

GammaLib - Bug #1496

Fit errors in log parabola fit are too large

07/01/2015 07:59 AM - Knödlseeder Jürgen

| | | | |
|------------------------|--------------------|------------------------|------------|
| Status: | Rejected | Start date: | 07/01/2015 |
| Priority: | Normal | Due date: | |
| Assigned To: | Knödlseeder Jürgen | % Done: | 0% |
| Category: | | Estimated time: | 0.00 hour |
| Target version: | 1.0.0 | | |

Description

When fitting all parameters, the fit errors of the log parabola model are too large.

The problem can be reproduced using this XML file: attachment:crab_logparabola.xml.

The ctlike run produces the following output:

```
2015-07-01T06:03:36: +=====+
2015-07-01T06:03:36: | Maximum likelihood optimisation |
2015-07-01T06:03:36: +=====+
2015-07-01T06:03:36: >Iteration 0: -logL=133492.928, Lambda=1.0e-03
2015-07-01T06:03:36: >Iteration 1: -logL=133489.599, Lambda=1.0e-03, delta=3.330, max(|grad|)=3.544902 [Index:8]
2015-07-01T06:03:36: >Iteration 2: -logL=133489.598, Lambda=1.0e-04, delta=0.000, max(|grad|)=0.013988 [Index:8]
2015-07-01T06:03:37:
2015-07-01T06:03:37: +=====+
2015-07-01T06:03:37: | Maximum likelihood optimization results |
2015-07-01T06:03:37: +=====+
2015-07-01T06:03:37: === GOptimizerLM ===
2015-07-01T06:03:37: Optimized function value ...: 133489.598
2015-07-01T06:03:37: Absolute precision .....: 0.005
2015-07-01T06:03:37: Acceptable value decrease ..: 2
2015-07-01T06:03:37: Optimization status .....: converged
2015-07-01T06:03:37: Number of parameters .....: 11
2015-07-01T06:03:37: Number of free parameters ..: 6
2015-07-01T06:03:37: Number of iterations .....: 2
2015-07-01T06:03:37: Lambda .....: 1e-05
2015-07-01T06:03:37: Maximum log likelihood .....: -133489.598
2015-07-01T06:03:37: Observed events (Nobs) ...: 57339.000
2015-07-01T06:03:37: Predicted events (Npred) ..: 57337.998 (Nobs - Npred = 1.00155)
2015-07-01T06:03:37: === GModels ===
2015-07-01T06:03:37: Number of models .....: 2
2015-07-01T06:03:37: Number of parameters .....: 11
2015-07-01T06:03:37: === GModelSky ===
2015-07-01T06:03:37: Name .....: Crab
2015-07-01T06:03:37: Instruments .....: all
2015-07-01T06:03:37: Instrument scale factors ..: unity
2015-07-01T06:03:37: Observation identifiers ...: all
2015-07-01T06:03:37: Model type .....: PointSource
2015-07-01T06:03:37: Model components .....: "SkyDirFunction" * "LogParabola" * "Constant"
2015-07-01T06:03:37: Number of parameters .....: 7
2015-07-01T06:03:37: Number of spatial par's ...: 2
2015-07-01T06:03:37: RA .....: 83.6331 [-360,360] deg (fixed,scale=1)
2015-07-01T06:03:37: DEC .....: 22.0145 [-90,90] deg (fixed,scale=1)
2015-07-01T06:03:37: Number of spectral par's ...: 4
2015-07-01T06:03:37: Prefactor .....: 5.86089e-16 +/- 4.39833e-11 [1e-23,1e-13] ph/cm2/s/MeV (free,scale=1e-16,gradient)
2015-07-01T06:03:37: Index .....: -2.32353 +/- 4567.39 [-0,-5] (free,scale=-1,gradient)
2015-07-01T06:03:37: Curvature .....: -0.0707068 +/- 0.00274528 [-0.01,-1000] (free,scale=-1,gradient)
2015-07-01T06:03:37: PivotEnergy .....: 998705 +/- 3.22562e+10 [10000,1e+09] MeV (free,scale=1e+06,gradient)
2015-07-01T06:03:37: Number of temporal par's ...: 1
2015-07-01T06:03:37: Normalization .....: 1 (relative value) (fixed,scale=1,gradient)
2015-07-01T06:03:37: === GCTAModellrfBackground ===
2015-07-01T06:03:37: Name .....: Background model
```

