Part 1

For the Julesz Ensemble, I used the following filter bank consisting of 49 filters.

- dirac delta

- 1D gradient filters as provided in the script

- Gaussian filters with $\sigma = 0.5, 1, 1.5, 2, 2.5, 3$

- 3 * 3 Laplacian

- log filters as provided in the script

- gabor filters of size 3, 7, 15 with orientations 0, 30, 60, 90, 120, 150

I used the weights $[8, 7, 6, 5, 4, 3, 2, 1, 2, 3, 4, 5, 6, 7, 8]$.

1. Fur

I used a initial temperature $T = 0.1$ and decay rate 0.96. The maximum iteration number is 50. The selected filter indices are $[3, 6, 27, 31, 35, 5, 13, 4, 46, 16, 41, 19, 37, 24, 33, 18, 47, 22, 40, 25]$ before reaching an error smaller than 200. The first several filters used are as following.
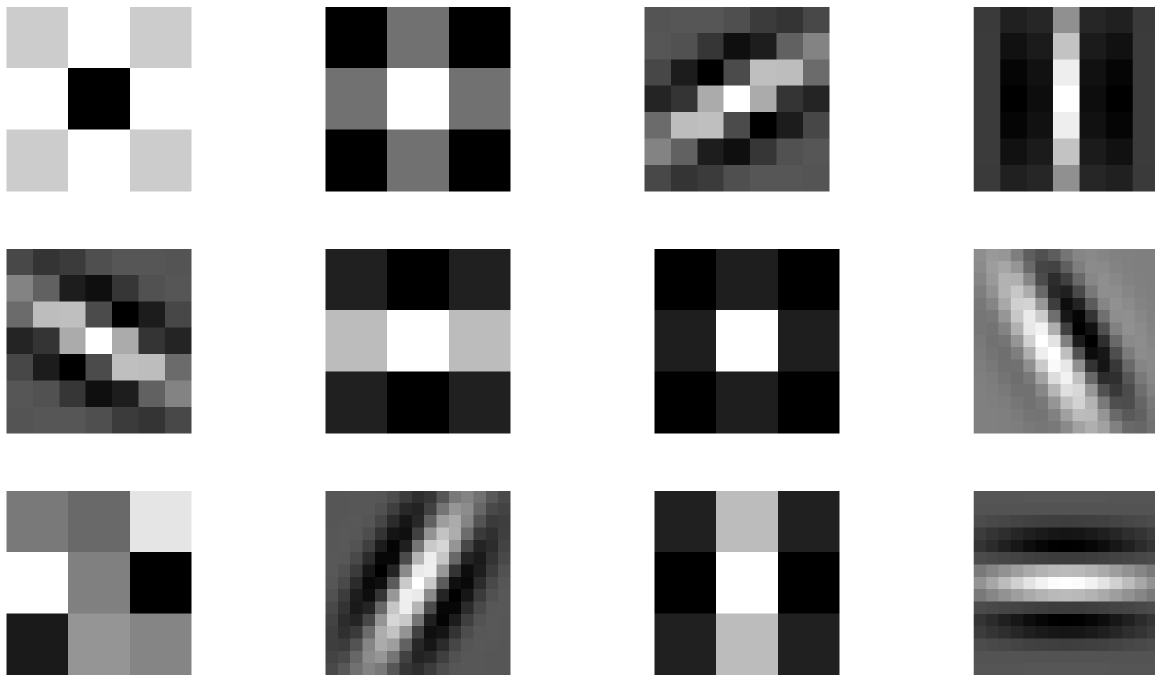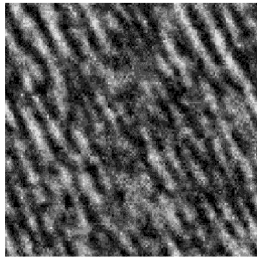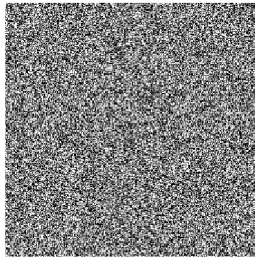

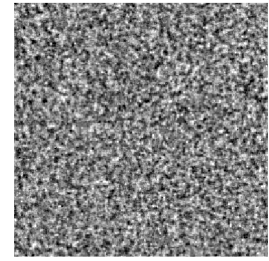**Figure 1:** The first 12 filters chosen

The synthesized images and the weighted error over iterations plot are shown below.

