1 Full Derivation of Outliers and Number of Clusters

1.1 Number of Clusters

$$D(X,K) = \sum_{x \in P(X)} d(x, \mu(X,K), \sigma(X,K)) \,. \tag{1}$$

The total description length of $P(X)$ with K different clusters is the description length of the model itself plus the description length of $P(X)$ under the model. The former requires specifying the means and covariances for each component, and so has description length

$$D(K) = Kd \log \left(\frac{a_{max} - a_{min}}{\epsilon} \right) + Kd^2 \log \left(\frac{a_{max} - a_{min}}{\epsilon} \right) , \tag{2}$$

where ϵ is, as above, our chosen precision with which to represent real numbers. Then, the full expression of the MDL-optimal number of clusters, K^* is

$$d(x, \mu, \Sigma) = -d \log \epsilon + \min \left(d \log(a_{max} - a_{min}), -\log(p(x, \mu, \Sigma) + \log \frac{N}{n_k} \right) \tag{3}$$

1.2 Outliers

When using the idea of indexing an ϵ-hypercube, as outlined in Section 3, the number of possible regions is

$$\left(\frac{a_{max} - a_{min}}{\epsilon} \right)^d ,$$

where d is the dimensionality of the data, and a_{max} and a_{min} are the maximum and minimum values, respectively, that appear anywhere in the image. The number of bits to specify a point directly is then

$$\log \left(\frac{a_{max} - a_{min}}{\epsilon} \right)^d = -d \log \epsilon + d \log(a_{max} - a_{min}). \tag{4}$$

Comparing to the description length in (**??**), a point is an outlier iff

$$-d \log \epsilon - \log(p(x, \mu, \Sigma) + \log K > -d \log \epsilon + d \log(a_{max} - a_{min}) \iff \tag{5}$$

$$-\log(p(x, \mu, \Sigma) + \log \frac{N}{n_k} > d \log(a_{max} - a_{min}) \iff \tag{6}$$

$$p(x, \mu, \Sigma) \frac{n_k}{K} < (a_{max} - a_{min})^{-d} , \tag{7}$$

2 Worked Examples

Here, we run through the steps, as described in Section 3, taken by our method when applied to some randomly selected input images. The second step is the key for processing white noise images, as MDL clustering consistently finds only 1 cluster at the first level, so the entropy there and at all higher layers, is zero.

2.1 Imagenet Chainsaw Image

Figure 1: Example of a relatively high resolution real-world image from imagenet. ID: n03000684_30692.

Layer 1

Num points to be clustered (pixels): 50000
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 4×4.
Num patch signatures: 48216
Num unique patch signatures: 1801
Entropy of categorical distribution of patch signatures: **6.42**

Layer 2

Num points to be clustered: 48216
Num components found by MDL: 8
Assign each point a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 8×8.
Num patch signatures: 44744
Num unique patch signatures: 3278
Entropy of categorical distribution of patch signatures: **7.32**

Layer 3

Num points to be clustered: 44744

Num components found by MDL: 8
Assign each point a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 16×16.
Num patch signatures: 38184
Num unique patch signatures: 7358
Entropy of categorical distribution of patch signatures: **11.07**

Layer 4

Num points to be clustered: 38184
Num components found by MDL: 8
Assign each point a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 32×32.
Num patch signatures: 26600
Num unique patch signatures: 7279
Entropy of categorical distribution of patch signatures: **12.73**

Total complexity: $6.42 + 7.32 + 11.07 + 12.73 = \mathbf{37.53}$

2.2 Imagenet Hang-Gliding Image

Figure 2: Example of a relatively high resolution real-world image from imagenet. ID: n03888257_2122.

Layer 1

Num points to be clustered (pixels): 50112
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 4×4.
Num patch signatures: 48316
Num unique patch signatures: 1001
Entropy of categorical distribution of patch signatures: **4.55**

Layer 2

Num points to be clustered: 48316
Num components found by MDL: 8
Assign each point a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 8×8.
Num patch signatures: 44820
Num unique patch signatures: 5875
Entropy of categorical distribution of patch signatures: **9.44**

Layer 3

Num points to be clustered: 44820
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 16×16.
Num patch signatures: 38212
Num unique patch signatures: 7788
Entropy of categorical distribution of patch signatures: **11.52**

Layer 4

Num points to be clustered: 38212
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 32×32.
Num patch signatures: 26532
Num unique patch signatures: 7505
Entropy of categorical distribution of patch signatures: **12.77**

Total complexity: $4.55 + 9.44 + 11.52 + 12.77 = \mathbf{38.28}$

2.3 Cifar Cat Image

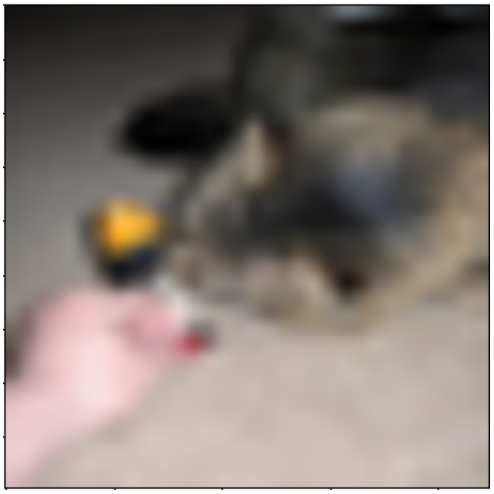

Figure 3: Example of a low-resolution, real-world image from CIFAR10.

