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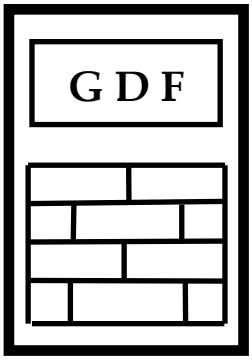

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SUDOKU: an algorithm for solution

Sudoku is a mental game which became more and more inciting for a wide category of ages and professions. The main characteristic of all kind of problems in our current life, no matter their nature, is to find an algorithm for their solution. This means to find the optimal steps for a certain and efficient solution, even this appears as a wasting time work. If we "are wasting time" first by establishing this algorithm, we will find out finally that the problem was solved by passing through easy steps in shortest time. For those who do not have a "working plan" or algorithm as the procedure with minimal risks, even simple problems will appear as unsolved and their majority will give up or will fail.
Algorithm establishing even in solving of a very complex problem is similar with careful study of the map before a long journey. In this way, long and difficult expeditions are transformed in a succession of steps easy to go.
The present algorithm is an efficient example especially for young students in teaching them with this manner of thinking which implies and trains discernment, logical thinking, discipline, patience, attention and continuity. It is also an efficient example in teaching the importance of the pencil and eraser in graphic performing of a project.

A. Necessary materials:

Pencil with soft lead (2B), eraser, pencil sharpener, Game Table (page 8), Logic Table (page 9), Sudoku problems from books, newspapers, etc.

B. Sudoku's rules

The Game Table is a square consisting from 9 horizontal rows and 9 vertical columns forming 9x9=81 elementary cells grouped in 3x3 sub-squares of 9 elementary cells each marked by thicker border lines. The initial data of the problem consists in the fact that some of the elementary cells contain one number each from 1 to 9.
The problem to solve is to complete the empty elementary cells with numbers also from 1 to 9, so that each row, column and sub-square must contain all these numbers, or otherwise said each number will appear only one time there.

C. Instructions to solve the problem

C1. Starting conditions

It is important to point out just from the beginning that Sudoku game is an individual game not a collective one. For its solution the player needs quiet and continuous concentration.

Player has to complete the form of Game Table with the initial numbers. These numbers will remain unchanged all time, so that to avoid their alteration they must be written with ink or ball pen and encircled, hachured or shaded.
Important: at each stage of problem solving player has to check up the basic rule of the game (A) on the Game Table.
Each elementary cell in the Game Table has a two digit number corresponding to the number of the raw and of the column, respectively. Figure 1 presents an example of Game Table with initial numbers.
The Logic Table helps to solve the problem and contains the 9 sub-squares of elementary cells identified by the two digit number, but having a column of 9 cells each corresponding to the possible 9 numbers which can be placed in.

C2. Filing up the Logic Table

Taking into account the basic rule (A), player has to shade or hachure the cells in the Logic Table for the numbers already taken and corresponding to each initial number in Game Table. Figure 2 shows the shaded cells corresponding for the two numbers in the first row of Game Table (Figure 1). The two numbers are 1 and 7 from elementary cells 12 and 14, respectively.
In view to avoid any fault, this stage must consider each initial number from Game Table strictly by increasing the two digit number of the elementary cell.
For beginners this stage will take several hours, so that they need continuous concentration. After its completion they may take a break and when resume they have to check it once again. It is possible to discover mistakes even at further checks. For this reason it is important do not push pencil by hachuring or shading, so to easy erasing the mistakes.
By experience, this stage could shorten to 1 hour or less. No matter the player experience, this stage must not be interrupted. The continuity in solving a problem is very important, so that Sudoku is a good training for this skill.
Figure 3 shows the Logic Table after its completion for all initial numbers from the Game Table.

C3. Finding the new numbers

It can observe that in Logic Table remains not shaded white cells corresponding to possible new numbers in empty elementary cells from Game Table.
It is important to select first the most isolated such white cells.
It is important also to observe that in general all Sudoku problems admit multiple solutions. There are rare cases for which exists a unique solution.
Figure 3 shows that the elementary cell 23 admits only number 5 written on the Game Table checking up the basic rule and shading the corresponding cells in Logic Table. This algorithm is repeated until all cells in Logic Table are shaded.
Figure 4 shows one of the final solutions.

