Source Model Editor

A Prototype Source Model Editor

I have created a GUI editor for creating and modifying source model xml files for use by Likelihood. It is available from the likeGui package and is implemented in Python. This is a brief tutorial of its use.

Starting it up from the linux command-line:

noric13[jchiang] ModelEditor

• We begin by extracting the 3EG sources within an acceptance cone on the sky:

	Source	e Model Edito	10		- • ×
<u>F</u> ile <u>E</u> dit					
<u>O</u> pen				Set com	ponents
E <u>x</u> tract					
<u>S</u> ave		Spectrum:	BrokenPo	werLaw	
Save as					
Quit					9
		Spatial Mode	el: Spatia	lMap	
					Ì
	V				

A dialog window pops up in which we specify the acceptance cone parameters, source catalog, and output file name.

	4	Source Model Editor
<u>F</u> ile	<u>E</u> dit	
		Set components
	Sou Sou	rce Extraction Region
	RA	86.4
	DEC	28.9
	radius	20
	flux limit	0.01
	input file /home/jchiang/ST/observationSim/v5r:	
	output file anticenter_model.xml	
		OK Cancel

The acceptance cone we choose has angular radius 20 degrees and is centered on the Galactic anticenter. One may specify xml source files that are either in the format recognized by the flux packageor an xml model file for Likelihood such as the DC2 preliminary catalog. The default is the version of the 3EG catalogthat was prepared for DC1. The flux limit has the same units of flux used in the xml file. For point sources used by the flux package, flux values are in units of photons m⁻² s⁻¹

• A list of the extracted sources appears in the list box on the left. Selection of a source in this list box causes the source model components and parameter values to be displayed in the list boxes on the right.

Source Model Editor: anticenter_model.xml				
<u>F</u> ile <u>E</u> dit				
Galactic Diffuse Extragalactic Diffuse my_3EG_J0628p1847 my_3EG_J0546p3948 my_3EG_J0517p2238 my_3EG_J0533p4751 my_3EG_J0530p1323 my_3EG_J0534p2200 my_3EG_J0534p2200 my_3EG_J0534p2200 my_3EG_J0520p2556 my_3EG_J0633p1751	Index: -2.19 Set components Scale: 100.00 Image: Prefactor: 27.00 Prefactor: 27.00 Image: Prefactor DEC: 22.01 Image: Prefactor RA: 83.57 Image: Prefactor			
	7			

If desired, the name of the source can be changed by editing the entry box on the upper right side:

Source Model Editor: anticenter_model.xml 📃 💻 🗶			
<u>F</u> ile <u>E</u> dit			
FileEditGalactic DiffuseExtragalactic Diffusemy_3EG_J0628p1847my_3EG_J0546p3948my_3EG_J0517p2238my_3EG_J0533p4751my_3EG_J0530p1323Crab Pulsarmy_3EG_J0542p2610my_3EG_J0520p2556my_3EG_J0633p1751	Crab Pulsal Set components Spectrum: PowerLaw Index: -2.19 A Scale: 100.00 Prefactor: 27.00 Spatial Model: SkyDirFunction DEC: 22.01 RA: 83.57		
7			

• Model components for the spectral and spatial parts of the source can be changed via the pull-down menus associated with each component. Here we choose a broken power-law for modeling the Crab.

Source Model Editor: anticenter_model.xml			
<u>F</u> ile <u>E</u> dit			
Galactic Diffuse Extragalactic Diffuse	Crab Pulsar	Set components	
my_3EG_J0628p1847 my_3EG_J0546p3948 my_3EG_J0617p2238 my_3EG_J0533p4751 my_3EG_J0530p1323 Crab Pulsar my_3EG_J0542p2610	Spectrum: PowerLaw Index: -2.19 BrokenPo Scale: 100.1 PowerLaw Prefactor: 2 Gaussian	werLaw	
my_3EG_J0459p3352 my_3EG_J0520p2556 my_3EG_J0633p1751	Spatial Model: SkyDi DEC: 22.01 RA: 83.57	irFunction	

• To edit any parameter value, just double-left-click on that parameter in the list box and a dialog window will pop-up giving access to its attributes.