(a) Original
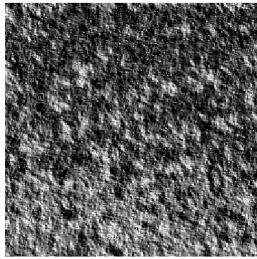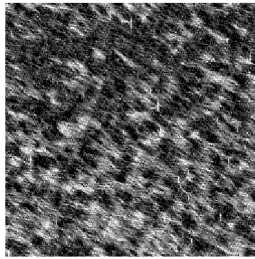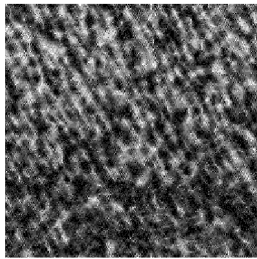

(b) 0 filter

(c) 1 filter
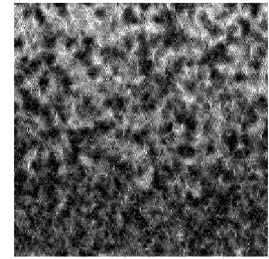
(d) 2 filter

(e) 3 filter
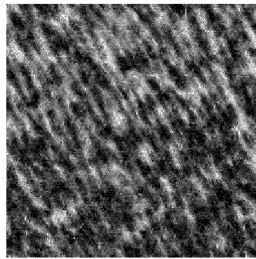
(f) 4 filter
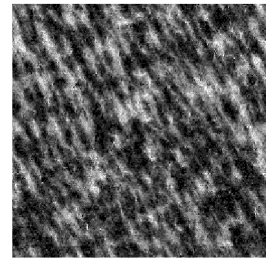
(g) 5 filter
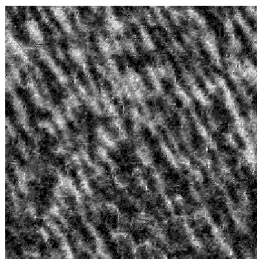
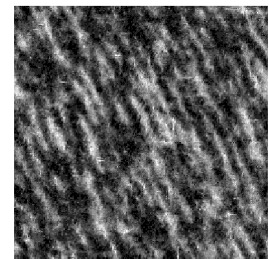**(h)** 6 filter

(i) 8 filter
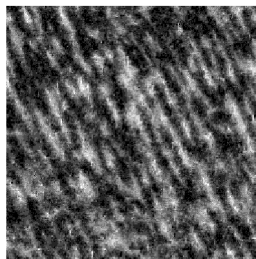
(j) 10 filter

(k) 15 filter

(l) 20 filter
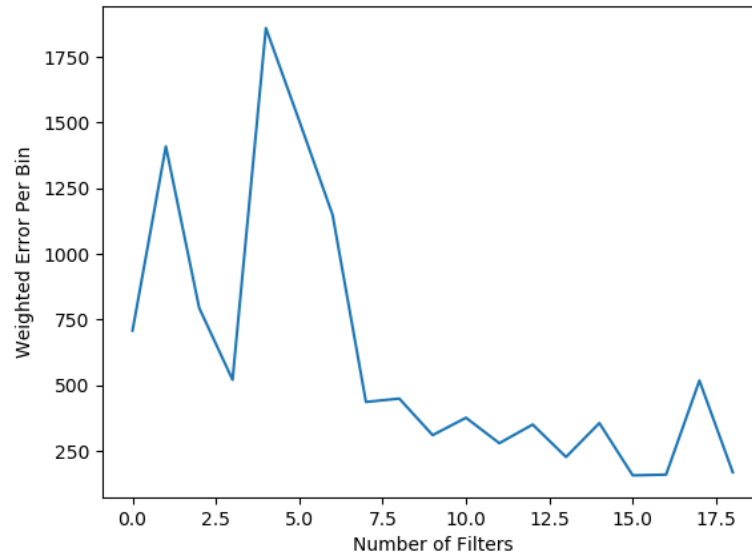
Figure 2: Synthesized fur texture