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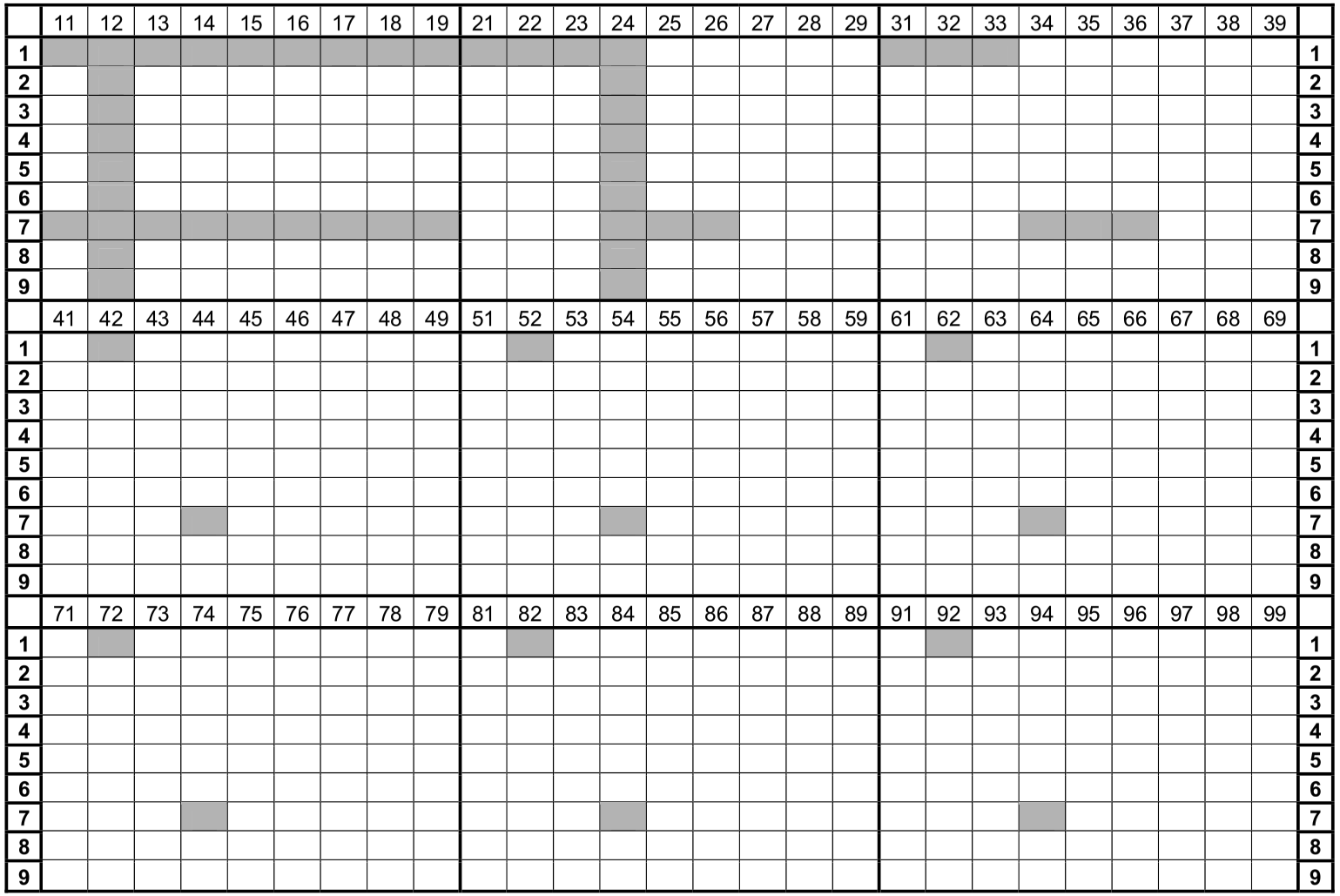
Figure 1.

