ExerciseAlgolOne: Introduction

In this exercise, we analyse the O-C data of Algol from **Paper II**. These data were stored into file **1hjdAlgol.dat**, which is available in Zenodo database. We divide these data into two separate files. These two files contain data before and after the mid epoch $t_{\rm mid}$ = HJD = 2415323. The file names are

1AlgolOne.dat (Data before $t_{\rm mid}$)

2AlgolOne.dat (Data after $t_{\rm mid}$)

Both data files can be downloaded from the course home-page. A new improved version of DCM code was applied in **Paper II**, this version is also available in Zenodo. To avoid confusion between different DCM code versions of **Paper I** and **Paper II**, this improved version is renamed **dcm2.py**, and it can also be downloaded from the course home-page. One signal DCM analysis of the first part of Algol data in file **1AlgolOne.dat** is based on the following control file **1AlgolOne13R112.dat**.

```
 1  = Tag          = 1AlgolOne13R112
 2  = RealData     = 1
 3  = file1        = 1AlgolOne.dat
 4  = dummy        = -99.999
 5  = K1           = 1
 6  = K2           = 1
 7  = K3           = 2
 8  = nL           = 80
 9  = nS           = 40
10  = c            = 0.10
11  = TestStat     = 0
12  = PMIN         = 6000.
13  = PMAX         = 40000.
14  = Rounds       = 2
15  = NonLinear    = 1
16  = SimT         = 1
17  = SimN         = 500
18  = SimSN        = 200
19  = SimDT        = 4.0
20  = SimMany      = 0
21  = SimRounds    = 10
22  = SimDF        = 0.05
23  = SimDA        = 0.5
24  = PrintScreen  = 1.0
```

The logic behind this file control file name **1AlgolOne13R112.dat** is

1AlgolOne refers to analysed data file **1AlgolOne.dat**.

13R means that one, two and three signal models will be compared.

112 refers to orders $K_1 = 1$, $K_2 = 1$ and $K_3 = 2$ of DCM model.

The analysis based of this control file **1AlgolOne13R112.dat** requires only two commands

cp 1AlgolOne13R112.dat dcm.dat
python dcm2.py

These DCM analysis results for $\text{model}_{1,1,2}$ are printed to the screen.

```
                                    n                1033
                                   T1  2.3722383510e+06
                                   DT  4.3066981000e+04
                                   my -5.8241142304e-03
                                   sy  7.2574173379e-02
                                sigma  1.0000000000e-04
                                   K1                 1
                                   K2                 1
                                   K3                 2
                                    p                 6
                                 PMIN  6.0000000000e+03
                                 PMAX  4.0000000000e+04
                                   nL                80
                                   nS                40
          CHI2 2.2399966529e+07   gives ZMIN  1.4725617789e+02
             R 2.2399966529e-01   gives ZMIN  1.4725617789e-02
  ..........................................................
                    F1  1.7761291600e-05 +/-  2.1036825000e-07
                    P1  5.6302211715e+04 +/-  6.4503200428e+02
                    A1  2.4986798914e-01 +/-  1.2573100872e-02     SN     2498.68
                T1MIN1  2.4220658084e+06 +/-  1.3170693058e+02
                T1MIN2               ... +/-               ...
                T1MAX1  2.3939147025e+06 +/-  1.9080907155e+02
                T1MAX2               ... +/-               ...
 ..........................................................
                     i              BETA[i]
                     1         F1  1.77613e-05 2.10368e-07
                     2        B11 -9.37070e-02 8.66768e-03
                     3        C11  8.26287e-02 6.95741e-04
                     4         M0 -9.21231e-02 1.18338e-02
                     5         M1  3.34822e-02 3.29583e-02
                     6         M2  3.93431e-03 1.50305e-02
```

The same results are also stored to file **1AlgolOne13R112Params.dat**
The p, R, P_1 and A_1 parameter values of $\text{model}_{1,1,2}$ are given in Table 1.

ExerciseAlgolOne: Problem

Analyse the first part of Algol data in file **1AlgolOne.dat** using the two signal DCM $\text{model}_{2,1,2}$ and the three signal DCM $\text{model}_{3,1,2}$.

