Advanced School on Non-linear Dynamics and Earthquake Prediction

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Analysis of Earthquake Catalogs

Exercises

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I. WRITTEN EXERCISES

1.1 SEPARATION OF THE CATALOG INTO MAIN SHOCKS AND AFTERSHOCKS

Definition of aftershocks

Consider two earthquakes: one with the origin time t_1 and magnitude M_1, and another with the origin time t_2, and magnitude M_2. The second earthquake is an aftershock of the first one if the following conditions are satisfied:

$0 \le t_2 - t_1 \le T(M_1)$

$M_2 \le M_1$

$r \le R(M_1)$, where r is the distance between their epicenters.

$h \le H(M_1)$, where h is the difference between the depths of the sources.

Here $T(M_1)$, $R(M_1)$, $H(M_1)$ are empirical functions.

The algorithm of separation of main shocks and aftershocks

The first earthquake in the catalog has to be counted as a main shock. Its aftershocks are identified and excluded from the catalog. The first remaining earthquake is the second main shock, etc.

Exercise 1: Separate the catalog in Table 1 into main shocks and aftershocks. Use the following empirical functions:
$T(M_1) = 2$ years, $R(M_1) = 100$ km, $H(M_1) = 10$ km.

Note: Different main shocks may have a common aftershock. The algorithm described above may indicate different main shocks to the same aftershock. The computer program assigns such aftershock to the strongest main shock. If these main shocks have equal magnitudes - the aftershock is assigned to the latest main shock.

TABLE 1

#	Date	φ^o	λ^o	M
1	1970.1.1	60	124.3	6.1
2	1970.1.3	60	124.0	5.9
3	1970.1.4	60	124.3	3.2
4	1970.1.4	60	125.3	6.2
5	1970.1.5	60	117.4	3.6
6	1970.1.6	60	124.9	6.0
7	1970.1.7	60	123.9	4.0
8	1970.1.7	60	125.0	4.8
9	1970.1.8	60	125.2	5.7
10	1970.1.9	60	125.8	6.6
11	1970.1.9	60	116.8	7.4
12	1970.1.10	60	124.3	4.5
13	1971.4.18	60	123.9	6.1
14	1971.6.20	60	124.2	4.2
15	1972.6.25	60	117.0	7.3
16	1972.7.28	60	116.9	6.5
17	1973.2.12	60	117.2	6.1
18	1973.2.13	60	119.9	6.3
19	1973.2.13	60	116.5	7.0
20	1973.2.14	60	119.4	6.0
21	1973.2.15	60	116.9	6.3
22	1974.8.11	60	124.3	3.1

All the earthquakes are normal (h_i = 33 km).
Let us remind you that 1^o of the Earth meridian is equal to 40 000 km / 360 = 111.11 km, by definition.
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1.2 THE COUNT OF AFTERSHOCKS

Consider the main shocks with $M_0 - a_2 \le M \le M_0 - a_1$. For each main shock $b(e)$ is the number of its aftershocks with $M \ge M_0 - a_3$ during the first e days.

A strong earthquake (with $M \ge M_0$, and which is not an aftershock of the stronger one) terminates the count of function $b(e)$, but not the identification of main shocks and aftershocks. In other words, it may happen that $t_i \le t_j \le t_i + e$, where t_j is the moment of a strong earthquake and t_i is the moment of a main shock under consideration. In this case the count is terminated just before t_j.

Exercise 2: Count $b(e)$ for each main shock in Table 1. (The main shocks and aftershocks were identified in previous ***Exercise 1***). Use e = 2 days, M_0 = 7, a_1= 0.1, a_2 = 1 and a_3 = 3.5.

1.3 BURST OF AFTERSHOCKS

This is a distraction from our major purpose, but it is useful for research in earthquake prediction. Let us diagnose an approach of a strong earthquake by the premonitory seismicity pattern called "**burst of aftershocks**" or "**pattern B**". The occurrence of this pattern starts a period of alarm, so called **Time of Increased Probability** of a strong earthquake or **TIP**.

We diagnose the occurrence of **pattern B**, when for some main shock $b(e) \geq B$, and assume that the duration of a **TIP** equals to 3 years.

To choose the threshold B one may use the histogram of values of b. B should be chosen near a minimum of the histogram; otherwise the diagnosis of pattern B will not be stable due to possible uncertainties in the choice of B.

Another condition on B: the number of **patterns B** should not be too small (preferably not less than the number of strong earthquakes) nor too large (to have the **TIP**s not more than about 1/3 of all time).

Exercise 3: Given is the catalog of strong and main shocks with values of $b(e)$ (Table 2). Make the histogram of the values of $b(e)$ and choose the value of ***B***. The histogram has to be made with a grouping interval equal to 2.

TABLE 2

Date	φ^o	λ^o	Depth	M	b
1962.07.30	-3.40	143.70	33	6.88	2
1963.08.14	-3.40	135.40	33	6.99	0
1964.01.01	-3.20	139.70	33	6.88	0
1968.10.23	-3.33	143.25	12	6.80	3
1970.10.31	-4.93	145.47	42	7.00	16
1970.11.08	-3.44	135.63	33	6.80	5
1971.01.10	-3.13	139.70	33	8.10	(strong shock)
1976.06.25	-4.60	149.09	33	7.10	19
1976.10.29	-4.52	139.92	33	7.20	4
1979.09.12	-1.68	136.04	5	7.90	(strong shock)
1980.07.16	-4.46	143.52	84	7.10	0

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1.4 DETERMINATION OF MAGNITUDE THRESHOLDS

Let m_1, m_2, and m_3 be three values of lower magnitude thresholds. Each value is selected from the condition: $N(m_i) = c_i$. Here $i = 1$, 2, and 3; $N(m_i)$ is the number of main shocks with $M \geq m_i$ within all the time considered; c_i is a numerical parameter. (In the description of algorithms the average annual number of main shocks (a) is used instead of N.)

Exercise 4: Using the catalog of main shocks (Table 3) make a two-dimensional distribution of the number of earthquakes for the period from 1967.05.25.15:00 through 1980.05.25.15:00 with a 1 year step and for magnitudes $4.9 \leq M < 6.7$ with a 0.1 step. Present the result in the table below:

Time*	Magnitude																		Sum in a line
	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	
1965.05.25	1			1															2
1966.05.25								1							1				2
1967.05.25																			
1968.05.25																			
1969.05.25																			
1970.05.25																			
1971.05.25																			
1972.05.25																			
1973.05.25																			
1974.05.25																			
1975.05.25																			
1976.05.25																			
1977.05.25																			
1978.05.25																			
1979.05.25																			
Sum in a column																			

*The time indicated in a line corresponds to the beginning of 1 year time interval.

TABLE 3

Year	month	date	hour	minute	φ^o	λ^o	Depth	*M*	*b*
1965	9	25	17	43	34.70	-116.50	10	5.20	4
1965	10	17	9	45	33.97	-116.77	17	4.90	6
1966	6	28	4	26	35.90	-120.53	18	5.60	17
1966	8	7	17	36	31.80	-114.50	0	6.30	0
1967	9	21	0	1	31.42	-115.95	1	5.20	1
1968	4	9	2	28	33.18	-116.12	11	6.40	57
1968	7	5	0	45	34.12	-119.70	5	5.20	10
1969	3	20	8	16	31.40	-114.00	0	5.20	0
1969	3	20	8	17	31.30	-114.20	0	5.70	12
1969	3	23	11	32	31.40	-115.00	0	5.20	0
1969	6	10	3	41	31.62	-116.20	2	5.00	0
1969	10	3	13	10	37.62	-118.92	2	4.90	0
1969	10	22	22	51	34.57	-121.62	10	5.40	17
1969	10	24	8	29	33.28	-119.18	10	5.10	10
1969	11	5	17	54	34.60	-121.43	10	5.60	8
1970	1	19	7	16	31.48	-115.97	10	4.90	0
1970	9	12	14	30	34.27	-117.53	8	5.40	8
1971	2	9	14	0	34.40	-118.40	8	6.40	210
1971	9	30	22	46	33.03	-115.82	8	5.10	9
1973	2	21	14	45	34.05	-119.03	8	5.90	9
1973	10	16	14	53	31.60	-115.82	8	4.90	3
1975	6	1	1	38	34.50	-116.48	4	5.20	8
1975	7	17	18	24	31.92	-115.77	17	5.00	6
1976	12	7	12	59	31.97	-114.77	8	5.00	0
1978	5	5	21	3	32.20	-115.30	6	5.20	4
1978	8	13	22	54	34.33	-119.68	12	5.10	19
1978	10	4	16	42	37.50	-118.67	5	5.80	55
1979	1	1	23	14	33.93	-118.67	11	5.00	18
1979	3	15	20	17	34.30	-116.43	2	4.90	1
1979	3	15	21	7	34.32	-116.43	2	5.20	28
1979	10	15	23	16	32.60	-115.32	12	6.60	359
1980	2	25	10	47	33.50	-116.50	13	5.50	6
1980	5	25	16	33	37.60	-118.62	3	6.40	80
1980	5	25	19	44	37.55	-118.78	6	6.50	288

Exercise 5: Using the result of previous ***Exercise 4***, find the values m_1, m_2, and m_3 from the following conditions:

within period 1965.05.25.15:00 - 1980.05.25.15:00
32 main shocks had $M \geq m_1$,
12 main shocks had $M \geq m_2$,
4 main shocks had $M \geq m_3$.

In other words, find m_1, m_2, and m_3 for $c_1 = 32$, $c_2 = 12$ and, $c_3 = 4$. Calculate also the average annual number of main shocks (a) for obtained m_1, m_2, and m_3.

