Compact Oxford Italian Dictionary and The Graphical Law

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(Dated: February 28, 2025)

Abstract

We study Compact Oxford Italian Dictionary, the first edition, 2013. We draw the natural logarithm of the number of Italian head 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,βH=0) i.e. a magnetisation curve for the Bethe-Peierls approximation of the Ising Model with four nearest neighbours, in the absence of external magnetic field, H. 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

In this paper, we count all the Italian head entries of Compact Oxford Italian Dictionary, the first edition, 2013, [1], one by one from beginning to the end. This was edited by Pat Bulhosen, Francesca Logi and Loredana Riu, [1]. We look 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 [92].

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 analysis of the Italian head entries of Compact Oxford Italian Dictionary, [1]. Sections IV and V are Acknowledgment and Bibliography respectively.

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, μNL, $M_{max} = \mu N$. $\frac{M}{M_{max}} = L$. $\frac{M}{M_{max}}$ is referred to as reduced magnetisation. Moreover, the Ising Hamiltonian,[93], 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, [94], $2\epsilon\gamma\bar{\sigma} + 2H$, where γ is the number of nearest neighbours of a spin. According to Boltzmann principle, $\frac{N_-}{N_+}$ equals $exp(-\frac{\triangle E}{k_B T})$, [95]. In the Bragg-Williams approximation,[96], $\bar{\sigma} = L$, 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, $c = \frac{H}{\gamma\epsilon}$, $T_c = \gamma\epsilon/k_B$, [97]. $\frac{T}{T_c}$ 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 [94]. 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, [93],[94],[95],[96],[97], due to Bethe-Peierls, [98], reduced magnetisation varies with reduced temperature, for γ neighbours, in absence of external magnetic field, as

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

$ln\frac{\gamma}{\gamma-2}$ 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 datas generated from the equation(1) and the equation(2) in the table, I, and curves of magnetisation plotted on the basis of those datas. 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.

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 datas 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 .

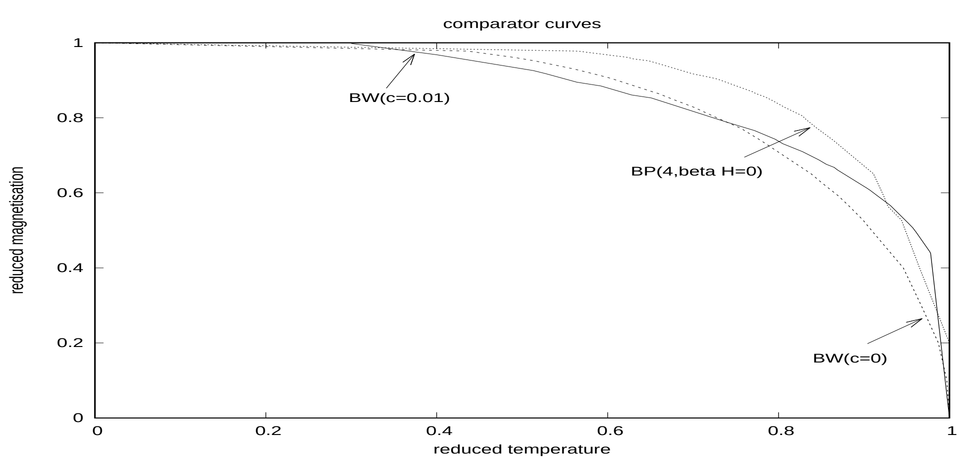

FIG. 1. Reduced magnetisation vs reduced temperature curves for Bragg-Williams approximation, in absence(dark) of and presence(inner in the top) of magnetic field, $c = \frac{H}{\gamma\epsilon} = 0.01$, and Bethe-Peierls approximation in absence of magnetic field, for four nearest neighbours (outer in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

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
2947	1039	3046	1756	915	1138	800	40	2295	28	50	699	1526	443	543	2345	141	1760	3545	1162	259	734	19	9	14	122