Layer 1

Num points to be clustered (pixels): 50176
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 4×4.
Num patch signatures: 48400
Num unique patch signatures: 231
Entropy of categorical distribution of patch signatures: **4.54**

Layer 2

Num points to be clustered: 48400
Num components found by MDL: 8
Assign each point a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 8×8.
Num patch signatures: 44944
Num unique patch signatures: 2355
Entropy of categorical distribution of patch signatures: **7.56**

Layer 3

Num points to be clustered: 44944
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 16×16.
Num patch signatures: 36416
Num unique patch signatures: 6374

Entropy of categorical distribution of patch signatures: **10.61**

Layer 4

Num points to be clustered: 38212
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 32×32.
Num patch signatures: 26896
Num unique patch signatures: 7336
Entropy of categorical distribution of patch signatures: **12.59**

Total complexity: $4.54 + 7.56 + 10.61 + 12.59 = \mathbf{35.31}$

2.4 MNIST Four Image

Figure 4: Example of a low-resolution, greyscale handwritten digit from MNIST.

Layer 1

Num points to be clustered (pixels): 50176
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 4×4.
Num patch signatures: 48400
Num unique patch signatures: 417
Entropy of categorical distribution of patch signatures: **3.17**

Layer 2

Num points to be clustered: 48400
Num components found by MDL: 8
Assign each point a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 8×8.
Num patch signatures: 44944
Num unique patch signatures: 1776
Entropy of categorical distribution of patch signatures: **4.84**

Layer 3

Num points to be clustered: 44944
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 16×16.
Num patch signatures: 36416
Num unique patch signatures: 5499

Entropy of categorical distribution of patch signatures: **8.36**

Layer 4

Num points to be clustered: 38212
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 32×32.
Num patch signatures: 26896
Num unique patch signatures: 6730
Entropy of categorical distribution of patch signatures: **12.09**

Total complexity: $3.17 + 4.84 + 8.36 + 12.09 = \mathbf{28.46}$

2.5 DTD Fine Woven Texture

Figure 5: Example of a detailed, high-resolution, repetitive pattern from DTD2.

Layer 1

Num points to be clustered (pixels): 50290
Num components found by MDL: 8
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 4×4.
Num patch signatures: 48400
Num unique patch signatures: 7568
Entropy of categorical distribution of patch signatures: **12.16**

Layer 2

Num points to be clustered: 48400
Num components found by MDL: 8
Assign each point a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 8×8.
Num patch signatures: 44944
Num unique patch signatures: 13356
Entropy of categorical distribution of patch signatures: **13.70**

Layer 3

Num points to be clustered: 44944
Num components found by MDL: 1
Assign each pixel a label from $0, \ldots, 7$, and form patch signatures as multisets of labels inside all patches of size 16×16.
Num patch signatures: 36416
Num unique patch signatures: 1
Entropy of categorical distribution of patch signatures: **0**

Layer 4

All patch signatures are identical because only one cluster was found at the previous level. So the entropy is **0**.

Total complexity: $12.16 + 13.70 + 0 + 0 = \mathbf{25.87}$

Table 1: Comparison, on the scores produced by our method, of downsampling ImageNet to 32×32 .

	Level 1	Level 2	Level 3	Level 4	Total
full resolution	7.70 (1.75)	9.71 (1.99)	11.93 (1.75)	12.43 (1.98)	**41.77** (5.78)
low resolution	5.60 (0.73)	9.07 (1.43)	11.92 (1.14)	12.72 (0.58)	**39.03** (3.40)

3 Effect of Low Resolution

To investigate how much our method is affected by the resolution of the input image, we apply it to a downsampled ImageNet. We randomly select 100 of the 500 ImageNet images used for our main experiment, convert them to resolution 32×32. Table 1 compares the results of our method on these downsampled images compared to the full-sized ImageNet images, which are roughly 256×256. There is a slight drop on the lower levels of the hierarchy, which corresponds to the greater uniformity at the local scale in the blurry, low resolution images. The scores at the higher levels are essentially identical, and overall the scores are almost the same for the downsampled images as for the full-resolution images. This shows our method to changes in resolution, responding more to the contents of the image than to the resolution it is depicted at.

4 Synthetic Datasets: Further Details

As described in Section 4, we created three synthetic datasets to help test our method on a variety of images. The experimental results we report use 500 images sampled from these synthetic datasets. Here, we give the full details for the creation of these datasets. Code will also be released on publication.

4.1 Stripes

These images depict a repeated striped black-and-white pattern. The thickness of the lines, in pixels, is sampled uniformly at random from $[3, 10]$, and the slope of the lines is sampled uniformly at random from $[-0.5, -1.5]$. It is sufficient to consider negative slopes only as our method, and all methods that we compare to, are invariant to reflections, so the striped images with slope in $[0.5, 1.5]$ would receive identical scores to those in $[-0.5, -1.5]$. Note that our method is not necessarily invariant to rotations, because it is based on square, axis-aligned patches of pixels. The same is true of the fractal dimension computed with the Minkowski-Bouligand dimension (i.e., the fractal dimension), as it uses a box-counting method. Examples of Stripes images are shown in Figure 6.

4.2 Halves

These images have one half entirely black and the other entirely white, with the dividing line being at various angles. As with Stripes, the slope of this dividing

line is sampled uniformly at random from $[-0.5, -1.5]$. Examples are shown in Figure 7.

4.3 Rand

These images are white noise. Their values are sampled uniformly at random from $[0, 1]$, independently for each location and each of three colour channels. Examples are shown in Figure 8.