Exercise 6: Using the result of ***Exercise 5***, find distributions of the number of main shocks with $M \geq 4.9$, $M \geq 5.3$, and $M \geq 6.2$ separately within the period from 1967.05.25.15:00 through 1980.05.25.15:00 with a 1 year step.
Present the result in the table below:

Time	Magnitude		
	$M \geq 4.9$	$M \geq 5.3$	$M \geq 6.2$
1965.05.25	2		
1966.05.25	2	2	1
1967.05.25			
1968.05.25			
1969.05.25			
1970.05.25			
1971.05.25			
1972.05.25			
1973.05.25			
1974.05.25			
1975.05.25			
1976.05.25			
1977.05.25			
1978.05.25			
1979.05.25			

1.5 FUNCTIONS

In ***Exercises 7*** and ***8*** the time step is 1 year, $m_1 = 4.9$, $m_2 = 5.3$, $m_3 = 6.2$, and $M_0 = 6.4$. The functions have to be calculated at the moment t' = 1980.05.25.15:00 for the catalog of the main shocks from Table 3. The results of ***Exercise 6*** in Section 1.4 are useful for these calculations. The functions and their definitions are listed in Table 4.

Exercise 7: Using definitions from Table 4 calculate N1(t'), N3(t'), SIGMA(t') (use also Table 5), G(t'), q(t') (take $a_2 = 1.4$), Q(t'), V(t'), K(t'), L(t') (assume $l_2 = 58$, $t' - t_0 = 48$ years, and get l_1 from Table 3), Smax(t') (use the result of ***Exercise 6*** from Section 1.4), Bmax(t') (the number of aftershocks $b(e)$ is given in the b column of Table 3).

Exercise 8: Use the following list of strong earthquakes:

1971.02.09.14:00 $M = 6.4$,
1976.11.26.11:19 $M = 6.8$,
1979.10.15.23:16 $M = 6.6$.

Find all the long-range aftershocks in the catalog (Table 3) in the time interval ((t' - 3 years), t') and calculate Ml(t').

TABLE 4

Name of function in computer dialog (program **FUNC**)	Definition
N1(t)	The number of main shocks with magnitude $M \geq m_2$, which occurred from (t - 6 years) to t.
N3(t)	The number of main shocks with magnitude $M \geq m_2$, which occurred from (t - 10 years) to (t - 7 years).
SIGMA(t)	SIGMA(t) = $\Sigma 10^{\beta(M_1 - \alpha)}$ The main shocks with $m_1 \leq M_i \leq M_0 - 0.1$ and the origin time (t - 3 years) $\leq t_i \leq t$ are included in summation; $\alpha = 4.5$, $\beta = 1.00$.
G(t)	G(t) = 1 - P, where P is the ratio of the number of the main shocks with $M_i \geq m_2$ to the number of the main shocks with $M_i \geq m_1$. Only the main shocks with the origin time t_i, which satisfies the condition (t - 3 years) $\leq t_i \leq t$, are considered.
q(t)	q(t)= $\sum_{j=1}^{6} \max\{0, \text{ENTIRE}(A - n_j)\}$, where $A = 6a_2$, a_2 is the average annual number of main shocks with $M \geq m_2$ in the catalog, n_j is the number of main shocks with $M_i \geq m_2$ and origin time (t - (8 + j) years) $\leq t_i \leq$ (t - (2 + j) years).
Q(t)	Q(t) = $\sum_{j=2}^{j^*} \lvert n_j - n_{j-1} \rvert$, where n_j is the number of main shocks with $M_i \geq m_1$ and (t - j years) $\leq t_i <$ (t - (j - 1) years); j^* is the first number j for which: $n_j > n_{j-1}$ and $n_j > n_{j+1}$ (if there are no such n_j for j = 2, 3, ..., 15 then j = 15).
V(t)	V(t) = $\sum_{j=2}^{7} \lvert n_j - n_{j-1} \rvert$, where n_j is the same as in definition of Q(t).
K(t)	K(t) = $K_1 - K_2$, where K_j is the number of main shocks with $M_i \geq m_2$ and origin time (t - 2j years) $\leq t_i \leq$ (t - 2(j - 1) years).

TABLE 4 (continuation)

Name of function in computer dialog (program **FUNC**)	Definition
L(t)	L(t) = l_1 - $\frac{l_2(t - t_0)}{t - t_0 - 6\,\text{years}}$, where t_0 is the beginning of the catalog, l_1 is the number of main shocks with $M_i \geq m_2$ between t_0 and t, l_2 is the similar number for the period between t_0 and (t - 6 years),
Smax(t)	Smax(t) = max$\{S_1/N_1, S_2/N_2, S_3/N_3\}$, where S_j is calculated by the same formula as SIGMA(t) for the events with the origin time (t - j years) $\leq t_i \leq$ (t - (j - 1) years), and N_j is the number of terms in the sum.
Bmax(t)	The maximal number of aftershocks for the main shocks with $M_i \geq m_1$ and origin time within ((t - 3 years), t). Aftershocks are counted for the first 2 days (e = 2 days) after the main shock.
Ml(t)	The maximal magnitude of the long-range aftershocks in the region under consideration within the time interval from (t - 3 years) to t. A long-range aftershock is a main shock with $M_i \geq m_1$, which follows a strong ($M \geq M_0$) main shock in the region or in its neighborhood within 1 year.

Notes: 1) The addition or subtraction of a year in the program does not change the month, day, and hour.

2) Almost all functions are defined here with the same values of numerical parameters as in the original design of the algorithms. These values may be changed in applications with an adequate attention to the danger of data-fitting. We would recommend to assume B and corresponding values of β in accordance with preferred magnitude-energy relation lg$E = A + BM$.

TABLE 5 Function $10^{\beta(M-\alpha)}$ for α = 4.5 and β = 1.00

M	$10^{\beta(M-\alpha)}$	M	$10^{\beta(M-\alpha)}$	M	$10^{\beta(M-\alpha)}$	M	$10^{\beta(M-\alpha)}$
4.5	1.00	5.0	3.16	5.5	10.00	6.0	31.62
4.6	1.26	5.1	3.98	5.6	12.59	6.1	39.81
4.7	1.58	5.2	5.01	5.7	15.85	6.2	50.12
4.8	2.00	5.3	6.31	5.8	19.95	6.3	63.10
4.9	2.51	5.4	7.94	5.9	25.12	6.4	79.43

II. WRITTEN EXERCISES: ANSWERS

Exercises 1, 2:

Main shocks	Aftershocks	$b(e)$
1	2, 3	1
4	6, 7, 8, 9, 13	1
5		weak
10	12, 14	0
11		strong
15	16, 17, 19, 21	strong
18	20	1
22		weak

Exercise 3: Any number between 6 and 15.

Exercise 4:

Time*	Magnitude																		Sum in a line
	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	
1965.05.25	1			1															2
1966.05.25								1							1				2
1967.05.25				1												1			2
1968.05.25				3					1										4
1969.05.25	2	1	1			1		1											6
1970.05.25						1										1			2
1971.05.25			1																1
1972.05.25											1								1
1973.05.25	1																		1
1974.05.25																			0
1975.05.25		1		1															2
1976.05.25		1																	1
1977.05.25				1															1
1978.05.25	1	1	1	1						1									5
1979.05.25							1											1	2
Sum in a column	5	4	3	8	0	2	1	2	1	1	1	0	0	0	1	2	0	1	32

Exercise 5: $m_1 = 4.9$, $m_2 = 5.3 \div 5.4$, $m_3 = 6.0 \div 6.3$,
$a_1 = 2.1$, $a_2 = 0.8$, $a_3 = 0.27$

Exercise 6:

Time	Magnitude		
	$M \geq 4.9$	$M \geq 5.3$	$M \geq 6.2$
1965.05.25	2		
1966.05.25	2	2	1
1967.05.25	2	1	1
1968.05.25	4	1	
1969.05.25	6	2	
1970.05.25	2	2	1
1971.05.25	1		
1972.05.25	1	1	
1973.05.25	1		
1974.05.25			
1975.05.25	2		
1976.05.25	1		
1977.05.25	1		
1978.05.25	5	1	
1979.05.25	2	2	1

Exercise 7: N1(t') = 3, N3(t') = 3, SIGMA(t') = 49.62,
G(t') = 0.625, q(t') = 18, Q(t') = 3,
V(t') = 11, K(t') = 3, L(t') = -5.29,
Smax(t') = 10.00, Bmax(t') = 359

Exercise 8: There is only one long-range aftershock:
1980.02.25 $M = 5.5$.

Ml(t') = 5.5

III. COMPUTER EXERCISES

EXERCISE 1

Task: Create the catalog of main shocks with statistics of aftershocks for the earthquake catalog of Southern California.
Program to use: **AFT.**
Input files: profile - no,
file with the input catalog - SCALIF28.DAT.
Input data: start from the 1st record,
time from 1932 1 1 0 0 to 1988 1 1 0 0,
use common magnitude which equals to maximum of mb, ms, mp and ml (transformation coefficients for all of them are equal to 1.0 and 0.0),
no limitations on magnitude and area,
depth from -10 to 100,
coefficients c, d, f for calculation of SIGMA - 1.0, 0.77, 4.5,
threshold magnitude for strong shocks - 9.0,
limitations for selection of aftershocks are the same for the whole main shocks magnitude interval:
for magnitude - absolute from 0.0 to the magnitude of the main shock,
for depth - no limitations,
for distance - absolute 50.0,
identification time for selection of aftershocks is different for 7 subintervals of main shock magnitude covering magnitudes from 0.0 to 9.0, the function b(e) is calculated for two time intervals e=T1 and e=T2:

magnitude subinterval	identification time	T1	T2
from 0.00 to 2.79	11 days	2 days	11 days
from 2.79 to 3.40	23 days	2 days	23 days
from 3.40 to 4.00	46 days	2 days	46 days
from 4.00 to 4.40	91 days	2 days	91 days
from 4.40 to 5.40	182 days	2 days	182 days
from 5.40 to 6.40	1 year	2 days	1 year
from 6.40 to 9.00	2 years	2 days	2 years

type - on, print - on, type SIGMA - off,
minimum number of aftershocks to type and print a main shock – 15.
Create output catalog of main shocks in file with name MAIN.DAT,
create output profile with name MAIN.AFT.