TABLE II. Italian head entries

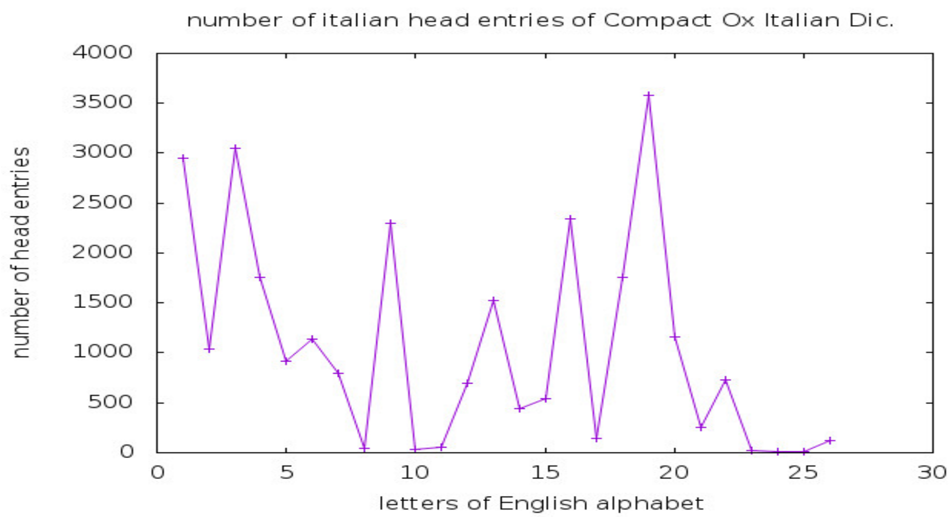

FIG. 2. Vertical axis is number of head entries of the Italian, [1], and horizontal axis is respective letters. Letters are represented by the sequence number in the alphabet or, dictionary sequence,[1].

III. ANALYSIS OF HEAD ENTRIES OF COMPACT OXFORD ITALIAN DICTIONARY

The Italian language alphabet is composed of twenty six letters. Counting all the Italian head entries of Compact Oxford Italian Dictionary, [1], one by one from the beginning to the end, starting with different letters, we obtain the table, II.

Highest number of head entries, three thousand five hundred seventy five, starts with the letter S followed by head entries numbering three thousand forty six beginning with C, two thousand nine hundred forty seven with the letter A etc. To visualise we plot the number of head entries against respective letters in the dictionary sequence, [1], in the figure fig.2.

For the purpose of exploring graphical law, we assort the letters according to the number of head 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 nine, corresponding to the letter X. Hence, we attach a limiting number of head entries equal to one. The respective rank, k, denoted as k_{lim} is twenty seven. 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, III and plot $\frac{lnf}{lnf_{max}}$ against $\frac{lnk}{lnk_{lim}}$ in the figure fig.3. We then ignore the letter with the highest number of head entries, tabulate in the adjoining table, III and redo the plot, normalising the lnfs with next-to-maximum lnf_{n-max}, and starting from $k = 2$ in the figure fig.4. Normalising the lnfs with next-to-next-to-maximum lnf_{2n-max}, we tabulate in the adjoining table, III, and starting from $k = 3$ we draw in the figure fig.5. Normalising the lnfs with next-to-next-to-next-to-maximum lnf_{3n-max} we record in the adjoining table, III, and plot starting from $k = 4$ in the figure fig.6. Normalising the lnfs with next-to-next-to-next-to-next-to-maximum lnf_{4n-max} we record in the adjoining table, III, and plot starting from $k = 5$ in the figure fig.7. Normalising the lnfs with nextnextnextnextnext-maximum lnf_{5n-max} we record in the adjoining table, III, and plot starting from $k = 6$ in the figure fig.8.