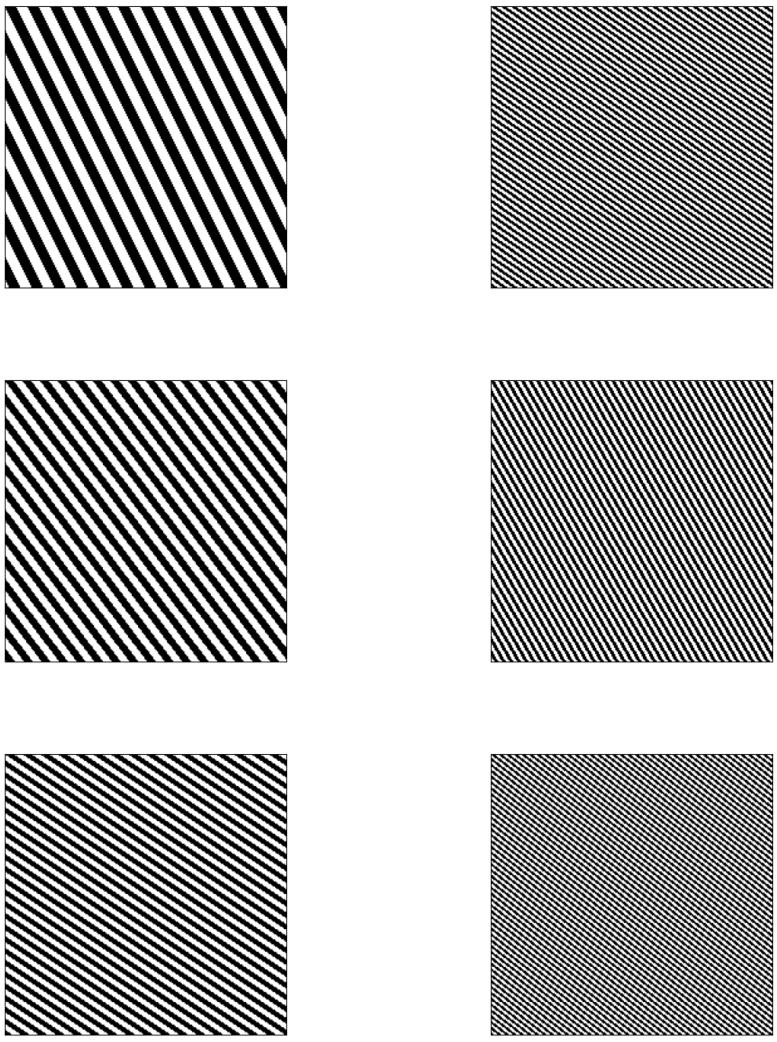

Figure 6: Examples of images from our synthetic Stripes dataset. Most existing methods assign theses images a high complexity. Ours assigns them low, but non-zero complexity.

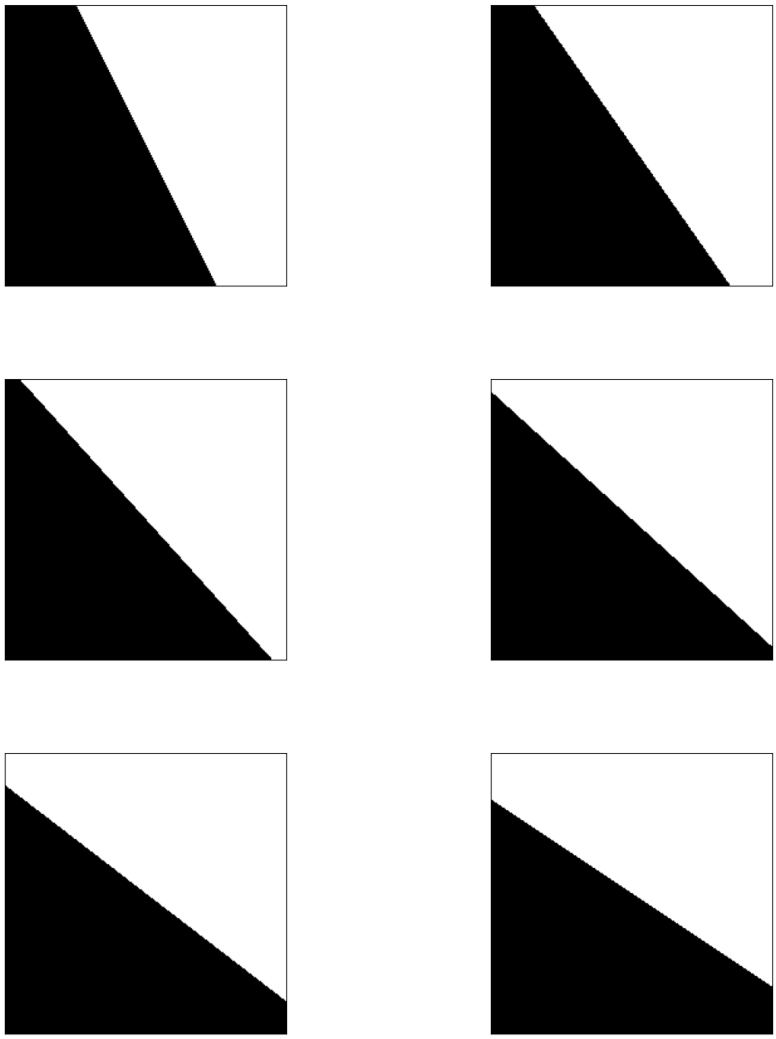

Figure 7: Examples of images from our synthetic Halves dataset. Our method assigns these low complexity as do existing methods. However, when we break our method down by scale, as discussed in Section 4, we see that it assigns some complexity at a high scale, more so than, e.g., Stripes, because there is some difference between different parts at a high scale, whereas in Stripes, both halves of each image are the same.

