New tool with GUI for fitting O-C diagrams

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O-C diagrams

- O-C diagram – difference between observed time and calculated time of minima
- precise timing of minima of EBs → mass transfer, 3rd body, etc.
- exact physical model of these changes is complicated and strongly non-linear
- we present new method and graphical user interface for fitting O-C diagrams

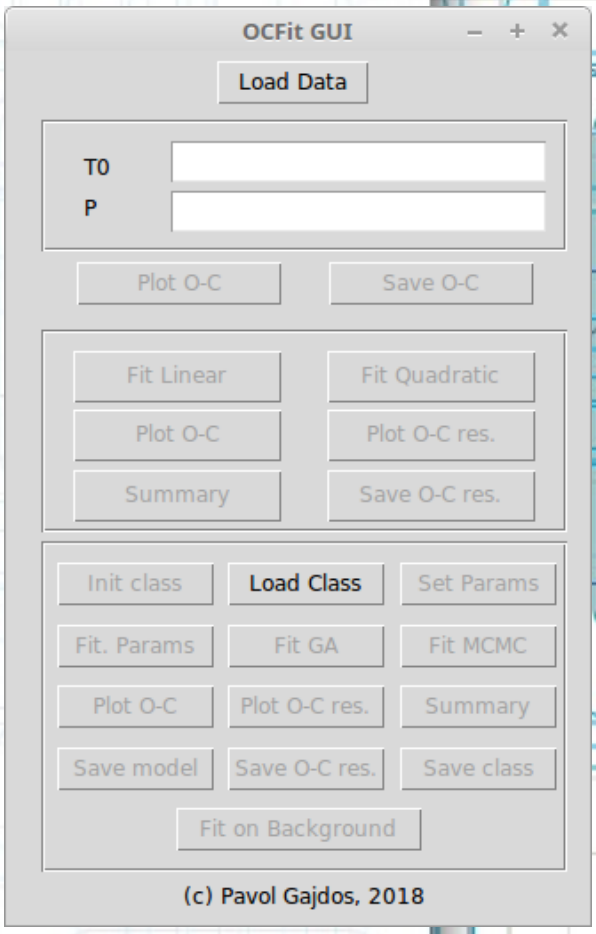
Fitting O-C diagrams

- using standard methods is problematic
- many free parameters
- our algorithms:

1. genetic algorithms
   - without any starting values (only interval)
   - initial estimation of parameters
2. Monte Carlo method
   - final values and errors of parameters

