V*-fit

VS-fit is a Python application that implements the DCDFT periodogram (a very basic, mostly nominal implementation) and performs curve fitting using a combination of algebraic and trigonometric polynomials. The program was inspired by I. L. Andronov's MCV software.

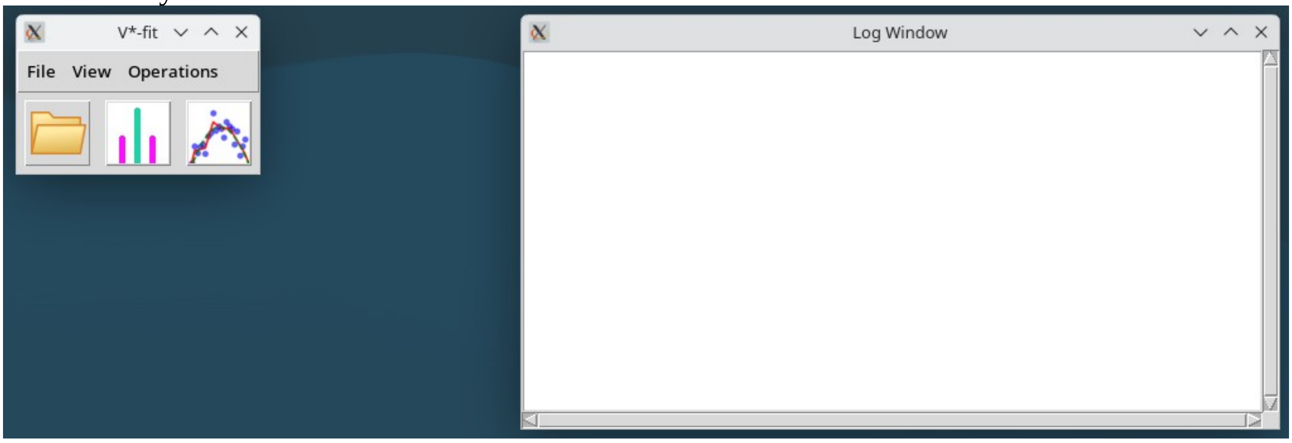
Download the program from its repository at https://github.com/mpyat2/VS-fit/
Go to the Releases section (https://github.com/mpyat2/VS-fit/releases)and download the ZIP file containing the source code (the program is written in Python, so the source code is essentially the program itself). Then unpack it to any desired location on your machine.

In Windows, launch **`VS-fit.bat`**. In Linux, launch **`vs-fit.sh`**. Note that in both cases it is assumed that Python is installed on the machine. You may edit **`VS-fit.bat`** (or **`vs-fit.sh`**) if the name of the Python interpreter differs from the expected one (**`py`** in Windows and **`python3`** in Linux, respectively), or if the interpreter is not in the system PATH.

The program requires the following Python packages:

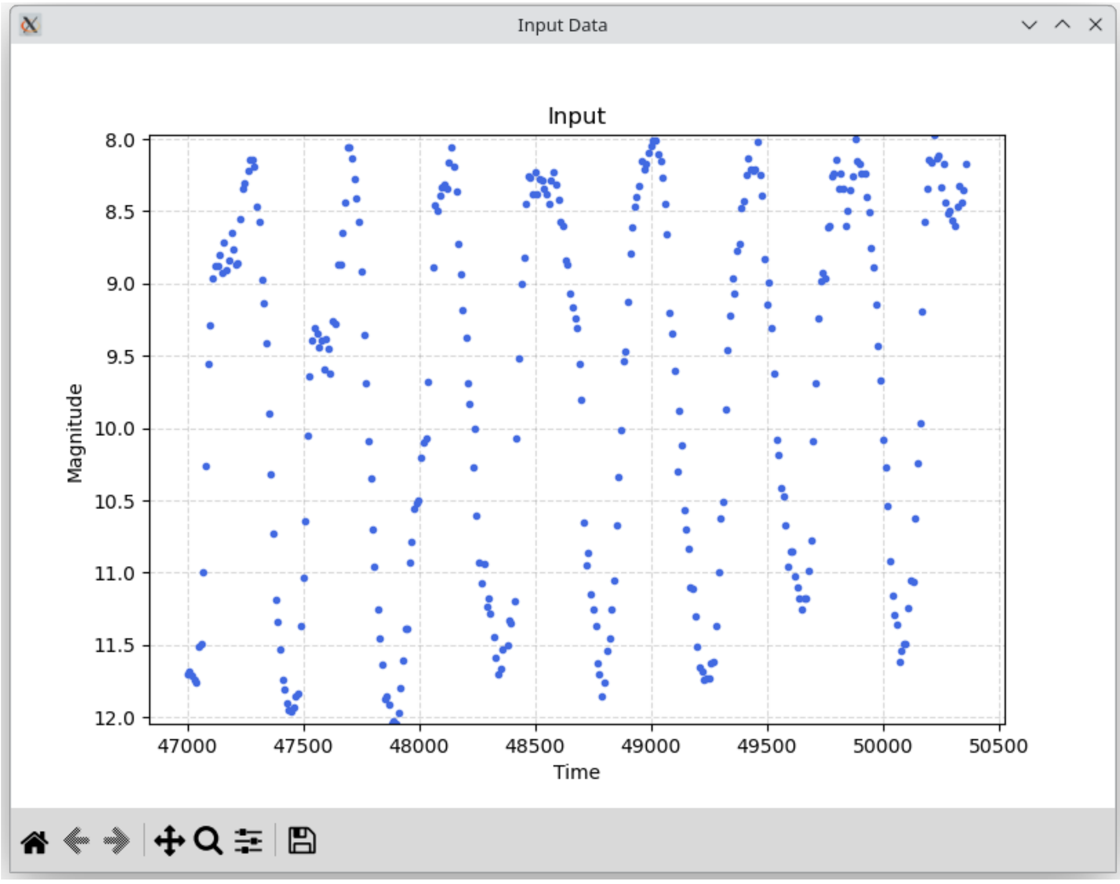
- scipy
- matplotlib
- pandas

After launching, the main program window and the "Log" window will appear. The main window contains only the main menu and three tool buttons:

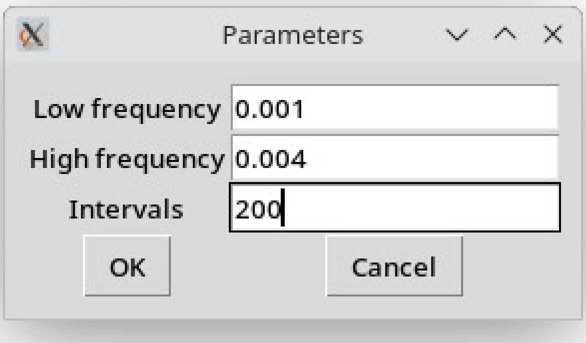


Use the first tool button (or File → Open Data File… from the menu) to open a data file. The program recognises files with columns delimited by spaces or tabs. Only the first and second columns are read. Consecutive spaces or tabs are treated as a single delimiter. Empty lines and lines beginning with "#" are ignored. It is assumed that the first column contains the X-values (i.e., times) and the second column contains the Y-values (i.e., magnitudes). You can find example data files in the **`data`** folder.