Figure 3: Error plot for fur texture

2. Grass

The selected filter indices are $[6, 13, 21, 43, 4, 16, 19, 38, 24, 12, 1, 3, 23, 17, 0, 27, 9, 11, 15, 22]$. The first several filters used are as following.
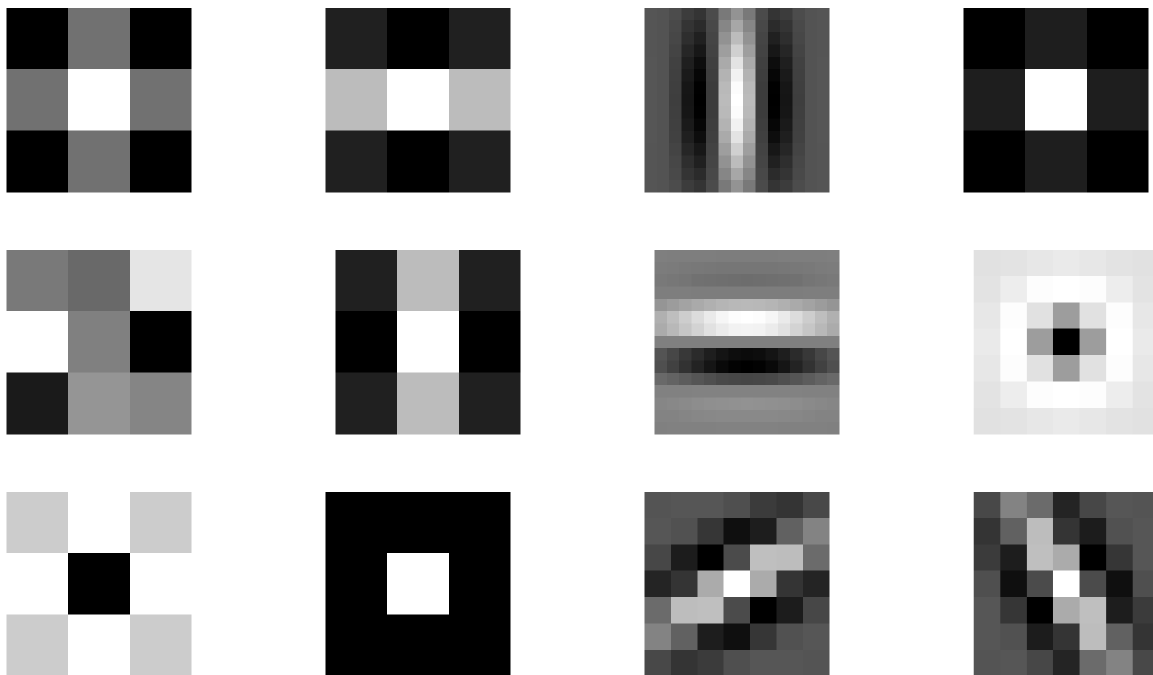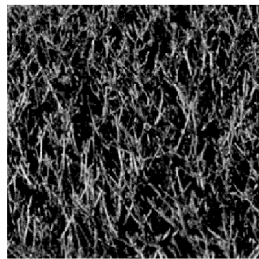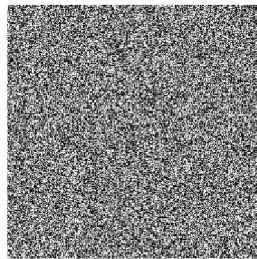

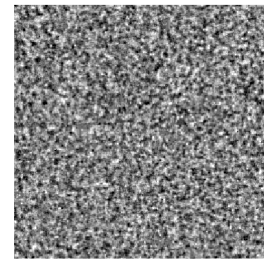**Figure 4:** The first 12 filters chosen

The synthesized images and the weighted error over iterations plot are shown below.

(a) Original
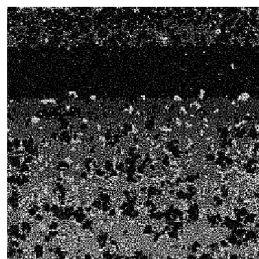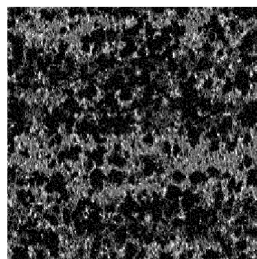
(b) 0 filter

(c) 1 filter
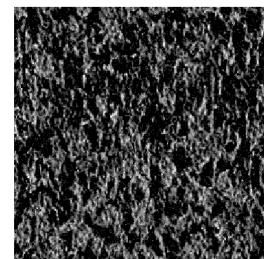
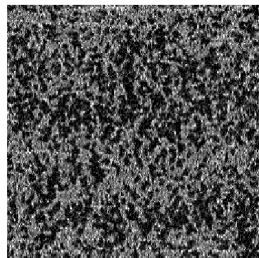**(d)** 2 filter

(e) 3 filter
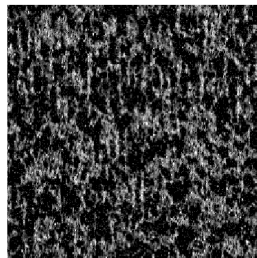
(f) 4 filter
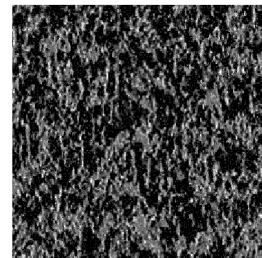
(g) 5 filter
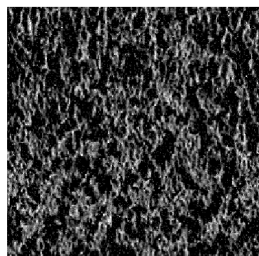
(h) 6 filter

(i) 8 filter

(j) 10 filter

(k) 15 filter

(l) 20 filter

Figure 5: Synthesized fur texture

Figure 6: Error plot for grass texture

3. Stucco

The selected filter indices are $[3, 6, 34, 13, 31, 10, 35, 18, 11, 47, 17, 39, 23, 16, 22, 36, 2, 1, 19, 45]$. The first several filters used are as following.

