Estlab

New tools for mathematical models

Measurements can be turned to math models - These programs can do it

1 Polysurf: Multivariable polynomial approximation.

The data is an ASCII text file (A valid data for regression analysis)

```
x1, x2, .... xk, Y1        (   k < 512  )
 ...
 .....
x1, x2, .... xk, Yn        (  max 1000 lines )
```

Polysurf seeks through all combinations up to 7 different variables.
The program solves 10 best fitting polynomials. polyn0.txt is the best
The criterion = sum of residual squares / degrees of freedom
The 5 largest residuals are picked for deeper inspection.

This program is an efficient tool in many fields

The number of polynomial coefficients is kept under 220.
So the degree of the polynomial is then lower if more arguments
are involved.

2 Multivariable function model by Funcfit program

If the polynomial fit is accurate, Funcfit solves an 8 parameter
..approximation.

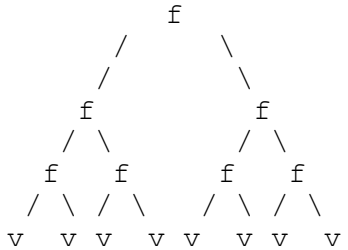
All analytic functions can be approximated by Taylor polynomials.
Polysurf can calculate the polynomial.
Funcfit seeks the best fitting function if the number of variables
..is less than 6.

The function seek has one restriction. The function is expected to be
presented by the following treelike structure. See picture below:

Each f is expected to be in the set

{ +, *, /, exp, log, sin, tan, asin, atan }

At the bottom line, v is one independent
variable { a, b, .. } added or multplied
by numeric parameter P.



The result may be like this

```
f = (((2.01+c)*(0.129+a))+exp((.903+c)+(1.04+b)))/
((5.05+b)*(0.306+a))*sin((1.87+a)*(0.708+b))
```

We can handle 10 first “simple” cases witht one to three variables free

Send your data.txt to info@estlabsoft.com or arto.p.huttunen@gmail.com

At least the Polysurf will be run, The Funcfit is run if polynomial
model looks good.

Example of Polysurf output

```
 Normalizations


  Y = (  F   -    0.8722 ) /    0.1866
  a = ( X1   -    0.4820 ) /    0.2898
  b = ( X2   -    0.0522 ) /    0.0284
  c = ( X3   -    0.4544 ) /    0.2685


   The Model

 Y =
 -    0.1386E-02
 -    0.2027     *      a
 +    0.2350E-02 *      b
 +    0.9775     *      c
 +    0.4847E-02 *     aa
 +    0.4132E-03 *     ab
 -    0.4205E-01 *     ac
 +    0.7714E-03 *     bb
 +    0.8482E-03 *     bc
 -    0.1845E-02 *     cc
 -    0.2930E-03 *    aaa
 +    0.2208E-03 *    aab
 +    0.1425E-02 *    aac
 -    0.3410E-03 *    abb
 -    0.5170E-03 *    abc
 +    0.3202E-03 *    acc
 -    0.1127E-03 *    bbb
 -    0.5464E-03 *    bbc
 -    0.4349E-03 *    bcc
 -    0.4557E-03 *    ccc
 -    0.1954E-03 *   aaaa
 -    0.6148E-03 *   aaab
 -    0.1729E-03 *   aaac
 -    0.1775E-03 *   aabb
 -    0.8204E-03 *   aabc
 -    0.4615E-03 *   aacc
 -    0.1275E-03 *   abbb
 +    0.1788E-03 *   abbc
 -    0.4841E-03 *   abcc
 -    0.8902E-03 *   accc
 -    0.4588E-03 *   bbbb
      .
      .
      .
 -    0.2357E-03 *  aaaac
 +    0.2014E-03 *  aaabb
 +    0.3313E-03 *  aaabc
 -    0.1358E-03 *  acccc
 +    0.4518E-04 *  bbbbb
 +    0.1179E-03 *  bbbbc
 +    0.9585E-04 *  bbbcc
 +    0.2760E-03 *  bbccc
 +    0.2265E-03 *  bcccc
 +    0.4368E-04 * bbbbbc
 +    0.2275E-03 * bbbbcc
 +    0.1935E-03 * bbbccc
 +    0.3439E-03 * bbcccc
 +    0.1805E-03 * bccccc
```

