MCMC demo

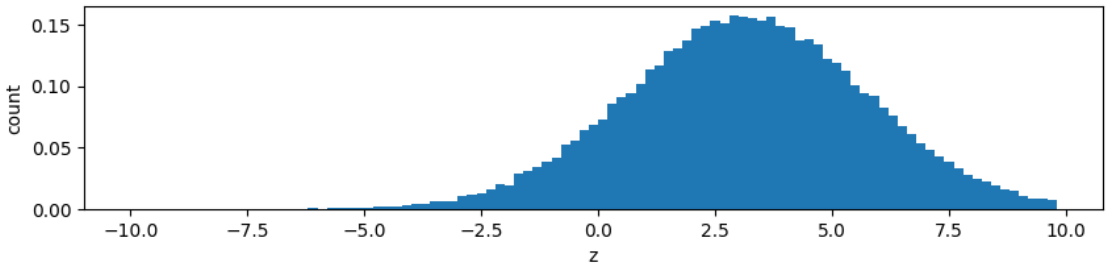
September 23, 2024

[5]:
```
import pangolin as pg
from matplotlib import pyplot as plt
import numpy as np
```

[2]:
```
z = pg.normal(1,5)
x = pg.normal(z,3)
z_samples = pg.sample(z,x,4,niter=100000)
```

[6]:
```
def hist_samples(z_sample):
    plt.figure(figsize=(10,2))
    plt.hist(z_sample,np.arange(-10,10,.2),density=True)
    plt.xlabel('z')
    plt.ylabel('count')
```

[7]:
```
hist_samples(z_samples)
```



[11]:
```
def normal_log_pdf(x, loc, scale):
    return -(x-loc)**2/(2*scale**2) - (1/2)*np.log(2*np.pi*scale**2)

def log_prior(z):
    return normal_log_pdf(z, 1, 5)

def log_likelihood(z):
    return normal_log_pdf(4, z, 3)

def log_posterior_unnormalized(z):
```

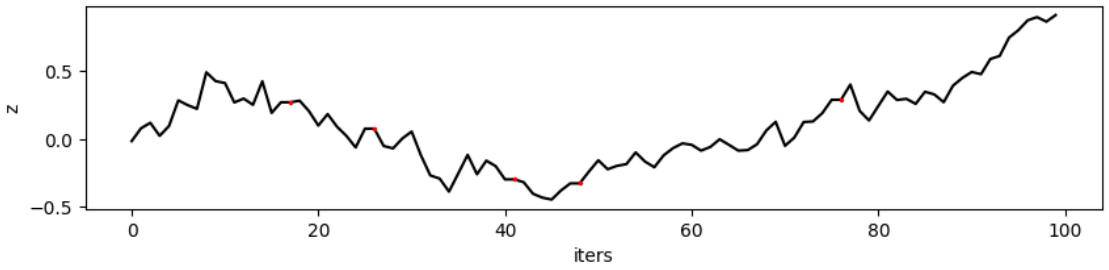
```
    return log_prior(z) + log_likelihood(z)
```

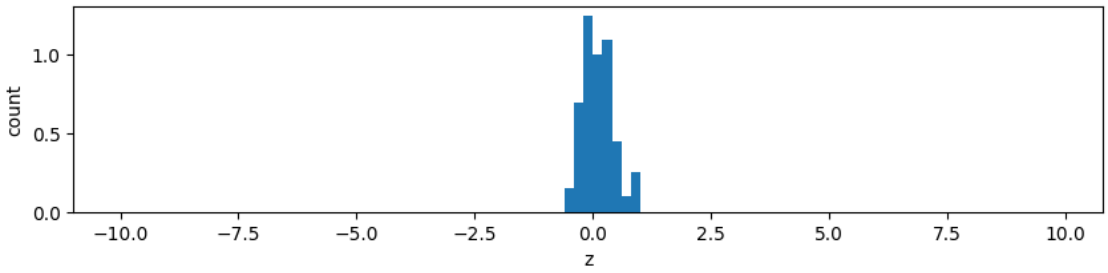
[47]:
```
def metropolis(jump_size, niter):
    z = 0.0
    l = log_posterior_unnormalized(z)
    z_samples = []
    for i in range(niter):
        z_new = z + jump_size * np.random.randn()
        l_new = log_posterior_unnormalized(z_new)
        if np.random.rand() < np.exp(l_new - l): # same as p_new / p
            z = z_new
            l = l_new
        z_samples.append(z)
    return np.array(z_samples)
```

