In [1]:
```
%matplotlib inline
import numpy as np
from rnn.arch import RNN
from vae.arch import VAE
import matplotlib.pyplot as plt
from gym.utils import seeding
from IPython import display
import time
from tensorflow.keras.utils import plot_model

np.set_printoptions(precision=4, suppress = True)
```

In [4]:
```
from tensorflow.keras import backend as K
K.set_image_data_format('channels_last')
rnn = RNN()
rnn.set_weights('./rnn/weights.h5')
```

In [5]:
```
plot_model(rnn.model, to_file='./rnn/model.png', show_shapes=True)
```

```
Failed to import pydot. You must install pydot and graphviz for `pydotprint` to work.
```

In [7]:
```
vae = VAE()
vae.set_weights('./vae/weights.h5')
```

In [9]:
```
# obs_data = np.load('./data/obs_data_car_racing_' + str(batch_num) + '.npy')
# action_data = np.load('./data/action_data_car_racing_' + str(batch_num) + '.npy')
# reward_data = np.load('./data/reward_data_car_racing_' + str(batch_num) + '.npy')
# done_data = np.load('./data/done_data_car_racing_' + str(batch_num) + '.npy')
rnn_files = np.load('./data/rnn_files.npz')
rnn_input = rnn_files['rnn_input']
rnn_output = rnn_files['rnn_output']

initial_mu = np.load('./data/initial_z.npz')['initial_mu']
initial_log_var = np.load('./data/initial_z.npz')['initial_log_var']
```

In [11]:
```
#rollout_files = np.load('./data/rollout/350636408.npz')
rollout_files = np.load('./data/rollout/310600388.npz')
obs_file = rollout_files['obs']
action_file = rollout_files['action']
reward_file = rollout_files['reward']
done_file = rollout_files['done']

series_files = np.load('./data/series/310600388.npz')
mu_file = series_files['mu']
log_var_file = series_files['log_var']
action_2_file = series_files['action']
reward_2_file = series_files['reward']
done_2_file = series_files['done']
```

In [12]:
```
hot_zs = np.where(np.exp(initial_log_var[0]/2) < 0.5)[0]
hot_zs
```

Out[12]:
```
array([21, 22, 26, 29])
```

In [13]:
```
GAUSSIAN_MIXTURES = 5
Z_DIM = 32
z_dim = 32

def get_mixture_coef(z_pred):

    log_pi, mu, log_sigma = np.split(z_pred, 3, 1)
    log_pi = log_pi - np.log(np.sum(np.exp(log_pi), axis = 1, keepdims = True))

    return log_pi, mu, log_sigma
```

In [14]:
```
def get_pi_idx(x, pdf):
  # samples from a categorial distribution
    N = pdf.size
    accumulate = 0
    for i in range(0, N):
        accumulate += pdf[i]
        if (accumulate >= x):
            return i
    random_value = np.random.randint(N)
    #print('error with sampling ensemble, returning random', random_value)
    return random_value
```

In [15]:
```
def sample_z(mu, log_sigma):
    z =  mu + (np.exp(log_sigma)) * np_random.randn(*log_sigma.shape) * 0.5
    return z
```

In [16]:
```
np_random, seed = seeding.np_random()
```

In [17]:
```
def sample_next_mdn_output(obs, h, c):

    d = GAUSSIAN_MIXTURES * Z_DIM
#     print(np.array([[obs]]))
#     print(np.array([h]))
#     print(np.array([c]))

#     print('------')
#     print(np.array([[obs]]).shape)
#     print(np.array([h]).shape)
#     print(np.array([c]).shape)
#     print('------')

    out = rnn.forward.predict([np.array([[obs]]),np.array([h]),np.array([c])])

    y_pred = out[0][0][0]
    new_h = out[1][0]
    new_c = out[2][0]

    z_pred = y_pred[:3*d]
    rew_pred = y_pred[-1]

    z_pred = np.reshape(z_pred, [-1, GAUSSIAN_MIXTURES * 3])

    log_pi, mu, log_sigma = get_mixture_coef(z_pred)

    chosen_log_pi = np.zeros(z_dim)
```

```
    chosen_mu = np.zeros(z_dim)
    chosen_log_sigma = np.zeros(z_dim)

    # adjust temperatures
    pi = np.copy(log_pi)
#     pi -= pi.max()
    pi = np.exp(pi)
    pi /= pi.sum(axis=1).reshape(z_dim, 1)

#     print(pi)

    for j in range(z_dim):

        idx = get_pi_idx(np_random.rand(), pi[j])
#         print(idx)
        chosen_log_pi[j] = idx
        chosen_mu[j] = mu[j,idx]
        chosen_log_sigma[j] = log_sigma[j,idx]

    next_z = sample_z(chosen_mu, chosen_log_sigma)

    if rew_pred > 0:
        next_reward = 1
    else:
        next_reward = 0

    return next_z, chosen_mu, chosen_log_sigma, chosen_log_pi, rew_pred, next_reward, new_h, new_c
```

