NAFF

hpNaff

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Numerical Analysis of Fundamental Frequencies (NAFF)

A little command line tool (macOS, Linux, Windows) to perform high-resolution frequency analysis of time series following the Laskar method.

Pre-compiled binaries are available at https://paloz.marum.de/bitbucket/projects/ESSP/repos/hpnaff/browse/Binaries.

> **Note for Windows**
>
> Windows version requires installation of Windows Swift Toolchain

For macOS:

after download, copy 'hpnaff' to a location in your search path,

and add execute permissions by 'chmod a+x ./hpnaff; cp hpnaff /usr/local/bin'.

For convenience: a code-signed .dmg file is also available here: hpNaff-0.4.0.dmg

Then try it on an example file that contains a weighted mix of Earth's orbital eccentricity, obliquity and climatic precession.

> **Prototype WebApp version**
>
> A prototype (alpha) version (without any of the options) of this tool via a WebApp is available at https://paloz.marum.de/hpNaffWeb/index.html
>
> Please drag and drop a tab-separated textfile (two columns only, evenly spaced) onto the area, adjust the time/depth step, and press compute.

Usage:

```
% ./hpnaff -v
Welcome to hpNAFF Analysis. ©2015-2021 Heiko Pälike. 3rd party licenses: see --licenses option
Please provide exactly one file name argument
Usage: hpnaff [options] file
file format: tab separated columns, data must be equidistantly spaced. Instead of file can specify '-' for stdin.
  -h, --help:
      Displays help message.
  -r, --fracRMSChangeLimit:
      fracRMSChangeLimit. Default: 0.000002
  -f, --fracFreqAccuracyLimit:
      fracFreqAccuracyLimit. Default: 0.00000001
  -m, --maxFrequencies:
      maxFrequencies. Default: 30
  -c, --freqCycleLimit:
      freqCycleLimit. Default: 100
  -l, --lowerFreqLimit:
      lowerFreqLimit. Default: 0.0
  -u, --upperFreqLimit:
      upperFreqLimit. Default: 0.5 (NYQUIST)
  -d, --detrendingOrder:
      Order for polynomial detrending. 0 removes DC only. >0 removes a polynomial fit. Default: not set
  -dC, --detrendChunks:
      Option to apply detrending (-d) to individual chunks. Default: false
  -fAL, --filterAbscissaLower:
      filter on Abscissa (x-axis) data greater or equal than value specified.
  -fAU, --filterAbscissaUpper:
      filter on Abscissa (x-axis) data lesser or equal than value specified.
  -s, --chunkSize:
      Split the input file into chunks of this size. Default: not set, no chunking
  -w, --window_offsets:
      Specify windowing offset for evolutive analysis. Default: chunkSize if set, or None.
  -z, --columnSeparator:
      Use this as columns separtor for input file instead of default tab \t. Default: \t
  -k, --skipHeaderLines:
      Specify number of (header)lines to be skipped. Default: 0
  -n, --decimate:
      Specify decimation of input data. Default: 1 (take every value)
  -a, --abscissaColumn:
      Specify column number for abscissa (time or depth). Default: 1
  -o, --ordinateColumn:
      Specify column number for ordinate (data). Default: 2
  -C, --complex:
      Compute spectra for complex input. Default: false. If true, by default takes values from abscissa column +
1.
  -Co, --ComplexOrdinateColumn:
      Specify column number for ordinate (data), complex part. Default: 3 (if C option used)
  -t, --deltaT:
      Specify time/depth offset between data. Default: 1.0
  -x, --ratios:
      Compute and output frequency ratio matrix. Default: false.
  --ratio_list:
      If ratio_option is set, provides comma separated list of frequency ratios to highlight in output.
  --output_detrended_data:
      Output detrended data to this filename. Not implemented yet.
  --version:
      Shows current version and build of this software
  -v, --verbose:
      Print verbose messages. Specify multiple times to increase verbosity.
  --references:
      Shows references to papers and sources.
  --licenses:
      Shows licenses of code components used in this software.
```