- 0.3612E-04 * cccccc

Residuals

	X1	X2	X3	fnc	appr	residual
1	0.0000	0.1320E-01	0.7556	1.156	1.156	0.1053E-04
2	0.2190	0.4700E-02	0.6789	1.064	1.064	0.1643E-04
3	0.3835	0.5190E-01	0.8310	1.143	1.143	-0.2123E-04
4	0.5297	0.6710E-01	0.7700	0.5637	0.5637	0.1712E-04
5	0.4175	0.6870E-01	0.5890	0.9729	0.9729	-0.4093E-04
6	0.5269	0.9200E-02	0.6539	0.9997	0.9997	0.1514E-04
7	0.9103	0.7620E-01	0.2625	0.6957	0.6957	-0.1864E-04
8	0.3282	0.6330E-01	0.7564	1.102	1.102	0.1214E-04
9	0.2470	0.9830E-01	0.7227	1.092	1.092	0.1173E-04
10	0.0727	0.6320E-01	0.8847	1.237	1.237	-0.2635E-05
11	0.7665	0.4780E-01	0.2378	0.6944	0.6944	0.3808E-05
12	0.1665	0.4870E-01	0.8977	1.228	1.228	-0.1958E-04
13	0.9047	0.5050E-01	0.5163	0.8579	0.8579	0.8616E-05
14	0.4940	0.2660E-01	0.9070	0.6230	0.6230	0.1224E-04
15	0.5007	0.3840E-01	0.2771	0.7492	0.7492	-0.1072E-04
16	0.4644	0.9410E-01	0.5010	0.5986	0.5986	-0.7057E-05
17	0.8278	0.1250E-01	0.1590	0.5438	0.5438	0.2173E-05
18	0.6295	0.7360E-01	0.7254	1.033	1.033	-0.9725E-05
19	0.2332	0.3060E-01	0.3510	0.8319	0.8320	-0.5309E-04
20	0.8460	0.4120E-01	0.8415	1.073	1.073	0.9738E-05
21	0.5373	0.4680E-01	0.2872	0.7520	0.7520	-0.1062E-04
22	0.5717	0.8020E-01	0.3310	0.5774	0.5774	-0.2293E-04
23	0.9554	0.7480E-01	0.5546	0.8760	0.8760	0.1948E-05
.						
.						
.						
97	0.1236	0.9730E-01	0.0296	0.6152	0.6152	-0.2267E-06
98	0.7694	0.9340E-01	0.2502	0.7027	0.7028	-0.5801E-04
99	0.5000	0.7490E-01	0.6719	1.017	1.017	0.6330E-04
100	0.0364	0.2310E-01	0.2217	0.7626	0.7626	-0.1823E-04
101	0.6166	0.3710E-01	0.2248	0.7014	0.7014	0.1522E-04
102	0.1659	0.7440E-01	0.1598	0.7043	0.7043	-0.2543E-04
103	0.1249	0.9490E-01	0.4842	0.9420	0.9420	-0.7772E-05
104	0.0179	0.5940E-01	0.7219	1.129	1.129	0.5960E-05
105	0.4416	0.5190E-01	0.7719	1.093	1.093	0.6314E-05
106	0.9772	0.4680E-01	0.3291	0.7305	0.7305	-0.6432E-05
107	0.2053	0.1710E-01	0.3725	0.8505	0.8505	0.1265E-04
108	0.2550	0.7000E-02	0.1238	0.6688	0.6688	-0.9730E-06
109	0.5177	0.1050E-01	0.8416	1.127	1.127	-0.6000E-06
110	0.3272	0.7140E-01	0.5768	0.9778	0.9778	0.1745E-04
111	0.8366	0.7000E-01	0.3891	0.7851	0.7851	-0.5458E-05
112	0.3621	0.5400E-01	0.4551	0.8883	0.8883	-0.1175E-04
113	0.0831	0.4220E-01	0.4724	0.9386	0.9386	0.1441E-04
114	0.2164	0.8020E-01	0.5274	0.9595	0.9595	0.2588E-04
115	0.2438	0.7120E-01	0.2637	0.7696	0.7696	0.3825E-04
116	0.4598	0.2330E-01	0.7954	1.106	1.106	0.1542E-06
117	0.2661	0.6650E-01	0.4252	0.8804	0.8804	-0.4645E-04
118	0.1340	0.7960E-01	0.9460	1.269	1.269	-0.6606E-05
119	0.0638	0.3470E-01	0.2925	0.8110	0.8110	0.3000E-04
120	0.8343	0.7260E-01	0.3294	0.7469	0.7469	0.1889E-04

