Problem_3_2

February 13, 2020

1 Problem_3_2

[3]:
```
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""
Created on Sun Feb  9 22:48:04 2020

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"""
import h5py
import numpy as np
import matplotlib.pyplot as plt

def LMS(v, z, eta):
    w = np.zeros([np.shape(v)[0], 3])
    err = np.zeros(np.shape(v)[0])
    y = np.zeros(np.shape(v)[0])
    for i in range(1, np.shape(v)[0]):
        y[i - 1] = np.sum(w[i - 1, :] * v[i - 1, :])
        err[i - 1] = z[i - 1] - y[i - 1]
        w[i] = w[i - 1] + eta * err[i - 1] * v[i - 1]

    return w, np.square(err)



model = h5py.File('D:\EE599\HW2\lms_fun_v3.hdf5','r')

v_10 = model['matched_10_v'][:]
y_10 = model['matched_10_y'][:]
z_10 = model['matched_10_z'][:]
v_3 = model['matched_3_v'][:]
y_3 = model['matched_3_y'][:]
z_3 = model['matched_3_z'][:]

# using z
# eta = 0.05
```
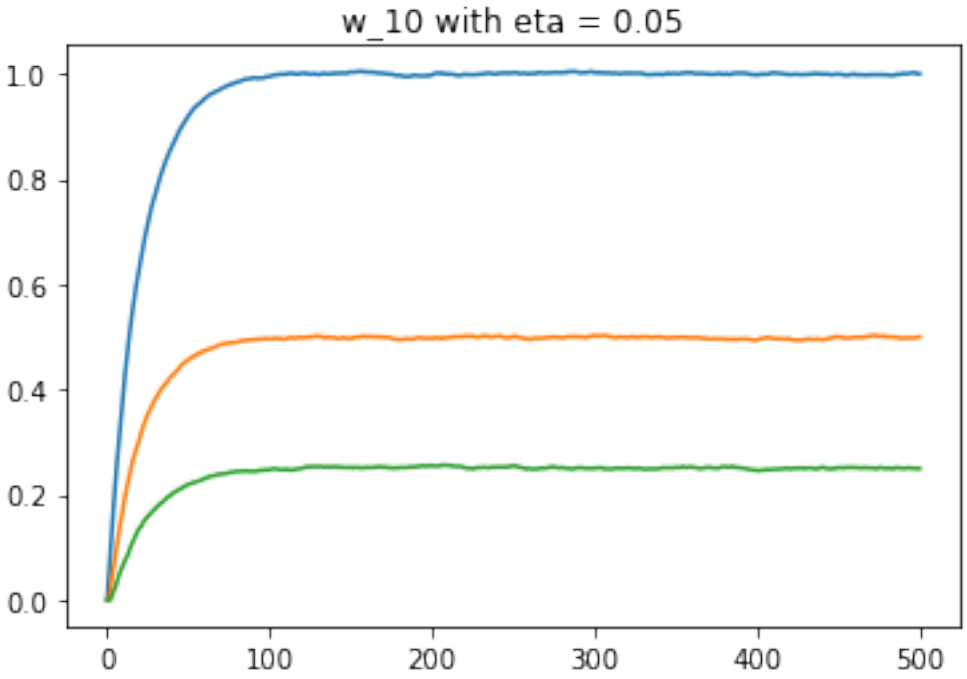
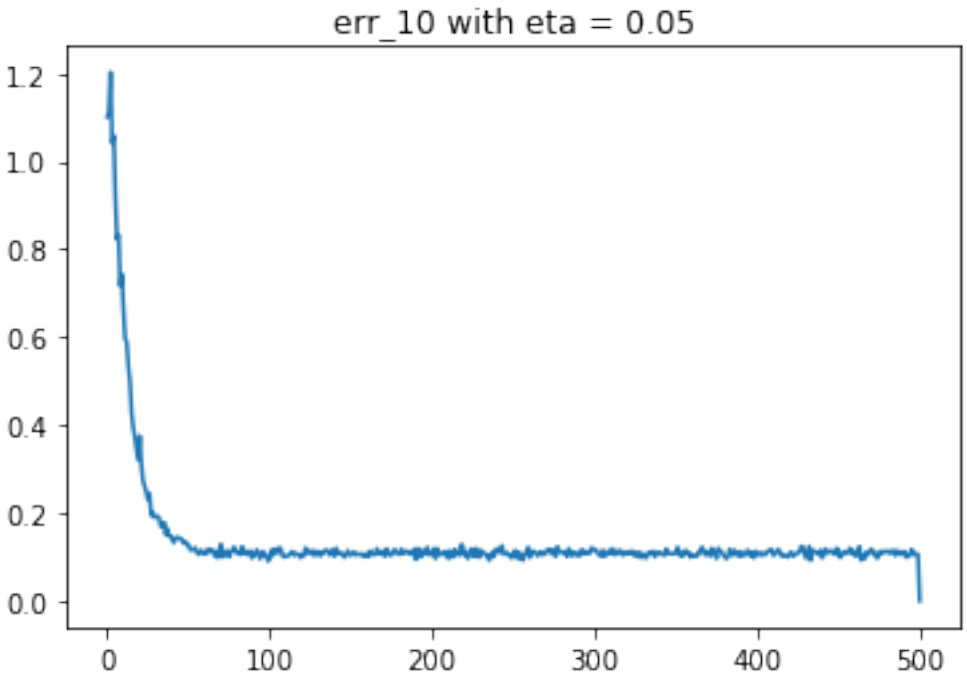