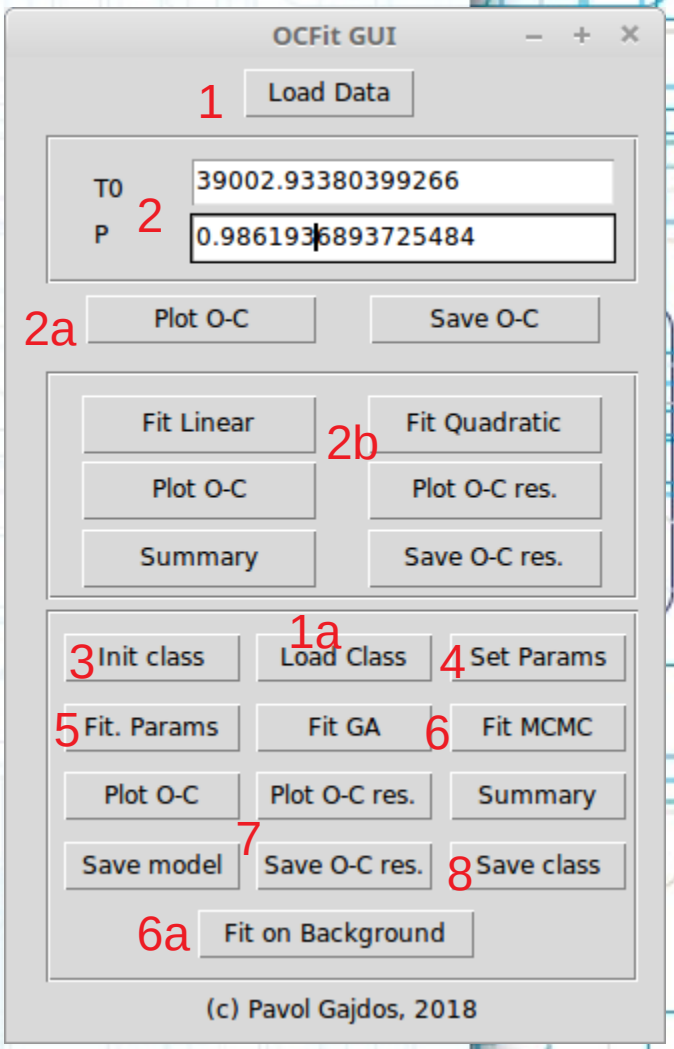
GUI

- basic control of OCFit class:
- load data, fitting, show results
- intuitive, buttons available after running necessary function
- python tkinter (python 2 & 3)
- version for Windows (exe file)



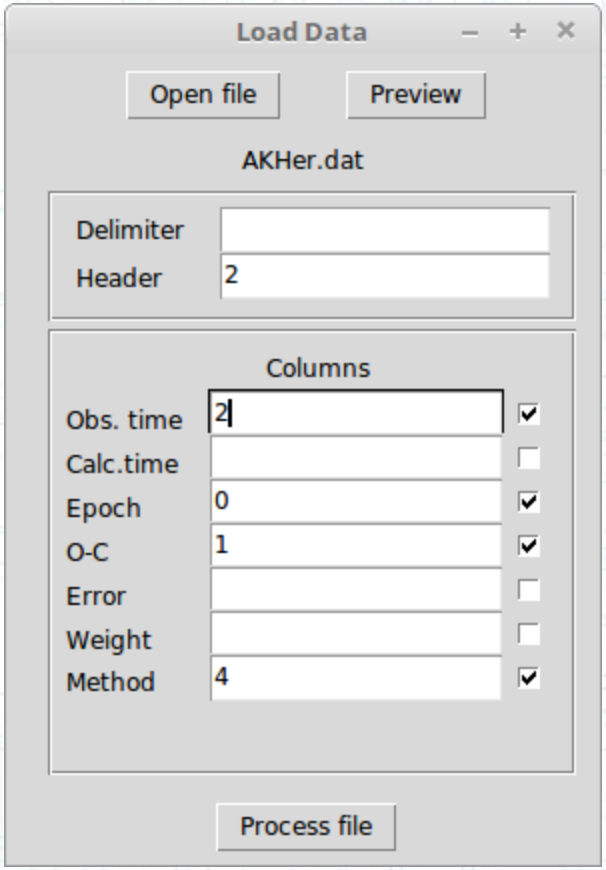
GUI - workflow

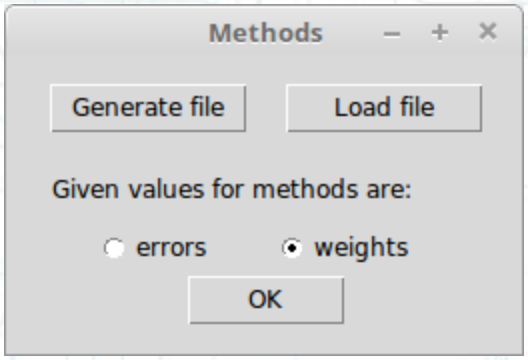
1. Loading data from file
   a. Load saved class (go to 4)
2. Set linear ephemeris
   a. Plot or save initial O-C
   b. Linear / quadratic fitting
3. Init class
4. Set parameters of model
5. Set fitting parameters
6. Fitting model – GA +MCMC
   a. Fit on background (go to 1a)
7. Working with results
8. Save class to file



GUI – loading data

- from text file
- data in columns
- no strict structure
- setting errors / weights of individual methods