2015-07-01T06:03:37: Instruments: CTA
 2015-07-01T06:03:37: Instrument scale factors ..: unity
 2015-07-01T06:03:37: Observation identifiers ...: all
 2015-07-01T06:03:37: Model type: "PowerLaw" * "Constant"
 2015-07-01T06:03:37: Number of parameters: 4
 2015-07-01T06:03:37: Number of spectral par's ...: 3
 2015-07-01T06:03:37: Prefactor: 0.999265 +/- 0.0215484 [0.001,1000] ph/cm2/s/MeV (free,scale=1,gradient)
 2015-07-01T06:03:37: Index: -0.0117382 +/- 0.0123976 [-5,5] (free,scale=1,gradient)
 2015-07-01T06:03:37: PivotEnergy: 1e+06 [10000,1e+09] MeV (fixed,scale=1e+06,gradient)
 2015-07-01T06:03:37: Number of temporal par's ..: 1
 2015-07-01T06:03:37: Normalization: 1 (relative value) (fixed,scale=1,gradient)

Related issues:

| | | |
|--|---------------|-------------------|
| Related to GammaLib - Bug # 1447: Fit errors too large | Closed | 03/18/2015 |
| Related to GammaLib - Action # 1004: Make gammalib compatible with P7REP LAT ... | Closed | 11/28/2013 |
| Related to GammaLib - Action # 1060: Investigate whether a more precise curva... | Closed | 01/07/2014 |

History

#1 - 07/01/2015 08:03 AM - Knödseder Jürgen

- File *crab_logparabola.xml* added
- Description updated

#2 - 07/01/2015 09:11 AM - Knödseder Jürgen

I just disabled the analytical gradient and replaced it by a numerical gradient. This did not solve the issues, meaning that the problem does not come from a wrong analytical gradient computation:

2015-07-01T07:11:37: === GOptimizerLM ===
 2015-07-01T07:11:37: Optimized function value ..: 133489.598
 2015-07-01T07:11:37: Absolute precision: 0.005
 2015-07-01T07:11:37: Acceptable value decrease ..: 2
 2015-07-01T07:11:37: Optimization status: errors are inaccurate
 2015-07-01T07:11:37: Number of parameters: 11
 2015-07-01T07:11:37: Number of free parameters ..: 6
 2015-07-01T07:11:37: Number of iterations: 2
 2015-07-01T07:11:37: Lambda: 1e-05
 2015-07-01T07:11:37: Maximum log likelihood: -133489.598
 2015-07-01T07:11:37: Observed events (Nobs) ...: 57339.000
 2015-07-01T07:11:37: Predicted events (Npred) ..: 57337.998 (Nobs - Npred = 1.00154)
 2015-07-01T07:11:37: === GModels ===
 2015-07-01T07:11:37: Number of models: 2
 2015-07-01T07:11:37: Number of parameters: 11
 2015-07-01T07:11:37: === GModelSky ===
 2015-07-01T07:11:37: Name: Crab
 2015-07-01T07:11:37: Instruments: all
 2015-07-01T07:11:37: Instrument scale factors ..: unity
 2015-07-01T07:11:37: Observation identifiers ...: all
 2015-07-01T07:11:37: Model type: PointSource
 2015-07-01T07:11:37: Model components: "SkyDirFunction" * "LogParabola" * "Constant"
 2015-07-01T07:11:37: Number of parameters: 7
 2015-07-01T07:11:37: Number of spatial par's ...: 2
 2015-07-01T07:11:37: RA: 83.6331 [-360,360] deg (fixed,scale=1)
 2015-07-01T07:11:37: DEC: 22.0145 [-90,90] deg (fixed,scale=1)
 2015-07-01T07:11:37: Number of spectral par's ...: 4
 2015-07-01T07:11:37: Prefactor: 5.86087e-16 +/- 1.03055e-11 [1e-23,1e-13] ph/cm2/s/MeV (free,scale=1e-16,gradient)
 2015-07-01T07:11:37: Index: -2.32353 +/- 1070.16 [-0,-5] (free,scale=-1,gradient)
 2015-07-01T07:11:37: Curvature: -0.0707068 +/- 0.00274528 [-0.01,-1000] (free,scale=-1,gradient)
 2015-07-01T07:11:37: PivotEnergy: 998706 +/- 7.55782e+09 [10000,1e+09] MeV (free,scale=1e+06)
 2015-07-01T07:11:37: Number of temporal par's ..: 1
 2015-07-01T07:11:37: Normalization: 1 (relative value) (fixed,scale=1,gradient)
 2015-07-01T07:11:37: === GCTAModellIrfBackground ===
 2015-07-01T07:11:37: Name: Background model
 2015-07-01T07:11:37: Instruments: CTA
 2015-07-01T07:11:37: Instrument scale factors ..: unity
 2015-07-01T07:11:37: Observation identifiers ...: all
 2015-07-01T07:11:37: Model type: "PowerLaw" * "Constant"

```

2015-07-01T07:11:37: Number of parameters .....: 4
2015-07-01T07:11:37: Number of spectral par's ...: 3
2015-07-01T07:11:37: Prefactor .....: 0.999265 +/- 0.0215484 [0.001,1000] ph/cm2/s/MeV (free,scale=1,gradient)
2015-07-01T07:11:37: Index .....: -0.0117382 +/- 0.0123976 [-5,5] (free,scale=1,gradient)
2015-07-01T07:11:37: PivotEnergy .....: 1e+06 [10000,1e+09] MeV (fixed,scale=1e+06,gradient)
2015-07-01T07:11:37: Number of temporal par's ...: 1
2015-07-01T07:11:37: Normalization .....: 1 (relative value) (fixed,scale=1,gradient)