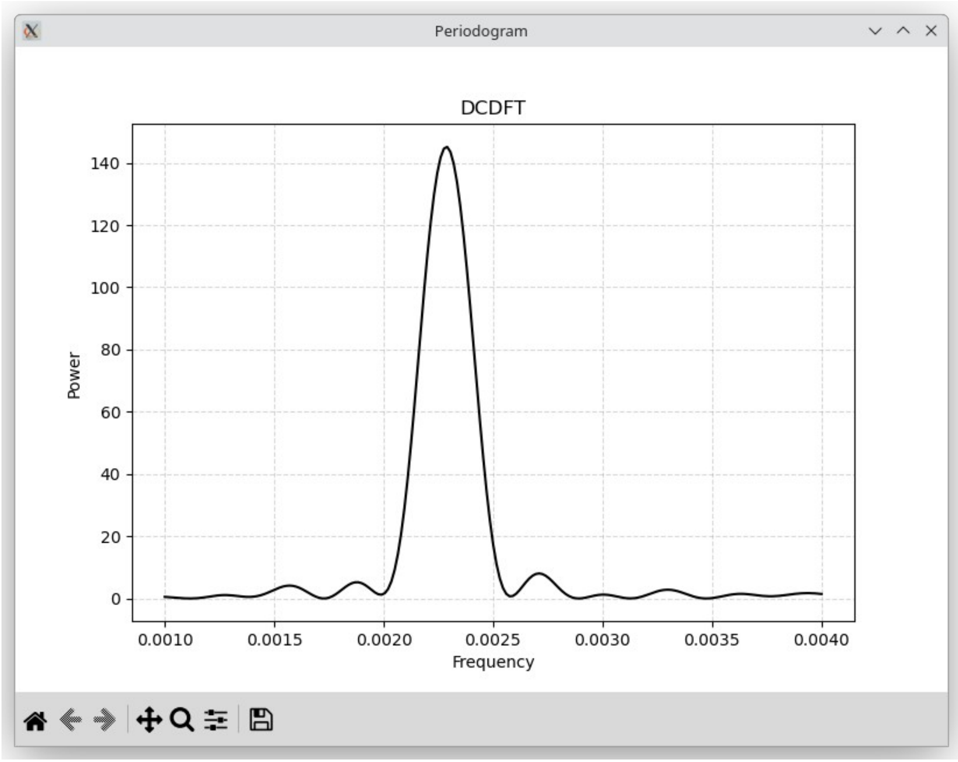
Let’s open the **`tcas.tsv`** file (T Cas observations). A new window will open showing the plot:



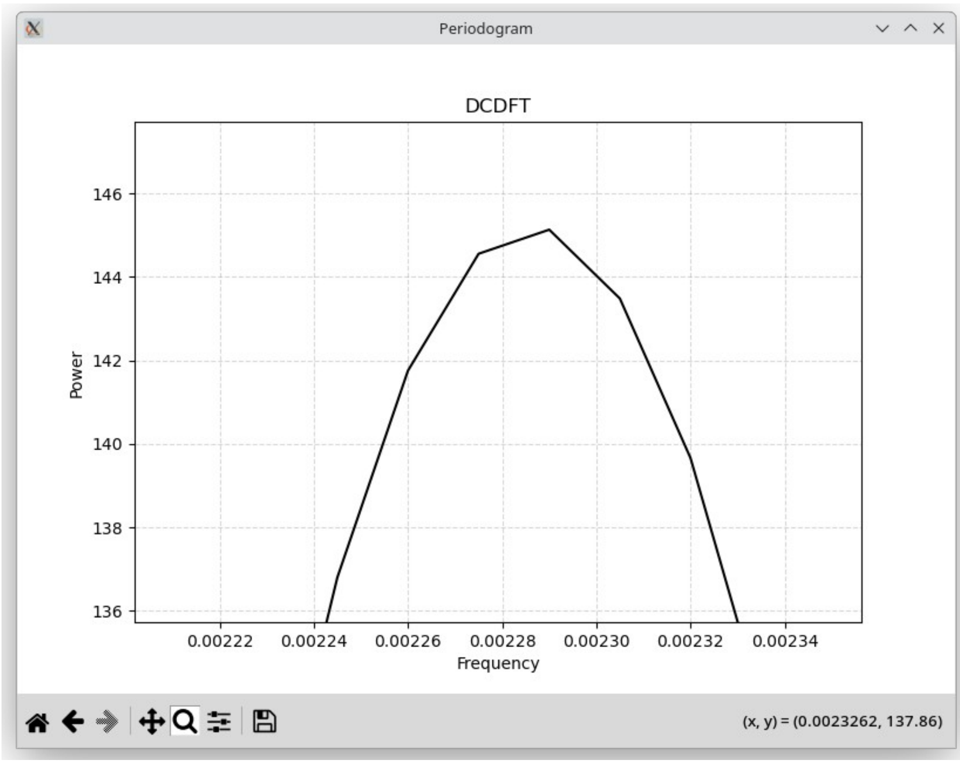
Let’s build a periodogram. Use Operations → DCDFT (Ferraz-Mello)... to do this. Specify the lowest and highest frequencies to analyze, as well as the number of intervals (which is one less than the number of frequencies). For this example, a reasonable choice would be:



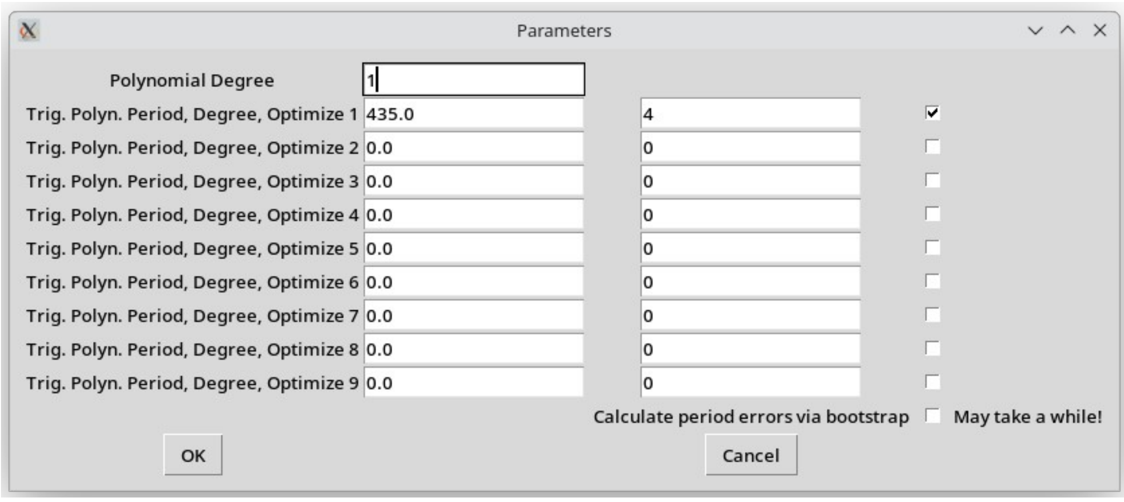
This corresponds to periods ranging from 250 to 1000 days. Press OK. Shortly thereafter, a new window displaying the periodogram will open:



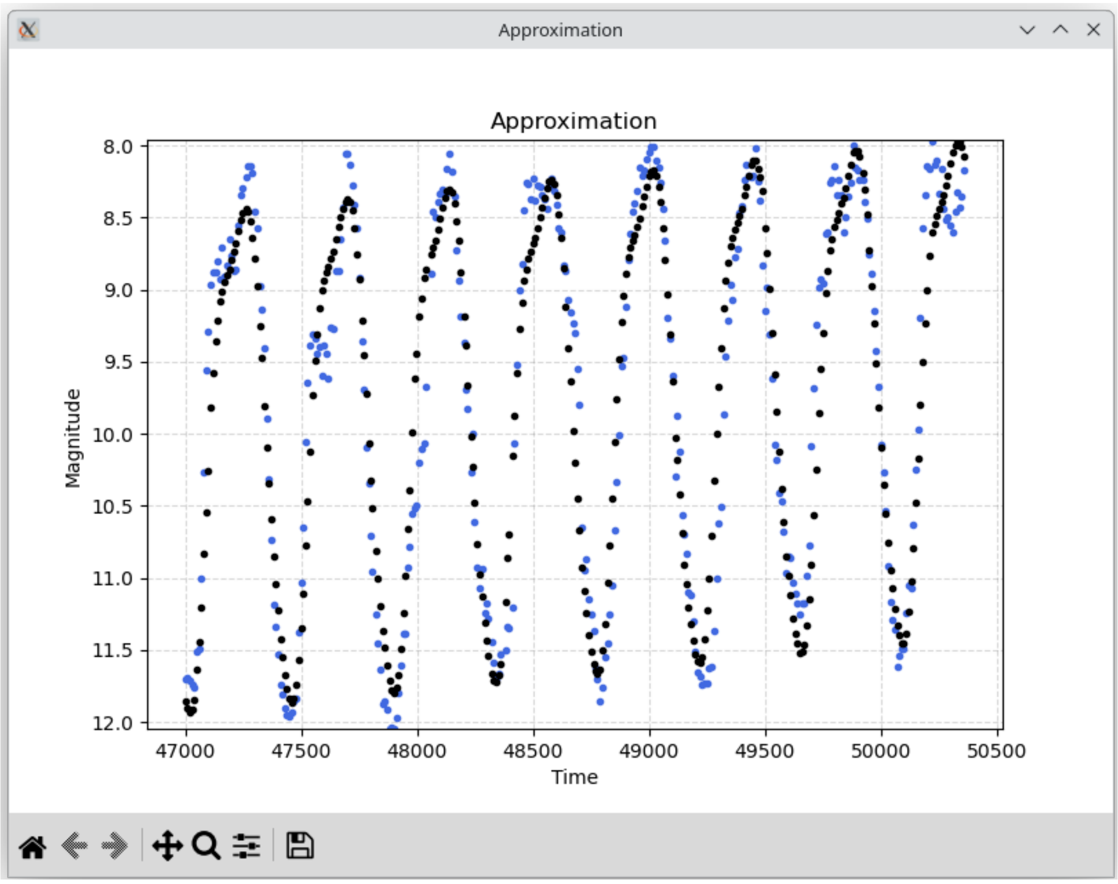
Use the “magnifying glass” icon and your mouse to zoom in on the region near the maximum:



The maximum occurs near the frequency 0.0023 d^{-1}, corresponding to a period of approximately 435 days. To refine this estimate, use the Operations → Polynomial Fit… menu command. Enter the preliminary period value, then set the trigonometric polynomial degree to 4 (this is an arbitrary choice for demonstration purposes). Also, set the algebraic polynomial degree to 1, which is appropriate given the upward trend in the data. Finally, enable the “Optimize” flag.



Press OK. Shortly, a new window will appear displaying the original data alongside the fitted polynomial model:

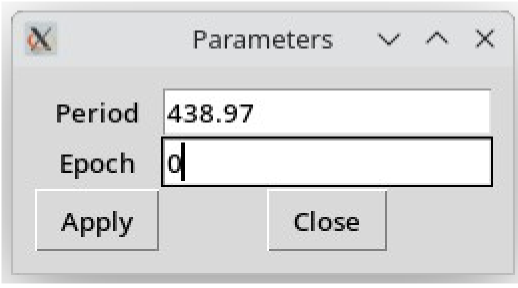


Check the Log window:

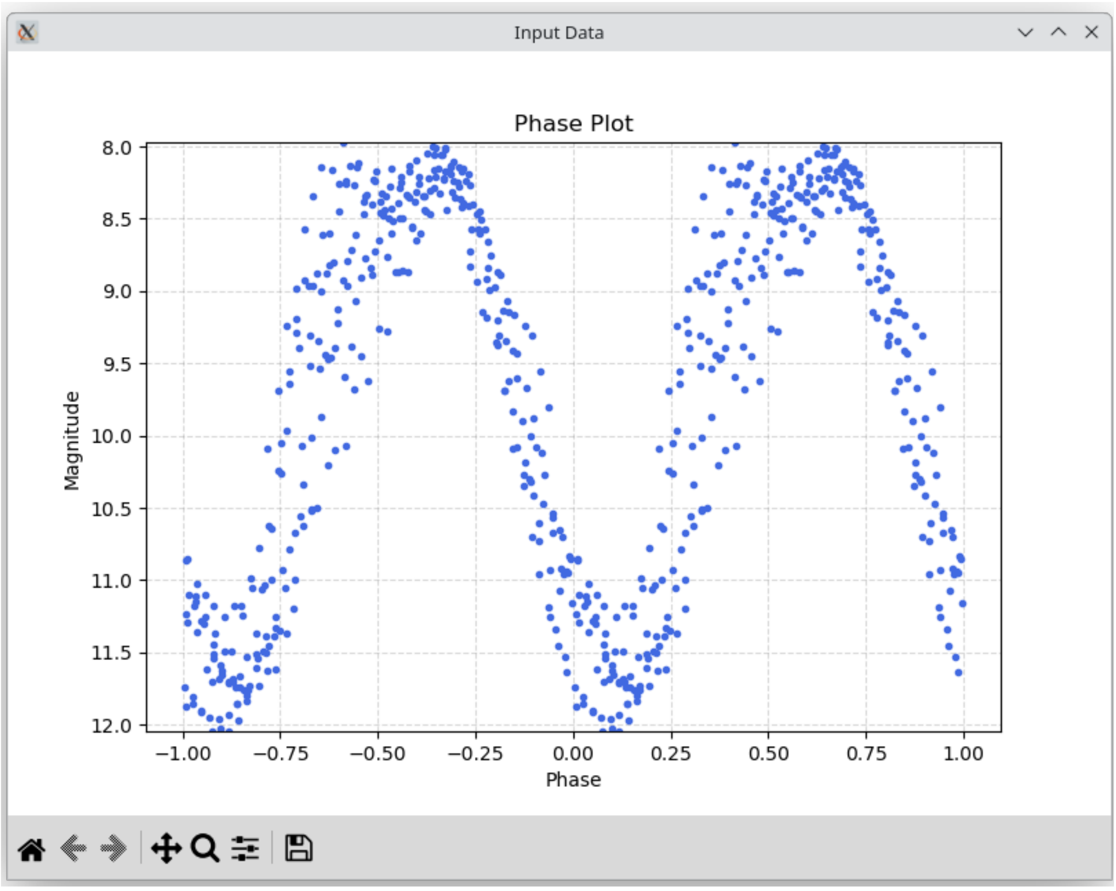
Log Window

```
PolyFit started.
PolyFit calculation time 0.03 s

=== INITIAL PERIODS ============================================================
period_1 = 435.000000000000
================================================================================


=== OPTIMIZED PERIODS ==========================================================
period_1 = 438.973709043232 ± 0.537531071871 (1σ)
================================================================================


=== LINEAR COEFFICIENTS ========================================================
poly_0      : 9.74368832e+00 ± 2.176e-02
poly_1      : -1.54947909e-04 ± 2.235e-05
cos_1       : 5.91421705e-01 ± 3.104e-02
sin_1       : 1.59441244e+00 ± 3.056e-02
cos_2       : -1.63687968e-01 ± 3.066e-02
sin_2       : 2.26644192e-01 ± 3.090e-02