GAME TABLE
with initial numbers

11	1 12	13	7 14	15	16	17	18	19
21	7 22	23	24	25	1 26	6 27	28	4 29
9 31	32	3 33	34	6 35	36	5 37	1 38	39
5 41	4 42	6 43	44	45	46	8 47	48	49
1 51	52	53	54	4 55	6 56	57	58	59
61	62	63	5 64	65	66	67	4 68	69
71	72	8 73	74	75	76	3 77	2 78	79
81	82	83	3 84	2 85	86	87	9 88	8 89
3 91	92	2 93	94	9 95	8 96	7 97	98	99

Figure 2.
Logic Table
(there are considered only the first two numbers from the first row from the Game Table)



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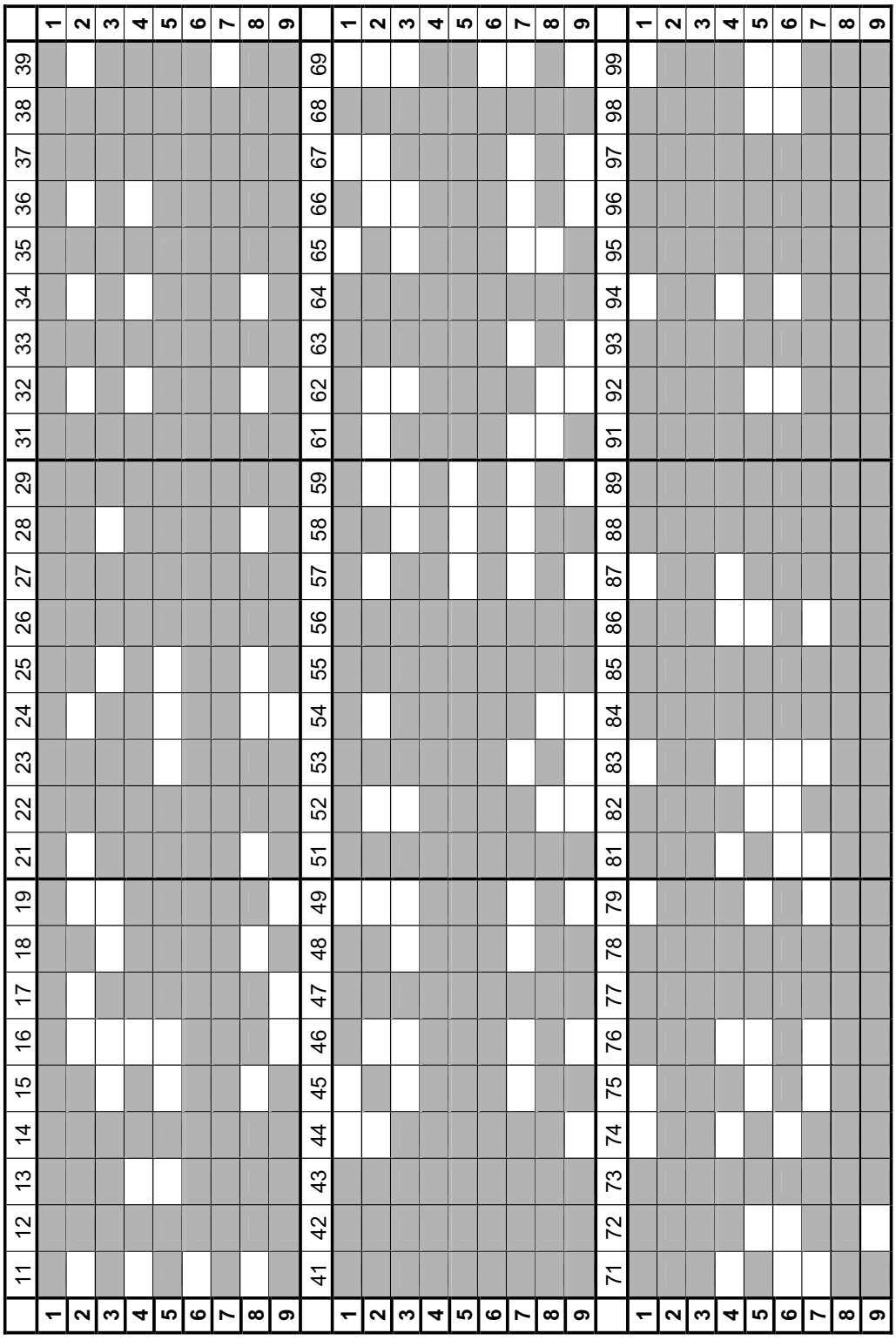

Figure 3.
Logic Table
(all initial numbers from the Game Table are considered)

Figure 4.

GAME TABLE
(cells with initial numbers are shaded)

6_{11}	1_{12}	4_{13}	7_{14}	5_{15}	3_{16}	2_{17}	8_{18}	9_{19}
2_{21}	7_{22}	5_{23}	9_{24}	8_{25}	1_{26}	6_{27}	3_{28}	4_{29}
9_{31}	8_{32}	3_{33}	2_{34}	6_{35}	4_{36}	5_{37}	1_{38}	7_{39}
5_{41}	4_{42}	6_{43}	1_{44}	3_{45}	9_{46}	8_{47}	7_{48}	2_{49}
1_{51}	2_{52}	7_{53}	8_{54}	4_{55}	6_{56}	9_{57}	5_{58}	3_{59}
8_{61}	3_{62}	9_{63}	5_{64}	7_{65}	2_{66}	1_{67}	4_{68}	6_{69}
4_{71}	9_{72}	8_{73}	6_{74}	1_{75}	7_{76}	3_{77}	2_{78}	5_{79}
7_{81}	6_{82}	1_{83}	3_{84}	2_{85}	5_{86}	4_{87}	9_{88}	8_{89}
3_{91}	5_{92}	2_{93}	4_{94}	9_{95}	8_{96}	7_{97}	6_{98}	1_{99}

S U D O K U - GAME TABLE

11	12	13	14	15	16	17	18	19
21	22	23	24	25	26	27	28	29
31	32	33	34	35	36	37	38	39
41	42	43	44	45	46	47	48	49
51	52	53	54	55	56	57	58	59
61	62	63	64	65	66	67	68	69
71	72	73	74	75	76	77	78	79
81	82	83	84	85	86	87	88	89
91	92	93	94	95	96	97	98	99

11	12	13	14	15	16	17	18	19
21	22	23	24	25	26	27	28	29
31	32	33	34	35	36	37	38	39
41	42	43	44	45	46	47	48	49
51	52	53	54	55	56	57	58	59
61	62	63	64	65	66	67	68	69
71	72	73	74	75	76	77	78	79
81	82	83	84	85	86	87	88	89
91	92	93	94	95	96	97	98	99

LOGIC TABLE

	11	12	13	14	15	16	17	18	19	21	22	23	24	25	26	27	28	29	31	32	33	34	35	36	37	38	39	
1																												1
2																												2
3																												3
4																												4
5																												5
6																												6
7																												7
8																												8
9																												9
	41	42	43	44	45	46	47	48	49	51	52	53	54	55	56	57	58	59	61	62	63	64	65	66	67	68	69	
1																												1
2																												2
3																												3
4																												4
5																												5
6																												6
7																												7
8																												8
9																												9
	71	72	73	74	75	76	77	78	79	81	82	83	84	85	86	87	88	89	91	92	93	94	95	96	97	98	99	
1																												1
2																												2
3																												3
4																												4
5																												5
6																												6
7																												7
8																												8
9																												9

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Previous issues of GDF DATABANKS BULLETIN

Year	VOL	NO	Content (titles)	$*)
1997	1	1	Editorial: Databanks – the compulsory language. LOGKOW – a Databank of evaluated octanol-water partition coefficients (James Sangster). Solubility behavior introducing topoenergetic working principles. Comments on 1-octanol-water partition of several n-alkane related series.	F
1997	1	2	Guide of good practice in metrology (Romanian)	AFI
1998	2	1	Editorial: socio-psychological implications in creation and utilization of a databank (Ioan-Bradu Iamandescu); Behavior in vapor-liquid equilibria (VLE): I. Structural aspects; Behavior in vapor-liquid equilibria: II. Several structures in databanks; Symposium on VDC-4 held on 30 October 1997 at Lubrifin-SA, Brasov (Romania).	F
1998	2	2	Practical course of metrology (Romanian)	AFI
1998	2	3	DIFFUTOR-01: Thermally driven diffusion in pure metals	AFI
1998	2	4	VAPORSAT-01: Databanks of thermally driven VLE. The first 100 simple molecules	AFI
1999	3	1	Editorial: New trends in material science: nanostructures (Dan Donescu) DIFFUTOR: Databanks of diffusion kinetics. VAPORSAT: Databanks of vapor-liquid separation kinetics.	F
1999	3	2	Discussions on Applied Metrology	AFI
2000	4	1	Editorial: Laboratory accreditation and inter-laboratory comparisons (Virgil Badescu) Doctoral Theses – important data banks. GDF intends to open new series of experiments on thermo-physical properties. Some comments on uncertainty: global budget and DFT analysis. Events: The 9th International Metrology Congress, Bordeaux, France, 18-21 October 1999.	F
2000	4	2	Measurement and Calibration.	AFI
2001	5	1	Editorial: Metrology ensures moral and technological progress. Topoenergetic aspects of amorphous-crystalline coupling. I. Composite behavior of water and aqueous solutions (paper presented at nanotubes and Nanostructures 2001, LNF, Frascati, Rome Italy, 17-27 October 2001). Events: Nanotubes and nanostructures 2000.School and workshop, 24 September – 4 October 2000, Cagliari, Italy.	F
2001	5	2	Editorial: Viscosity – a symptomatic problem of actual metrology. Visco-Dens Calorimeter: general features on density and viscosity measurements. New vision on the calibration of thermometers: ISOCALT® MOSATOR: Topoenergetic databanks on molten salts properties driven by temperature and composition.	F

continued

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2002	6	1	MOSATOR-01: Topoenergetic databanks for one component molten salts; thermally driven viscosity and electrical conductance.	AFI
2002	6	2	Editorial: HuPoTest - Operator calibration or temporal scale psychic test. MOSATOR: topoenergetic databanks of one component molten salts; thermally driven viscosity and electrical conductance.	F
2002	6	3	Editorial: Quo vadis Earth experiment? ISOCALT® : Report on metrological tests	F
2003	7	1	Editorial: Time – an instrument of the selfish thinking. 1st NOTE: Homoeopathy: upon some efficient physical tests revealing structural modifications of water and aqueous solutions. I. Mixing experiments.	F
2004	8	1	Metrological verification and calibration of thermometers using thermostats type ISOCALT® 21/70/2. Metrological verification and calibration of thermometers using thermostats type ISOCALT® 2.2R.	F
2004	8	2	Aspects of correct measurements of temperature. I. measurement of a fixed point according to ITS-90. Physics and Homoeopathy: some physical requirements for homoeopathic practice.(Plenary lecture at the 19th SRH National Congress, 21-22 September 2004, Bucharest, Romania)	F
2005	9	1	AWARD for ISOCALT® at the International Fair TIB-2004, October 2004, Bucharest. ISOCALT® 3/70/21 was awarded in a selection of 20 products by a commission of experts from the Polytechnic University of Bucharest. Upon some aspects of temperature measurements. (12th International Metrology Congress, 20-23 June 2005, Lyon, France)	F
2005	9	2	A new technique for temperature measurement and calibration. National Society of Measurements (NSM). Important warning for T-calibrator users: MSA has chose metrology well calibrators from Fluke (Hart Scientific).	F
2005	9	3	Universal representation of Cancer Diseases. 1. First sight on NSW-2003 report. Universal representation of Cancer Diseases. 2. UK cancer registrations on 1999-2002. Vital Potential can estimate our predisposition for cancer diseases.	F
2006	10	1	NTC – thermistors -1	AFI
2007	11	1	HuPoTest - 40 years of continuous research Basic rules for preventing and vanishing cancer diseases Climate change = change of mentality Hot nuclear fusion – a project of actual mentality	F
2007	11	2	MT – Introduction to Mental Technology HuPoTest – general procedure, assignments of results, specimen of complete test , order and obtain your complete HuPoTest report	F

Year	VOL	NO	Content (titles)	$*)
2007	11	3	TRESISTOR© - data banks of materials with thermally driven electric and magnetic properties TRESISTOR© - NTC -1 - data bank of NTC thermistors	AFI
2008	12	1	Australian population: life, death and cancer	F
2008	12	2	Pattern of Cancer Diseases	F
2008	12	3	Adiabatic calorimetry – summary description of the demo prototype	F
2008	12	4	Flight QF 30 and even more… Temperature calibration of NTC-thermistors. 1.Preliminary results.	F
2009	13	1	Proposal for interlaboratory comparisons. Calibration of NTC-thermistors (The 14th International Metrology Congress, Paris, France, 22-25 June 2009)	F

*) F=free, AFI=ask for invoice.

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