01_19_sim check_real

January 21, 2021

[1]:
```
import dssvi_fn
import time

import numpy as np
import matplotlib.pyplot as plt
import random
import pandas as pd
```

[2]:
```
true_pi_W = [0.3, 0.3, 0.4]
true_pi_H = [0.3, 0.5, 0.2]
```

[3]:
```
def number_K(obj):
    len_good_k = [len(obj.good_k_list[i]) for i in range(len(obj.good_k_list))]
    plt.figure()
    plt.plot(len_good_k)
    plt.xticks(np.arange(0, 19+1, 1.0))
    plt.title("number of K's across iterations")
    plt.show()

def log_likelihoods(obj, burn_in, max_iter):
    log_ll_list = [obj.log_ll[i,burn_in] for i in range(max_iter)]
    plt.figure()
    plt.plot(log_ll_list)
    plt.xticks(np.arange(0, len(log_ll_list),1))
    plt.title("log ll")
    plt.show()

def K_and_log_ll(obj, burn_in, max_iter):
    len_good_k = [len(obj.good_k_list[i]) for i in range(len(obj.good_k_list))]
    log_ll_list = [obj.log_ll[i,burn_in] for i in range(max_iter)]

    fig, ax = plt.subplots(1, 1)
    ax.plot(len_good_k, 'r', label="number of K")
    ax.set_yticks(np.arange(0, max(len_good_k)+1))
    ax.set_xticks(np.arange(0, len(log_ll_list), 1.0))

    ax2 = ax.twinx()
```

```
    ax2.plot(log_ll_list, label="log likelihood")
    ax2.ticklabel_format(useOffset=False, style='plain')

    plt.draw()
    fig.legend()
    print(log_ll_list)
    return

def plot_pi(obj, true_pi_W=true_pi_W, true_pi_H=true_pi_H, label=True):
    fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(10, 5), sharey=True)
    labels = np.arange(0, obj.n_components,1)
    for i in range(obj.n_components):
            axes[0].plot(obj.Epi_W_list[:,i], label="pi_" + str(labels[i]))
    axes[0].title.set_text("Value of Pi_W's across iterations")
    for j in range(len(true_pi_W)):
        axes[0].axhline(y=true_pi_W[j], color='grey', linestyle='dashed')

    if label:
        axes[0].legend()

    for i in range(obj.n_components):
        axes[1].plot(obj.Epi_H_list[:,i], label="pi_" + str(labels[i]))
    axes[1].title.set_text("Value of Pi_H's across iterations")

    for j in range(len(true_pi_H)):
        axes[1].axhline(y=true_pi_H[j], color='grey', linestyle='dashed')
    if label:
        axes[1].legend()

    return
```

[4]:
```
S_W = np.vstack((np.hstack((np.ones(30), np.zeros(70))),
                 np.hstack((np.zeros(30), np.ones(30), np.zeros(40))),
                  np.hstack((np.zeros(60), np.ones(40))))).T

S_H = np.vstack((np.hstack((np.ones(30), np.zeros(70))),
                  np.hstack((np.zeros(50), np.ones(50))),
                 np.hstack((np.zeros(30), np.ones(20), np.zeros(50)))))
```

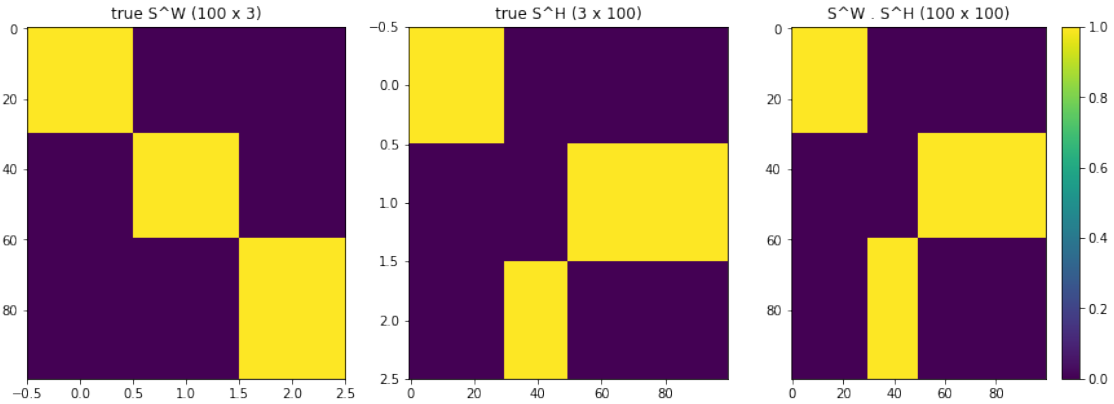
[5]:
```
print("true pi_W:", true_pi_W)
print("true pi_H:", true_pi_H)
```

```
true pi_W: [0.3, 0.3, 0.4]
true pi_H: [0.3, 0.5, 0.2]
```

[6]:
```
fig, axes = plt.subplots(ncols=3, figsize=(15,5))
ax1, ax2, ax3 = axes
```

```
im1, im2, im3 = ax1.imshow(S_W, aspect="auto", interpolation='none'), ax2.
 ↪imshow(S_H, aspect="auto", interpolation='none')\
, ax3.imshow(S_W.dot(S_H), aspect="auto", interpolation="none")
ax1.title.set_text('true S^W (100 x 3)')
ax2.title.set_text('true S^H (3 x 100)')
ax3.title.set_text('S^W . S^H (100 x 100)')
plt.colorbar(im3, ax=ax3)

plt.show()
```



[7]:
```
np.random.seed(10)

cluster1 = np.random.gamma(20, 1, 50)
cluster2 = np.random.gamma(10, 1, 50)
cluster3 = np.random.gamma(5, 1, 50)
```

[8]:
```
W_S_W = np.zeros((S_W.shape))
W_S_W[:30, 0] = S_W[:30, 0] * cluster1[:30]
W_S_W[30:60, 1] = S_W[30:60, 1] * cluster2[:30]
W_S_W[60:, 2] = S_W[60:, 2] * cluster3[:40]
```

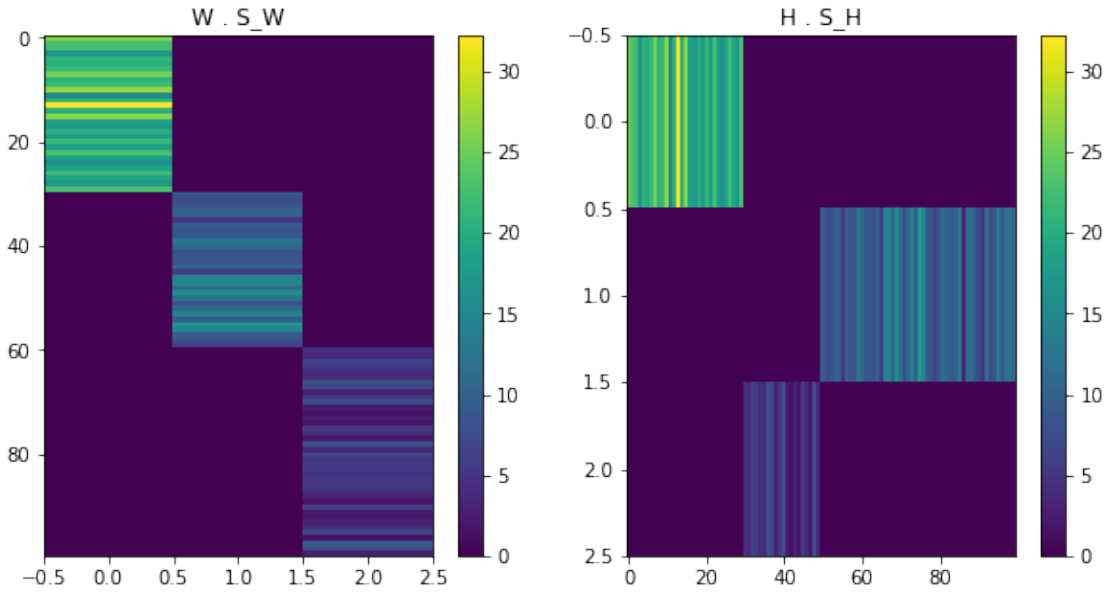
[9]:
```
H_S_H = np.zeros((S_H.shape))

H_S_H[0, :30] = S_H[0, :30] * cluster1[:30]
H_S_H[1, 50:] = S_H[1, 50:] * cluster2[:50]
H_S_H[2, 30:50] = S_H[2, 30:50 ] * cluster3[:20]
```

[10]:
```
fig, axes = plt.subplots(ncols=2, figsize=(10,5))
ax1, ax2 = axes
im1, im2 = ax1.imshow(W_S_W, aspect="auto", interpolation='none'), ax2.
 ↪imshow(H_S_H, aspect="auto", interpolation='none')
ax1.title.set_text('W . S_W')
```

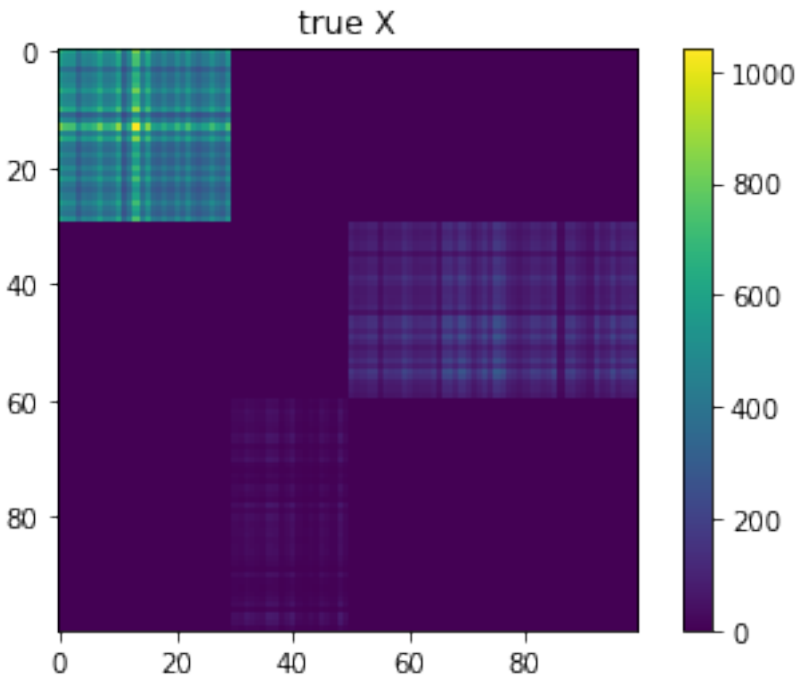
```
ax2.title.set_text('H . S_H')
plt.colorbar(im1, ax=ax1)
plt.colorbar(im2, ax=ax2)

plt.show()
```

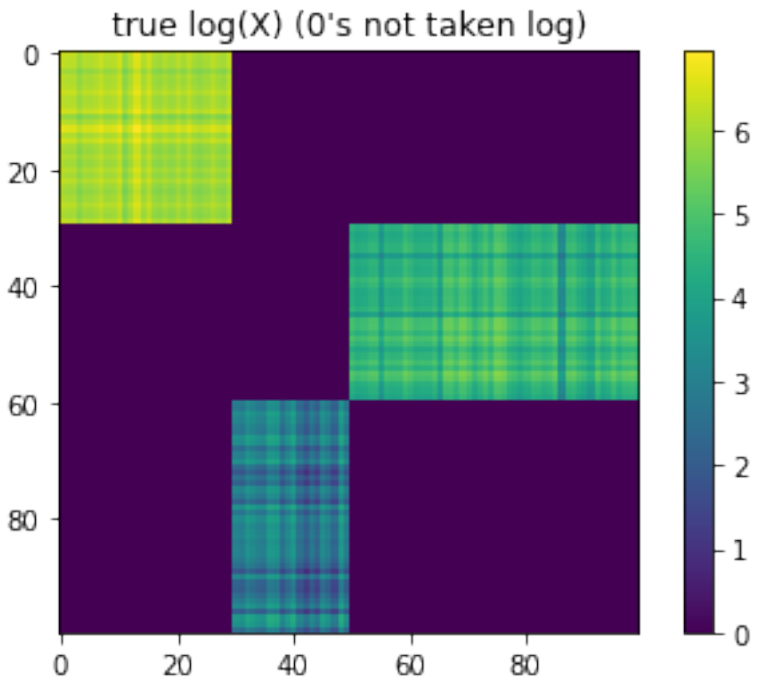


[11]:
```
X = np.dot(W_S_W, H_S_H)
X = pd.DataFrame.from_records(X)
```

[12]:
```
plt.imshow(X, interpolation='none')
plt.colorbar()
plt.title("true X")
plt.show()
```



[13]:
```
plt.imshow(np.log(X.replace(0, np.nan)).replace(np.nan, 0),␣
↪interpolation='none')
plt.colorbar()
plt.title("true log(X) (0's not taken log)")
plt.show()
```



0.1 Run 1: K=3, burn=30, max_iter=20

[14]:
```
dssvi_run = dssvi_fn.SSMF_BP_NMF(n_components=3, burn_in=30, random_state=10,␣
↪verbose=True, max_iter=20,
                                 a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)
```

[15]:
```
start_t = time.time()
dssvi_run.fit(X)
t = time.time() - start_t
```

```
SSMF-A iteration 0      good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 1      good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 2      good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 3      good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 4      good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 5      good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 6      good K:3:
```

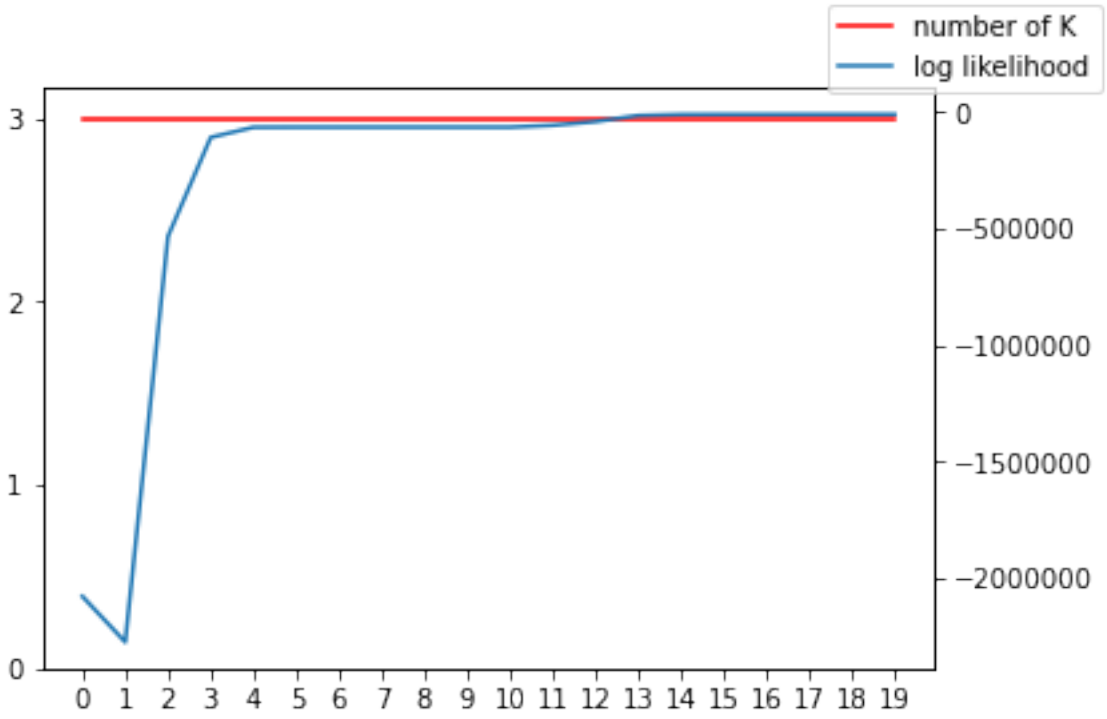
```
        Gibbs burn-in: 30
SSMF-A iteration 7      good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 8      good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 9      good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 10     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 11     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 12     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 13     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 14     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 15     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 16     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 17     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 18     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 19     good K:3:
        Gibbs burn-in: 30
```

[16]:
```
t
```

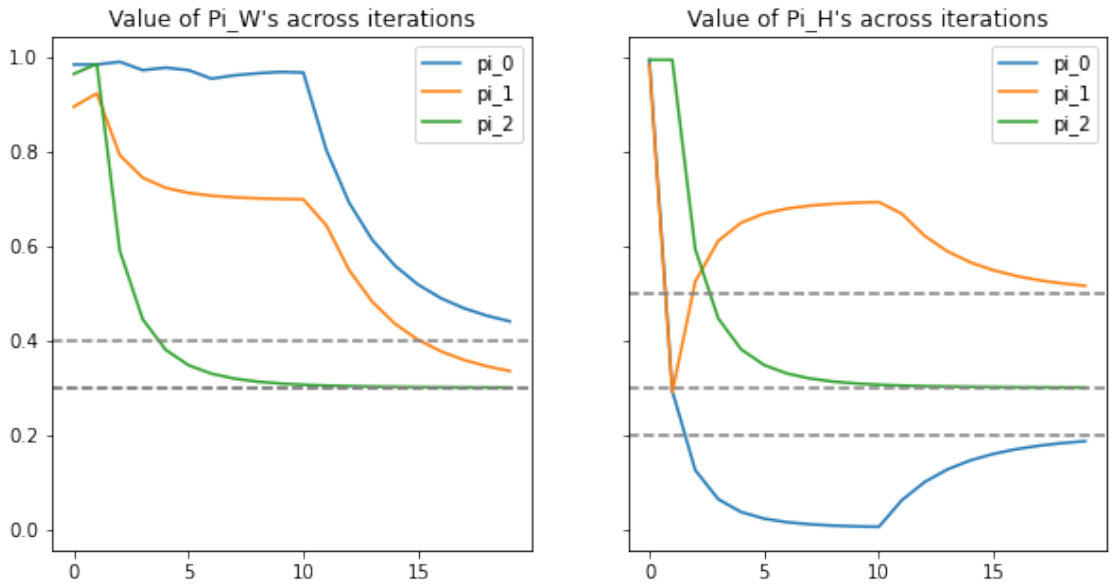
[16]:
```
20.361778497695923
```

[17]:
```
K_and_log_ll(dssvi_run, 30, 20) # prints log-likelihoods calculated each␣
↪iteration
```

```
[-2079981.0108942022, -2275746.4001533287, -534322.3292252664,
-109227.16724647142, -65870.11504878564, -65419.76439393273, -65419.44634637383,
-65400.33376564072, -65408.89049433645, -65384.36166670424, -65408.79461889039,
-57453.73543446944, -41382.67636371251, -15505.17615876438, -11282.329502832557,
-10800.613318588363, -10802.833776747699, -10705.740700997861,
-10721.737012364805, -10701.361428483533]
```



[18]:
```
plot_pi(dssvi_run)
```

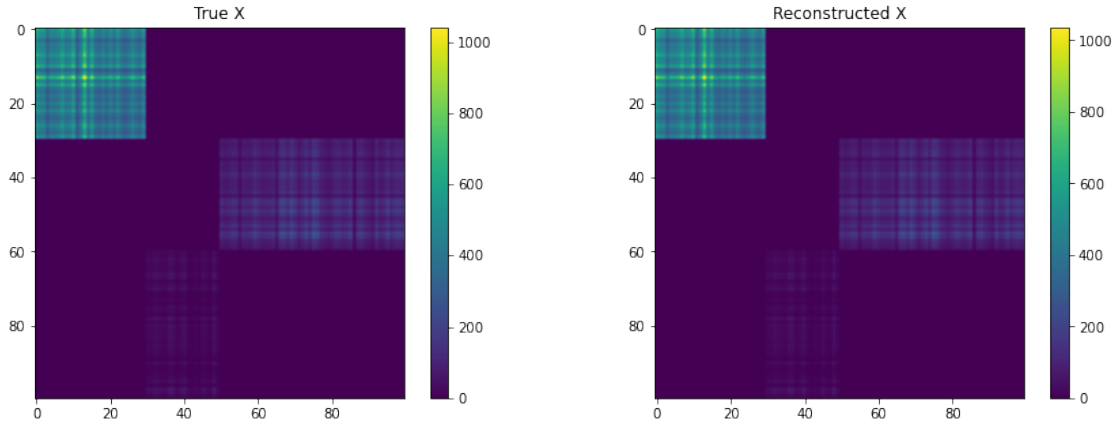


[19]:
```
print("Expected pi_H at last iteration:", dssvi_run.Epi_W_list[-1])
print("Expected pi_W at last iteration:",dssvi_run.Epi_H_list[-1])
```

```
Expected pi_H at last iteration: [0.4405041  0.33534436 0.30076966]
Expected pi_W at last iteration: [0.18713403 0.51566943 0.30077525]
```