```

#3 - 07/01/2015 11:17 AM - Knödseder Jürgen

I replaced the error computation in ctklike by the Hessian error computation. Surprisingly, this gives basically the same covariance matrix, yet this covariance matrix is not positive definite:

```

=== GMatrixSparse === (curvature matrix)
Number of rows .....: 11
Number of columns .....: 11
Number of nonzero elements : 36
Number of allocated cells .: 548
Memory block size .....: 512
Sparse matrix fill .....: 0.297521
Pending element .....: 0
Fill stack size .....: 0 (none)
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 1268.55, 5724.77, -14854.5, 16486.8, 0, 43.0204, -79.7296, 0, 0
0, 0, 5724.77, 87060.3, -93910, 65733.2, 0, 467.303, -917.921, 0, 0
0, 0, -14854.5, -93910, 318438, -189252, 0, -917.99, 1841.59, 0, 0
0, 0, 16486.8, 65733.2, -189252, 215500, 0, 520.441, -957.187, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 43.0204, 467.303, -917.99, 520.441, 0, 13279, -21126.9, 0, 0
0, 0, -79.7296, -917.921, 1841.59, -957.187, 0, -21126.9, 40119.7, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
=== GMatrixSparse === (Hessian)
Number of rows .....: 11
Number of columns .....: 11
Number of nonzero elements : 36
Number of allocated cells .: 512
Memory block size .....: 512
Sparse matrix fill .....: 0.297521
Pending element .....: 0
Fill stack size .....: 0 (none)
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 1268.47, 5725.31, -14851.8, 16487.6, 0, 43.0624, -79.2227, 0, 0
0, 0, 5725.31, 87059.9, -93708.9, 65739, 0, 467.462, -917.827, 0, 0
0, 0, -14851.8, -93708.9, 319855, -189275, 0, -917.479, 1846.5, 0, 0
0, 0, 16487.6, 65739, -189275, 215497, 0, 520.326, -958.55, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 43.0624, 467.462, -917.479, 520.326, 0, 13279, -21127, 0, 0
0, 0, -79.2227, -917.827, 1846.5, -958.55, 0, -21127, 40278.9, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
Non-Positive definite hessian matrix encountered.
Load diagonal elements with 1e-10. Fit errors may be inaccurate.
Non-Positive definite hessian matrix encountered, even after diagonal loading.

```

#4 - 07/01/2015 12:39 PM - Knödseder Jürgen

I played with the PivotEnergy scale factor, and this had an impact on the result.

```
<parameter name="Scale" scale="1.0" value="1.0e6" min="0.01" max="1.0e9" free="1"/>
```