standard dev 0.00001 residual sum -0.0000

Potential outliers

check data line 99 res= 0.00006
check data line 98 res= -0.00006
check data line 19 res= -0.00005
check data line 117 res= -0.00005

check data line 39 res= 0.00005

Example of Funcfit output

Nro 1 1.784 Ppm Best 1.784

Estf =((+1.09371) +(-0.66775+a))sin((+0.09535) *(-1.37687+b)) +
((+0.18222) +(-0.13203+c))atan((+1.22446) ^ (+1.87894*a))

Normalisations

f = (Y - 0.8722) / 0.1866
a = (X1 - 0.4820) / 0.2898
b = (X2 - 0.0521) / 0.0284
c = (X3 - 0.4544) / 0.2685

Residuals

	X1	X2	X3	Y	est	res
1	0.000	0.013	0.756	1.156	1.147	-0.009
2	0.219	0.005	0.679	1.064	1.060	-0.004
3	0.384	0.052	0.831	1.143	1.136	-0.007
4	0.530	0.067	0.008	0.564	0.568	0.004
5	0.417	0.069	0.589	0.973	0.970	-0.002
6	0.527	0.009	0.654	1.000	0.988	-0.012
7	0.910	0.076	0.262	0.696	0.732	0.037
8	0.328	0.063	0.756	1.102	1.089	-0.012
9	0.247	0.098	0.723	1.092	1.063	-0.029
10	0.073	0.063	0.885	1.237	1.193	-0.044
11	0.766	0.048	0.238	0.694	0.695	0.001
12	0.167	0.049	0.898	1.228	1.202	-0.027
13	0.905	0.051	0.516	0.858	0.876	0.018
14	0.494	0.027	0.091	0.623	0.614	-0.009
15	0.501	0.038	0.277	0.749	0.744	-0.005
16	0.464	0.094	0.050	0.599	0.606	0.007
17	0.828	0.012	0.016	0.544	0.503	-0.041
18	0.629	0.074	0.725	1.033	1.056	0.023
19	0.233	0.031	0.351	0.832	0.827	-0.005
20	0.846	0.041	0.841	1.073	1.093	0.020
21	0.537	0.047	0.287	0.752	0.750	-0.002
22	0.572	0.080	0.033	0.577	0.589	0.011
23	0.955	0.075	0.555	0.876	0.929	0.053
24	0.842	0.016	0.213	0.670	0.639	-0.031
25	0.091	0.027	0.003	0.598	0.610	0.012
26	0.710	0.094	0.240	0.702	0.737	0.035
27	0.887	0.065	0.150	0.626	0.644	0.018
28	0.388	0.050	0.148	0.673	0.669	-0.003
29	0.590	0.095	0.556	0.927	0.953	0.026
30	0.409	0.014	0.565	0.957	0.949	-0.008
31	0.464	0.096	0.126	0.651	0.658	0.008
32	0.629	0.013	0.651	0.983	0.970	-0.012
33	0.248	0.048	0.389	0.857	0.847	-0.010
34	0.902	0.043	0.142	0.619	0.611	-0.008
35	0.131	0.089	0.092	0.660	0.636	-0.024
36	0.365	0.025	0.135	0.666	0.663	-0.003
37	0.350	0.045	0.809	1.134	1.124	-0.010
38	0.215	0.068	0.909	1.228	1.199	-0.029
39	0.471	0.051	0.600	0.973	0.971	-0.001
40	0.462	0.095	0.633	0.997	1.004	0.007
41	0.689	0.070	0.987	1.194	1.230	0.036

