Well Log Interpretation Model for the Determination of Lithology and Fluid Contents.

O.C. Akinyokun[1], P.A. Enikanselu[2], A.B. Adeyemo[3], and A. Adesida[2]

[1]Department Computer Science, Federal University of Technology, Akure, Nigeria.
[2]Department of Applied Geophysics, Federal University of Technology, Akure, Nigeria.
[3]Computer Science Department, University of Ibadan, Ibadan, Nigeria.

E-mail: sesan_adeyemo@yahoo.com[3]

ABSTRACT

The detection of hydrocarbon content from geophysical data has always been an important practical issue in the interpretation of geophysical oil prospecting data. This paper reviews the literature on well log lithology and neuron-computing technology. An Unsupervised Self Organizing Map (SOM) of neural networks for the determination of oil well lithology and fluid contents is proposed. Fuzzy inference rules derived from known characteristics of well logs were proposed and used in the interpretation of the clusters generated by the SOM neural networks. The process was tested with the log data obtained from the Niger Delta region of Nigeria. The results obtained were interpreted and presented.

(Keywords: well log analysis, lithology, neural network, fuzzy logic, geophysical data)

INTRODUCTION

There are two generations of schools of taught in the field of Information and Communications Technology (ICT). The old school attempts to study ICT and use the knowledge acquired to build ICT based systems for the purpose of enhancing the performance of human experts in high problem domains. The new school takes a study of the structure and function of the human body and attempts to use he knowledge acquired to build human-like intelligence systems. The major tools used for the building of human-like intelligent systems are Neural Networks (Rosenblatt, 1958), Fuzzy Logic (Zadeh, 1965), Genetic Algorithm (Holland, 1975), Data Warehousing (Firestone, 1998), and Data Mining (Mohaghegh, 2003).

The knowledge of the lithology of an oil well can be used to determine many parameters of the well including its fluid contents. The conventional method used for the identification of lithofacies is by direct observation of underground cores (Chang et al., 2002). Lithology determination by direct observation of underground cores is an expensive process and is not always reliable and valid because different geologists may provide different interpretations.

In the research reported in this paper, gamma ray logs, neutron logs, density logs, deep resistivity logs, and shallow resistivity logs were identified as lithology logs (Rider, 1996). Figure 1 shows the characteristic response of the logs to the logging tool and their graphical interpretation.

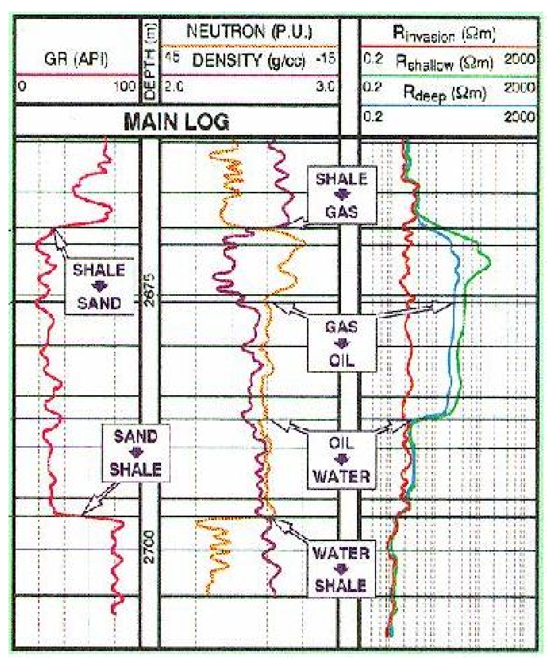

Figure 1: Characteristic Response of Lithology Logs.

Gamma ray logs measure natural radioactivity in formations. Shale-free sandstones and carbonates give low gamma ray readings. As shale content increases, the gamma ray log response also increases.

The resistivity log is a measure of a formation's resistivity. Most rock materials are essentially insulators, while their enclosed fluids are conductors. When a formation is porous and contains salty water, the resistivity will be low. When this same formation contains hydrocarbons, its resistivity will be very high. In this research, deep resistivity and shallow resistivity were studied. Deep resistivity is the resistivity recorded farther away from the inversion core created by the drilling mud. Shallow resistivity log is the resistivity recorded close to the oil well bore. A deep resistivity and shallow resistivity with low gamma ray log is indicative of hydrocarbon (HC) presence. Shales show low resistivity values with high gamma ray values.