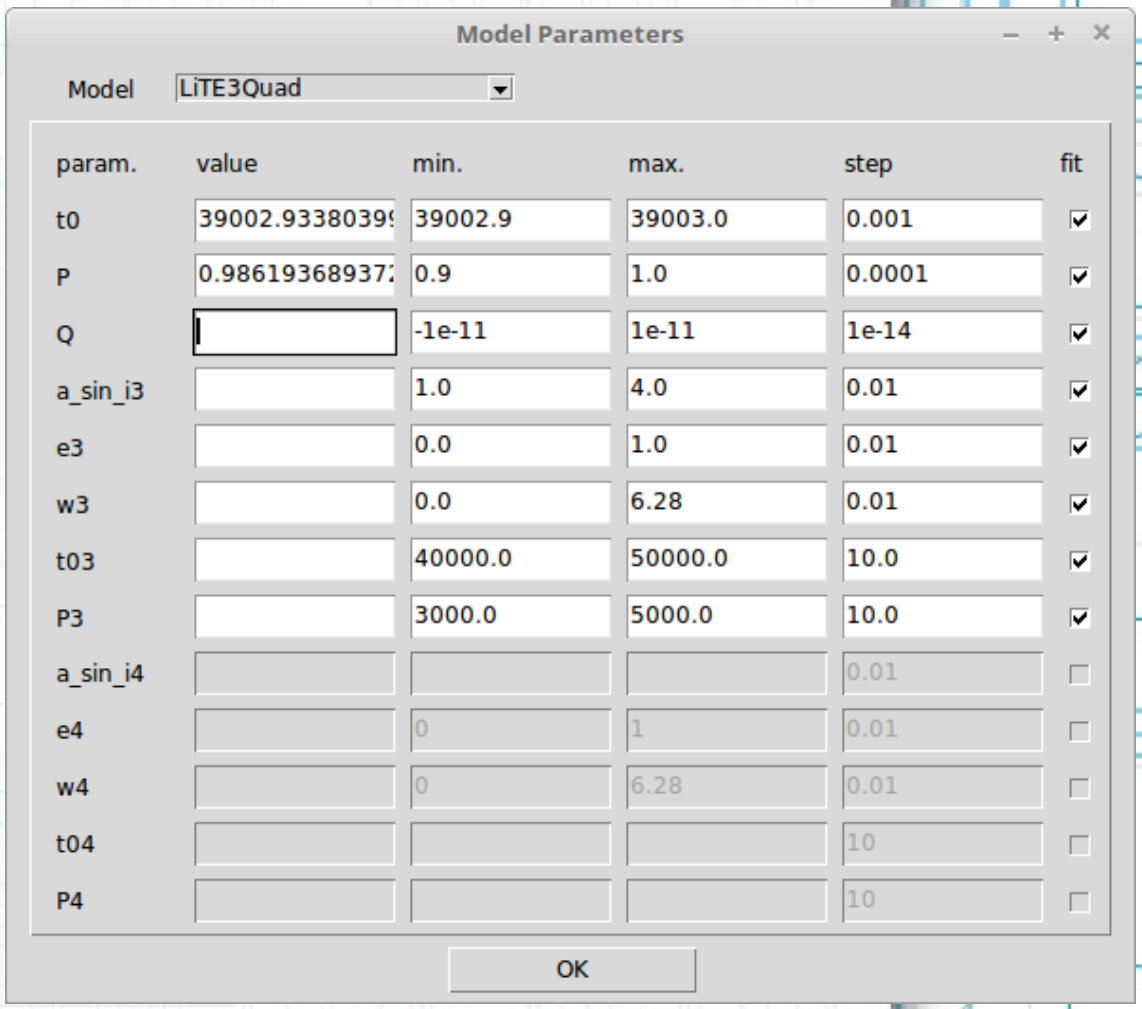





```
# Write errors / weights for each used method to next column!
pg      3
vis     1
pe      5
Vis     1
V       10
B       10
Y       10
R       10
BV      10
ccd     10
U       10
```