EXERCISE 2

Task: For the catalog of main shocks created in Exercise 1 make the two-dimensional histogram for the time period 1932-1986 with the number of aftershocks as a horizontal axis and the time as a vertical axis and with the counts of the number of main shocks.
Note that records of a catalog of main shocks contain the number of aftershocks divided by 100 in the ms (= m2) position so that the number of aftershocks can be obtained as a common magnitude, which values are defined as equal to ms*100 (i.e., m2*100).
Program to use: **CompiCat.**

Input files: import the input catalog - MAIN.DAT (created by AFT in Exercise 1).
Input data: *Draw histograms* mode with
limitations on m2 (=ms) - from 0. to 3.6.
horizontal Axis X – m2 with min: 0.0 and max: 3.6, and number of intervals: 73;
vertical Axis Y – Years with min: 1932 and max: 1986, and number of intervals: 55;
count Weight - off.
Draw 2-D histogram: view temporal distribution of the number of aftershocks; highlight isolated occurrence of high numbers by switching to Log scale.
Draw 1-D histogram (Axis X, frequencies of earthquakes): view histogram of the number of aftershocks over the entire catalog time span. For a better view of the tail of the histogram, change Axis X min to 0.20 and switch scale back to linear.
For your reference make PDFs of the results.

EXERCISE 3

Task: Select the subcatalog of the main shocks in Southern California (created in Exercise 1), which epicenters fall inside polygon defined below (i.e., Region 1) and which magnitude is 4.5 or above.
Program to use: **CompiCat.**
import the input catalog - MAIN.DAT (created by AFT in Exercise 1).
Input data: *Select* mode with
limitations on m1 (= mb) - from 4.5 to 9.0 -
and area inside the polygon with 11 vertices :
(latitude, longitude): (31.25, -113.), (32., -113.),
(34., -115.), (36., -116.), (38., -117.), (38., -119),
(37., -120.4), (35.5, -123.), (33.75, -121.5),
(31.25, -119), (31.25, -116.25).
Create output subcatalog and export it in the 20 bytes binary format under the name REG1.DAT (to be used by **FUNC** later).

EXERCISE 4

Task: Create the subcatalog of larger magnitude main shocks with m1 $\geq$ 4.9 in the time interval from 25.09.1965 to 26.05.1980 inside Region 1 (just selected in the previous exercise).

Program to use: **CompiCat.**
import the input catalog – REG1.DAT (created in Exercise 3).

Input data: *Select* mode with
limitation on m1 (= mb) - from 4.9 to 9.0.
Create output subcatalog and export it in the ASCII 68 bytes catalog standard format under the name REG1-L.68bytes.

View the file REG1-L.68bytes and compare it with Table 3 of Section 1.4 of the written exercises.

EXERCISE 5

Task: For the subcatalog selected in Exercise 4 make the 2-D histogram with the magnitude as a horizontal axis and the time as a vertical axis that accounts the number of earthquakes.

Program to use: **CompiCat.**
import the catalog – REG1-L.68bytes (created in Exercise 4).

Input data: *Draw histograms* mode
horizontal Axis X – m1 with min: 4.85 and max: 6.65, and number of intervals: 18;
vertical Axis Y – Years with min: 1965.398 and max: 1980.398, and number of intervals: 15;
count Weight - off.

1) *Draw 2-D histogram*: view temporal distribution of the number of aftershocks.

Make PDF of the histogram and compare it with the answer to Exercise 4 of Section 1.4 of the written exercises.

2) *Draw 1-D histogram (Axis Y, frequencies of earthquakes)*: view temporal distribution of the number of main shocks. Change Axis X – m1 min to 5.25 then to 6.15 and each time *Draw 1-D histogram (Axis Y, frequencies of earthquakes).*

Make the three PDFs of the 1-D histograms and compare them with the answer to Exercise 6 of Section 1.4 of the written exercises.

EXERCISE 6

Task: To calculate values of functions on seismic flow using the catalog of main shocks of the first region of the Southern California (file REG1.DAT created in Exercise 3) and the catalog of enough strong earthquakes of California (file CAL6.DAT). Compare the values of functions obtained for the object 1805 with the answers to Exercises 7 and 8 of Section 1.5 of the written exercises.

Program to use: **FUNC.**

Input files: profile - no,
common name of files with regional catalogs of main shocks - REG.DAT.

Output profile: EX14.PAT.

Input data: list of regions: 1,
time from 1932 5 25 16 33 to 1984 1 1 1 0,
skipping to 1938 5 25 16,
learning to 1984 1 1 0,
threshold magnitude for strong shocks - 6.4,
dates of objects are set by step from 1938 5 25 16 to 1984 1 1 1 with step 1 year,
list of functions to calculate:

#	name	time	magnitude
1	N1	6	m2
3	K	2	m2
4	G	3	m2
5	SIGMA	3	m1
6	Smax	3	m1
9	N3	3	m2
10	L	6	m2
11	q	6	m2
12	Ml	3	m1
13	Bmax	3	--
14	Q	1	m1
15	V	6	m1
21	SIGTH	3	m1

(see definitions of functions in the user's guide to the program FUNC).

Maximum magnitude for calculation of SIGMA - 6.3,
coefficients for calculation of SIGMA and SIGTH:
C=1., D=1., F=4.5,
maximum magnitude for calculation of Smax - 6.3,
coefficients for calculation of Smax: C=1., D=1., F=4.5,
file with catalog for selection of long range aftershocks - CAL6.DAT,
threshold magnitude for long range aftershocks - 6.4,
magnitude thresholds: m1=4.9, m2=5.3, m3=6.2,
type - on, print - on, type all objects.

EXERCISE 7

Task: To calculate values of functions on seismic flow using the catalog of main shocks of the first region of the Southern California (file REG1.DAT created in Exercise 3) and the catalog of enough strong earthquakes of California (file CAL6.DAT). Dates of objects have to be set by list according to the input profile REGL1.PAT.

Program to use: **FUNC.**

Input files: profile - REGL1.PAT,
common name of files with regional catalogs of main shocks - REG.DAT.

Output profile: EX15.PAT.

Input data: list of regions: 1,
time from 1932 1 1 0 0 to 1984 1 1 1 0,
skipping to 1938 1 1 1,
learning to 1984 1 1 0,
threshold magnitude for strong shocks - 6.4,
dates of objects are set by list according to the input profile REGL1.PAT (see printout for this exercise), calculate " Standard CN" set of functions:

#	name	time	magnitude
2	N2	3	m3
3	K	2	m2
4	G	3	m2
5	SIGMA	3	m1
6	Smax	3	m1
8	Zmax	3	m1
9	N3	3	m2
11	q	6	m2
13	Bmax	3	--
21	SIGTH	3	m1

maximum magnitude for calculation of SIGMA - 6.3,
coefficients for calculation of SIGMA and SIGTH:
C=1., D=1., F=4.5,
maximum magnitude for calculation of Smax - 6.3,
coefficients for calculation of Smax: C=1., D=1.,
F=4.5,
maximum magnitude for calculation of Zmax - 6.3,
coefficients for calculation of Zmax: C=1., D=0.5,
F=4.5,
magnitude thresholds: m1=4.9, m2=5.3, m3=6.2,
type - on, print - on, type all objects.

EXERCISE 8

Task: To calculate values of functions on seismic flow using the catalog of main shocks of the first region of the Southern California (file LREG1.DAT) and the catalog of enough strong earthquakes of California (file CAL6.DAT). Dates of objects have to be set with time step 2 months.

Program to use: **FUNC.**

Input files: profile - REGL1.PAT,
common name of files with regional catalogs of main shocks - LREG.DAT.

Output profile: EX16.PAT.

Input data: list of regions: 1,
time from 1932 1 1 0 0 to 1991 1 1 0 0,
skipping to 1938 1 1 1,
learning to 1984 1 1 0,
threshold magnitude for strong shocks - 6.4,
dates of objects are set by step from 1938 1 1 0 to 1990 1 1 0 with step 2 months,
calculate " Standard CN" set of functions:

#	name	time	magnitude
2	N2	3	m3
3	K	2	m2
4	G	3	m2
5	SIGMA	3	m1
6	Smax	3	m1
8	Zmax	3	m1
9	N3	3	m2
11	q	6	m2
13	Bmax	3	--
21	SIGTH	3	m1

maximum magnitude for calculation of SIGMA - 6.3,
coefficients for calculation of SIGMA and SIGTH: C=1., D=1., F=4.5,
maximum magnitude for calculation of Smax - 6.3,
coefficients for calculation of Smax: C=1., D=1., F=4.5,
maximum magnitude for calculation of Zmax - 6.3,
coefficients for calculation of Zmax: C=1., D=0.5, F=4.5,
definition of magnitudes m1, m2, m3, by using the average annual numbers of events: a1=3., a2=1.4, a3=0.4,
type - on, print - off, protocol - on, type all objects.