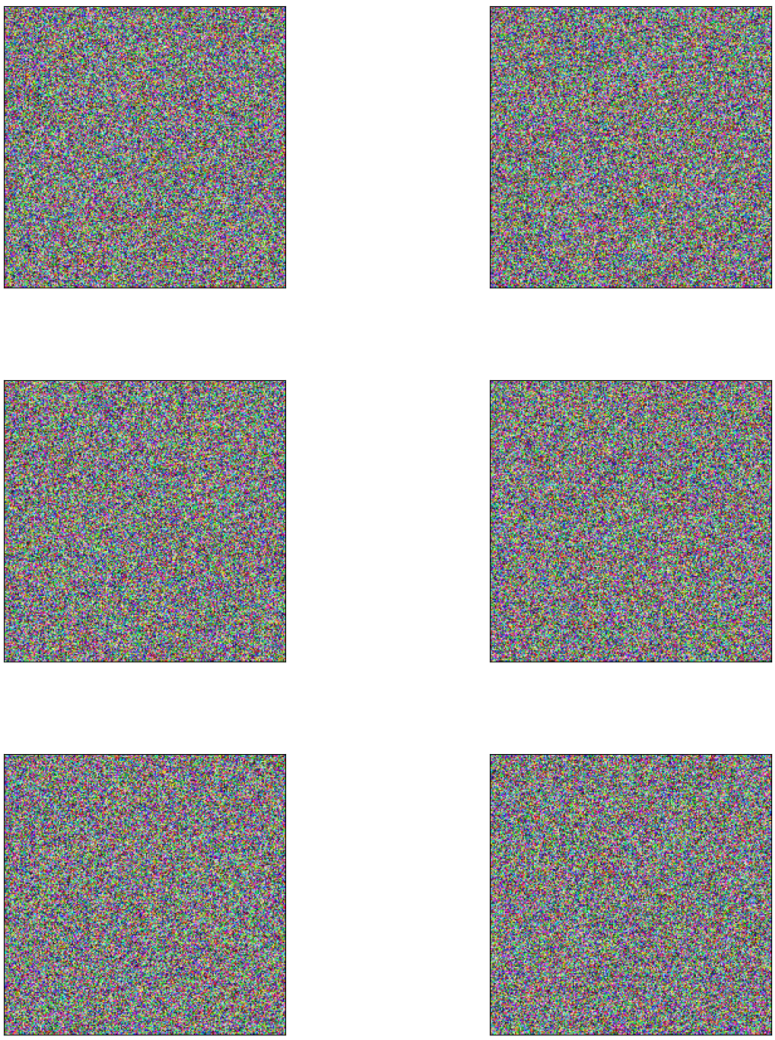

Figure 8: Examples of the white noise images we used in the Rand dataset. Existing complexity measures assign these images a very high complexity. Our method, in contrast, gives them all a zero complexity.

5 Images Used in Existing Datasets

For the experiments in Section 4, we randomly sample 1500 images from each of ImageNet, CiFAR, and MNIST. For DTD2, we manually search through all 5640 images in the original Describable Textures Dataset [1], and we find 341 images with fine detailed but repetitive textures. This section contains further information on the images used for each dataset.

5.1 ImageNet

All images are from the Imagenette subset of ImageNet. The list of labels that we present is taken from the Imagenette labels, available at https://s3.amazonaws.com/fast-ai-imageclas/imagenette2.tgz. Most of the images IDs are of the form <wordnet-synset-id> - <index-within-synset>. Some instead use the class label from the 2012 version of ILSVRC.

- n03394916 - 50642.
- n02979186 - 10250.
- n03028079 - 14492.
- n03888257 - 36631.
- n03445777 - 3291.
- n03425413 - 14940.
- n03417042 - 19472.
- n03000684 - 9440.
- n01440764 - 16090.
- ILSVRC2012-00023440.
- n03394916 - 39102.
- n02979186 - 24592.
- n03028079 - 25712.
- n03888257 - 16542.
- n03445777 - 12262.
- n03425413 - 17220.
- n03417042 - 3351.
- n03000684 - 32351.
- n01440764 - 21191.
- n02102040 - 1782.
- n03394916 - 46700.
- n02979186 - 17680.
- n03028079 - 7422.
- n03888257 - 25150.
- n03445777 - 5582.
- n03425413 - 8801.
- n03417042 - 25411.
- n03000684 - 20052.
- n01440764 - 5361.
- n02102040 - 2930.
- n03394916 - 43381.
- n02979186 - 20620.
- n03028079 - 16811.
- n03888257 - 21201.
- n03445777 - 11171.
- n03425413 - 13581.
- n03417042 - 6420.
- ILSVRC2012-00045501.

- n01440764 - 16192.
- n02102040 - 5890.
- n03394916 - 43532.
- n02979186 - 9910.
- ILSVRC2012-00004912.
- n03888257 - 22330.
- n03445777 - 10762.
- n03425413 - 11061.
- n03417042 - 9620.
- n03000684 - 16872.
- n01440764 - 6812.
- n02102040 - 3452.
- n03394916 - 32870.
- n02979186 - 23650.
- n03028079 - 27781.
- n03888257 - 20300.
- n03445777 - 6091.
- n03425413 - 20371.
- n03417042 - 3771.
- n03000684 - 10992.
- n01440764 - 13842.
- n02102040 - 6851.
- n03394916 - 11582.
- n02979186 - 18720.
- n03028079 - 29062.
- n03888257 - 18441.
- n03445777 - 520.
- n03425413 - 21180.
- n03417042 - 4072.
- n03000684 - 9452.
- n01440764 - 14150.
- n02102040 - 652.
- n03394916 - 36000.
- n02979186 - 1810.
- n03028079 - 4612.
- n03888257 - 7921.
- n03445777 - 5932.
- n03425413 - 12711.
- n03417042 - 4462.
- n03000684 - 661.
- n01440764 - 9152.
- n02102040 - 7942.
- n03394916 - 36172.
- n02979186 - 13740.
- n03028079 - 9920.
- n03888257 - 36390.
- n03445777 - 6162.
- n03425413 - 12951.
- n03417042 - 2150.
- n03000684 - 10690.
- n01440764 - 14342.
- n02102040 - 5942.
- n03394916 - 43422.
- n02979186 - 13442.
- n03028079 - 34051.
- n03888257 - 46870.
- n03445777 - 13480.

