, resulting in figures up to fig.9.

k	lnk	lnk/lnk_{lim}	f	lnf	lnf/lnf_{max}	lnf/$lnf_{next-max}$	lnf/lnf_{2nmax}	lnf/lnf_{3nmax}	lnf/lnf_{4nmax}	lnf/lnf_{5nmax}
1	0	0	365	5.900	1	Blank	Blank	Blank	Blank	Blank
2	0.69	0.217	270	5.598	0.949	1	Blank	Blank	Blank	Blank
3	1.10	0.346	255	5.541	0.939	0.990	1	Blank	Blank	Blank
4	1.39	0.437	248	5.513	0.934	0.985	0.995	1	Blank	Blank
5	1.61	0.506	247	5.509	0.934	0.984	0.994	0.999	1	Blank
6	1.79	0.563	203	5.313	0.901	0.949	0.959	0.964	0.964	1
7	1.95	0.613	201	5.303	0.899	0.947	0.957	0.962	0.963	0.998
8	2.08	0.654	182	5.204	0.882	0.930	0.939	0.944	0.945	0.979
9	2.20	0.692	172	5.147	0.872	0.919	0.929	0.834	0.934	0.969
10	2.30	0.723	165	5.106	0.865	0.912	0.921	0.926	0.927	0.961
11	2.40	0.755	125	4.828	0.818	0.862	0.871	0.876	0.876	0.909
12	2.48	0.780	121	4.796	0.813	0.857	0.866	0.870	0.871	0.903
13	2.56	0.805	112	4.718	0.800	0.843	0.851	0.856	0.856	0.888
14	2.64	0.830	110	4.700	0.797	0.840	0.848	0.853	0.853	0.885
15	2.71	0.852	107	4.673	0.792	0.835	0.843	0.848	0.848	0.880
16	2.77	0.871	104	4.644	0.787	0.830	0.838	0.842	0.843	0.874
17	2.83	0.890	80	4.382	0.743	0.783	0.791	0.795	0.795	0.825
18	2.89	0.909	79	4.369	0.741	0.780	0.788	0.792	0.793	0.822
19	2.94	0.925	76	4.331	0.734	0.774	0.782	0.786	0.786	0.815
20	3.00	0.943	58	4.060	0.688	0.725	0.733	0.736	0.737	0.764
21	3.04	0.956	47	3.850	0.653	0.688	0.695	0.698	0.699	0.725
22	3.09	0.972	39	3.664	0.621	0.655	0.661	0.665	0.665	0.690
23	3.14	0.987	24	3.178	0.539	0.568	0.574	0.576	0.577	0.598
24	3.18	1	1	0	0	0	0	0	0	0

TABLE IV. The entries of Dictionary of Computers by Pankaj Dhaka: ranking, natural logarithms, normalisations

