Visibility parameters

Mignano, Liuzzo, Massardi

Good indicators of the data quality could be extracted from the visibility plane. On one hand, the analysis on the visibility plane does not depend on deconvolution methods or weighting schemes, as the analysis on the image plane does. It also talks about the effects of the antenna configuration and the sensitivity without being driven by the target for which the observations were performed. This helps to generalize the description of use to an archive-user that is not usually looking for the same targets as the PI that requested initially the observations. On the other hand, the data on the visibility plane is not always easy to interpret to a non-radioastronomer. Hence, they request proper documentation and could be moved to a more advanced search (i.e. for expert users). Here follows a description of the quantities that we have analyzed and a short report on the results applied to the test dataset.

1 UV plane description

Request:

> UV distance:
> algorithm: median and first and third quartile of the distribution
> exact algorithm TBD, could also be the 10% top/bottom.
> units: kilowavelengths
> searchable: no
> level: observation level

Each baseline draws tracks on the visibility plane ('U-V plane') determined by the movement due to the Earth rotation of the projection of the baseline center while tracking the target that is in the center of the U, V plane ('phase center'). From the visibility table we can extract for each visibility the values of distance from the phase center. By expressing this value in kilowavelengths its distribution is independent from the spectral set up and is the same for each spectral channel. The distribution describes the effects of the antenna pattern and, to an experienced user, can give precious indications about the resolution and the sensitivity that could be obtained on the observed angular scales. The baseline tracks behave, in fact, as angular scales filters. In raw words, shortest baselines give information on the largest scales and viceversa. However, the sensitivity that could be reached at a given range of angular scales depends on the number of baselines that correspond to that angular scale. So to make an example: an array with 5-antennas equally spaced between the minimum and maximum baselines give information on 5 ranges of angular scales with almost the same sensitivity; the same array with 4 antennas concentrated in the core and one antenna on the longest baseline can in principle reach the same resolution, but the sensitivity that will be reached in the same observing time on the smallest angular scale is worst than in the previous case, and this array will be better suited for extended emission. This is a simplification, but further effects to the distribution of the tracks on the U-V plane are given by the declination of the source and the duration of the observation. Hence, in the case of an archive-user who is looking only for the extended or the compact component of an object that has previously been observed, the properties of the distribution of the visibility plane is necessary to understand if the data could be suitable to him/her.

Algorithm

The algorithm is coded in the new task "vis_stat" From the visibility table we can extract for each visibility the values of U and V (distance from the phase center) and calculated the UVDIST ($\sqrt{(}U^2 + v^2)$). The distributions are described by its 1st, 2nd (median) and 3rd quartiles.

Examples on test cases

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Open issues

How does it works for mosaics?

2 Visibility noise

Request:

> Visibility noise:
> algorithm: standard, all visibilities (12m, ACA, TP) combined
> unit: TBD (Jy/beam?)
> searchable: no
> level: SPW/cube level (?)

The thermal noise in the visibility plane is an overall evaluation of the sensitivity that can be reached with the given visibility. It can be calculated after all the flagging is applied, after the calibration, but before the imaging so that it is independent on the procedure applied to obtain the image. It only depends on the number of visibilities (which is a function of the observing time and the number of baselines), of the Tsys, and of the band/channel-width. Hence it gives an overall view of the instrumental-weather conditions (number of antennas and Tsys) and of the observing setup (spectral setup and time), after all the bad effects have been removed (flagging). In our opinion it could be searched as well as the sensitivity from the image plane, as wrt the latter, the thermal noise is also deconvolution-independent.

Algorithm

The algorithm is coded in the new task "vis_noise". For each channel (or spectral window) of width δw and field of interest we extract the $Tsys_i$ (where i is the i-th antenna) we calculate the variance as the sum over all the baselines with antennae i and j that observed in the observing time δt:

$$var = \Sigma_{i,j} \frac{2JperK \cdot Tsys_i \cdot Tsys_j}{\delta w \cdot \delta t}$$

where $JperK = 2k/\mu A$ with k the Boltzmann A the area of the antennas and μ an efficiency factor. The thermal noise is the square root of var.

$Tsys_i$ is read from the T_sys table, and averaged for each antenna i. The observing time is read from the visibility main table (.ms).

Examples on test cases

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Open issues

How does it works for mosaics?
How can we describe different spectral setup?
How to deal with varying Tsys over the observations? (i.e. Is it enough to use $Tsys_i$ averaged over all the visibilities for a given antenna?

3 Noise measured from visibiliies

The noise estimated directly from visibilities takes into account both thermal and phase noise and represents a lower limit of noise measured into the images after cleaning process (e.g. imstat task in CASA). It deals with visibilities' real and imaginary parts and relative weights. A comparison between "image" noise and visibilities noise provides a tool to estimate how "good" was the cleaning process.

Algorithm

The algorithm is coded in the new task "vis_noise" and it is very similar to the "@noise" already present in mapping package and used to reduce PdBI data. Later on, the details about the algorithms used.

Examples on test cases

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Open issues

How does it works for mosaics?
How can we describe different spectral setup? What is the definition of weight for ALMA data?