- n03425413 - 20751.
- n03417042 - 5920.
- n03000684 - 18020.
- n01440764 - 7982.
- n02102040 - 182.
- n03394916 - 42721.
- n02979186 - 11971.
- n03028079 - 10191.
- n03888257 - 19580.
- n03445777 - 1390.
- n03425413 - 13862.
- n03417042 - 18582.
- ILSVRC2012-00045940.
- n01440764 - 1561.
- n02102040 - 4090.
- n03394916 - 33380.
- n02979186 - 2002.
- n03028079 - 9682.
- n03888257 - 9770.
- n03445777 - 11162.
- n03425413 - 15321.
- n03417042 - 14000.
- n03000684 - 15441.
- n01440764 - 16051.
- n02102040 - 6552.
- n03394916 - 59361.
- n02979186 - 9811.
- n03028079 - 29942.
- n03888257 - 20352.
- n03445777 - 2611.
- n03425413 - 11180.
- n03417042 - 26782.
- n03000684 - 7222.
- n01440764 - 19302.
- ILSVRC2012-00036282.
- n03394916 - 62451.
- n02979186 - 140.
- n03028079 - 49281.
- n03888257 - 14530.
- n03445777 - 5240.
- n03425413 - 21730.
- n03417042 - 12790.
- n03000684 - 13402.
- n01440764 - 4360.
- n02102040 - 352.
- n03394916 - 46672.
- n02979186 - 1542.
- n03028079 - 15392.
- n03888257 - 10680.
- n03445777 - 17492.
- n03425413 - 16220.
- n03417042 - 7080.
- n03000684 - 16291.
- n01440764 - 2921.
- n02102040 - 8061.
- n03394916 - 30072.
- n02979186 - 5321.

- n03028079 - 17690.
- n03888257 - 70632.
- n03445777 - 9572.
- n03425413 - 1672.
- n03417042 - 4761.
- n03000684 - 18591.
- n01440764 - 8030.
- n02102040 - 5641.
- n03394916 - 50730.
- n02979186 - 8861.
- ILSVRC2012-00016542.
- n03888257 - 3651.
- n03445777 - 5312.
- n03425413 - 21362.
- n03417042 - 8822.
- n03000684 - 19272.
- n01440764 - 6421.
- n02102040 - 960.
- n03394916 - 26422.
- n02979186 - 3260.
- n03028079 - 6110.
- n03888257 - 33021.
- n03445777 - 15810.
- n03425413 - 8661.
- n03417042 - 21361.
- n03000684 - 2820.
- n01440764 - 650.
- n02102040 - 1791.
- n03394916 - 52191.
- n02979186 - 14630.
- n03028079 - 6722.
- n03888257 - 142.
- n03445777 - 11150.
- n03425413 - 20500.
- n03417042 - 27630.
- n03000684 - 15521.
- n01440764 - 6130.
- n02102040 - 491.
- n03394916 - 71910.
- n02979186 - 8092.
- n03028079 - 5942.
- n03888257 - 11222.
- n03445777 - 2530.
- n03425413 - 602.
- n03417042 - 5221.
- n03000684 - 1970.
- n01440764 - 13702.
- n02102040 - 3450.
- n03394916 - 35320.
- n02979186 - 16142.
- n03028079 - 14992.
- n03888257 - 37362.
- n03445777 - 6042.
- n03425413 - 12712.
- n03417042 - 26850.
- n03000684 - 180.
- n01440764 - 12881.

- n02102040 - 4111.
- n03394916 - 16601.
- n02979186 - 4511.
- n03028079 - 5432.
- n03888257 - 64711.
- n03445777 - 7711.
- n03425413 - 17212.
- n03417042 - 5510.
- n03000684 - 19890.
- n01440764 - 27422.
- n02102040 - 651.
- n03394916 - 54570.
- n02979186 - 11.
- n03028079 - 16731.
- n03888257 - 13410.
- n03445777 - 7090.
- n03425413 - 13970.
- n03417042 - 27862.
- n03000684 - 2340.
- n01440764 - 3782.
- n02102040 - 290.
- n03394916 - 59430.
- n02979186 - 26820.
- n03028079 - 3600.
- n03888257 - 12401.
- n03445777 - 1750.
- n03425413 - 14302.
- n03417042 - 28552.
- n03000684 - 11511.
- n01440764 - 20451.
- n02102040 - 371.
- n03394916 - 47852.
- n02979186 - 3472.
- n03028079 - 8572.
- n03888257 - 14901.
- n03445777 - 3301.
- n03425413 - 14510.
- n03417042 - 2141.
- n03000684 - 31112.
- n01440764 - 2102.
- n02102040 - 2572.
- n03394916 - 38680.
- n02979186 - 1200.
- n03028079 - 17922.
- n03888257 - 15382.
- n03445777 - 13462.
- n03425413 - 20121.
- n03417042 - 15592.
- n03000684 - 31721.
- n01440764 - 32420.
- n02102040 - 1830.
- n03394916 - 35811.
- n02979186 - 12072.
- n03028079 - 46322.
- n03888257 - 28581.
- n03445777 - 602.
- n03425413 - 32871.

- n03417042 - 18042.
- n03000684 - 6220.
- n01440764 - 17501.
- n02102040 - 7392.
- n03394916 - 36361.
- n02979186 - 22761.
- n03028079 - 24471.
- n03888257 - 13790.
- n03445777 - 7930.
- n03425413 - 21040.
- n03417042 - 1330.
- n03000684 - 1542.
- n01440764 - 8302.
- n02102040 - 6081.
- n03394916 - 27071.
- n02979186 - 5781.
- ILSVRC2012-00034021.
- n03888257 - 38102.
- n03445777 - 16321.
- n03425413 - 20562.
- n03417042 - 4560.
- n03000684 - 6471.
- n01440764 - 762.
- n02102040 - 2110.
- n03394916 - 44882.
- n02979186 - 5481.
- n03028079 - 9220.
- n03888257 - 19211.
- n03445777 - 14301.
- n03425413 - 19050.
- n03417042 - 6691.
- n03000684 - 2972.
- n01440764 - 10040.
- n02102040 - 430.
- n03394916 - 46391.
- n02979186 - 13281.
- n03028079 - 16820.
- n03888257 - 30712.
- n03445777 - 14232.
- n03425413 - 21562.
- n03417042 - 29412.
- n03000684 - 13182.
- n01440764 - 10852.
- n02102040 - 5101.
- n03394916 - 29940.
- n02979186 - 2841.
- n03028079 - 23280.
- n03888257 - 23192.
- n03445777 - 2041.
- n03425413 - 14570.
- n03417042 - 20280.
- n03000684 - 8411.
- n01440764 - 7492.
- n02102040 - 6532.
- n03394916 - 28590.
- n02979186 - 560.
- n03028079 - 38692.