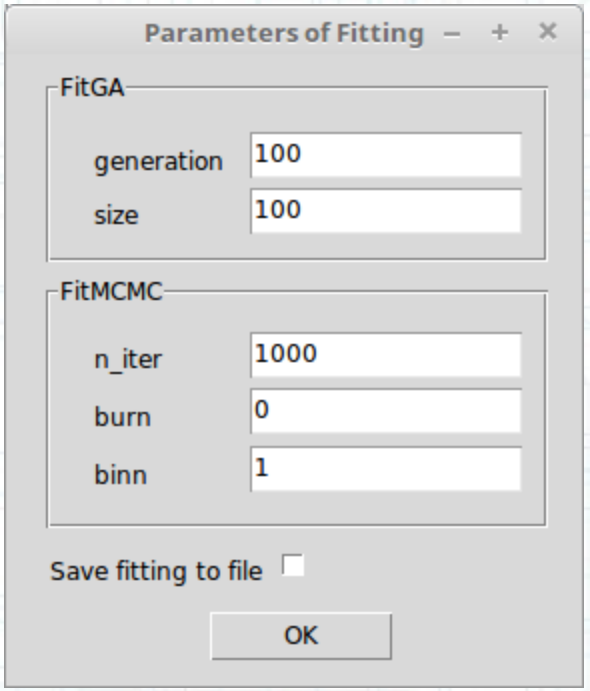
GUI – model parameters

- 9 available models:
  - LiTE – 3rd, 4th body + quadratic trend
  - Agol's models (Agol et al., 2005)
  - apsidal motion
- setting values, limits and steps of params