[48]:
```
z_samples=metropolis(.1, 100)
```

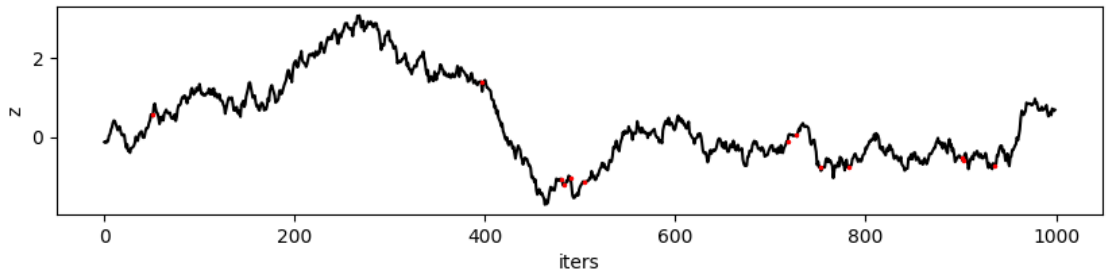
[49]:
```
def plot_mcmc(z_samples):
    plt.figure(figsize=(10,2))
    iters = np.arange(len(z_samples))
    plt.plot(iters, z_samples,'k-')
    same = z_samples[:-1] == z_samples[1:]
    plt.plot(iters[1:][same], z_samples[1:][same], 'r.', ms=3)
    plt.xlabel('iters')
    plt.ylabel('z')
    plt.show()

    hist_samples(z_samples)
```

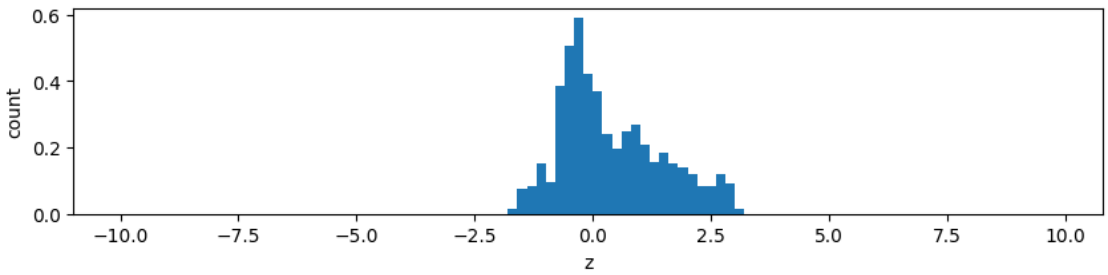
[50]:
```
z_samples=metropolis(.1, 100)
plot_mcmc(z_samples)
```



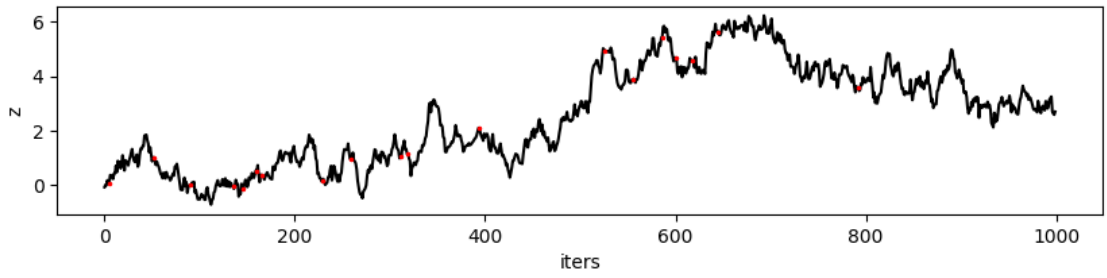


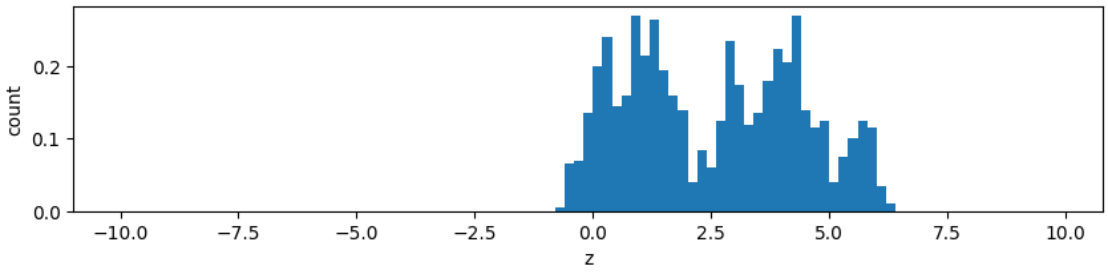
[51]:
```
z_samples=metropolis(.1, 1000)
plot_mcmc(z_samples)
```