The density log is a continuous record of a formation's bulk density. It is used mainly for the determination of porosity, and the differentiation between liquids and gases (when used in combination with neutron log). When organic content is present, density is low. Variation of density indicates porosity changes. For example, low density indicates high porosity and vice-versa.

The neutron log is used mainly for lithology identification, porosity evaluation, and the differentiation between liquids and gases when used in combination with density log. On cross-plot of neutron and density logs, pure shale can be recognized by the high neutron value relative to the density value which gives a large positive separation to the logs while gas stands out distinctly giving a large negative separation.

WELL LOG ANALYSIS PROCEDURE

The procedure adopted for the identification and analysis of the well logs is as follows:

a. The well logs that were relevant to the research were first identified.

b. The raw well logs were inspected and erroneous data items such as that which carry negative and null values were removed from the log data.

c. The raw well logs are subjected to a statistical correlation test, to determine the relationships among the data elements for the purpose of clustering them.

d. The raw well log values are normalized (in the range 0 to 1) for the purpose of rendering the data dimensionless, and removing the effect of scaling on the values.

e. The normalized log values are subjected to the clustering algorithm of the SOM neural network for the purpose of generating meaningful clusters.

f. The mean and standard deviation values of the log data by clusters are computed to determine their fuzzy value which can be considered High, Moderate, or Low. These are important variables desirable for identifying the physical property of each cluster and subsequently generating a chart which shows the distribution of the rocks in the well and location of hydrocarbon and fluid content.

Base Data: The base data used for the lithology determination are the open-hole wireline subsurface well log data. Cross-plot techniques are employed in the analysis of well log data. The log data models the response of the subsurface rocks to the measuring instrument according to the rock properties. The cross-plots allow the nature of the rocks properties to be inferred from the logs. The SOM based clustering algorithm, which provides a platform for plotting a multi-dimensional log cross-plot is adopted in this regard.

Data Pre-Processing: A log data set from the Niger Delta Basin was used as for the base data for the research reported in this paper. Only the five lithology logs required were used. A correlation test was carried out on the log values to determine if there was any relationship between the log data values. Knowing the nature of the relationships also helps in the selection of the appropriate log variables when similar data items are present in the data records. The result of the correlation test is presented in Table 1.

Self Organizing Map (SOM) Based Clustering: SOM involves competitive learning of one-layer networks with linear processing elements (neurons) organized in one, two or multi-dimensional arrays. Competitive learning is an adaptive process in which the processing elements in a neural network gradually become sensitive to different input categories or sets of data samples in a specific domain of the input space. In such networks, there is only one winning processing element for every input pattern and only the weights of the winning node are updated. Kohonen (1999) proposes networks which allows the data points that are similar in input space to be mapped to small neighborhoods.

If the input data sets in a Kohonen SOM are arranged logically in an array and are to be mapped onto the output array, it is proposed in Kohonen (1999) that each processing element *i* of the SOM has an associated *d*-dimensional reference (also called the weight, codebook, model or prototype) vector $m_i = [m_{i1}\ m_{i2}\ \ldots\ m_{id}]$, where *d* is equal to the dimension of the input vectors. The training of the SOM is carried out by using the following iterative procedure:

The input data (that is the well log data) were first normalized to the range 0 to 1 for the purpose of rendering the data dimensionless, and removing the effect of scaling on the values.

In each training step, one sample vector 'x' from the input data set is chosen randomly and a similarity measure is calculated between it and all the weight vectors of the map. The Best-Matching Unit (BMU), denoted by '*c*', is the unit whose weight vector has the greatest similarity with the input sample 'x'. The similarity is usually defined by means of a distance measure, usually the Euclidian distance. The BMU is defined mathematically as the processing element for which the expression:

$$||x - m_c|| = \min_i\{||x - m_i||\}, \quad \textbf{(1)}$$

where ||.|| is the distance measure.

The reference vectors of the BMU and its topological neighbors are moved closer to the input vector in the input space. This adaptation procedure stretches the prototypes of the BMU and its topological neighbors towards the sample vector as shown in Figure 2. The figure illustrates the process of updating BMU and its neighbors towards the input sample marked with 'x' The solid and dashed lines correspond to situation before and after updating, respectively. The SOM update rule for the weight vector of the unit *i* is given mathematically as:

$$m_i\,(t+1) = m_i + a(t)\,h_{ci}(r(t))\,[x(t) - m_i\,(t)],. \quad \textbf{(2)}$$

where *t* represents time, *a(t)* represents the learning rate, and $h_{ci}(r(t))$ represents the neighborhood kernel around the winner unit '*c*', with neighborhood radius *r(t)*.