1. Download files **dcm2.py**, **1AlgolOne.dat** and **1AlgolOne13R112.dat** from homepage.
2. Print next page Table 1.
3. Perform the two and the three signal DCM analysis of **1AlgolOne.dat**. Except for **K1** and **Tag**, use the same values for all other control file parameters as in **1AlgolOne13R112.dat**.
4. In columns Col 2-4 of Table 1, use a pencil to write your values for periods P_1, P_2 and P_3, and amplitudes A_1, A_2 and A_3, to the places marked |.....|. Note that you do not need to give the errors of periods and amplitudes, because you run only two bootstrap rounds.
5. In columns Col 5-6 of Table 1, use a pencil to write your values for p_1, p_2, R_1 and R_2 to the places marked |.....| and |.....|. As in Fisher-test application of **ExerciseFisher**, use $\gamma_F = 0.001$ to identify the best model with Fisher-test. In places marked |.....|, use arrows $\uparrow$ and $\leftarrow$ to point towards the better model.

Use the following accuracy
P_1, P_2, P_3 (days, e.g. $P_1 = 25001$)
A_1, A_2, A_2 (two significant digits, e.g. $A_1 = 0.0076$)
p (integer, e.g. $p = 12$)
F (one decimal accuracy, e.g. $F = 14.9$)
Q_F (two first significant digits, e.g. $Q_F = 1.1 \times 10^{-15}$ or $Q_F = 0.0042$).
Note: Computations with DCM $\text{model}_{3,1,2}$ may take a few hours. Just wait patiently for the results. This is what happens when one buys all lottery tickets, and then pays it in computation time.

Table 1: Fill missing parts |.....|, |.....| and |.....|.

Col 1	Col 2 Signal 1	Col 3 Signal 2	Col 4 Signal 3	Col 5 $\text{model}_{2,1,2}$ $p_2 = \lvert\ldots\ldots\rvert$ $R_2 = \lvert\ldots\ldots\ldots\ldots\rvert$	Col 6 $\text{model}_{3,1,2}$ $p_2 = \lvert\ldots\ldots\rvert$ $R_2 = \lvert\ldots\ldots\ldots\ldots\rvert$
$\text{model}_{1,1,2}$ $p_1 = 6$ $R_1 = 0.2240$	– $P_1 = 56302$ $A_1 = 0.25$	– – –	– – –	$\lvert\ldots\ldots\rvert$ $F = \lvert\ldots\ldots\ldots\ldots\rvert$ $Q_F = \lvert\ldots\ldots\ldots\ldots\rvert$	$\lvert\ldots\ldots\rvert$ $F = \lvert\ldots\ldots\ldots\ldots\rvert$ $Q_F = \lvert\ldots\ldots\ldots\ldots\rvert$
$\text{model}_{2,1,2}$ $p_1 = \lvert\ldots\ldots\rvert$ $R_1 = \lvert\ldots\ldots\ldots\ldots\rvert$	– $P_1 = \lvert\ldots\ldots\ldots\ldots\rvert$ $A_1 = \lvert\ldots\ldots\ldots\ldots\rvert$	– $P_2 = \lvert\ldots\ldots\ldots\ldots\rvert$ $A_2 = \lvert\ldots\ldots\ldots\ldots\rvert$	– – –	– – –	$\lvert\ldots\ldots\rvert$ $F = \lvert\ldots\ldots\ldots\ldots\rvert$ $Q_F = \lvert\ldots\ldots\ldots\ldots\rvert$
$\text{model}_{3,1,2}$ $p_1 = \lvert\ldots\ldots\rvert$ $R_1 = \lvert\ldots\ldots\ldots\ldots\rvert$	– $P_1 = \lvert\ldots\ldots\ldots\ldots\rvert$ $A_1 = \lvert\ldots\ldots\ldots\ldots\rvert$	– $P_2 = \lvert\ldots\ldots\ldots\ldots\rvert$ $A_2 = \lvert\ldots\ldots\ldots\ldots\rvert$	– $P_3 = \lvert\ldots\ldots\ldots\ldots\rvert$ $A_3 = \lvert\ldots\ldots\ldots\ldots\rvert$	– – –	– – –

Scan your final hand written answers to pdf-file **1AlgolOne.pdf**.

Answer with less than 100 words, which model is the best model?

Send your **1AlgolOne.pdf** file and your **answer** to the assistant.