

SimpleMC

Estimación de parámetros de modelos de energía oscura y otras curiosidades

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- 1 Introducción
- 2 Estructura
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Motivación

SimpleMC: toolbox for cosmological data analysis

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<https://github.com/ja-vazquez/SimpleMC>

Análisis de datos

- Estimación del Máximo Likelihood (MLE):

$$\ln \mathcal{L}(D, \theta) = \sum_{i=1}^n \ln f(x_i; \theta),$$

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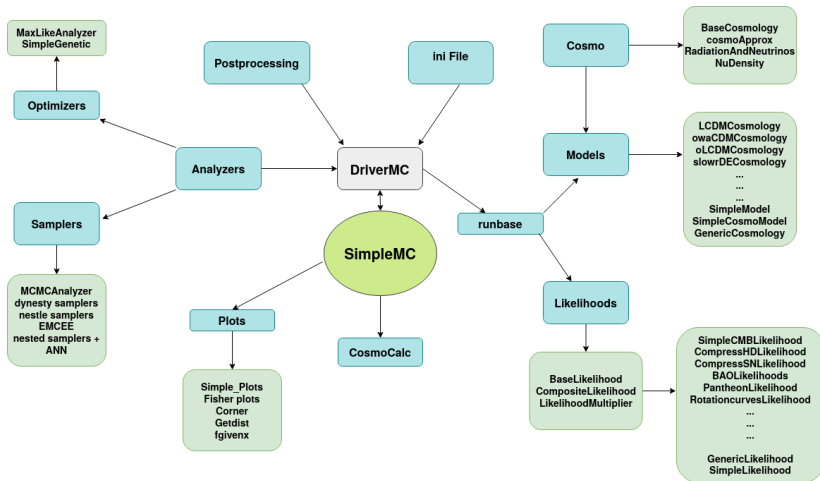
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- Visualización.
- Interpretación física.

Estructura



Modelos

Modelo	Ecuación de Friedmann (H^2/H_0^2)
Λ CDM	$\Omega_{cb}a^{-3} + \Omega_{\Lambda} + \rho_{\nu+r}(z)/\rho_{\text{crit}}$
$o\Lambda$ CDM	$\Omega_{cb}a^{-3} + \Omega_{\Lambda} + \rho_{\nu+r}(z)/\rho_{\text{crit}} + \Omega_k a^{-2}$
w CDM	$\Omega_{cb}a^{-3} + \Omega_{\text{de}}a^{-3(1+w)} + \rho_{\nu+r}(z)/\rho_{\text{crit}}$
ow CDM	$\Omega_{cb}a^{-3} + \Omega_{\text{de}}a^{-3(1+w)} + \rho_{\nu+r}(z)/\rho_{\text{crit}} + \Omega_k a^{-2}$
$w_0 w_a$ CDM	$\Omega_{cb}a^{-3} + \Omega_{\text{de}}a^{-3(1+w_0+w_a)} \exp[-3w_a(1-a)] + \rho_{\nu+r}(z)/\rho_{\text{crit}}$

Modelos

Modelo	Ecuación de Friedmann (H^2/H_0^2)
Slow Roll Dark Energy	$\Omega_{cb}a^{-3} + \rho_{\nu+r}(z)/\rho_{\text{crit}} + \Omega_{DE} \left[a^{-3}/(\Omega_m a^{-3} + \Omega_{DE}) \right]^{\delta w_0/\Omega_{DE}}$
ow_0w_a CDM	$\Omega_{cb}a^{-3} + \Omega_{de}a^{-3(1+w_0+w_a)} \exp[-3w_a(1-a)] + \rho_{\nu+r}(z)/\rho_{\text{crit}} + \Omega_k a^{-2}$
PolyCDM	$\Omega_{cb}a^{-3} + (\Omega_1 + \Omega_k)a^{-2} + \Omega_2 a^{-1} + (1 - \Omega_{cb} - \Omega_k - \Omega_1 - \Omega_2)$
Early Dark Energy	See relevant section.
Decaying Dark Matter	See relevant section.
ν CDM	free neutrino mass ($\Sigma m_\nu < 1 \text{ eV}$)
$\Delta N_{\text{eff}} \Lambda$ CDM	non-standard radiation component ($2 < N_{\text{eff}} < 5$)

Datos

- SNIa
- Cronómetros cósmicos.
- BAO.
- Planck 2015 y 2018.- Versiones comprimidas de Planck-15 y Planck-18 (tratadas como un BAO a $z = 1090$)
- $f\sigma_8$

Analizadores

- Optimizadores.
- Algoritmo de inferencia Bayesiana.