The function h(t) is called the neighborhood function. It represents a non-increasing function of time and distance between the winning neuron and its neighbors on the grid. The function consists of two parts: the distance function and the learning rate function of time. If the locations of units *c* and *i* on the map grid are denoted by the two-dimensional vectors r_c and r_i, respectively, then the neighborhood function is expressed mathematically as:

$$h_{ci}(t) = h(||r_c - r_i||, t) * \sigma(t) \quad \textbf{(3)}$$

where r_c represents the location of unit *c* on the map grid and $\sigma(t)$ represents the neighborhood radius at time *t*.

Table 1: Correlation Test Result.

	DEP	NEU	DEN	GR	DRS	SRS
DEP	1					
NEU	-0.50854	1				
DEN	0.487547	-0.41668	1			
GR	0.076405	0.466654	0.222112	1		
DRS	0.039717	-0.306	-0.06557	-0.34206	1	
SRS	0.253511	-0.40028	-0.05902	-0.23694	0.755617	1

Two functions of distance have been reported in the literature. They are:

i. Simple constant defined by:

$$h(d,t) = \begin{cases} const, \; d \le \sigma(t) \\ 0, \; d > \sigma(t) \end{cases} \quad \textbf{(4)}$$

where $\sigma(t)$ is a diminishing function of time.

ii. Gaussian function defined by:

$$h(d,t) = e^{-\frac{d^2}{2\sigma^2(t)}} \text{ ……………………… ..(5)}$$

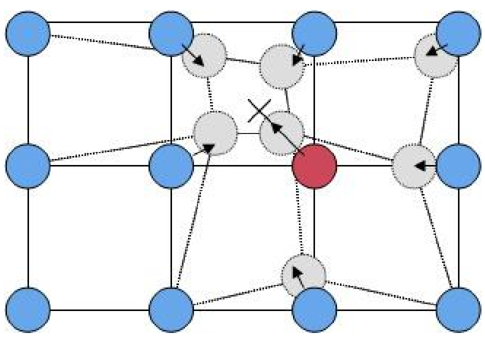

Figure 2: Updating of the Best Matching Unit (BMU) and Its Neighbors.

It is noted that the Gaussian function of distance provides better results. At the beginning of the learning procedure, it is fairly large, but it is made to gradually shrink during learning by using linear diminishing function of time with a view to obtaining a single winning processing element at the end.

The learning process consisting of winner selection by Equation (1) and adaptation of the synaptic weights by Equation (2) can be modeled with a neural network structure, in which the processing elements are coupled by inhibitory connections.

After training the SOM, the neural network would have learned the structure of the input data. The test data file is submitted to the trained SOM network, which then identifies the clusters it had recognized during the training process and the data samples are assigned to cluster groups. An output report typical of the form presented in Table 2 is generated.

The mean of the log values and their standard deviation are then computed. The computed mean of the log values are then used to infer the lithology and fluid content of the rock species that characterize the geological formation of the oil well being investigated by determining their fuzzy value.

Table 2: SOM Software Output File Format

S/No	DEP	GR	DRS	SRS	NEU	DEN	Clusters
7065	7532	42.37	35.23	22.83	0.29	2.29	20
7066	7532.5	48.43	38.05	24.11	0.28	2.32	20
7067	7533	54.32	41.32	25.73	0.26	2.34	20
7068	7533.5	58.31	44.83	27.58	0.24	2.34	2
7069	7534	59.31	48.08	29.34	0.23	2.34	2
7070	7534.5	56.29	50.5	30.66	0.22	2.33	2
7071	7535	50.15	51.41	31.08	0.22	2.33	2
7072	7535.5	43.88	50.44	30.4	0.22	2.32	2
7073	7536	39.47	48.25	29.08	0.22	2.32	3
7074	7536.5	37.96	46.25	27.89	0.22	2.31	3
7075	7537	38.42	45.11	27.2	0.22	2.3	20
7076	7537.5	38.9	44.95	27.06	0.22	2.29	20
7077	7538	38.59	45.92	27.56	0.22	2.28	20
7078	7538.5	37.39	48.57	29.02	0.22	2.28	3
7079	7539	35.85	53.25	31.54	0.21	2.28	3
7080	7539.5	34.92	58.67	34.35	0.21	2.29	3
7081	7540	34.96	63.17	36.49	0.21	2.3	3
7082	7540.5	35.78	66.68	37.97	0.21	2.3	3
7083	7541	37.24	69.64	39.02	0.21	2.31	3