LIST OF PROGRAMS WITH THEIR FUNCTIONS AND INPUT AND OUTPUT FILES

NAME OF PROGRAM	MAIN FUNCTIONS	NAMES OF INPUT FILES		NAMES OF OUTPUT FILES	
		PROFILE	files with information	for other programs	for printer
CompiCat	Reformatting and testing of catalogs; Selection of subcatalogs; Construction of histograms	*.pro	Catalogs in a number of supported formats (upgradeable)	*.DAT file with a catalog	*.68bytes (ASCII text); *.PS, *.PDF, *.CSV (Comma Separated Values)
AFT	Selection of aftershocks and creation of a catalog of main shocks	*.AFT	*.DAT file with a catalog	*.DAT file with a catalog of main shocks	AFT.PRI
FUNC	Calculation of values of functions on an earthquake flow	*.PAT	*.DAT files with catalogs of main shocks	*.PAT file with values of functions	PRO.PRI FUN.PRI

IV. RESULTING PRINTOUTS FOR COMPUTER EXERCISES

Exercise 1 (AFT.PRI)

Printout of Aftershocks
Input catalog scalif28.dat - format20
Catalog has 19668 events
1: You start in input catalog from 1 event
Time(yr,mo,d,hr,mi) from 1932 1 1 0 to 1988 1 1 0
2: Blank magnitude - 0.00
Coeff. for magn.
mb- 1.00, 0.00,ms- 1.00, 0.00,ml- 1.00, 0.00,mp- 1.00, 0.00
Priority -max
3: Min, max magnitude : 0.00, 9.00
depth : -10, 100
4: No limit on area
5: Coeff. c,d,f - 1.00, 0.77, 4.50
6: Magnitude of strong shock : 9.00
7: Magnitude of main shock - from 0.00 to 9.00
8: Limits for selection of aftershocks:

9: Interval		10: Magnitude	11: Depth	12: Distance
0.00	2.79	0.00		50.00
2.79	3.40	0.00		50.00
3.40	4.00	0.00		50.00
4.00	4.40	0.00		50.00
4.40	5.40	0.00		50.00
5.40	6.40	0.00		50.00
6.40	9.00	0.00		50.00
		Mono Abs	No Abs	Mono

13: Intervals of time for selection of aftershocks

Interval		Time			Time1			Time2			Time3			Time4			Time5		
0.00	2.79	0	11	0	0	2	0	0	11	0	0	0	0	0	0	0	0	0	0
2.79	3.40	0	23	0	0	2	0	0	23	0	0	0	0	0	0	0	0	0	0
3.40	4.00	0	46	0	0	2	0	0	46	0	0	0	0	0	0	0	0	0	0
4.00	4.40	0	91	0	0	2	0	0	91	0	0	0	0	0	0	0	0	0	0
4.40	5.40	0	182	0	0	2	0	0	182	0	0	0	0	0	0	0	0	0	0
5.40	6.40	1	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0
6.40	9.00	2	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0

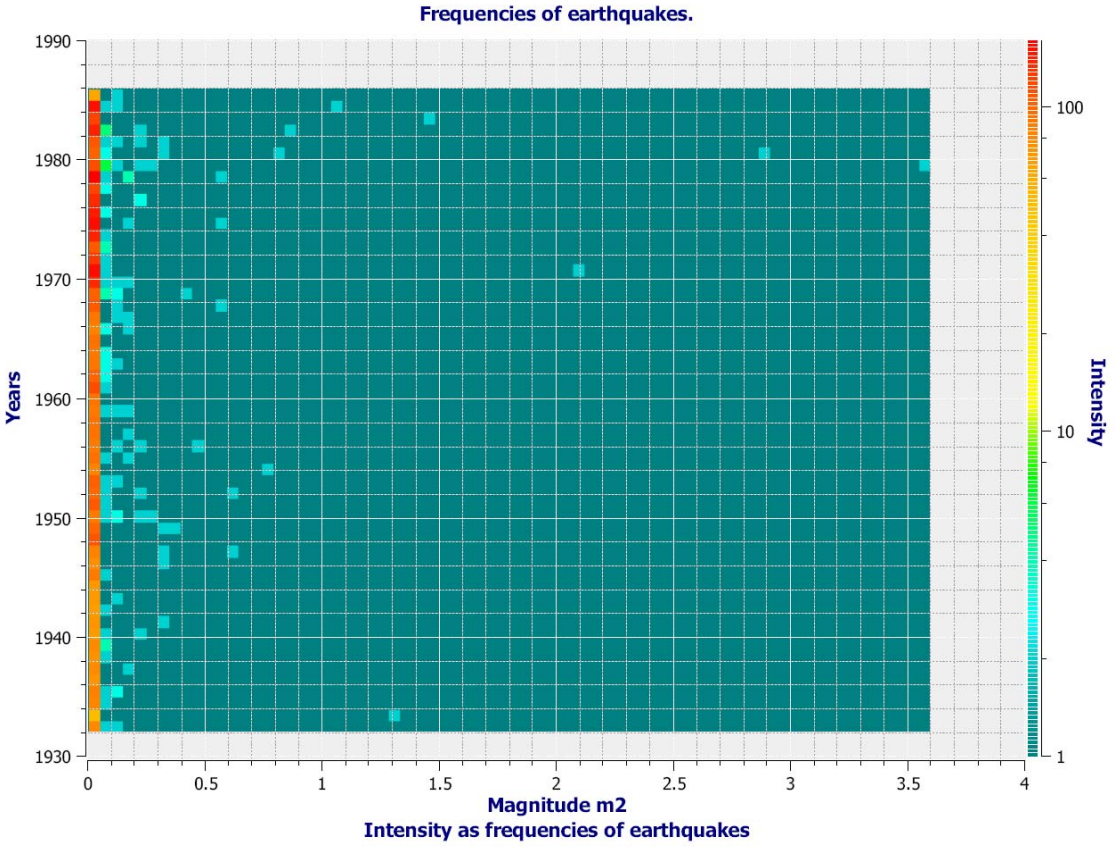
14: Type output - y; print output - y
15: Type Sigma - n
16: Min number of aftershocks for type, print- 15
17: Output catalog - main.dat; format :20
18: Output profile - main.aft

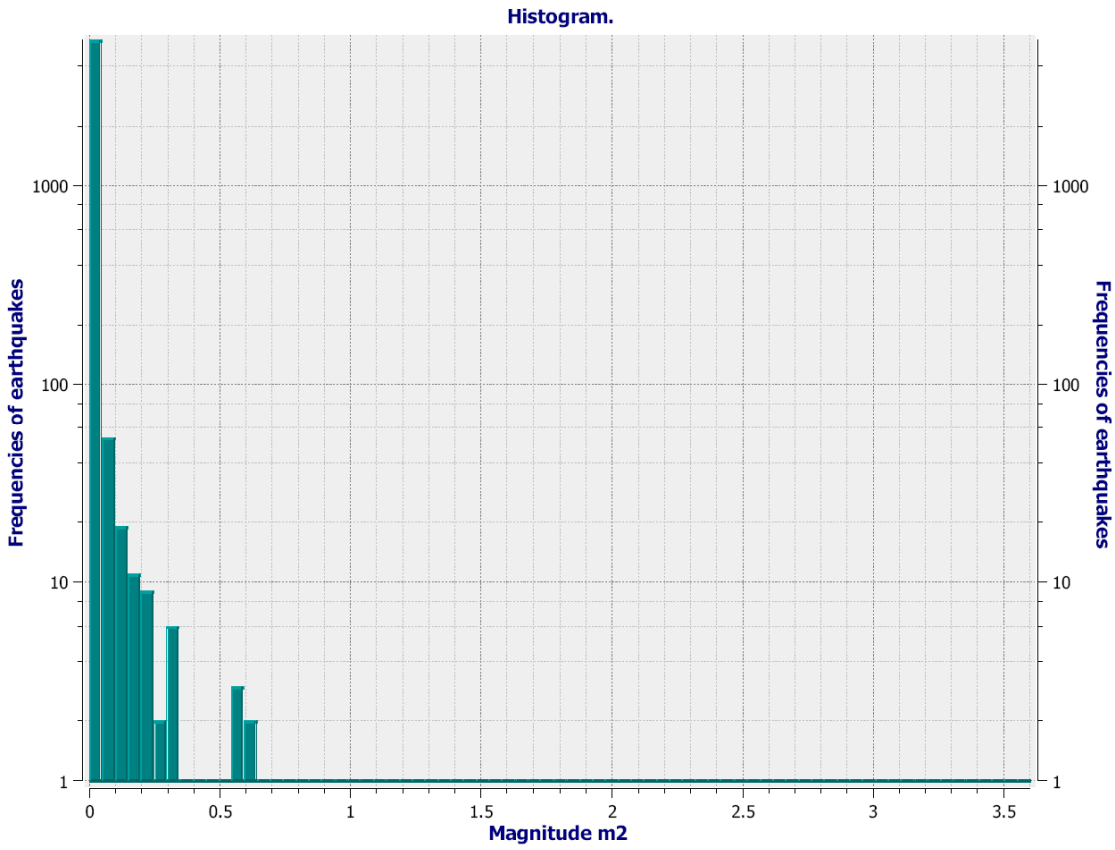
printout of catalogue of main shocks selected from file scalif28.dat

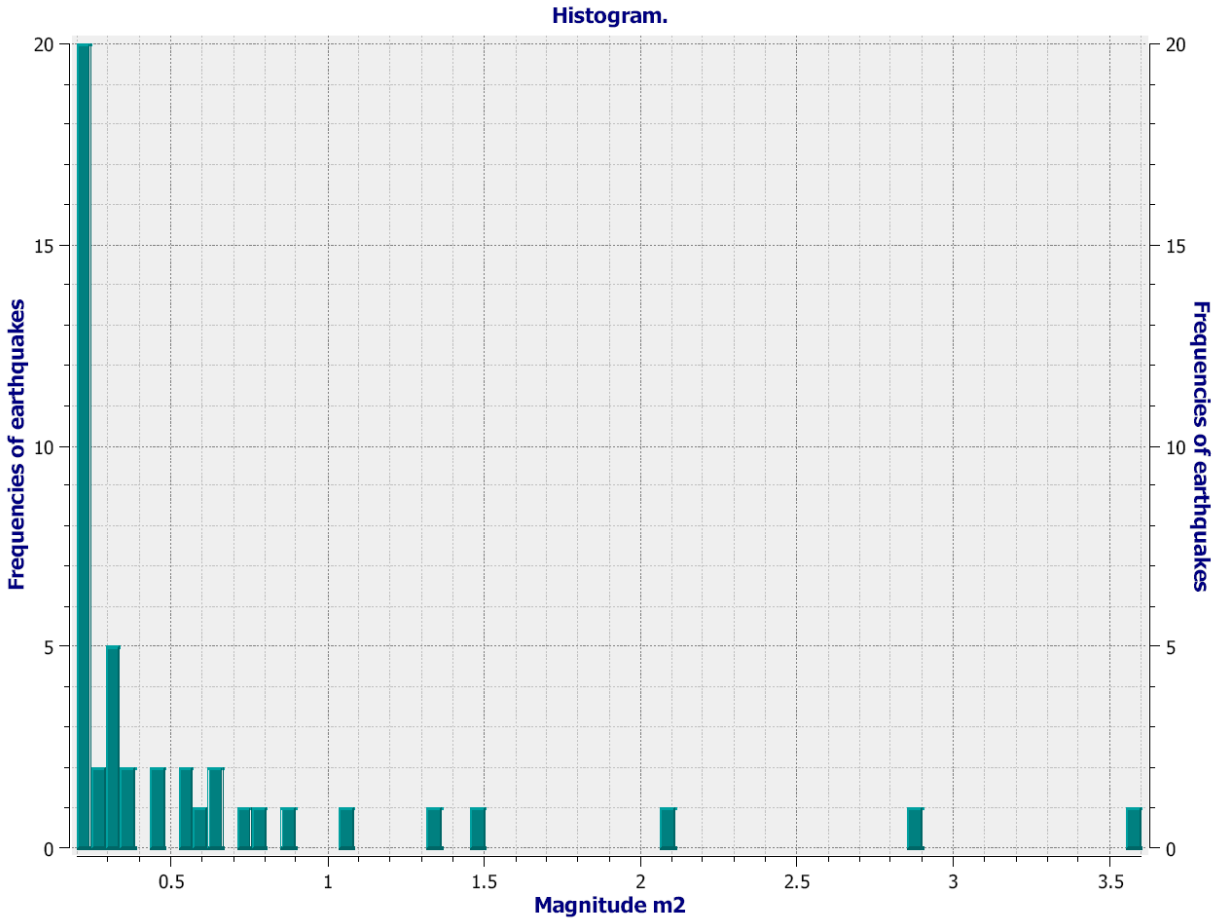
	year	mo	d	d.y	lat	long	dep	mag	b1	sigma	b2	sigma
189.	1933	3	11	70	33.62	-117.97	0	6.30	132	9.89e+001	244	1.43e+002
1283.	1937	3	25	84	33.40	-116.25	10	6.00	19	4.43e+000	57	9.94e+000
1959.	1940	5	19	140	32.73	-115.50	0	6.70	20	2.98e+001	55	3.94e+001
2255.	1941	7	1	182	34.37	-119.58	0	5.90	30	7.15e+000	73	1.53e+001
3273.	1946	3	15	74	35.72	-118.05	22	6.30	32	2.46e+001	192	6.37e+001
3669.	1947	4	10	100	34.98	-116.55	0	6.20	63	1.92e+001	161	3.52e+001
3825.	1947	7	24	205	34.02	-116.50	0	5.50	33	1.87e+001	105	2.94e+001
4241.	1948	12	4	339	33.93	-116.38	0	6.50	31	9.30e+000	146	2.49e+001
4415.	1949	5	2	122	34.02	-115.68	0	5.90	35	6.07e+000	124	2.21e+001
4653.	1949	11	4	308	32.20	-116.55	0	5.70	29	6.80e+000	50	1.17e+001
4839.	1950	7	27	208	33.12	-115.57	0	4.80	21	8.89e+000	21	8.89e+000
5356.	1952	7	21	203	35.00	-119.02	0	7.70	64	1.03e+002	409	2.49e+002
5431.	1952	7	23	205	35.37	-118.58	0	6.10	24	2.13e+001	200	9.66e+001
6321.	1954	3	19	78	33.28	-116.18	0	6.20	75	2.71e+001	123	3.67e+001
6675.	1954	11	12	316	31.50	-116.00	0	6.30	19	2.52e+001	33	3.63e+001
6977.	1955	12	17	351	33.00	-115.50	0	5.40	23	4.95e+000	27	5.47e+000
7032.	1956	2	9	40	31.75	-115.92	0	6.80	46	1.21e+002	142	2.98e+002
7428.	1957	4	25	115	33.20	-115.80	0	5.20	19	7.24e+000	26	1.09e+001
7672.	1958	7	14	195	34.33	-119.48	16	4.70	16	1.78e+000	21	2.69e+000
9301.	1965	6	16	167	33.05	-115.62	0	4.40	16	3.43e+000	32	6.58e+000
9530.	1966	6	28	179	35.90	-120.53	18	5.60	17	6.59e+000	40	1.01e+001
9882.	1968	4	9	100	33.18	-116.12	11	6.40	57	1.68e+001	212	4.96e+001
10322.	1969	3	21	80	31.20	-114.20	0	5.80	44	1.12e+002	55	1.36e+002
10575.	1969	10	22	295	34.57	-121.62	10	5.40	17	3.02e+000	26	5.30e+000
11030.	1971	2	9	40	34.40	-118.40	8	6.40	210	8.41e+001	408	1.12e+002
12359.	1974	7	30	211	34.62	-116.33	8	4.40	17	2.28e+000	32	3.36e+000
12565.	1975	1	23	23	32.95	-115.48	4	4.80	59	7.69e+000	118	1.36e+001
13426.	1976	11	4	309	33.12	-115.58	5	4.20	22	4.37e+000	22	4.37e+000
13449.	1976	11	4	309	33.12	-115.58	5	4.40	20	1.97e+000	42	3.99e+000
13873.	1978	3	11	70	32.40	-115.13	6	4.80	18	4.10e+000	39	6.44e+000
14041.	1978	8	13	225	34.33	-119.68	12	5.10	19	1.55e+000	30	2.63e+000
14092.	1978	10	4	277	37.50	-118.67	5	5.80	55	1.39e+001	125	2.56e+001
14252.	1979	1	1	1	33.93	-118.67	11	5.00	18	2.01e+000	31	3.30e+000
14361.	1979	3	15	74	34.32	-116.43	2	5.20	28	5.84e+000	91	1.68e+001
14643.	1979	10	15	288	32.60	-115.32	12	6.60	359	6.47e+001	494	8.10e+001
14893.	1979	10	16	289	33.00	-115.57	8	4.00	23	2.18e+000	25	2.35e+000
15404.	1980	5	25	146	37.60	-118.82	3	6.40	80	3.24e+001	90	3.47e+001
15486.	1980	5	25	146	37.55	-118.78	6	6.50	288	8.62e+0011	198	2.24e+002
16475.	1980	9	7	251	37.98	-118.40	5	5.70	30	9.31e+000	114	2.35e+001
16953.	1981	4	25	115	33.10	-115.62	4	4.10	20	2.52e+000	20	2.52e+000
16979.	1981	4	26	116	33.08	-115.62	3	5.70	34	3.84e+000	59	6.20e+000
17662.	1982	10	1	274	35.73	-117.75	8	4.90	23	4.64e+000	99	1.21e+001
17869.	1983	1	7	7	37.65	-118.92	5	5.70	88	1.84e+001	227	4.14e+001
18119.	1983	5	2	122	36.23	-120.25	9	6.30	146	3.44e+001	425	9.95e+001
19228.	1984	11	23	328	37.47	-118.58	6	6.20	105	1.87e+001	226	4.46e+001

catalogue of main shocks contains 5540 records,
it has been written in file main.dat

Exercise 2 (output PDFs)







*Exercise 3 (***CompiCat** *Protocol Message page)*

```
CompiCat program Protocol created on 2007/09/28 11:33:14

*** Message page ***

Build Project Messages:

Project File: C:/Program Files/Earthquake Catalog
Processing/ecp/exercises/main.pro

Initial catalog "main.csf" has 5540 records from 1932/ 1/ 3 17:57: 0.00 to
1985/ 6/21  0:50: 0.00


*** Task: Select subcatalog ***

Current catalog has 5540 records from 1932/ 1/ 3 17:57: 0.00 to 1985/ 6/21
0:50: 0.00

Sample conditions:
Hypocenter Polygon: number vertices: 11
   List vertices: "< number [Latitude,Longitude] >"
    1:  [  31.25 ,     -113 ];  2:  [     32 ,     -113 ];
    3:  [     34 ,     -115 ];  4:  [     36 ,     -116 ];
    5:  [     38 ,     -117 ];  6:  [     38 ,     -119 ];
    7:  [     37 ,   -120.4 ];  8:  [   35.5 ,     -123 ];
    9:  [  33.75 ,   -121.5 ]; 10:  [  31.25 ,     -119 ];
   11:  [  31.25 ,  -116.25 ];
Magnitudes Intervals:  M1  [ 4.5 , 9.0 ]
```

Selected 336 records.Process of subcatalog creation is completed.

Output catalog: has 336 records from 1932/ 1/28 17:17: 0.00 to 1985/ 5/ 8 23:40: 0.00

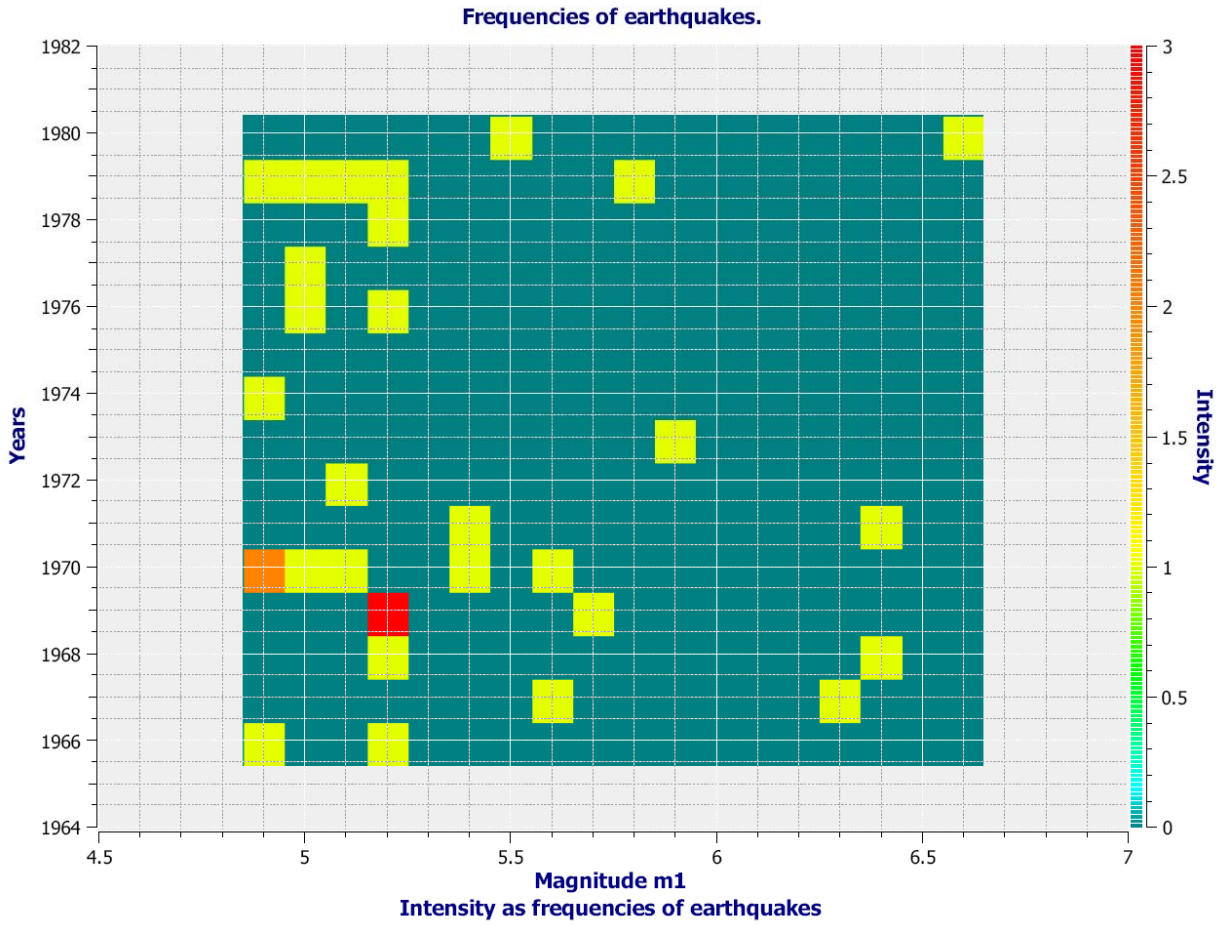
****** End of Task: : Select subcatalog ******