In [18]:

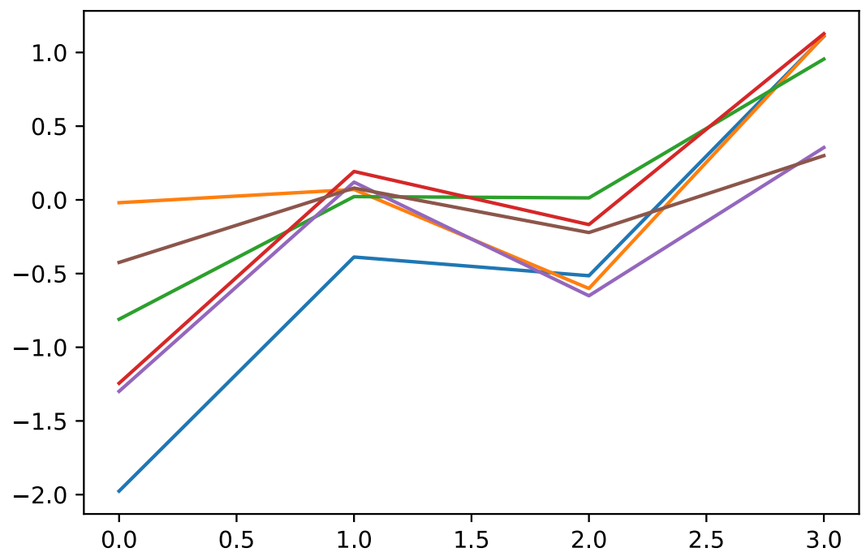
```
run_idx = 10

idx = 0

# real = obs_data[run_idx]
obs = rnn_input[run_idx]
actual = rnn_output[run_idx]

print(obs.shape)
print(actual.shape)
```

```
(299, 36)
(299, 33)
```

In [19]:

```
d = GAUSSIAN_MIXTURES * Z_DIM

print(sum(np.abs(obs[idx,hot_zs])))

plt.plot(actual[idx,hot_zs])


y_pred = rnn.model.predict(np.array([[obs[idx,:]]]))

# print(y_pred)

z_pred = y_pred[:,:,:(3*d)]
rew_pred = y_pred[:,:,-1]



print(rew_pred)

z_pred = np.reshape(z_pred, [-1, GAUSSIAN_MIXTURES * 3])

log_pi, mu, log_sigma = np.split(z_pred, 3, 1)


plt.plot(mu[hot_zs])

log_pi = log_pi - np.log(np.sum(np.exp(log_pi), axis = 1, keepdims = True))

print(sum(np.abs(mu)))
```

```
3.9342151131666654
[[2.8731]]
[4.8781 5.7302 5.8363 6.5953 4.6347]
```



In [20]:

```
current_z = obs[idx]
i = idx
current_h = np.zeros(256)
current_c = np.zeros(256)
```