Example: Try it on a sample file: etp_1kyr_36Ma.txt

```
user$ ./hpnaff etp_1kyr_36Ma.txt -d 1 -m 75

=====================================================================================================================
=================================
    # | chunk |       t0       | points |    frequency |     amplitude |        phase | significance |
period |    arcsec/yr |  phase (deg)
    0 |     0 |         0.0000 |  14001 |  0.000000000 |    0.00000000 |  0.000000000 |  0.000000000 |
inf |    0.0000000 |    0.0000000
    1 |     0 |         0.0000 |  14001 |  0.002472456 |    0.75721258 |  3.740563127 |  0.795224850 |
404.45610756 |    3.2043032 |  214.3184802
    2 |     0 |         0.0000 |  14001 |  0.010522542 |    0.59639514 | -0.083030087 |  0.840326031 |
95.03406718 |   13.6372149 |   -4.7572736
    3 |     0 |         0.0000 |  14001 |  0.024999241 |    0.53877772 |  5.657761056 |  0.827374133 |
40.00121445 |   32.3990163 |  324.1658300
    4 |     0 |         0.0000 |  14001 |  0.008040668 |    0.50803290 |  2.884638325 |  0.832167805 |
124.36778406 |   10.4207051 |  165.2776014
```

5	0	0.0000	14001	0.010102115	0.39766702	4.191460276	0.868275179	98.98917382	13.0923408	240.1529838
6	0	0.0000	14001	0.042828239	0.31115152	1.466354530	0.901608023	23.34908056	55.5053976	84.0159259
7	0	0.0000	14001	0.007627856	0.30706911	0.558756463	0.900168886	131.09844523	9.8857008	32.0143871
8	0	0.0000	14001	0.000407279	0.27097231	2.625060814	0.917986628	2455.31930796	0.5278336	150.4049056
9	0	0.0000	14001	0.045302069	0.26148887	5.142663822	0.908826103	22.07404698	58.7114815	294.6529325
10	0	0.0000	14001	0.025832617	0.23907704	3.749692849	0.917331368	38.71075060	33.4790718	214.8415747
11	0	0.0000	14001	0.001034652	0.22887920	0.316263467	0.926607014	966.50814962	1.3409095	18.1205619
12	0	0.0000	14001	0.053350844	0.23311864	1.355155680	0.912974999	18.74384580	69.1426943	77.6447010
13	0	0.0000	14001	0.009911387	0.18079485	5.692179885	0.941223401	100.89404923	12.8451580	326.1378837
14	0	0.0000	14001	0.019210470	0.15673509	-0.475810951	0.949106113	52.05494759	24.8967689	-27.2619593
15	0	0.0000	14001	0.052929481	0.14841497	5.755575872	0.947991689	18.89306257	68.5966076	329.7702061
16	0	0.0000	14001	0.009488271	0.15112041	-0.166596764	0.960411285	105.39327551	12.2967997	-9.5452915
17	0	0.0000	14001	0.025098798	0.17311913	2.629896209	0.958954086	39.84254538	32.5280423	150.6819533
18	0	0.0000	14001	0.025414340	0.14355863	4.818018103	0.948646430	39.34786366	32.9369851	276.0521029
19	0	0.0000	14001	0.024888808	0.14098312	5.710170222	0.964800625	40.17870229	32.2558949	327.1686540
20	0	0.0000	14001	0.010323185	0.13699989	-1.010239654	0.950068676	96.86932826	13.3788478	-57.8824685
21	0	0.0000	14001	0.007440236	0.12986997	2.040413354	0.952028440	134.40433245	9.6425463	116.9070736
22	0	0.0000	14001	0.001455303	0.12708837	2.315320953	0.947284449	687.14223688	1.8860724	132.6581188
23	0	0.0000	14001	0.010925100	0.11817448	-0.359553604	0.955088752	91.53234018	14.1589300	-20.6009040
24	0	0.0000	14001	0.009667251	0.11874251	2.622499903	0.954076811	103.44202802	12.5287567	150.2581762
25	0	0.0000	14001	0.010413463	0.09715315	2.916722459	0.980490597	96.02953115	13.4958485	167.1158869
26	0	0.0000	14001	0.000901134	0.09569726	1.601650029	0.968540900	1109.71245232	1.1678701	91.7677869
27	0	0.0000	14001	0.012994167	0.10086003	0.611296497	0.967944111	76.95760564	16.8404408	35.0247093
28	0	0.0000	14001	0.042724400	0.09486676	1.049712893	0.980633322	23.40582906	55.3708222	60.1441185
29	0	0.0000	14001	0.000231340	0.09813349	0.120421080	0.967044518	4322.64694648	0.2998163	6.8996196
30	0	0.0000	14001	0.005563540	0.10009924	2.397732816	0.967425007	179.74168484	7.2103475	137.3799708
31	0	0.0000	14001	0.010638958	0.09688648	-0.508419978	0.964555303	93.99417100	13.7880891	-29.1303190
32	0	0.0000	14001	0.008918727	0.08741944	2.593049312	0.963917464	112.12362149	11.5586705	148.5707817
33	0	0.0000	14001	0.007853668	0.09431921	1.158980960	0.966015093	127.32903632	10.1783540	66.4047175
34	0	0.0000	14001	0.024592220	0.08828171	3.104291584	0.962948350	40.66326600	31.8715176	177.8628061
35	0	0.0000	14001	0.008385587	0.08641115	2.992612020	0.964466604	119.25223732	10.8677206	171.4640385
36	0	0.0000	14001	0.018145511	0.08763660	3.810401603	0.965100179	55.11004768	23.5165828	218.3199301
37	0	0.0000	14001	0.024810831	0.08240291	4.521072773	0.982190253	40.30497880	32.1548364	259.0383888
38	0	0.0000	14001	0.042929640	0.09470460	-1.714770886	0.974168391	23.29392958	55.6368128	-98.2491346
39	0	0.0000	14001	0.001312871	0.08074684	0.777678607	0.975863805	761.68923898	1.7014813	44.5577020
40	0	0.0000	14001	0.002884917	0.08065197	2.947032331	0.969528197	346.63039200	3.7388528	168.8525146
41	0	0.0000	14001	0.009282092	0.07995912	-0.902914836	0.959472393	107.73432964	12.0295917	-51.7332094
42	0	0.0000	14001	0.002172887	0.07898195	1.985388299	0.966843584	460.21714558	2.8160620	113.7543702
43	0	0.0000	14001	0.025182288	0.07351399	1.270869502	0.989395181	39.71045117	32.6362447	72.8154588
44	0	0.0000	14001	0.002006049	0.07122474	1.007509645	0.970121706	498.49230512	2.5998395	57.7260505
45	0	0.0000	14001	0.008233354	0.07018462	4.902075131	0.962605563	121.45718541	10.6704267	280.8682159
46	0	0.0000	14001	0.043838032	0.06715352	3.232504867	0.965810782	22.81124276	56.8140900	185.2088861

```
   47 |      0 |          0.0000 |  14001 |  0.007224019 |    0.06531452 |  4.276908703 |  0.978785703 |
138.42710917 |    9.3623280 |  245.0488180
   48 |      0 |          0.0000 |  14001 |  0.045402169 |    0.07436495 |  2.063108445 |  0.977076727 |
22.02537938 |   58.8412112 |  118.2074066
   49 |      0 |          0.0000 |  14001 |  0.002344771 |    0.06402237 |  1.101819579 |  0.974716549 |
426.48086343 |    3.0388233 |   63.1296117
   50 |      0 |          0.0000 |  14001 |  0.034012471 |    0.06632261 |  0.311286623 |  0.964879805 |
29.40098080 |   44.0801621 |   17.8354097
   51 |      0 |          0.0000 |  14001 |  0.000615717 |    0.06955959 |  0.324652566 |  0.966238480 |
1624.12260860 |    0.7979693 |   18.6012218
   52 |      0 |          0.0000 |  14001 |  0.024999132 |    0.06125458 |  3.871230190 |  0.987944595 |
40.00138890 |   32.3988750 |  221.8051514
   53 |      0 |          0.0000 |  14001 |  0.012584554 |    0.06352103 |  4.354136361 |  0.970616108 |
79.46248859 |   16.3095823 |  249.4736369
   54 |      0 |          0.0000 |  14001 |  0.007042302 |    0.05954369 |  3.178070923 |  0.967975779 |
141.99901671 |    9.1268238 |  182.0900509
   55 |      0 |          0.0000 |  14001 |  0.053168977 |    0.06126971 | -0.361831203 |  0.974607869 |
18.80796025 |   68.9069938 |  -20.7314008
   56 |      0 |          0.0000 |  14001 |  0.018476857 |    0.05675901 |  1.358226583 |  0.977498040 |
54.12175935 |   23.9460065 |   77.8206508
   57 |      0 |          0.0000 |  14001 |  0.025289765 |    0.06621217 | -0.908124254 |  0.973848255 |
39.54168736 |   32.7755361 |  -52.0316871