Optimizadores

- MaxLikeAnalyzer.
- Algoritmo genético simple.

Inferencia Bayesiana

- Metropolis-Hastings .
- Muestreo anidado.
- Emcee.

Extras

- Métodos no paramétricos.
- MCEvidence.
- Redes neuronales.

Salidas y gráficas

SimpleMC arroja como salida un `.paramnames`, un resumen y, para inferencia Bayesiana, un formato compatible con CosmoMC que se puede graficar con:

- `Simple_Plots` (nativo) .
- `corner`.
- `getdist`.
- `fgivenx`.

Otros

- CosmoCalc
- Archivo ini para configuración del usuario.
- MPI y multiprocessing

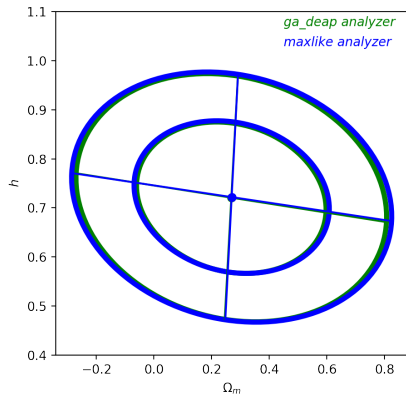
MLE

maxlike	ga_deap
[custom]	[custom]
model = waCDM	model = waCDM
datasets = SN+HD	datasets = SN+HD
analyzer = maxlike	analyzer = ga_deap
	population = 200

MLE

	maxlike	ga_deap
Ω_m	0,2697	0,2683
$\Omega_b h^2$	0,0220	0,02201
h	0,7221	0,7207
w_0	-1,3668	-1,3564
w_a	1,3103	1,3206
$\max \log \mathcal{L}$	7,1334	7,1336

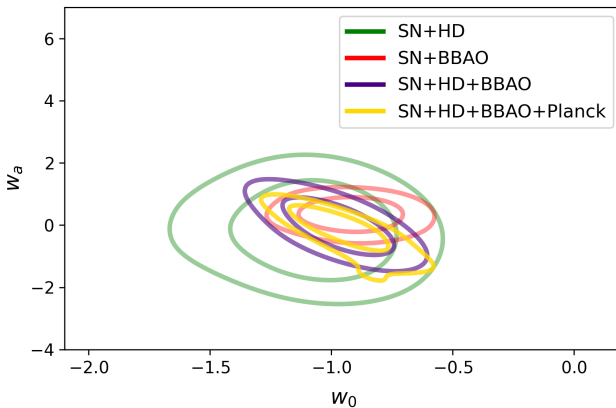
MLE



MAP

```
[custom]
model = waCDM
datasets = SN+HD
analyzer = mcmc
mcevidence = False
[mcmc]
GRstop = 0.01
nsamp = 10000
```

MAP



MAP

	SN+HD	SN+BBAO	SN+HD	SN+BBAO+HD
Ω_m	$0,3050 \pm 0,0775$	$0,2399 \pm 0,0472$	$0,2993 \pm 0,0180$	$0,3058 \pm 0,0103$
$\Omega_b h^2$	$0,0220 \pm 0,0005$	$0,0220 \pm 0,0004$	$0,0221 \pm 0,0005$	$0,0224 \pm 0,0003$
h	$0,6850 \pm 0,0324$	$0,5865 \pm 0,0673$	$0,6651 \pm 0,0206$	$0,6769 \pm 0,0111$
w_0	$-1,0202 \pm 0,1624$	$-0,8932 \pm 0,0934$	$-0,9420 \pm 0,0978$	$-0,9592 \pm 0,0966$
w_a	$-0,1983 \pm 0,9194$	$0,4076 \pm 0,3272$	$-0,1199 \pm 0,4291$	$-0,0765 \pm 0,3715$
$\max \log \mathcal{L}$	27,6746	23,5360	31,7931	30,7215

Comparación de modelos

```
[custom]  
model = LCDM  
datasets = SN+HD  
analyzer = nested  
mcevidence = False
```

Comparación de modelos

```
[custom]  
model = LCDM  
datasets = SN+HD  
analyzer = mcmc  
mcevidence = True
```