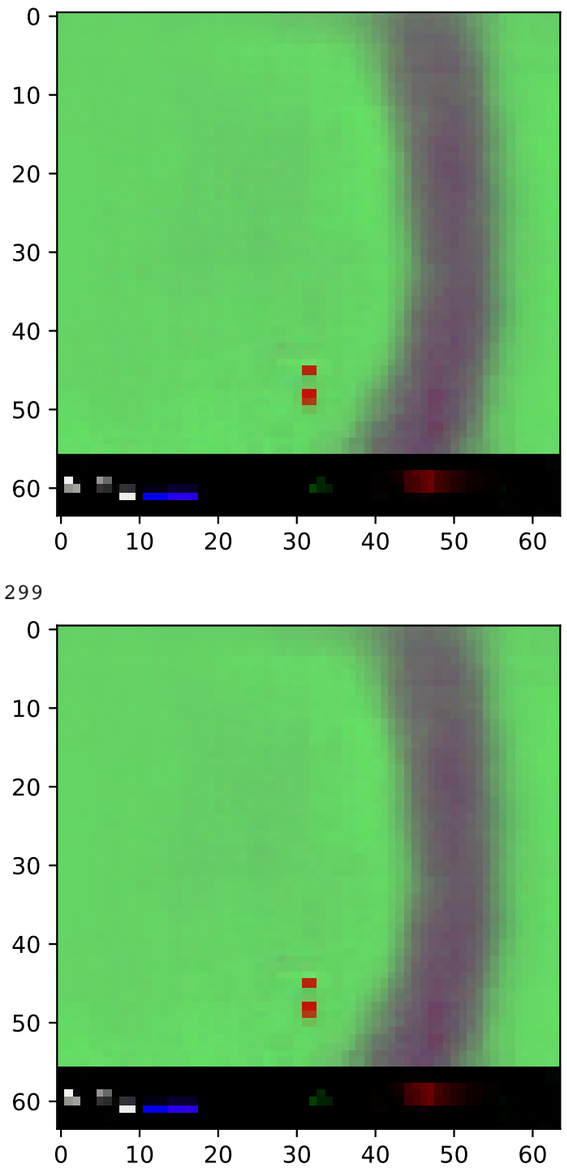
In [22]:

```
next_z = obs[idx,:]
next_h = np.zeros(256)
next_c = np.zeros(256)
# next_z_decoded = vae.decoder.predict(np.array([next_z]))[0]
# plt.imshow( next_z_decoded)
# plt.show()
```

In [23]:

```
#SIMULATE TURNING IN THE DREAM
for i in range(300):
    next_z, chosen_mu, chosen_log_sigma, chosen_pi, rew_pred, next_reward, next_h, next_c \
    = sample_next_mdn_output(next_z, next_h, next_c)

    next_z_decoded = vae.decoder.predict(np.array([next_z]))[0]
    next_z = np.concatenate([next_z, [1,1,0], [next_reward]])

    plt.gca().cla()
    plt.imshow(next_z_decoded)

    print(next_reward)
```

```
    display.clear_output(wait=True)
    display.display(plt.gcf())

    print(i)
```




```
299
```

In [62]:

```
b = np.swapaxes(actual,0,1)
print(b.shape)
actual_rew = b[-1,:]

next_zs = np.zeros(shape = (32,299))
next_mus = np.zeros(shape = (32,299))
next_rews = np.zeros(shape = (1,299))
# next_z = np.copy(obs)
# print(next_z.shape)
next_z = obs[idx,:]

next_mus[:,0] = next_z[:32]
next_zs[:,0] = next_z[:32]
next_rews[:,0] = next_z[-1]

for i in range(1,299):
    next_z, chosen_mu, chosen_log_sigma, chosen_pi, rew_pred, next_reward, next_h, next_c = sample_next_mdn_output(next_z, next_h, next_c)
    next_mus[:,i] = chosen_mu
    next_zs[:,i] = next_z
    next_rews[:,i] = rew_pred

    next_z_decoded = vae.decoder.predict(np.array([next_z]))[0]

#     plt.gca().cla()
#     plt.imshow( next_z_decoded)
# #     plt.show()
#     display.clear_output(wait=True)
#     display.display(plt.gcf())

    next_z = np.concatenate([next_z, [-1,1,0], [next_reward]])

plt.figure(figsize=(20,30))
for i in hot_zs:
    plt.subplot(511)
    plt.plot( b[i,:])
    plt.subplot(512)
    plt.plot( next_zs[i,:])
    plt.subplot(513)
    plt.plot( next_mus[i,:])

plt.subplot(514)
plt.plot(next_rews[0,:])

plt.subplot(515)
plt.plot(actual_rew[:])

# print(next_zs)
```

```
(33, 299)
<ipython-input-62-c908ee524837>:34: MatplotlibDeprecationWarning: Adding an axes using the same arguments as a previous axes currently reuses the earlier instance.  I
n a future version, a new instance will always be created and returned.  Meanwhile, this warning can be suppressed, and the future behavior ensured, by passing a uniq
ue label to each axes instance.
  plt.subplot(511)
<ipython-input-62-c908ee524837>:36: MatplotlibDeprecationWarning: Adding an axes using the same arguments as a previous axes currently reuses the earlier instance.  I
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  plt.subplot(512)
<ipython-input-62-c908ee524837>:38: MatplotlibDeprecationWarning: Adding an axes using the same arguments as a previous axes currently reuses the earlier instance.  I
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```

```
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  plt.subplot(513)
```

Out[62]: [<matplotlib.lines.Line2D at 0x13b282850>]

In [ ]: