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CASE STUDY OF COALS FROM FĂRCĂŞEŞTI AREA. 1. DEPENDENCIES EXCLUDING FIXED CARBON DETERMINATIONS

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SUMMARY

A statistical study of analysis results was made for lignite from the Fărcăşeşti area (Gorj County, Romania), exemplified for the eight characteristic properties, as moisture content (imbibitions and hygroscopic), volatile, density, sulfur, ash softening content, higher heating value and seam. Previously, the properties dependencies were investigate in pairs of two. In present study the properties was investigated using an automat processing routine for multivariate regression, available at address:

http://academicdirect.ro/virtual_library/applied_statistics/linear_regression/multiple/v1.5/

The program is capable to identify multiple dependencies between given properties. Few significant results were obtained, that make possible to simplify analysis procedure of coals by reducing number of determinations and/or measured properties. All equations are made for predicting heating value Q_{si} from other measured properties excluding fixed carbon content C_{fi}. Present article is focused on identifying dependencies between W_{ii}, W_{hi}, V_i, S_{ti}, Q_{si}, t_i, r_o and seam (see text). Application of the model among others at prospecting new coalfields and coal conversion, can contribute to the reduction of drilling and analysis costs.

Keywords: coal analysis, regression models, software implementation study

INTRODUCTION

In field of statistical data processing it exist a large set of software to compute and fit the regressions, but few are free. Even for free software, another problem it appear, operating system license and portability of the software. As example, to use well-known Microsoft Excel software, you must have Microsoft Windows and Microsoft Excel license and portability of Excel program is restricted to Windows platform. To import Excel files in another programs or platforms, conversion modules are needs, and conversion is not totally in most of the cases. Platform independent and free software is a real alternative to this. First step to build free software is to install a free operating system. Unix-like operating systems are knows to be free, but even here exist licensed software. In order to select a free Unix-like operating system, best offer come from BSD family. The most secure and license check for installed software is NetBSD [1]. The NetBSD detect so called "license agreement" and do not permit to install a software if the software contain unacceptable license agreement (different form free) and software can be installed only if the acceptance is explicitly stipulated by the user in configuration files of the system. Another advantage of NetBSD operating system is his huge portability under various hardware platforms from i386 family to Sun and Macintosh machines. By another hand, most full featured operating system of BSD family is FreeBSD [2]. One of the advantages of the FreeBSD operating system is his software portability. With adequate packages, under FreeBSD, can be executed DOS, Windows, Linux [3] and Sun-OS [4] programs. Another advantage of FreeBSD system comes from easiest to install and use it. Once you have an operating system installed, the next step is to choose a proper programming language for software developing. Here, some major questions require an answer. In terms of programming, portability of resulted program can be a problem. As example, if we are chose to implement the algorithm in Visual Basic, the execution of the program is restricted to Windows machines. If Perl is our choice, a Unix-based machine is necessary to run program. Even if we chouse to implement the program in C language, we will have serious difficulties to

compile the programs on machines running with different operating systems. The complexity of program building is also a serious reason in language chousing. Is known that C based languages is poor in simplicity and necessity more time to expend for application building than other languages. Other questions require an answer: We want a server-based application or client based application? We want a server side application or a client side application? As example, a client side application can have disadvantage of execution on client, and dependence of processing speed by power of client machine. If we prefer this variant, a java script or visual basic script is our programming language.

A server side application requires a web server installed. The area of web servers is also a large set, but few have multiplatform capability. If we want a full featured web server, Apache is our solution [5]. Under Apache, we have the possibility to execute programs already compiled in C, Fortran and Java, under Unix machines we can directly execute Perl programs, and, most important, under all operating system platforms we can execute PHP programs if we previously install PHP language and module binaries.

The advantage of PHP programs consist in his portability under most of operating system platforms and internal compilation feature that do not necessity the compilation “by hand” from the user. The disadvantage can be same internal compilation that consumes supplementary time in execution. However, this disadvantage is partially eliminates through installing a PHP proxy, that store compiled programs and next execution of the unmodified program use this compiled binary. In terms of program developing PHP is easy to use, the language borrow syntax from C, Pascal, Basic and Perl, but do not borrow the complex declaration syntax from them. The pointer mechanism is absolute. Thus, a variable used as a string, can be exploited as an integer or real if the value represent a number such that. Class constructing is also available and PHP posses a strong library of database connectivity. Modular programming, recursivity and graphics are at home! Module loading of compiled programs in other languages and execution of binary programs is also available. System services such as mail service are easy to exploit in PHP scripts. A very

easy mechanism to link PHP scripts to HTML scripts make PHP language to be one of the best. Shell executing commands make PHP a useful platform for system administration (PhpSysInfo [6], WebAdmin [7], PhpMyAdmin [8], PhpPgAdmin [9]). As a conclusion, PHP is our choice!

Putting PHP programs on a web server into a data folder and executes by them using PHP module. The output of the PHP program is in HTML style and can be viewed by any web client (Microsoft Internet Explorer [10], Mozilla [11], Opera [12], Netscape [13], Konkueror [14]).

DATA MINING

To characterize a coal seam the results of proximate analyses as function of depth as related to the initial sample (i), the sample for analysis (a), or anhydrous sample (anh) can be considered [15,16].

A set of measured data from Farcăşeşti area was taken into statistical analysis. The probes for analysis were taken from the 64040.15 platform at different seams. The analysis results are given in table 1.

All measured data from table 1 refer to the initial sample “i” and are expressed in percents (excepting the ash softening temperature, the density and the number of seam). The imbibitions moisture content is W_{ii}, the hygroscopic moisture content is W_{hi}, the volatile content is V_i, the fixed carbon content is C_{fi}, the content of total sulfurs is S_{ti}, the higher heating value is Q_{si}, the ash softening temperature is t_i, the density is r_o, and the seam is represented by a number.

The used functions for Q_{si} prediction are:

$$f(x_0,x_1,x_2) = x_0 \cdot 34.2 + x_1 \cdot 168 + x_2 \cdot 102 - 2620;\ r = 0.9776;\ s = 0.127$$

$$f(x_0,x_1,x_2,x_4) = x_0 \cdot 33.9 + x_1 \cdot 170 + x_2 \cdot 103 - x_4 \cdot 36.2 - 2630;\ r = 0.9783;\ s = 0.124$$

$$f(x_0,x_1,x_2,x_8) = x_0 \cdot 34.3 + x_1 \cdot 171 + x_2 \cdot 107 + x_8 \cdot 13.1 - 2920;\ r = 0.9770;\ s = 0.127$$

$$f(x_0,x_1,x_2,x_4,x_8) = x_0 \cdot 34.3 + x_1 \cdot 171 + x_2 \cdot 107 - x_4 \cdot 2 + x_8 \cdot 13 - 2920;\ r = 0.9771;\ s = 0.127$$

$f(x_0,x_1,x_2,x_6,x_7,x_8) = x_0 \cdot 45 + x_1 \cdot 175 + x_2 \cdot 124 + x_6 \cdot 2 + x_7 \cdot 282 + x_8 \cdot 5.47 - 6260$; r = 0.9518; s = 0.185

Table I. Data values and Q_{si} predicted values

W_{ii}	W_{hi}	V_i	C_{fi}	S_{fi}	Q_{si}	t_i	r_o	seam	$f(W_{ii}, W_{hi}, V_i)$	$f(W_{ii}, W_{hi}, V_i, S_{ti})$	$f(W_{ii}, W_{hi}, V_i,$ seam)	$f(W_{ii}, W_{hi}, V_i, S_{ti},$ seam)	$f(W_{ii}, W_{hi}, V_i, t_i, r_o,$ seam)
x_0	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8					
A	B	C	D	E	F	G	H	I					
34.4	8.1	23.4	14.7	1.03	2225	1130	1.23	16	2304	2286	2358	2355	2347
24.7	9.9	25.3	17.5	0.69	2529	1100	1.19	14	2469	2471	2511	2508	2377
27.1	7.9	20.1	12.1	0.64	1802	1250	1.39	13	1684	1679	1681	1679	1847
25.0	10.5	26.2	19.2	0.90	2700	1250	1.22	12	2671	2669	2694	2691	2911
29.0	8.4	22.1	14.6	0.95	2117	1150	1.11	10	2037	2023	2007	2004	1969
33.0	9.6	26.0	17.9	1.25	2641	1105	1.10	10	2773	2753	2767	2763	2748
28.5	9.1	25.5	18.2	1.32	2590	1120	1.25	10	2485	2462	2473	2469	2469
32.2	8.9	27.2	18.6	0.97	2816	1130	1.12	10	2751	2741	2748	2745	2795
33.3	9.6	25.0	18.6	0.93	2647	1115	1.10	10	2682	2672	2670	2667	2658
25.5	9.4	30.5	20.9	2.10	3043	1100	1.22	10	2942	2898	2957	2951	2957
30.0	8.3	21.2	14.0	1.67	2025	1105	1.13	8	1963	1921	1902	1897	1788
34.7	9.8	26.6	20.9	0.88	2919	1115	1.08	8	2926	2920	2897	2894	2938
26.9	10.7	28.5	19.8	1.63	2983	1100	1.02	8	3005	2977	2987	2983	2932
33.1	9.5	27.1	20.6	1.07	2949	1085	1.20	7	2872	2860	2831	2828	2842
34.4	9.1	26.3	18.7	1.97	2692	1125	1.28	6	2768	2721	2709	2704	2830
25.0	8.8	29.5	15.7	0.82	2650	1110	1.20	5.9	2722	2722	2666	2663	2694
27.5	10.2	26.9	19.0	1.69	2737	1120	1.13	5.1	2778	2746	2713	2709	2729
25.4	10.7	27.5	19.1	2.23	2741	1115	1.20	5	2851	2802	2789	2784	2806

RESULTS AND DISCUSSION

The plots from figure 1 are organized in two columns. First column contain the regressions between Q_{si} and calculated values (f functions) by a regular regression equation and second column contain regressions between Q_{si} and calculated values through a forced origin regression equation (like functions f express Q_{si}).