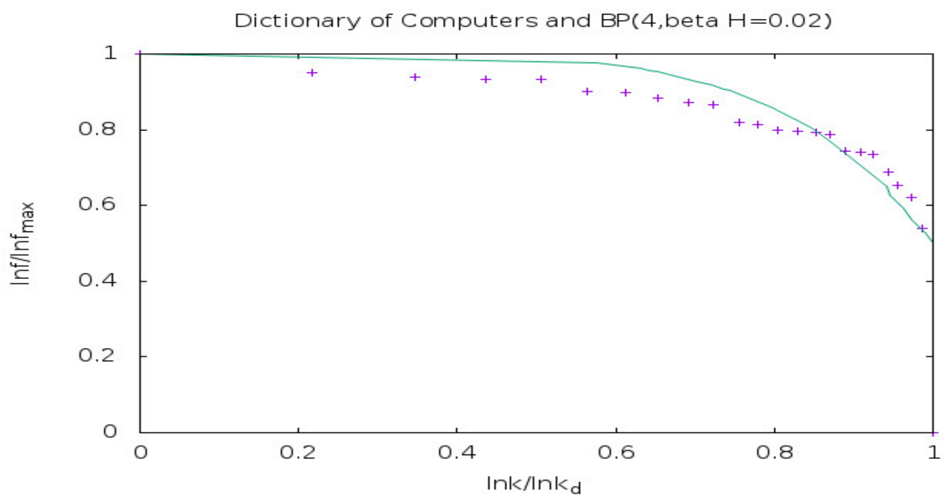

FIG. 4. The vertical axis is $\frac{lnf}{lnf_{max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Computers with the fit curve, BP(4,$\beta H = 0.02$), being the Bethe-Peierls curve in the presence of four nearest neighbours and little external magnetic field, $m = 0.01$ or, $\beta H = 0.02$, of the Ising Model.

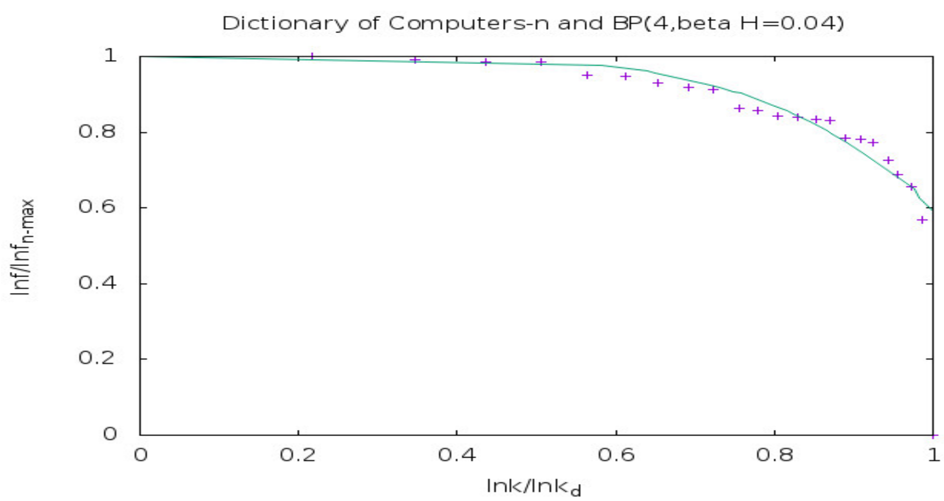

FIG. 5. The vertical axis is $\frac{lnf}{lnf_{n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Computers with the fit curve, BP(4,$\beta H = 0.04$), being the Bethe-Peierls curve in the presence of four nearest neighbours and little external magnetic field, $m = 0.02$ or, $\beta H = 0.04$, of the Ising Model.

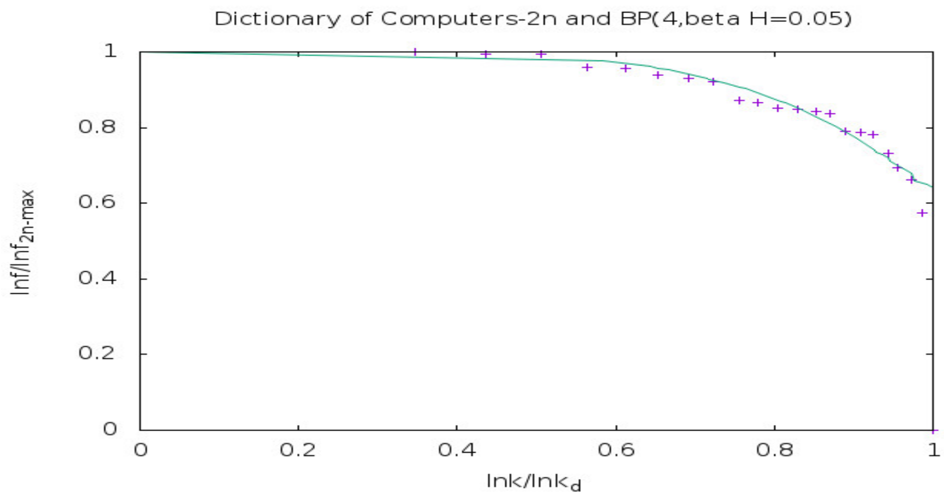

FIG. 6. The vertical axis is $\frac{lnf}{lnf_{2n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Computers with the fit curve, BP(4,$\beta H = 0.05$), being the Bethe-Peierls curve in the presence of four nearest neighbours and little external magnetic field, $m = 0.025$ or, $\beta H = 0.05$, of the Ising Model.

