3ML

The Multi-Mission Maximum Likelihood framework

- not your usual spectral fitting package
- multi-wavelength, multi-messenger architecture
- use plugins: you can interact with heterogeneous data in a unified way, while they are handled differently behind the scene
- Maximum Likelihood and Bayesian analysis
- Local and global minimization
- Simulations capabilities
- python-based

https://github.com/giacomov/3ML

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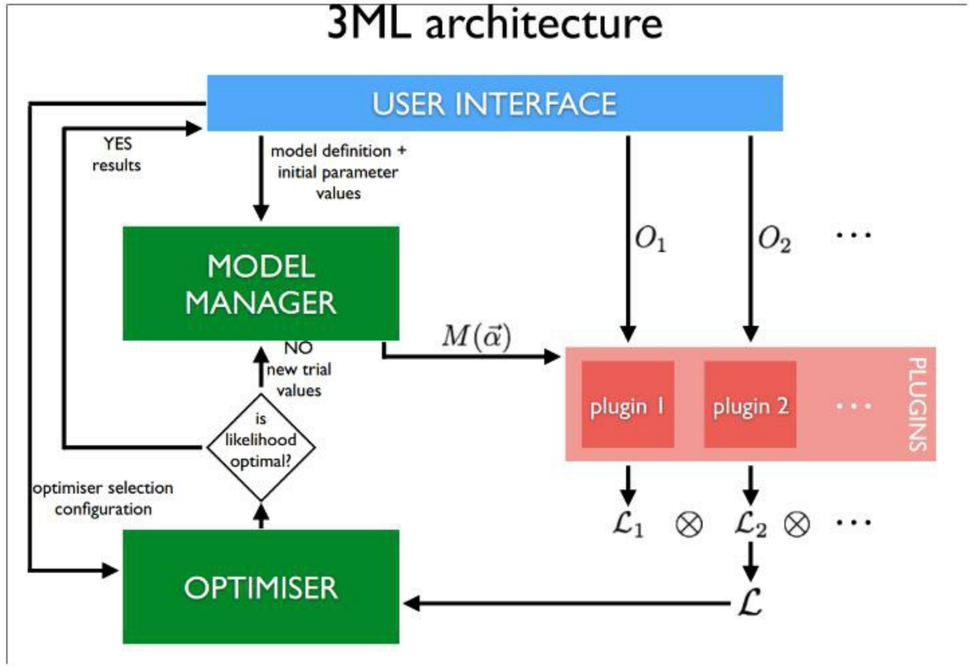
the 3ML team

3ML is different

- Existing solutions (xspec, sherpa...) are more or less a one-size-fits-all approach
- only good for instruments which can be reconducted to the same analysis

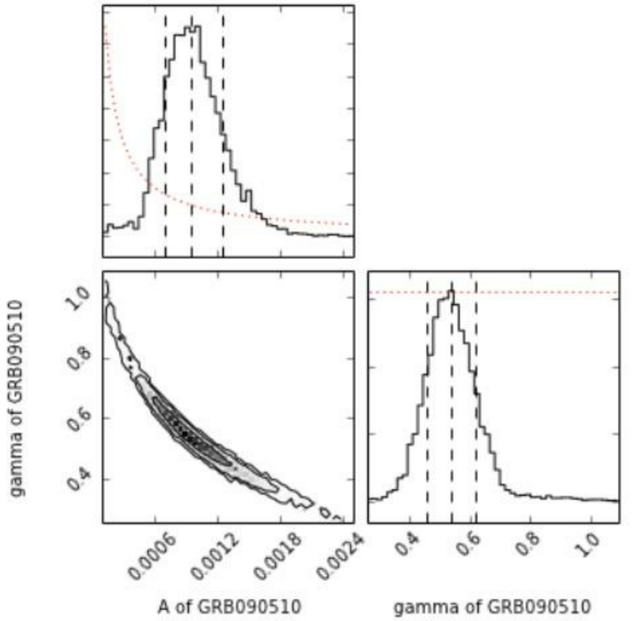
- plugin: connects 3ML with the instrument-specific software
  - receive in input the model, give in output the likelihood value
- no constraints on:
  - messenger, data formats, likelihood function, background estimation and handling, language (C++, fortran...)
- existing solutions (ST, sherpa, xspec, gammapy, isis) can be plugins



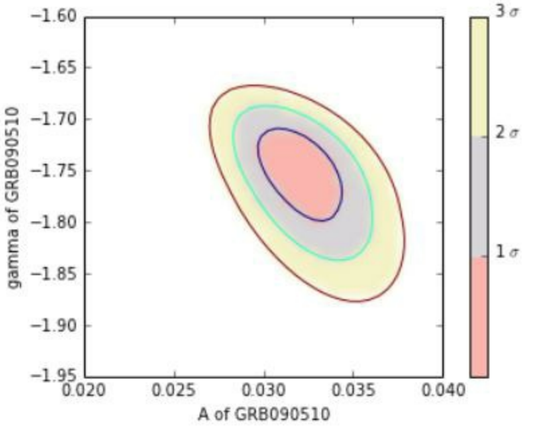
A MW analysis with 3ML:

```python
from threeML import *

# Download data
tstart = '2010-01-01 00:00:00'
tstop = '2010-01-08 00:00:00'
evfile, scfile = download_LAT_data(ra, dec, 20.0,
                                   tstart, tstop, time_type='Gregorian',
                                   destination_directory='Crab_data')

# Interrogate the public catalog (currently 3FGL)
lat_catalog = FermiLATSourceCatalog()
ra, dec, table = lat_catalog.search_around_source("Crab", radius=20.0)

# Get likelihood model from the table
model = lat_catalog.get_model()
model.free_point_sources_within_radius(3.0, normalization_only=True)

# Use Fermipy to analyze the data with the model
config = FermipyLike.get_basic_config(evfile=evfile, scfile=scfile, ra=ra, dec=dec)
LAT = FermipyLike("LAT", config)

veritas = VERITASLike("VERITAS", ...)
hawc = HAWCLike("HAWC", ...)
grond = PhotometryLike('GROND', filters=threeML_filter_library.ESO.GROND,
                       i=(21.8,.01), z=(21.2,.01),
                       J=(19.6,.01), H=(18.6,.01), K=(18.,.01))

data = DataList(LAT, hawc, veritas, grond)

jl = JointLikelihood(model, data)
best_fit_parameters, likelihood_values = jl.fit()
```

- Available plugins: Fermi/LAT, HAWC, VERITAS, OGIP-like (Swift, Chandra, XMM, Fermi/GBM, Konus...), Optical telescopes (2000 filters), SED data
- more in development (polarization)
- extended source support is in development (fully available only for HAWC at the moment)



A posterior probability visualization for a Bayesian analysis



A contour plot from a Maximum Likelihood analysis

Join the 3ML team!

- 3ML is currently an effort of ~10 people
- Development is following the scientific interests of these people
- Join the team! We need people who are willing to contribute
- Repositories:
  - https://github.com/giacomov/3ML
  - https://github.com/giacomov/astromodels
- Docs (under development):
  - threeml.readthedocs.org
  - astromodels.readthedocs.org