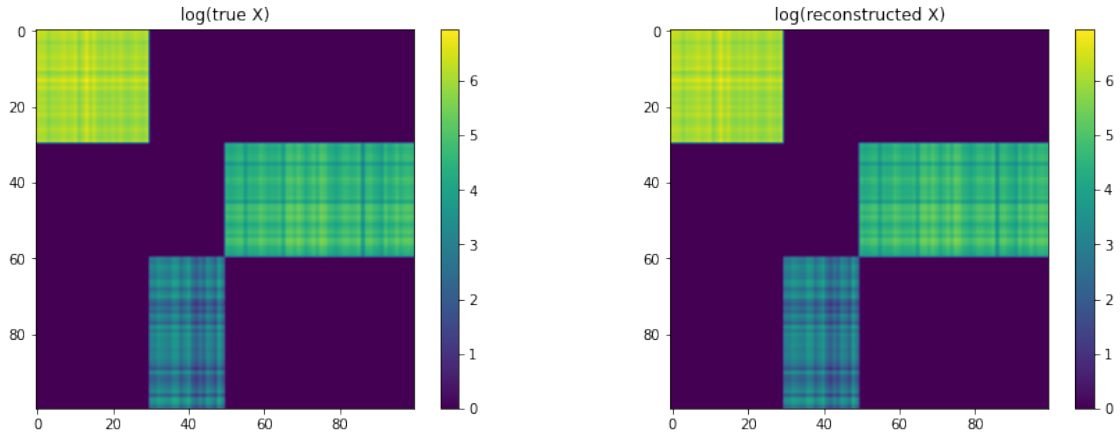
[20]:
```
W_post_mean, H_post_mean, X_post_mean = dssvi_fn.get_post_means(dssvi_run)

dssvi_fn.draw_two_matrices(X, X_post_mean, 1, 1, first='True X',␣
 ↪second='Reconstructed X')
```

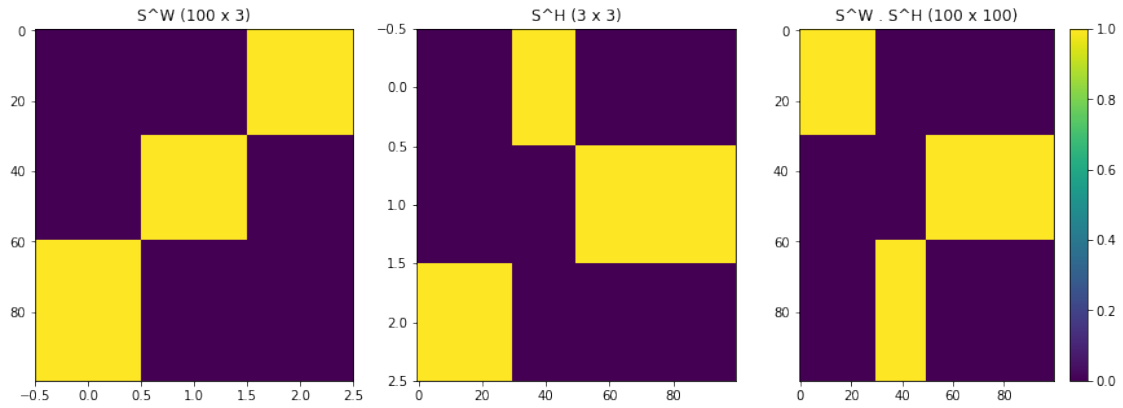


[117]:
```
X_post_mean = pd.DataFrame.from_records(X_post_mean)


dssvi_fn.draw_two_matrices(np.log(X.replace(0, np.nan)).replace(np.nan, 0),
                           np.log(X_post_mean.replace(0, np.nan)).replace(np.
 ↪nan, 0), 1, 1, 'log(true X)',
                           'log(reconstructed X)')
```



[21]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run)
```



1 Run 2: K=4

[22]:
```
dssvi_run2 = dssvi_fn.SSMF_BP_NMF(n_components=4, burn_in=30, random_state=10,␣
↪verbose=True, max_iter=20, cutoff=1e-2,
                                  a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run2.fit(X)
t2 = time.time() - start_t
```

```
SSMF-A iteration 0      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 1      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 2      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 3      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 4      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 5      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 6      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 7      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 8      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 9      good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 10     good K:4:
```

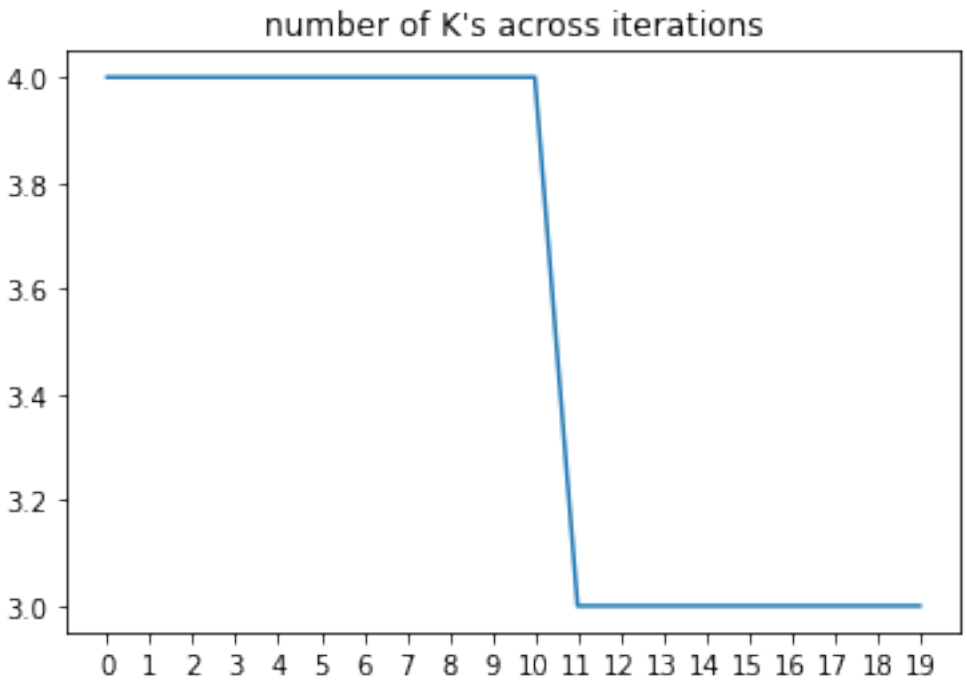
```
        Gibbs burn-in: 30
SSMF-A iteration 11     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 12     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 13     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 14     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 15     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 16     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 17     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 18     good K:3:
        Gibbs burn-in: 30
SSMF-A iteration 19     good K:3:
        Gibbs burn-in: 30
```

[23]:
```
t2
```

[23]:
```
26.059136152267456
```

[24]:
```
len_good_k = [len(dssvi_run2.good_k_list[i]) for i in range(len(dssvi_run2.
 ↪good_k_list))]
```

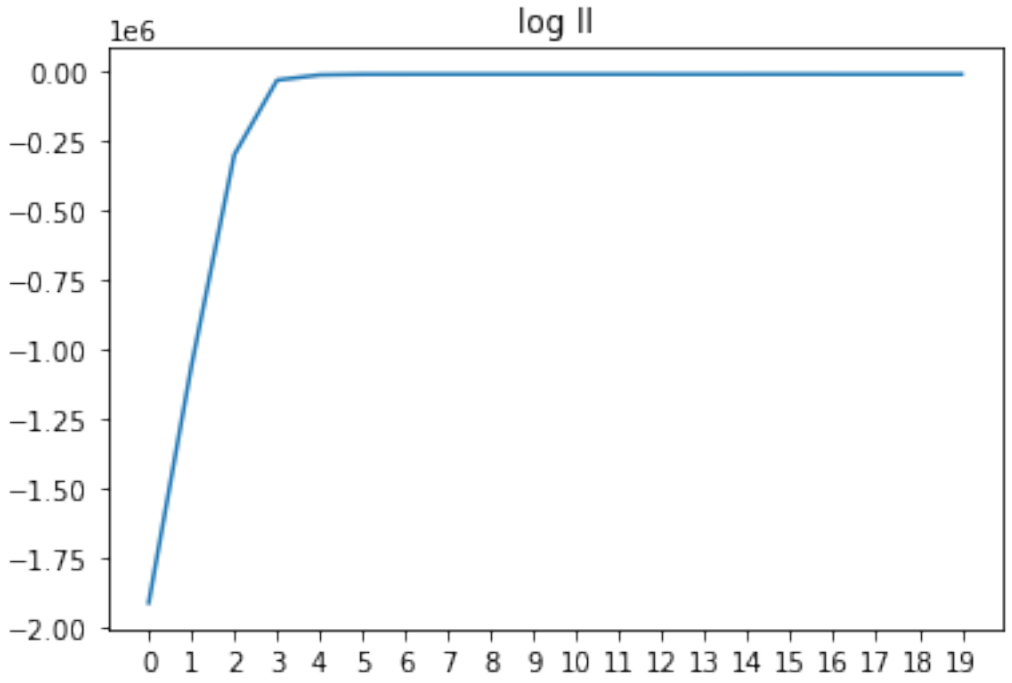
[25]:
```
number_K(dssvi_run2)
```



[26]:
```
log_ll_list = [dssvi_run2.log_ll[i,30] for i in range(20)]
log_ll_list
```

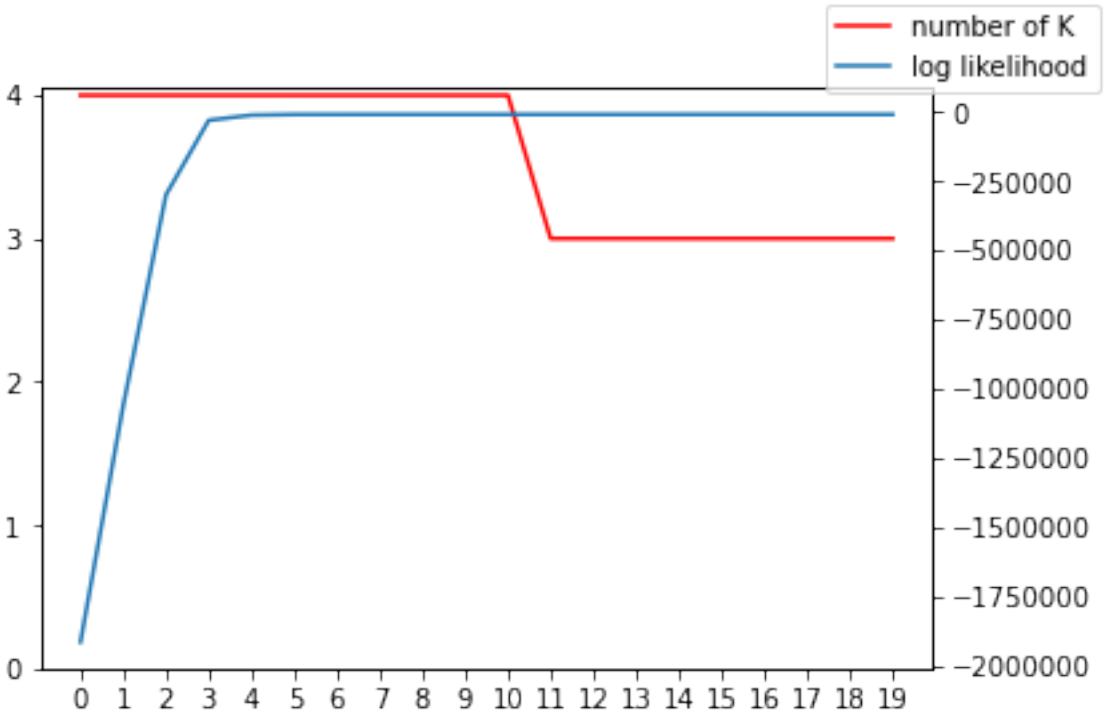
[26]:
```
[-1913504.4145709837,
 -1060306.2990473085,
 -300630.0575652924,
 -31884.094783652807,
 -13147.570473712245,
 -10885.443479517977,
 -10779.035640741415,
 -10748.924756921937,
 -10758.015331446373,
 -10736.064428468133,
 -10752.302893094035,
 -10757.288597135994,
 -10736.797865532026,
 -10696.833403467792,
 -10699.062364684285,
 -10681.167884783144,
 -10702.315960650525,
 -10713.083941572258,
 -10687.371802909598,
 -10698.325910001935]
```

[27]:
```
log_likelihoods(dssvi_run2,30,20)
```



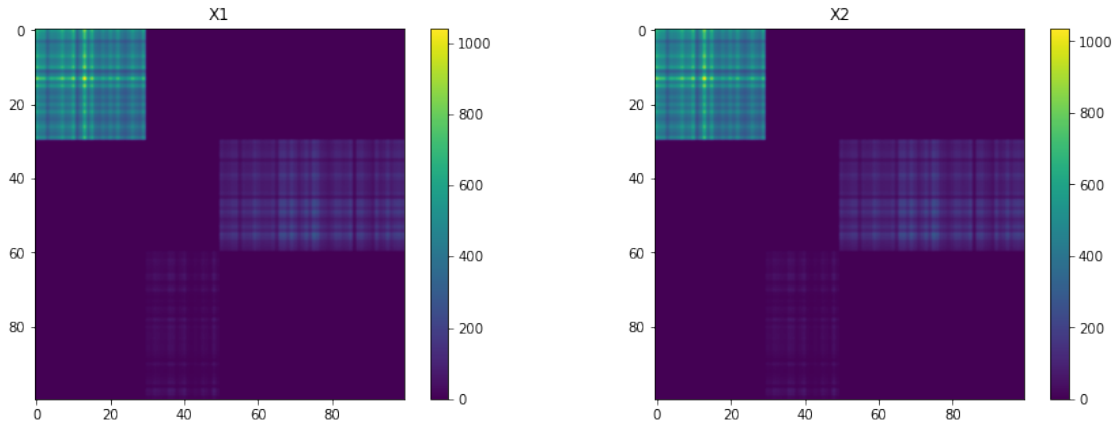
[28]:
```
K_and_log_ll(dssvi_run2, 30, 20)
```

```
[-1913504.4145709837, -1060306.2990473085, -300630.0575652924,
-31884.094783652807, -13147.570473712245, -10885.443479517977,
-10779.035640741415, -10748.924756921937, -10758.015331446373,
-10736.064428468133, -10752.302893094035, -10757.288597135994,
-10736.797865532026, -10696.833403467792, -10699.062364684285,
-10681.167884783144, -10702.315960650525, -10713.083941572258,
-10687.371802909598, -10698.325910001935]
```



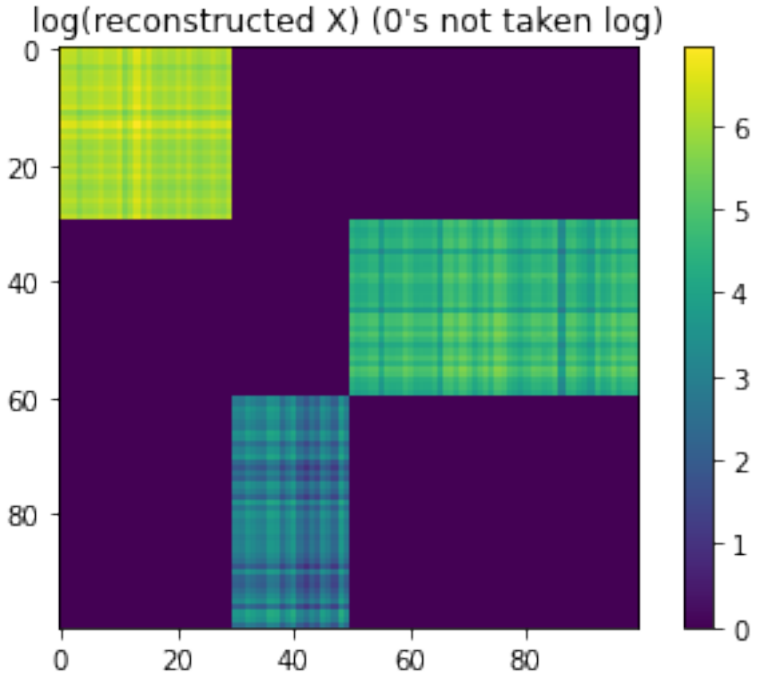
[29]:
```
W_post_mean2, H_post_mean2, X_post_mean2 = dssvi_fn.get_post_means(dssvi_run2)

dssvi_fn.draw_two_matrices(X, X_post_mean2, 1, 1)
```

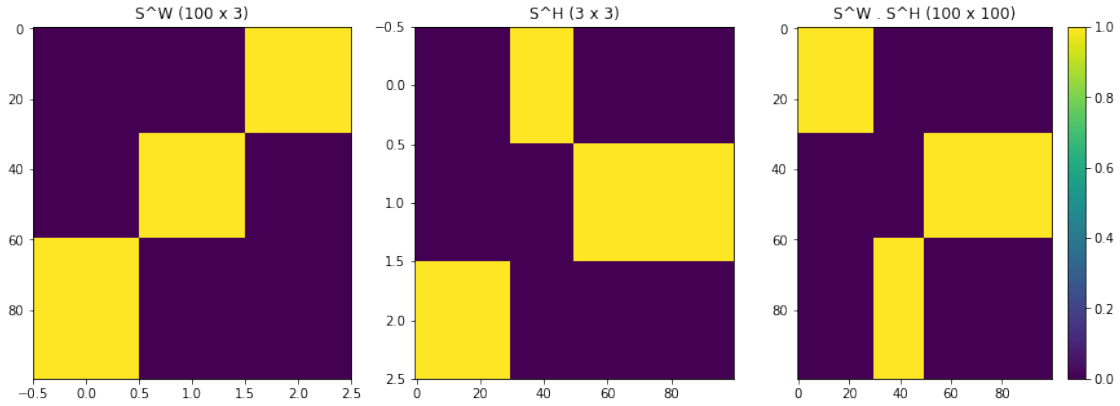


[111]:
```
X_post_mean3 = pd.DataFrame.from_records(X_post_mean3)
plt.imshow(np.log(X_post_mean3.replace(0, np.nan)).replace(np.nan, 0),␣
 ↪interpolation='none')
plt.colorbar()
```

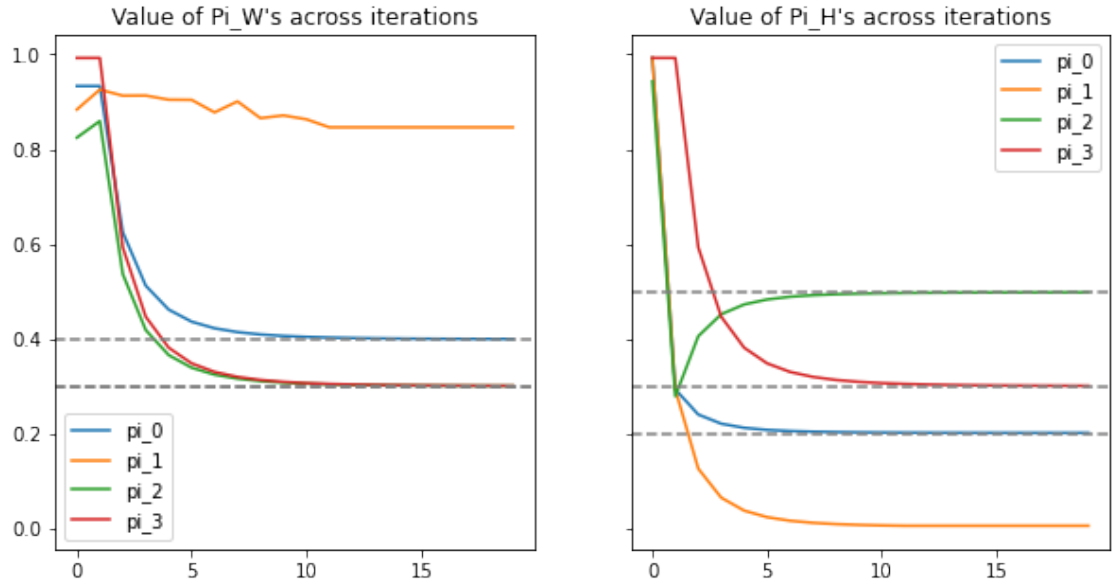
```
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



[30]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run2)
```



[34]:
```
plot_pi(dssvi_run2)
```



1.1 Run 3: K = 5, burn = 30, max_iter =20

[35]:
```
dssvi_run3 = dssvi_fn.SSMF_BP_NMF(n_components=5, burn_in=30, random_state=10,␣
↪verbose=True, max_iter=20, cutoff=1e-2,
                                  a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run3.fit(X)
t3 = time.time() - start_t
```

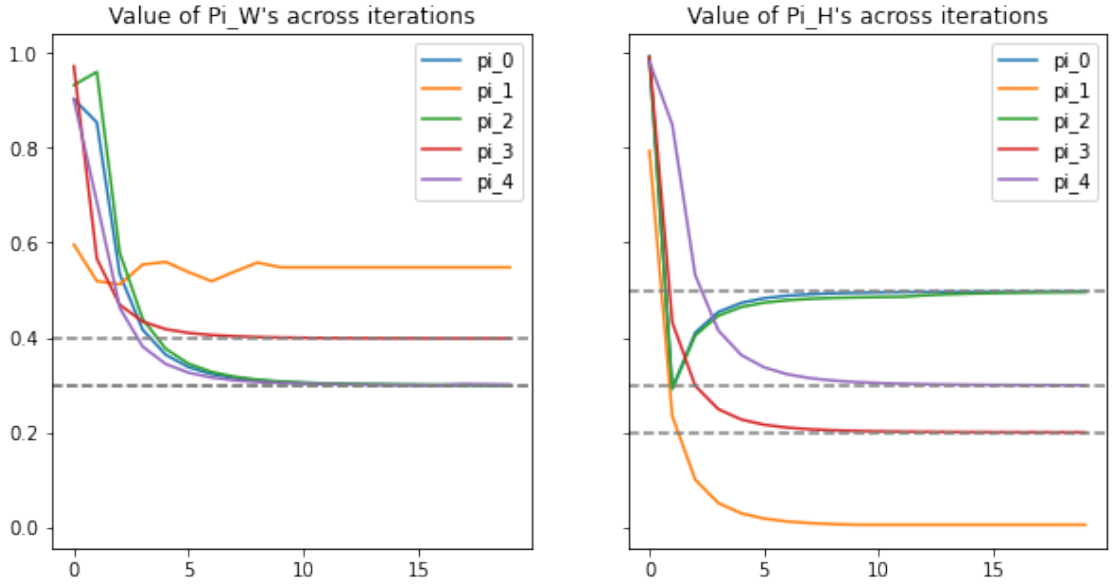
```
SSMF-A iteration 0      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 1      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 2      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 3      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 4      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 5      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 6      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 7      good K:5:
        Gibbs burn-in: 30
```

```
SSMF-A iteration 8      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 9      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 10     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 11     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 12     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 13     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 14     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 15     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 16     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 17     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 18     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 19     good K:4:
        Gibbs burn-in: 30
```

[36]:
```
t3
```

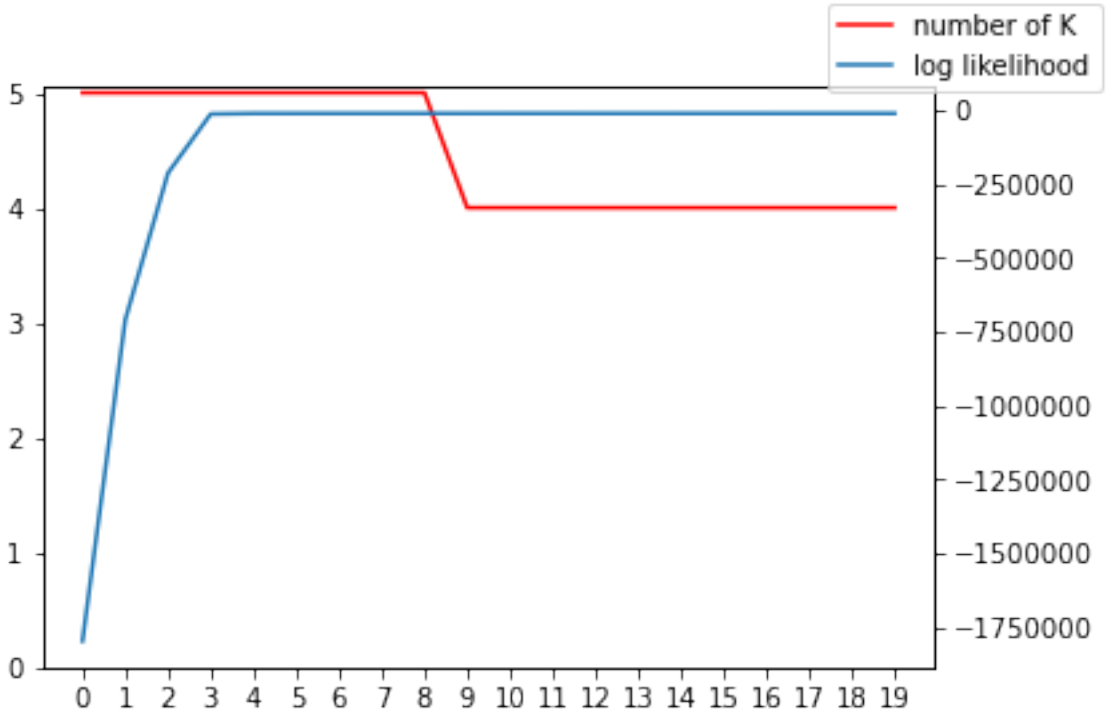
[36]:
```
32.74858236312866
```

[37]:
```
plot_pi(dssvi_run3)
```



[38]:
```
K_and_log_ll(dssvi_run3, 30, 20)
```

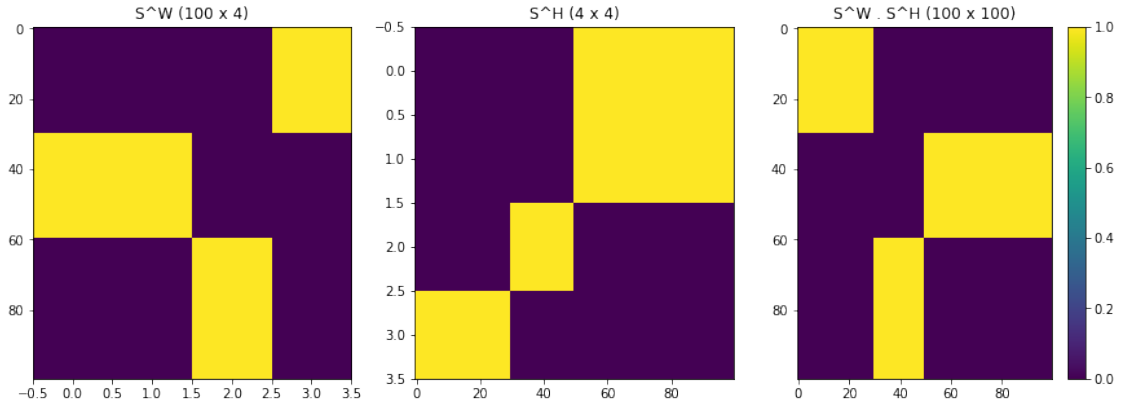
```
[-1797170.1395828, -709588.1554463771, -212713.4314165143, -12831.373081263053,
-10968.045902495382, -10962.448775230177, -10947.996328305637,
-10962.679968664757, -10947.014537005683, -10928.610385788288,
-10872.785039239217, -10849.888706785952, -10892.748695469763,
-10880.619157745672, -10862.926080445483, -10852.250646327779,
-10875.606121177365, -10864.134086813257, -10871.814495368222,
-10855.519718424905]
```



[39]:
```
dssvi_run3.good_k
```

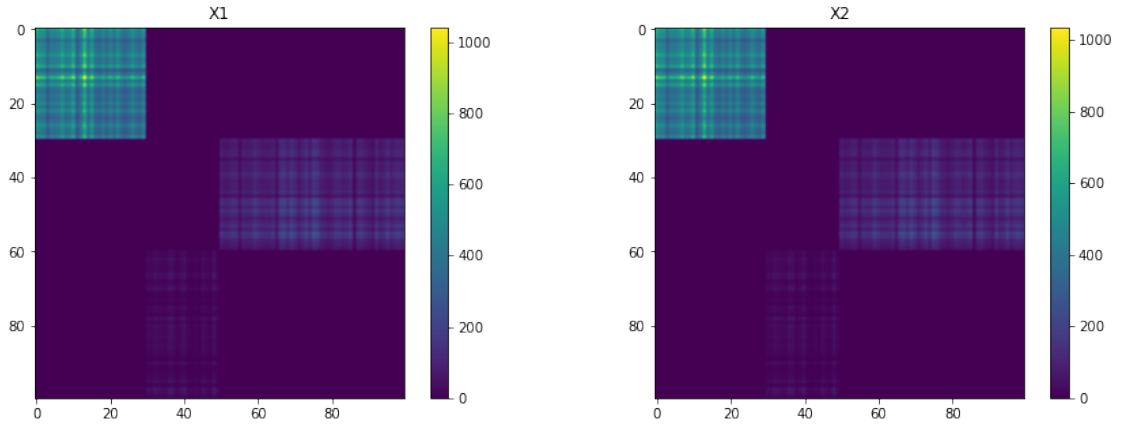
[39]:
```
array([0, 2, 3, 4])
```

[40]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run3)
```

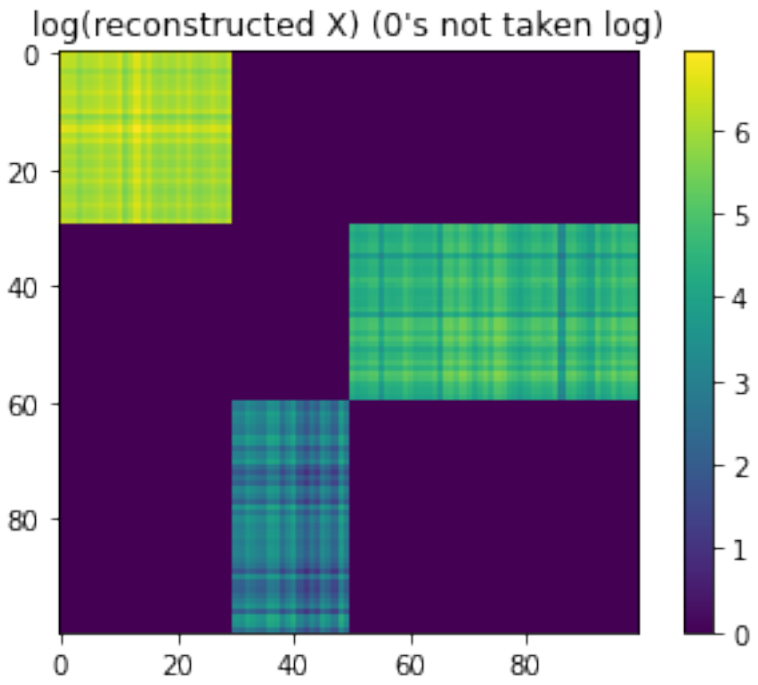


[109]:
```
W_post_mean3, H_post_mean3, X_post_mean3 = dssvi_fn.get_post_means(dssvi_run3)

dssvi_fn.draw_two_matrices(X, X_post_mean3, 1, 1)
```



[110]:
```
X_post_mean3 = pd.DataFrame.from_records(X_post_mean3)
plt.imshow(np.log(X_post_mean3.replace(0, np.nan)).replace(np.nan, 0),␣
 ↪interpolation='none')
plt.colorbar()
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



1.2 Run 4: K=5, burn = 60, max_iter = 20

[41]:
```
dssvi_run4 = dssvi_fn.SSMF_BP_NMF(n_components=5, burn_in=60, random_state=10,␣
↪verbose=True, max_iter=20, cutoff=1e-2,
                                  a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run4.fit(X)
t4 = time.time() - start_t
```

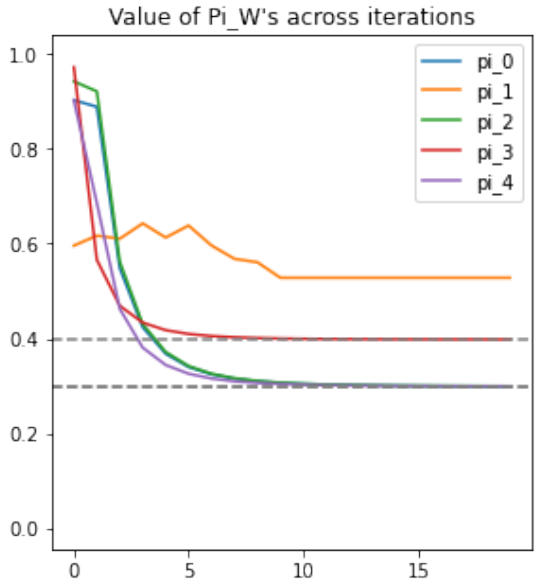
```
SSMF-A iteration 0      good K:5:
        Gibbs burn-in: 60
SSMF-A iteration 1      good K:5:
        Gibbs burn-in: 60
SSMF-A iteration 2      good K:5:
        Gibbs burn-in: 60
SSMF-A iteration 3      good K:5:
        Gibbs burn-in: 60
SSMF-A iteration 4      good K:5:
        Gibbs burn-in: 60
SSMF-A iteration 5      good K:5:
        Gibbs burn-in: 60
SSMF-A iteration 6      good K:5:
```

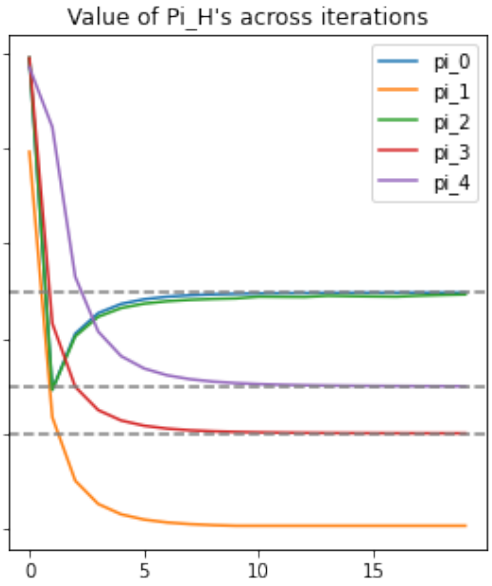
```
        Gibbs burn-in: 60
SSMF-A iteration 7      good K:5:
        Gibbs burn-in: 60
SSMF-A iteration 8      good K:5:
        Gibbs burn-in: 60
SSMF-A iteration 9      good K:5:
        Gibbs burn-in: 60
SSMF-A iteration 10     good K:4:
        Gibbs burn-in: 60
SSMF-A iteration 11     good K:4:
        Gibbs burn-in: 60
SSMF-A iteration 12     good K:4:
        Gibbs burn-in: 60
SSMF-A iteration 13     good K:4:
        Gibbs burn-in: 60
SSMF-A iteration 14     good K:4:
        Gibbs burn-in: 60
SSMF-A iteration 15     good K:4:
        Gibbs burn-in: 60
SSMF-A iteration 16     good K:4:
        Gibbs burn-in: 60
SSMF-A iteration 17     good K:4:
        Gibbs burn-in: 60
SSMF-A iteration 18     good K:4:
        Gibbs burn-in: 60
SSMF-A iteration 19     good K:4:
        Gibbs burn-in: 60
```

[42]:
```
t4
```

[42]:
```
62.98468327522278
```

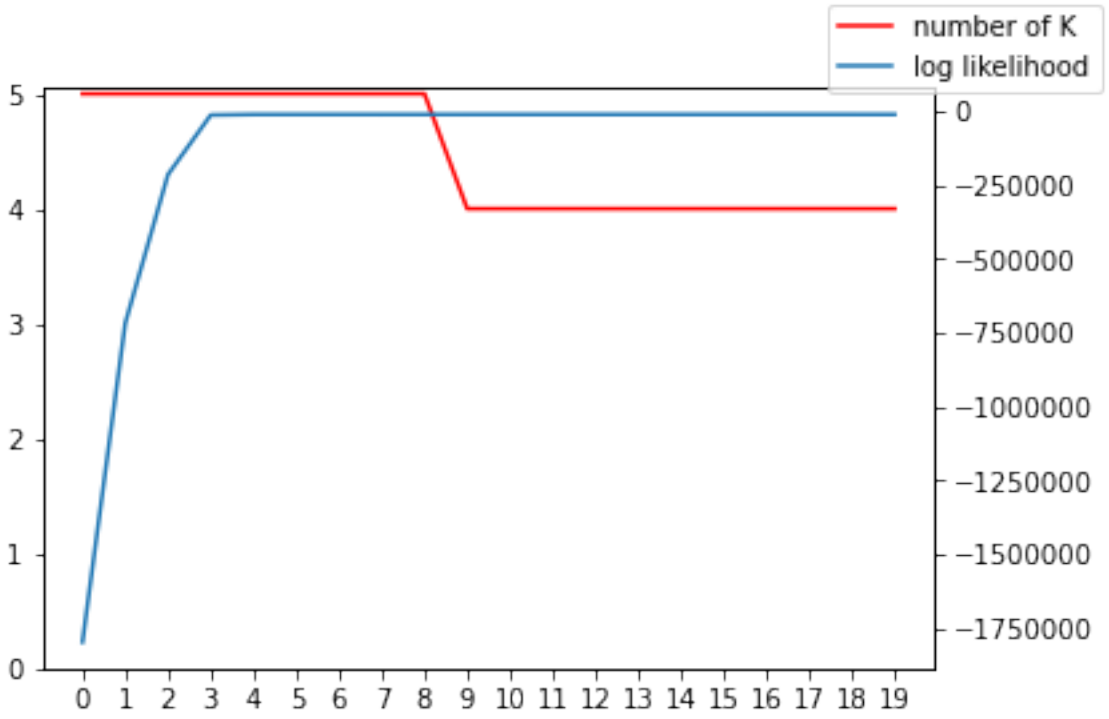
[43]:
```
plot_pi(dssvi_run4)
```



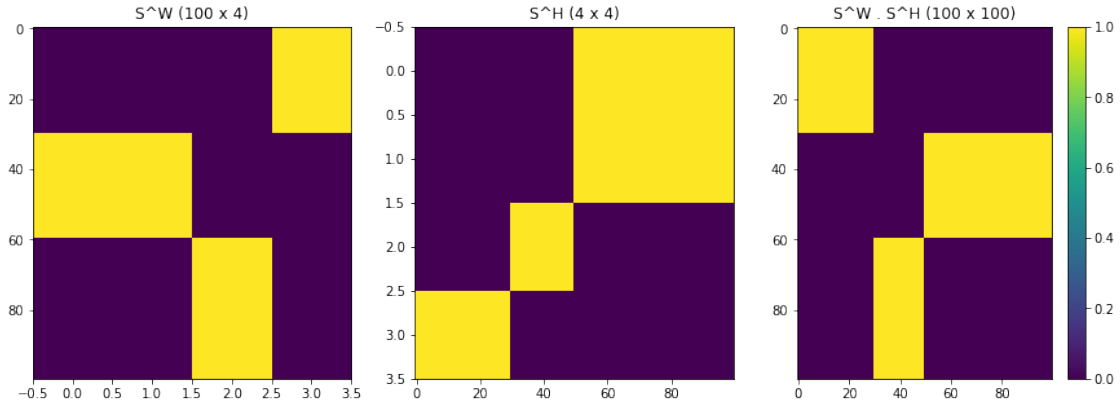


[44]:
```
K_and_log_ll(dssvi_run4, 60, 20)
```

```
[-1797166.9513130942, -717833.9876844536, -214455.96168394867,
-12865.889841415663, -10972.07384328549, -10959.990177463762,
-10934.140250650435, -10961.448664493044, -10951.723469448112,
-10927.279445537011, -10858.509310124206, -10880.469968200301,
-10875.079817722904, -10864.363761174263, -10875.329584897392,
-10869.411389907764, -10860.758394402508, -10850.895544754685,
-10863.865127983596, -10872.569803331315]
```

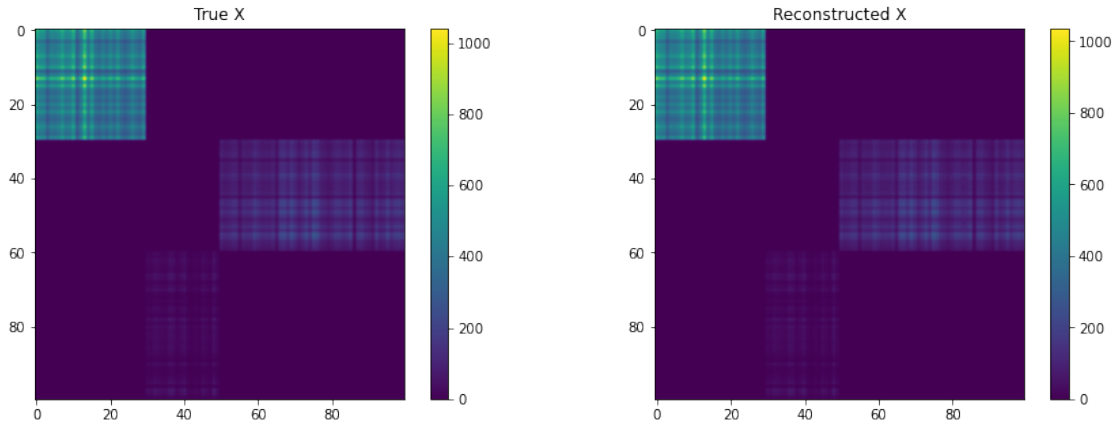


[45]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run4)
```

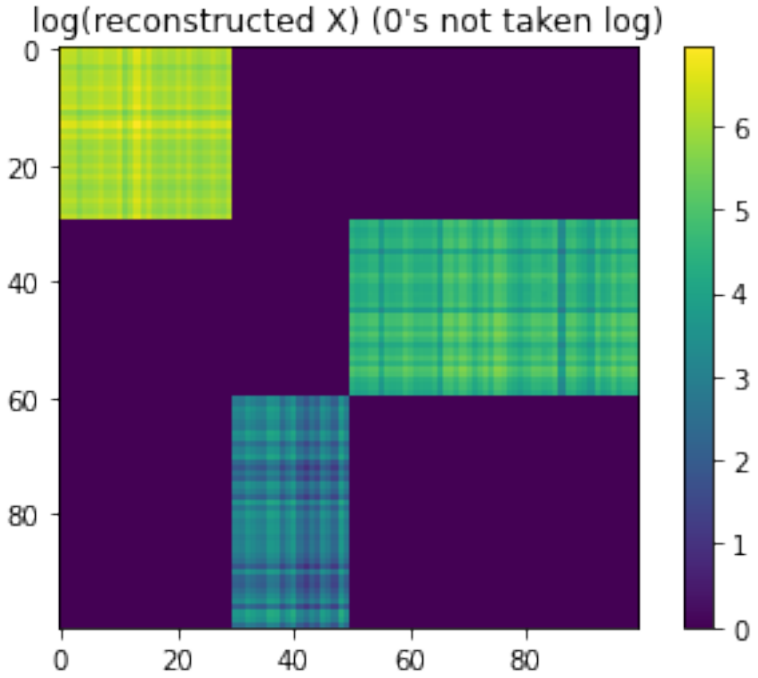


[46]:
```
W_post_mean4, H_post_mean4, X_post_mean4 = dssvi_fn.get_post_means(dssvi_run4)

dssvi_fn.draw_two_matrices(X, X_post_mean4, 1, 1, 'True X', 'Reconstructed X')
```



[107]:
```
X_post_mean4 = pd.DataFrame.from_records(X_post_mean4)
plt.imshow(np.log(X_post_mean4.replace(0, np.nan)).replace(np.nan, 0),␣
↪interpolation='none')
plt.colorbar()
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



1.3 Run: K=5, burn=30, max_iter = 50

[47]:
```
dssvi_run_ = dssvi_fn.SSMF_BP_NMF(n_components=5, burn_in=30, random_state=10,␣
↪verbose=True, max_iter=50, cutoff=1e-2,
                                  a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run_.fit(X)
t_ = time.time() - start_t
```

```
SSMF-A iteration 0      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 1      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 2      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 3      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 4      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 5      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 6      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 7      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 8      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 9      good K:5:
        Gibbs burn-in: 30
SSMF-A iteration 10     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 11     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 12     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 13     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 14     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 15     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 16     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 17     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 18     good K:4:
```

```
        Gibbs burn-in: 30
SSMF-A iteration 19     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 20     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 21     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 22     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 23     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 24     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 25     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 26     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 27     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 28     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 29     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 30     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 31     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 32     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 33     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 34     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 35     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 36     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 37     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 38     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 39     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 40     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 41     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 42     good K:4:
```

```
        Gibbs burn-in: 30
SSMF-A iteration 43     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 44     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 45     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 46     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 47     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 48     good K:4:
        Gibbs burn-in: 30
SSMF-A iteration 49     good K:4:
        Gibbs burn-in: 30
```

[48]:
```
t_
```

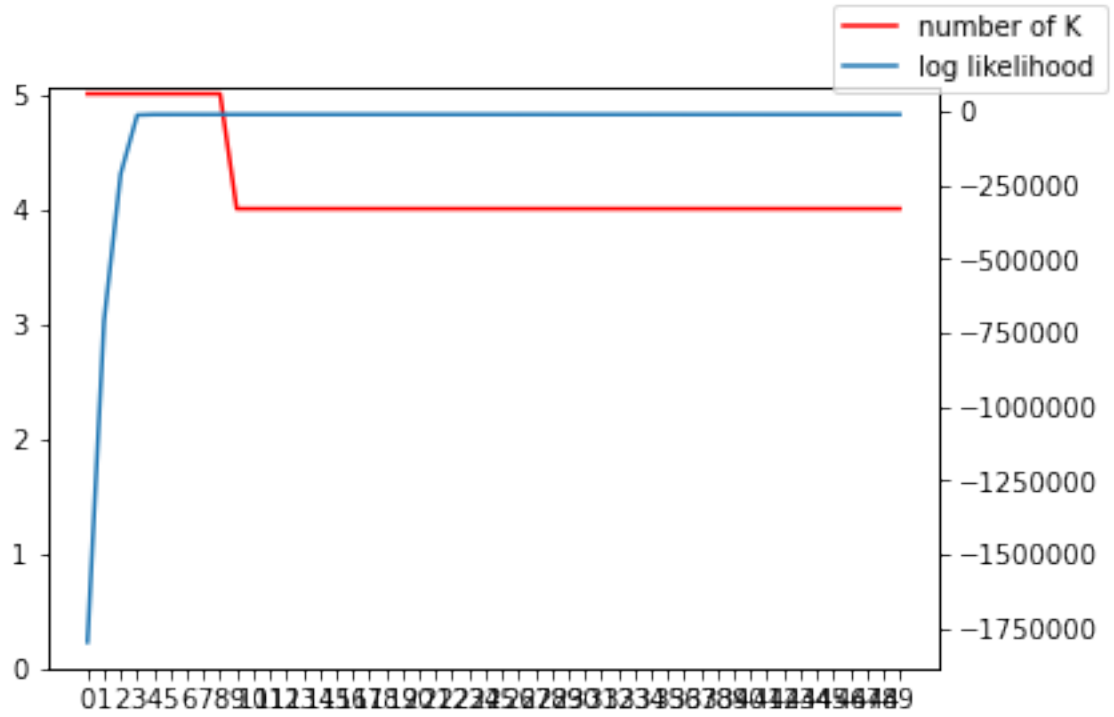
[48]:
```
81.53423643112183
```

[49]:
```
dssvi_run_.good_k
```

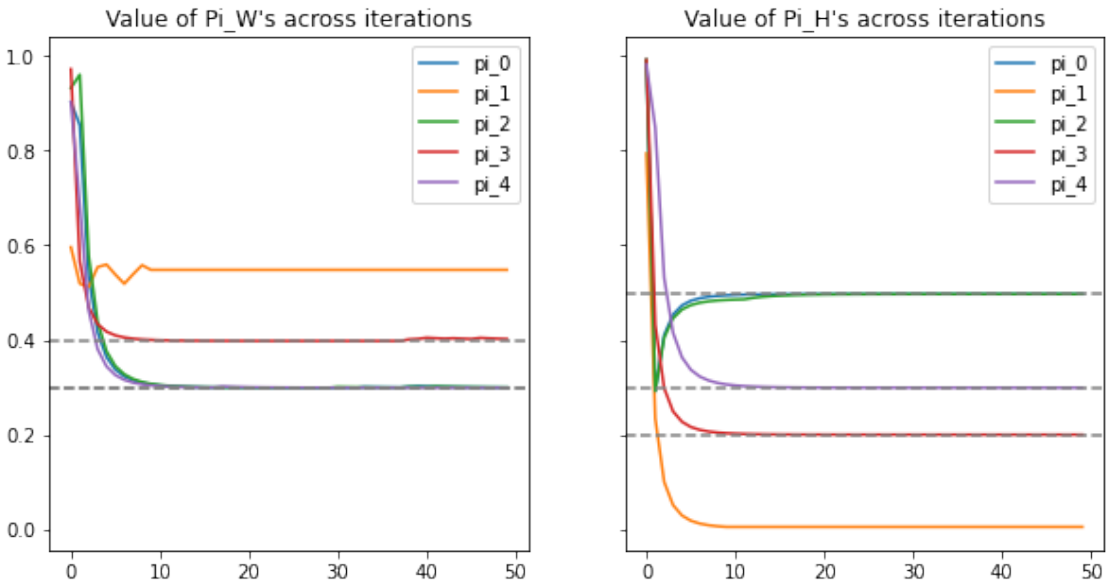
[49]:
```
array([0, 2, 3, 4])
```

[50]:
```
K_and_log_ll(dssvi_run_, 30, 50)
```

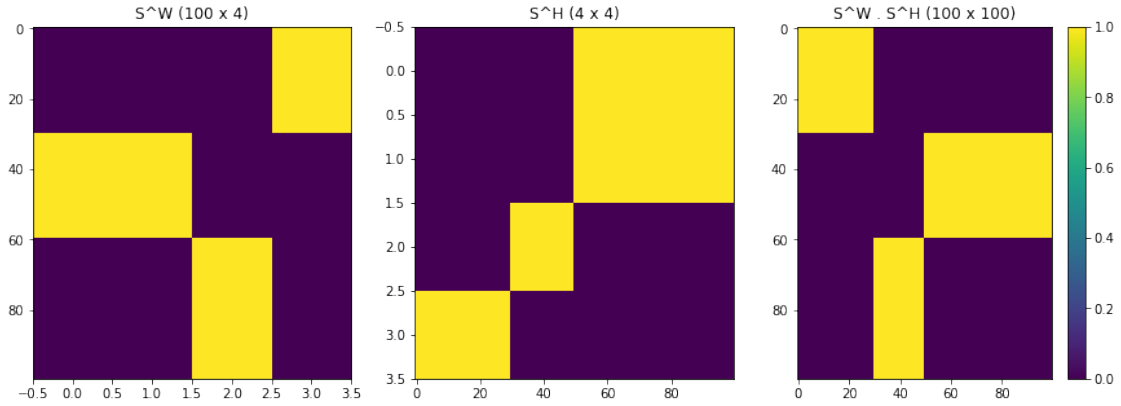
```
[-1797170.1395828, -709588.1554463771, -212713.4314165143, -12831.373081263053,
-10968.045902495382, -10962.448775230177, -10947.996328305637,
-10962.679968664757, -10947.014537005683, -10928.610385788288,
-10872.785039239217, -10849.888706785952, -10892.748695469763,
-10880.619157745672, -10862.926080445483, -10852.250646327779,
-10875.606121177365, -10864.134086813257, -10871.814495368222,
-10855.519718424905, -10866.214641650935, -10893.195570026415,
-10855.714953733795, -10846.366448580626, -10878.167985067266,
-10868.961471791697, -10874.354023701071, -10842.433238564143,
-10853.497133010604, -10844.945969412644, -10863.167566257547,
-10867.060528724538, -10858.14490249956, -10864.807749336413,
-10865.534386667689, -10844.591896166407, -10853.603798417265,
-10856.485440650773, -10861.315615835529, -10848.579858054363,
-10840.506523955288, -10859.72207194283, -10862.987291944894,
-10862.38461631021, -10852.52577604607, -10852.38535432219, -10870.134185578512,
-10840.109184383817, -10867.894149553153, -10855.310666037865]
```



[51]:
```
plot_pi(dssvi_run_)
```

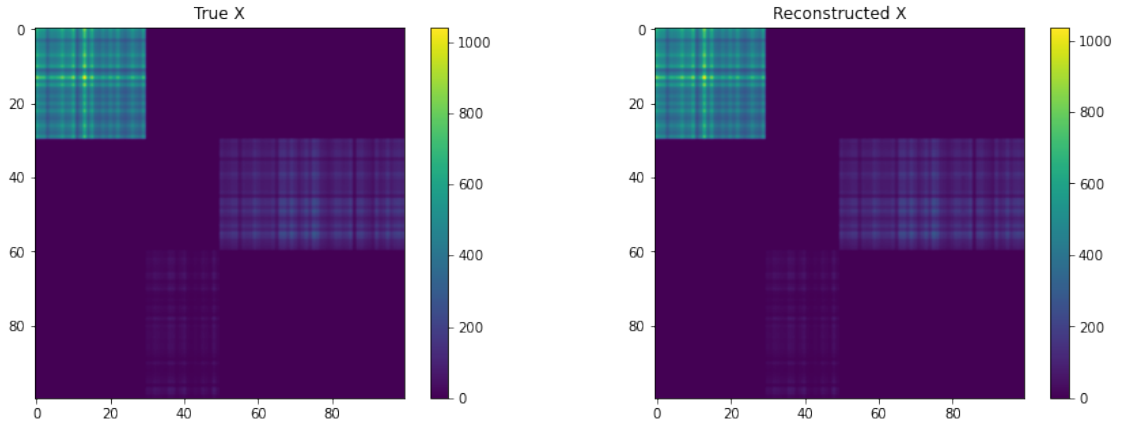


[52]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run_)
```

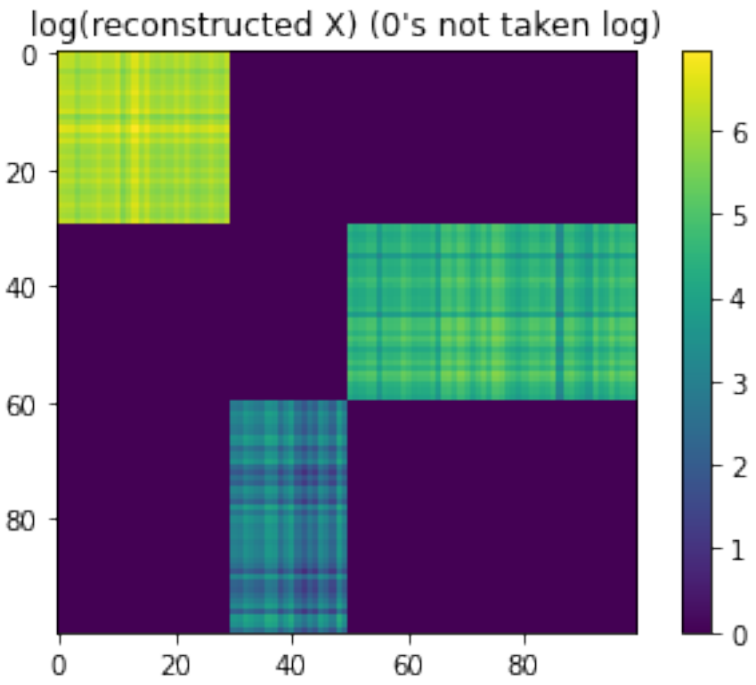


[53]:
```
W_post_mean_, H_post_mean_, X_post_mean_ = dssvi_fn.get_post_means(dssvi_run_)

dssvi_fn.draw_two_matrices(X, X_post_mean_, 1, 1, 'True X', 'Reconstructed X')
```



[106]:
```
X_post_mean_ = pd.DataFrame.from_records(X_post_mean_)
plt.imshow(np.log(X_post_mean_.replace(0, np.nan)).replace(np.nan, 0),␣
 ↪interpolation='none')
plt.colorbar()
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



1.4 Run 5: K = 10, burn = 50, max_iter = 50

[54]:
```
dssvi_run5 = dssvi_fn.SSMF_BP_NMF(n_components=10, burn_in=50, random_state=10,␣
↪verbose=True, max_iter=50, cutoff=1e-2,
                                  a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run5.fit(X)
t5 = time.time() - start_t
```

```
SSMF-A iteration 0      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 1      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 2      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 3      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 4      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 5      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 6      good K:10:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 7      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 8      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 9      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 10     good K:9:
        Gibbs burn-in: 50
SSMF-A iteration 11     good K:9:
        Gibbs burn-in: 50
SSMF-A iteration 12     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 13     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 14     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 15     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 16     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 17     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 18     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 19     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 20     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 21     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 22     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 23     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 24     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 25     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 26     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 27     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 28     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 29     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 30     good K:8:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 31     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 32     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 33     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 34     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 35     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 36     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 37     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 38     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 39     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 40     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 41     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 42     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 43     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 44     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 45     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 46     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 47     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 48     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 49     good K:8:
        Gibbs burn-in: 50
```

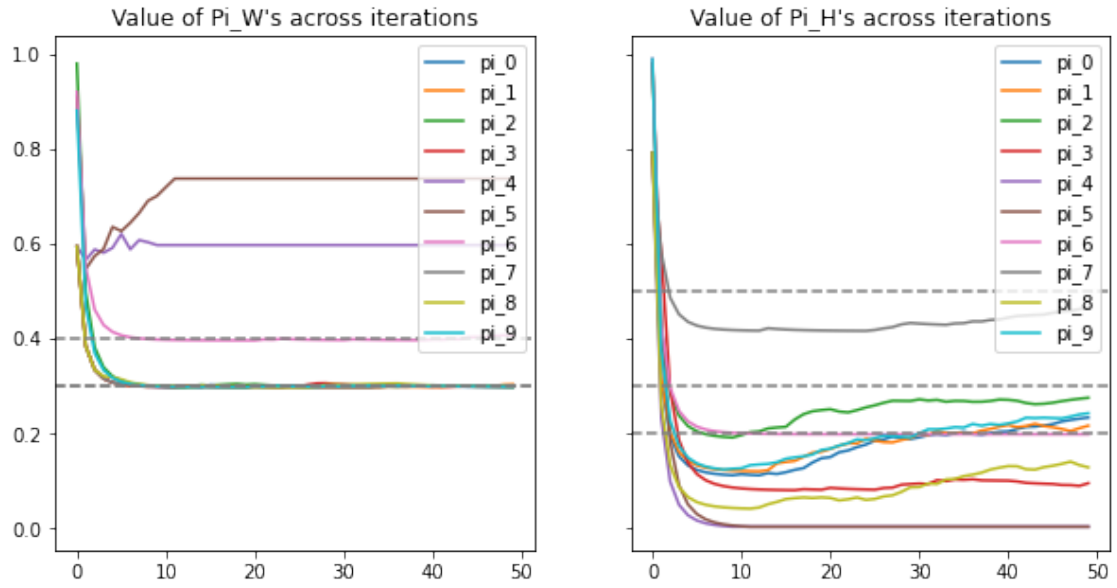
[55]:
```
t5
```

[55]:
```
223.45148873329163
```

[56]:
```
dssvi_run5.good_k
```

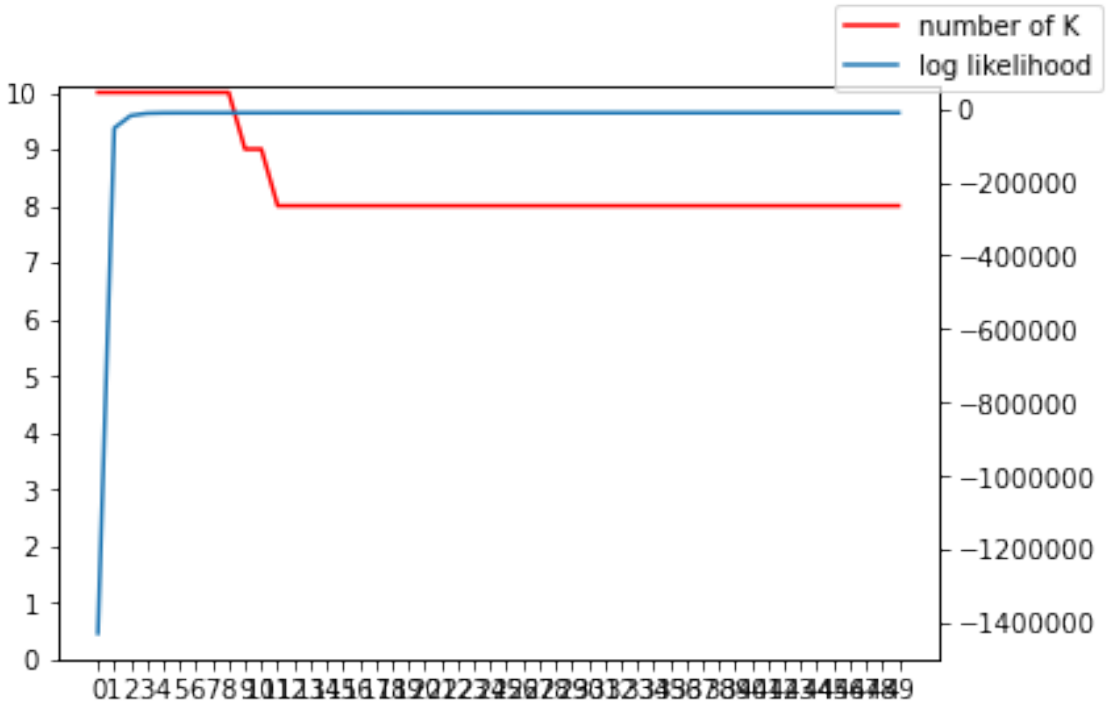
[56]:
```
array([0, 1, 2, 3, 6, 7, 8, 9])
```

[57]:
```
plot_pi(dssvi_run5)
```

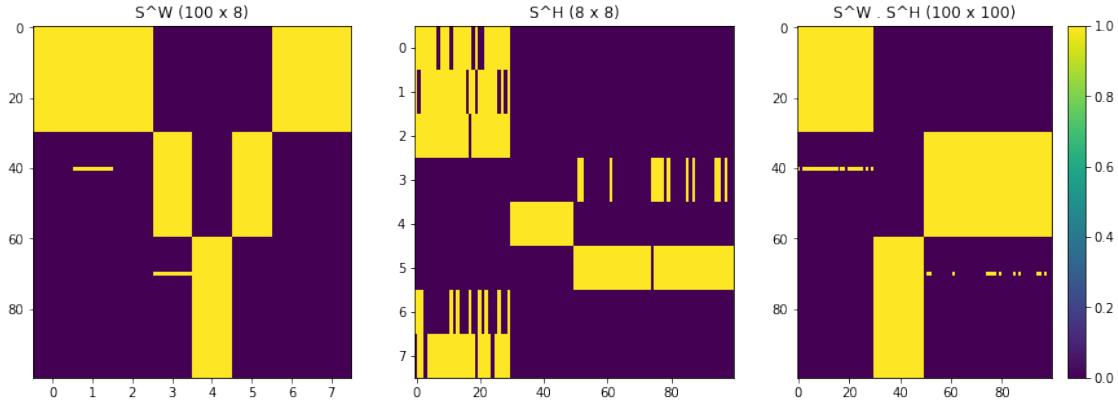


[58]:
```
K_and_log_ll(dssvi_run5, 50, 50)
```

```
[-1428623.348077554, -53031.83471908225, -19198.723430477883,
-12788.87613836939, -11697.026787077579, -11530.849329025134,
-11511.09804520131, -11503.255640889867, -11491.81880147754,
-11453.806019340376, -11405.728445901428, -11370.564419818353,
-11301.08882555038, -11329.03183257621, -11318.638928420492,
-11296.106238867682, -11294.003753802033, -11291.391832244437,
-11324.995428876127, -11288.387514567268, -11315.54371319688,
-11302.31928793309, -11306.910073063968, -11302.05374535164,
-11318.386275184588, -11290.526006477421, -11301.187881227497,
-11298.936160315236, -11324.417216965016, -11311.939832264623,
-11323.996498222708, -11293.711125179194, -11330.979559336593,
-11320.256768545863, -11317.698204982316, -11333.763065221106,
-11313.440890369675, -11303.460174034832, -11307.1447839247,
-11295.963069746957, -11308.20617274677, -11295.109304815485,
-11296.722059190177, -11295.12129359343, -11312.820359421417,
-11315.86276548556, -11298.87744636344, -11308.994648898704, -11325.62098792596,
-11302.633815554937]
```

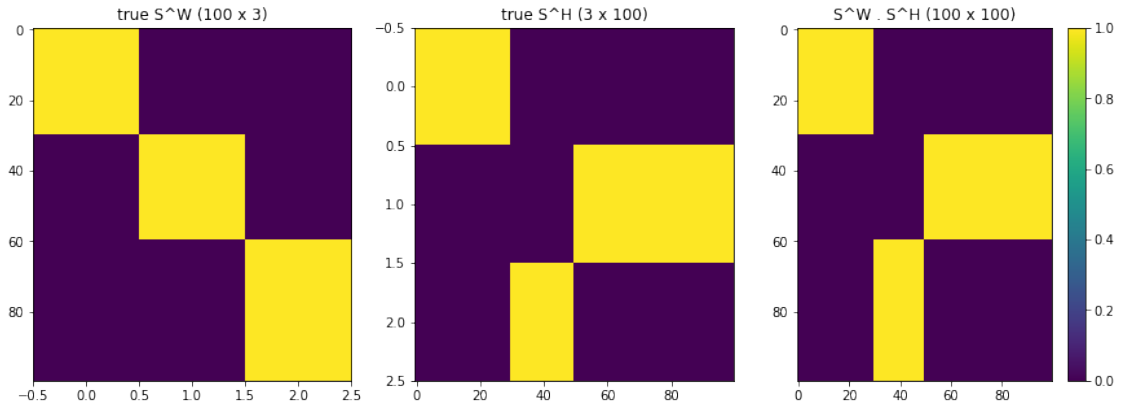


[59]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run5)
```



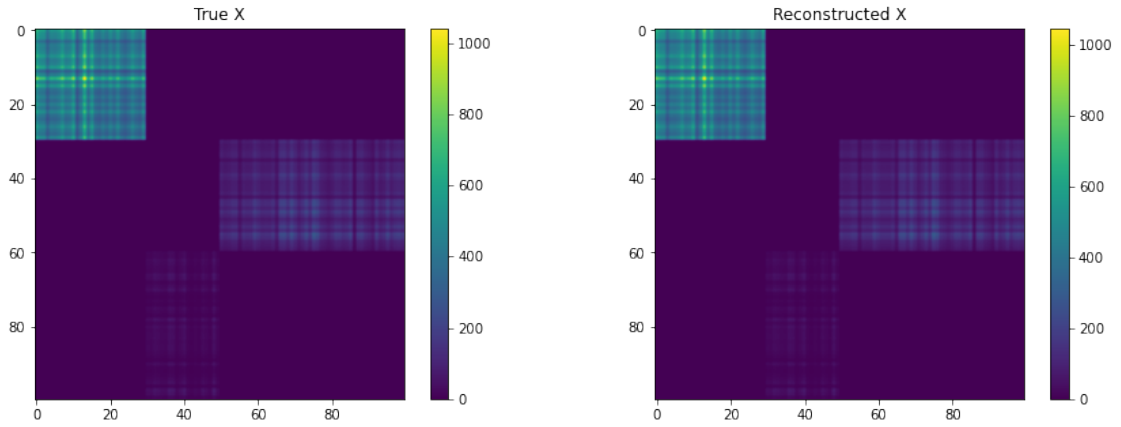
[60]:
```
fig, axes = plt.subplots(ncols=3, figsize=(15,5))
ax1, ax2, ax3 = axes
im1, im2, im3 = ax1.imshow(S_W, aspect="auto", interpolation='none'), ax2.
 ↪imshow(S_H, aspect="auto", interpolation='none')\
, ax3.imshow(S_W.dot(S_H), aspect="auto", interpolation="none")
ax1.title.set_text('true S^W (100 x 3)')
ax2.title.set_text('true S^H (3 x 100)')
```

```
ax3.title.set_text('S^W . S^H (100 x 100)')
plt.colorbar(im3, ax=ax3)
plt.show()
```

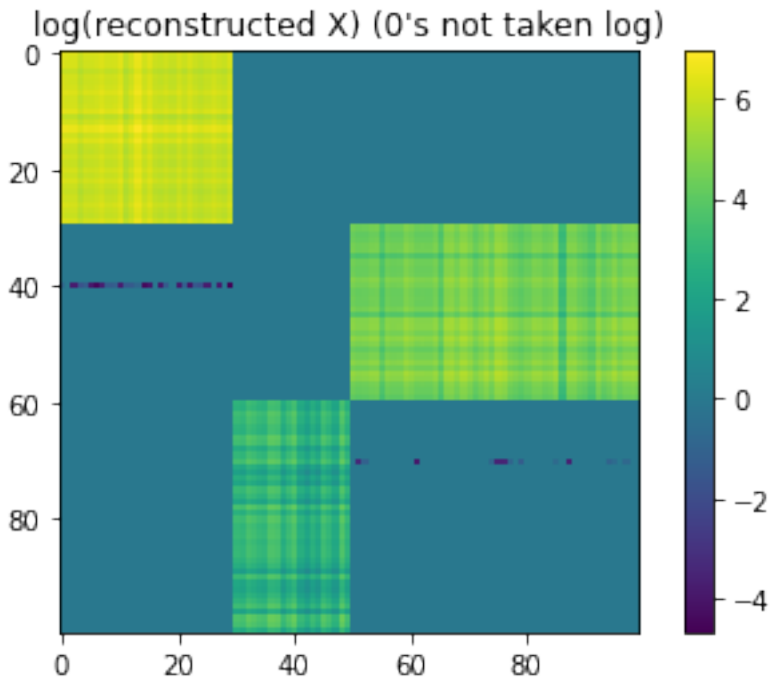


[61]:
```
W_post_mean5, H_post_mean5, X_post_mean5 = dssvi_fn.get_post_means(dssvi_run5)

dssvi_fn.draw_two_matrices(X, X_post_mean5, 1, 1, 'True X', 'Reconstructed X')
```



[105]:
```
X_post_mean5 = pd.DataFrame.from_records(X_post_mean5)
plt.imshow(np.log(X_post_mean5.replace(0, np.nan)).replace(np.nan, 0),␣
 ↪interpolation='none')
plt.colorbar()
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



1.5 Run 7: K=10, burn = 100, max_iter= 50

[62]:
```
dssvi_run7 = dssvi_fn.SSMF_BP_NMF(n_components=10, burn_in=100,␣
↪random_state=10, verbose=True, max_iter=50, cutoff=1e-2,
                                  a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run7.fit(X)
t7 = time.time() - start_t
```

```
SSMF-A iteration 0      good K:10:
        Gibbs burn-in: 100
SSMF-A iteration 1      good K:10:
        Gibbs burn-in: 100
SSMF-A iteration 2      good K:10:
        Gibbs burn-in: 100
SSMF-A iteration 3      good K:10:
        Gibbs burn-in: 100
SSMF-A iteration 4      good K:10:
        Gibbs burn-in: 100
SSMF-A iteration 5      good K:10:
        Gibbs burn-in: 100
SSMF-A iteration 6      good K:10:
```

```
        Gibbs burn-in: 100
SSMF-A iteration 7      good K:10:
        Gibbs burn-in: 100
SSMF-A iteration 8      good K:10:
        Gibbs burn-in: 100
SSMF-A iteration 9      good K:9:
        Gibbs burn-in: 100
SSMF-A iteration 10     good K:9:
        Gibbs burn-in: 100
SSMF-A iteration 11     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 12     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 13     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 14     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 15     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 16     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 17     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 18     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 19     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 20     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 21     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 22     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 23     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 24     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 25     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 26     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 27     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 28     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 29     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 30     good K:8:
```

```
        Gibbs burn-in: 100
SSMF-A iteration 31     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 32     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 33     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 34     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 35     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 36     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 37     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 38     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 39     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 40     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 41     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 42     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 43     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 44     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 45     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 46     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 47     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 48     good K:8:
        Gibbs burn-in: 100
SSMF-A iteration 49     good K:8:
        Gibbs burn-in: 100
```

[63]:
```
t7
```

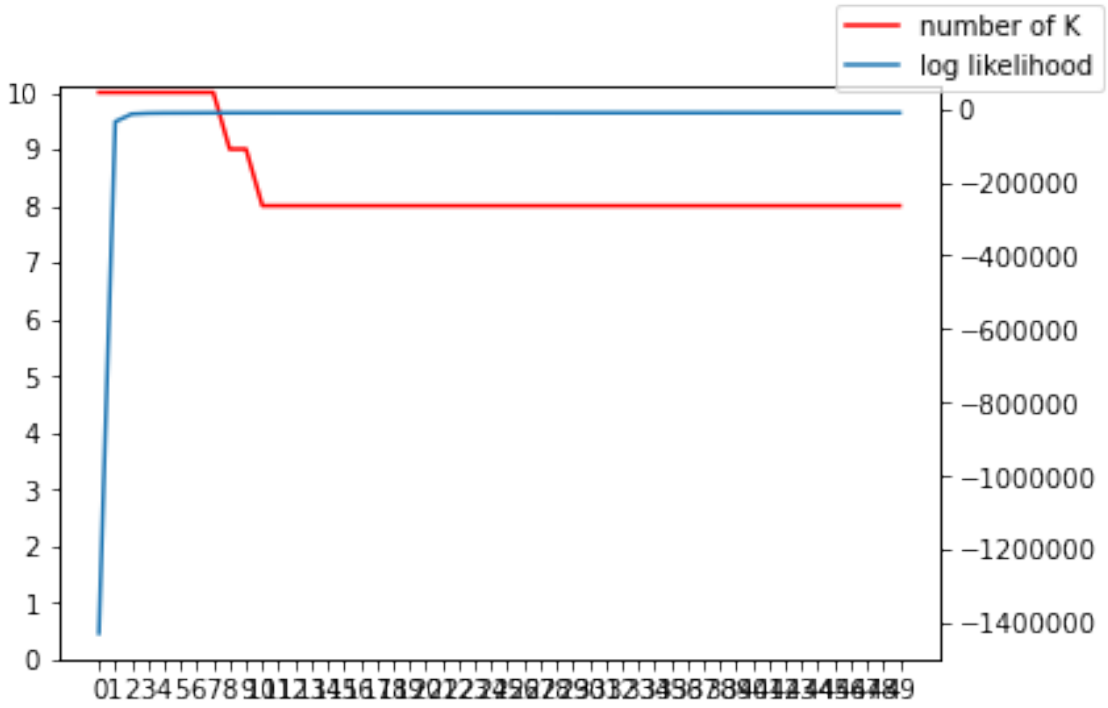
[63]:
```
445.0749204158783
```

[64]:
```
dssvi_run7.good_k
```

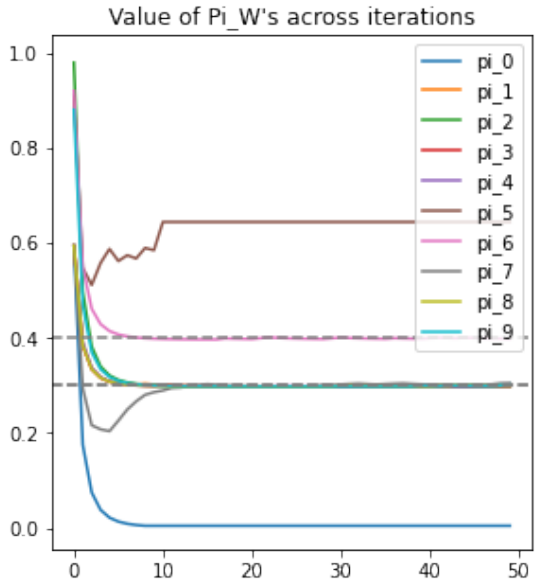
[64]:
```
array([1, 2, 3, 4, 6, 7, 8, 9])
```

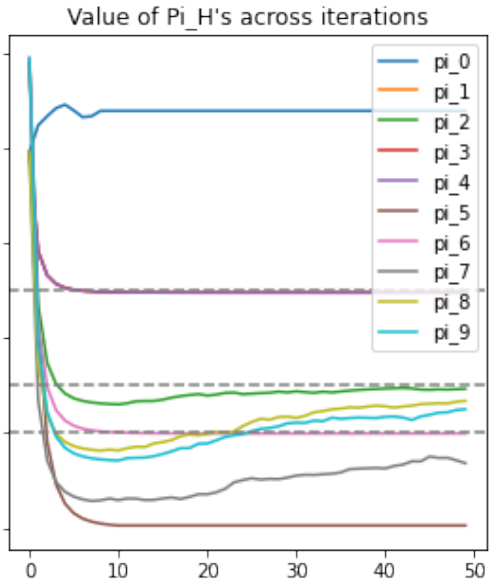
[65]:
```
K_and_log_ll(dssvi_run7, 100, 50)
```

```
[-1428623.348077554, -35593.311805709185, -14850.747504378356,
-12652.842142464362, -12054.977683904614, -11925.904131050891,
-11771.255609677799, -11591.223668898583, -11565.725233412684,
-11479.102735075921, -11482.829235583205, -11398.213509626843,
-11411.779442024817, -11396.882587696815, -11393.93074268351,
-11391.216308236717, -11394.266708766434, -11394.706675078685,
-11375.098341717508, -11370.458996604539, -11370.02300389421,
-11385.937226798565, -11385.836236494659, -11379.657480935124,
-11397.377072248393, -11379.19693845303, -11373.586306973993,
-11361.056734656251, -11432.252693231894, -11397.175446075988,
-11370.172058956183, -11379.873066126138, -11392.774879360284,
-11386.207702613488, -11407.926401127688, -11387.803491412966,
-11378.385168560375, -11371.569038577381, -11374.180634012768,
-11353.231490276432, -11376.022839825971, -11387.992930869015,
-11371.461708827499, -11401.880478187808, -11378.60789138459,
-11402.941226841169, -11368.580923989888, -11360.495365137447,
-11380.295761202851, -11371.564351569963]
```

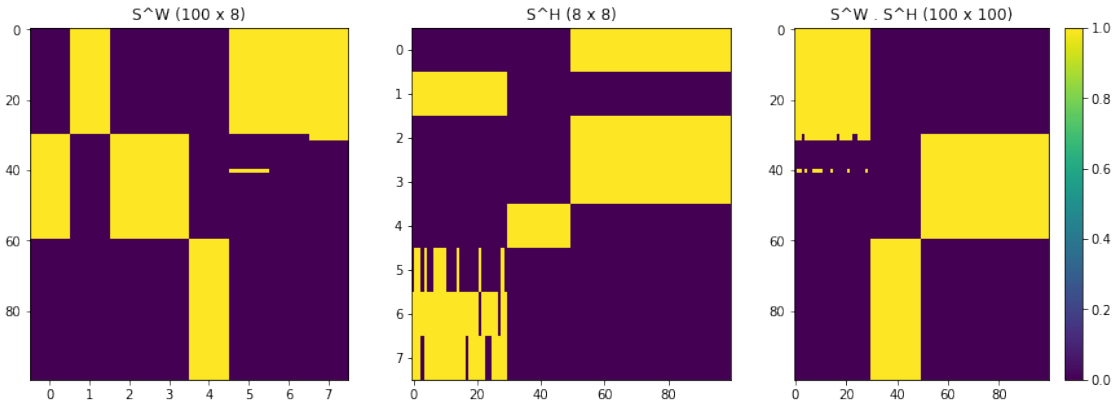


[66]:
```
plot_pi(dssvi_run7)
```



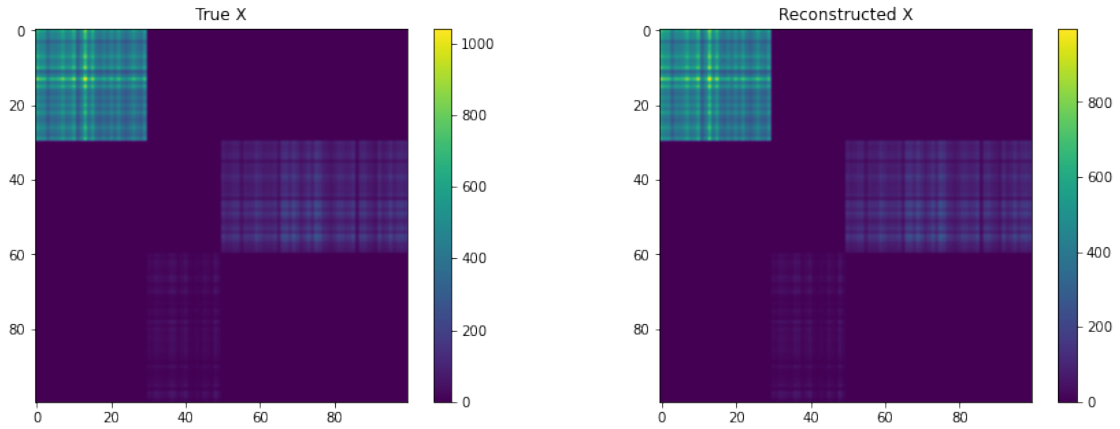


[67]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run7)
```

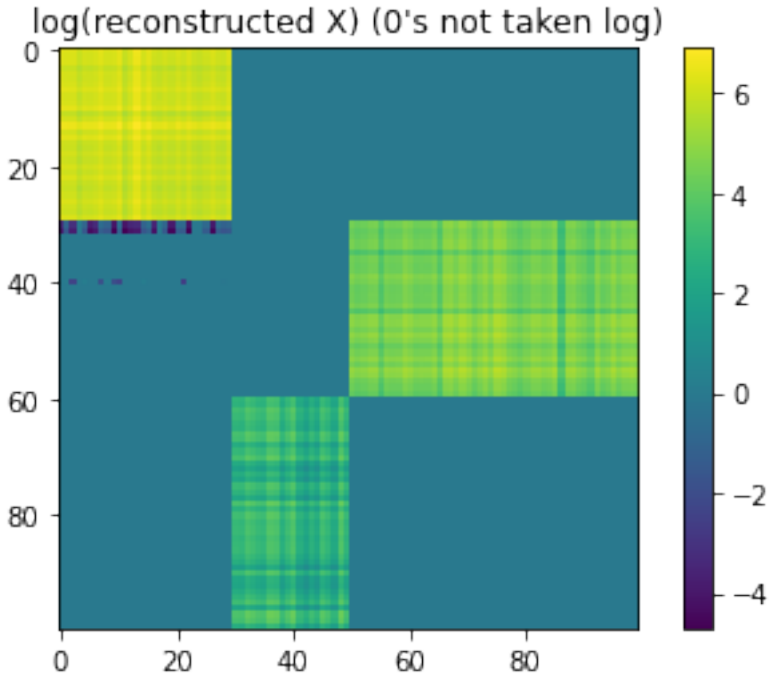


[68]:
```
W_post_mean7, H_post_mean7, X_post_mean7 = dssvi_fn.get_post_means(dssvi_run7)

dssvi_fn.draw_two_matrices(X, X_post_mean7, 1, 1, 'True X', 'Reconstructed X')
```



[104]:
```
X_post_mean7 = pd.DataFrame.from_records(X_post_mean7)
plt.imshow(np.log(X_post_mean7.replace(0, np.nan)).replace(np.nan, 0),␣
↪interpolation='none')
plt.colorbar()
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



1.6 Run 8: K =10, burn=50, max_iter=100

[69]:
```
dssvi_run8 = dssvi_fn.SSMF_BP_NMF(n_components=10, burn_in=50, random_state=10,␣
↪verbose=True, max_iter=100, cutoff=1e-2,
                                  a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run8.fit(X)
t8 = time.time() - start_t
```

```
SSMF-A iteration 0      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 1      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 2      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 3      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 4      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 5      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 6      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 7      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 8      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 9      good K:10:
        Gibbs burn-in: 50
SSMF-A iteration 10     good K:9:
        Gibbs burn-in: 50
SSMF-A iteration 11     good K:9:
        Gibbs burn-in: 50
SSMF-A iteration 12     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 13     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 14     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 15     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 16     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 17     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 18     good K:8:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 19     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 20     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 21     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 22     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 23     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 24     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 25     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 26     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 27     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 28     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 29     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 30     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 31     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 32     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 33     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 34     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 35     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 36     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 37     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 38     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 39     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 40     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 41     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 42     good K:8:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 43     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 44     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 45     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 46     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 47     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 48     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 49     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 50     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 51     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 52     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 53     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 54     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 55     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 56     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 57     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 58     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 59     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 60     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 61     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 62     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 63     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 64     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 65     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 66     good K:8:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 67     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 68     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 69     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 70     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 71     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 72     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 73     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 74     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 75     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 76     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 77     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 78     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 79     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 80     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 81     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 82     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 83     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 84     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 85     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 86     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 87     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 88     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 89     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 90     good K:8:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 91     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 92     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 93     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 94     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 95     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 96     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 97     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 98     good K:8:
        Gibbs burn-in: 50
SSMF-A iteration 99     good K:8:
        Gibbs burn-in: 50
```

[70]:
```
t8
```

[70]:
```
452.51365661621094
```

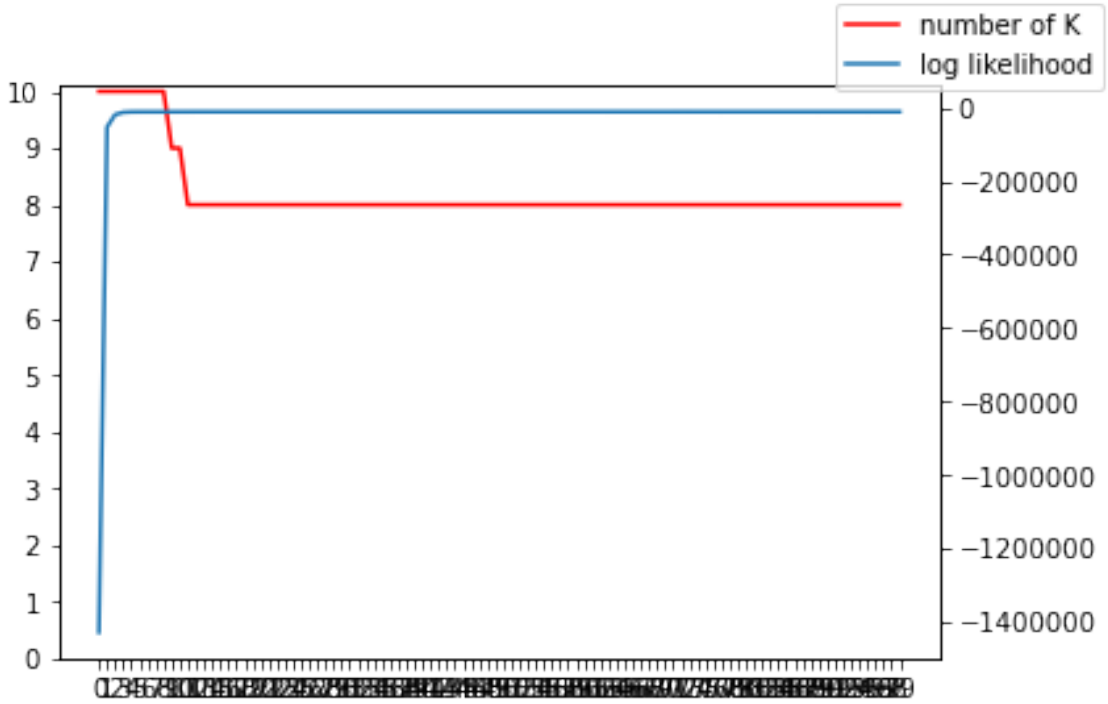
[71]:
```
dssvi_run8.good_k
```

[71]:
```
array([0, 1, 2, 3, 6, 7, 8, 9])
```

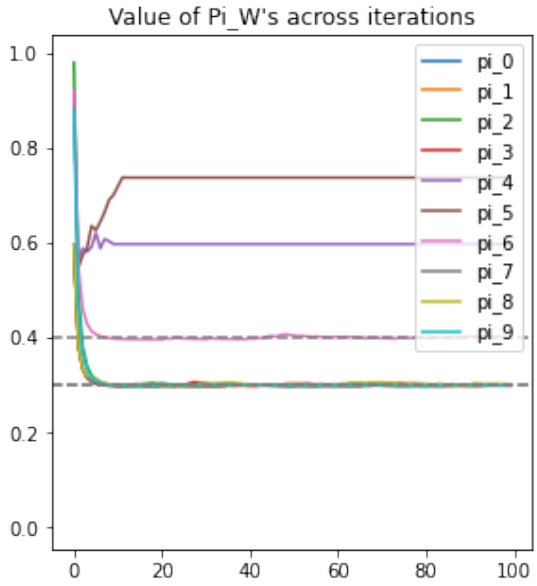
[72]:
```
K_and_log_ll(dssvi_run8, 50, 100)
```

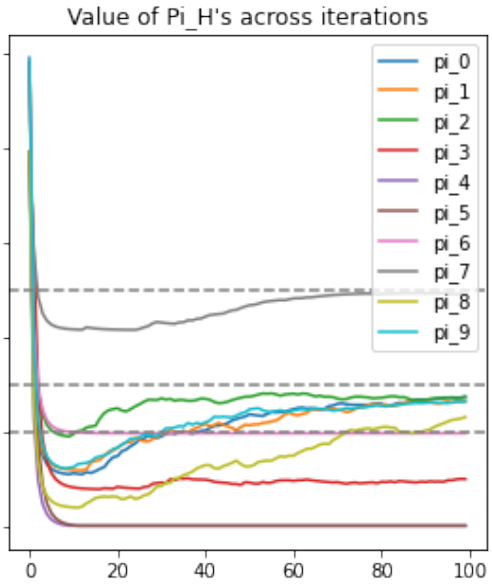
```
[-1428623.348077554, -53031.83471908225, -19198.723430477883,
-12788.87613836939, -11697.026787077579, -11530.849329025134,
-11511.09804520131, -11503.255640889867, -11491.81880147754,
-11453.806019340376, -11405.728445901428, -11370.564419818353,
-11301.08882555038, -11329.03183257621, -11318.638928420492,
-11296.106238867682, -11294.003753802033, -11291.391832244437,
-11324.995428876127, -11288.387514567268, -11315.54371319688,
-11302.31928793309, -11306.910073063968, -11302.05374535164,
-11318.386275184588, -11290.526006477421, -11301.187881227497,
-11298.936160315236, -11324.417216965016, -11311.939832264623,
-11323.996498222708, -11293.711125179194, -11330.979559336593,
-11320.256768545863, -11317.698204982316, -11333.763065221106,
-11313.440890369675, -11303.460174034832, -11307.1447839247,
-11295.963069746957, -11308.20617274677, -11295.109304815485,
-11296.722059190177, -11295.12129359343, -11312.820359421417,
-11315.86276548556, -11298.87744636344, -11308.994648898704, -11325.62098792596,
-11302.633815554937, -11306.78988978581, -11336.43800362196,
-11310.839599599121, -11324.966130597604, -11292.002660640826,
```

```
-11297.494731036475, -11317.9830365652, -11315.796546778387, -11318.39340625538,
-11319.632363375884, -11296.30135785685, -11316.031939296718,
-11315.12535807364, -11340.076411530456, -11300.902664593104,
-11314.881102024918, -11315.970332096262, -11297.875686563362,
-11328.355579362673, -11329.293623372454, -11312.66332612067,
-11322.54616771053, -11279.745445973145, -11307.674290941823,
-11307.039152380326, -11329.764864587838, -11307.309480680944,
-11348.104761040886, -11332.914387176355, -11327.528693693004,
-11322.6263166285, -11326.933217333906, -11323.535998608775,
-11306.382799244384, -11318.719324883701, -11331.613765653256,
-11325.79338107605, -11319.251808180514, -11322.020785070346,
-11340.878762835608, -11307.13335319969, -11326.029238555837,
-11325.204476722682, -11319.08116889412, -11329.919428812856,
-11347.693889285802, -11318.172297269633, -11338.283881958014,
-11313.735559909854, -11326.838886785474]
```

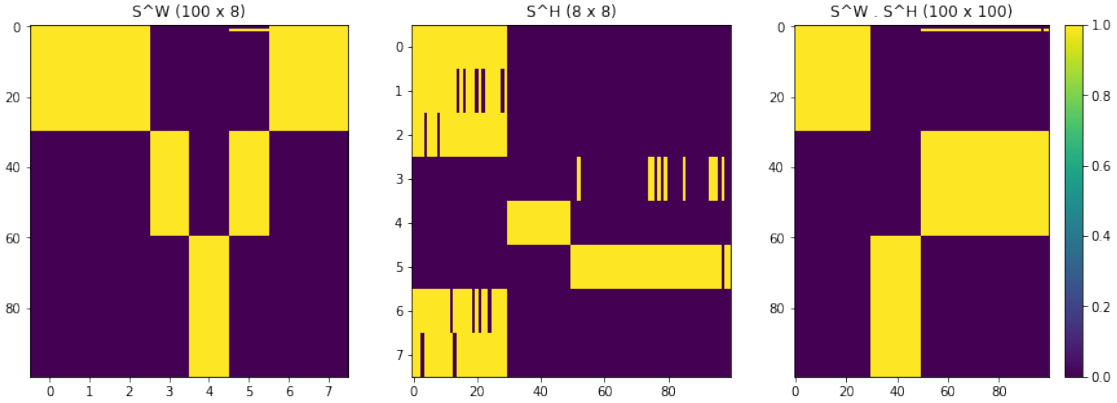


[73]:
```
plot_pi(dssvi_run8)
```



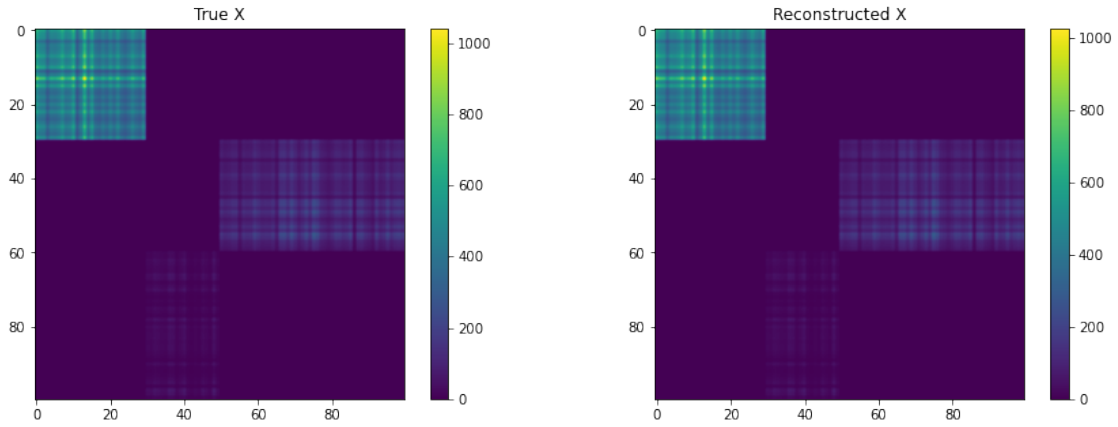


[74]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run8)
```

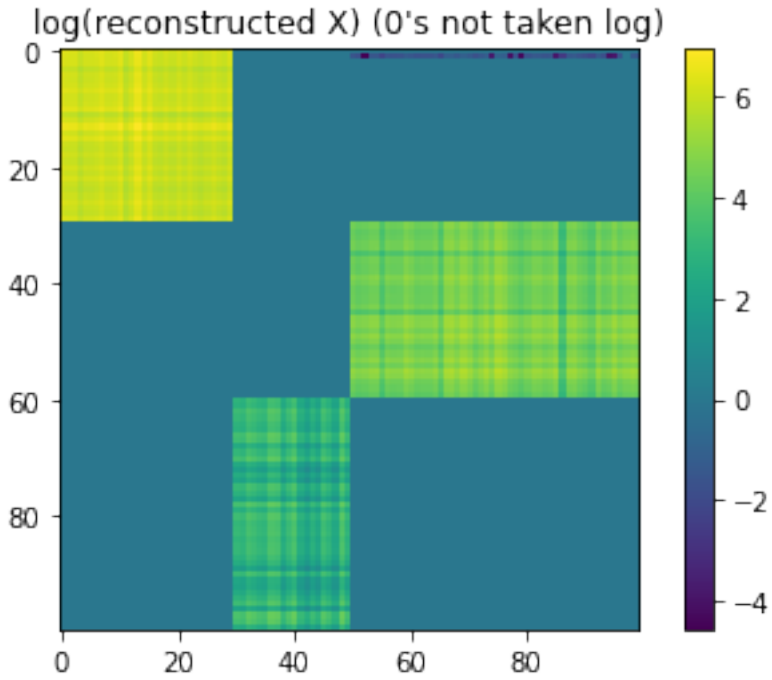


[75]:
```
W_post_mean8, H_post_mean8, X_post_mean8 = dssvi_fn.get_post_means(dssvi_run8)

dssvi_fn.draw_two_matrices(X, X_post_mean8, 1, 1, 'True X', 'Reconstructed X')
```



[103]:
```
X_post_mean8 = pd.DataFrame.from_records(X_post_mean8)
plt.imshow(np.log(X_post_mean8.replace(0, np.nan)).replace(np.nan, 0),␣
 ↪interpolation='none')
plt.colorbar()
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



1.7 K = 20, burn = 50, max_iter = 50

[76]:
```
dssvi_run6 = dssvi_fn.SSMF_BP_NMF(n_components=20, burn_in=50, random_state=10,␣
↪verbose=True, max_iter=50, cutoff=1e-2,
                                  a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run6.fit(X)
t6 = time.time() - start_t
```

```
SSMF-A iteration 0      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 1      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 2      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 3      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 4      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 5      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 6      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 7      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 8      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 9      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 10     good K:17:
        Gibbs burn-in: 50
SSMF-A iteration 11     good K:17:
        Gibbs burn-in: 50
SSMF-A iteration 12     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 13     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 14     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 15     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 16     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 17     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 18     good K:15:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 19     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 20     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 21     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 22     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 23     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 24     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 25     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 26     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 27     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 28     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 29     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 30     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 31     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 32     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 33     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 34     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 35     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 36     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 37     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 38     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 39     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 40     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 41     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 42     good K:15:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 43     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 44     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 45     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 46     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 47     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 48     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 49     good K:15:
        Gibbs burn-in: 50
```

[77]:
```
t6
```

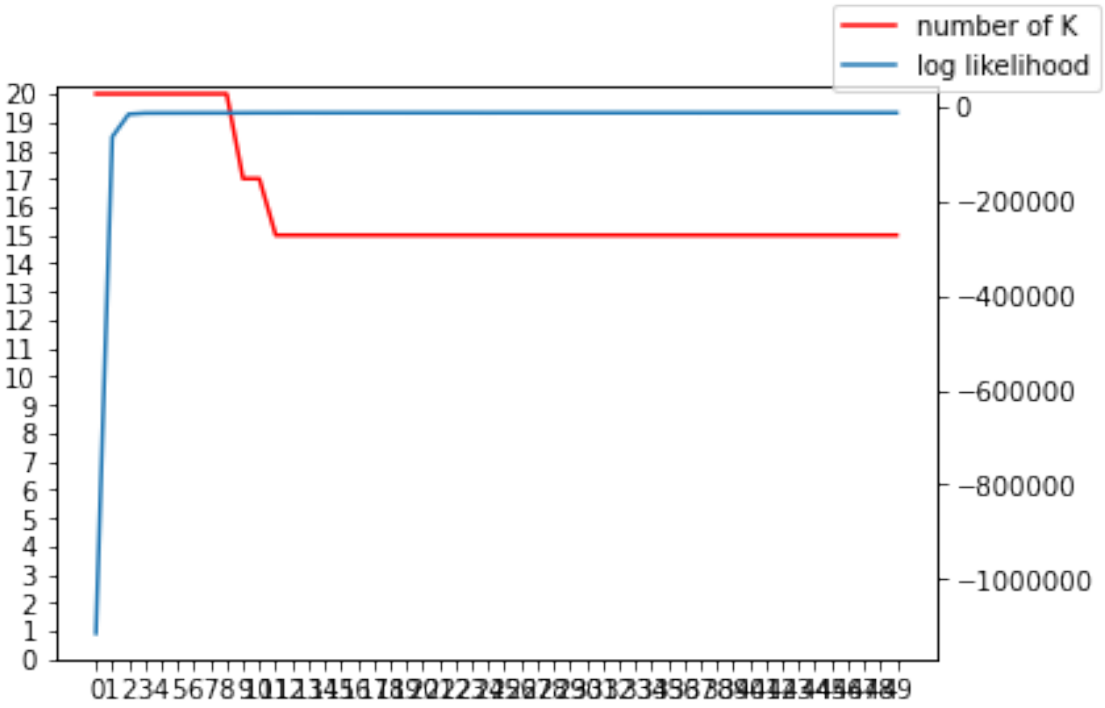
[77]:
```
391.66060400009155
```

[78]:
```
dssvi_run6.good_k
```

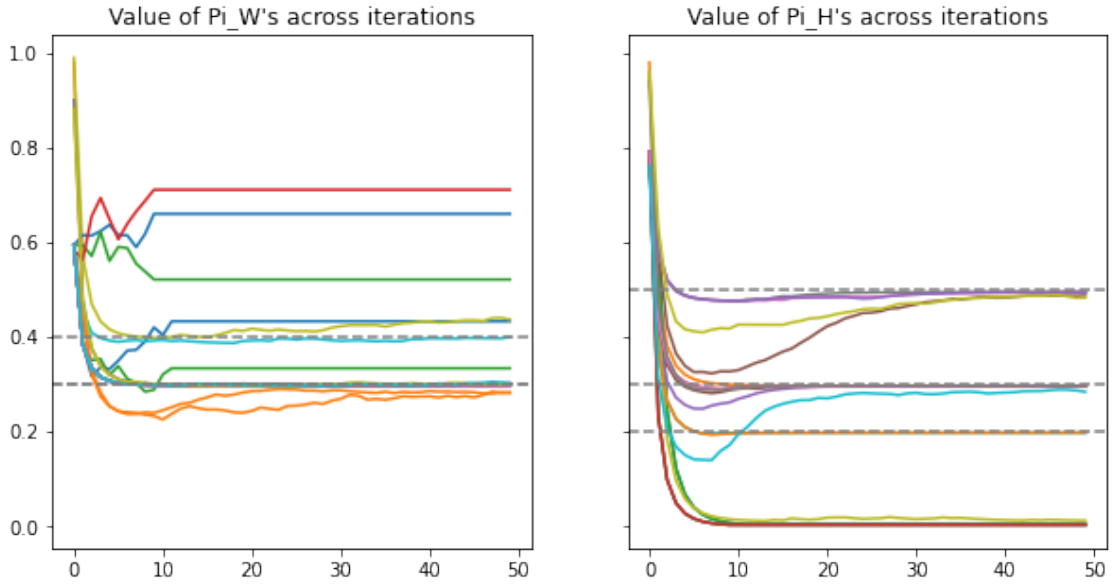
[78]:
```
array([ 1,  3,  4,  5,  6,  7,  8,  9, 11, 14, 15, 16, 17, 18, 19])
```

[79]:
```
K_and_log_ll(dssvi_run6, 50, 50)
```

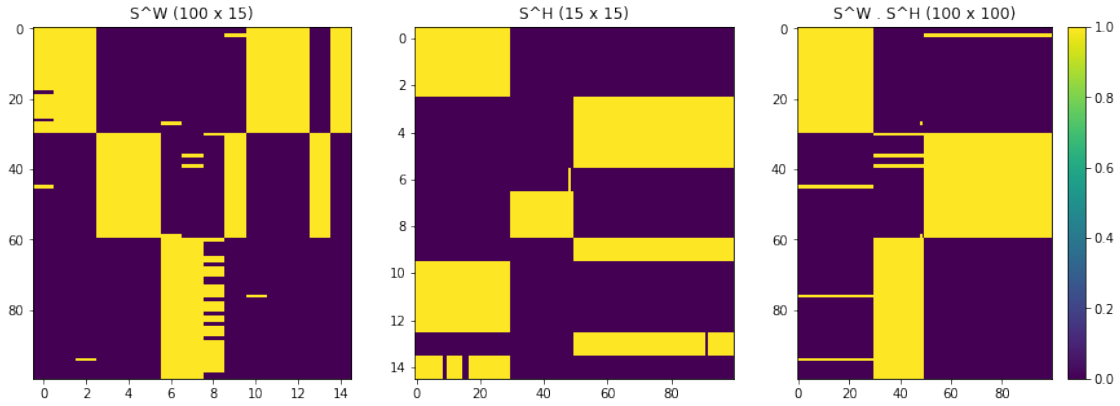
```
[-1114876.983751481, -63197.26355503041, -15386.45227999154, -12990.07755311271,
-12836.226983680413, -12768.617533565775, -12707.783622397616,
-12656.943615197826, -12643.5813264265, -12602.008223958504,
-12448.324821651076, -12446.88428554658, -12315.085690322803,
-12294.164714027605, -12327.724468389424, -12303.214053331765,
-12295.567742845175, -12299.978776378353, -12289.356620827155,
-12312.50118637966, -12280.056399041365, -12287.413835926314,
-12277.288395718342, -12301.381604461842, -12325.70086017958,
-12279.988583307402, -12278.729843663825, -12261.987380222683,
-12288.53852317285, -12296.427130938679, -12285.844609085672,
-12289.773939479204, -12288.135154014093, -12277.747591475792,
-12260.721277932555, -12282.315135804598, -12262.55127232295,
-12306.669956743219, -12269.31351562593, -12269.100587798812,
-12259.716077931515, -12271.625418264877, -12288.1766629993,
-12268.776276136585, -12268.158455240895, -12260.565588129277,
-12290.867095388665, -12266.575671119715, -12269.577241578409,
-12255.941911533206]
```



[80]:
```
plot_pi(dssvi_run6, label=False)
```

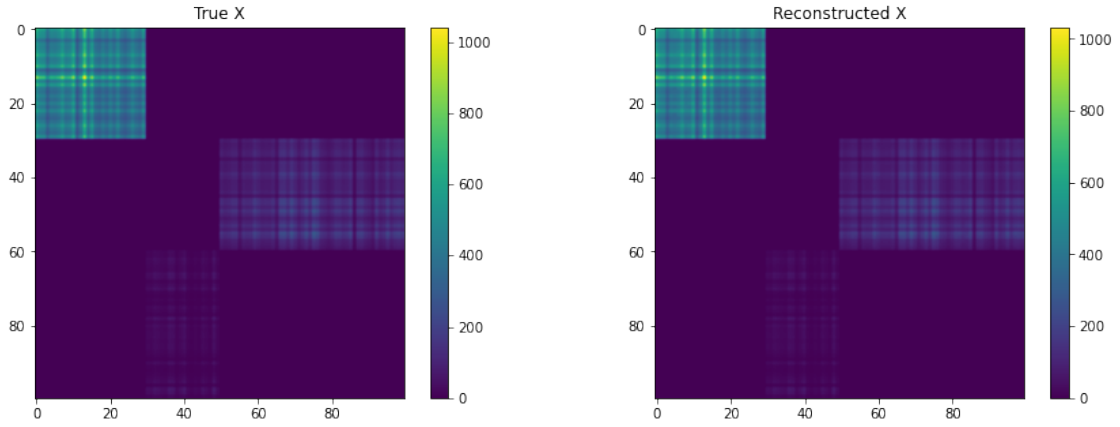


[81]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run6)
```

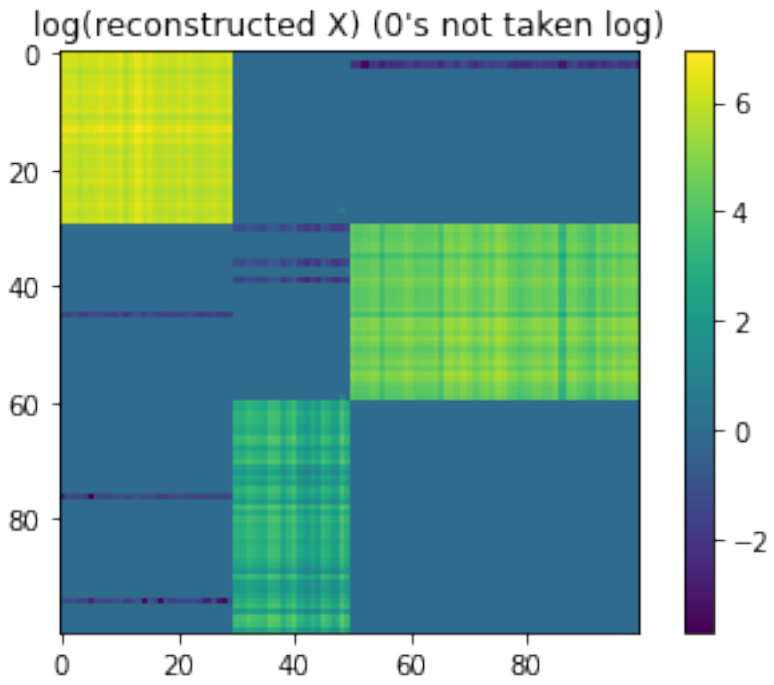


[82]:
```
W_post_mean6, H_post_mean6, X_post_mean6 = dssvi_fn.get_post_means(dssvi_run6)

dssvi_fn.draw_two_matrices(X, X_post_mean6, 1, 1, 'True X', 'Reconstructed X')
```



[102]:
```
X_post_mean6 = pd.DataFrame.from_records(X_post_mean6)
plt.imshow(np.log(X_post_mean6.replace(0, np.nan)).replace(np.nan, 0),␣
 ↪interpolation='none')
plt.colorbar()
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



1.8 K = 20, burn=100, max_iter=50

[83]:
```
dssvi_run9 = dssvi_fn.SSMF_BP_NMF(n_components=20, burn_in=100,␣
↪random_state=10, verbose=True, max_iter=50, cutoff=1e-2,
                                  a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run9.fit(X)
t9 = time.time() - start_t
```

```
SSMF-A iteration 0      good K:20:
        Gibbs burn-in: 100
SSMF-A iteration 1      good K:20:
        Gibbs burn-in: 100
SSMF-A iteration 2      good K:20:
        Gibbs burn-in: 100
SSMF-A iteration 3      good K:20:
        Gibbs burn-in: 100
SSMF-A iteration 4      good K:20:
        Gibbs burn-in: 100
SSMF-A iteration 5      good K:20:
        Gibbs burn-in: 100
SSMF-A iteration 6      good K:20:
```

```
        Gibbs burn-in: 100
SSMF-A iteration 7      good K:20:
        Gibbs burn-in: 100
SSMF-A iteration 8      good K:20:
        Gibbs burn-in: 100
SSMF-A iteration 9      good K:15:
        Gibbs burn-in: 100
SSMF-A iteration 10     good K:15:
        Gibbs burn-in: 100
SSMF-A iteration 11     good K:15:
        Gibbs burn-in: 100
SSMF-A iteration 12     good K:14:
        Gibbs burn-in: 100
SSMF-A iteration 13     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 14     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 15     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 16     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 17     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 18     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 19     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 20     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 21     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 22     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 23     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 24     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 25     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 26     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 27     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 28     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 29     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 30     good K:13:
```

```
        Gibbs burn-in: 100
SSMF-A iteration 31     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 32     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 33     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 34     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 35     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 36     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 37     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 38     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 39     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 40     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 41     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 42     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 43     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 44     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 45     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 46     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 47     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 48     good K:13:
        Gibbs burn-in: 100
SSMF-A iteration 49     good K:13:
        Gibbs burn-in: 100
```

[84]:
```
t9
```

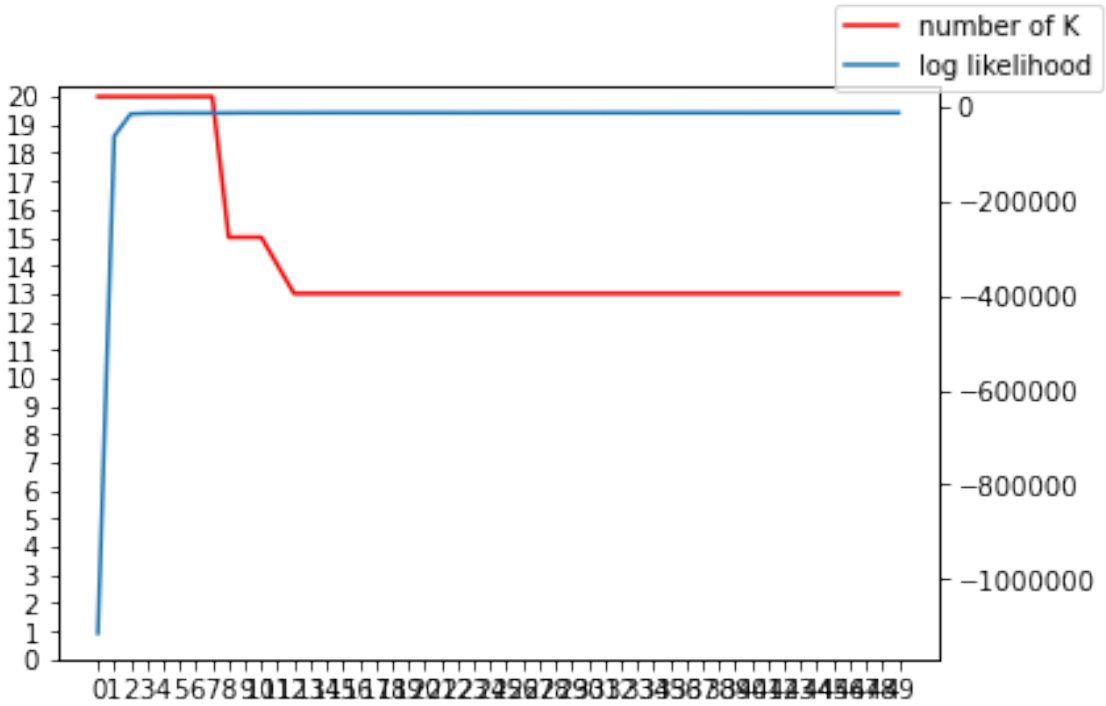
[84]:
```
720.0963819026947
```

[85]:
```
dssvi_run9.good_k
```

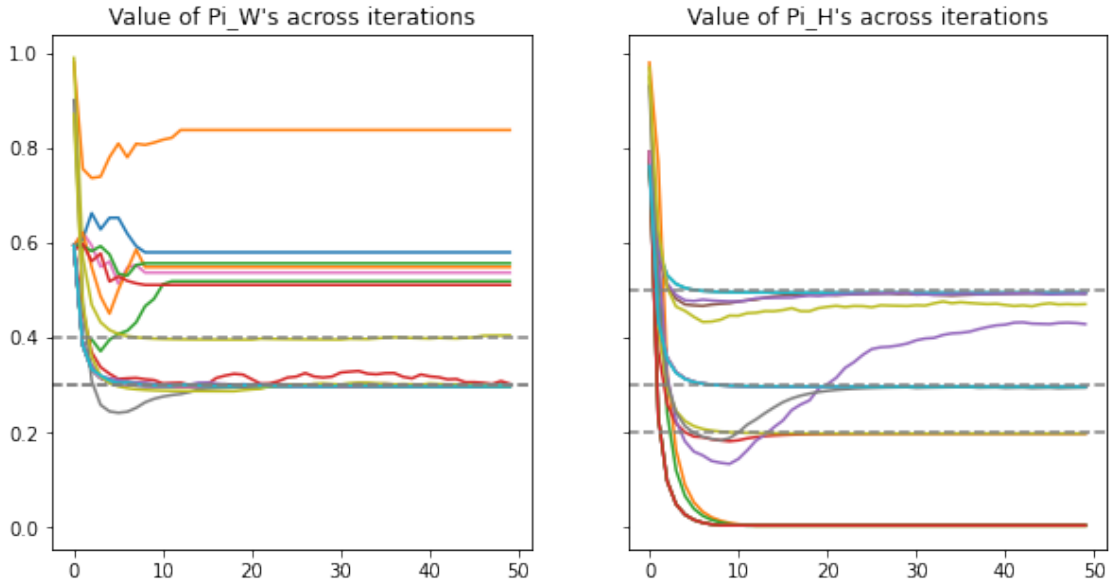
[85]:
```
array([ 0,  3,  4,  5,  7,  8,  9, 14, 15, 16, 17, 18, 19])
```

[87]:
```
K_and_log_ll(dssvi_run9, 100, 50)
```

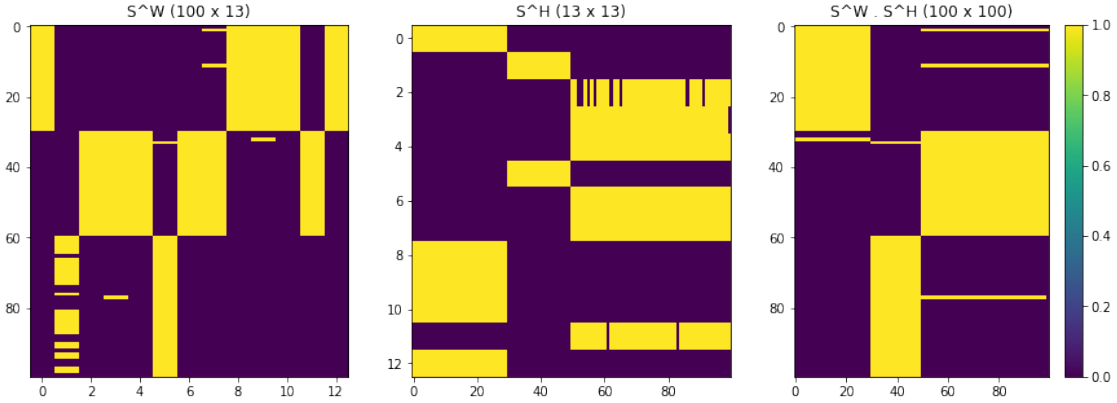
```
[-1114876.1586504786, -61376.539459310596, -14523.931474156747,
-13088.599662141522, -12837.094250935086, -12742.174107859264,
-12730.44000962798, -12641.738564237628, -12609.79955635812,
-12234.487017706242, -12225.48787916084, -12204.661028837452,
-12135.301711192424, -12064.071752770727, -12054.769562602054,
-12070.201163157133, -12059.634925911962, -12061.179053790573,
-12052.806238966734, -12084.636310715272, -12051.238073497494,
-12052.454158038163, -12074.682701688082, -12068.278836004229,
-12046.292629854963, -12061.500683491255, -12059.880397675384,
-12029.049859574763, -12059.173610508144, -12060.37483831762,
-12033.251904209963, -12083.675775277856, -12054.784898299706,
-12069.598515561234, -12028.238699699668, -12053.164607350287,
-12043.307353296668, -12051.48682968192, -12055.324405037554,
-12028.383664329527, -12076.626465125353, -12049.712221658021,
-12025.71809174355, -12052.776138636624, -12026.558453544087,
-12039.914095155316, -12037.054248738585, -12017.44521621172,
-12053.83882374272, -12064.373753643269]
```



[88]:
```
plot_pi(dssvi_run9, label=False)
```

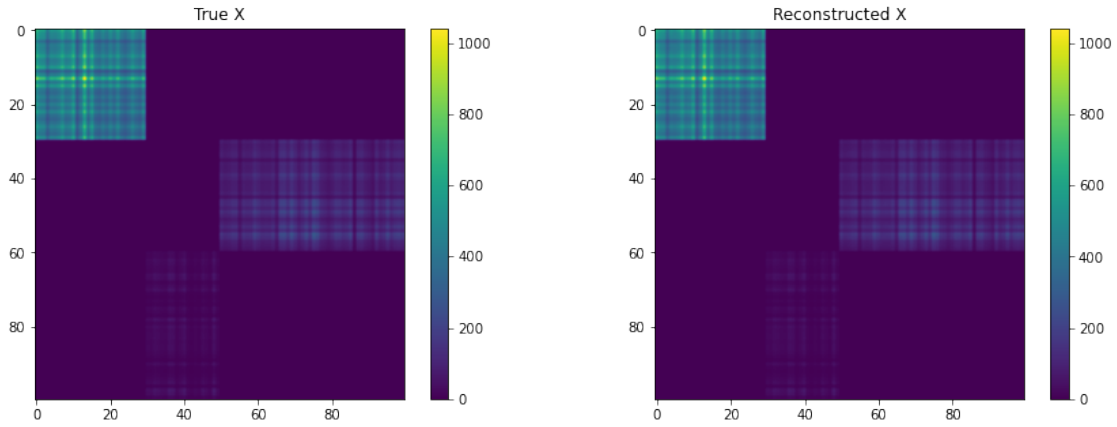


[89]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run9)
```

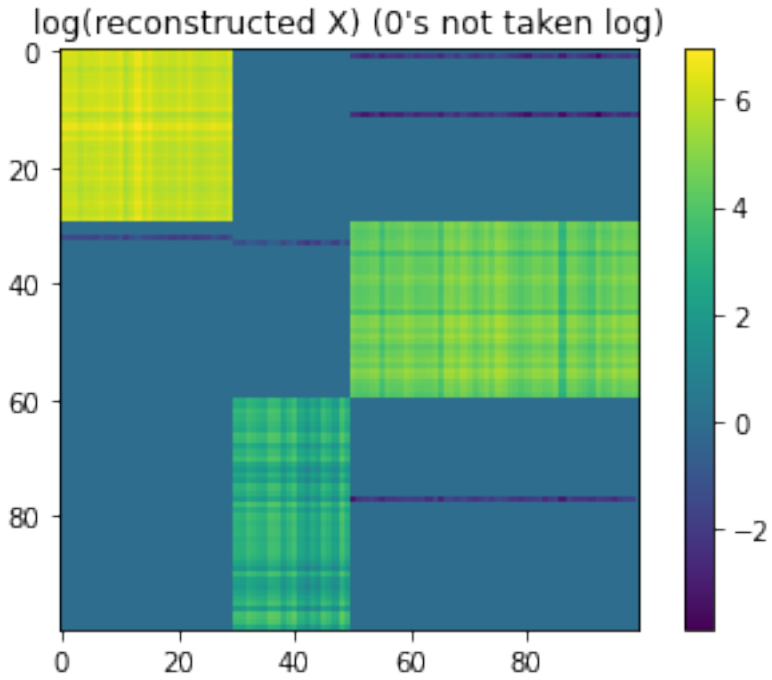


[90]:
```
W_post_mean9, H_post_mean9, X_post_mean9 = dssvi_fn.get_post_means(dssvi_run9)

dssvi_fn.draw_two_matrices(X, X_post_mean9, 1, 1, 'True X', 'Reconstructed X')
```



[101]:
```
X_post_mean9 = pd.DataFrame.from_records(X_post_mean9)
plt.imshow(np.log(X_post_mean9.replace(0, np.nan)).replace(np.nan, 0),␣
↪interpolation='none')
plt.colorbar()
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



1.9 K = 20, burn=50, max_iter = 100

[91]:
```
dssvi_run10 = dssvi_fn.SSMF_BP_NMF(n_components=20, burn_in=50,␣
↪random_state=10, verbose=True, max_iter=100, cutoff=1e-2,
                                   a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run10.fit(X)
t10 = time.time() - start_t
```

```
SSMF-A iteration 0      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 1      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 2      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 3      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 4      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 5      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 6      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 7      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 8      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 9      good K:20:
        Gibbs burn-in: 50
SSMF-A iteration 10     good K:17:
        Gibbs burn-in: 50
SSMF-A iteration 11     good K:17:
        Gibbs burn-in: 50
SSMF-A iteration 12     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 13     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 14     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 15     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 16     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 17     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 18     good K:15:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 19     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 20     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 21     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 22     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 23     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 24     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 25     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 26     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 27     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 28     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 29     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 30     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 31     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 32     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 33     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 34     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 35     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 36     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 37     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 38     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 39     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 40     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 41     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 42     good K:15:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 43     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 44     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 45     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 46     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 47     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 48     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 49     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 50     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 51     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 52     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 53     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 54     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 55     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 56     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 57     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 58     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 59     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 60     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 61     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 62     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 63     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 64     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 65     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 66     good K:15:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 67     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 68     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 69     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 70     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 71     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 72     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 73     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 74     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 75     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 76     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 77     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 78     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 79     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 80     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 81     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 82     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 83     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 84     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 85     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 86     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 87     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 88     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 89     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 90     good K:15:
```

```
        Gibbs burn-in: 50
SSMF-A iteration 91     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 92     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 93     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 94     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 95     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 96     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 97     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 98     good K:15:
        Gibbs burn-in: 50
SSMF-A iteration 99     good K:15:
        Gibbs burn-in: 50
```

[92]:
```
t10
```

[92]:
```
758.6015729904175
```

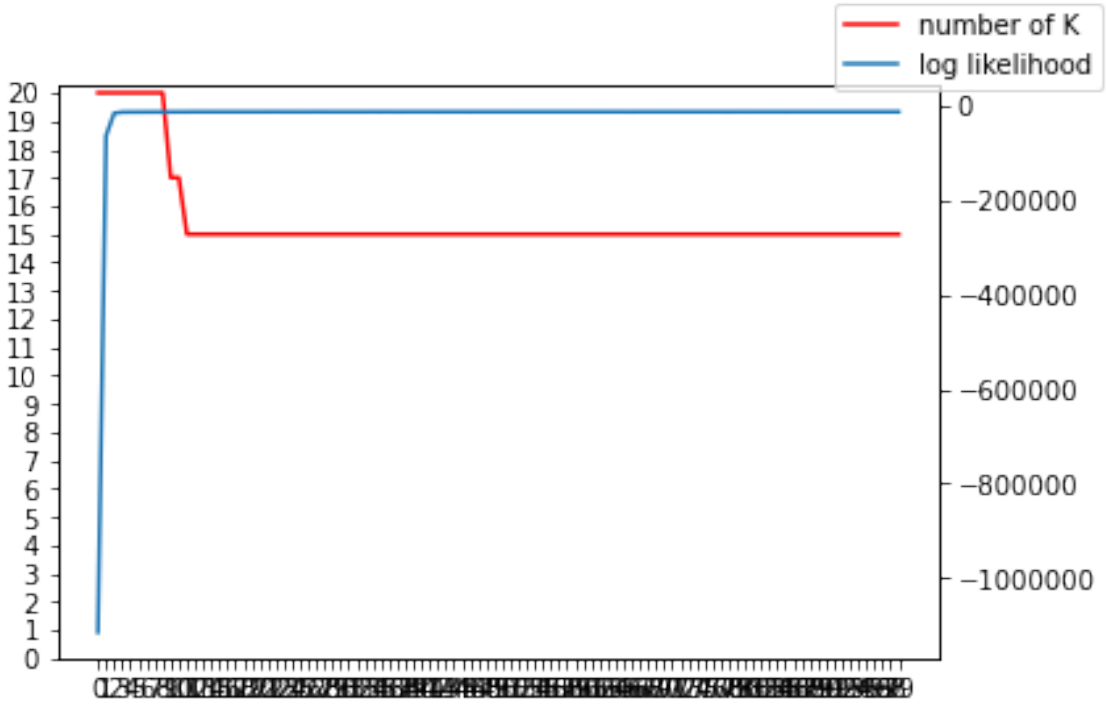
[93]:
```
dssvi_run10.good_k
```

[93]:
```
array([ 1,  3,  4,  5,  6,  7,  8,  9, 11, 14, 15, 16, 17, 18, 19])
```

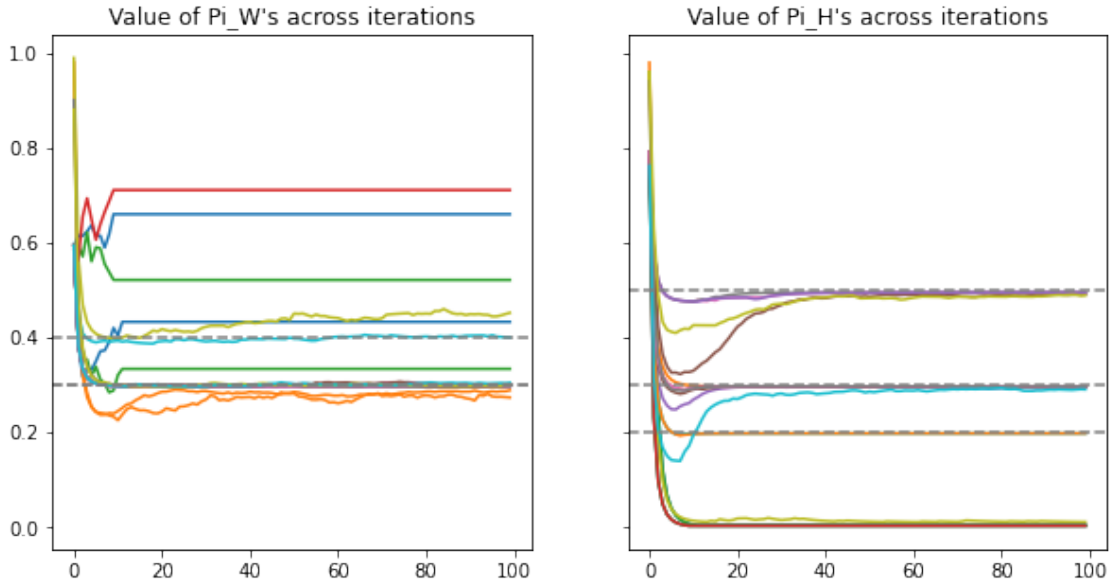
[94]:
```
K_and_log_ll(dssvi_run10, 50, 100)
```

```
[-1114876.983751481, -63197.26355503041, -15386.45227999154, -12990.07755311271,
-12836.226983680413, -12768.617533565775, -12707.783622397616,
-12656.943615197826, -12643.5813264265, -12602.008223958504,
-12448.324821651076, -12446.88428554658, -12315.085690322803,
-12294.164714027605, -12327.724468389424, -12303.214053331765,
-12295.567742845175, -12299.978776378353, -12289.356620827155,
-12312.50118637966, -12280.056399041365, -12287.413835926314,
-12277.288395718342, -12301.381604461842, -12325.70086017958,
-12279.988583307402, -12278.729843663825, -12261.987380222683,
-12288.53852317285, -12296.427130938679, -12285.844609085672,
-12289.773939479204, -12288.135154014093, -12277.747591475792,
-12260.721277932555, -12282.315135804598, -12262.55127232295,
-12306.669956743219, -12269.31351562593, -12269.100587798812,
-12259.716077931515, -12271.625418264877, -12288.1766629993,
-12268.776276136585, -12268.158455240895, -12260.565588129277,
-12290.867095388665, -12266.575671119715, -12269.577241578409,
-12255.941911533206, -12268.303206320841, -12269.384646445507,
-12247.349246106034, -12262.88723343311, -12251.175131279826,
```

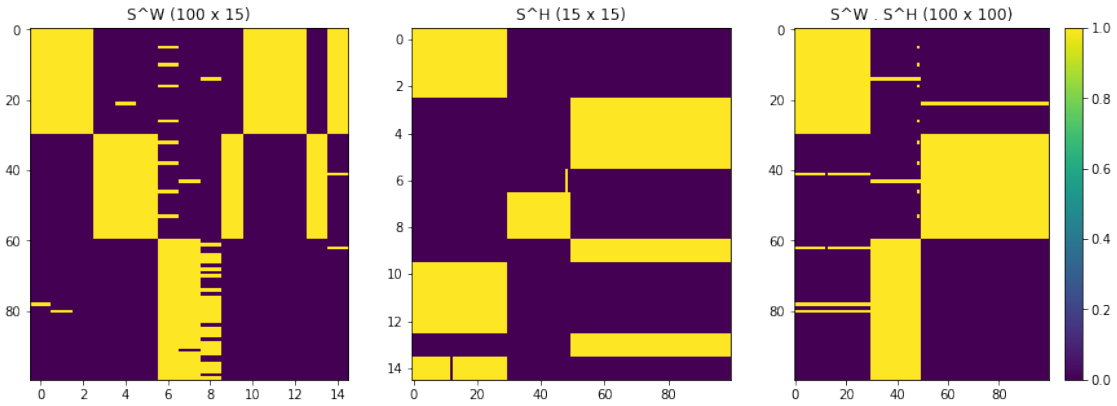
```
-12276.80399166911, -12251.277955675316, -12246.702261713262,
-12250.812613063445, -12254.195483332673, -12264.590357206887,
-12270.371031556435, -12253.410071260429, -12246.416391657667,
-12264.906593085658, -12278.515680771356, -12280.207070536913,
-12250.051098328648, -12267.247603519896, -12265.374203257252,
-12252.396747923996, -12277.126825736534, -12267.619517724914,
-12256.771549100786, -12269.581539283092, -12259.645858745955,
-12290.665155322211, -12253.452623884627, -12301.567128144363,
-12247.088678965183, -12230.96626050696, -12242.25358184581, -12257.68089293858,
-12245.362650621448, -12243.150432715713, -12284.92910843033,
-12276.166624015686, -12276.086153008895, -12273.672056228277,
-12258.840977316095, -12252.764606000217, -12269.212923500054,
-12242.634101225482, -12242.17864735025, -12262.49249877956, -12275.43125759339,
-12265.447611165977, -12268.485086509343, -12263.318907763234,
-12239.153749787049]
```



[95]:
```
plot_pi(dssvi_run10, label=False)
```

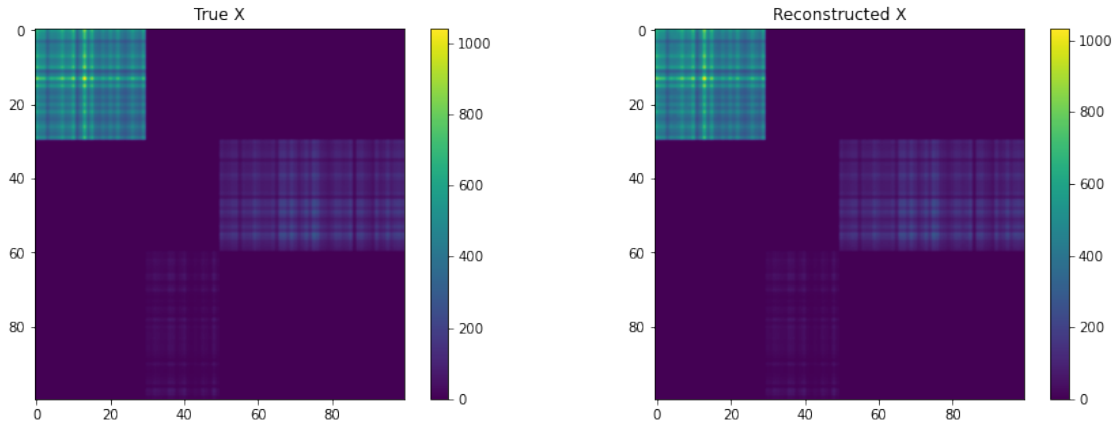


[96]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run10)
```

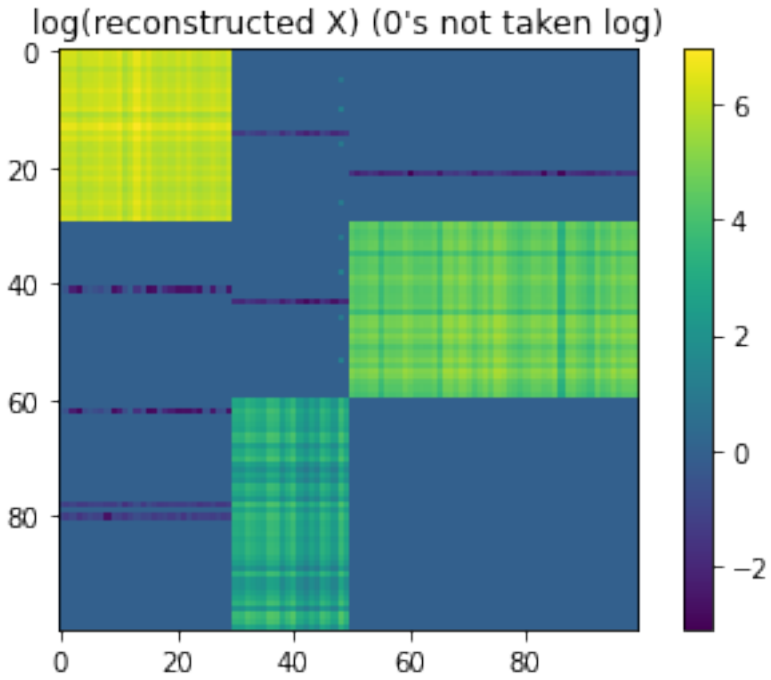


[97]:
```
W_post_mean10, H_post_mean10, X_post_mean10 = dssvi_fn.
 ↪get_post_means(dssvi_run10)

dssvi_fn.draw_two_matrices(X, X_post_mean10, 1, 1, 'True X', 'Reconstructed X')
```



[100]:
```
X_post_mean10 = pd.DataFrame.from_records(X_post_mean10)
plt.imshow(np.log(X_post_mean10.replace(0, np.nan)).replace(np.nan, 0),␣
 ↪interpolation='none')
plt.colorbar()
plt.title("log(reconstructed X) (0's not taken log)")
plt.show()
```



2 K = 100, burn=200, max_iter=200

[ ]:
```
dssvi_run11 = dssvi_fn.SSMF_BP_NMF(n_components=100, burn_in=200,␣
↪random_state=10, verbose=True, max_iter=200, cutoff=1e-2,
                                a=1, b=1, c=5, d=5, a0_W=1, b0_W=1, a0_H=1,␣
↪b0_H=1)

start_t = time.time()
dssvi_run11.fit(X)
t11 = time.time() - start_t
```

[ ]:
```
t11
```

[ ]:
```
dssvi_run11.good_k
```

[ ]:
```
K_and_log_ll(dssvi_run6, 200, 200)
```

[ ]:
```
plot_pi(dssvi_run11, label=False)
```

[ ]:
```
dssvi_fn.draw_S_H_S_W(dssvi_run11)
```

[ ]:
```
W_post_mean11, H_post_mean11, X_post_mean11 = dssvi_fn.
↪get_post_means(dssvi_run11)

dssvi_fn.draw_two_matrices(X, X_post_mean11, 1, 1, 'True X', 'Reconstructed X')
```