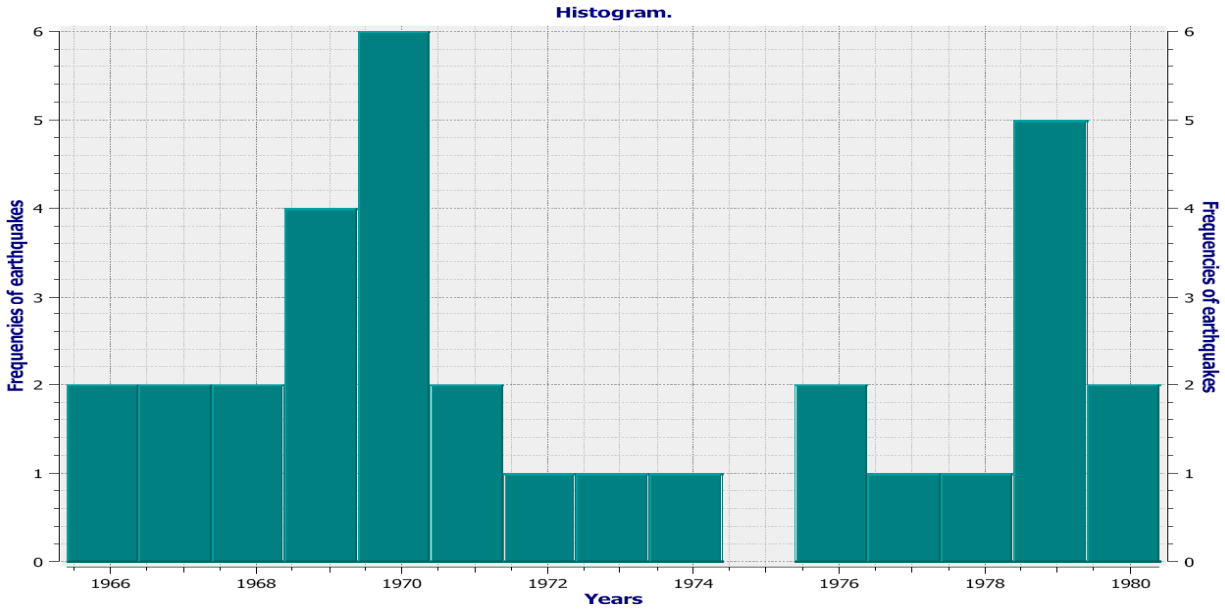
****** End of Message page ******

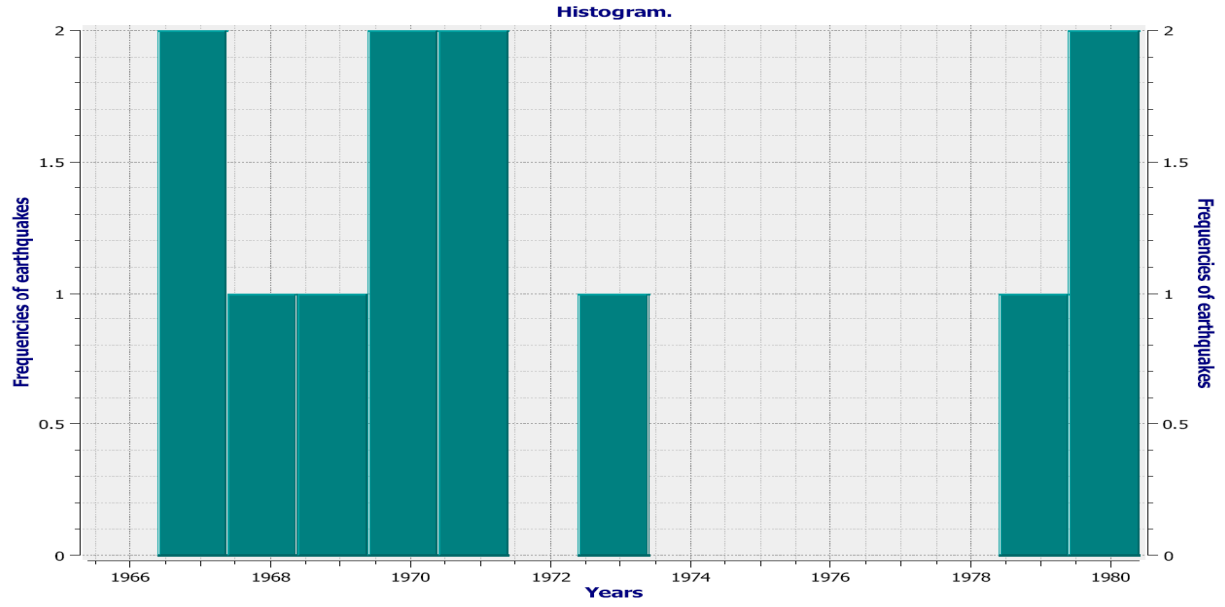
Exercise 4 (REG1-L.68bytes***)***

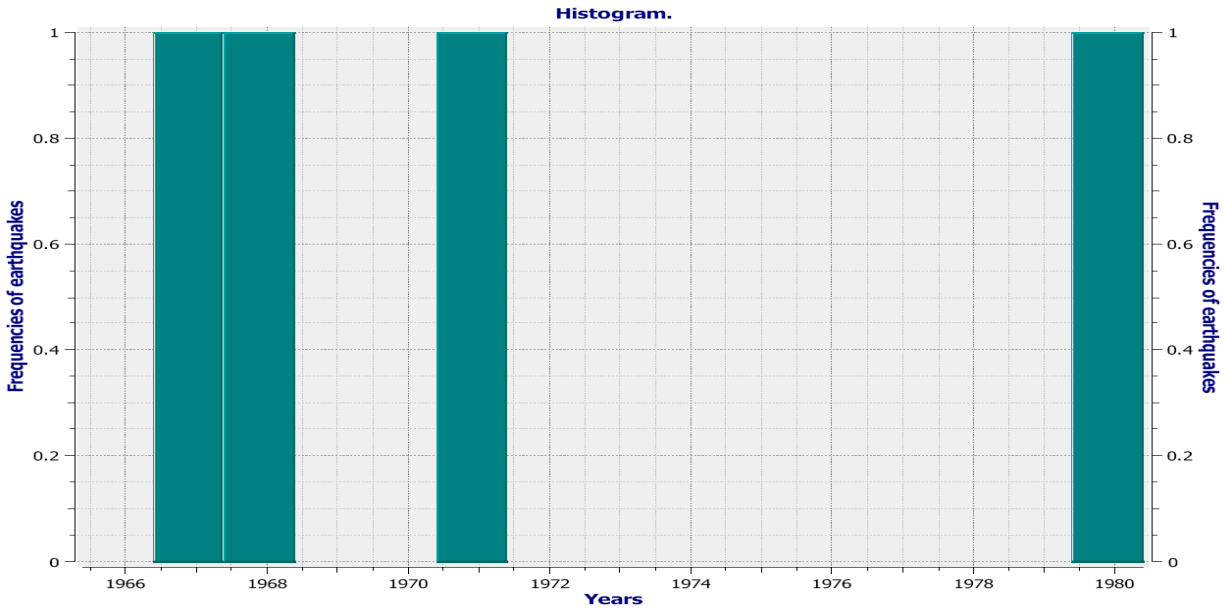
```
#    68 bytes - Standard Wide Text Format File
# created on 2007-09-27T21:23:36 by CompiCat program
#
1965/ 9/25 17:43: 0.00  34.700 -116.500  10.0 5.20 0.04 0.00 0.00  0
1965/10/17  9:45: 0.00  33.970 -116.770  17.0 4.90 0.06 0.00 0.00  0
1966/ 6/28  4:26: 0.00  35.900 -120.530  18.0 5.60 0.17 0.00 0.00  0
1966/ 8/ 7 17:36: 0.00  31.800 -114.500   0.0 6.30 0.00 0.00 0.00  0
1967/ 9/21  0: 1: 0.00  31.420 -115.950   1.0 5.20 0.01 0.00 0.00  0
1968/ 4/ 9  2:28: 0.00  33.180 -116.120  11.0 6.40 0.57 0.00 0.00  0
1968/ 7/ 5  0:45: 0.00  34.120 -119.700   5.0 5.20 0.10 0.00 0.00  0
1969/ 3/20  8:16: 0.00  31.400 -114.000   0.0 5.20 0.00 0.00 0.00  0
1969/ 3/20  8:17: 0.00  31.300 -114.200   0.0 5.70 0.12 0.00 0.00  0
1969/ 3/23 11:32: 0.00  31.400 -115.000   0.0 5.20 0.00 0.00 0.00  0
1969/ 6/10  3:41: 0.00  31.620 -116.200   2.0 5.00 0.00 0.00 0.00  0
1969/10/ 3 13:10: 0.00  37.620 -118.920   2.0 4.90 0.00 0.00 0.00  0
1969/10/22 22:51: 0.00  34.570 -121.620  10.0 5.40 0.17 0.00 0.00  0
1969/10/24  8:29: 0.00  33.280 -119.180  10.0 5.10 0.10 0.00 0.00  0
1969/11/ 5 17:54: 0.00  34.600 -121.430  10.0 5.60 0.08 0.00 0.00  0
1970/ 1/19  7:16: 0.00  31.480 -115.970  10.0 4.90 0.00 0.00 0.00  0
1970/ 9/12 14:30: 0.00  34.270 -117.530   8.0 5.40 0.08 0.00 0.00  0
1971/ 2/ 9 14: 0: 0.00  34.400 -118.400   8.0 6.40 2.10 0.00 0.00  0
1971/ 9/30 22:46: 0.00  33.030 -115.820   8.0 5.10 0.09 0.00 0.00  0
1973/ 2/21 14:45: 0.00  34.050 -119.030   8.0 5.90 0.09 0.00 0.00  0
1973/10/16 14:53: 0.00  31.600 -115.820   8.0 4.90 0.03 0.00 0.00  0
1975/ 6/ 1  1:38: 0.00  34.500 -116.480   4.0 5.20 0.08 0.00 0.00  0
1975/ 7/17 18:24: 0.00  31.920 -115.770  17.0 5.00 0.06 0.00 0.00  0
1976/12/ 7 12:59: 0.00  31.970 -114.770   8.0 5.00 0.00 0.00 0.00  0
1978/ 5/ 5 21: 3: 0.00  32.200 -115.300   6.0 5.20 0.04 0.00 0.00  0
1978/ 8/13 22:54: 0.00  34.330 -119.680  12.0 5.10 0.19 0.00 0.00  0
1978/10/ 4 16:42: 0.00  37.500 -118.670   5.0 5.80 0.55 0.00 0.00  0
1979/ 1/ 1 23:14: 0.00  33.930 -118.670  11.0 5.00 0.18 0.00 0.00  0
1979/ 3/15 20:17: 0.00  34.300 -116.430   2.0 4.90 0.01 0.00 0.00  0
1979/ 3/15 21: 7: 0.00  34.320 -116.430   2.0 5.20 0.28 0.00 0.00  0
1979/10/15 23:16: 0.00  32.600 -115.320  12.0 6.60 3.59 0.00 0.00  0
1980/ 2/25 10:47: 0.00  33.500 -116.500  13.0 5.50 0.06 0.00 0.00  0
1980/ 5/25 16:33: 0.00  37.600 -118.820   3.0 6.40 0.80 0.00 0.00  0
1980/ 5/25 19:44: 0.00  37.550 -118.780   6.0 6.50 2.88 0.00 0.00  0
```

Exercise 5 (PDFs)




Histogram.
Frequencies of earthquakes
Years
0
1
2
3
4
5
6
1966
1968
1970
1972
1974
1976
1978
1980


Histogram.
Frequencies of earthquakes
Years
0
0.5
1
1.5
2
1966
1968
1970
1972
1974
1976
1978
1980


Histogram.
Frequencies of earthquakes
Years
0
0.2
0.4
0.6
0.8
1
1966
1968
1970
1972
1974
1976
1978
1980

Exercise 6

File PRO.PRI

FUNC - calculation of functions on earthquake flow
COMMON CONSTANTS
Title: Exercise 6.
Common name of subcatalogs: reg.dat
Time from 1932. 5.25.16.33 to 1984. 1. 1. 1. 0
Skipping to 1938. 5.25.16
Learning to 1984. 1. 1. 0
List of regions: 1
DATES OF OBJECTS
from 1938. 5.25.16 to 1984. 1. 1. 1
with step 1 y 0 m 0 d
LIST OF FUNCTIONS

#	Function	Time	Magnitude	Delta
1	N1	6	m2	--
3	K	2	m2	--
4	G	3	m2	--
5	SIGMA	3	m1	--
6	Smax	3	m1	--
9	N3	3	m2	--
10	L	6	m2	--
11	q	6	m2	--
12	Ml	3	m1	--
13	Bmax	3	--	--
14	Q	1	m1	--
15	V	6	m1	--
21	SIGTH	3	m1	--

COEFFICIENTS C, D, F AND MAXIMUM MAGNITUDE
For function SIGMA: 1.00, 1.00, 4.50, 6.30
For functions Smax and S1max: 1.00, 1.00, 4.50, 6.30
For function SIGTH: 1.00, 1.00, 4.50, --
FOR FUNCTION Ml (LONG-RANGE AFTERSHOCKS)
Catalog of main shocks: cal6.dat
Threshold magnitude for main shocks: 6.40
MAGNITUDE THRESHOLDS
(Directly defined)
For region m1 n1 m2 n2 m3 n3
1 4.90 147 5.30 72 6.20 19
OUTPUT PROFILE: ex14.pat

File FUN.PRI

	N1	K	G	SIGMA	Smax	N3	L	q	Ml	Bmax	Q	V	SIGTH
1395	6	1	0.63	73	17.39	-	0	-	0	19	11	18	73
1405	9	4	0.55	63	6.42	-	6	-	0	20	1	17	221
1415	7	2	0.57	102	12.92	-	-1	-	600	20	3	14	260
1425	11	0	0.50	162	12.92	4	5	-	600	30	8	17	320
1435	11	1	0.50	137	12.92	3	5	-	600	30	7	23	237
1445	13	-2	0.36	118	12.31	4	8	-	600	30	8	22	218
1455	13	-1	0.29	42	10.00	1	7	-	550	11	10	18	142
1465	12	1	0.40	130	21.78	3	5	-	550	32	10	17	130
1475	13	0	0.54	180	21.78	5	6	3	0	63	11	16	180
1485	11	0	0.50	177	21.78	6	2	1	0	63	2	13	177
1495	13	1	0.42	133	14.24	8	4	1	590	63	3	7	233
1505	12	0	0.33	81	14.24	6	3	0	590	35	2	8	181
1515	13	-1	0.22	92	14.24	7	4	0	590	35	3	7	192
1525	12	0	0.29	79	15.07	5	3	0	570	29	1	8	79
1535	13	0	0.30	139	19.64	6	3	0	610	64	4	10	1724
1545	14	2	0.46	192	19.64	6	4	0	610	75	5	9	1777
1555	14	2	0.44	283	24.12	6	4	0	630	75	1	9	1867
1565	16	0	0.40	225	24.12	7	6	0	630	75	2	8	424
1575	13	-3	0.50	152	24.12	6	3	0	630	46	3	8	352
1585	12	-6	0.57	32	6.97	7	2	0	540	46	6	10	231
1595	10	-2	0.75	31	19.95	5	-1	0	500	19	7	8	31
1605	7	1	0.67	27	19.95	7	-4	0	0	16	8	8	27
1615	6	1	0.50	45	19.95	7	-5	0	0	16	9	8	45
1625	3	1	0.71	33	5.88	9	-8	0	0	5	1	8	33
1635	3	-2	0.78	38	5.88	9	-8	1	0	12	3	9	38
1645	4	-1	0.90	49	7.20	6	-7	3	0	12	3	6	49
1655	4	2	0.78	54	12.59	3	-6	8	0	12	3	8	54
1665	4	0	0.71	49	12.59	1	-6	13	0	6	4	8	49
1675	4	0	0.40	96	37.84	1	-6	17	0	17	4	7	96
1685	5	2	0.50	88	37.84	3	-5	21	0	57	4	5	168
1695	6	0	0.50	112	37.84	2	-3	24	570	57	6	7	191
1705	7	0	0.67	69	7.72	2	-2	26	570	57	8	8	148
1715	8	2	0.58	72	7.94	1	-1	24	570	210	4	9	151
1725	8	-1	0.56	45	7.94	2	-1	21	510	210	5	9	124
1735	7	-3	0.25	37	25.12	2	-2	18	510	210	5	9	116
1745	6	-1	0.67	32	25.12	3	-3	14	510	9	5	9	32
1755	5	-1	0.50	28	25.12	3	-4	10	0	59	6	8	28
1765	3	-1	1.00	11	4.09	4	-6	7	0	59	8	8	11
1775	1	0	1.00	11	4.09	4	-8	6	500	59	1	5	11
1785	1	0	1.00	16	5.01	5	-8	7	500	18	1	4	16
1795	1	1	0.86	43	6.92	4	-8	11	500	55	5	8	43
1805	3	3	0.63	50	10.00	3	-6	18	550	359	3	11	176
1815	8	6	0.33	116	23.84	1	0	25	610	359	6	13	421
1825	9	3	0.00	88	23.84	1	1	31	610	359	4	15	393
1835	12	-3	0.18	177	23.84	0	4	34	610	288	8	18	356