Fuzzy Inference System: The fuzzy value of the logs can be modeled by three fuzzy membership functions, which correspond to the linguistic values High (H), Moderate (M), or Low (L). The fuzzy values are used to generate fuzzy rules for the determination of rock lithology and fluid content. The fuzzy sets are presented in Figures 3 - 7. Figure 8 shows the output fuzzy sets.

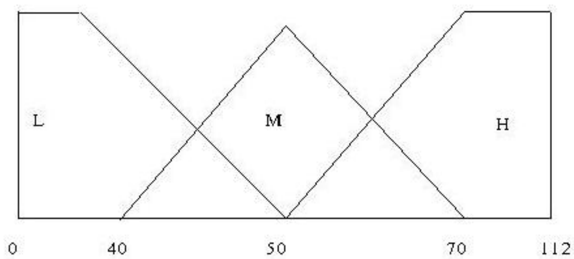

Figure 3: GR Log Membership Functions.

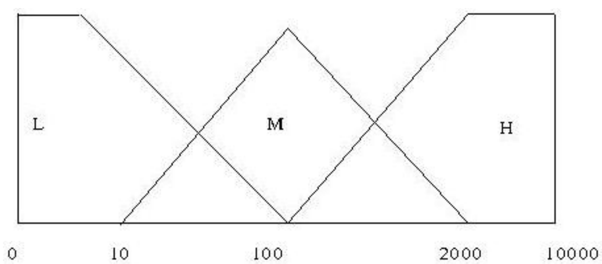

Figure 4: DRS Log Membership Functions.

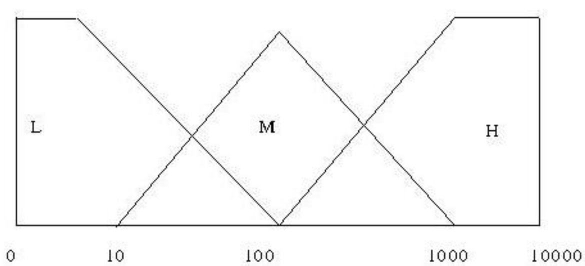

Figure 5: SRS Log Membership Function.

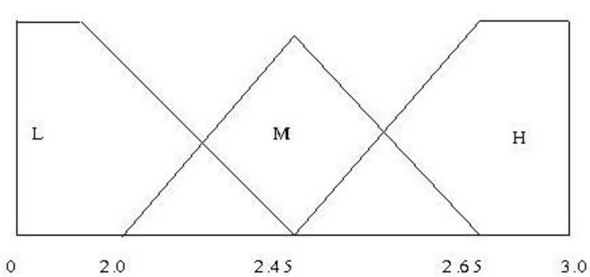

Figure 6: DEN Log Membership Functions.

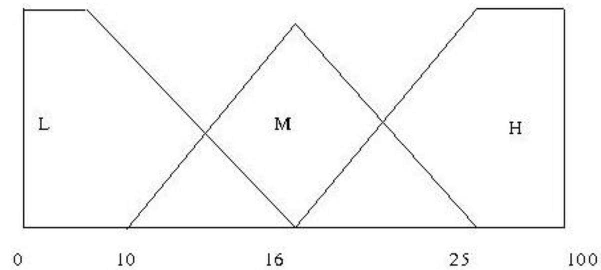

Figure 7: NEU Log Membership Functions.

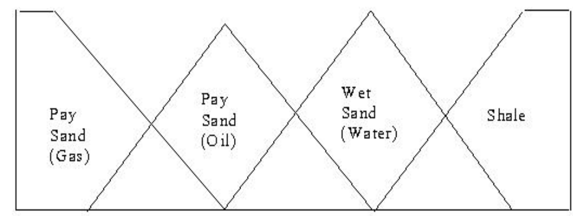

Figure 8: Output Membership Functions.