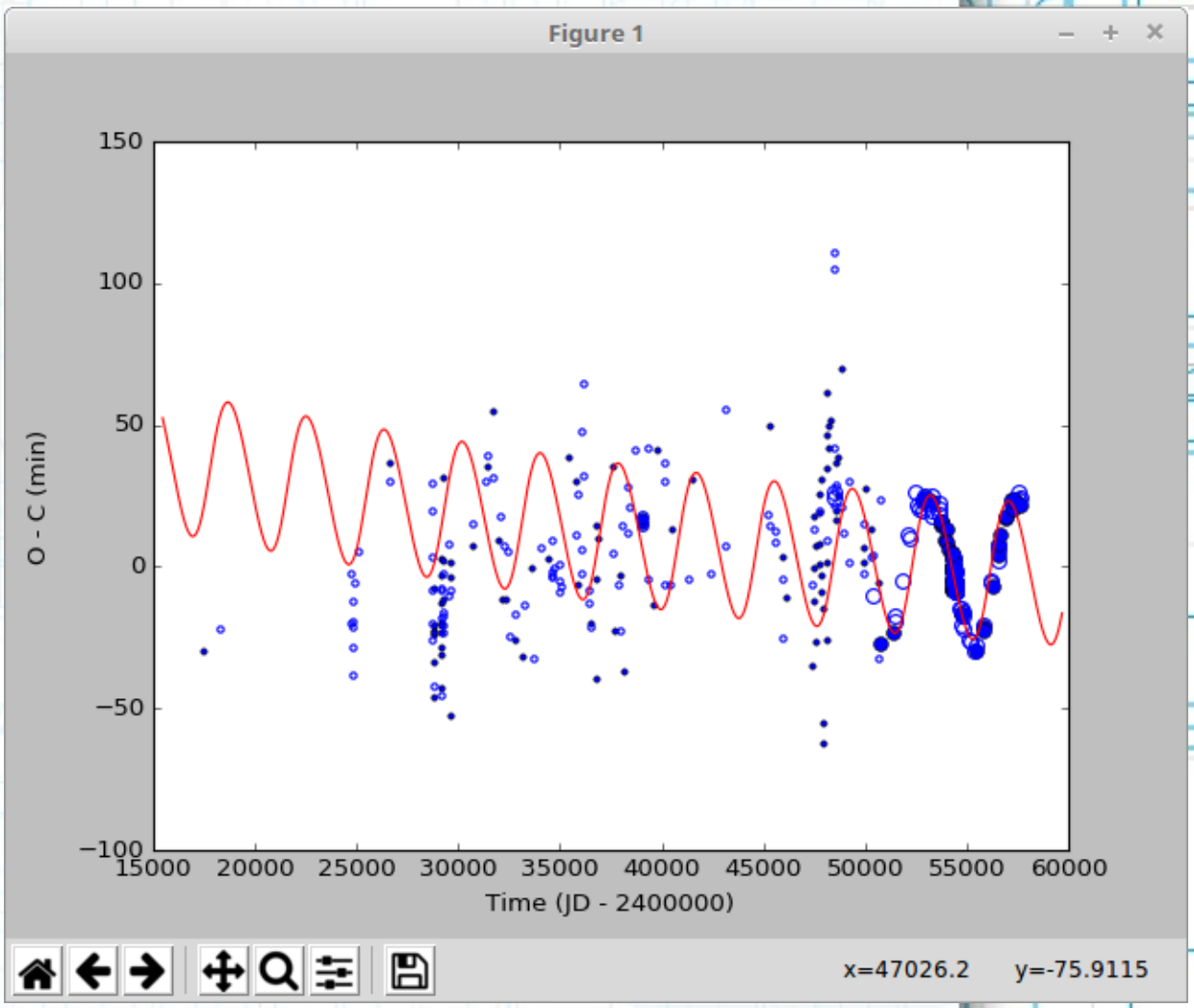
GUI – parameters of fitting

- setting parameters of fitting function:
  - genetic algorithms (GA)
  - Monte Carlo (MCMC)
- save fitting sampling to file (for detailed analysis)



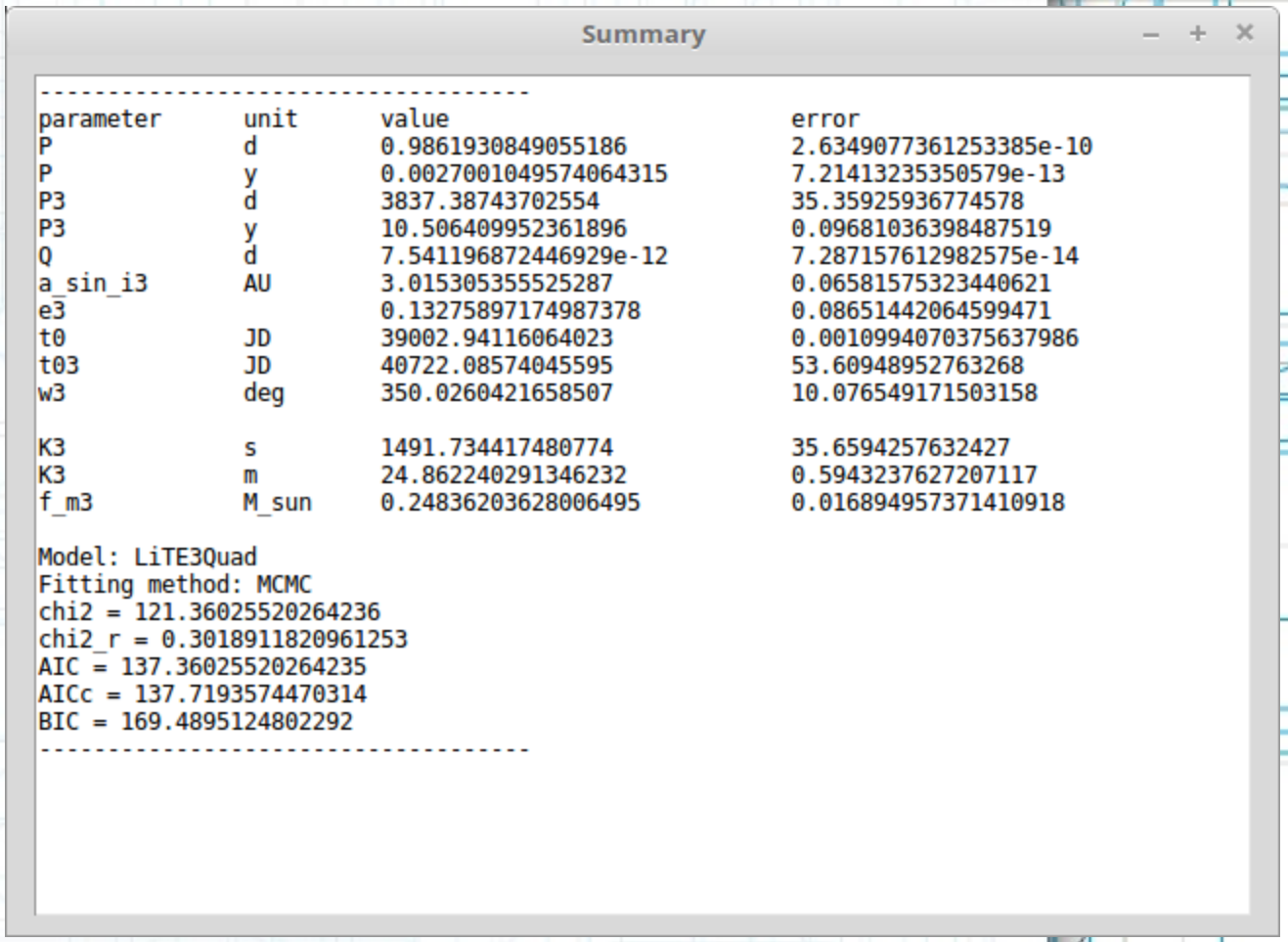
GUI – plot results

- plotting model with O-C data
- zoom, pan
- save to file
- plot residual O-C



GUI - summary

- list of model parameters – values & errors
- some other calculated parameters
- statistics

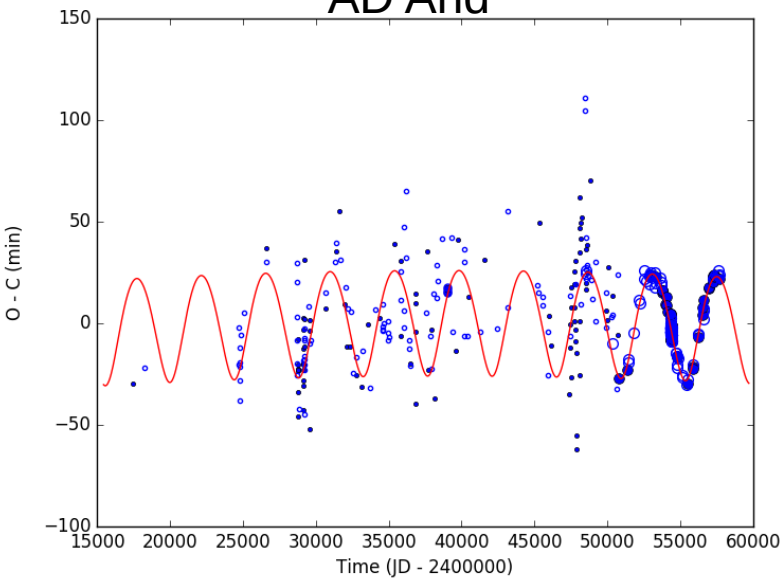


Some hints...

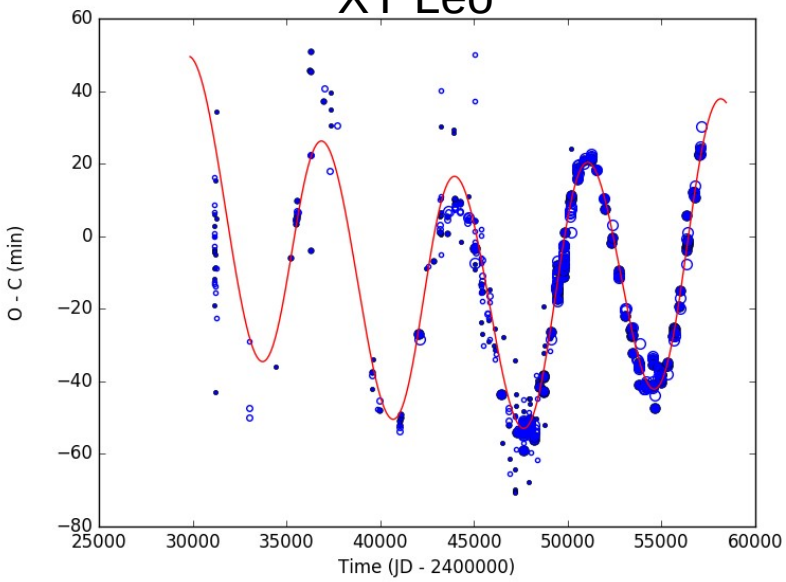
- use errors (instead of weights)
- good initial ephemeris!
- NOT fit linear ephemeris, if it isn't necessary
- if fitting ephemeris, use very small interval
- set appropriate fitting parameters:
  - for testing: GA (100, 100); MC (1000, 0 , 1)
  - for good results – at least: GA (1000, 1000); MC (1e6, 1e3, 10)
- save class to file

Examples

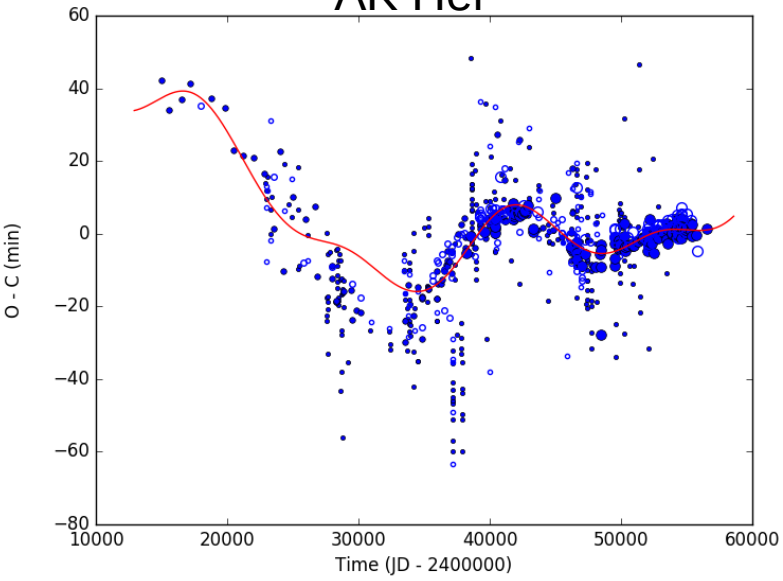
AD And



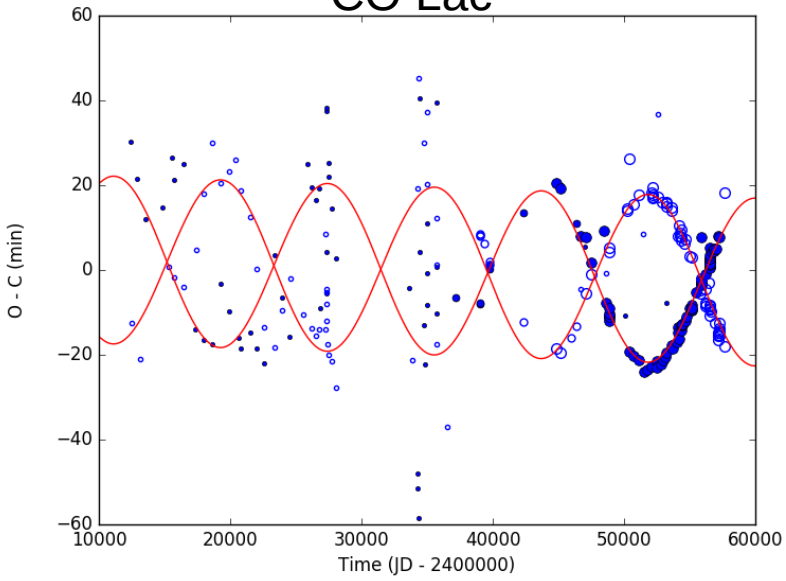
XY Leo



AK Her



CO Lac



Conclusion

- without entering exact starting values
- time and computationally intensive
- possibility to include more models of O-Cs
- already used in papers Gajdoš et al. (2017), Parimucha et al. (2018)
- available at: *https://github.com/pavolgaj/OCFit*
- if you have any problems with this program, please, contact me: *pavol.gajdos (a) student.upjs.sk*

Thank you for your attention!