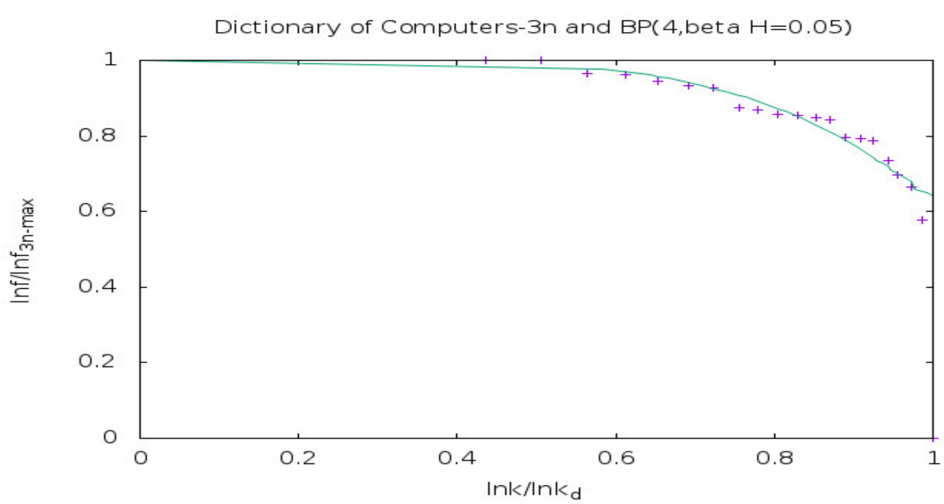

FIG. 7. The vertical axis is $\frac{lnf}{lnf_{3n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Computers with the fit curve, BP(4,$\beta H = 0.05$), being the Bethe-Peierls curve in the presence of four nearest neighbours and little external magnetic field, $m = 0.025$ or, $\beta H = 0.05$, of the Ising Model.

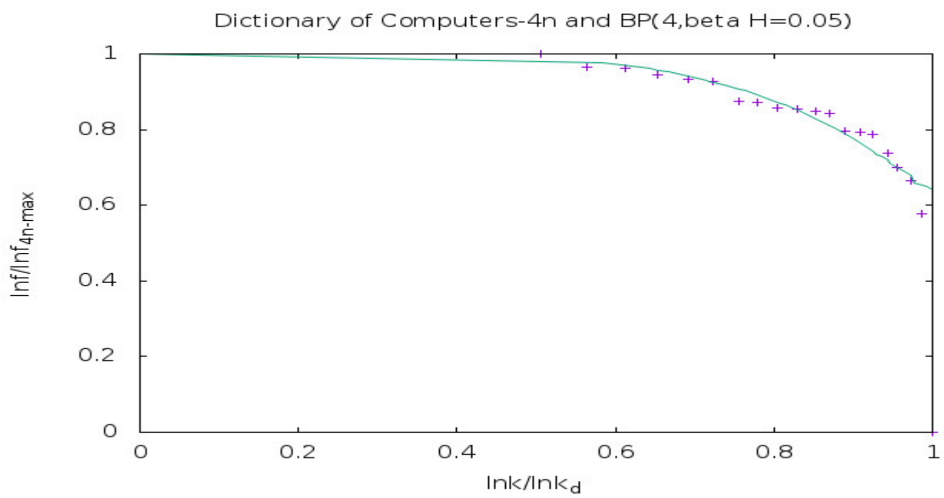

FIG. 8. The vertical axis is $\frac{lnf}{lnf_{4n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Computers with the fit curve, BP(4,$\beta H = 0.05$), being the Bethe-Peierls curve in the presence of four nearest neighbours and little external magnetic field, $m = 0.025$ or, $\beta H = 0.05$, of the Ising Model.

