homework5

March 4, 2019

$$m_{obs} = 2.5log_{10}(\frac{f_0}{f_{obs}}) \tag{1}$$

$$\begin{aligned}\sigma_m &= \frac{dm_{obs}}{f_{obs}}\sigma_{obs} \\ &= \frac{2.5}{f_0 log10}\sigma_{obs}\end{aligned} \tag{2}$$

```
In [1]: %pylab inline
        import scipy.stats as stats
        import astropy.stats as astats
        import numpy.random as random
```

```
Populating the interactive namespace from numpy and matplotlib
```

```
In [2]: def cal_means(hboot):
            return (np.mean(hboot,axis=1))
```

```
In [3]: def cal_set_errplus(hboot):
            means=cal_means(hboot)
            return np.percentile(means,[97.5])-np.mean(cal_means(hboot))
```

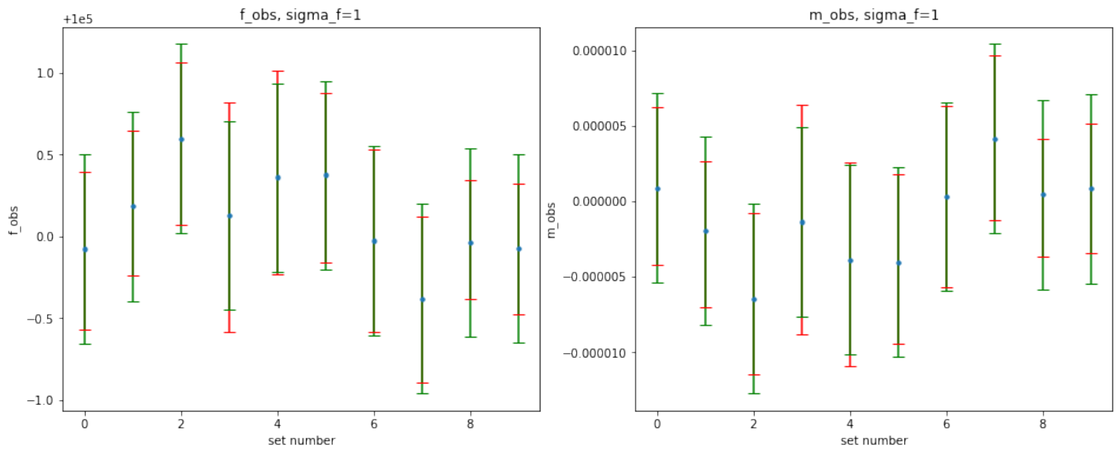
```
In [4]: def cal_set_errminus(hboot):
            means=cal_means(hboot)
            return np.mean(cal_means(hboot))-np.percentile(means,[2.5])
```

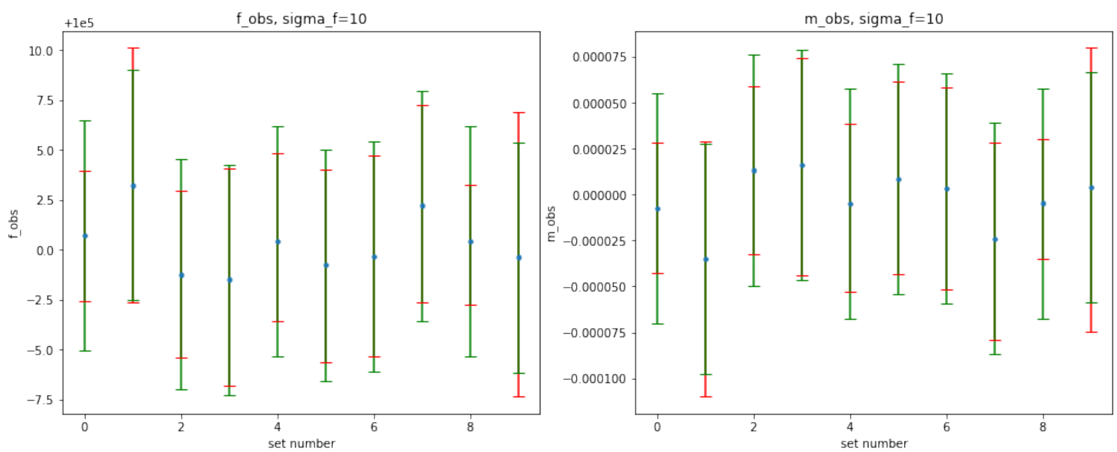
```
In [100]: def set_bootstrap(f0,sigma_f,ndata,nbootstraps,nset,ax1,ax2):

              set_mean_f=[0 for i in range(nset)]
              set_errplus_f=[0 for i in range(nset)]
              set_errminus_f=[0 for i in range(nset)]

              set_mean_m=[0 for i in range(nset)]
              set_errplus_m=[0 for i in range(nset)]
              set_errminus_m=[0 for i in range(nset)]
```