Comparación de modelos

Método	ΛCDM (Modelo 1)	CPL (Modelo 2)
muestreo anidado	$-28,9465 \pm 0,1899$	$-30,8858 \pm 0,2246$
mcmc+mcevidence	-35,8112	-35,8611

Comparación de modelos

Calculando el factor de Bayes:

Comparación de modelos

Calculando el factor de Bayes:

$$\begin{aligned} B_{12[nested]} &= -28,947 \pm 0,19 - (-30,886 \pm 0,225) \\ &= 1,939 \pm 0,035 \implies \textbf{Ventaja significativa para el modelo 1} \end{aligned}$$

Comparación de modelos

Calculando el factor de Bayes:

$$\begin{aligned} B_{12[nested]} &= -28,947 \pm 0,19 - (-30,886 \pm 0,225) \\ &= 1,939 \pm 0,035 \implies \textbf{Ventaja significativa para el modelo 1} \end{aligned}$$

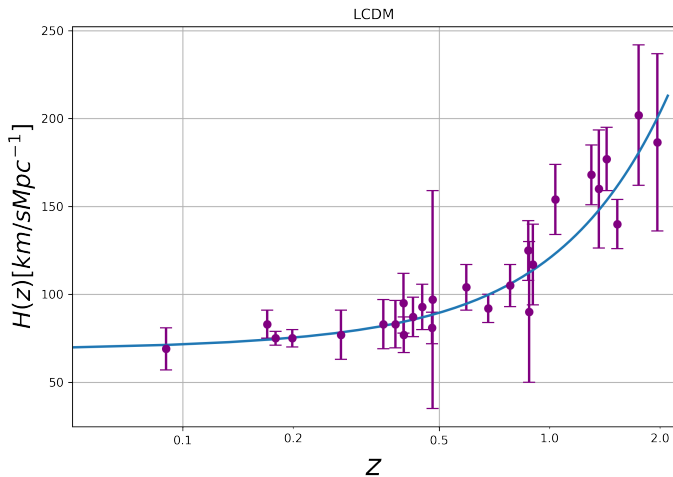
$$\begin{aligned} B_{12[mcevidence]} &= -35,811 - (-35,861) \\ &= 0,05 \implies \textbf{Ventaja poco convincente para el modelo 1} \end{aligned}$$

CosmoCalc

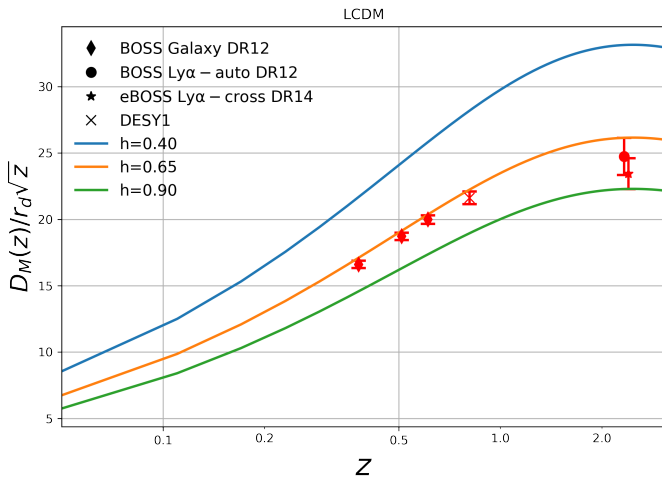
```
from simplemc.CosmoCalc import CosmoCalc

C_1 = CosmoCalc('LCDM', 'Hubble', plot_data=True, zmax=2.1)
C_2 = CosmoCalc('LCDM', 'DaOverrd', 'h', 0.4, 0.9, plot_data=True)
C_3 = CosmoCalc('LCDM', 'SNIa', plot_data=True, zmax=2.3)
C_4 = CosmoCalc('owaCDM', 'fs8', 'wa', -0.5, 0.5, 5, zmax=3.1, plot_data=True)
```