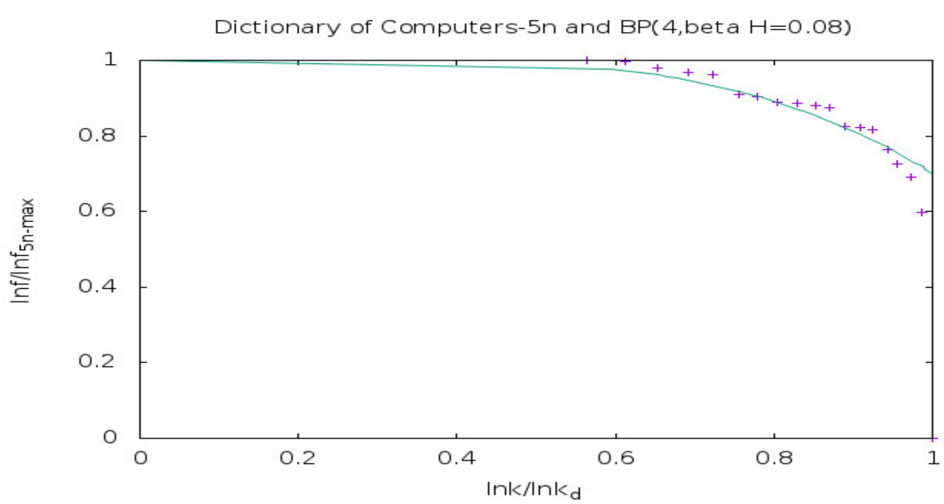

FIG. 9. The vertical axis is $\frac{lnf}{lnf_{5n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the entries of Dictionary of Computers with the fit curve, BP(4,$\beta H = 0.08$), being the Bethe-Peierls curve in the presence of four nearest neighbours and little external magnetic field, $m = 0.04$ or, $\beta H = 0.08$, of the Ising Model.

A. conclusion

From the figures (fig.4-fig.9), we observe that there is a curve of magnetisation behind the entries of Dictionary of Computers edited by Pankaj Dhaka,[1]. This is the magnetisation curve, BP(4,$\beta H = 0.05$), in the Bethe-Peierls approximation, in the presence of four nearest neighbours and little external magnetic field, $\beta H = 0.05$, of the Ising Model.
Moreover, the associated correspondence is,

$$\frac{lnf}{lnf_{2n-max}} \longleftrightarrow \frac{M}{M_{max}},$$

$$lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [87].

IV. ACKNOWLEDGMENT

The author would like to thank the State Central Library, West Bengal, Calcutta, to allow us to use Dictionary of Computers edited by Pankaj Dhaka,[1], in its premises. We have used gnuplot for plotting the figures in this paper.

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[1] Dictionary of Computers edited by Pankaj Dhaka, 2010, Bulbul Books, 61-A, IIIrd Floor, Guru Angad Nagar Ext. Laxmi Nagar, Delhi-1100921(India).

[2] Anindya Kumar Biswas, "Graphical Law beneath each written natural language", arXiv:1307.6235v3[physics.gen-ph]. A preliminary study of words of dictionaries of twenty six languages, more accurate study of words of dictionary of Chinese usage and all parts of speech of dictionary of Lakher(Mara) language and of verbs, adverbs and adjectives of dictionaries of six languages are included.

[3] Anindya Kumar Biswas, "A discipline of knowledge and the graphical law", IJARPS Volume 1(4), p 21, 2014; viXra: 1908:0090[Linguistics].

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