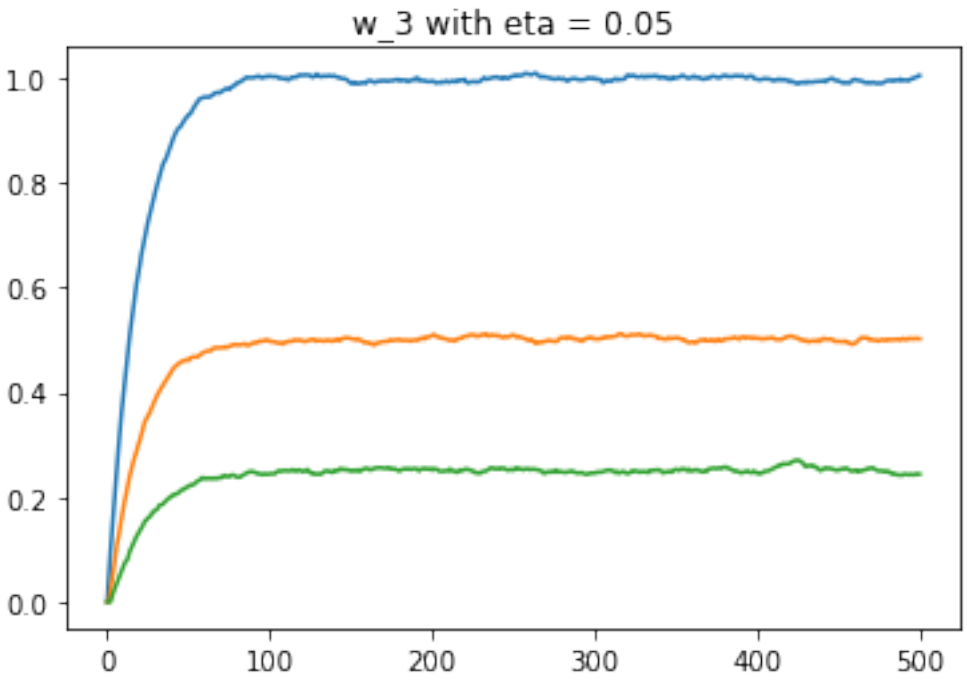

```
eta = 0.05
w_10 = np.zeros(np.shape(v_10))
err_10 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
w_3 = np.zeros(np.shape(v_10))
err_3 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
for i in range(np.shape(v_10)[0]):
    w_10[i], err_10[i] = LMS(v_10[i], z_10[i], eta)
    w_3[i], err_3[i] = LMS(v_3[i], z_3[i], eta)

w_10_eta_005 = np.average(w_10, axis=0)
err_10_eta_005 = np.average(err_10, axis=0)
w_3_eta_005 = np.average(w_3, axis=0)
err_3_eta_005 = np.average(err_3, axis=0)

print()
print('(b):')

plt.figure()
plt.plot(w_10_eta_005[:, 0])
plt.plot(w_10_eta_005[:, 1])
plt.plot(w_10_eta_005[:, 2])
plt.title('w_10 with eta = 0.05')

plt.figure()
plt.plot(err_10_eta_005)
plt.title('err_10 with eta = 0.05')


plt.figure()
plt.plot(w_3_eta_005[:, 0])
plt.plot(w_3_eta_005[:, 1])
plt.plot(w_3_eta_005[:, 2])
plt.title('w_3 with eta = 0.05')

plt.figure()
plt.plot(err_3_eta_005)
plt.title('err_3 with eta = 0.05')
```