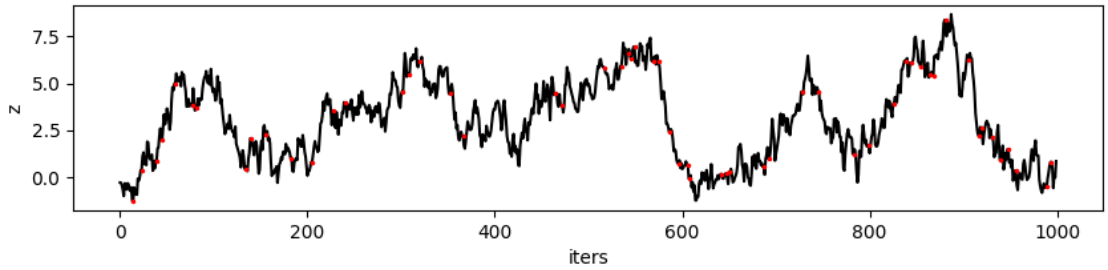


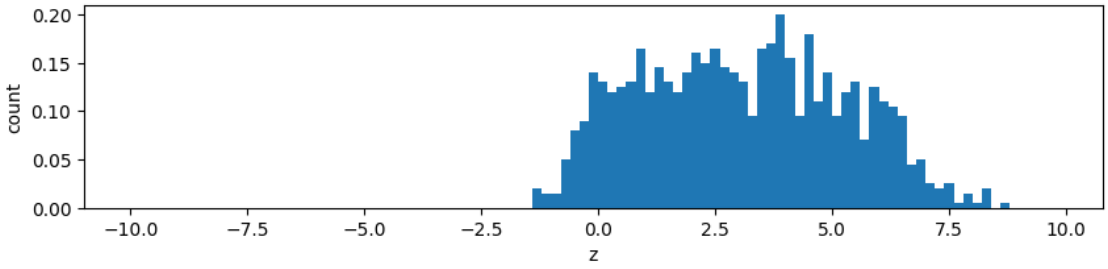
[52]:
```
z_samples=metropolis(.2, 1000)
plot_mcmc(z_samples)
```



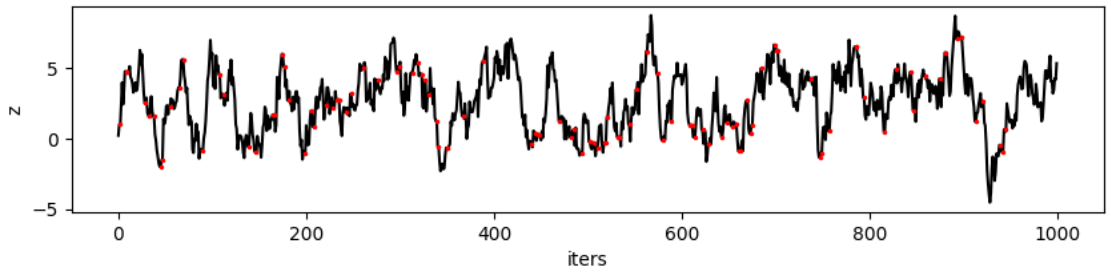


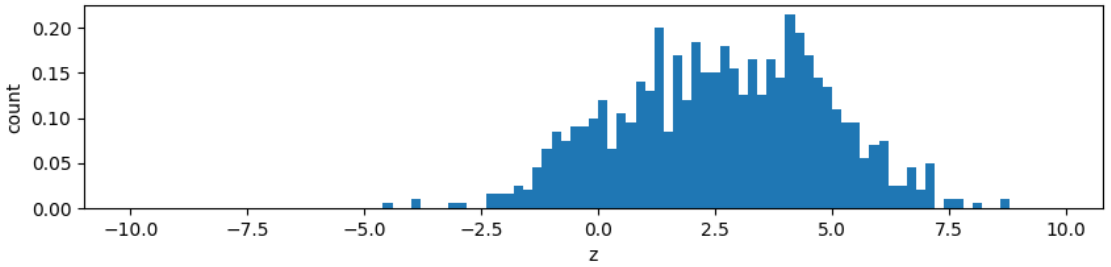
[53]:
```
z_samples=metropolis(.5, 1000)
plot_mcmc(z_samples)
```



