1 Read me

Along this work we have used SNAG package [1], an important toolbox based on the MATLAB environment to analyse GW signal. Using this package, we have implemented some codes to check these algorithms. The most important of these codes can be found in this repository. In this section, we are going to explain the most relevant ones.

1.1 Gen_sour

Inputs:

- **nsim**: number of source toy models generated.
- **f0_int**: frequency upper limit used to generate random frequencies in the range [10, 10 + **f0_int**] Hz.

This function generates **nsim** source toy models with random parameters. We choose the parameter ranges refering to the ATNF catalogue [2].
It returns a table with **nsim** rows, one for each source toy model struct. The fields are:

- **fepoch**: Reference time of the frequency, 58664 MJD.
- **pepoch**: Reference time of the position, 58664 MJD.
- **v_a**: Ascension velocity, set to zero.
- **v_d**: Declination velocity, set to zero.
- **name**: Name of the pulsar, set to 'pulsar'.
- **a**: Ascension, measured in hours, minutes and seconds.
- **d**: Declination, measured in degrees, minutes and seconds.
- **f0**: Source toy model frequency.
- **df0**: Source toy model first order spin down.
- **ddf0**: Source toy model second order spin down.
- **eta**: Ratio of the polarization ellipse semi-minor to the semi-major axis.
- **psi**: Polarization angle.
- **gamma**: Conversion factor from $H_0 = 2A_{BSD} \times 10^{-20}$ (Rome) to h_0 where $H_0 = h * \mathbf{gamma}$; on average $\frac{1}{\mathbf{gamma}} = 1.32$

1.2 Test_sd

Inputs:

- **in**: Input data in the BSD format.
- **sour_inj**: Source toy model, with the frequency in the frequency band of the BSD.
- **a**: Order of magnitude of the amplitude of the signal injected. It is used to calculate the input $A \equiv A_{BSD}$, with A_{BSD} defined in Eq.(**??**), of the SNAG function "bsd_soft_re_mod.m" [1] as $A = 5 \times 10^{\mathbf{a}}$.

- **TFFT**: Coherence time, that is the length of the FFTs.
- **file2save**: Name of the output file.

The function injects a signal in the BSD, using a toy model given in input. Then, it calculates SNR and CR, using the function *SNRlight* in three different cases:

(I) Not correcting the signal.

(II) Correcting the signal, without considering the second order spin down.

(III) Correcting the signal considering the second order spin down.

It reiterates this procedure for 5 order of magnitude of the second order spin down, from 10^{-23} $\frac{\text{Hz}}{\text{s}^2}$ to 10^{-28} $\frac{\text{Hz}}{\text{s}^2}$. It returns as an output a table with the following columns:

- **par**: Type of correction between (i), (ii) and (iii).
- **a_ddf0**: Order of magnitude of the second order spin down used to correct the signal, i.e. $\ddot{f}_0 = 5 \times 10^{\mathbf{a}\_\mathbf{ddf0}}$.
- **cr**: CR.
- **SNR**: SNR.

1.3 Lim_corr_f

Inputs:

- **in**: Input data in the BSD format.
- **sour_inj**: Source toy model.
- **a**: Order of magnitude of the amplitude of the signal injected. It is used to calculate the input $\text{A} \equiv \text{A}_{BSD}$, with A_{BSD} defined in Eq.(**??**), of the SNAG function "bsd_soft_re_mod.m" [1] as $\text{A}= 5 \times 10^{\mathbf{a}}$.
- **TFFT**: Coherence time.
- **file2save**: Name of the output file.

The function injects a signal, using a source toy model given in input, then it corrects the data changing the frequency of the source toy model. The frequency range is $\pm\frac{20}{3}\delta f$, where $\frac{\delta f}{3}$ is the step. Then, for each case, it calculates CR and SNR. It returns as an output a table with the following entrances:

- **f0**: Source toy model frequency used for the correction.
- **cr**: CR.
- **SNR**: SNR.

1.4 Lim_corr_g

Inputs:

- **in**: Input data in the BSD format.
- **sour_inj**: Source toy model.
- **a**: Order of magnitude of the amplitude of the signal injected. It is used to calculate the input $A \equiv A_{BSD}$, with A_{BSD} defined in Eq.(**??**), of the SNAG function "bsd_soft_re_mod.m" [1] as $A = 5 \times 10^{\mathbf{a}}$.
- **TFFT**: Coherence time, that is the length of the FFTs.
- **q**: Bin fraction.
- **file2save**: Name of the output file.

The function injects a signal, using a source toy model given in input, then it corrects the data changing the frequency, the first order and the second order spin down of the source toy model, in the range $\pm 10q\delta$, where δ indicates the bin for each parameter that is changing. Then, for each case, it calculates CR and SNR.

It returns as an output a table with the following entrances:

- **f0**: Source toy model frequency used for the correction.
- **df0**: Source toy model first order spin down used for the correction.
- **ddf0**: Source toy model second order spin down used for the correction.
- **cr**: CR.
- **SNR**: SNR.

1.5 Search_cand

Inputs:

- **in**: Input data in the BSD format.
- **sour_inj**: Candidate source to be.
- **ant**: Detector from which we have taken data.
- **TFFT**: Coherence time, that is the length of the FFTs.
- **c1,c2**: Frequency bin range.
- **c1,c2**: First order spin down bin range.
- **file2save**: Name of the output file.

The function correct the BSD with values of frequency and a first order spin down that ranges around the values of the source to be. Thanks to the parameters c_1, c_2, b_1 and b_2 is possible to fix the variation range. It returns as an output a table with the following entrances:

- **f0**: Source toy model frequency used for the correction.
- **df0**: Source toy model first order spin down used for the correction.
- **cr**: CR.
- **SNR**: SNR.

References

[1] S. Frasca et al. "SNAG, A TOOLBOX FOR GRAVITATIONAL WAVE DATA ANALYSIS". In: *International Journal of Modern Physics D* 09 (Jan. 2012). DOI: 10.1142/S0218271800000311.

[2] *Australian Telescope National Facility pulsar catalogue*. URL: https://www.atnf.csiro.au/research/pulsar/psrcat/.