cos_3       : 1.08010336e-01 ± 3.068e-02
sin_3       : -9.60732600e-02 ± 3.089e-02
cos_4       : 7.26619325e-03 ± 3.078e-02
sin_4       : 1.89386124e-02 ± 3.075e-02
================================================================================

=== AMPLITUDES =================================================================
Ampl_1      : 1.70056775e+00 ± 3.059e-02  Period: 1 * 438.9737090432318
Ampl_2      : 2.79573498e-01 ± 3.077e-02  Period: 2 * 438.9737090432318
Ampl_3      : 1.44555539e-01 ± 3.072e-02  Period: 3 * 438.9737090432318
Ampl_4      : 2.02846889e-02 ± 3.081e-02  Period: 4 * 438.9737090432318
================================================================================

RSS [Sum(O-C)^2] = 5.125016e+01, sigma = 3.977179e-01
Npoints = 335, dof = 324, Nparams = 11
R.M.S. accuracy of the fit sigma[x_c] = 0.07206908805981614

================================================================================
```

Here you will find the refined period value: 438.97 ± 0.54 days. Go to the View menu, select Plot Input → Phase, and enter the period value:



Enter 0 in the “Epoch” field for now, then press “Apply.”
A phase plot will be displayed. You can further refine the initial epoch to align the maximum with phase = 0.



The period value of 438.97 days is quite close to the one listed in the VSX database.

Epoch	16 Nov 2020 (HJD 2459170.0)
Outburst	--
Period	443.5 d
Rise/eclipse dur.	55% (244 d)

(End of the document)