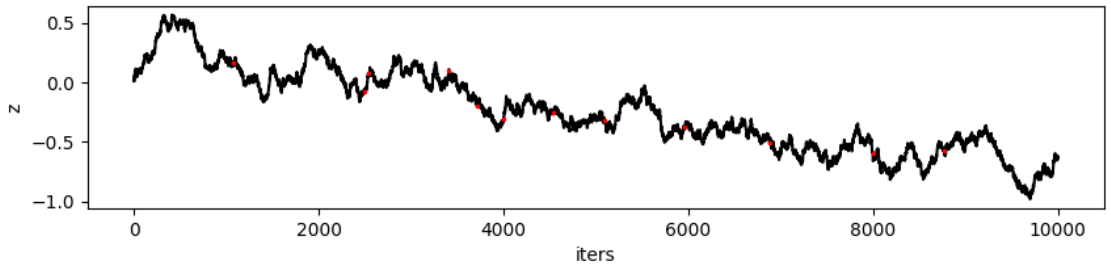


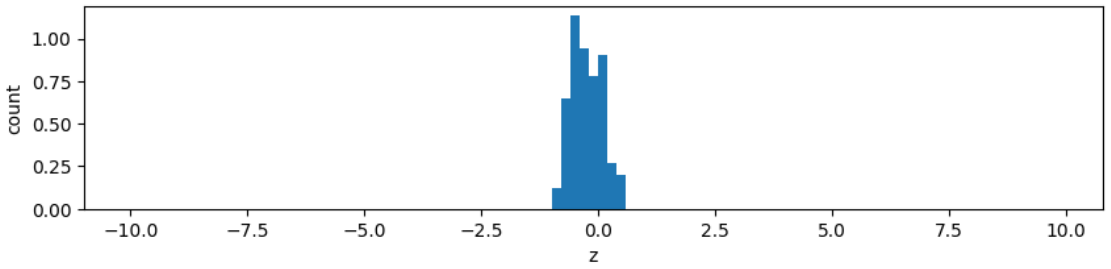
[55]:
```
z_samples=metropolis(1, 1000)
plot_mcmc(z_samples)
```



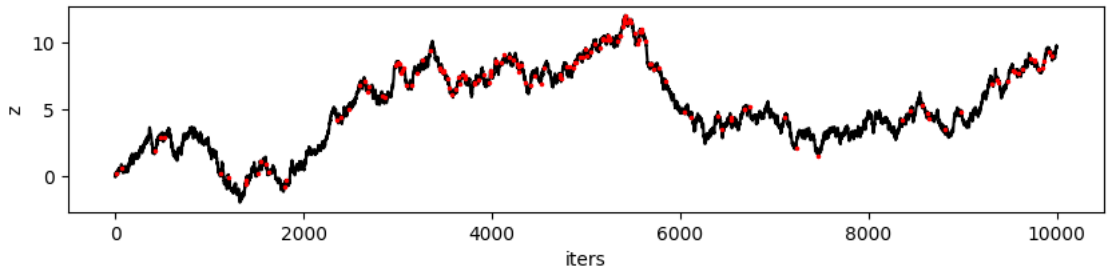


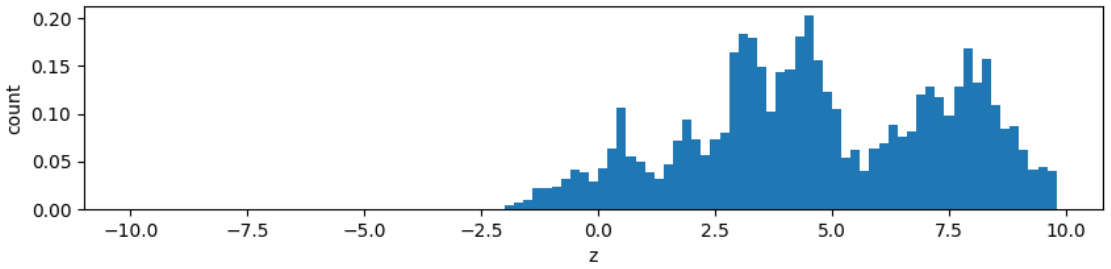
[56]:
```
z_samples=metropolis(.01, 10000)
plot_mcmc(z_samples)
```



