



 AHELP for CIAO 3.4

cash

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Synopsis

A maximum likelihood function.

Description

Counts are sampled from the Poisson distribution, and so the best way to assess the quality of model fits is to use the product of individual Poisson probabilities computed in each bin i , or the likelihood L :

$$L = \text{(product)}_i [M(i)^{N(i)} / N(i)!] * \exp[-M(i)]$$

where $M(i) = S(i) + B(i)$ is the sum of source and background model amplitudes, and $D(i)$ is the number of observed counts, in bin i .

The CASH statistic (Cash 1979, ApJ 228, 939) is derived by (1) taking the logarithm of the likelihood function, (2) changing its sign, (3) dropping the factorial term (which remains constant during fits to the same dataset), and (4) multiplying by two:

$$C = 2 * \text{(sum)}_i [M(i) - D(i) \log M(i)]$$

The factor of two exists so that the change in CASH statistic from one model fit to the next, $(\Delta)C$, is distributed approximately as $(\Delta)\chi^2$ when the number of counts in each bin is high (> 5). One can then in principle use $(\Delta)C$ instead of $(\Delta)\chi^2$ in certain model comparison tests. However, unlike χ^2 , the CASH statistic may be used regardless of the number of counts in each bin.

The magnitude of the CASH statistic depends upon the number of bins included in the fit and the values of the data themselves. Hence one cannot analytically assign a 'goodness-of-fit' measure to a given value of the CASH statistic. Such a measure can, in principle, be computed by performing Monte Carlo simulations. One would repeatedly sample new datasets from the best-fit model, and fit them, and note where the observed CASH statistic lies within the derived distribution of CASH statistics. (The ability to perform Monte Carlo simulations is a feature that will be included in a future version of Sherpa.)

Note on Background Subtraction

The background should not be subtracted from the data when this statistic is used. It should be modeled simultaneously with the source, as in this example:

```
sherpa> DATA source.data
sherpa> BACK background.data
sherpa> SOURCE = [source model]
sherpa> BG = [background model]
sherpa> STATISTIC CASH
sherpa> FIT
```

Example

Specify the fitting statistic and then confirm it has been set.

```
sherpa> STATISTIC CASH
sherpa> SHOW STATISTIC
Statistic:          Cash
```

Bugs

See the [Sherpa bug pages](#) online for an up-to-date listing of known bugs.

See Also

sherpa

[bayes](#), [chicvar](#), [chidvar](#), [chigehrels](#), [chimvar](#), [chiprimini](#), [chisquare](#), [cstat](#), [get_stat_expr](#), [statistic](#), [truncate](#), [userstat](#)

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URL:
<http://cxc.harvard.edu/ciao3.4/cash.html>
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