Exercise 7

File PRO.PRI

FUNC - calculation of functions on earthquake flow
COMMON CONSTANTS
Title: Exersise 7.
Common name of subcatalogs: reg.dat
Time from 1932. 1. 1. 0. 0 to 1984. 1. 1. 1. 0
Skipping to 1938. 1. 1. 1
Learning to 1984. 1. 1. 0
List of regions: 1

DATES OF OBJECTS:
1. 1938. 1. 1. 1
2. 1938. 5.19. 3
3. 1939. 5.19. 3
4. 1940. 5.19. 3
5. 1940.10.21.15
6. 1941.10.21.15
7. 1942.10.21.15
8. 1943. 1. 1. 1
9. 1944. 1. 1. 1
10. 1945. 1. 1. 1
11. 1946. 1. 1. 1
12. 1946.12. 4.22
13. 1947.12. 4.22
14. 1948.12. 4.22
15. 1949. 1. 1. 1
16. 1950. 1. 1. 1
17. 1950. 7.21.10
18. 1951. 7.21.10
19. 1952. 7.21.10
20. 1953. 1. 1. 1
21. 1954. 1. 1. 1
22. 1954. 2. 9.13
23. 1955. 2. 9.13
24. 1956. 2. 9.13
25. 1957. 1. 1. 1
26. 1958. 1. 1. 1
27. 1959. 1. 1. 1
28. 1960. 1. 1. 1
29. 1961. 1. 1. 1
30. 1962. 1. 1. 1
31. 1963. 1. 1. 1
32. 1964. 1. 1. 1
33. 1965. 1. 1. 1
34. 1966. 1. 1. 1
35. 1966. 4. 9. 1
36. 1967. 4. 9. 1
37. 1968. 4. 9. 1
38. 1969. 1. 1. 1
39. 1969. 2. 9.13
40. 1970. 2. 9.13
41. 1971. 2. 9.13
42. 1972. 1. 1. 1
43. 1973. 1. 1. 1
44. 1974. 1. 1. 1
45. 1975. 1. 1. 1
46. 1976. 1. 1. 1
47. 1977. 1. 1. 1
48. 1977.10.15.22
49. 1978.10.15.22
50. 1979.10.15.22
51. 1980. 5.25.15
52. 1981. 1. 1. 1
53. 1982. 1. 1. 1
54. 1983. 1. 1. 1
55. 1984. 1. 1. 1

LIST OF FUNCTIONS

#	Function	Time	Magnitude	Delta
2	N2	3	m3	--
3	K	2	m2	--
4	G	3	m2	--
5	SIGMA	3	m1	--
6	Smax	3	m1	--
8	Zmax	3	m1	--
9	N3	3	m2	--
11	q	6	m2	--
13	Bmax	3	--	--
21	SIGTH	3	m1	--

COEFFICIENTS C, D, F AND MAXIMUM MAGNITUDE
For function SIGMA: 1.00, 1.00, 4.50, 6.30
For functions Smax and S1max: 1.00, 1.00, 4.50, 6.30
For function Zmax: 1.00, 0.50, 4.50, 6.30
For function SIGTH: 1.00, 1.00, 4.50, --
MAGNITUDE THRESHOLDS
(Directly defined)

For region	m1	n1	m2	n2	m3	n3
1	4.90	147	5.30	72	6.20	19

OUTPUT PROFILE: ex15.pat

File FUN.PRI

	N2	K	G	SIGMA	Smax	Zmax	N3	q	Bmax	SIGTH
1381	0	-2	0.80	45	17.39	4.66	-	-	19	45
1385	0	-2	0.80	45	17.39	4.66	-	-	19	45
1395	0	1	0.63	73	17.39	4.66	-	-	19	73
1405	0	3	0.60	63	6.42	4.32	-	-	8	63
140o	1	2	0.62	70	8.04	4.25	-	-	20	228
141o	1	3	0.43	164	22.67	7.85	-	-	30	322
142o	1	1	0.50	148	22.67	7.85	4	-	30	307
1431	2	1	0.43	145	15.36	6.59	4	-	30	404
1441	1	-4	0.36	118	15.36	6.59	3	-	30	218
1451	1	-3	0.40	26	10.00	3.98	1	-	11	126
1461	0	0	0.38	61	10.00	4.58	3	-	5	61
146d	1	3	0.45	135	20.96	6.15	4	-	32	135
147d	2	0	0.53	194	20.96	6.15	5	1	63	194
148d	2	-2	0.50	158	20.96	6.15	8	0	63	158
1491	3	-1	0.45	158	20.96	6.15	8	1	63	258
1501	2	1	0.42	136	13.66	5.60	8	0	63	236
1507	1	1	0.33	81	14.24	5.19	6	0	35	181
1517	1	-1	0.22	92	14.24	5.19	6	0	35	192
1527	0	0	0.29	79	15.07	4.58	5	0	29	79
1531	1	0	0.30	139	19.64	6.23	5	0	64	1724
1541	1	0	0.45	137	19.64	6.23	5	0	64	1722
1542	1	1	0.50	142	19.64	6.23	5	0	64	1727
1552	3	2	0.40	278	33.14	9.19	7	0	75	1862
1562	2	1	0.43	225	33.14	9.19	6	0	75	225
1571	3	-3	0.43	215	26.19	8.92	7	0	75	414
1581	1	-6	0.63	37	6.48	4.01	7	0	46	236
1591	1	-2	0.60	31	19.95	4.47	7	0	46	230
1601	0	0	0.75	32	19.95	4.47	7	0	19	32
1611	0	-1	0.75	32	19.95	4.47	6	0	16	32
1621	0	1	0.71	33	5.20	3.59	9	0	5	33
1631	0	2	0.71	32	5.20	3.59	8	0	12	32
1641	0	-1	0.73	59	6.26	3.83	8	4	12	59
1651	0	0	0.78	54	7.88	3.83	3	8	12	54
1661	0	0	0.78	55	7.88	3.83	2	13	6	55
1664	0	0	0.71	49	12.59	3.81	1	13	6	49
1674	1	0	0.40	96	37.84	7.24	1	17	17	96
1684	1	1	0.60	88	37.84	7.24	3	21	17	88
1691	2	-1	0.40	86	37.84	7.24	2	25	57	165
1692	2	-1	0.40	86	37.84	7.24	2	24	57	165
1702	1	2	0.67	69	6.51	5.03	2	26	57	148
1712	1	3	0.58	72	7.94	5.03	1	25	57	151
1721	1	-2	0.58	70	7.01	5.05	2	21	210	150
1731	1	-3	0.50	14	5.23	2.77	2	18	210	94
1741	1	-1	0.50	32	13.82	4.16	3	15	210	111
1751	0	0	0.50	28	13.82	4.16	2	11	9	28
1761	0	-1	0.75	36	13.82	4.16	3	11	59	36
1771	0	-1	1.00	11	4.09	2.53	4	8	59	11
177o	0	0	1.00	11	4.09	2.53	5	8	59	11
178o	0	1	0.75	32	9.65	4.18	5	8	55	32
179o	0	1	0.86	43	9.65	4.18	4	14	55	43
1805	1	3	0.63	50	10.00	4.13	3	18	359	176
1811	3	5	0.42	105	21.89	6.47	2	23	359	411
1821	3	5	0.20	95	21.89	6.47	1	27	359	401
1831	2	-3	0.20	108	21.89	6.47	1	32	288	287
1841	1	-4	0.29	121	39.47	7.51	0	31	146	121

Exercise 8 (PRO.PRI)

FUNC - calculation of functions on earthquake flow
COMMON CONSTANTS
Title: CALCULATION OF FUNCTIONS
Common name of subcatalogs: lreg.dat
Time from 1932. 1. 1. 0. 0 to 1991. 1. 1. 0. 0
Skipping to 1938. 1. 1. 1
Learning to 1984. 1. 1. 0
List of regions: 1
DATES OF OBJECTS
from 1938. 1. 1. 0 to 1990. 1. 1. 0
with step 0 y 2 m 0 d
LIST OF FUNCTIONS

#	Function	Time	Magnitude	Delta
2	N2	3	m3	--
3	K	2	m2	--
4	G	3	m2	--
5	SIGMA	3	m1	--
6	Smax	3	m1	--
8	Zmax	3	m1	--
9	N3	3	m2	--
11	q	6	m2	--
13	Bmax	3	--	--
21	SIGTH	3	m1	--

COEFFICIENTS C, D, F AND MAXIMUM MAGNITUDE
For function SIGMA: 1.00, 1.00, 4.50, 6.30
For functions Smax and S1max: 1.00, 1.00, 4.50, 6.30
For function Zmax: 1.00, 0.50, 4.50, 6.30
For function SIGTH: 1.00, 1.00, 4.50, --
MAGNITUDE THRESHOLDS
(Defined by annual numbers of events: 3.0, 1.4, 0.4)

For region	m1	n1	m2	n2	m3	n3
1	4.90	147	5.30	72	6.20	21

OUTPUT PROFILE: ex16.pat