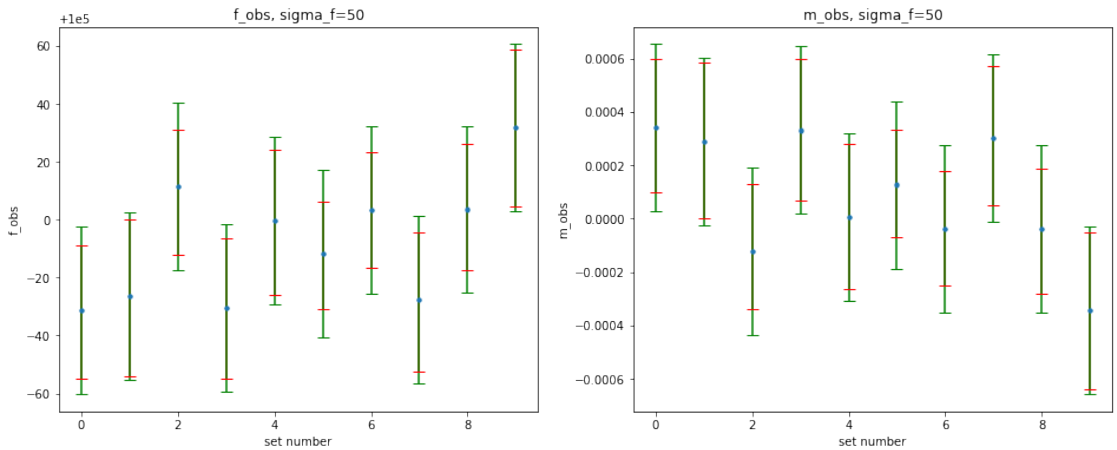
```
    sample_mean_f=[0 for i in range(nset)]
    sample_mean_m=[0 for i in range(nset)]

    for i in range(nset):
        hdata_f=random.randn(ndata)*sigma_f+f0
        hdata_m=2.5*np.log10(f0/hdata_f)
        sample_mean_f[i]=np.mean(hdata_f)
        sample_mean_m[i]=np.mean(hdata_m)
        bootidx=np.floor((random.rand(nbootstraps,ndata)*ndata))
        bootidx=bootidx.astype(int)
        hboot_f=hdata_f[bootidx]
        hboot_m=hdata_m[bootidx]

        set_mean_f[i]=np.mean(cal_means(hboot_f))
        set_errplus_f[i]=float(cal_set_errplus(hboot_f))
        set_errminus_f[i]=float(cal_set_errminus(hboot_f))

        set_mean_m[i]=np.mean(cal_means(hboot_m))
        set_errplus_m[i]=float(cal_set_errplus(hboot_m))
        set_errminus_m[i]=float(cal_set_errminus(hboot_m))

    set_number=[i for i in range(nset)]


    ax1.set_title('f_obs, sigma_f={}'.format(sigma_f))
    ax1.set_xlabel('set number')
    ax1.set_ylabel('f_obs')
    ax1.errorbar(set_number,set_mean_f,yerr=[set_errplus_f,set_errminus_f],\
                 fmt='.',ecolor='r',capsize=5)
    ax1.errorbar(set_number,sample_mean_f,yerr=sigma_f/(np.sqrt(12))*2,fmt='.',ecolor=




    ax2.set_xlabel('set number')
    ax2.set_ylabel('m_obs')
    ax2.set_title('m_obs, sigma_f={}'.format(sigma_f))
    ax2.errorbar(set_number,set_mean_m,yerr=[set_errplus_m,set_errminus_m],\
                 fmt='.',ecolor='r',capsize=5)
    ax2.errorbar(set_number,sample_mean_m,yerr=(2.5/(f0*np.log(10)))*sigma_f/np.sqrt(1
```

```
In [101]: f0=int(1E3)
          ndata=12
          nbootstraps=int(1E4)
          nset=10
          f0=int(10E4)
          sigma=[1,10,50]
```

```python
#sigma=[1]

for i, sigma_f in enumerate(sigma):
    plt.figure(figsize=(16,6))

    ax1=plt.subplot(1,2,1)
    ax2=plt.subplot(1,2,2)
    set_bootstrap(f0,sigma_f,ndata,nbootstraps,nset,ax1,ax2)
```







The 3 figures on the left side are for f_{obs}. The red errorbars are for bootstrap confidence interval of f_{obs} and the green errorbars are for true σf. The bootstrap understates errors. The 3 figures on the right side are for m_{obs}. The red errorbars are for bootstrap confidence interval of m_{obs} and the green errorbars are for true σm calculated by the error propagation. The σm is a little larger than the true σm. Generally the error propagation works well.