Figure 7: The first 12 filters chosen

The synthesized images and the weighted error over iterations plot are shown below.

(a) Original

(b) 0 filter
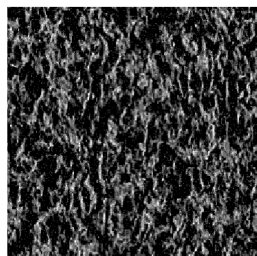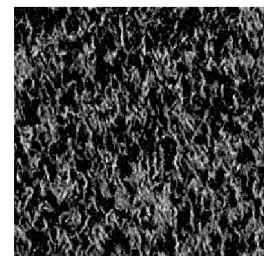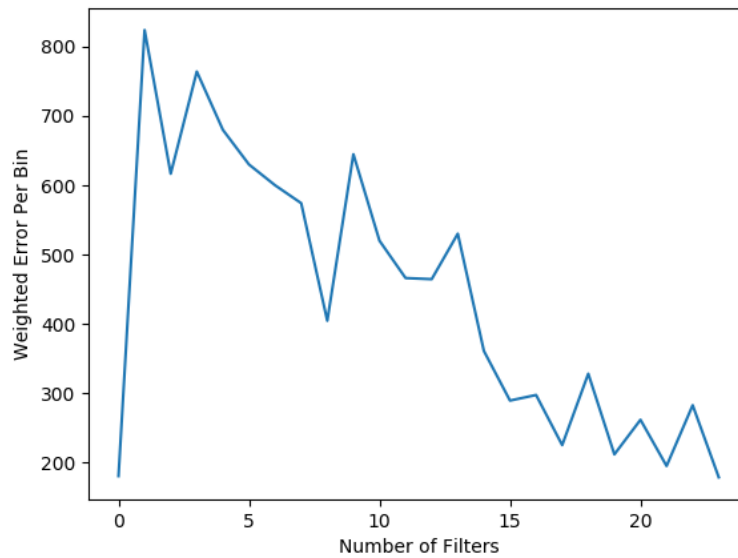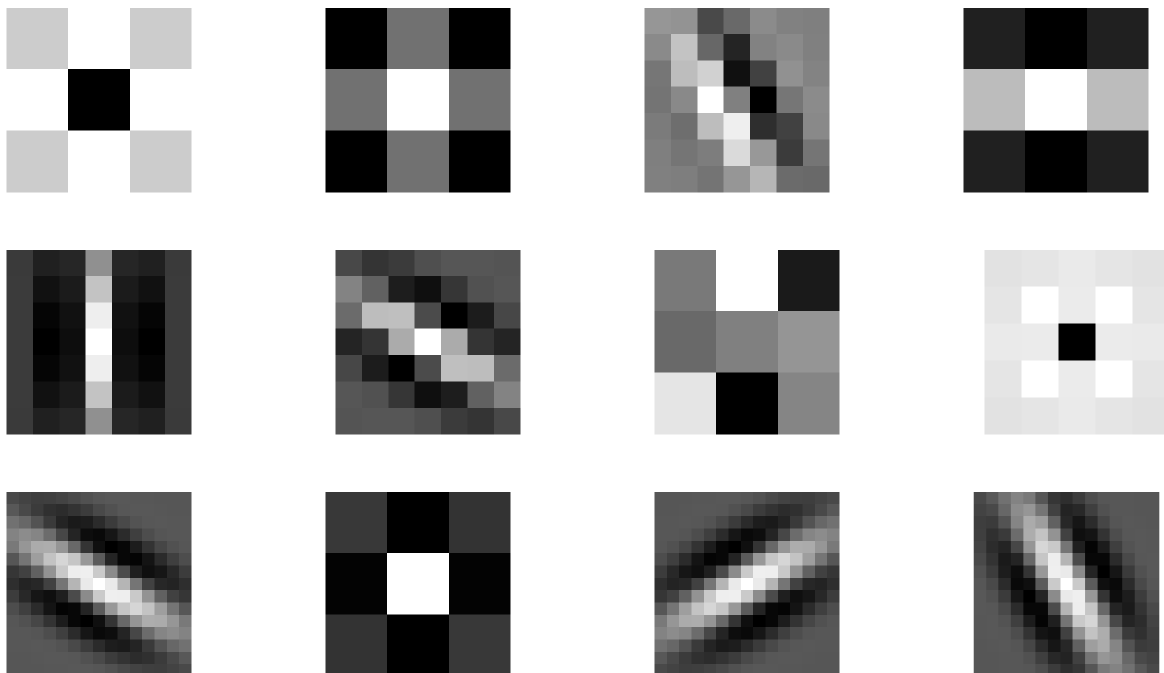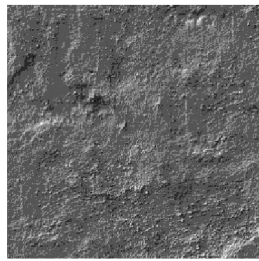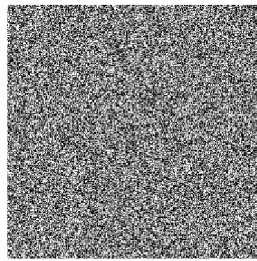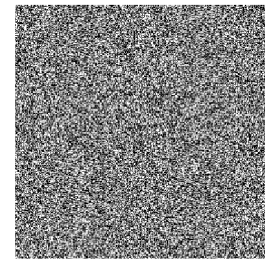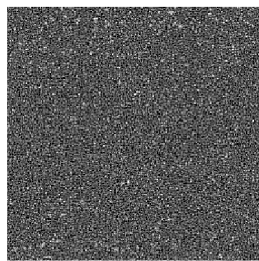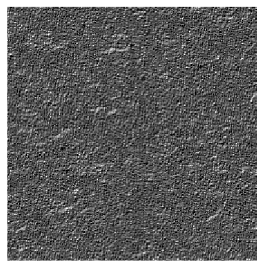
(c) 1 filter
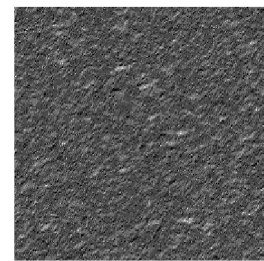
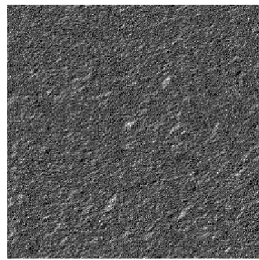**(d)** 2 filter