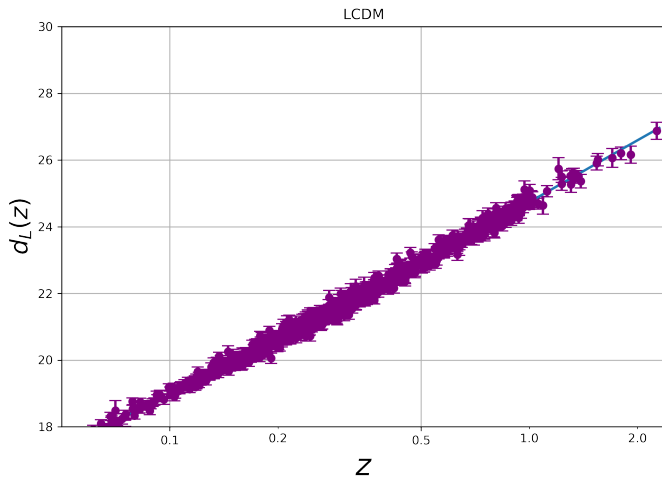

CosmoCalc C1



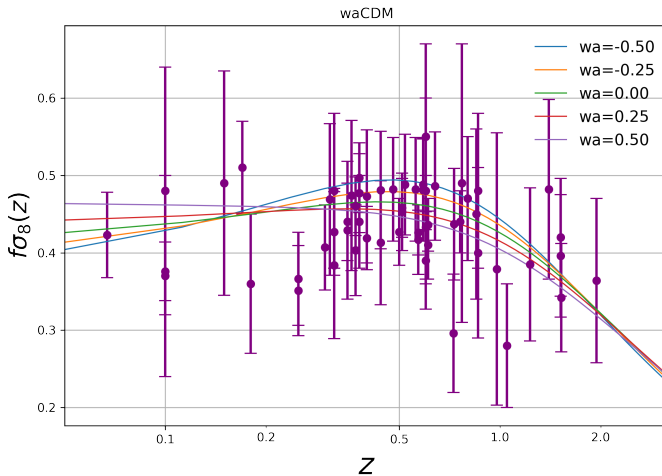
CosmoCalc C2



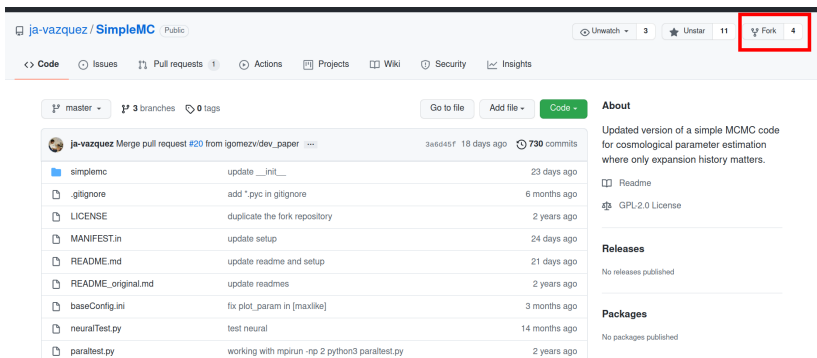
CosmoCalc C3



CosmoCalc C4



1. Fork al repositorio original



The screenshot shows the GitHub repository page for `ja-vazquez / SimpleMC`. The repository is public. In the top right corner, the 'Fork' button is highlighted with a red box, showing 4 forks. Below the repository name, there are tabs for Code, Issues, Pull requests (1), Actions, Projects, Wiki, Security, and Insights. The main content area shows a list of files and their commit history. The right sidebar contains sections for About, Releases, and Packages.

ja-vazquez / SimpleMC Public

Unwatch 3 Unstar 11 Fork 4

<> Code Issues Pull requests 1 Actions Projects Wiki Security Insights

master 3 branches 0 tags

Go to file Add file Code

About

Updated version of a simple MCMC code for cosmological parameter estimation where only expansion history matters.

Readme

GPL-2.0 License

Releases

No releases published

Packages

No packages published

File	Commit	Time
simplemc	update __init__	23 days ago
.gitignore	add *.pyc in gitignore	6 months ago
LICENSE	duplicate the fork repository	2 years ago
MANIFEST.in	update setup	24 days ago
README.md	update readme and setup	21 days ago
README_original.md	update readmes	2 years ago
baseConfig.ini	fix plot_param in [maxlike]	3 months ago
neuralTest.py	test neural	14 months ago
paraltest.py	working with mpirun -np 2 python3 paraltest.py	2 years ago

2. Clone a la copia

The screenshot shows the GitHub interface for the repository **igomezv / SimpleMC**, which is public and forked from **ja-vazquez/SimpleMC**. The repository has 4 branches and 0 tags. The current branch is **master**, which is 1 commit ahead of the parent repository's master. A file list shows **simplemc** (update __init__), **.gitignore** (add *.pyc in gitignore), and **LICENSE** (duplicate the fork repository).

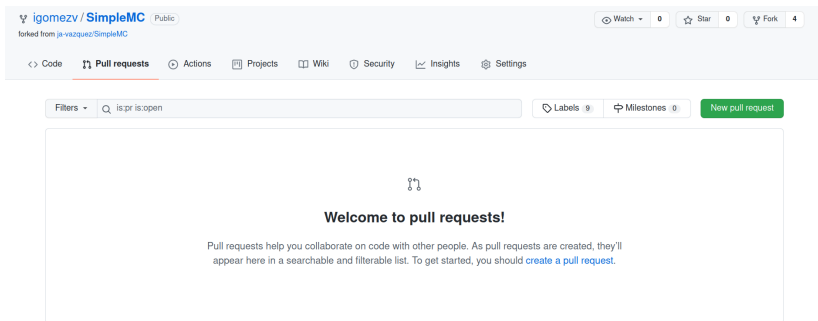
A **Clone** dialog is open, showing the **HTTPS** URL: `https://github.com/igomezv/SimpleMC.git`. Below the dialog, a terminal window shows the command to clone the repository:

```
lsidro@ubik:~/Documents/github$ git clone https://github.com/igomezv/SimpleMC.git
```

3. Commit y push a los cambios realizados en la copia

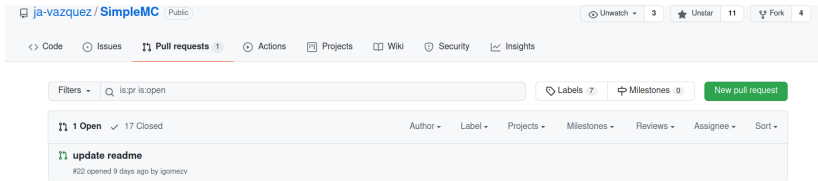
```
(base) isidro@ubik:~/Documents/gitHub/SimpleMC$ git commit -m "add X parameterization in a new DE model" simplemc/runbase.py simplemc/models/new_model.py baseConfig.ini
```

4. Pull request al repo original



The screenshot shows the GitHub interface for the repository `igomezv / SimpleMC`, which is public and forked from `ja-vazquez / SimpleMC`. The repository has 0 watches, 0 stars, and 4 forks. The navigation bar includes links for Code, Pull requests (active), Actions, Projects, Wiki, Security, Insights, and Settings. Below the navigation bar, there is a search filter set to `is:pr is:open`, a 'Labels' section with 9 items, a 'Milestones' section with 0 items, and a green 'New pull request' button. The main content area displays a welcome message with a branching diagram icon, stating: 'Welcome to pull requests! Pull requests help you collaborate on code with other people. As pull requests are created, they'll appear here in a searchable and filterable list. To get started, you should [create a pull request](#).'

4. Pull request al repo original



The screenshot shows the GitHub interface for the repository `ja-vazquez / SimpleMC`, which is public. The navigation bar includes links for Code, Issues, Pull requests (1), Actions, Projects, Wiki, Security, and Insights. On the right, there are buttons for Unwatch (3), Unstar (11), and Fork (4).

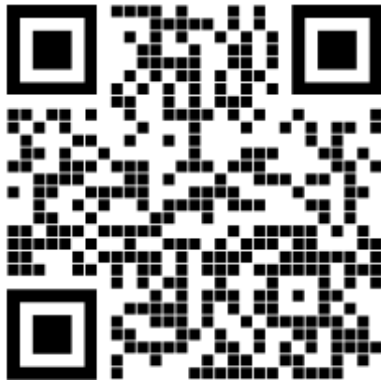
Below the navigation bar, the 'Pull requests' tab is active, showing a search filter `is:pr is:open` and buttons for Labels (7) and Milestones (0). A green button labeled 'New pull request' is visible.

The list of pull requests shows 1 Open and 17 Closed. The first pull request is titled 'update readme' and was opened 9 days ago by user `igomezv`. The table headers for the pull requests are: Author, Label, Projects, Milestones, Reviews, Assignee, and Sort.

Bonus

Explorar documentación si da tiempo.

<https://igomezv.github.io/SimpleMC/>



Gracias.