The fuzzy rules matrix presented in Table 3 was derived from the characteristic response of the lithology logs to the logging tools in different rock materials. In deriving the rules, the following were considered:

a. The gamma ray log, which is the primary lithology log, was used to determine the primary lithology of the rock type.

b. The resistivity logs were inspected to determine if there is any hydrocarbon presence indicated by an inversion of the deep resistivity logs and the shallow resistivity logs.

c. The density and neutron logs are used to confirm either the presence of oil, gas or water in the rock materials matrix.

CASE STUDY OF LOG DATA OF NIGER DELTA OF NIGERIA

A case study was carried out using geophysical well log data from the Niger-Delta region of Nigeria. Twelve cluster groups were identified in the well log data. The cluster groups (denoted by their cluster numbers), their mean values and computed standard deviations are presented in Table 4.

Table 3: Fuzzy Rules Matrix.

Rule	GR value	DRS value	SRS value	DEN value	NEU value	Primary Lithology	Final Lithology	Fluid content
1	H or M	L	L	H or M	H or M	Shale	Shale	None
2	L	L	L	M	H or M	Sandstone	Sandy-shale	None
3	L	H	H	M	M	Sandstone	Pay Sand	Oil
4	L	H	H	L	L	Sandstone	Pay Sand	Gas
5	L	M	M	M	M	Sandstone	Pay Sand	Oil
6	L	M	M	L	L	Sandstone	Pay Sand	Gas
8	L	L	L	L	M	Sandstone	Wet Sand	Water

Table 4: Identified Cluster Groups.

Cluster No.	No. of samples	Value	GR	DRS	SRS	DEN	NEU
1	44	Mean	34.78091	1797.661	646.9207	2.122727	0.1025
		SD	4.098724	640.3153	133.0228	0.020839	0.016861
2	525	Mean	101.152	25.47221	20.02962	2.364	0.286533
		SD	17.74415	52.78437	34.29039	0.108893	0.068276
3	52	Mean	33.15673	36.47615	31.785	2.255	0.186538
		SD	4.954649	28.36702	26.73754	0.045092	0.052239
4	149	Mean	27.66638	636.7572	324.199	2.136443	0.102483
		SD	6.193327	655.1077	179.5119	0.035165	0.026276
5	302	Mean	73.72493	20.83497	17.96874	2.253543	0.362252
		SD	20.10554	31.77368	26.70736	0.101342	0.135341
6	3	Mean	73.27	44.35667	38.19	1.466667	0.543333
		SD	10.6865	29.90384	23.00508	0.030551	0.055076
7	11	Mean	22.45636	6663.72	916.8719	2.185455	0.079091
		SD	1.111362	989.4961	24.25633	0.005222	0.009439
8	46	Mean	108.5622	21.68348	16.45804	2.386304	0.471087
		SD	13.26835	9.696412	6.700888	0.107442	0.050519
9	668	Mean	31.14049	64.80641	33.6712	2.229701	0.227695
		SD	5.427909	20.89779	11.143	0.06483	0.039719
10	425	Mean	30.38256	209.0674	115.5055	2.194635	0.173882
		SD	5.412735	107.8224	91.93481	0.049334	0.058011
11	68	Mean	26.47603	994.1869	262.3741	2.147059	0.122647
		SD	4.332712	536.3986	110.8691	0.034471	0.019518
12	1630	Mean	70.93486	64.38815	40.78978	2.294018	0.26716
		SD	22.56937	49.62646	33.97884	0.115673	0.070795

In a fuzzy system, the general inference process proceeds in the following steps (Krause et al., 1994; Akinyokun, 2002):

a. Fuzzification which involves the conversion of numeric data in real world domain to fuzzy numbers in fuzzy domain.

b. Fuzzy inference which involves the computation of the truth value of each rule and its application to the conclusion part of the rule.

c. Composition of the output variables of sub rules which can fire in parallel for the purpose of drawing a global conclusion.

d. Deffuzzification, which is optional, involves the conversion of the derived fuzzy number to the numeric data in real world domain.

The fuzzy inference process started with the fuzzification sub-process where the membership functions defined on the input variables were applied to their actual values to determine the degree of truth for each rule premise. If a rules premise has a non-zero degree of truth, then the rule fires. In the inference sub-process, the truth-value of each rule was computed and applied to its conclusion part.

The fuzzy 'max' rule of composition of inferences was then applied after which the output was defuzzified. The results after carrying out the inference procedure showing the lithology and fluid contents inferred from the cluster groups are presented in Table 5.