(e) 3 filter
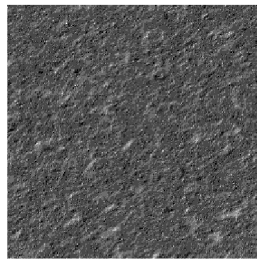
(f) 4 filter
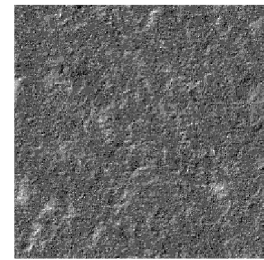
(g) 5 filter
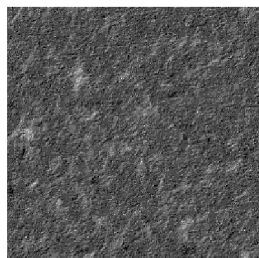
(h) 6 filter

(i) 8 filter
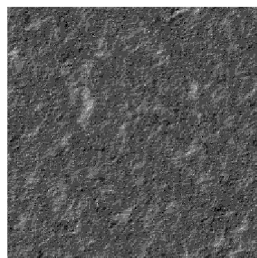
(j) 10 filter

(k) 15 filter
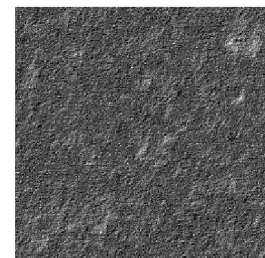
(l) 20 filter

Figure 8: Synthesized stucco texture
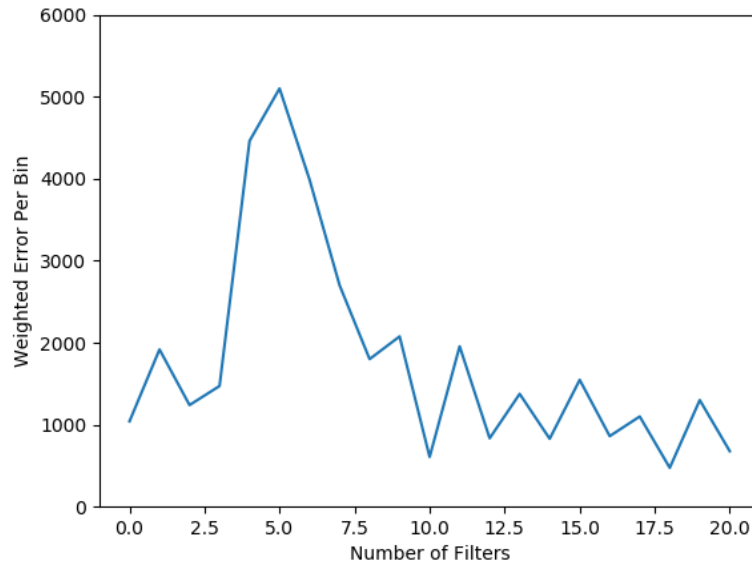
Figure 9: Error plot for stucco texture

Part 2

The bin number was chosen to be 15. I initialized the weights to 0 and updated them with a learning rate of 1. So the update formula is $\lambda^{(\alpha)} = \lambda^{(\alpha)} + \eta * (H_{syn}^{(\alpha)} - H_{obs}^{(\alpha)})$.

The selected filter indices are $[3, 6, 46, 11, 39, 13, 5, 4, 16, 45, 24, 0, 19, 33, 29, 41, 42, 18, 44, 23, 30, 21, 43, 10, 48]$. The first several filters used are as following.

Figure 10: The first 12 filters chosen

The synthesized images are shown below.

(a) Original

(b) 0 filter

(c) 1 filter

(d) 2 filter

(e) 3 filter

(f) 4 filter

(g) 5 filter

(h) 8 filter

(i) 10 filter

(j) 15 filter

(k) 20 filter

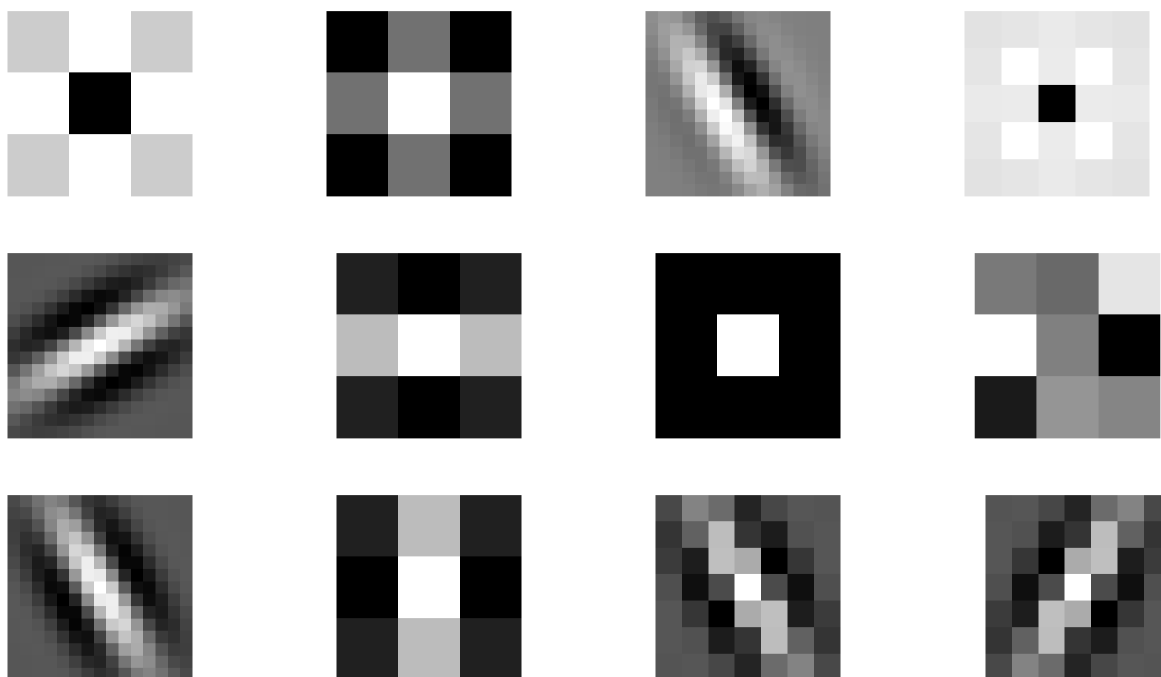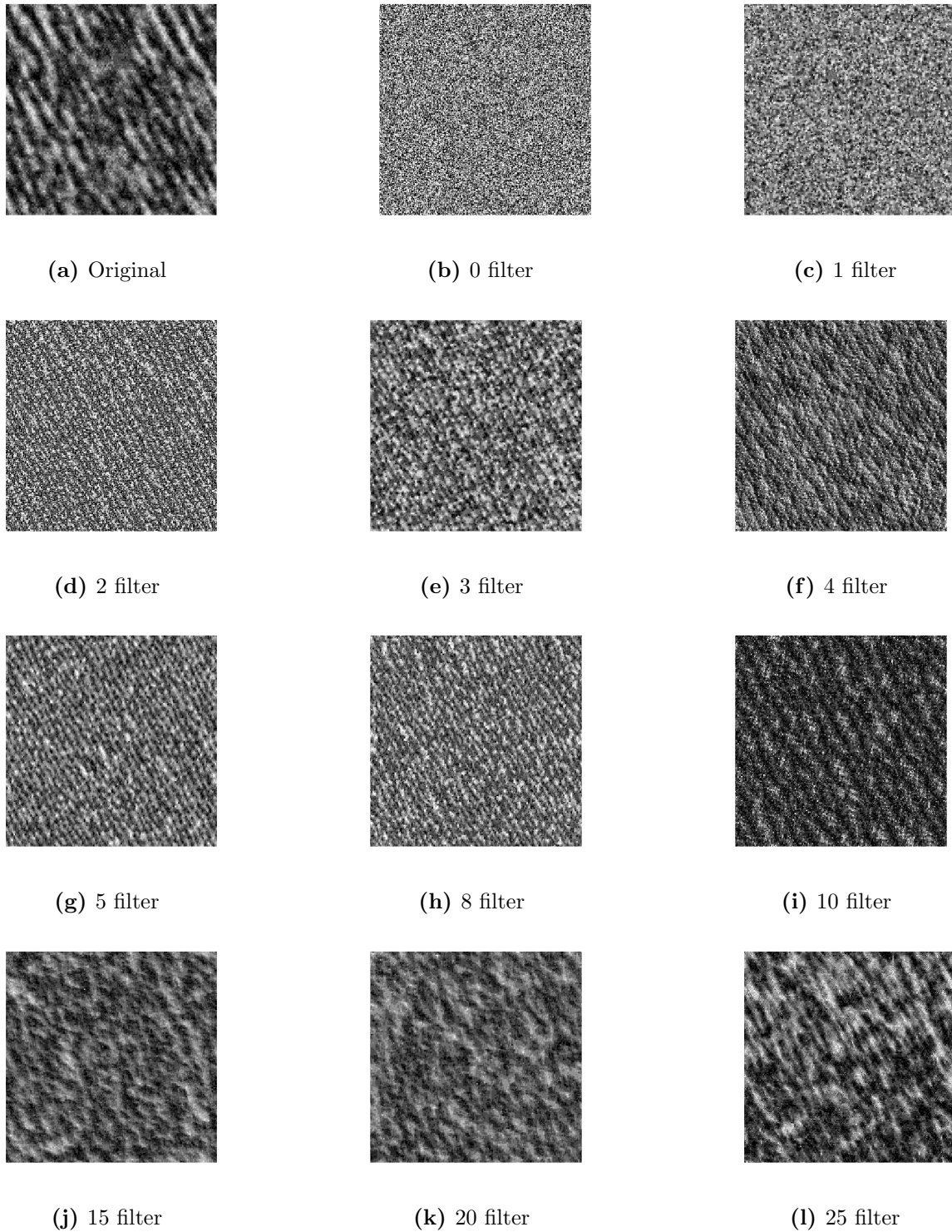

(l) 25 filter

Figure 11: Synthesized fur texture

I obtained weights of several different shapes during learning, which are presented below. The third filter (first one in figure 10) was selected first, and the weights evolved as following. The last plot is a superimposed plot across iterations.
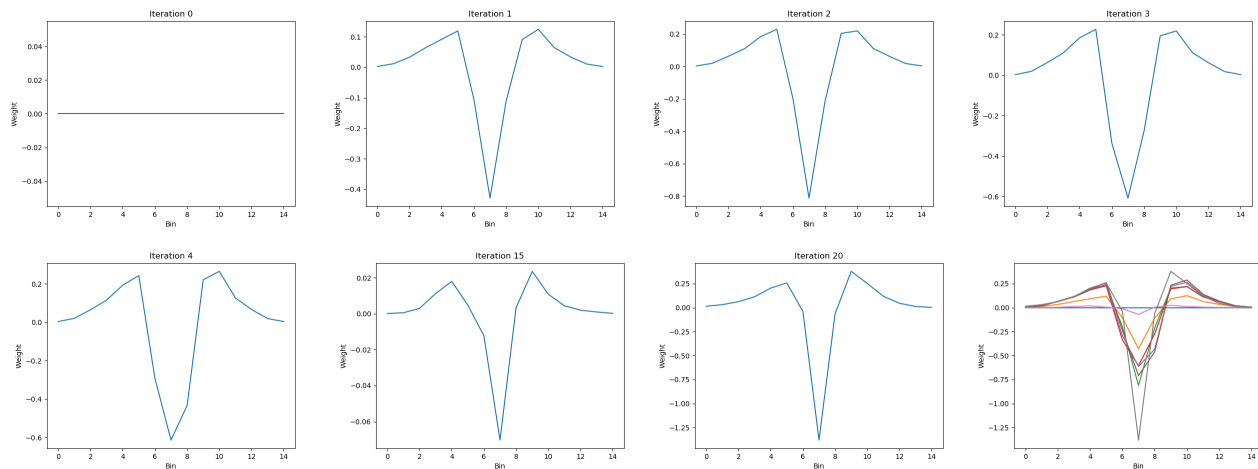
Figure 12: Weights for filter 3