- n03888257 - 23571.
- n03445777 - 13680.
- ILSVRC2012-00000732.
- n03417042 - 18551.
- n03000684 - 34440.
- n01440764 - 522.
- ILSVRC2012-00008162.
- n03394916 - 1091.
- n02979186 - 10151.
- n03028079 - 12802.
- n03888257 - 171.
- n03445777 - 7670.
- n03425413 - 21202.
- n03417042 - 9601.
- ILSVRC2012-00029211.
- n01440764 - 5432.
- n02102040 - 4732.
- n03394916 - 292.
- n02979186 - 5460.
- n03028079 - 3700.
- n03888257 - 35800.
- n03445777 - 9921.
- n03425413 - 21911.
- n03417042 - 5090.
- n03000684 - 19211.
- n01440764 - 8601.
- n02102040 - 7841.
- n03394916 - 27932.
- n02979186 - 3161.
- n03028079 - 29012.
- n03888257 - 17340.
- n03445777 - 10782.
- n03425413 - 11161.
- n03417042 - 29722.
- n03000684 - 1490.
- n01440764 - 4962.
- n02102040 - 7792.
- n03394916 - 47110.
- n02979186 - 16952.
- n03028079 - 28242.
- n03888257 - 29762.
- n03445777 - 230.
- n03425413 - 3021.
- n03417042 - 10462.
- n03000684 - 2060.
- n01440764 - 6301.
- n02102040 - 2480.
- n03394916 - 44580.
- n02979186 - 20362.
- n03028079 - 3492.
- n03888257 - 30412.
- n03445777 - 13831.
- n03425413 - 20301.
- n03417042 - 10280.
- n03000684 - 16861.
- n01440764 - 9212.
- n02102040 - 6152.

- n03394916 - 34332.
- n02979186 - 14251.
- n03028079 - 9320.
- n03888257 - 35890.
- n03445777 - 5131.
- n03425413 - 16221.
- n03417042 - 5381.
- n03000684 - 3470.
- n01440764 - 8142.
- n02102040 - 762.
- n03394916 - 51071.
- n02979186 - 20160.
- n03028079 - 25542.
- n03888257 - 57010.
- n03445777 - 261.
- n03425413 - 7731.
- n03417042 - 3821.
- ILSVRC2012-00047060.
- n01440764 - 12971.
- n02102040 - 1300.
- n03394916 - 7292.
- n02979186 - 23362.
- n03028079 - 10020.
- ILSVRC2012-00038942.
- n03445777 - 11690.
- n03425413 - 13100.
- n03417042 - 6811.
- n03000684 - 20762.
- n01440764 - 11350.
- n02102040 - 1822.
- n03394916 - 33012.
- n02979186 - 1061.
- n03028079 - 16660.
- n03888257 - 38200.
- n03445777 - 10671.
- n03425413 - 6772.
- n03417042 - 1492.
- n03000684 - 24991.
- n01440764 - 7462.
- n02102040 - 362.
- n03394916 - 26802.
- n02979186 - 3530.
- n03028079 - 80.
- n03888257 - 66102.
- n03445777 - 8192.
- ILSVRC2012-00035211.
- n03417042 - 10300.
- n03000684 - 16072.
- n01440764 - 8451.
- n02102040 - 3260.
- ILSVRC2012-00025761.
- n02979186 - 5031.
- n03028079 - 10241.
- n03888257 - 12400.
- n03445777 - 6201.
- n03425413 - 260.
- n03417042 - 2062.

- n03000684 - 27850.
- n01440764 - 9491.
- n02102040 - 821.
- n03394916 - 32340.
- n02979186 - 1932.
- n03028079 - 26291.
- n03888257 - 9552.
- n03445777 - 101.
- n03425413 - 1792.
- n03417042 - 18152.
- n03000684 - 5041.
- n01440764 - 4980.
- n02102040 - 3532.
- n03394916 - 6742.
- n02979186 - 22882.
- n03028079 - 25462.
- n03888257 - 8381.
- n03445777 - 5382.
- n03425413 - 13232.
- n03417042 - 9170.
- n03000684 - 17330.
- n01440764 - 6361.
- n02102040 - 142.
- n03394916 - 51161.
- n02979186 - 15931.
- n03028079 - 28662.
- n03888257 - 12070.
- n03445777 - 10401.
- n03425413 - 4511.
- n03417042 - 1601.
- n03000684 - 10212.
- n01440764 - 7752.
- n02102040 - 1110.
- n03394916 - 38212.
- n02979186 - 1621.
- n03028079 - 2060.
- n03888257 - 7610.
- n03445777 - 7902.
- n03425413 - 21211.
- n03417042 - 3390.
- n03000684 - 11821.
- n01440764 - 8221.
- n02102040 - 350.
- n03394916 - 37321.
- n02979186 - 2312.
- n03028079 - 16501.
- n03888257 - 11081.
- n03445777 - 471.
- n03425413 - 24461.
- n03417042 - 6272.
- n03000684 - 6460.
- n01440764 - 7160.
- n02102040 - 3112.
- n03394916 - 33221.
- n02979186 - 15972.
- n03028079 - 9112.
- n03888257 - 7130.

- n03445777 - 8861.
- n03425413 - 14552.
- n03417042 - 2960.
- n03000684 - 5231.
- n01440764 - 16072.
- n02102040 - 672.