k	lnk	lnk/lnk_{lim}	f	lnf	lnf/lnf_{max}	lnf/lnf_{n-max}	lnf/lnf_{2n-max}	lnf/lnf_{3n-max}	lnf/lnf_{4n-max}	lnf/lnf_{5n-max}
1	0	0	3575	8.182	1	Blank	Blank	Blank	Blank	Blank
2	0.69	0.209	3046	8.022	0.980	1	Blank	Blank	Blank	Blank
3	1.10	0.333	2947	7.989	0.976	0.996	1	Blank	Blank	Blank
4	1.39	0.421	2345	7.760	0.948	0.967	0.971	1	Blank	Blank
5	1.61	0.488	2295	7.738	0.946	0.965	0.969	0.997	1	Blank
6	1.79	0.542	1760	7.473	0.913	0.932	0.935	0.963	0.966	1
7	1.95	0.591	1756	7.471	0.913	0.931	0.935	0.963	0.965	0.9997
8	2.08	0.630	1526	7.330	0.896	0.914	0.918	0.945	0.947	0.981
9	2.20	0.667	1162	7.058	0.863	0.880	0.883	0.910	0.912	0.944
10	2.30	0.697	1138	7.037	0.860	0.877	0.881	0.907	0.909	0.942
11	2.40	0.727	1039	6.946	0.849	0.866	0.869	0.895	0.898	0.929
12	2.48	0.752	915	6.819	0.833	0.850	0.854	0.879	0.881	0.912
13	2.56	0.776	800	6.685	0.817	0.833	0.837	0.861	0.864	0.895
14	2.64	0.800	734	6.599	0.807	0.823	0.826	0.850	0.853	0.883
15	2.71	0.821	699	6.550	0.801	0.817	0.820	0.844	0.846	0.876
16	2.77	0.839	543	6.297	0.770	0.785	0.788	0.811	0.814	0.843
17	2.83	0.858	443	6.094	0.745	0.760	0.763	0.785	0.788	0.815
18	2.89	0.876	259	5.557	0.679	0.693	0.696	0.716	0.718	0.744
19	2.94	0.891	141	4.949	0.605	0.617	0.619	0.638	0.640	0.662
20	3.00	0.909	122	4.804	0.587	0.599	0.601	0.619	0.621	0.643
21	3.04	0.921	50	3.912	0.478	0.488	0.490	0.504	0.506	0.523
22	3.09	0.936	40	3.689	0.451	0.460	0.462	0.475	0.477	0.494
23	3.14	0.952	28	3.332	0.407	0.415	0.417	0.429	0.431	0.446
24	3.18	0.964	19	2.944	0.360	0.367	0.369	0.379	0.380	0.394
25	3.22	0.976	14	2.639	0.323	0.329	0.330	0.340	0.341	0.353
26	3.26	0.988	9	2.197	0.269	0.274	0.275	0.283	0.284	0.294
27	3.30	1	1	0	0	0	0	0	0	0

TABLE III. Compact Oxford Italian Dictionary: ranking,natural logarithm, normalisations

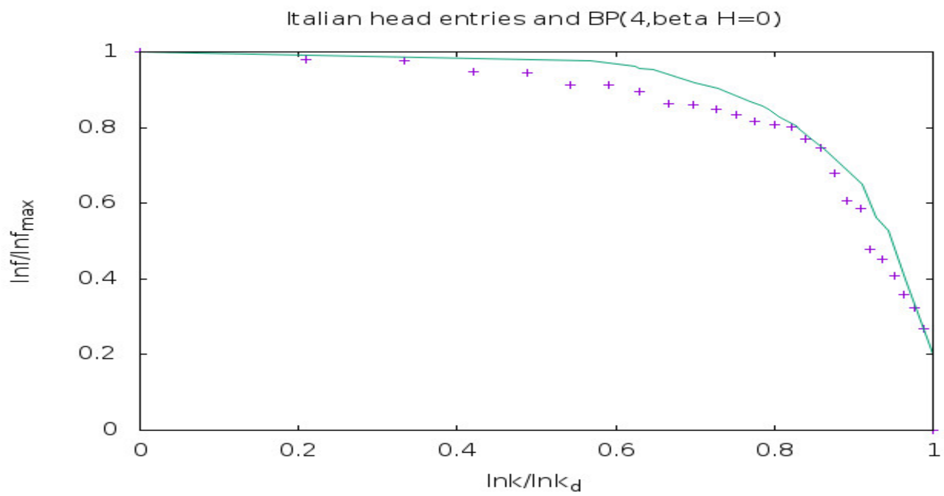

FIG. 3. The vertical axis is $\frac{lnf}{lnf_{max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the head entries of the Italian, [1] with the fit curve being the Bethe-Peierls curve of the Ising Model with four nearest neighbours, in the absence of external magnetic field.