42	0.289	0.054	0.514	0.939	0.928	-0.011
43	0.577	0.088	0.440	0.851	0.870	0.019
	.					
	.					
	.					
77	0.992	0.070	0.280	0.698	0.732	0.034
78	0.004	0.050	0.080	0.663	0.658	-0.005
79	0.783	0.075	0.436	0.822	0.854	0.032
80	0.518	0.007	0.544	0.927	0.914	-0.013
81	0.386	0.063	0.659	1.026	1.020	-0.006
82	0.280	0.082	0.372	0.841	0.827	-0.015
83	0.009	0.010	0.521	0.984	0.987	0.003
84	0.055	0.007	0.160	0.716	0.735	0.019
85	0.051	0.048	0.457	0.932	0.912	-0.020
86	0.150	0.029	0.834	1.186	1.168	-0.017
87	0.681	0.033	0.058	0.584	0.570	-0.013
88	0.002	0.086	0.029	0.626	0.596	-0.031
89	0.576	0.074	0.679	1.010	1.027	0.016
90	0.123	0.097	0.188	0.730	0.697	-0.033
91	0.608	0.013	0.553	0.921	0.907	-0.014
92	0.838	0.097	0.259	0.701	0.754	0.053
93	0.813	0.090	0.245	0.695	0.737	0.042
94	0.452	0.026	0.665	1.019	1.013	-0.007
95	0.114	0.055	0.006	0.599	0.595	-0.004
96	0.432	0.008	0.687	1.037	1.028	-0.009
97	0.124	0.097	0.030	0.615	0.588	-0.027
98	0.769	0.093	0.250	0.703	0.744	0.041
99	0.500	0.075	0.672	1.017	1.025	0.008
100	0.036	0.023	0.222	0.763	0.770	0.007
101	0.617	0.037	0.225	0.701	0.695	-0.007
102	0.166	0.074	0.160	0.704	0.687	-0.017
103	0.125	0.095	0.484	0.942	0.900	-0.042
104	0.018	0.059	0.722	1.129	1.087	-0.042
105	0.442	0.052	0.772	1.094	1.091	-0.002
106	0.977	0.047	0.329	0.730	0.737	0.006
107	0.205	0.017	0.373	0.850	0.850	-0.001
108	0.255	0.007	0.124	0.669	0.674	0.006
109	0.518	0.010	0.842	1.127	1.118	-0.009
110	0.327	0.071	0.577	0.978	0.966	-0.011
111	0.837	0.070	0.389	0.785	0.815	0.030
112	0.362	0.054	0.455	0.888	0.882	-0.007
113	0.083	0.042	0.472	0.939	0.923	-0.016
114	0.216	0.080	0.527	0.960	0.935	-0.025
115	0.244	0.071	0.264	0.770	0.756	-0.013
116	0.460	0.023	0.795	1.106	1.100	-0.006
117	0.266	0.067	0.425	0.880	0.866	-0.014
118	0.134	0.080	0.946	1.269	1.223	-0.046
119	0.064	0.035	0.292	0.811	0.807	-0.004
120	0.834	0.073	0.329	0.747	0.777	0.030

```
 Variance     =   0.328896E-02
 Mean error   =   0.401071E-03
 Residual sum =   0.967288E-02     should be near zero


 Largest residuals

check line    55  resid   0.6944E-01
check line    47  resid   0.5886E-01
check line    92  resid   0.5310E-01
check line    23  resid   0.5263E-01
check line   118  resid  -0.4639E-01
```