5.2 DTD2

The Describable Textures Dataset contains 47 classes, grouped according to texture: bumpy, dotted, lined, veined etc. The image ids below are of the form <class-id> - <index-within-class>. Unsurprisingly, most of the suitable images, i.e., those with detailed repeating textures, are from classes such as 'woven', 'grid', or 'wrinkled'. The number of images of each class is given below.

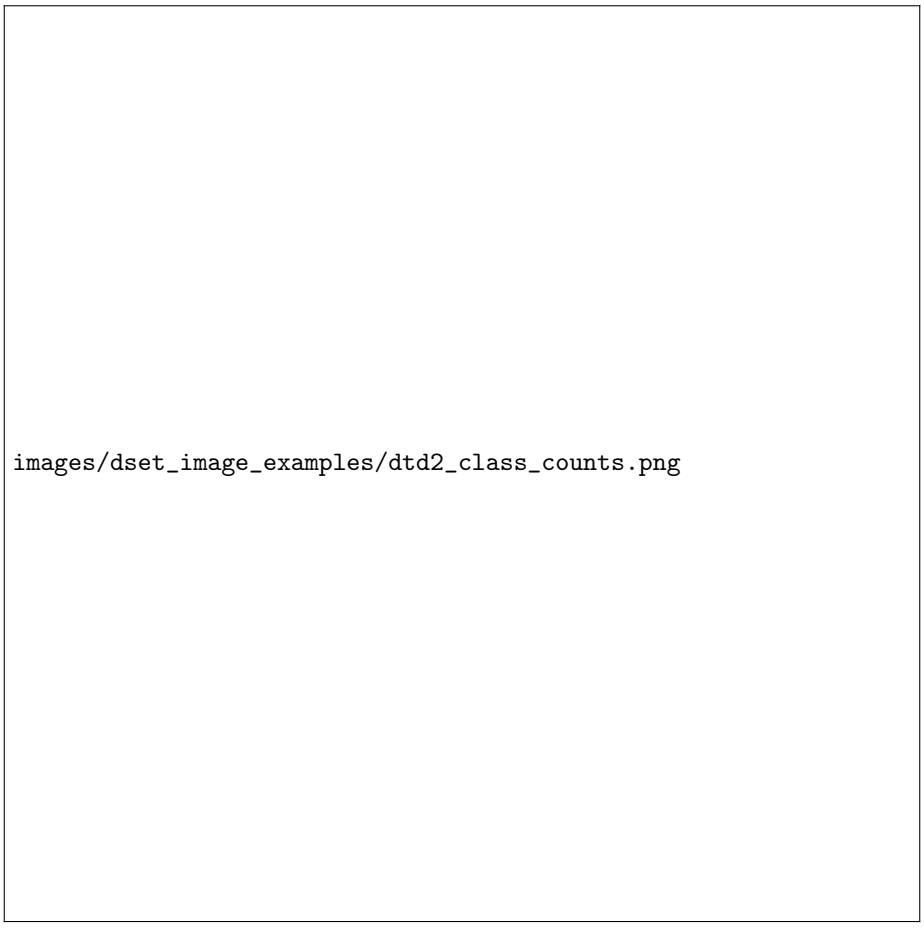

Figure 9: Number of images of each class from DTD that we select to be part of our curated dataset, DTD2. We select images that show a detailed, repeating pattern, meaning some types of textures are much more likely to be selected.

- perforated - 0074.
- meshed - 0164.
- dotted - 0164.
- sprinkled - 0066.
- porous - 0117.
- woven - 0106.
- knitted - 0185.
- crosshatched - 0081.
- pleated - 0163.
- banded - 0046.
- wrinkled - 0129.
- banded - 0055.
- braided - 0008.
- grooved - 0119.
- dotted - 0131.
- wrinkled - 0015.
- bumpy - 0098.
- woven - 0004.
- zigzagged - 0109.
- matted - 0136.
- stratified - 0174.
- grooved - 0051.
- perforated - 0014.
- grooved - 0089.
- woven - 0025.
- wrinkled - 0106.
- lined - 0159.
- banded - 0008.
- matted - 0070.
- lined - 0109.
- dotted - 0192.
- fibrous - 0138.
- matted - 0150.
- pleated - 0142.
- grid - 0088.
- blotchy - 0038.
- chequered - 0043.
- banded - 0081.
- wrinkled - 0063.
- waffled - 0156.
- grid - 0073.
- grid - 0016.
- lacelike - 0078.
- matted - 0071.
- chequered - 0050.
- wrinkled - 0132.
- porous - 0149.
- stained - 0119.
- knitted - 0118.
- pleated - 0116.
- stained - 0066.
- knitted - 0144.
- chequered - 0062.
- grooved - 0085.
- blotchy - 0091.
- knitted - 0150.
- grid - 0124.

- pleated - 0168.
- zigzagged - 0133.
- grooved - 0058.
- zigzagged - 0008.
- stained - 0132.
- blotchy - 0088.
- bumpy - 0067.
- grid - 0049.
- woven - 0062.
- blotchy - 0059.
- matted - 0069.
- lined - 0133.
- woven - 0075.
- bubbly - 0097.
- matted - 0073.
- porous - 0151.
- blotchy - 0083.
- chequered - 0052.
- wrinkled - 0041.
- lacelike - 0096.
- matted - 0085.
- fibrous - 0150.
- banded - 0122.
- waffled - 0124.
- fibrous - 0164.
- grid - 0083.
- fibrous - 0193.
- dotted - 0060.
- meshed - 0176.
- woven - 0043.
- woven - 0088.
- stained - 0090.
- wrinkled - 0045.
- pleated - 0090.
- zigzagged - 0085.
- veined - 0135.
- dotted - 0132.
- stratified - 0046.
- woven - 0061.
- woven - 0028.
- swirly - 0074.
- matted - 0065.
- sprinkled - 0065.
- waffled - 0068.
- grooved - 0048.
- perforated - 0066.
- grid - 0022.
- woven - 0053.
- porous - 0152.
- fibrous - 0160.
- woven - 0055.
- matted - 0148.
- pitted - 0134.
- flecked - 0060.
- lacelike - 0020.
- grid - 0052.
- woven - 0067.