Appendix A presents a chart of the oil well showing the location of the fluid content (that is whether there is oil, gas, or water) that is contained in the rock matrix (sandstone) of the oil well. On the chart, the depth intervals containing pay sand with gas content is represented by the yellow colored regions, depth intervals containing pay sand with oil content is represented by the green colored regions, depth intervals containing wet sand with water content is represented by the blue colored regions. Regions where shales (or shaly rock materials) can be found are shown in ochre. Clusters 2, 5, 6, 8 and 12 represent shales. Cluster 7 represents a pay sand cluster containing gas while clusters 1, 4, 10 and 11 represents pay sand clusters containing oil. Cluster 3 and 9 represent wet sand clusters containing water. The results were verified by a log analyst that was familiar with the dataset used.

Table 5: Identified Clusters.

Cluster	Lithology	Fluid Content	Legend
1	Pay Sand	Oil	1
2	Shale		2
3	Wet Sand	Water	3
4	Pay Sand	Oil	4
5	Shale		5
6	Shale		6
7	Pay Sand	Gas	7
8	Shale		8
9	Wet Sand	Water	9
10	Pay Sand	Oil	10
11	Pay Sand	Oil	11
12	Shale		12

CONCLUSION

In this work, the SOM neural network had been used to analyze well log data obtained from the Niger-Delta region of Nigeria in order to extract knowledge from the well log data. The fuzzy inference methodology adopted in the interpretation of the clusters was derived from the methods used in the interpretation of traditional graphical cross-plots by log analysts.

There are generally two types of petroleum reservoirs: carbonates and siliciclastics. The former is composed chiefly of limestone or dolomite and the latter sand or sandstone. In the Niger Delta Region (of the Niger Delta province) of Nigeria, the general lithology is mainly sand and shale (Tuttle et al., 1999). This is consistent with the result obtained in this work. The result not only gives the oil well lithology, it also gives an indication of the fluid content of the oil well and rock materials identified. The SOM based clustering and the fuzzy inference rules developed in this paper can form the basis for the development of a neuro-fuzzy expert system that can be used for the detection of fluid content in oil wells.