gave

```
2015-07-01T10:38:41: +=====+
2015-07-01T10:38:41: | Curvature matrix |
2015-07-01T10:38:41: +=====+
2015-07-01T10:38:41: === GMatrixSparse ===
2015-07-01T10:38:41: Number of rows .....: 11
2015-07-01T10:38:41: Number of columns .....: 11
2015-07-01T10:38:41: Number of nonzero elements : 36
2015-07-01T10:38:41: Number of allocated cells .: 548
2015-07-01T10:38:41: Memory block size .....: 512
2015-07-01T10:38:41: Sparse matrix fill .....: 0.297521
2015-07-01T10:38:41: Pending element .....: 0
2015-07-01T10:38:41: Fill stack size .....: 0 (none)
2015-07-01T10:38:41: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
2015-07-01T10:38:41: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
2015-07-01T10:38:41: 0, 0, 1270.09, 5730.2, -14866.5, 0.0164925, 0, 43.0466, -79.7782, 0, 0
2015-07-01T10:38:41: 0, 0, 5730.2, 87077.9, -93978.4, 0.0657413, 0, 467.369, -918.043, 0, 0
2015-07-01T10:38:41: 0, 0, -14866.5, -93978.4, 318537, -0.189237, 0, -918.235, 1842.07, 0, 0
2015-07-01T10:38:41: 0, 0, 0.0164925, 0.0657413, -0.189237, 2.15387e-07, 0, 0.000520305, -0.000956936, 0, 0
2015-07-01T10:38:41: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
2015-07-01T10:38:41: 0, 0, 43.0466, 467.369, -918.235, 0.000520305, 0, 13279, -21126.9, 0, 0
2015-07-01T10:38:41: 0, 0, -79.7782, -918.043, 1842.07, -0.000956936, 0, -21126.9, 40119.7, 0, 0
2015-07-01T10:38:41: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
2015-07-01T10:38:41: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
2015-07-01T10:38:41: Non-Positive definite curvature matrix encountered.
2015-07-01T10:38:41: Load diagonal elements with 1e-10. Fit errors may be inaccurate.
...
2015-07-01T10:38:41: === GModelSky ===
2015-07-01T10:38:41: Name .....: Crab
2015-07-01T10:38:41: Instruments .....: all
2015-07-01T10:38:41: Instrument scale factors ...: unity
2015-07-01T10:38:41: Observation identifiers ...: all
2015-07-01T10:38:41: Model type .....: PointSource
2015-07-01T10:38:41: Model components .....: "SkyDirFunction" * "LogParabola" * "Constant"
2015-07-01T10:38:41: Number of parameters .....: 7
2015-07-01T10:38:41: Number of spatial par's ...: 2
2015-07-01T10:38:41: RA .....: 83.6331 [-360,360] deg (fixed,scale=1)
2015-07-01T10:38:41: DEC .....: 22.0145 [-90,90] deg (fixed,scale=1)
2015-07-01T10:38:41: Number of spectral par's ...: 4
2015-07-01T10:38:41: Prefactor .....: 5.85732e-16 +/- 1.36307e-16 [1e-23,1e-13] ph/cm2/s/MeV (free,scale=1e-16,gradient)
2015-07-01T10:38:41: Index .....: -2.32357 +/- 0.014771 [-0,-5] (free,scale=-1,gradient)
2015-07-01T10:38:41: Curvature .....: -0.0707068 +/- 0.00274528 [-0.01,-1000] (free,scale=-1,gradient)
2015-07-01T10:38:41: PivotEnergy .....: 998967 +/- 100000 [0.01,1e+09] MeV (free,scale=1,gradient)
2015-07-01T10:38:41: Number of temporal par's ...: 1
2015-07-01T10:38:41: Normalization .....: 1 (relative value) (fixed,scale=1,gradient)
```

#5 - 07/01/2015 12:45 PM - Knödseder Jürgen

Here some more results:

```
<parameter name="Scale" scale="10.0" value="1.0e5" min="0.01" max="1.0e9" free="1"/>
```

...

```
2015-07-01T10:41:09: Prefactor .....: 5.86064e-16 +/- 5.67734e-11 [1e-23,1e-13] ph/cm2/s/MeV (free,scale=1e-16,gradient)
2015-07-01T10:41:09: Index .....: -2.32353 +/- 5895.79 [-0,-5] (free,scale=-1,gradient)
2015-07-01T10:41:09: Curvature .....: -0.0707068 +/- 0.00274528 [-0.01,-1000] (free,scale=-1,gradient)
2015-07-01T10:41:09: PivotEnergy .....: 998723 +/- 4.16386e+10 [0.1,1e+10] MeV (free,scale=10,gradient)
```

```
<parameter name="Scale" scale="100.0" value="1.0e4" min="0.01" max="1.0e9" free="1"/>
```

...

```
2015-07-01T10:42:48: Prefactor .....: 5.86114e-16 +/- 5.04599e-11 [1e-23,1e-13] ph/cm2/s/MeV (free,scale=1e-16,gradient)
2015-07-01T10:42:48: Index .....: -2.32353 +/- 5239.71 [-0,-5] (free,scale=-1,gradient)
2015-07-01T10:42:48: Curvature .....: -0.0707068 +/- 0.00274528 [-0.01,-1000] (free,scale=-1,gradient)
2015-07-01T10:42:48: PivotEnergy .....: 998687 +/- 3.70038e+10 [1,1e+11] MeV (free,scale=100,gradient)
```

Looks that playing around with the scales does lead to a non positive definite matrix, resulting in diagonal loading which essentially switches off the pivot energy.

#6 - 07/01/2015 01:50 PM - Knödseder Jürgen

After some lunch time discussions we concluded that it is impossible to constrain the pivot energy of the log-parabola model as the model parameters are fully degenerated. This issue is thus considered as a non-issue, and can be rejected.

Note, however, that this should be mentioned in the known issues of the ctools documentation.

#7 - 07/02/2015 06:12 PM - Knödseder Jürgen

- Status changed from New to Rejected

Files

| | | | |
|----------------------|---------|------------|------------------|
| crab_logparabola.xml | 1.21 KB | 07/01/2015 | Knödseder Jürgen |
|----------------------|---------|------------|------------------|