- knitted - 0192.
- flecked - 0053.
- chequered - 0054.
- chequered - 0088.
- lined - 0027.
- stained - 0030.
- knitted - 0146.
- grid - 0078.
- blotchy - 0070.
- swirly - 0060.
- perforated - 0057.
- porous - 0098.
- wrinkled - 0087.
- blotchy - 0096.
- grooved - 0081.
- wrinkled - 0039.
- lined - 0041.
- flecked - 0126.
- lined - 0038.
- dotted - 0135.
- pitted - 0036.
- wrinkled - 0103.
- wrinkled - 0034.
- grid - 0050.
- bubbly - 0083.
- woven - 0001.
- knitted - 0116.
- pleated - 0069.
- wrinkled - 0043.
- woven - 0059.
- knitted - 0079.
- matted - 0128.
- lacelike - 0017.
- fibrous - 0165.
- wrinkled - 0088.
- grid - 0129.
- blotchy - 0090.
- wrinkled - 0017.
- sprinkled - 0038.
- woven - 0032.
- flecked - 0074.
- woven - 0029.
- knitted - 0130.
- crosshatched - 0092.
- lacelike - 0065.
- knitted - 0141.
- grid - 0011.
- porous - 0099.
- woven - 0039.
- woven - 0113.
- fibrous - 0211.
- sprinkled - 0067.
- wrinkled - 0125.
- crosshatched - 0093.
- dotted - 0154.
- woven - 0130.
- veined - 0075.

- meshed - 0181.
- fibrous - 0103.
- fibrous - 0183.
- woven - 0082.
- woven - 0099.
- perforated - 0041.
- grid - 0099.
- grooved - 0084.
- meshed - 0162.
- wrinkled - 0036.
- banded - 0147.
- porous - 0157.
- wrinkled - 0108.
- dotted - 0185.
- grid - 0089.
- grid - 0101.
- woven - 0048.
- grid - 0066.
- bumpy - 0190.
- matted - 0166.
- woven - 0104.
- waffled - 0171.
- wrinkled - 0040.
- flecked - 0135.
- swirly - 0151.
- stratified - 0115.
- perforated - 0045.
- woven - 0026.
- fibrous - 0111.
- swirly - 0065.
- perforated - 0026.
- banded - 0107.
- woven - 0068.
- banded - 0037.
- fibrous - 0204.
- wrinkled - 0026.
- waffled - 0178.
- woven - 0108.
- grooved - 0164.
- woven - 0021.
- fibrous - 0127.
- banded - 0141.
- scaly - 0131.
- woven - 0123.
- braided - 0167.
- woven - 0046.
- grooved - 0057.
- perforated - 0024.
- swirly - 0137.
- grid - 0081.
- bubbly - 0118.
- grooved - 0108.
- wrinkled - 0079.
- flecked - 0003.
- fibrous - 0120.
- wrinkled - 0114.
- woven - 0083.

- fibrous - 0110.
- wrinkled - 0067.
- lined - 0169.
- wrinkled - 0025.
- wrinkled - 0021.
- wrinkled - 0013.
- dotted - 0041.
- woven - 0049.
- lined - 0076.
- scaly - 0122.
- grid - 0059.
- waffled - 0081.
- matted - 0117.
- fibrous - 0101.
- stained - 0075.
- woven - 0036.
- wrinkled - 0086.
- wrinkled - 0084.
- banded - 0047.
- banded - 0068.
- matted - 0155.
- perforated - 0080.
- pitted - 0078.
- pitted - 0008.
- fibrous - 0089.
- sprinkled - 0068.
- woven - 0084.
- grooved - 0093.
- woven - 0056.
- pitted - 0064.
- wrinkled - 0046.
- woven - 0109.
- banded - 0086.
- grid - 0084.
- grid - 0116.
- woven - 0038.
- pleated - 0082.
- bumpy - 0140.
- wrinkled - 0111.
- matted - 0115.
- fibrous - 0096.
- woven - 0093.
- swirly - 0144.
- banded - 0059.
- lined - 0141.
- woven - 0003.
- banded - 0114.
- woven - 0002.
- woven - 0127.
- knitted - 0126.
- banded - 0115.
- woven - 0051.
- lined - 0166.
- bubbly - 0084.
- flecked - 0165.
- wrinkled - 0105.
- woven - 0114.

- woven - 0126.
- grooved - 0063.
- wrinkled - 0083.
- grooved - 0088.
- grid - 0032.
- wrinkled - 0065.
- grid - 0067.
- perforated - 0016.
- meshed - 0108.
- blotchy - 0082.
- grooved - 0045.
- swirly - 0147.
- grooved - 0068.
- woven - 0065.
- grid - 0085.
- blotchy - 0089.
- wrinkled - 0085.
- woven - 0107.
- stratified - 0100.
- fibrous - 0201.
- scaly - 0137.
- woven - 0071.
- perforated - 0119.
- swirly - 0138.
- grooved - 0083.
- matted - 0072.
- grid - 0093.
- chequered - 0093.
- knitted - 0098.
- matted - 0084.
- pitted - 0010.
- porous - 0053.
- matted - 0129.
- woven - 0066.
- crosshatched - 0109.
- wrinkled - 0033.
- pitted - 0157.
- porous - 0142.
- woven - 0092.
- crosshatched - 0116.
- swirly - 0159.
- grid - 0082.
- banded - 0099.
- meshed - 0112.
- knitted - 0155.
- woven - 0112.
- meshed - 0161.
- banded - 0061.
- bubbly - 0055.
- woven - 0063.
- bubbly - 0096.
- blotchy - 0041.
- banded - 0002.
- woven - 0007.
- banded - 0090.
- pleated - 0094.