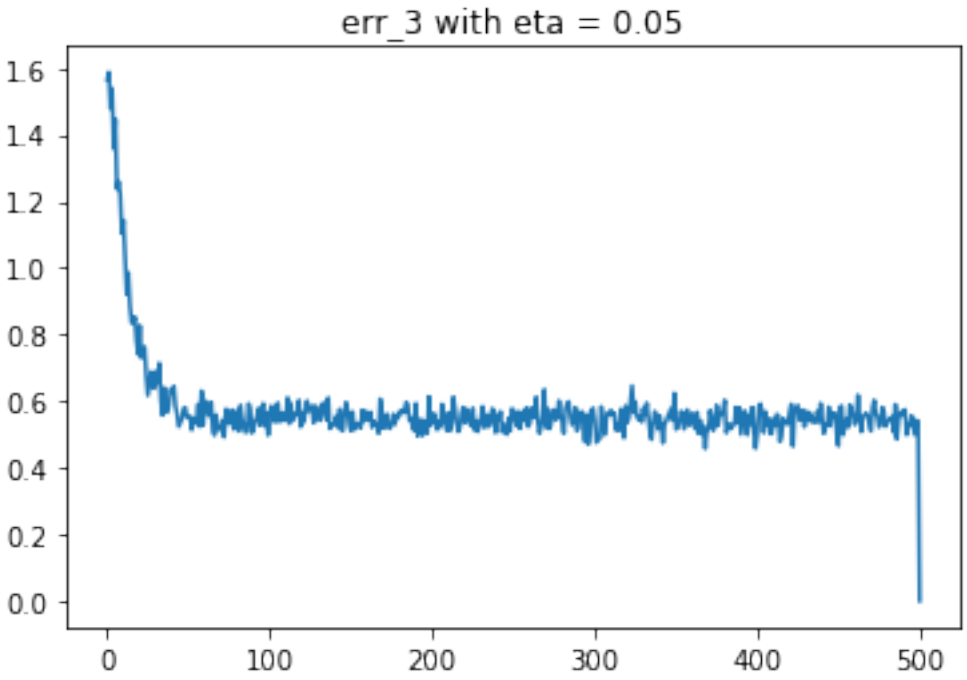
```
(b):
```

[3]: `Text(0.5, 1.0, 'err_3 with eta = 0.05')`


w_10 with eta = 0.05
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500


err_10 with eta = 0.05
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500

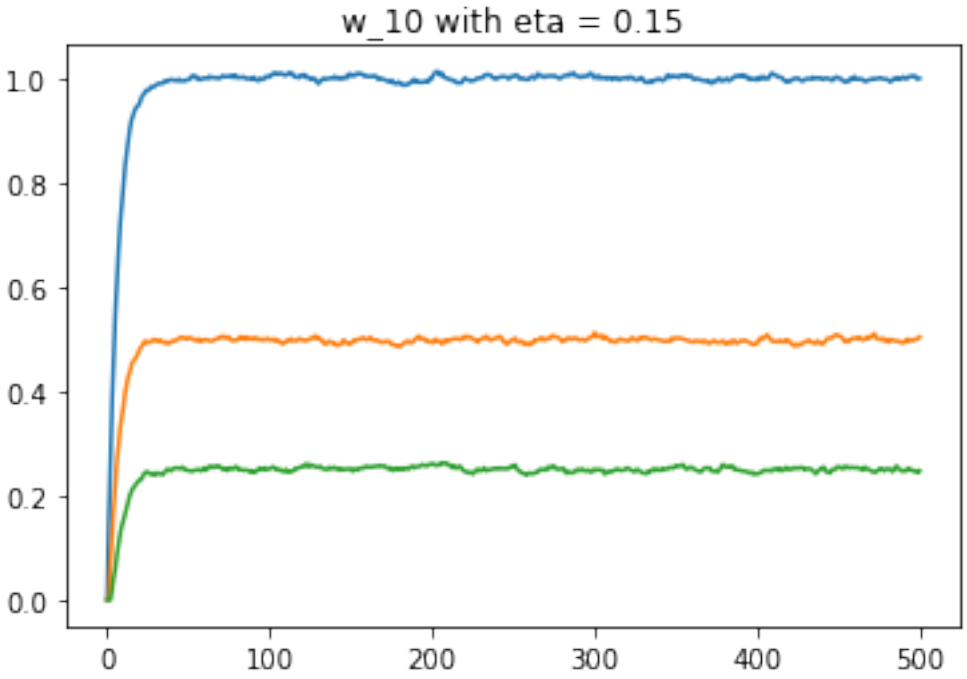

w_3 with eta = 0.05
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500

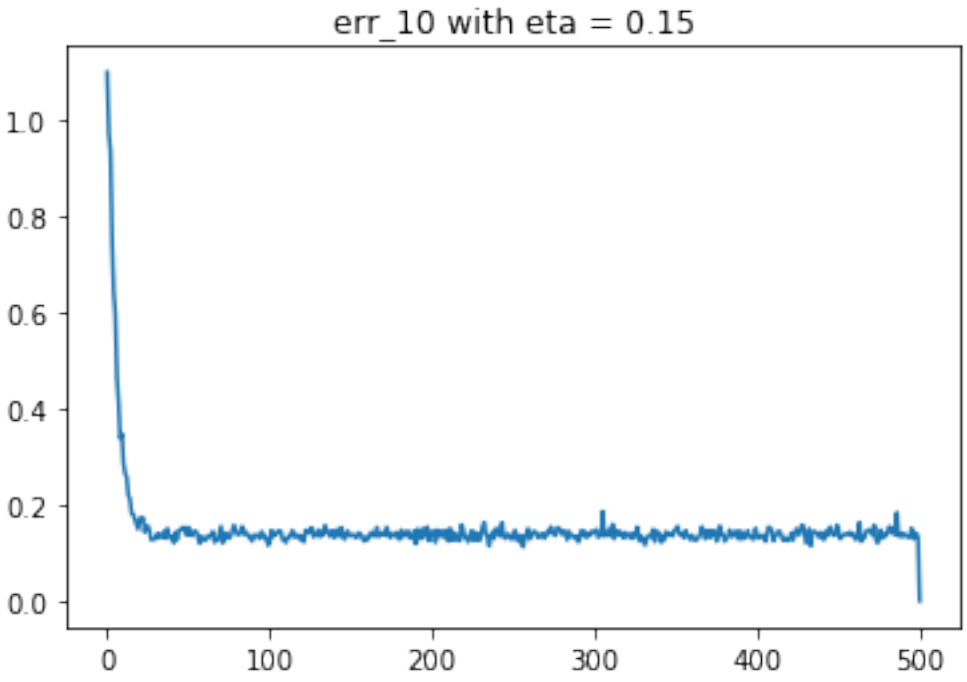

err_3 with eta = 0.05
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500

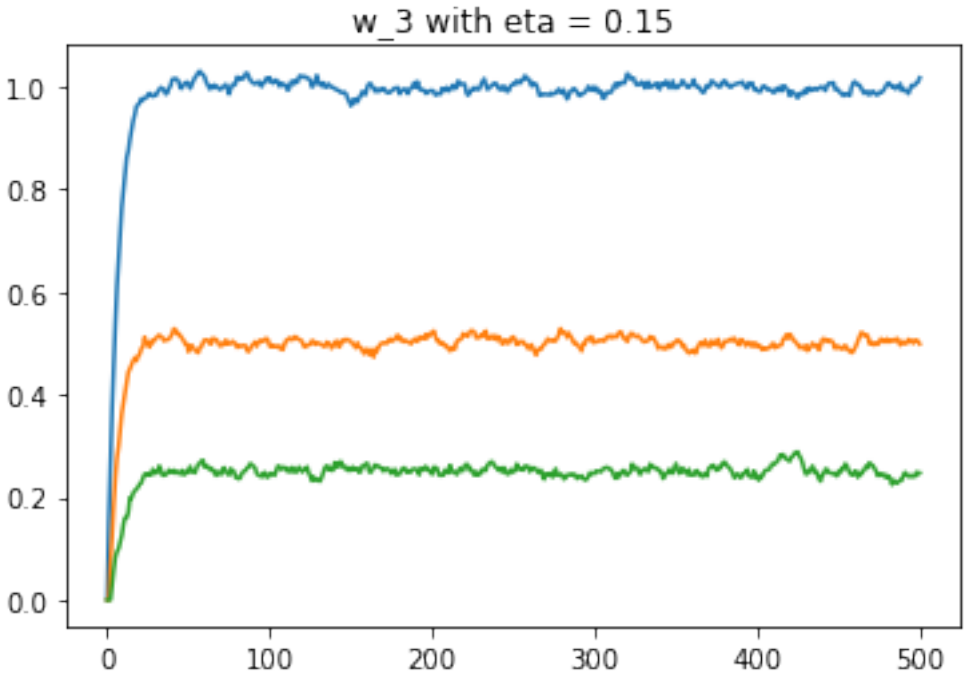
[4]:
```
# eta = 0.15
```

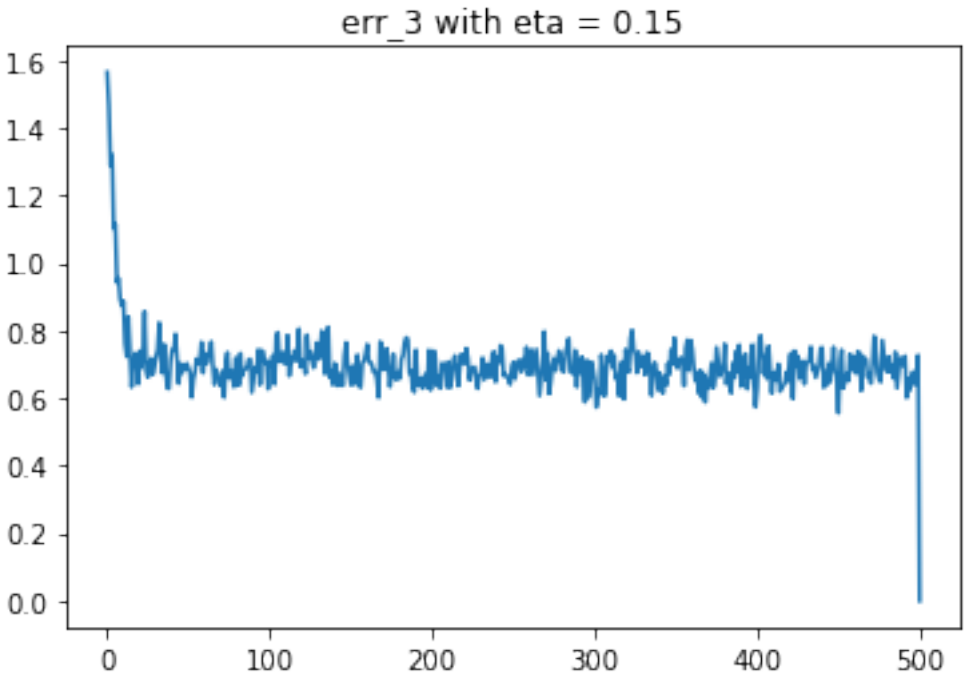
```
eta = 0.15
w_10 = np.zeros(np.shape(v_10))
err_10 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
w_3 = np.zeros(np.shape(v_10))
err_3 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
for i in range(np.shape(v_10)[0]):
    w_10[i], err_10[i] = LMS(v_10[i], z_10[i], eta)
    w_3[i], err_3[i] = LMS(v_3[i], z_3[i], eta)

w_10_eta_015 = np.average(w_10, axis=0)
err_10_eta_015 = np.average(err_10, axis=0)
w_3_eta_015 = np.average(w_3, axis=0)
err_3_eta_015 = np.average(err_3, axis=0)


plt.figure()
plt.plot(w_10_eta_015[:, 0])
plt.plot(w_10_eta_015[:, 1])
plt.plot(w_10_eta_015[:, 2])
plt.title('w_10 with eta = 0.15')


plt.figure()
plt.plot(err_10_eta_015)
plt.title('err_10 with eta = 0.15')


plt.figure()
plt.plot(w_3_eta_015[:, 0])
plt.plot(w_3_eta_015[:, 1])
plt.plot(w_3_eta_015[:, 2])
plt.title('w_3 with eta = 0.15')


plt.figure()
plt.plot(err_3_eta_015)
plt.title('err_3 with eta = 0.15')
```

[4]: Text(0.5, 1.0, 'err_3 with eta = 0.15')


w_10 with eta = 0.15
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500


err_10 with eta = 0.15
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500





(c)

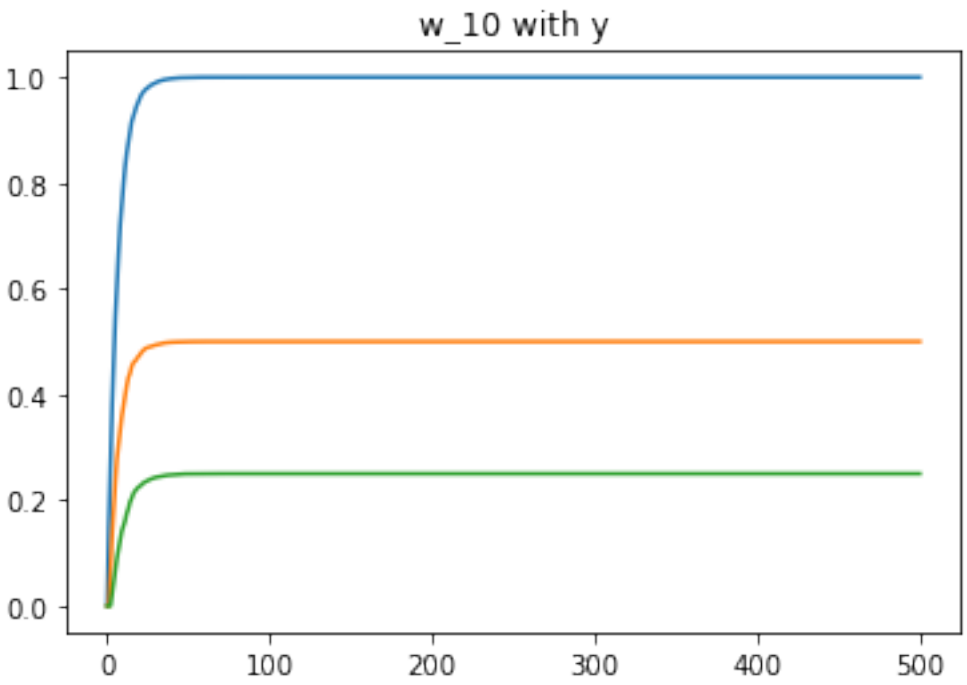
The MSE when eta=0.05 is about 0.55 when SNR=3 and 0.12 when SNR=10, a little higher than

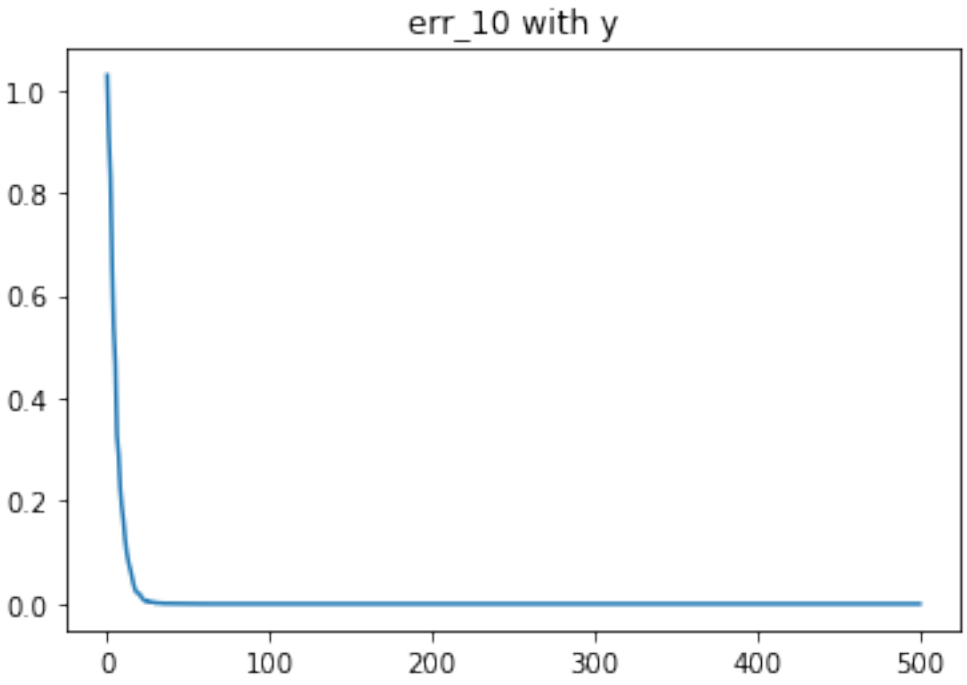
LMMSE.

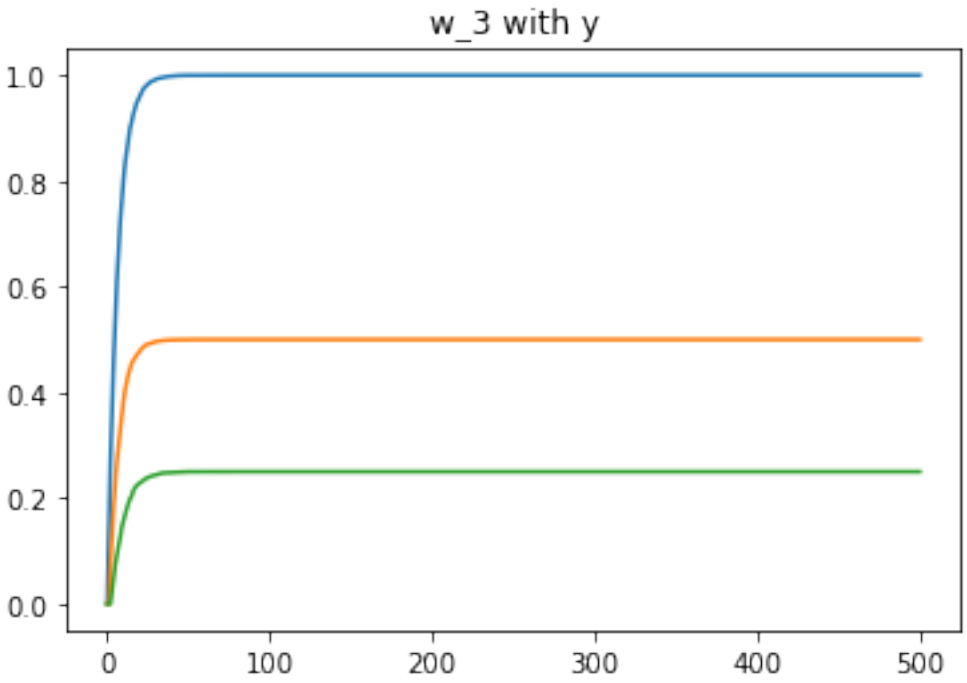
The MSE when eta=0.15 is about 0.7 when SNR=3 and 0.18 when SNR=10, much higher than LMMSE in comparasion with that when eta=0.05. Besides, they are more noisy than those when eta=0.05

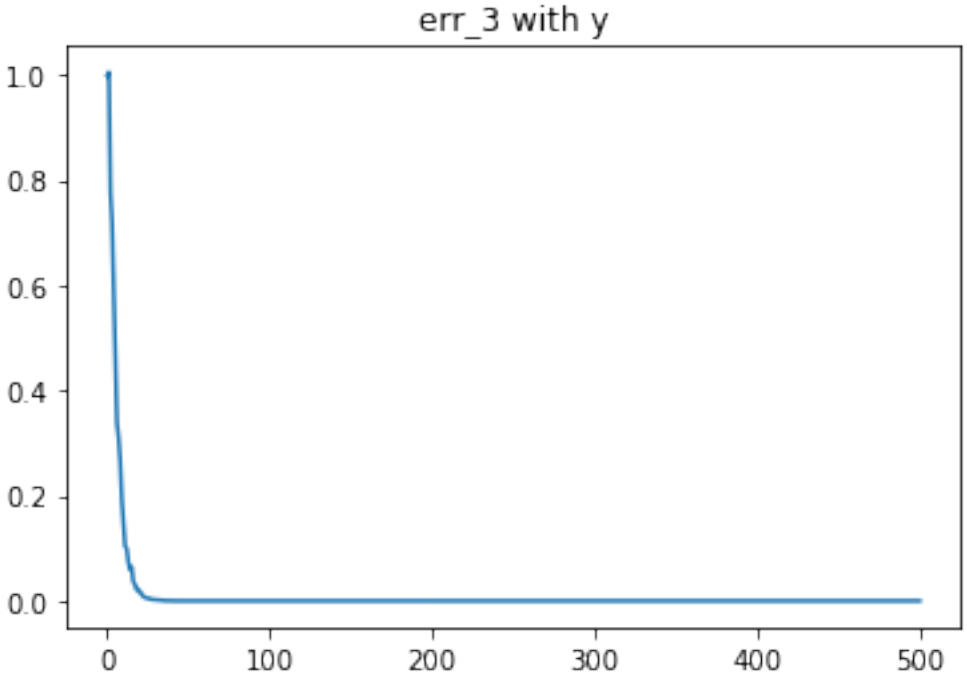
[6]:
```
# using y
# eta = 0.05
eta = 0.15
w_10 = np.zeros(np.shape(v_10))
err_10 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
w_3 = np.zeros(np.shape(v_10))
err_3 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
for i in range(np.shape(v_10)[0]):
    w_10[i], err_10[i] = LMS(v_10[i], y_10[i], eta)
    w_3[i], err_3[i] = LMS(v_3[i], y_3[i], eta)

w_10_eta_015 = np.average(w_10, axis=0)
err_10_eta_015 = np.average(err_10, axis=0)
w_3_eta_015 = np.average(w_3, axis=0)
err_3_eta_015 = np.average(err_3, axis=0)


plt.figure()
plt.plot(w_10_eta_015[:, 0])
plt.plot(w_10_eta_015[:, 1])
plt.plot(w_10_eta_015[:, 2])
plt.title('w_10 with y')

plt.figure()
plt.plot(err_10_eta_015)
plt.title('err_10 with y')


plt.figure()
plt.plot(w_3_eta_015[:, 0])
plt.plot(w_3_eta_015[:, 1])
plt.plot(w_3_eta_015[:, 2])
plt.title('w_3 with y')

plt.figure()
plt.plot(err_3_eta_015)
plt.title('err_3 with y')
```

[6]:
```
Text(0.5, 1.0, 'err_3 with y')
```


w_10 with y
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500


err_10 with y
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500

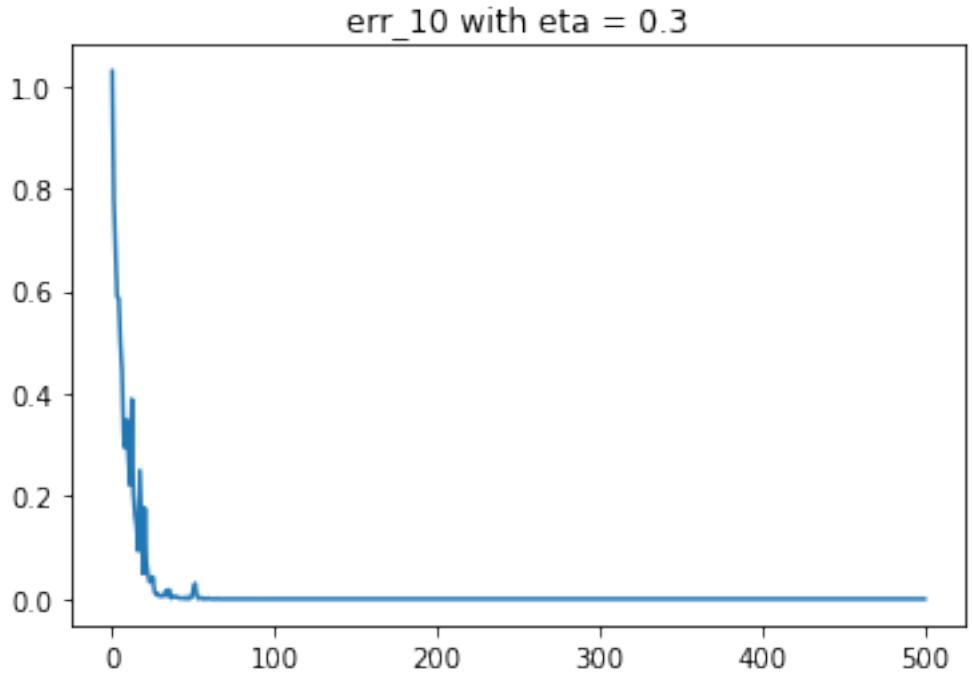

w_3 with y
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500

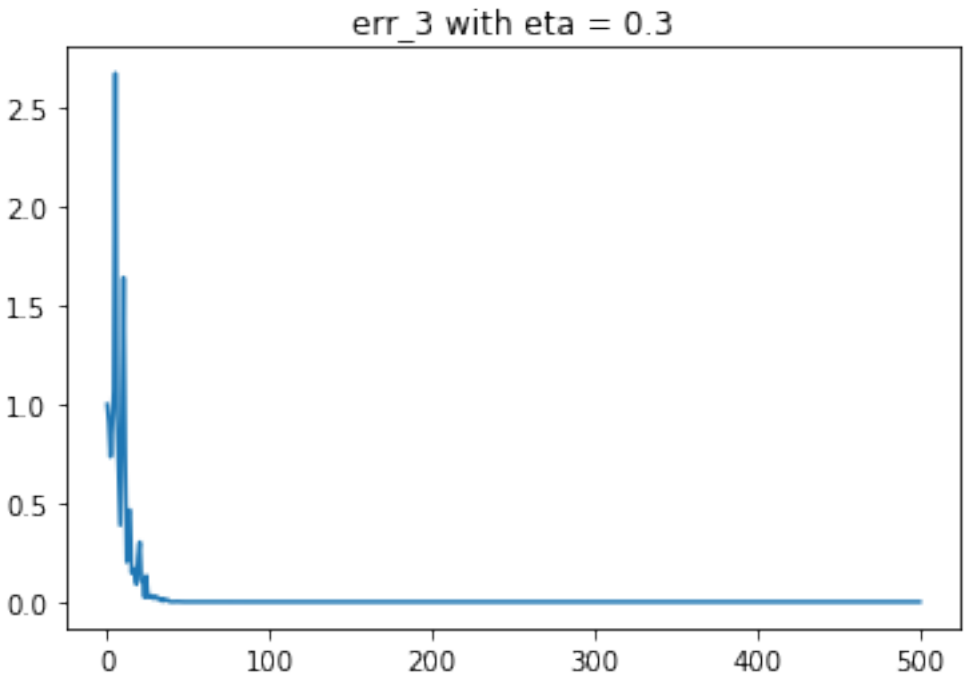

err_3 with y
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500

(d)

[11]:
```
# largest eta
eta = 0.3
w_10 = np.zeros(np.shape(v_10))
err_10 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
w_3 = np.zeros(np.shape(v_10))
err_3 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
for i in range(np.shape(v_10)[0]):
    w_10[i], err_10[i] = LMS(v_10[i], y_10[i], eta)
    w_3[i], err_3[i] = LMS(v_3[i], y_3[i], eta)

w_10_eta_015 = np.average(w_10, axis=0)
err_10_eta_015 = np.average(err_10, axis=0)
w_3_eta_015 = np.average(w_3, axis=0)
err_3_eta_015 = np.average(err_3, axis=0)
plt.figure()
plt.plot(err_10_eta_015)
plt.title('err_10 with eta = 0.3')

plt.figure()
plt.plot(err_3_eta_015)
plt.title('err_3 with eta = 0.3')
```

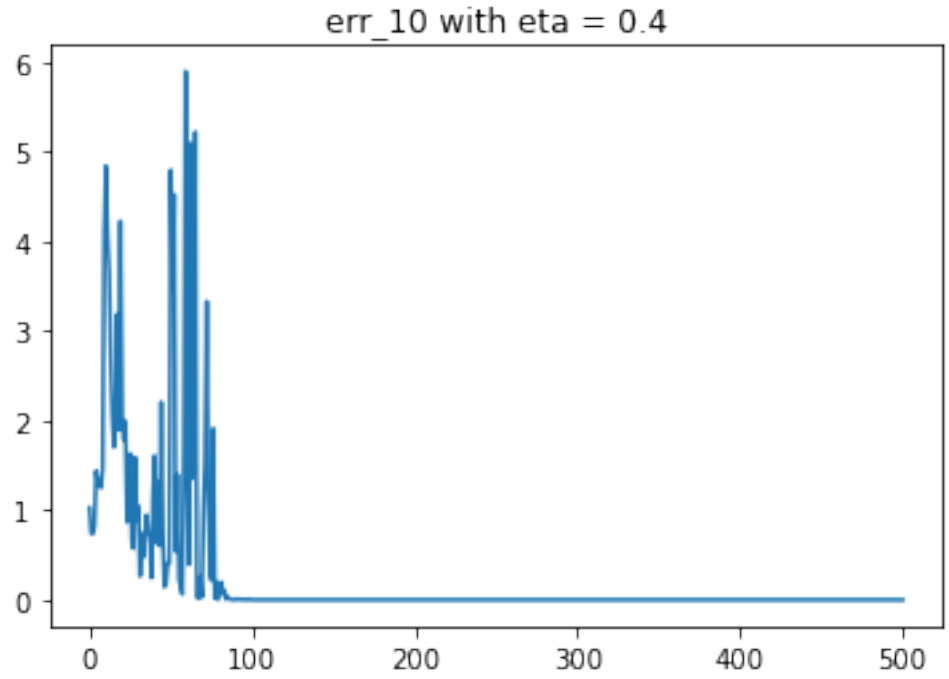
[11]:
```
Text(0.5, 1.0, 'err_3 with eta = 0.3')
```

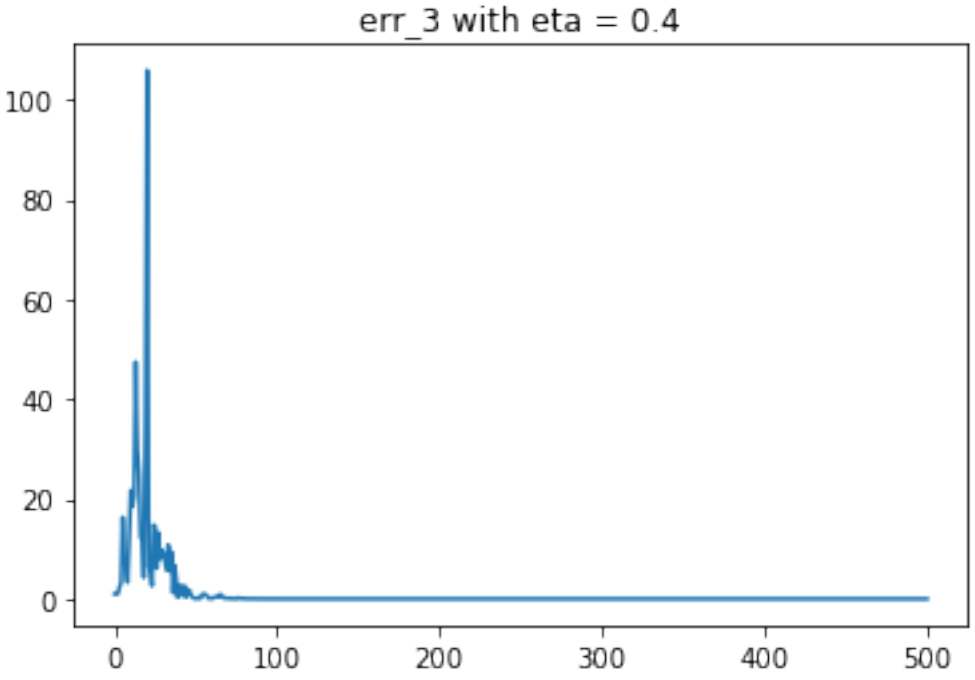




[12]:
```
# largest eta
eta = 0.4
w_10 = np.zeros(np.shape(v_10))
err_10 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
w_3 = np.zeros(np.shape(v_10))
err_3 = np.zeros([np.shape(v_10)[0], np.shape(v_10)[1]])
for i in range(np.shape(v_10)[0]):
    w_10[i], err_10[i] = LMS(v_10[i], y_10[i], eta)
    w_3[i], err_3[i] = LMS(v_3[i], y_3[i], eta)

w_10_eta_015 = np.average(w_10, axis=0)
err_10_eta_015 = np.average(err_10, axis=0)
w_3_eta_015 = np.average(w_3, axis=0)
err_3_eta_015 = np.average(err_3, axis=0)
plt.figure()
plt.plot(err_10_eta_015)
plt.title('err_10 with eta = 0.4')

plt.figure()
plt.plot(err_3_eta_015)
plt.title('err_3 with eta = 0.4')
```

[12]:
```
Text(0.5, 1.0, 'err_3 with eta = 0.4')
```





from the plots above, the maximum eta is 0.3