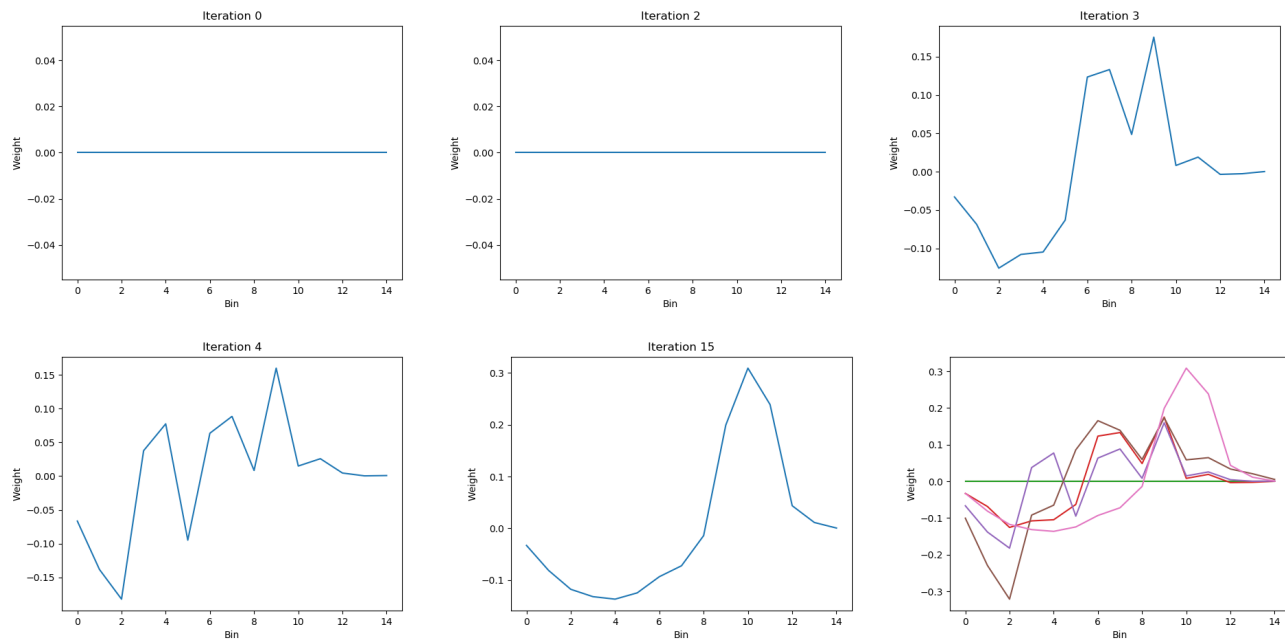Another example is filter 5, which was chosen in the third iteration.

Figure 13: Weights for filter 5
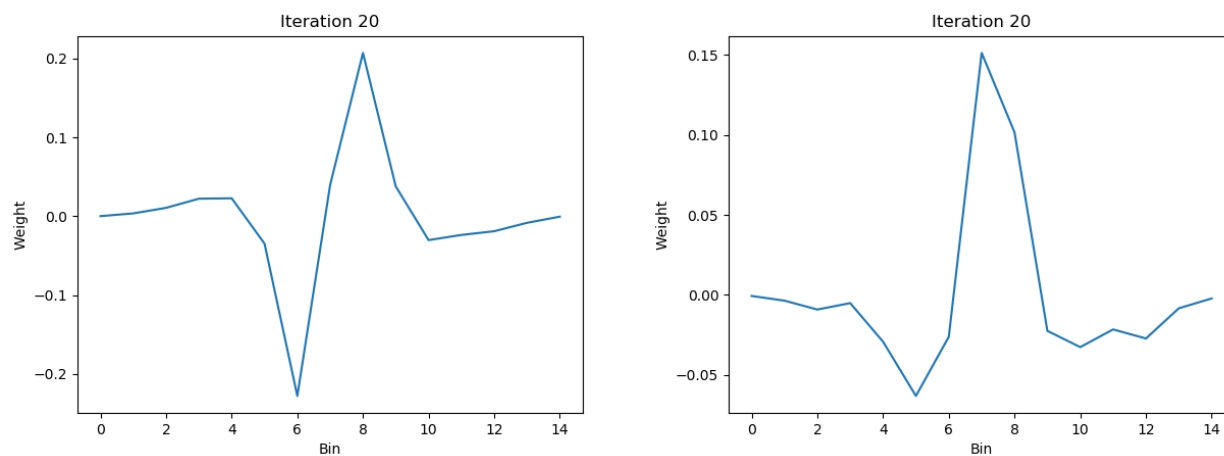
Some other typical shapes I got are:

Figure 14: Other weight shapes