   58 |      0 |          0.0000 |  14001 |  0.045202487 |    0.05979910 |  4.539755712 |  0.986931113 |
22.12267664 |   58.5824230 |  260.1088423
   59 |      0 |          0.0000 |  14001 |  0.001552070 |    0.05459046 |  3.384103161 |  0.981459103 |
644.30080647 |    2.0114828 |  193.8948286
   60 |      0 |          0.0000 |  14001 |  0.010774958 |    0.06013873 | -0.920994981 |  0.970525666 |
92.80778711 |   13.9643455 |  -52.7691253
   61 |      0 |          0.0000 |  14001 |  0.035180014 |    0.05381168 |  6.108664303 |  0.971837152 |
28.42523015 |   45.5932984 |  350.0006830
   62 |      0 |          0.0000 |  14001 |  0.025932854 |    0.05497186 |  0.528441367 |  0.981080756 |
38.56112370 |   33.6089791 |   30.2774600
   63 |      0 |          0.0000 |  14001 |  0.019098347 |    0.05289607 |  5.666427635 |  0.977106362 |
52.36055271 |   24.7514576 |  324.6623884
   64 |      0 |          0.0000 |  14001 |  0.052829237 |    0.05592637 |  4.622260192 |  0.978276065 |
18.92891225 |   68.4666917 |  264.8360008
   65 |      0 |          0.0000 |  14001 |  0.011547573 |    0.05030718 |  3.661455364 |  0.969207741 |
86.59828253 |   14.9656548 |  209.7859392
   66 |      0 |          0.0000 |  14001 |  0.052667555 |    0.04771644 |  4.565272429 |  0.975236135 |
18.98702155 |   68.2571512 |  261.5708425
   67 |      0 |          0.0000 |  14001 |  0.008514638 |    0.04804064 |  4.938804770 |  0.978348985 |
117.44480713 |   11.0349707 |  282.9726692
   68 |      0 |          0.0000 |  14001 |  0.017723966 |    0.04660213 |  1.785804511 |  0.976900743 |
56.42078067 |   22.9702600 |  102.3190615
   69 |      0 |          0.0000 |  14001 |  0.013408861 |    0.04526629 | -0.218064195 |  0.976731996 |
74.57754915 |   17.3778840 |  -12.4941580
   70 |      0 |          0.0000 |  14001 |  0.004944881 |    0.04401069 |  3.792380702 |  0.977679719 |
202.22932980 |    6.4085660 |  217.2874085
   71 |      0 |          0.0000 |  14001 |  0.024477668 |    0.04221972 |  2.795577253 |  0.982047896 |
40.85356574 |   31.7230571 |  160.1747779
   72 |      0 |          0.0000 |  14001 |  0.025733760 |    0.04584982 |  3.159868039 |  0.992264403 |
38.85945885 |   33.3509534 |  181.0471025
   73 |      0 |          0.0000 |  14001 |  0.044937430 |    0.04272239 |  0.214967789 |  0.979100871 |
22.25316390 |   58.2389096 |   12.3167471
   74 |      0 |          0.0000 |  14001 |  0.018373301 |    0.04170326 |  4.267372537 |  0.976418419 |
54.42680232 |   23.8117976 |  244.5024360
   75 |      0 |          0.0000 |  14001 |  0.016041231 |    0.04508949 |  2.028721000 |  0.980103195 |
62.33935561 |   20.7894353 |  116.2371511
```

Notes

"Evolutive" outputs can be obtained with the -s option, e.g. -s 1000 computes an analysis for every 1000 points.

Source code available at repository below. Note: There are three branches, "main" contains a new swift package manager version, which can also be compiled for Linux/Windows, and "Accelerate" whichh uses the LinearAlgebra system library. The Linux version is linked statically. The "Windows" branch is modified to enable compilation with the Windows Swift Toolchain (see top).

https://paloz.marum.de/bitbucket/scm/essp/hpnaff.git

This is a Swift implementation of

https://ops.aps.anl.gov/manuals/SDDStoolkit/SDDStoolkitsu61.html

Related efforts:

https://github.com/MichaelEhrlichman/FortNAFF

https://github.com/adrn/SuperFreq

https://github.com/nkarast/PyNAFF

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