APPENDIX A - Well Stratigraphy Chart

DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP	
7000	10	7050	12	7100	12	7150	10	7200	10	7250	9	7300	9	7350	12	7400	12	7450	9	7500	9	7550	12	7600	8
7001	10	7051	9	7101	12	7151	10	7201	10	7251	9	7301	9	7351	12	7401	12	7451	9	7501	9	7551	12	7601	8
7001	10	7051	9	7101	12	7151	10	7201	10	7251	9	7301	9	7351	12	7401	12	7451	9	7501	9	7551	12	7601	8
7002	10	7052	9	7102	12	7152	10	7202	10	7252	9	7302	12	7352	12	7402	12	7452	9	7502	9	7552	12	7602	8
7002	10	7052	9	7102	12	7152	10	7202	10	7252	9	7302	12	7352	12	7402	12	7452	12	7502	9	7552	12	7602	8
7003	10	7053	9	7103	12	7153	10	7203	10	7253	10	7303	12	7353	12	7403	12	7453	12	7503	9	7553	9	7603	8
7003	10	7053	9	7103	12	7153	10	7203	10	7253	10	7303	12	7353	12	7403	12	7453	12	7503	9	7553	9	7603	12
7004	10	7054	9	7104	12	7154	10	7204	10	7254	10	7304	12	7354	12	7404	12	7454	12	7504	9	7554	9	7604	12
7004	10	7054	9	7104	12	7154	10	7204	10	7254	10	7304	9	7354	12	7404	12	7454	12	7504	9	7554	9	7604	12
7005	10	7055	9	7105	12	7155	10	7205	10	7255	10	7305	9	7355	12	7405	12	7455	12	7505	9	7555	9	7730	9
7005	10	7055	9	7105	12	7155	10	7205	10	7255	10	7305	12	7355	12	7405	12	7455	12	7505	9	7555	9	7731	9
7006	10	7056	9	7106	12	7156	10	7206	10	7256	10	7306	12	7356	12	7406	9	7456	12	7506	9	7556	9	7731	9
7006	10	7056	9	7106	12	7156	10	7206	10	7256	10	7306	12	7356	12	7406	9	7456	12	7506	9	7556	9	7732	12
7007	10	7057	9	7107	12	7157	10	7207	10	7257	10	7307	12	7357	12	7407	9	7457	12	7507	9	7557	9	7732	12
7007	10	7057	9	7107	12	7157	10	7207	10	7257	10	7307	12	7357	12	7407	9	7457	12	7507	9	7557	9	7733	10
7008	10	7058	9	7108	12	7158	10	7208	10	7258	10	7308	12	7358	12	7408	9	7458	12	7508	9	7558	9	7733	10
7008	10	7058	9	7108	12	7158	10	7208	10	7258	10	7308	12	7358	12	7408	9	7458	12	7508	9	7558	9	7734	10
7009	10	7059	9	7109	12	7159	10	7209	10	7259	10	7309	12	7359	12	7409	9	7459	12	7509	9	7559	9	7734	9
7009	10	7059	9	7109	12	7159	10	7209	10	7259	10	7309	12	7359	12	7409	9	7459	12	7509	9	7559	9	7735	12
7010	10	7060	9	7110	12	7160	10	7210	10	7260	10	7310	12	7360	12	7410	9	7460	12	7510	9	7560	9	7735	12
7010	10	7060	12	7110	12	7160	10	7210	10	7260	10	7310	12	7360	12	7410	9	7460	12	7510	9	7560	9	7736	12
7011	10	7061	12	7111	12	7161	10	7211	10	7261	10	7311	12	7361	12	7411	9	7461	12	7511	9	7561	9	7736	12
7011	10	7061	12	7111	12	7161	10	7211	9	7261	10	7311	12	7361	12	7411	9	7461	12	7511	9	7561	9	7737	12
7012	10	7062	12	7112	12	7162	10	7212	9	7262	10	7312	12	7362	12	7412	9	7462	12	7512	9	7562	9	7737	12
7012	10	7062	12	7112	12	7162	10	7212	9	7262	10	7312	12	7362	12	7412	9	7462	12	7512	9	7562	9	7738	12
7013	10	7063	12	7113	12	7163	10	7213	9	7263	10	7313	12	7363	12	7413	9	7463	12	7513	9	7563	9	7738	12
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DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP	
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DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP		DEP	
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8460	9	8510	12	8560	12	8610	4	8660	12	8710	5	8760	2	8821	9	8871	5	8921	5	8971	2	9021	4	9071	5
8460	12	8510	12	8560	12	8610	4	8660	12	8710	5	8760	2	8822	9	8872	5	8922	5	8972	2	9022	4	9072	5
8461	12	8511	12	8561	12	8611	10	8661	12	8711	5	8761	2	8822	9	8872	5	8922	5	8972	2	9022	4	9072	5
8461	12	8511	12	8561	12	8611	10	8661	12	8711	5	8761	2	8823	9	8873	5	8923	2	8973	2	9023	4	9073	5
8462	12	8512	12	8562	12	8612	10	8662	12	8712	12	8762	2	8823	9	8873	5	8923	2	8973	2	9023	4	9073	5
8462	12	8512	2	8562	12	8612	10	8662	12	8712	12	8762	2	8824	9	8874	5	8924	2	8974	2	9024	4	9074	5
8463	12	8513	2	8563	12	8613	10	8663	12	8713	2	8763	2	8824	9	8874	5	8924	2	8974	2	9024	4	9074	5
8463	12	8513	2	8563	12	8613	10	8663	12	8713	2	8763	2	8825	12	8875	5	8925	2	8975	2	9025	4	9075	5
8464	12	8514	2	8564	12	8614	10	8664	12	8714	2	8764	2	8825	2	8875	5	8925	2	8975	2	9025	4	9075	5
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8472	12	8522	2	8572	12	8622	4	8672	2	8722	2	8772	2	8833	5	8883	2	8933	5	8983	5	9033	4	9083	2
8472	12	8522	2	8572	12	8622	4	8672	2	8722	2	8772	2	8834	5	8884	2	8934	5	8984	5	9034	4	9084	2
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8473	12	8523	2	8573	12	8623	4	8673	2	8723	2	8773	2	8835	5	8885	2	8935	5	8985	5	9035	4	9085	2
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8475	9	8525	2	8575	12	8625	4	8675	2	8725	2	8775	2	8836	3	8886	2	8936	5	8986	5	9036	4	9086	2
8475	12	8525	2	8575	2	8625	4	8675	2	8725	2	8775	2	8837	9	8887	2	8937	5	8987	5	9037	4	9087	2

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