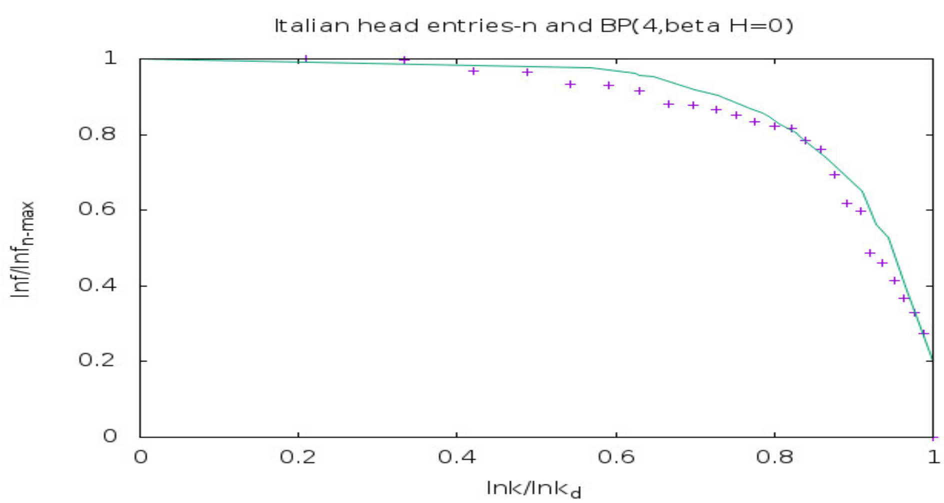

FIG. 4. The vertical axis is $\frac{lnf}{lnf_{n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the head entries of the Italian, [1] with the fit curve being the Bethe-Peierls curve of the Ising Model, with four nearest neighbours, in the absence of external magnetic field.

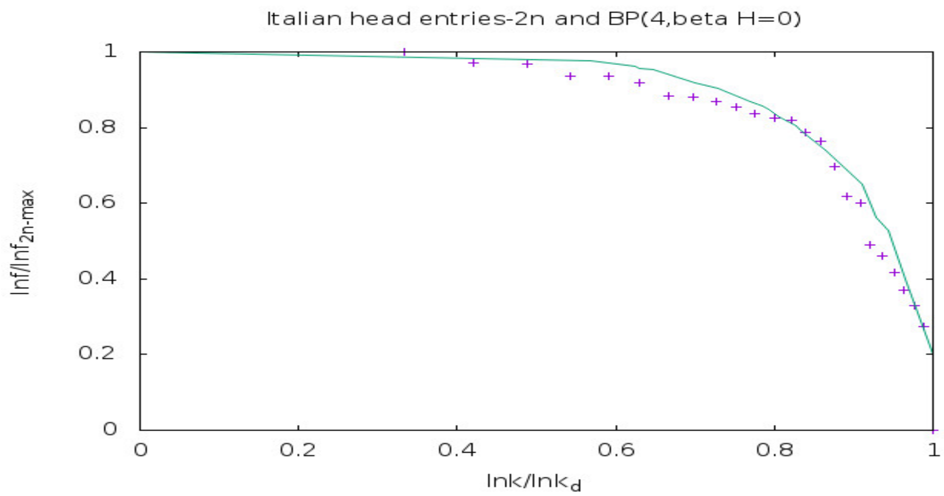

FIG. 5. The vertical axis is $\frac{lnf}{lnf_{2n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the head entries of the Italian, [1] with the fit curve being the Bethe-Peierls curve ofr the Ising Model, with four nearest neighbours, in the absence of external magnetic field.

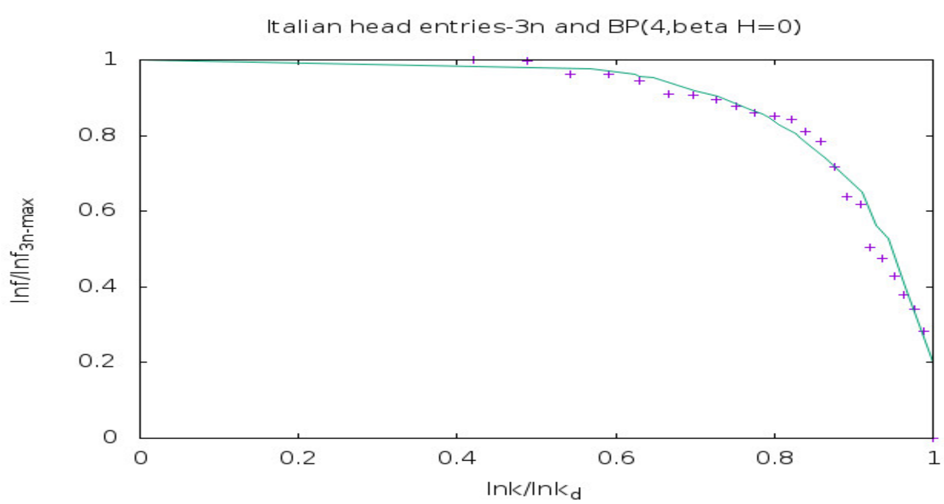

FIG. 6. The vertical axis is $\frac{lnf}{lnf_{3n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the head entries of the Italian, [1], with the fit curve being the Bethe-Peierls curve of the Ising Model, with four nearest neighbours, in the absence of external magnetic field.