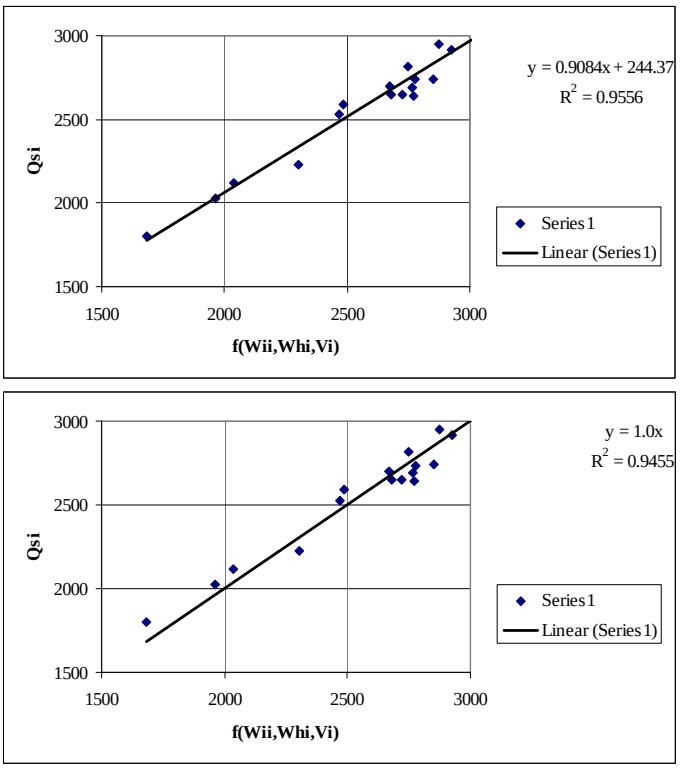

Figure 1. Dependencies of Q_{si} by other measured data from table 1

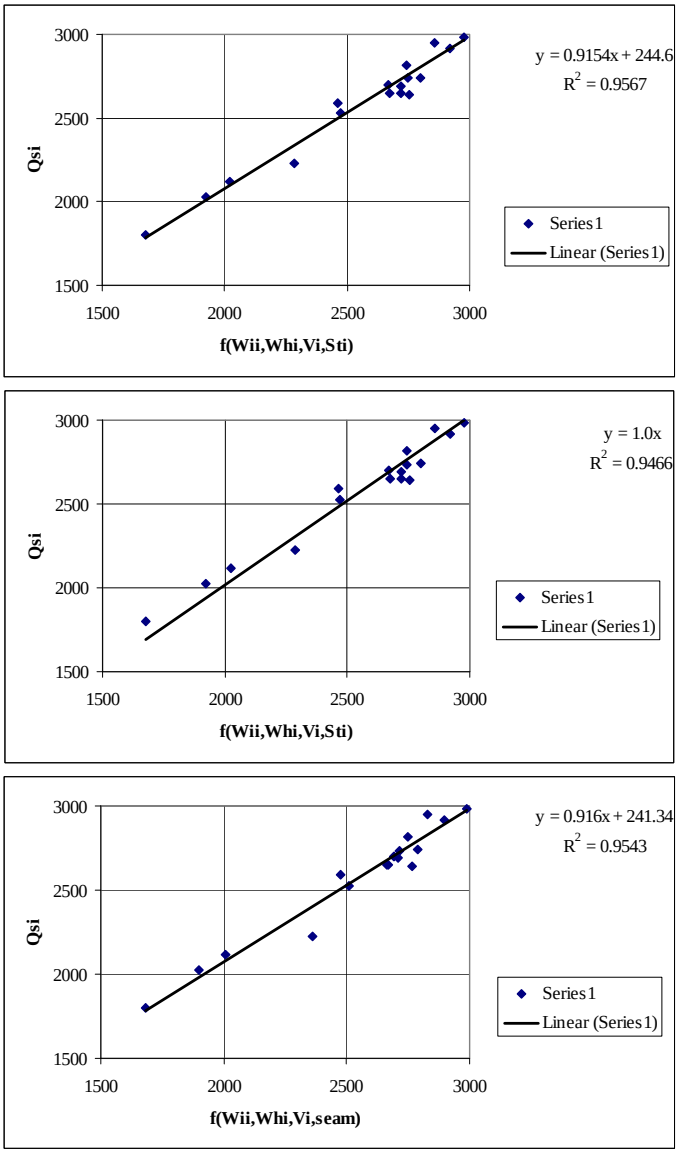

Figure 1. Dependencies of Q_{si} by other measured data from table 1 - continuing