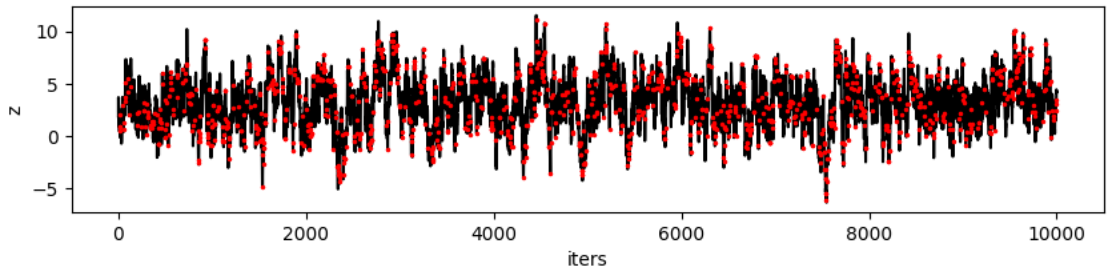


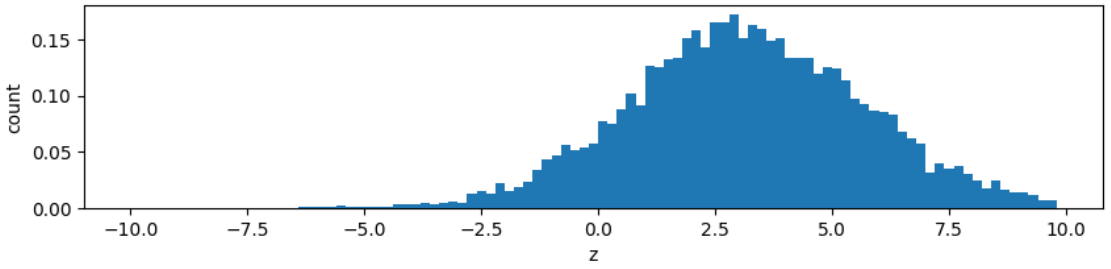
[57]:
```
z_samples=metropolis(.1, 10000)
plot_mcmc(z_samples)
```



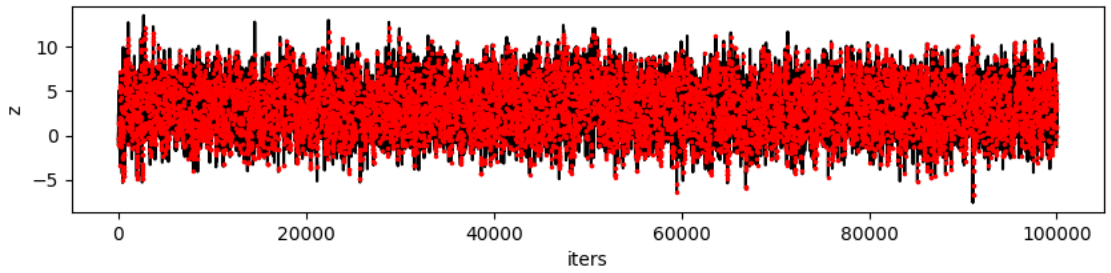


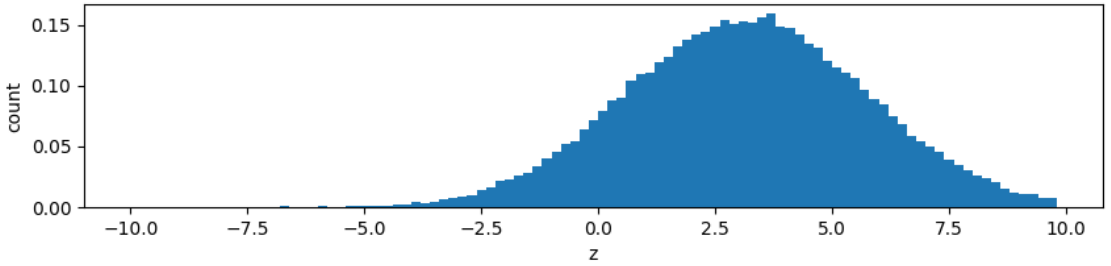
[58]:
```
z_samples=metropolis(1, 10000)
plot_mcmc(z_samples)
```





[59]:
```
z_samples=metropolis(1, 100000)
plot_mcmc(z_samples)
```





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