Source Model Editor: anticenter_model.xml			
<u>F</u> ile <u>E</u> dit			
Galactic Diffuse Extragalactic Diffuse my_3EG_J0628p1847 my_3EG_J0546p3948 my_3EG_J0617p2238	Crab Pul Spect	sar rum: BrokenPo 2: -2.30	Set components werLaw
my_3EG_J0533p4751 my_3EG_J0530p1323 Crab Pulsar my_3EG_J0542p2610 my_3EG_J0459p3352	Index Break Spatia	1: -1.80 Value: 1000.00	verLaw: BreakVa = •
my_3EG_J0520p2556 my_3EG_J0633p1751	DEC: RA: 8	scale 1.0 min 30.0	
		max 2000.0 free 1	
		ок	Cancel

• After altering a model component type, e.g., PowerLaw -> BrokenPowerLaw, the model components must be explicitly saved by clicking on the "Set components" button:

Source Model Editor: anticenter_model.xml			
<u>F</u> ile <u>E</u> dit			
Galactic Diffuse Extragalactic Diffuse	Crab Pulsar Set components		
my_3EG_J0628p1847 my_3EG_J0546p3948	Spectrum: BrokenPowerLaw		
my_3EG_J0617p2238 my_3EG_J0533p4751	Index2: -2.30		
my_3EG_J0530p1323 Crab Pulsar	BreakValue: 1500.00		
my_3EG_J0542p2610 my_3EG_J0459p3352	Spatial Model: SkyDirFunction		
my_3EG_J0520p2556 my_3EG_J0633p1751	DEC: 22.01		
	7		

This does not have to be performed if only a parameter attribute value is modified.

• The spatial model can also be changed by switching between diffuse sources (ConstantValue, SpatialMap) and point sources (SkyDirFunction):

Source Model Editor: anticenter_model.xml			
<u>F</u> ile <u>E</u> dit			
Galactic Diffuse	🛆 Extragalactic Diffus	e Set components	
Extragalactic Diffuse my_3EG_J0628p1847 my_3EG_J0546p3948 my_3EG_J0617p2238 my_3EG_J0533p4751 my_3EG_J0530p1323 Crab Pulsar my_3EG_J0542p2610 my_3EG_J0459p3352 my_3EG_J0520p2556 my_3EG_J0633p1751	Spectrum: Pov Index: -2.10 Scale: 100.00 Prefactor: 1.45 Spatial Model: Value: 1.00	VerLaw	
		ConstantValue	
	y .		

Presently, the SpatialModel component uses the EGRET Galactic diffuse model as its FITS image template. The name of this file must be edited by hand in the xml file in order to specify a different template.

• Finally, sources can be deleted and point-like or diffuse sources can be added by hand, skipping the extraction step if desired:

Source Model Editor: anticenter_model.xml			
<u>File</u> <u>E</u> dit			
Galac Add point source	1y_3EG_J0520p2556 Set components		
Extrai Add diffuse source			
my_3 my_3Delete selected	Spectrum: PowerLaw		
my_3EG_J0617p2238	Index: -2.83		
my_3EG_J0533p4751	Scale: 100.00		
my_3EG_J0530p1323	Prefactor: 2.87		
Crab Pulsar			
my_JEG_J0J42p2010 mv_3EG_J0459n3352	Spatial Model: SkyDirFunction		
my 3EG J0520p2556	DEC: 25.75		
my_3EG_J0633p1751	RA: 80.14		
M M			

• For reference, here is an **abridged** version of the xml file that resulted from this session:

anticenter_model.xml

```
<?xml version="1.0" ?>
<source_library title="source library">
 <source name="Extragalactic Diffuse" type="DiffuseSource">
   <spectrum type="PowerLaw">
     <parameter free="1" max="100.0" min="le-05" name="Prefactor" scale="le-07" value="1.45"/>
     <parameter free="0" max="-1.0" min="-3.5" name="Index" scale="1.0" value="-2.1"/>
      <parameter free="0" max="200.0" min="50.0" name="Scale" scale="1.0" value="100.0"/>
    </spectrum>
    <spatialModel type="ConstantValue">
     <parameter free="0" max="10.0" min="0.0" name="Value" scale="1.0" value="1.0"/>
    </spatialModel>
 </source>
  <source name="Galactic Diffuse" type="DiffuseSource">
    <spectrum type="PowerLaw">
     <parameter free="1" max="1000.0" min="0.001" name="Prefactor" scale="0.001" value="11.0"/>
     <parameter free="0" max="-1.0" min="-3.5" name="Index" scale="1.0" value="-2.1"/>
     <parameter free="0" max="200.0" min="50.0" name="Scale" scale="1.0" value="100.0"/>
    </spectrum>
    <spatialModel file="$(LIKELIHOODROOT)/src/test/Data/gas.cel" type="SpatialMap">
     <parameter free="0" max="1000.0" min="0.001" name="Prefactor" scale="1.0" value="1.0"/>
    </spatialModel>
  </source>
  <source name="my_3EG_J0459p3352" type="PointSource">
    <spectrum type="PowerLaw">
     <parameter free="1" max="1000.0" min="0.001" name="Prefactor" scale="1e-09" value="2.079"/>
     <parameter free="1" max="-1.0" min="-5.0" name="Index" scale="1.0" value="-2.54"/>
     <parameter free="0" max="2000.0" min="30.0" name="Scale" scale="1.0" value="100.0"/>
    </spectrum>
    <spatialModel type="SkyDirFunction">
     <parameter free="0" max="360.0" min="-360.0" name="RA" scale="1.0" value="74.78"/>
     <parameter free="0" max="90.0" min="-90.0" name="DEC" scale="1.0" value="33.87"/>
   </spatialModel>
  </source>
  <source name="my_3EG_J0520p2556" type="PointSource">
    <spectrum type="PowerLaw">
     <parameter free="1" max="1000.0" min="0.001" name="Prefactor" scale="1e-09" value="2.873"/>
     <parameter free="1" max="-1.0" min="-5.0" name="Index" scale="1.0" value="-2.83"/>
     <parameter free="0" max="2000.0" min="30.0" name="Scale" scale="1.0" value="100.0"/>
   </spectrum>
    <spatialModel type="SkyDirFunction">
      <parameter free="0" max="360.0" min="-360.0" name="RA" scale="1.0" value="80.14"/>
     <parameter free="0" max="90.0" min="-90.0" name="DEC" scale="1.0" value="25.75"/>
   </spatialModel>
  </source>
   <source name="Crab Pulsar" type="PointSource">
   <spectrum type="BrokenPowerLaw">
      <parameter free="1" max="1000.0" min="0.001" name="Prefactor" scale="1e-09" value="1"/>
      <parameter free="1" max="-1.0" min="-5." name="Index1" scale="1.0" value="-1.8"/>
     <parameter free="1" max="2000.0" min="30.0" name="BreakValue" scale="1.0" value="1500.0"/>
      <parameter free="1" max="-1.0" min="-5." name="Index2" scale="1.0" value="-2.3"/>
   </spectrum>
    <spatialModel type="SkyDirFunction">
      <parameter free="0" max="360.0" min="-360.0" name="RA" scale="1.0" value="83.57"/>
      <parameter free="0" max="90.0" min="-90.0" name="DEC" scale="1.0" value="22.01"/>
   </spatialModel>
 </source>
</source_library>
```

Interaction with DS9

If you have DS9 v3.0.3 and the XPAmessaging system installed, you can set point source locations interactively on a display of a WCS-compliant FITS image using DS9's Regions capability. In order to get ModelEditor.py to communicate with DS9 via XPA, you must first install Russell Owen's RO.DS9 python package. If everything is installed correctly, a "ds9" pull-down menu will be available:

Source Model Edit	or: my_source_model.xml 🛛 📒 💌
<u>F</u> ile <u>E</u> dit <u>d</u> s9	
Galactic Diff <u>D</u> isplay sources	Set components
Extragalactic Import sources	
my_3EG_J06zopro47 my_3EG_J0546p3948	Spectrum: BrokenPowerLaw
my_3EG_J0617p2238	
my_3EG_J0530p1323	
my_3EG_J0542p2610	J. J. J. J.
my_3EG_J0536p0405	
my 3EG J0459p3352	Spatial Model: SpatialMap
my_3EG_J0450p1105	
my_3EG_J0520p2556	
my_3EG_J0423p1707	Ι
my_3EG_J0633p1751	
I IV	

"Display sources" will plot the locations of the current set of point sources on the current DS9 frame, and "Import sources" will add the point sources displayed in the current frame to the list of sources. **NB:** DS9 must be running for these menu items to have any effect.