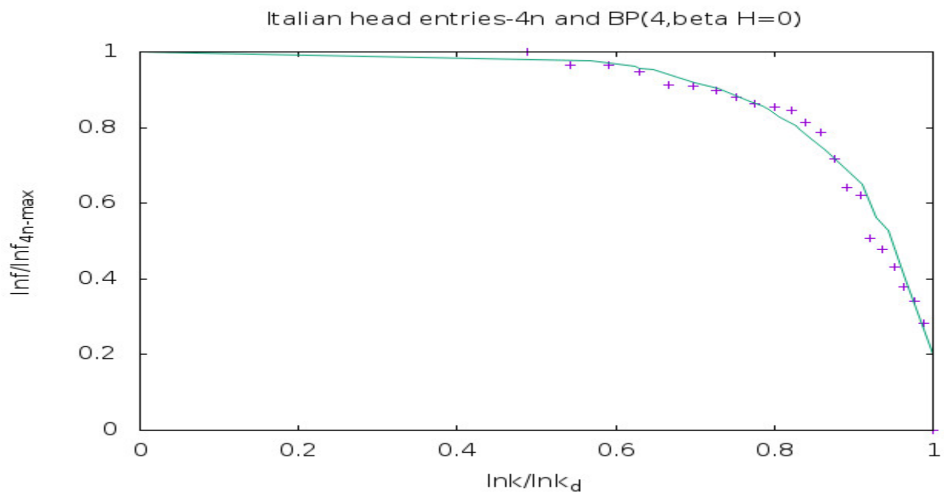

FIG. 7. The vertical axis is $\frac{lnf}{lnf_{4n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the head entries of the Italian, [1], with the fit curve being the Bethe-Peierls curve of the Ising Model, with four nearest neighbours, in the absence of magnetic field.

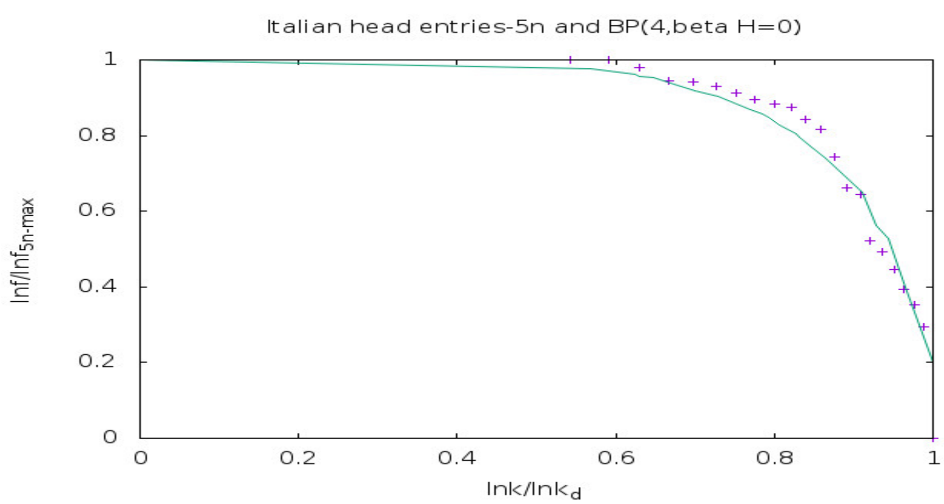

FIG. 8. The vertical axis is $\frac{lnf}{lnf_{5n-max}}$ and the horizontal axis is $\frac{lnk}{lnk_{lim}}$. The + points represent the head entries of the Italian, [1] with fit curve being the Bethe-Peierls curve of the Ising Model, with four nearest neighbours, in the absence of magnetic field.

A. conclusion

From the figures (fig.3-fig.8), we observe that there is a curve of magnetisation, behind the Italian head entries of Compact Oxford Italian Dictionary,[1]. This is the magnetisation curve, BP(4,βH=0), in the Bethe-Peierls approximation of the Ising Model, in the absence of external magnetic field.
Moreover, the associated correspondence is,

$$\frac{lnf}{lnf_{3n-max}} \longleftrightarrow \frac{M}{M_{max}},$$

$$lnk \longleftrightarrow T.$$

k corresponds to temperature in an exponential scale, [100].

IV. ACKNOWLEDGMENT

We have used gnuplot for plotting the figures in this paper.

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