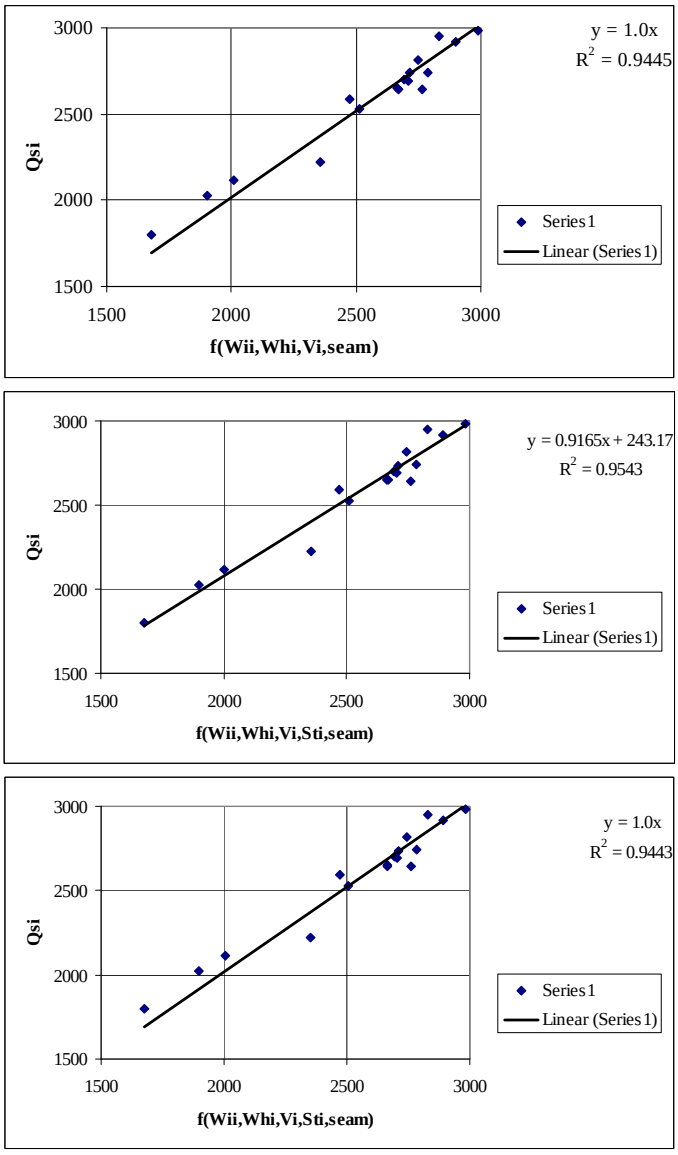

Figure 1. Dependencies of Q_{si} by other measured data from table 1 - continuing

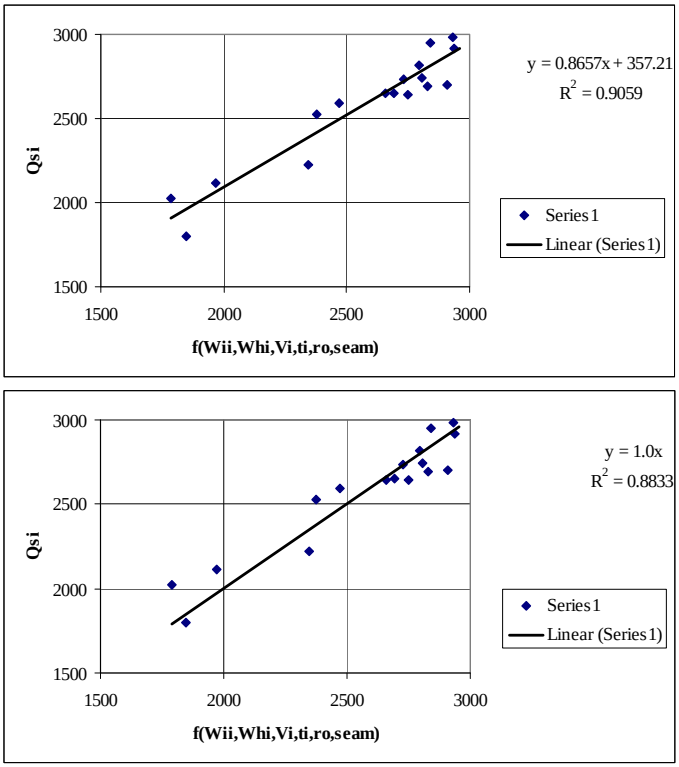

Figure 1. Dependencies of Q_{si} by other measured data from table 1 - continuing

First group consider only dependence of higher heating value Q_{si} by imbibitions moisture content W_{ii}, the hygroscopic moisture content W_{hi} and the volatile content V_i and predict them with an squared r about 0.95.

Following dependencies prove that including more variables in regression do not add more accuracy in prediction.

Dependency functions of Q_{si} do not include fixed carbon C_{fi} parameter, discussed in other paper [17].

CONCLUSIONS

The study shows the possibility of reducing number of analysis for physical and chemical parameters of coals without reducing the quality of information. Are obtained the dependency of higher heating value Q_{si} by imbibitions moisture content W_{ii}, the hygroscopic moisture content W_{hi} and the volatile content V_i and predict them with an squared r about 0.95.

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